ahdm

HP 8656B SYNTHESIZED SIGNAL GENERATOR 0.1–990 MHz (Including Options 001 and 002)

SERIAL NUMBERS

This manual provides complete information for instruments with serial-number prefixes:

2425A to 2649A

rev.20OCT87

Information for MAJOR changes is also provided for instruments with serial-number prefixes not listed in the above range.

NOTE

Use this manual only with instruments that have an "A" in their serial-number prefix.

First Edition

EAST 24001 MISSION AVENUE, TAF C-34, SPOKANE, WASHINGTON, U.S.A., 99220

Service Manual Part (Volumes 2, 3) 08656-90205

Other Documents Availlable:
Operation and Calibration Manual Part (Volume 1) 08656-90204
Microfiche Operation and Calibration Manual Part 08656-90213
Microfiche Service Manual Part 08656-90214

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SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

This section contains information for ordering parts. Table 6-1 lists reference designations, and Table 6-2 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers.

6-2. ABBREVIATIONS

Table 6-2 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are used, one all in capitals letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-3. REPLACEABLE PARTS LIST

Table 6-3 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumeric order by reference designation.
b. Chassis-mounted parts in alphanumeric order by reference designation.
c. Mechanical parts.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.
b. Part number check digit (CD).
c. The total quantity (Qty) for the entire instrument except for option assemblies.
d. The description of the part.
e. A typical manufacturer of the part in a fivedigit code.
f. The manufacturer's number for the part.

NOTE

The total quantity for each part is given only once, that is, at the first occurrence of the part number in the list. The total quantities for optional assemblies are totalled by assembly and not integrated into the standard list.

6-4. FACTORY SELECTED PARTS (*)

Parts marked with an asterisk (*) are factory selected parts. The value listed in the parts list is the nominal value. Refer to Sections V and VIII of this manual for information on determining what value to use for replacement.

6-5. PARTS LIST UPDATING (MANUAL UPDATES)

Production changes to the Signal Generator made after the publication date of this manual are accompanied by a change in the serial number prefix. Changes to the parts list are recorded by serial number prefix on an addition or replacement page(s). The MANUAL UPDATE pages can be ordered by filling out and returning the DOCUMENTATION UPDATE SERVICE REQUEST reply card found in the beginning of this manual.

6-6. ILLUSTRATED PARTS BREAKDOWNS

Most mechanical parts are identified in Figures 6-1 through 6-8. These figures are located at the end of the replaceable parts table.

6-7. ORDERING INFORMATION

To order a part listed in the replaceable parts table, include the Hewlett-Packard part number (with the check digit) and the quantity required. Address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, description and function of the part, and the quantity of parts required. Address the order to the nearest Hewlett-Packard office.

NOTE

Within the USA, it is better to order directly from the HP Parts Center in Mountain View, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System".

6-8. RECOMMENDED SPARES LIST

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard has prepared a "Recommended Spares" list for this instrument. The contents of the list are based on failure reports and repair data. Quantities given are for one year of parts support. A complimentary copy of the "Recommended Spares" list may be requested from your nearest Hewlett-Packard office.

When stocking parts to support more than one Signal Generator or to support a variety of Hewlett-Packard instruments, it may be more economical to work from one consolidated list rather than simply adding together stocking quantities from the individual instrument lists. Hewlett-Packard will prepare consolidated "Recommended Spares" lists for any number or combination of instruments. Contact your nearest Hewlett-Packard office for details.

Table 6-1. Reference Designations

REFERENCE DESIGNATIONS

A	assembly
AT	attenuator; isolator; termination
B	fan; motor
BT	battery
C	capacitor
CP	coupler
CR	diode; diode thyristor; varactor
DC	directional coupler
DL	delay line
DS	annunciator; signaling device (audible or visual); lamp; LED
E	miscellaneous electrical part
F	fuse
FL	filter
H	hardware
HY	circulator
J	electrical connector (stationary portion); jack
K	relay
L	coil; inductor
M	meter
MP	miscellaneous mechanical part
P	electrical connector (movable portion); plug
Q	transistor; SCR; triode thyristor; FET
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
U	integrated circuit; microcircuit
V	electron tube
VR	voltage regulator; breakdown diode
W	cable; transmission path; wire
X	socket
Y	crystal unit (piezo-electric or quartz)
Z	tuned cavity; tuned circuit

Table 6-2. Abbreviations (1 of 2)

ABBREVIATIONS

A	ampere
ac	alternating current
ACCESS	accessory
ADJ	adjustment
A/D	analog-to-digital
AF	audio frequency
AFC	automatic frequency control
AGC	automatic gain control
AL	aluminum
ALC	automatic level control
AM	amplitude modulation
AMPL	amplifier
APC	automatic phase control
ASSY	assembly
AUX	auxiliary
avg	average
AWG	American wire gauge
BAL	balance
BCD	binary coded decimal
BD	board
BECU	beryllium copper
BFO	beat frequency oscillator
BH	binder head
BKDN	breakdown
BP	bandpass
BPF	bandpass filter
BRS	brass
BWO	backware-wave oscillator
CAL	calibrate
ccw	counter-clockwise
CER	ceramic
CHAN	channel
cm	centimeter
CMO	cabinet mount only
COAX	coaxial
COEF	coefficient
COM	common
COMP	composition
COMPL	complete
CONN	connector
CP	cadmium plate
CRT	cathode-ray tube
CTL	complementary transistor logic
CW	continuous wave
cw	clockwise
cm	centimeter
D/A	digital-to-analog
dB	decibel
dBm	decibel referred to 1 mW
dc	direct current
deg	degree (temperature interval or difference)
...°	degree (plane angle)
°C	degree Celsius (centigrade)
°F	degree Fahrenheit
°K	degree Kelvin
DEPC	deposited carbon
DET	detector
diam	diameter
DIA	diameter (used in parts list)
DIFF AMPL	differential amplifier
div	division
DPDT	double-pole, double-throw
DR	drive
DSB	double sideband
DTL	diode transistor logic
DVM	digital voltmeter
ECL	emitter coupled logic
EMF	electromotive force
EDP	electronic data processing
ELECT	electrolytic
ENCAP	encapsulated
EXT	external
F	farad
FET	field-effect transistor
F/F	flip-flop
FH	flat head
FIL H	fillister head
FM	frequency modulation
FP	front panel
FREQ	frequency
FXD	fixed
g	gram
GE	germanium
GHz	gigahertz
GL	glass
GRD	ground(ed)
H	henry
h	hour
HET	heterodyne
HEX	hexagonal
HD	head
HDW	hardware
HF	high frequency
HG	mercury
HI	high
HP	Hewlett-Packard
HPF	high pass filter
HR	hour (used in parts list)
HV	high voltage
Hz	Hertz
IC	integrated circuit
ID	inside diameter
IF	intermediate frequency
IMPG	impregnated
in	incandescent
INCL	include(s)
INP	input
INS	insulation
INT	internal
kg	kilogram
kHz	kilohertz
k	kilohm
kV	kilovolt
lb	pound
LC	inductance-capacitance
LED	light-emitting diode
LF	low frequency
LG	long
LH	left hand
LIM	limit
LIN	linear taper (used in parts list)
LK WASH	lock washer
LO	low; local oscillator
LOG	logarithmic taper (used in parts list)
log	logarithm(ic)
LPF	low pass filter
LV	low voltage
m	meter (distance)
mA	milliampere
MAX	maximum
M	megohm
MEG	meg (10^6) (used in parts list)
MET FLM	metal film
MET OX	metallic oxide
MF	medium frequency; microfarad (used in parts list)
MFR	manufacturer
mg	milligram
MHz	megahertz
mH	millihenry
mho	mho
min	minute (time)
...′	minute (plane angle)
MINAT	miniature
mm	millimeter

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-2. Abbreviations (2 of 2)

MOD .... modulator
MOM .... momentary
MOS .... metal-oxide semiconductor
ms .... millisecond
MTG .... mounting
MTR .... meter (indicating device)
mV .... millivolt
mVac .... millivolt, ac
mVdc .... millivolt, dc
mVpk .... millivolt, peak
mVp-p .... millivolt, peak-to-peak
mVrms .... millivolt, rms
mW .... milliwatt
MUX .... multiplex
MY .... mylar
μA .... microampere
μF .... microfarad
μH .... microhenry
μmho .... micromho
μs .... microsecond
μV .... microvolt
μVac .... microvolt, ac
μVdc .... microvolt, dc
μVpk .... microvolt, peak
μVp-p .... microvolt, peak-to-peak
μVrms .... microvolt, rms
μW .... microwatt
nA .... nanoampere
NC .... no connection
N/C .... normally closed
NE .... neon
NEG .... negative
nF .... nanofarad
NI PL .... nickel plate
N/O .... normally open
NOM .... nominal
NORM .... normal
NPN .... negative-positive-negative
NPO .... negative-positive zero (zero temperature coefficient)
NRFR .... not recommended for field replacement
NSR .... not separately replaceable
ns .... nanosecond
nW .... nanowatt
OBD .... order by description
OD .... outside diameter
OH .... oval head
OP AMPL .... operational amplifier
OPT .... option
OSC .... oscillator
OX .... oxide
oz .... ounce
Ω .... ohm
P .... peak (used in parts list)
PAM .... pulse-amplitude modulation
PC .... printed circuit
PCM .... pulse-code modulation; pulse-count modulation
PDM .... pulse-duration modulation
pF .... picofarad
PH BRZ .... phosphor bronze
PHL .... Phillips
PIN .... positive-intrinsic-negative
PIV .... peak inverse voltage
pk .... peak
PL .... phase lock
PLO .... phase lock oscillator
PM .... phase modulation
PNP .... positive-negative-positive
P/O .... part of
POLY .... polystyrene
PORC .... porcelain
POS .... positive; position(s) (used in parts list)
POSN .... position
POT .... potentiometer
p-p .... peak-to-peak
PP .... peak-to-peak (used in parts list)
PPM .... pulse-position modulation
PREAMPL .... preamplifier
PRF .... pulse-repetition frequency
PRR .... pulse repetition rate
ps .... picosecond
PT .... point
PTM .... pulse-time modulation
PWM .... pulse-width modulation
PWV .... peak working voltage
RC .... resistance-capacitance
RECT .... rectifier
REF .... reference
REG .... regulated
REPL .... replaceable
RF .... radio frequency
RFI .... radio frequency interference
RH .... round head; right hand
RLC .... resistance-inductance-capacitance
RMO .... rack mount only
rms .... root-mean-square
RND .... round
ROM .... read-only memory
R&P .... rack and panel
RWV .... reverse working voltage
S .... scattering parameter
s .... second (time)
..." .... second (plane angle)
S-B .... slow-blow (fuse) (used in parts list)
SCR .... silicon controlled rectifier; screw
SE .... selenium
SECT .... sections
SEMICON .... semiconductor
SHF .... superhigh frequency
SI .... silicon
SIL .... silver
SL .... slide
SNR .... signal-to-noise ratio
SPDT .... single-pole, double-throw
SPG .... spring
SR .... split ring
SPST .... single-pole, single-throw
SS .... Service Sheet
SSB .... single sideband
SST .... stainless steel
STL .... steel
SQ .... square
SWR .... standing-wave ratio
SYNC .... synchronize
T .... timed (slow-blow fuse)
TA .... tantalum
TC .... temperature compensating
TD .... time delay
TERM .... terminal
TFT .... thin-film transistor
TGL .... toggle
THD .... thread
THRU .... through
TI .... titanium
TOL .... tolerance
TRIM .... trimmer
TSTR .... transistor
TTL .... transistor-transistor logic
TV .... television
TVI .... television interference
TWT .... traveling wave tube
U .... micro (10^{-6}) (used in parts list)
UF .... microfarad (used in parts list)
UHF .... ultrahigh frequency
UNDEF .... undefined
UNREG .... unregulated
V .... volt
VA .... voltampere
Vac .... volts, ac
VAR .... variable
VCO .... voltage-controlled oscillator
Vdc .... volts, dc
VDCW .... volts, dc, working (used in parts list)
V(F) .... volts, filtered
VFO .... variable-frequency oscillator
VHF .... very-high frequency
Vpk .... volts, peak
Vp-p .... volts, peak-to-peak
Vrms .... volts, rms
VSWR .... voltage standing wave ratio
VTO .... voltage-tune oscillator
VTVM .... vacuum-tube voltmeter
V(X) .... volts, switched
W .... watt
W/ .... with
WIV .... working inverse voltage
WW .... wirewound
W/O .... without
YIG .... yttrium-iron-garnet
Z_o .... characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1						
A1	08656-60134	1	1	KEYBOARD ASSEMBLY	28480	08656-60134
A1J1	1251-5923	0	1	CONNECTOR 14-PIN M POST TYPE	28480	1251-5923
A1S1	5060-9436	7	48	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1805	8	1	KEY HALF V	28480	5041-1805
A1S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1793	3	1	KEY HALF SEQ	28480	5041-1793
A1S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1806	9	1	KEY HALF MV	28480	5041-1806
A1S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1789	7	1	KEY HALF STORE	28480	5041-1789
A1S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1807	0	1	KEY HALF MICRO V	28480	5041-1807
A1S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1790	0	1	KEY HALF RECALL	28480	5041-1790
A1S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1792	2	1	KEY HALF LOCAL	28480	5041-1792
A1S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2887	8	1	KEY HF RF ON/OFF	28480	5041-2887
A1S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1796	6	1	KEY HALF MHZ	28480	5041-1796
A1S10	5060-9436	.		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1802	5	1	KEY HALF DBM	28480	5041-1802
A1S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1795	5	1	KEY HALF KHZ	28480	5041-1795
A1S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1803	6	1	KEY HALF DBF	28480	5041-1803
A1S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1800	3	1	KEY HALF %	28480	5041-1800
A1S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1801	4	1	KEY HALF DB	28480	5041-1801
A1S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1813	8	1	KEY HALF ARRW H	28480	5041-1813
A1S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1804	7	1	KEY HALF EMF	28480	5041-1804
A1S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1786	4	1	KEY HALF 8	28480	5041-1786
A1S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1784	2	2	KEY HALF 6	28480	5041-1784
A1S19	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1783	1	1	KEY HALF 5	28480	5041-1783
A1S20	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1784	2		KEY HALF 6	28480	5041-1784
A1S21	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1780	8	1	KEY HALF 2	28480	5041-1780
A1S22	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1781	9	1	KEY HALF 3	28480	5041-1781
A1S23	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1787	5	1	KEY HALF (DECIMAL POINT)	28480	5041-1787
A1S24	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1788	6	1	KEY HALF (MINUS SIGN)	28480	5041-1788
A1S25	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1814	9	1	KEY HALF AMPTD	28480	5041-1814
A1S26	5060-9436	7		PUSHBUTTON SWITCH P.C MOUNT	28480	5060-9436
	5041-1785	3	1	KEY HALF 7	28480	5041-1785
A1S27	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1	8	KEY HALF ARRW DN	28480	5041-2856
A1S28	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1782	0	1	KEY HALF 4	28480	5041-1782
A1S29	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S30	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1779	5	1	KEY HALF 1	28480	5041-1779

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1S31	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1815	0	1	KEY SDF INCR SET	28480	5041-1815
A1S32	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1778	4	1	KEY HALF 0	28480	5041-1778
A1S33	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1627	2	1	KEY FULL BK FM	28480	5041-1627
A1S34	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1630	7	1	KEY F DBL FREQ	28480	5041-1630
A1S35	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S36	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1808	1	1	KEY HALF COARSE TUNE	28480	5041-1808
A1S37	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S38	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S39	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1809	2	1	KEY HALF FINE TUNE	28480	5041-1809
A1S40	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S41	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1794	4	1	KEY HALF EXT	28480	5041-1794
A1S42	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1628	3	1	KEY FULL BK AM	28480	5041-1628
A1S43	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1810	5	1	KEY HALF INT 400HZ	28480	5041-1810
A1S44	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856
A1S45	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1811	6	1	KEY HALF INT 1 KHZ	28480	5041-1811
A1S46	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-4537	9	1	KEY HALF SHIFT	28480	5041-4537
A1S47	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1797	7	1	KEY HALF OFF	28480	5041-1797
A1S48	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-2856	1		KEY HALF ARRW DN	28480	5041-2856

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2						
2511A AND ABOVE A2	08656-60176	1	1	DISPLAY ASSEMBLY	28480	08656-60176
2425A TO 2509A A2	08656-60126	1	1	DISPLAY ASSEMBLY	28480	08656-60126
A2C1	0180-0100	3	3	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A2C2	0160-4832	4	23	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C4	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C5	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C8	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C12	0160-4831	3	1	CAPACITOR-FXD 4700PF +-10% 100VDC CER	28480	0160-4831
A2C13	0160-4822	2	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
2425A TO 2509A A2DS1-2	1990-0486	6	20	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	08656-20132	5	2	LED MOUNT	28480	08656-20132
A2DS3-20	1990-0486	6		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	08656-20138	1	18	LED MOUNT	28480	08656-20138
2511A TO 2635A A2DS1-2	1990-0486	6	20	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	08656-80020	6	2	LED MOUNT	28480	08656-80020
A2DS3-20	1990-0486	6		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	1400-1008	1	18	LED MOUNT	28480	1400-1008
2637A AND ABOVE A2DS1-2	1990-0486	6	20	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	08656-80022	8	3	LED MOUNT	28480	08656-80022
A2DS3-10	1990-0486	6		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	0340-1176	5	17	LED MOUNT	28480	0340-1176
A2DS11	1990-0486	6		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	08656-80022	8		LED MOUNT	28480	08656-80022
A2DS12-20	1990-0486	6		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684
	0340-1176	5		LED MOUNT	28480	0340-1176
2425A TO 2509A A2J1	1251-5568	9	3	CONNECTOR 8-PIN M POST TYPE	28480	1251-5568
2511A TO 2622A A2J1	1251-8843	9	3	CONNECTOR 10-PIN M POST TYPE	28480	1251-8843
2623A AND ABOVE A2J1	1251-8671	1	1	CONN-POST TYPE .100-PIN-SPCG 10-CONT	28480	1251-8671
	1251-5595	2	1	POLARIZING KEY-POST CONN	28480	1251-5595
A2J2	1251-5922	9	2	CONNECTOR 14-PIN M POST TYPE	28480	1251-5922
A2MP1	08656-00008	2	4	BRACKET FRONT	28480	08656-00008
	2360-0113	2	78	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R1	1810-0273	9	1	NETWORK-RES 10-SIP470.0 OHM X 9	01121	210A471
A2R2	1810-0665	3	1	N-R 820 8 PINS	28480	1810-0665
A2R3	0757-0279	0	9	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A2R4	0698-3161	9	3	RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A2R5	0757-0443	0	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A2R6	1810-0402	6	13	NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R7	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R8	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R9	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R10	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R11	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R12	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R13	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R14	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R15	1810-0229	5	2	NETWORK-RES 8-SIP330.0 OHM X 7	01121	208A331
A2R16	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R17	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R18	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R19	0698-3446	3	5	RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A2R20	0698-3441	8	8	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A2R21	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4 1/8-T0-215R-F
A2R22	1810-0403	7	1	NETWORK-RESISTOR R1-R15: 330 OHM+-2%	01121	316A331
A2R23	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A2R24	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A2R25	0698-7235	6	1	RESISTOR 909 1% .05W F TC=0+-100	24546	C3-1/8-T0-909R-F
A2R26	0698-3438	3	6	RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A2R27	1810-0229	5		NETWORK-RES 8-SIP330.0 OHM X 7	01121	208A331
A2R28	1810-0280	8	1	NETWORK-RES 10-SIP10.0K OHM X 9	01121	210A103
A2R29	0698-7236	7	4	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A2S1	3101-2692	9	1	SW-PB SPST ALT C	28480	3101-2692
	5041-0944	4	1	KEY CAP "POWER"	28480	5041-0944
A2TP1	0360-0077	5	15	TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP2	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP3	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP4	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP5	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP6	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP7	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP8	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP9	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP10	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP11	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP12	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP13	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP14	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2TP15	0360-0077	5		TERMINAL-STUD SGL-TUR SWGFRM-MTG	28480	0360-0077
A2U1	1820-2056	1	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS378N
A2U2	1820-1858	9	3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U3	1820-1975	1	2	IC SHF-RGTR TTL LS NEG-EDGE-TRIG PRL-IN	01295	SN74LS165N
A2U4	1990-0751	8	14	DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4	14	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U5	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U6	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U7	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U8	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U9	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U10	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2U11	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U12	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U13	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DTP-SLDR	28480	1200-0859
A2U14	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U15	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U16	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U17	1990-0751	8		DISPLAY-NUM-SEG 14-CHAR .43-H RED	28480	1990-0751
	1200-0859	4		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0859
A2U18	1820-1975	1		IC SHF-RGTR TTL LS NEG-EDGE-TRIG PRL-IN	01295	SN74LS165N
A2U19	1820-1200	5	1	IC INV TTL LS HEX	01295	SN74LS05N
A2U20	1820-0668	7	1	IC BFR TTL NON-INV HE[illegible] 1-INP	01295	SN7407N
A2U21	1820-2186	8	2	IC DRVR TTL LED DRVR 7-INP	01295	SN75497N
A2U22	1820-2186	8		IC DRVR TTL LED DRVR 7-INP	01295	SN75497N
A2U23	1820-1433	6	2	IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
A2U24	1820-1433	6		IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
A2U25	1820-1216	3	5	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U26	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U27	1820-1413	2	13	IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U28	1820-1423	4	2	IC MV TTL LS MONOST[illegible] [illegible]TRIG DU[illegible]	01295	SN74LS123N
A2U29	1820-1413	2		IC DCDR CMOS BCD-T[illegible] 4-TO-7-LINE	3L585	CD4511BE
A2U30	1820-2056	1		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS378N
A2U31	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U32	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U33	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U34	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U35	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U36	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U37	1820-1413	2		IC DCDR CMOS BCD-TO-7 SE[illegible] 4-TO-7-LINE	3L585	CD4511BE
A2U38	1820-1413	2		IC DCDR CMOS BCD-TO-7-SE[illegible] 4-TO-7-LINE	3L585	CD4511BE
A2U39	1820-2056	1		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS378N
A2U40	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U41	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U42	1820-1413	2		IC DCDR CMOS BCD-TO-7-SEG 4-TO-7-LINE	3L585	CD4511BE
A2U43	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3						
2511A AND ABOVE A3	08656-60179	4	1	LOW FREQUENCY LOOP ASSEMBLY	28480	08656-60179
2425A TO 2509A A3	08656-60129	4	1	LOW FREQUENCY LOOP ASSEMBLY	28480	08656-60129
A3A1	08656-60137	4	2	BD, AY LF LP VCO	28480	08656-60137
A3C1	0160-4835	7	56	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C2	0160-4834	6	16	CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C3	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C4	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C6	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C8	0180-0197	8	7	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C9	0180-2929	8	2	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A3C10	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C11	0160-4789	0	2	CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A3C12	0160-4814	2	2	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A3C13	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A3C14	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C15	0160-4834	6		CAPACITOR-FXD .047UF [illegible] 100VDC CER	28480	0160-4834
A3C16	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C17	0160-4535	4	9	CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A3C18	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A3C19	0180-0094	4	2	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A3C20	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C21	0121-0061	1	1	CAPACITOR-V TRMR-CER 5.5-18PF 350V	52763	304322 5.5/18PF NPO
A3C22	0160-4833	5	3	CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A3C23*	0160-4805	1	1	CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A3C24	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C25	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C26	0180-0094	4		CAPACITOR-FXD [illegible]UF+75-10% [illegible] AL	56289	30D107G025DD2
A3C27	0160-4803	9	4	CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A3C28	0160-2436	0	1	CAPACITOR-FDTHRU 10PF 20% 200V CER	28480	0160-2436
A3C29	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C30	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C31-A3C99			2	NOT ASSIGNED		
A3C100	0180-0058	0	1	CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A3C101	0180-2821	9	6	CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C102-A3C199				NOT ASSIGNED		
A3C200	0180-2208	6	5	CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A3C201	0180-2208	6		CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A3C202	0180-2144	9	2	CAPACITOR-FXD 200UF+75-10% 25VDC AL	56289	30D207G025DH9
A3C203	0180-2144	9		CAPACITOR-FXD 200UF+75-10% 25VDC AL	56289	30D207G025DH9
A3C204	0160-4791	4	3	CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A3C205	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C206	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C207	0160-4801	7	5	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C208	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C209	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C210	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C211	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C212	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A3C213-A3C299				NOT ASSIGNED		
A3C300	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C301	0160-4786	7	3	CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A3C302	0180-0291	3	6	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C303	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C304	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835

See introduction to this section for ordering information.

* indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C305	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C306	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C307	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C308	0180-1746	5	6	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C309	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C310	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C311	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C312	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A3C313	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C314-A3C399				NOT ASSIGNED		
A3C400	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C401	0180-2208	6		CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A3C402	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C403	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C404	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C405	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A3C406	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C407	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C408	0180-2667	1	2	CAPACITOR-FXD 150UF+-10% 20VDC TA	56289	150D157X9020S2
A3C409	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A3C410	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A3C411	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C412	0180-0097	7	3	CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035S2
A3C413	0180-2667	1		CAPACITOR-FXD 150UF+-10% 20VDC TA	56289	150D157X9020S2
A3C414	0160-5098	6	1	CAPACITOR-FXD .22UF +-10% 50VDC CER	16299	CAC05X7R224J050A
A3C415	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C416	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C417-A3C499				NOT ASSIGNED		
A3C500	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A3C501	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A3C502	0180-2208	6		CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A3C503	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C504	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C505	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C506	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C507	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C508	0160-4810	8	2	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A3C509	0160-4810	8		CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A3C510	0160-4812	0	3	CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A3C511	0160-5558	3	1	CAPACITOR-FXD .68UF +-5% 100VDC	28480	0160-5558
A3C512	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C513	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A3C514	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C515	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C516	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A3C517	0160-4799	2	1	CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A3C518	0160-4824	4	1	CAPACITOR-FXD 680PF +-5% 100VDC CER	28480	0160-4824
A3C519	0160-4808	4	2	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3C520	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C521	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C522-A3C599				NOT ASSIGNED		
A3C600	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C601	0160-4787	8	7	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C602	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C603	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C604	0160-3674	0	1	CAPACITOR-FXD .47UF +-5% 100VDC	28480	0160-3674
A3C605	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C606	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C607	0160-3661	5	1	CAPACITOR-FXD .1UF +-5% 50VDC MET-POLYC	28480	0160-3661
A3C608	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C609	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C610	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C611	0160-3426	0	1	CAPACITOR-FXD .027UF +-2% 200VDC	28480	0160-3426

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C612	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C613	0180-2821	9		CAPACITOR-FXD 22UF +-20% 35VDC TA	28480	0180-2821
A3C614	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C615	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C616	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C617	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C618	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C619	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A3C620	0160-5853	1	1	CAPACITOR-FXD 5UF +-2% 500VDC MET-POLYC	28480	0160-5853
A3C621- A3C699				NOT ASSIGNED		
A3C700	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C701	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C702	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C703	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C704	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C705	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C706	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C707	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C708	0160-4565	0	1	CAPACITOR-FXD 1000PF +-1% 100VDC CER	28480	0160-4565
A3C709	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C710	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C711	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3CR1	1901-0539	3	20	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR2	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR3	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR4	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR5	1901-0050	3	58	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR7	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR8	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR10	1901-0880	7	4	DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A3CR11	1901-0880	7	4	DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A3CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
2425A TO 2542A						
A3CR13	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR14	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
2549A AND ABOVE						
A3CR13				NOT ASSIGNED		
A3CR14				NOT ASSIGNED		
A3CR15	0122-0173	8	6	DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A3CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR19- A3CR199				NOT ASSIGNED		
A3CR200	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR201	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR202- A3CR399				NOT ASSIGNED		
A3CR400	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR401	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR402	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR403	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR404	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR405	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR406	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR407- A3CR499				NOT ASSIGNED		
A3CR500	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR501	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR502	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR503	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR504	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR505	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR506	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3CR507- A3CR599				NOT ASSIGNED		
A3CR600	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR601	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR602	1901-0880	7	4	DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A3CR603	1901-0880	7	4	DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A3CR604- A3CR699				NOT ASSIGNED		
A3CR700	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR701	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR702	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR703	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR704	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR705	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR706	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3CR707	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A3DS1- A3DS499				NOT ASSIGNED		
A3DS500	1990-0517	4	1	LED-LAMP LUM-INT=3MCD IF=20MA-MAX BVR=5V	28480	5082-4655
A3E1	9170-0847	3	1	CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A3FL1	9135-0002	8		FILTER-LOW PASS SOLDER-TERMS	33095	51-744-018
A3FL2	9135-0002	8	4	FILTER-LOW PASS SOLDER-TERMS	33095	51-744-018
A3FL3	9135-0002	8		FILTER-LOW PASS SOLDER-TERMS	33095	51-744-018
A3FL4	9135-0002	8		FILTER-LOW PASS SOLDER-TERMS	33095	51-744-018
2425A TO 2509A *A3J1*	1251-5568	9		CONNECTOR 8-PIN M POST TYPE	28480	1251-5568
2511A AND ABOVE *A3J1*	1251-5647	5		CONNECTOR 10-PIN M POST TYPE	28480	1251-5647
A3J2	1250-0835	1	3	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A3J3	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A3J4	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A3J5	1250-0828	2	5	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-0828
A3J6	1250-0828	2		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-0828
A3J7	1250-0828	2		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-0828
A3J8	1250-0828	2		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-0828
A3L1	9140-0394	2	3	INDUCTOR RF-CH-MLD 680NH 5% .166DX.385LG	28480	9140-0394
A3L2	9140-0394	2		INDUCTOR RF-CH-MLD 680NH 5% .166DX.385LG	28480	9140-0394
A3L3	9140-0394	2		INDUCTOR RF-CH-MLD 680NH 5% .166DX.385LG	28480	9140-0394
2425A TO 2542A *A3L4*	9140-0112	2	2	INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
2549A AND ABOVE *A3L4*				NOT ASSIGNED		
A3L5	9140-0144	0	4	INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
*A3L6	9140-0140	7	2	INDUCTOR RF-CH-MLD 680NH 10% .105DX .26LG	28480	9140-0141
A3L7				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3L8	9140-0141	7		INDUCTOR RF-CH-MLD 680NH 10% .105DX.26LG	28480	9140-0141
A3L9- A3L199				NOT ASSIGNED		
A3L200	9100-1618	1	9	INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A3L201	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A3L202	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A3L203	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A3L204	9100-3922	4	10	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A3L205- A3L299				NOT ASSIGNED		
A3L300	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A3L301- A3L399				NOT ASSIGNED		
A3L400	9140-0129	1	3	INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG	28480	9140-0129
A3L401	9100-1620	5	3	INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
A3L402	9140-0129	1		INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG	28480	9140-0129
A3L403	9140-0129	1		INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG	28480	9140-0129
A3L404	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
A3L405- A3L499				NOT ASSIGNED		
A3L500	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
A3L501	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A3L502	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3L503	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A3MP1	08656-00126	5	2	COVER TOP	28480	08656-00126
A3MP2	2360-0277	9		SCREW-MACH 6-32 .312-IN-LG HEX-HD-SLT	00000	ORDER BY DESCRIPTION
A3MP3	08656-00044	6	2	FENCE LFL SHLD	28480	08656-00044
A3MP4	08656-00128	7	2	COVER FRAME	28480	08656-00128
A3MP5	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP6	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP7	2190-0009	4	8	WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3MP8	2580-0002	4	8	NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3MP9	08656-00127	6	2	COVER BOTTOM	28480	08656-00127
A3MP10	1400-0966	8	12	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A3Q1	1853-0405	9	12	TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q2	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q3	1854-0810	2	5	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A3Q4	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q5	1854-0809	9	8	TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q6	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q7	1855-0276	6	9	TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q8	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q9	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q10	1853-0281	9	9	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q11	1853-0459	3	6	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A3Q12	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q13	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A3Q14	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A3Q15	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q16	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q17	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q18	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q19	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q20	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A3Q21	1853-0594	7	1	TRANSISTOR-DUAL PNP 2N3808 TO-78	2N3808	1853-0594
A3Q22	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q23	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q24	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q25	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q26	1855-0277	7	1	TRANSISTOR J-FET 2N5268 P-CHAN D-MODE	04713	2N5268
A3Q27	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q28	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q29	1854-0401	7	1	TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0401
A3Q30	1853-0430	0	2	TRANSISTOR PNP 2N4959 SI TO-72 PD=200MW	04713	2N4959
A3Q31	1858-0087	3	1	TRANSISTOR ARRAY 14-PIN PLSTC TO-116	28480	1858-0087
A3Q32	1855-0418	8	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0418
A3Q33	1853-0430	0		TRANSISTOR PNP 2N4959 SI TO-72 PD=200MW	04713	2N4959
A3Q34	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q35	1855-0420	2	7	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q36	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q37	1855-0276	6		TRANSISTOR J-FET 2N4416A N-CHAN D-MODE	01295	2N4416A
A3Q38	1854-0477	7	2	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A3Q39	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q40	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q41	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q42	1854-0809	9		TRANSISTOR NPN 2N2369A SI TO-18 PD=360MW	28480	1854-0809
A3Q43	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q44	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q45	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A3Q46	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A3Q47	1854-0345	8	3	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A3Q48	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q49	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A3Q50	1854-0247	9	3	TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ	28480	1854-0247
A3Q51	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q52	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q53	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q54	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q55	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3Q56	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3R1	0757-0398	4	6	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R2	0757-0402	1	3	RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A3R3	0757-0402	1		RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A3R4	0757-1094	9	6	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A3R5	0757-0402	1		RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A3R6	0757-0397	3	1	RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A3R7	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A3R8	1810-0203	5	1	NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A3R9	0698-7215	2	1	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-TO-133R-F
A3R10	0698-3457	6	6	RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A3R11	0698-3457	6		RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A3R12	0698-3444	1	13	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R13	0698-3155	1	4	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R14	0698-3457	6		RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A3R15	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R16	0698-3457	6		RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A3R17	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R18	0757-0438	3	19	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R19	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R20	0757-0280	3	40	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R21	0757-0465	6	9	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R22	2100-3659	7	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN	32997	3292W-1-203
A3R23	0698-0084	9	5	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R24	0698-7199	1	1	RESISTOR 28.7 1% .05W F TC=0+-100	24546	C3-1/8-TO-28R7-F
A3R25	0698-3445	2	3	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
2425A TO 2548A						
A3R26	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24548	C4-1/8-T0-316R-F
2549A AND ABOVE						
A3R26	0757-0280	3	40	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R27	0757-0405	4	4	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A3R28	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R29	0698-3432	7	3	RESISTOR 26.1 1% .125W F TC=0+-100	03888	PME55-1/8-T0-26R1-F
A3R30	0757-0442	9	25	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R31	0757-0416	7	8	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R32	0698-4037	0	18	RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R33	0698-0082	7	12	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A3R34- A3R99				NOT ASSIGNED		
A3R100	0757-0441	8	7	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R101	0757-0382	6	3	RESISTOR 16.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-16R2-F
A3R102	0757-0424	7	13	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R103	0757-0440	7	7	RESISTOR 7.5K 1% .125W F TC=0+-100	24548	C4-1/8-T0-7501-F
A3R104	0757-0346	2	6	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A3R105- A3R199				NOT ASSIGNED		
A3R200	0757-0418	9	3	RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A3R201	0757-0400	9	1	RESISTOR 90.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-90R9-F
A3R202	0757-0394	0	8	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A3R203	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R204	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R205	0757-0401	0	18	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R206	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R207	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24548	C4-1/8-T0-316R-F
A3R208	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R209	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R210	0698-0083	8	22	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A3R211	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A3R212- A3R299				NOT ASSIGNED		

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R300	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A3R301	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A3R302	1810-0206	8	3	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
2425A TO 2617A *A3R303*	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4641-F
2620A AND ABOVE *A3R303**	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3161-F
A3R304	0757-0444	1	7	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1212-F
A3R305	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A3R306	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A3R307	0698-3432	7		RESISTOR 26.1 1% .125W F TC=0+-100	03888	PME55-1/8-TO-26R1-F
A3R308	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-TO-46R4-F
A3R309-A3R399				NOT ASSIGNED		

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R400	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R401	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R402	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R403	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R404	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R405	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R406	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R407	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R408	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R409	0698-3153	9	12	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R410	0757-0200	7	3	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R411	0757-0419	0	4	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A3R412	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R413	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A3R414	2100-2060	2	1	RESISTOR-TRMR 50 20% C TOP-ADJ 1-TRN	73138	82PR50
A3R415	1810-0294	4	1	NETWORK-RESISTOR 16 PIN DIP; RES	28480	1810-0294
A3R416	0757-0278	9	5	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A3R417	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R418	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R419	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R420	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R421	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A3R422	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R423	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R424	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A3R425	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R426	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A3R427	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R428	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R429	0698-8961	7	1	RESISTOR 909K 1% .125W F TC=0+-100	28480	0698-8961
A3R430	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R431	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R432	2100-3296	8	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 17-TRN	28480	2100-3296
A3R433	0698-3450	9	1	RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A3R434	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R435	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R436	0699-0073	8	2	RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A3R437	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1211-F
A3R438	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R439	2100-3096	6	1	RESISTOR-TRMR 50K 10% C TOP-ADJ 17-TRN	32997	3292W-1-503
A3R440	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R441	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R442	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R443	0698-8828	5	1	RESISTOR 25.6K .1% .125W F TC=0+-10	28480	0698-8828
A3R444	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R445	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R446	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R447	0698-3159	5	1	RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F
A3R448	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R449	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R450	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R451	0698-8812	7	1	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A3R452	2100-2031	7	2	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A3R453-A3R499				NOT ASSIGNED		
A3R500	0757-0395	1	2	RESISTOR 56.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-56R2-F
A3R501	0757-0395	1		RESISTOR 56.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-56R2-F
A3R502	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A3R503	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A3R504	0757-0317	7	3	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A3R505	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A3R506	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R507	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R508	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A3R509	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R510	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A3R511	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A3R512	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R513	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R514	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R515	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R516	0757-0421	4	10	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A3R517	0698-3440	7	7	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A3R518	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R519	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A3R520	0698-3150	6	2	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A3R521	0698-3162	0	11	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R522	0698-3430	5	1	RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A3R523	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R524	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R525	0698-3161	9		RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A3R526	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R527	0757-0422	5	2	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A3R528	0698-3132	4	3	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A3R529	0698-3156	2	10	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3R530	0757-0382	6		RESISTOR 16.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-16R2-F
A3R531	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R532	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R533	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R534	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R535	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R536	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R537	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R538	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R539	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R540	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3R541	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R542	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A3R543	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A3R544	0757-0439	4	2	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R545	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A3R546	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R547	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R548	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R549	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R550	0757-0382	6		RESISTOR 16.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-16R2-F
A3R551	0698-3443	0	5	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A3R552	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A3R553	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R554	0698-3136	8	2	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A3R555	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R556	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R557	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A3R558	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R559	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R560	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A3R561	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R562	2100-2497	9	1	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	82PR2K
A3R563	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R564	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R565	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A3R566	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3R567	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A3R568	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R569	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A3R570	0757-0199	3	3	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A3R571- A3R599				NOT ASSIGNED		
A3R600	0757-0462	3	2	RESISTOR 75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7502-F
A3R601	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R602	0698-3157	3	6	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R603	0757-0467	8	2	RESISTOR 121K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A3R604	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R605	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R606	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R607	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R608	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R609	0757-0434	9	1	RESISTOR 3.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3651-F
A3R610	0757-0467	8		RESISTOR 121K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A3R611	0698-3581	7	1	RESISTOR 13.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1372-F
A3R612	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R613	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R614	0757-0338	2	1	RESISTOR 1K 1% .25W F TC=0+-100	24546	C5-1/4-T0-1001-F
A3R615	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A3R616	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R617	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R618	0698-3154	0	5	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A3R619	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A3R620	2100-3210	6	2	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	28480	2100-3210
A3R621	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R622	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R623	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A3R624-A3R699				NOT ASSIGNED		
A3R700	0698-0085	0	6	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A3R701	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A3R702	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A3R703	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A3R704	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A3R705	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R706	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R707	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A3R708	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R709	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R710	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R711	1810-0666	4	1	NETWORK-RES 8-DIP 2.5K OHM X 2	28480	1810-0666
A3R712	2100-3090	0	1	RESISTOR-TRMR 500 10% C TOP-ADJ 17-TRN	32997	3292W-1-501
A3R713	0698-3460	1	1	RESISTOR 422K 1% .125W F TC=0+-100	28480	0698-3460
A3R714	2100-3733	8	1	RESISTOR-TRMR 1M 20% C TOP-ADJ 17-TRN	28480	2100-3733
A3R715	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A3R716	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R717	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R718	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A3R719	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R720	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R721	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R722	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
2425A TO 2622A *A3R723*	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
2626A AND ABOVE *A3R723*	2100-2030	6	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	73138	82PR20K
A3R724	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
2425A TO 2622A *A3R725*	0757-0459	8	1	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
2626A AND ABOVE *A3R725*	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	0698-3162
A3R726	0698-3454	3	5	RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A3R727	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R728	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R729	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
2425A TO 2509A *A3R730*	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
2511A AND ABOVE *A3R730*				NOT ASSIGNED		
2425A TO 2509A *A3R731*	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
2511A AND ABOVE *A3R731*	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-471F
A3R732	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R733	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R734	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R735	0757-0458	7	5	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R736	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R737	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R738	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3TP1	1251-0600	0	68	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP15	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP16	1251-4926	1	4	CONNECTOR 8-PIN M POST TYPE	28480	1251-4926
A3TP17	1251-4926	1		CONNECTOR 8-PIN M POST TYPE	28480	1251-4926
A3TP18	1251-4926	1		CONNECTOR 8-PIN M POST TYPE	28480	1251-4926
A3TP19	1251-4926	1		CONNECTOR 8-PIN M POST TYPE	28480	1251-4926
A3TP20	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP21	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP22	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP23	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP24	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP25	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP26	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP27	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP28	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP29	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP30	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP31	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP32	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP33	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3U1	1820-1225	4	2	IC FF ECL D-M/S DUAL	04713	MC10231P
A3U2	1826-0371	1	5	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A3U3	1858-0032	8	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A3U4	1826-1012	9	2	ANALOG SWITCH 4 SPST 16-PIN	28480	1826-1012
A3U5	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG.	27014	LF256H
A3U6	1820-0693	8	4	IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A3U7	1826-0932	0	2	IC OP AMP PRCN 8-DIP-C PKG	06665	OP-27FZ
A3U8	1820-1196	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A3U9	1826-0141	3	1	IC COMPARATOR GP DUAL 14-DIP-C PKG	27014	LM319J
A3U10	1826-0026	3	2	IC COMPARATOR PRCN TO-99 PKG	01295	LM311L
A3U11	1826-0026	3		IC COMPARATOR PRCN TO-99 PKG	01295	LM311L
A3U12	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A3U13	1826-1012	9		ANALOG SWITCH 4 SPST 16-PIN	28480	1826-1012
A3U14	1826-0845	4	1	IC OP AMP PRCN TO-99 PKG	06665	OP-07EJ
A3U15	1820-1144	6	3	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A3U16	1826-0462	1	3	IC CONV 10-B-D/A 16-DIP-C PKG	04713	MC3410CL
2425A TO 2614A						
A3U17	1820-2004	9	1	IC MISC NMOS	28480	1820-2004
	1200-0553	5	2	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2617A AND ABOVE						
A3U17	1820-2004	9	1	IC MISC NMOS	28480	1820-2004
	1200-0553	5	2	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
	0520-0128	7	2	SCREW-MACH 2-56 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	0610-0001	6	2	NUT-HEX-DBL-CHAM 1-27-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
	2190-0654	5	2	WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A3U18	1820-1201	6	2	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A3U19	1820-1112	8	6	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U20	1820-1278	7	3	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A3U21	1826-0021	8	1	IC OP AMP GP TO-99 PKG	27014	LM310H
A3U22	1826-1100	6	1	A/D 8-1/2-BIT 18-DIP-C BPLR	28480	1826-1100
A3U23	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A3U24	1820-1279	8	3	IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01295	SN74LS190N
A3U25	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U26	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A3U27	1826-0889	6	2	IC OP AMP LOW-NOISE DUAL 14-DIP-C PKG	52063	XR5533AN(PER HP DWG)

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3U29	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A3U30	1820-1279	8		IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01295	SN74LS190N
A3U31	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A3U32	1820-1278	7		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS191N
A3U33	1826-0889	6		IC OP AMP LOW-NOISE DUAL 14-DIP-C PKG	52063	XR5533AN(PER HP DWG)
A3U34	1826-1202	9	2	IC 7533SPC1DAC 8	28480	1826-1202
A3U35	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A3U36	1820-1279	8		IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01295	SN74LS190N
A3U37	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A3U38	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U39	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U40	1820-1882	9	1	IC GATE ECL EXCL-OR QUAD	04713	MC10113L
A3U41	1820-1206	1	1	IC GATE TTL LS NOR TPL 3-INP	01295	SN74LS27N
A3U42	1820-1446	1	1	IC SHF-RGTR TTL LS R-S PRL-IN PRL-OUT	01295	SN74LS395AN
A3U43	1820-1367	5	1	IC GATE TTL S AND QUAD 2-INP	01295	SN74S08N
A3U44	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U45	1826-0785	1	2	IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A3U46	1820-1225	4		IC FF ECL D-M/S DUAL	04713	MC10231P
A3U47	1820-0629	0	5	IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A3U48	1820-1991	1	1	IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A3U49	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A3U50	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A3U51	1820-1322	2	1	IC GATE TTL S NOR QUAD 2-INP	01295	SN74S02N
A3U52	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A3U53	1820-1383	5	1	IC CNTR ECL BCD POS-EDGE-TRIG	04713	MC10138L
A3U54	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A3U55	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A3VR1- A3VR299				NOT ASSIGNED		
A3VR300	1902-0945	7	1	DIODE-ZNR 3V 5% DO-35 PD=.4W TC=-.043%	28480	1902-0945
A3VR301- A3VR399				NOT ASSIGNED		
A3VR400	1902-0680	7	2	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A3VR401	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A3VR402- A3VR499				NOT ASSIGNED		
A3VR500	1902-0947	9	1	DIODE-ZNR 3.6V 5% DO-35 PD=.4W TC=-.036%	28480	1902-0947
A3VR501- A3VR600				NOT ASSIGNED		
A3VR601	1902-0962	8	1	DIODE-ZNR 15V 5% DO-35 PD=.4W TC=+.087%	28480	1902-0962
A3W1	1251-4670	2	4	CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
A3W2	1251-8557	2	8	CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W3	1251-4670	2		CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
A3W4	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W5	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W6	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W7	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W8	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W9	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
A3W10	1251-8557	2		CONN-POST TYPE .100-PIN-SPCG DPSLDR	28480	1251-8557
	1258-0209	9	10	JUMPER, A3W1-W10	28480	1258-0209
A3W11	8159-0005	0	2	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W12	08656-60144	3	1	CABLE COAX (5), VCO/N OUT TO VCO/N IN	28480	08656-60144
A3W13	08656-60145	4	1	CABLE COAX (6), 100 KHZ REF OUT TO 100 KHZ REF IN	28480	08656-60145
A3Y1	0410-1130	0	1	CRYSTAL-QUARTZ 50 MHZ HC-42/U-HLDR	28480	0410-1130
	1200-0758	2	1	SOCKET-XTAL 2-CONT HC-25/U DIP-SLDR	28480	1200-0758
A3Y2- A3Y299				NOT ASSIGNED		
A3Y300	0410-1180	0	2	CRYSTAL-QUARTZ 4.000 MHZ HC-18/U-HLDR	28480	0410-1180

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3A1						
A3A1	08656-60137	4		LOW FREQUENCY OSCILLATOR	28480	08656-60137
A3A1C1- A3A1C99				NOT ASSIGNED		
A3A1C100	0160-2437	1	2	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-2437
A3A1C101	0160-2437	1		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-2437
A3A1C102	0160-4350	1	1	CAPACITOR-FXD 68PF +-5% 200VDC CER 0+-30	28480	0160-4350
A3A1C103	0160-4040	6	51	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3A1C104	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3A1C105	0160-0700	7	1	CAPACITOR-FXD 150PF +-10% 100VDC CER	28480	0160-0700
A3A1C106	0160-4386	3	1	CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	28480	0160-4386
A3A1C107	0160-0575	4	12	CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A3A1C108	0160-4491	1	5	CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491
A3A1C109	0121-0448	8	4	CAPACITOR-V TRMR-CER 2.5-5PF 63V PC-MTG	28480	0121-0448
A3A1C110	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3A1C111	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A3A1C112	0160-4521	8	1	CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A3A1C113	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A3A1C114	0160-3872	0	1	CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER	28480	0160-3872
A3A1C115	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A3A1C116	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A3A1C117	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A3A1C118	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A3A1C119	0121-0448	8		CAPACITOR-V TRMR-CER 2.5-5PF 63V PC-MTG	28480	0121-0448
A3A1C120	0160-2436	0	3	CAPACITOR-FDTHRU 10PF 20% 200V CER	28480	0160-2436
A3A1C121	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A3A1CR1- A3A1CR99				NOT ASSIGNED		
A3A1CR100	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A3A1CR101	1901-0179	7	6	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A3A1CR102	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A3A1J1	1250-0828	2		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-0828
A3A1L1- A3A1L99				NOT ASSIGNED		
A3A1L100	9100-3315	9	1	INDUCTOR RF-CH-MLD 820NH 5% .166DX.385LG	28480	9100-3315
A3A1L101				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L102				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L103				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L104				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L105				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L106				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L107				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L108				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L109				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L110				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A3A1L111	9135-0073	3	6	INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A3A1L112	9135-0071	1	2	INDUCTOR RF-CH-MLD 62NH 5% .102DX.26LG	28480	9135-0071
A3A1L113	9140-0112	2		INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A3A1L114	9100-3368	2	1	INDUCTOR RF-CH-MLD 600NH 5% .2DX.385LG	28480	9100-3368
2425A TO 2639A *A3A1MP1*	08656-00126	5		COVER TOP	28480	08656-00126
2649A AND ABOVE *A3A1MP1*	08656-00126	5		COVER TOP	28480	08656-00126
	5001-5529	4		RFI STRIP GASKET	28480	5001-5529
A3A1MP2	2360-0277	9		SCREW-MACH 6-32 .312-IN-LG HEX-HD-SLT	00000	ORDER BY DESCRIPTION
A3A1MP3	08656-00044	6		FENCE LFL SHLD	28480	08656-00044
A3A1MP4				NOT ASSIGNED		
A3A1MP5	08656-00128	7		COVER-FRAME	28480	08656-00128
A3A1MP6	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3A1MP7	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3A1MP8	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3A1MP9	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3A1MP10	2260-0001	5	4	NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3A1MP11	2190-0004	9	4	WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
A3A1MP12	4208-0277	9	1	FOAM-POLYU 9.53-MM-THK 110-MM-WD	28480	4208-0277
A3A1MP13	08656-00127	6		COVER BOTTOM	28480	08656-00127
A3A1MP14	0570-1189	7	4	STUD-PRS-IN 4-40 UNC-2A .312-IN-LG PH	28480	0570-1189
A3A1Q1	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT=800MHZ	28480	1854-0610
A3A1Q2	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A3A1Q3	1854-0696	2	4	TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0696
A3A1R1-A3A1R99				NOT ASSIGNED		
A3A1R100	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3A1R101	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3A1R102	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A3A1R103	0757-0294	9	2	RESISTOR 17.8 1% .125W F TC=0+-100	19701	MF4C1/8-T0-17R8-F
A3A1R104	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3A1R105	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A3A1R106	0698-3151	7	4	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A3A1R107	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3A1R108	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3A1R109	0757-0180	2	2	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A3A1R110	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A3A1R111	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A3A1R112	0698-3433	8	4	RESISTOR 28.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-28R7-F
A3A1R113	0698-3433	8		RESISTOR 28.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-28R7-F
A3A1R114	0698-3433	8		RESISTOR 28.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-28R7-F
A3A1R115	0698-3433	8		RESISTOR 28.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-28R7-F
A3A1R116	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4						
A4	08656-60001	1	1	HIGH FREQUENCY LOOP ASSEMBLY	28480	08656-60001
A4C1	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C2	0160-2055	9	12	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C3	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C4	0160-4389	6	7	CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C5	0160-4082	6	2	CAPACITOR-FDTHRU 1000PF 20% 200V CER	28480	0160-4082
	2190-0630	7	2	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0630
	2420-0026	4	2	NUT-HEX-DBL-CHAM 6-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A4C6	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C7	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C8	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C9	0160-3568	1	5	CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A4C10	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A4C11	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A4C12	0160-4764	1	1	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4764
A4C13	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C14	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A4C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C16	0160-3456	6	5	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A4C17	0160-3879	7	6	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C18	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C19	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C20	0160-4103	2	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	72982	8121-M100-COG-221J
A4C21	0160-4498	8	3	CAPACITOR-FXD 5.6PF +-.5PF 200VDC CER	28480	0160-4498
A4C22	0160-3873	1	6	CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A4C23	0160-4498	8		CAPACITOR-FXD 5.6PF +-.5PF 200VDC CER	28480	0160-4498
A4C24	0160-4518	3	3	CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER	28480	0160-4518
A4C25	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C26	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C27				NOT ASSIGNED		
A4C28	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C29	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A4C30	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A4C31	0160-3876	4	2	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A4C32	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C33	0160-3029	9	3	CAPACITOR-FXD 7.5PF +-.5PF 100VDC CER	28480	0160-3029
A4C34	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C35	0160-3029	9		CAPACITOR-FXD 7.5PF +-.5PF 100VDC CER	28480	0160-3029
A4C36	0160-4383	0	3	CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
A4C37	0160-3029	9		CAPACITOR-FXD 7.5PF +-.5PF 100VDC CER	28480	0160-3029
A4C38	0160-4491	1		CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491
A4C39	0160-2257	3	1	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
	4330-0145	9	2	INSULATOR-BEAD GLASS	28480	4330-0145
A4C40				NOT ASSIGNED		
A4C41	0160-4491	1		CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491
A4C42	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C43	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A4C44	0160-3926	5	1	CAPACITOR-FDTHRU 100PF 20% 200V CER	28480	0160-3926
	2190-0630	7		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0630
	2420-0026	4		NUT-HEX-DBL-CHAM 6-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A4C45	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C46				NOT ASSIGNED		
A4C47	0160-3454	4	1	CAPACITOR-FXD 220PF +-10% 1KVDC CER	28480	0160-3454
A4C48	0160-3459	9	1	CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A4C49	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A4C50	0160-4494	4	2	CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	28480	0160-4494
A4C51	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C52				NOT ASSIGNED		
A4C53	0121-0449	9	3	CAPACITOR-V TRMR-CER 3.5-10PF 63V PC-MTG	28480	0121-0449
A4C54-A4C58				NOT ASSIGNED		

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4C59	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A4C60	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C61	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A4C62	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A4C63	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C64	0160-4767	4	1	CAPACITOR-FXD 20PF +-5% 200VDC CER 0+-30	28480	0160-4767
A4C65	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A4C66	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C67	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C68	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C69	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C70	0160-2204	0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A4C71	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C72	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C73	0160-0155	6	1	CAPACITOR-FXD 3300PF +-10% 200VDC POLYE	28480	0160-0155
A4C74	0160-3453	3	1	CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0160-3453
A4C75	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C76	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C77	0160-2218	6	1	CAPACITOR-FXD 1000PF +-5% 300VDC MICA	28480	0160-2218
A4C78	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C79	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A4C80	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A4C81	0160-4382	9	3	CAPACITOR-FXD 3.3PF +-.25PF 200VDC CER	28480	0160-4382
A4C83	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C84	0160-3874	2		CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A4C85	0121-0449	9		CAPACITOR-V TRMR-CER 3.5-10PF 63V PC-MTG	28480	0121-0449
2425A TO 2542A						
A4C86	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NPO-279J
2542A AND ABOVE						
A4C86	0160-4491	1		CAPACITOR-FXD 8.2PF +-.5PF 200VDC CER	51642	200-200-NPO-829J
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR2	1901-0189	9	1	DIODE-STEP RECOVERY	28480	1901-0189
A4CR3	1906-0098	9	4	DIODE-MATCHED 1V	28480	1906-0098
A4CR4	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A4CR5	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A4CR6	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A4CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR14				NOT ASSIGNED		
A4CR15				NOT ASSIGNED		
A4CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR19	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4J1	1251-6731	0	1	CONNECTOR 7-PIN M POST TYPE	28480	1251-6731
A4L1	9100-1627	2	4	INDUCTOR RF-CH-MLD 39UH 5% .166DX.385LG	28480	9100-1627
A4L2	9100-1627	2		INDUCTOR RF-CH-MLD 39UH 5% .166DX.385LG	28480	9100-1627
A4L3	9100-1627	2		INDUCTOR RF-CH-MLD 39UH 5% .166DX.385LG	28480	9100-1627
A4L4	9100-1627	2		INDUCTOR RF-CH-MLD 39UH 5% .166DX.385LG	28480	9100-1627
A4L5	9100-2247	4	17	INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A4L6				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L7				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L8				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L9				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L10	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A4L11	9135-0071	1		INDUCTOR RF-CH-MLD 62NH 5% .102DX.26LG	28480	9135-0071
A4L12				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L13	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A4L14				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L15	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4L16	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A4L17				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L18				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L19	9135-0076	6	2	INDUCTOR RF-CH-MLD 39NH 6% .102DX.25LG	28480	9135-0076
A4L20	9135-0074	4	1	INDUCTOR RF-CH-MLD 47NH 4% .102DX.26LG	28480	9135-0074
A4L21	9135-0081	3	3	INDUCTOR RF-CH-MLD 68NH 5% .102DX.26LG	28480	9135-0081
A4L22	9135-0081	3		INDUCTOR RF-CH-MLD 68NH 5% .102DX.26LG	28480	9135-0081
A4L23	9140-0158	6	20	INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A4L24	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A4L25				NOT ASSIGNED		
A4L26	9135-0081	3		INDUCTOR RF-CH-MLD 68NH 5% .102DX.26LG	28480	9135-0081
A4L27	9135-0076	6		INDUCTOR RF-CH-MLD 39NH 6% .102DX.26LG	28480	9135-0076
A4L28	9100-3512	8	2	INDUCTOR 50UH .285DX.4LG	28480	9100-3512
A4L29				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L30	9100-2248	5	2	INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG	28480	9100-2248
A4L31	9140-0141	7		INDUCTOR RF-CH-MLD 680NH 10% .105DX.26LG	28480	9140-0141
A4L32				NOT ASSIGNED		
A4L33	9100-2249	6	2	INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG	28480	9100-2249
A4L34	9100-1641	0	1	INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A4L35	9135-0068	6	2	INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A4L36	9100-3514	0	2	INDUCTOR 30UH .285DX.4LG	28480	9100-3514
A4L37	9100-3512	8		INDUCTOR 50UH .285DX.4LG	28480	9100-3512
A4L38	9100-3514	0		INDUCTOR 30UH .285DX.4LG	28480	9100-3514
A4L39	9100-3513	9	1	INDUCTOR 75UH .285DX.4LG	28480	9100-3513
A4L40	9135-0068	6		INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A4L41	9100-2249	6		INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG	28480	9100-2249
A4MP1	08656-00074	2	1	PLATE-HFL BRKT	28480	08656-00074
A4MP2	08656-00089	9	1	BRKT HFL FDTHRU	28480	08656-00089
A4MP3	08656-00090	2	1	TAB-GROUNDING	28480	08656-00090
A4MP4	08656-00133	4	14	CLIP SEMI-R GRND	28480	08656-00133
A4Q1	1853-0020	4	4	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q2	1854-0632	6	8	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91
A4Q3	1854-0696	2		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0696
A4Q4	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q5	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A4Q6	1855-0235	7	1	TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	28480	1855-0235
A4Q7	1853-0007	7	6	TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A4Q8	1854-0071	7	3	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q10	1855-0423	5	1	TRANSISTOR MOSFET N-CHAN E-MODE	17856	VN10KM
A4R1	0698-7227	6	4	RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A4R2	0698-7189	9	2	RESISTOR 11 1% .05W F TC=0+-100	24546	C3-1/8-T0-11R0-F
A4R3	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-T0-422R-F
A4R4	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R5	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A4R6*	0699-1970	6		RESISTOR-FXD 178 1% F TC-0=-100	28480	0699-1970
A4R7*	0699-1903	5		RESISTOR-FXD 51.1 1% F TC=0+-100	28480	0699-1903
A4R8	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A4R9	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R10*	0699-1970	6		RESISTOR-FXD 178 1% F TC=0+-100	28480	0699-1970
A4R11	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A4R12	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A4R13	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A4R14	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A4R15	0757-0179	9	1	RESISTOR 196 1% .25W F TC=0+-100	24546	C5-1/4-T0-196R-F
A4R16	0698-7220	9	2	RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A4R17	0698-7198	0	2	RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A4R18	0698-7198	0		RESISTOR 26.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-26R1-F
A4R19	0699-1903	5	2	RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A4R20	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A4R21	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A4R22	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A4R23	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A4R24	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A4R25	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4R26	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A4R27	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R28	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A4R29	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A4R30	0698-3447	4	5	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A4R31	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A4R32	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A4R33	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R34				NOT ASSIGNED		
2514A AND ABOVE A4R35	0757-0416	7		RES 511 1% .125W	28480	0757-0416
2425A TO 2511A A4R35	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R36	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R37	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A4R38	0699-1902	4	1	RESISTOR-FXD 10 1% .05W F TC=0+-100	28480	0699-1902
A4R39	0698-8816	1	1	RESISTOR 2.15 1% .125W F TC=0+-100	28480	0698-8816
A4R40	0698-7221	0	5	RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-TO-237R-F
A4R41	0698-7221	0		RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-TO-237R-F
A4R42	0698-7221	0		RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-TO-237R-F
A4R43	0698-7221	0		RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-TO-237R-F
A4R44	0698-7221	0		RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-TO-237R-F
A4R45	0698-3442	9	6	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A4R46	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A4R47	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A4R48	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A4R49	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A4R50	1810-0269	3	1	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0269
A4R51	0698-3158	4	2	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2372-F
2425A TO 2630A A4R52	2100-2216	0	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	73138	82PR5K
2635A AND ABOVE A4R52	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A4R53	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2372-F
A4R54	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R55	2100-2030	6	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	73138	82PR20K
A4R56	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A4R57	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R58	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A4R59	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A4R60	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A4R61				NOT ASSIGNED		
A4R62	0698-3457	6		RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A4R63	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A4R64	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R65	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R66	0698-3266	5	3	RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A4R67	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A4R68	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A4R69	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A4R70	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R71	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R72	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A4R73	0698-3452	1	2	RESISTOR 147K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1473-F
A4R74	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A4R75	0698-3452	1		RESISTOR 147K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1473-F
A4R76	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4T1	11661-60087	7	1	TRANSFRMR ASSY	28480	11661-60087
A4TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP2	1251-1556	7	25	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP3	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP4	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP5	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP6	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP8	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP9	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A4TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM BSC-SZ SQ	28480	1251-0600
A4TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP15	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP16	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4U1	0955-0146	0	1	MIXER-DBL BALANCED FREQ=1 TO 1000 MHZ	28480	0955-0146
A4U2	1820-1976	2	2	IC BFR CMOS NON-INV HEX	3L585	CD4050BE
A4U3	1820-0618	7	2	IC BFR TTL NON-INV HEX	01295	SN7417N
A4U4	1820-1662	3	2	IC SHF-RGTR CMOS SERIAL-IN PRL-OUT 8-BIT	3L585	CD4094BE
A4U5	1826-0522	4	1	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074CN
A4U6	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5						
A5	08656-60013	5	1	HIGH FREQUENCY OSCILLATOR ASSEMBLY	28480	08656-60013
A5C1	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C2	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A5C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C5	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C6	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C7	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A5C8	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C9	0160-3568	1		CAPACITOR-FXD 2.7PF +-.25PF 200VDC CER	28480	0160-3568
A5C10	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A5C11	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C12	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A5C13	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C14	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C15*	0160-3875	3	7	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A5C16	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A5C17	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C18	0160-4494	4		CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	28480	0160-4494
A5C19	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A5C20	0160-4498	8		CAPACITOR-FXD 5.6PF +-.5PF 200VDC CER	28480	0160-4498
A5C21	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C22*	0160-0690	4	2	CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
2530A AND ABOVE						
A5CR1	0122-0161	4	7	DVVC 2.2PF 5.0CR	28480	0122-0161
A5CR2	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
2511A TO 2523A						
A5CR1	0122-0329	6		DIODE VCC 2.2PF 5% C3/C25-MIN=4.5	28480	0122-0329
A5CR2	0122-0329	6		DIODE VCC 2.2PF 5% C3/C25-MIN=4.5	28480	0122-0329
2425A TO 2509A						
A5CR1	0122-0161	4	7	DVVC 2.2PF 5.0CR	28480	0122-0161
A5CR2	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A5L1				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A5L2				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A5L3	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A5L4				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A5L5	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A5L6	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A5L7	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A5L8				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A5L9	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A5L10	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A5L11				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A5L12	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A5MP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5Q1	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q2	1854-0632	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91
A5Q3	1854-0632	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91
A5R1	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A5R2	0698-7222	1	1	RESISTOR 261 1% .05W F TC=0+-100	24546	C3-1/8-TO-261R-F
A5R3	0698-7225	4	1	RESISTOR 348 1% .05W F TC=0+-100	24546	C3-1/8-TO-348R-F
A5R4	0699-1947	7	2	RESISTOR 38.3 1% .05W F TC=0+-100	28480	0699-1947
A5R5	0698-7216	3	3	RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-TO-147R-F
A5R6	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A5R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R8	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A5R9	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-TO-215R-F
A5R10	0699-1966	0	2	RESISTOR 26.1 1% .05W F TC=0+-100	28480	0699-1966
A5R11	0699-1966	0		RESISTOR 26.1 1% .05W F TC=0+-100	28480	0699-1966
A5R12	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A5R13	0699-2027	6	1	RESISTOR 11 1% .05W F TC=0+-100	28480	0699-2027
A5R14	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A5R15	0698-7212	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R16	0698-7216	3		RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A5R17	0698-7202	7		RESISTOR 38.3 1% .05W F TC=0+-100	24546	C3-1/8-T0-38R3-F
A5R18	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R19	0698-7216	3		RESISTOR 147 1% .05W F TC=0+-100	24546	C3-1/8-T0-147R-F
A5R20	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A5R21	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A5R22	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A5R23	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A5TP1	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A5TP2	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A5TP3	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A5TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP5	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6						
2425A TO 2509A A6	08656-60150	1	1	OUTPUT ASSEMBLY	28480	08656-60150
2511A AND ABOVE A6	08656-60180	7	1	OUTPUT ASSEMBLY	28480	08656-60180
A6C1	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C2	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C3	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C4	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C5	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C6	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C7	0160-0576	5	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A6C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C9	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A6C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C11	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C12	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C13	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C14	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
2425A TO 2617A A6C16	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
2620A AND ABOVE A6C16	0180-1794	3	1	CAPACITOR-FXD 22UF+-10% 35VDC TA	56289	150D266X9035R2
A6C17	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C18	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C20	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C21	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C22	0160-3877	5	3	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A6C23	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A6C24	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A6C25	0180-0374	3	2	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A6C26	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A6C27	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A6C28	0160-0690	4		CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
A6C29	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C30	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C31	0160-5975	8		CAPACITOR-FXD 10PF +-5% 50VDC CER 0+-30	28480	0160-5975
A6C32				NOT ASSIGNED		
A6C33	0160-6469	7	4	CAPACITOR-FXD 620PF 50VDC CER	28480	0160-6469
A6C34	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C35	0160-5971	4	1	CAPACITOR-FXD 4.7PF +-.5PF 50VDC CER	28480	0160-5971
A6C36	0160-4387	4	1	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A6C37	0160-5957	6	1	CAPACITOR 47PF +-5% 50VDC CER 0+-30	28480	0160-5957
A6C38	0160-6469	7	4	CAPACITOR-FXD 620PF 50VDC CER	28480	0160-6469
A6C39	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
2425A ONLY A6C40	0160-4471	7		CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4471
2447A AND ABOVE A6C40				NOT ASSIGNED		
A6C41	0160-6469	7	4	CAPACITOR-FXD 620PF 50VDC CER	28480	0160-6469
A6C42	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C43	0160-6469	7	4	CAPACITOR-FXD 620PF 50VDC CER	28480	0160-6469
A6C44	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C45	0160-4084	8	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A6C46	0121-0447	7	2	CAPACITOR-V TRMR-CER 1-3PF 63V PC-MTG	28480	0121-0447
A6C47	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A6C48	0121-0447	7	2	CAPACITOR-V TRMR-CER 1-3PF 63V PC-MTG	28480	0121-0447
A6C49	0160-0570	9	1	CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A6C50	0160-4493	3		CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-4493
A6C51	0160-4493	3		CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-4493
A6C52	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A6C53	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A6C54	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C55	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A6C56	0121-0448	8		CAPACITOR-V TRMR-CER 2.5-5PF 63V PC-MTG	28480	0121-0448
A6C57	0121-0449	9		CAPACITOR-V TRMR-CER 3.5-10PF 63V PC-MTG	28480	0121-0449
A6C58	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A6C59	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A6C60				NOT ASSIGNED		

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6C61	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C62	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
2425A TO 2508A						
A6C63	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C64	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
2509A AND ABOVE						
A6C63	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C64	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A6C65	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C66	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C67	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C68	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A6C69	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
2425A TO 2530A						
A6C70	0160-5049	7	1	CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-5049
2532A AND ABOVE						
A6C70	0160-5978	1	1	CAPACITOR-FXD 2.2PF 50VDC CER	28480	0160-5978
2523A TO 2613A						
A6C71	0160-4304	5	1	CAPACITOR-FXD 10PF +-10% 100VDC CER	28480	0160-4304
2614A AND ABOVE						
A6C71	0160-5975	8	2	CAPACITOR-FXD 10PF +-5% 50VDC CER 0+-30	28480	0160-5975
2425A TO 2616A						
A6C72				NOT ASSIGINED		
2620A AND ABOVE						
A6C72	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A6C73*	0160-0690	4		CAPCITOR-FXD 10PF +-.1PF 100VDC CER	28480	0160-0690
A6C74*	0160-0690	4		CAPACITOR-FXD 10PF +-.1PF 100VDC CER	28480	0160-0690
A6C75*	0160-3872	0		CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER	28480	0160-3872
A6CR1	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A6CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A6CR3	1901-1134	6	4	DIODE PIN	28480	1901-1134
A6CR4	1901-1134	6		DIODE PIN	28480	1901-1134
A6CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A6CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR7	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A6CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR9	1902-0970	8	1	DIODE-ZNR 33V 5% DO-35 PD=.4W TC=+.097%	28480	1902-0970
A6CR10-CR12				NOT ASSIGNED		
A6CR13	1901-1096	9	3	DIODE-PIN	28480	1901-1096
A6CR14	1901-1096	9		DIODE-PIN	28480	1901-1096
A6CR15	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR18	1901-1096	9		DIODE-PIN	28480	1901-1096
A6CR19	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR20	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
2425A TO 2637A						
A6CR21	1901-1134	6		DIODE PIN	28480	1901-1134
2639A AND ABOVE						
A6CR21	1901-1096	0		DIODE PIN	28480	1901-1096
A6CR22	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A6CR23	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR24	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR25	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A6CR26	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A6CR27	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A6CR28	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A6CR29	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A6CR30	0122-0173	8		DIODE-VVC 20PF 10% C3/C25-MIN=5 BVR=30V	28480	0122-0173
A6CR31	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR32	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A6CR33	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR34	1901-1134	6		DIODE PIN	28480	1901-1134
A6CR35	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR36	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR37	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6CR38	1906-0245	8	2	DIODE-MATCHED VF DIFF=5MV	28480	1906-0245
A6CR39	1906-0245	8		DIODE-MATCHED VF DIFF=5MV	28480	1906-0245
A6CR40	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR41	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR42	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR43	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR44	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR45	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR46	0122-0161	4		DVVC 2.2PF 5.0CR	28480	0122-0161
A6CR47	1902-0949	1	2	DIODE-ZNR 4.3V 5% DO-35 PD=.4W TC=+.017%	28480	1902-0949
A6CR48	1902-0949	1		DIODE-ZNR 4.3V 5% DO-35 PD=.4W TC=+.017%	28480	1902-0949
A6J1	1251-5568	9		CONNECTOR 8-PIN M POST TYPE	28480	1251-5568
A6J2	1251-5618	0	1	CONNECTOR 8-PIN M POST TYPE	28480	1251-5618
A6J3	1200-0507	9	6	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
2425A TO 2509A A6J4	1251-4051	3	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-4051
2511A TO 2622A A6J4	1251-4928	3	1	CONN-POST TYPE .100-PIN-SPCG 10-CONT	28480	1251-4928
2623A AND ABOVE A6J4	1251-8599	2	1	CONN-POST TYPE .100-PIN-SPCG 10-CONT	28480	1251-8599
	1251-5595	2	1	POLARIZING KEY-POST CONN	28480	1251-5595

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6J5	1250-0836	2	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A6J6	1250-0836	2		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A6J7	1250-2090	4		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-2090
A6K1	0490-1171	7	1	RELAY-REED 2A 500MA 200VAC 5VDC-COIL	28480	0490-1171
A6L1	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L2				NOT ASSIGNED		
A6L3	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A6L4	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A6L5	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A6L6	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L7	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L8	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L9	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L10	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L11	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A6L12				NOT ASSIGNED		
A6L13	9100-2258	7	1	INDUCTOR RF-CH-MLD 1.2UH 10% .105DX.26LG	28480	9100-2258
A6L14	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L15	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L16	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L17	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A6L18	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A6L19				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L20				NOT ASSIGNED		
A6L21	9135-0078	8	3	INDUCTOR RF-CH-MLD 82NH 7% .102DX.26LG	28480	9135-0078
A6L22	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L23	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L24	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L25				NOT ASSIGNED		
A6L26				NOT ASSIGNED		
2425A TO 2626A A6L27	9100-2248	5		INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG	28480	9100-2248
2630A AND ABOVE A6L27	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A6L28				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L29				NOT ASSIGNED		
A6L30	9135-0078	8		INDUCTOR RF-CH-MLD 82NH 7% .102DX.26LG	28480	9135-0078
A6L31				NOT ASSIGNED		
A6L32	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L33				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L34	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L35				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L36	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A6L37	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L38	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A6L39	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L40				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L41				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L42				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L43				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L44				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L45				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L46				NOT ASSIGNED		
A6L47	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A6L48	9135-0078	8		INDUCTOR RF-CH-MLD 82NH 7% .102DX.26LG	28480	9135-0078
A6L49	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A6L50	9100-2255	4	1	INDUCTOR RF-CH-MLD 470NH 10% .105DX.26LG	28480	9100-2255
A6L51	9140-0158	6		INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG	28480	9140-0158
A6L52	9100-2252	1	1	INDUCTOR RF-CH-MLD 270NH 10% .105DX.26LG	28480	9100-2252
A6L53	9100-1648	7	1	INDUCTOR RF-CH-MLD 560UH 5% .2DX.45LG	28480	9100-1648
A6L54	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A6L55				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6L56				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A6MP1	08656-00133	3	1	CLIP SEMI-R GRND	28480	08656-00033
A6MP2	08656-00154	9	1	SHIELD, PC BOARD	28480	08656-00154
A6MP3	08656-00090	2	2	TAB-GROUNDING	28480	08656-00090
A6MP4	08656-00090	2	2	TAB-GROUNDING	28480	08656-00090
A6Q1	1853-0527	6	1	TRANSISTOR PNP NONE SI PD=500MW FT=4GHZ	28480	1853-0527
A6Q2	1854-0632	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91
A6Q3	1854-0720	3	1	TRANSISTOR NPN SI PD=500MW FT=4GHZ	28480	1854-0720
A6Q4	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A6Q5	1853-0012	4	1	TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6Q6	1854-0942	1	1	TRANSISTOR NPN SI PD=2.25W FT=3GHZ	28480	1854-0942
A6Q7	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A6Q8	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A6Q9	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A6Q10	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A6Q11	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A6Q12	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A6Q13	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A6Q14	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD=360MW	04713	2N3251
A6Q15	1854-0696	2		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0696
	1200-0172	4	2	INSULATOR-XSTR DAP-GL	28480	1200-0172
A6Q16	1854-0721	4	1	TRANSISTOR NPN SI TO-39 PD=1.5W	25403	BFR 95
	1200-0173	5	3	INSULATOR-XSTR DAP-GL	28480	1200-0173
	1205-0011	0	1	HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A6R1	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A6R2	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A6R3	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A6R4	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A6R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R6	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A6R7				NOT ASSIGNED		
A6R8	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=+-100	28480	0699-1903
2506A AND ABOVE						
A6R9	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511-F
2425A TO 2451A						
A6R9	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R10	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A6R11	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A6R12	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A6R13- A6R15				NOT ASSIGNED		
A6R16	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A6R17	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A6R18	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A6R19	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A6R20	0698-3161	9		RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A6R21	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A6R22	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R23	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A6R24	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R25	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R26	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R27	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A6R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R29	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A6R30	2100-2031	7		RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A6R31	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A6R32	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A6R33	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A6R34	0698-3439	4	5	RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A6R35	2100-1788	9	1	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-1788
A6R36	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A6R37	0699-0178	4	3	RESISTOR 30.4 5% .1W C TC=0+-200	28480	0699-0178
A6R38	0699-0178	4		RESISTOR 30.4 5% .1W C TC=0+-200	28480	0699-0178
A6R39	0699-0178	4		RESISTOR 30.4 5% .1W C TC=0+-200	28480	0699-0178
A6R40	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A6R41	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A6R42	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R43	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A6R44	0698-7210	7	1	RESISTOR 82.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-82R5-F
A6R45	0698-3626	1	1	RESISTOR 180 5% 2W MO TC=0+-200	28480	0698-3626
2425A TO 2637A						
A6R46	0699-0251	4	3	RESISTOR 44.8 5% .1W C TC=0+-200	28480	0699-0251
A6R47	0699-0251	4		RESISTOR 44.8 5% .1W C TC=0+-200	28480	0699-0251
2639A AND ABOVE						
A6R46	0699-1364	2	3	RESISTOR 68.1 1% .125W F TC=0+-100	28480	0699-1364
A6R47	0699-1364	2		RESISTOR 68.1 1% .125W F TC=0+-100	28480	0699-1364
A6R48	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A6R49	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A6R50	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R51	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6R52	0698-3613	6	1	RESISTOR 39 5% 2W MO TC=0+-200	27167	FP42-2-T00-39R0-J
A6R53	0699-1106	0	1	RESISTOR 75 5% .15W C TC=0+-200	28480	0699-1106
A6R54	0699-0251	4		RESISTOR 44.8 5% .1W C TC=0+-200	28480	0699-0251
A6R55	0699-1967	1	2	RESISTOR 56.2 1% .05W F TC=0+-100	28480	0699-1967
A6R56	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A6R57*	0698-7223	2	1	RESISTOR 287 1% .05W F TC=0+-100	24546	C3-1/8-TO-287R-F
A6R58	0699-1967	1	2	RESISTOR 56.2 1% .05W F TC=0+-100	28480	0699-1967
A6R59	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A6R60	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-TO-825R-F
A6R61	0699-1903	5		RESISTOR-FXD 51.1 1% .05W F TC=0+-100	28480	0699-1903
A6R62	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-TO-383R-F
A6R63	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A6R64	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-TO-511R-F
A6R65	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-TO-383R-F
A6R66	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A6R67	0699-1964	8	6	RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R68	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-TO-162R-F
A6R69	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-TO-383R-F
A6R70	0699-1964	8	6	RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R71	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R72	0698-1964	8		RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R73	0698-3449	6	1	RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2872-F
A6R74	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-TO-383R-F
A6R75	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R76	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R77	0699-1964	8	6	RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R78	0757-0796	6	1	RESISTOR 82.5 1% .5W F TC=0+-100	28480	0757-0796
A6R79	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1962-F
A6R80	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A6R81	0699-1964	8	6	RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R82	0699-1964	8	6	RESISTOR 14.7 1% .05W F TC=0+-100	28480	0699-1964
A6R83	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R84	0698-3398	4	1	RESISTOR 46.4 1% .5W F TC=0+-100	28480	0698-3398
A6R85	0698-8819	4	1	RESISTOR 3.83 1% .125W F TC=0+-100	28480	0698-8819
A6R86	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1962-F
A6R87	0898-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A6R88	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A6R89	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A6R90	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1962-F
A6R91	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A6R92	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1003-F
A6R93	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R94	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R95	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3831-F
A6R96	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A6R97	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A6R98	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4221-F
A6R99	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-TO-5111-F
A6R100	0698-3432	7		RESISTOR 26.1 1% .125W F TC=0+-100	03888	PME55-1/8-TO-26R1-F
A6R101				NOT ASSIGNED		
A6R102	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A6R103	0698-3243	8	1	RESISTOR 178K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1783-F
A6R104	0698-3260	9	1	RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A6R105	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
2425A TO 2637A						
A6R106				NOT ASSIGNED		
A6R107				NOT ASSIGNED		
2639A AND ABOVE						
A6R106	0699-1364	2	3	RESISTOR 68.1 1% .125W F TC=0+-100	28480	0699-1364
A6R107	0699-1364	2		RESISTOR 68.1 1% .125W F TC=0+-100	28480	0699-1364
A6TP1	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A6TP2	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A6TP3	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A6TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP7	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A6U1	1820-2933	3	1	IC PRESCR ECL	28480	1820-2933
A6U2	1820-3485	2	1	IC PRESCR ECL	04731	MC12090LN
A6U3	1826-0013	8	2	IC OP AMP LOW-NOISE TO-99 PKG	06665	SSS741CJ
A6U4	1820-1976	2		IC BFR CMOS NON-INV HEX	3L585	CD4050BE
A6U5	1820-0618	7		IC BFR TTL NON-INV HEX	01295	SN7417N

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6U6	1826-0488	1	1	IC OP AMP WB TO-99 PKG	27014	LM218H
A6U7	1820-1662	3		IC SHF-RGTR CMOS SERIAL-IN PRL-OUT 8-BIT	3L585	CD4094BE
A6U8	1820-1422	3	2	IC MV TTL LS MONOSTBL RETRIG	01295	SN74LS122N
A6U9	1820-0304	8	1	IC FF TTL J-K M/S PULSE PRESET/CLEAR	01295	SN7472N
A6U10	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A6U11	0955-0145	9	2	MIXER-DBL BALANCED FREQ=1 TO 1000 MHZ	28480	0955-0145
A6W1	1251-4670	2		CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
A6W1	1258-0209	9		JUMPER-REMOVABLE 2 POSITION; .200 IN	28480	1258-0209

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7						
2511A AND ABOVE						
A7				NOT ASSIGNED		
2425A TO 2509A						
A7	08656-60063	5	1	RFI ASSEMBLY	28480	08656-60063
A7C1	0160-0571	0	7	CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C2	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C3	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C4	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C5	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C6	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7C7	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A7J1				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A7J2				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A7L1	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L2	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L3	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L4	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L5	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L6	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A7L7	9100-2247	4		INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8						
A8	08656-60004	4	1	FREQUENCY MULTIPLIER ASSEMBLY	28480	08656-60004
A8C1	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A8C2	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C4	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C5*	0160-4527	4	4	CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A8C6	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C7	0160-2249	3	1	CAPACITOR-FXD 4.7PF +-.25PF 500VDC CER	28480	0160-2249
A8C8	0160-4527	4		CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A8C9	0160-4527	4		CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A8C10	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C11	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C12	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C13	0160-4383	0		CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
A8C14	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C16	0160-6705	4		CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-6705
A8C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C18	0160-2243	7	1	CAPACITOR-FXD 2.7PF +-.25PF 500VDC CER	28480	0160-2243
A8C19*	0160-6705	4	5	CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-6705
A8C20	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C21	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C22	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C23	0160-6705	4		CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	28480	0160-6705
A8C24	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C25	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C26	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C27	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C28	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A8C29	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A8C30	0160-2237	9	1	CAPACITOR-FXD 1.2PF +-.25PF 500VDC CER	28480	0160-2237
A8C31	0121-0448	8		CAPACITOR-V TRMR-CER 2.5-5PF 63V PC-MTG	28480	0121-0448
A8C32	0160-4491	1		CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491
A8C33	0160-4518	3		CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER	28480	0160-4518
A8C34	0160-4527	4		CAPACITOR-FXD 56PF +-5% 200VDC CER 0+-30	28480	0160-4527
A8C35	0160-4382	9		CAPACITOR-FXD 3.3PF +-.25PF 200VDC CER	28480	0160-4382
A8C36	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C37	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C38	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C39	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C40*	0160-3878	6	27	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C41	0160-4383	0		CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
A8C42	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C43	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C44	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C45	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C46	0160-2234	6	1	CAPACITOR-FXD .51PF +-.25PF 500VDC CER	28480	0160-2234
A8C47	0121-0452	4	1	CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A8C48	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C49				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8C50	0160-4518	3		CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER	28480	0160-4518
A8C51				NOT ASSIGNED		
A8C52	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C53				NOT ASSIGNED		
A8C54	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C55	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A8C56	0160-4382	9		CAPACITOR-FXD 3.3PF +-.25PF 200VDC CER	28480	0160-4382
A8C57	0160-4490	0	1	CAPACITOR-FXD 1.8PF +-.25PF 200VDC CER	28480	0160-4490
A8C58	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8J1	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A8J2	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A8J3	1250-1626	0	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1626
	2190-0124	4	7	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9	7	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A8J4	1250-1626	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1626
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A8L1	9100-1618	1		INDUCTOR RF-CH-MLD 5.6UH 10%	28480	9100-1618
A8L2	9140-0141	7		INDUCTOR RF-CH-MLD 680NH 10% .105DX.26LG	28480	9140-0141
A8L3				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L4				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L5				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L6				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L7	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A8L8				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L9				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L10				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L11	9100-2251	0	3	INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG	28480	9100-2251
A8L12				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L13				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L14				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L15				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L16	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A8L17				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L18				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L19				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L20				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L21				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L22				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L23				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L24	9100-2251	0		INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG	28480	9100-2251
A8L25				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L26				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L27	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A8L28				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L29				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L30				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L31				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L32				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L33				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L34				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L35				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L36				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L37				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L38				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L39				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L40	9100-2251	0		INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG	28480	9100-2251
A8L41				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L42				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L43				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L44-A8L50				NOT ASSIGNED		
A8L51				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8L52				NOT ASSIGNED		
A8L53				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A8MP1	08656-00099	1	1	MULTI GROUND TAB	28480	08656-00099
A8MP2	08656-00133	4		CLIP SEMI-R GRND	28480	08656-00133
A8MP3	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A8MP4	1251-2194	1	1	CONNECTOR-SGL CONT SKT .021-IN-BSC-SZ	28480	1251-2194
A8Q1	1854-1050	4		TRANSISTOR NPN SI PD=180MW FT=5GHZ	25403	BFR91A
A8Q2	1854-1050	4		TRANSISTOR NPN SI PD=180MW FT=5GHZ	25403	BFR91A
A8Q3	1854-0632	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91
A8Q4	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A8Q5	1854-0632	6		TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR-91

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8Q6	1854-0696	2		TRANSISTOR NPN SI TO-72 PD=200MW	28480	1854-0696
A8Q7	1854-0247	9		TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A8Q8	1854-0247	9		TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A8R1	0757-0294	9		RESISTOR 17.8 1% .125W F TC=0+-100	19701	MF4C1/8-T0-17R8-F
A8R2	0757-0403	2	1	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A8R3	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A8R4	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A8R5	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R6	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A8R7	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A8R8	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R9	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R10	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A8R11	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A8R12	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A8R13	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A8R14	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A8R15	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A8R16	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R17	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R18	0698-4037	0		RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A8R19	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R20	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R21	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A8R22	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A8R23	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A8R24	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R25	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A8R26	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R27	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R28	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R29	0757-0346	2		RESISTOR 10 1% .125W F [illegible]	24546	C4-1/8-T0-10R0-F
A8R30	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+ [illegible]00	24546	C4-1/8-T0-3831-F
A8R31	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R32	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A8R33	0757-0180	2		RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A8R34	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R35	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A8R36	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R37	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R38	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R39	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A8TP1	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A8TP2	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A8TP3	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A8U1	0955-0145	9		MIXER-DBL BALANCED FREQ=1 TO 1000 MHZ	28480	0955-0145
A8W1	08656-20018	6	1	CBL SEMI RGD 2	28480	08656-20018

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9						
A9	08656-60105 -60305	6	1	ATTENUATOR REPLACEMENT KIT	28480	08656-60105

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10						
2511A AND ABOVE						
A10	08656-60178	3	1	AUDIO/POWER SUPPLY ASSEMBLY	28480	08656-60178
2425A TO 2509A						
A10	08656-60128	3	1	AUDIO/POWER SUPPLY ASSEMBLY	28480	08656-60128
A10C1				NOT ASSIGNED		
A10C2				NOT ASSIGNED		
A10C3	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A10C4	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A10C5	0180-2821	9		CAPACITOR-FXD 22UF+-20% 35VDC TA	28480	0180-2821
A10C6	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A10C7	0180-2815	1	2	CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A10C8	0160-5035	1	1	CAPACITOR-FXD .051UF +-2% 100VDC	28480	0160-5035
A10C9	0160-5036	2	1	CAPACITOR-FXD .27UF +-2% 100VDC	28480	0160-5036
A10C10	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A10C11	0180-0375	4	1	CAPACITOR-FXD 68UF+-10% 20VDC TA	56289	150D686X9020B2
A10C12	0160-2225	5	1	CAPACITOR-FXD 2000PF +-5% 300VDC MICA	28480	0160-2225
A10C13	0160-0336	5	1	CAPACITOR-FXD 100PF +-1% 300VDC MICA	28480	0160-0336
A10C14	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A10C15	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A10C16	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A10C17	0160-4795	8	1	CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A10C18	0160-4807	3	1	CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A10C19	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A10C20	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A10C21	0160-4789	0		CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A10C22	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A10C23	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
2451A AND ABOVE						
A10C24	0160-3490	8	2	CAPACITOR-FXD 1UF +-20% 50VDC CER	28480	0160-3490
A10C25	0160-3490	8		CAPACITOR-FXD 1UF +-20% 50VDC CER	28480	0160-3490
2425A TO 2448A						
A10C24	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A10C25	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A10C26	0180-2874	2	3	CAPACITOR-FXD 3200UF+75-10% 40VDC AL	28480	0180-2874
A10C27	0180-2141	6	1	CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A10C28	0180-2874	2		CAPACITOR-FXD 3200UF+75-10% 40VDC AL	28480	0180-2874
A10C29	0180-2874	2		CAPACITOR-FXD 3200UF+75-10% 40VDC AL	28480	0180-2874
A10C30	0180-3209	9	1	CAPACITOR-FXD .024F + 75-10% 20VDC AL	28480	0180-3209
A10C31-A10C34				NOT ASSIGNED		
A10C35	0180-0097	7		CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035S2
A10C36	0180-2208	6		CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A10C37	0180-0097	7		CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035S2
A10C38	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A10C39	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A10C40	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A10C41	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A10C42	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A10C43	0160-5098	6		CAPACITOR-FXD .22UF +-10% 50VDC CER	28480	0160-5098
2451A AND ABOVE						
A10C44	0160-5098	6	1	CAPACITOR-FXD .22UF +-10% 50VDC CER	28480	0160-5098
2425A TO 2448A						
A10C44				NOT ASSIGNED		
A10CR1	1901-0880	7	4	DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A10CR2	1901-0040	1	4	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A10CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A10CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A10CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A10CR8	1901-0418	7	6	DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR9	1901-0418	7		DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR10	1901-0418	7		DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR11	1901-0418	7		DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR12	1901-0418	7		DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR13	1901-0418	7		DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A10CR14	1901-0028	5	6	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR16	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR17	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR19	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR20	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10CR21	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR22	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10DS1	1990-0835	9	5	LED-LAMP LUM-INT=6MCD IF=30MA-MAX BVR=5V	28480	HLMP-1523
A10DS2	1990-0835	9		LED-LAMP LUM-INT=6MCD IF=30MA-MAX BVR=5V	28480	HLMP-1523
A10DS3	1990-0835	9		LED-LAMP LUM-INT=6MCD IF=30MA-MAX BVR=5V	28480	HLMP-1523
A10DS4	1990-0835	9		LED-LAMP LUM-INT=6MCD IF=30MA-MAX BVR=5V	28480	HLMP-1523
A10DS5	1990-0835	9		LED-LAMP LUM-INT=6MCD IF=30MA-MAX BVR=5V	28480	HLMP-1523
A10F1	2110-0004	1	1	FUSE .25A 250V NTD 1.25X.25 UL	28480	2110-0004
	2110-0269	0	4	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A10F2	2110-0001	8	2	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A10F3	2110-0001	8		FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A10F4	2110-0010	9	1	FUSE 5A 250V NTD 1.25X.25 UL	75915	312005
	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
2511A AND ABOVE						
A10J1	1251-5671	5	2	CONNECTOR 20-PIN M POST TYPE	28480	1251-5671
A10J2	1251-5810	4	3	CONNECTOR 10-PIN M POST TYPE	28480	1251-5810
2425A TO 2509A						
A10J1	1251-5571	4	2	CONNECTOR 17-PIN M POST TYPE	28480	1251-5571
A10J2	1251-5569	4	3	CONNECTOR 7-PIN M POST TYPE	28480	1251-5569
A10J3	1251-5717	0	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-5717
A10J4	1251-5569	0		CONNECTOR 7-PIN M POST TYPE	28480	1251-5569
A10J5	1251-5569	0		CONNECTOR 7-PIN M POST TYPE	28480	1251-5569
A10J6	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A10K1	0490-1407	2	1	RLY 10A 4C 24VDC	28480	0490-1407
A10L1	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A10L2	9140-0142	8	1	INDUCTOR RF-CH-MLD 2.2UH 10% .105DX.26LG	28480	9140-0142
A10L3	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A10MP1	1400-0482	3	6	CABLE TIE .062-3-DIA .14-WD NYL	28480	1400-0482
A10MP2	1400-0966	8		CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A10Q1	1884-0244	9	1	THYRISTOR-SCR VRRM=400	3L585	S2600D
	1205-0361	3	1	HEAT SINK SGL TO-5/TO-39-CS	13103	2226C
A10Q2	1855-0292	6	2	TRANSISTOR J-FET 2N5432 N-CHAN D-MODE	17856	2N5432
A10Q3	1884-0018	5	1	THYRISTOR-SCR 2N4186 VRRM=200	04713	2N4186
A10Q4				NOT ASSIGNED		
A10Q5	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q7	1855-0292	6		TRANSISTOR J-FET 2N5432 N-CHAN D-MODE	17856	2N5432
A10Q8	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q9	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q10	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q11	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A10Q12	1855-0253	9	1	TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0253
A10R1	0757-0814	9	1	RESISTOR 511 1% .5W F TC=0+-100	28480	0757-0814
A10R2	2100-0568	1	2	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568
A10R3	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A10R4	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A10R5				NOT ASSIGNED		
A10R6				NOT ASSIGNED		
A10R7				NOT ASSIGNED		
A10R8	0698-6295	6	2	RESISTOR 300 .1% .125W F TC=0+-50	28480	0698-6295
A10R9	0698-6295	6		RESISTOR 300 .1% .125W F TC=0+-50	28480	0698-6295
A10R10	0698-3160	8	1	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A10R11	0698-4015	4	2	RESISTOR 600 .5% .125W F TC=0+-100	24546	C4-1/8-T0-600R-D
A10R12	0699-0073	8		RESISTOR 10M 1% .125W F TC=0+-150	28480	0699-0073
A10R13	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R14	0698-4015	4		RESISTOR 600 .5% .125W F TC=0+-100	24546	C4-1/8-T0-600R-D
A10R15	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10R16	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A10R17	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R18	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A10R19	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A10R20	0757-0462	3		RESISTOR 75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7502-F
A10R21	0757-0461	2	1	RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6812-F
A10R22	0698-3457	6		RESISTOR 316K 1% .125W F TC=0+-100	28480	0698-3457
A10R23	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R24	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A10R25	0698-6983	9	5	RESISTOR 20.4K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2042-B
A10R26	0698-6983	9		RESISTOR 20.4K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2042-B
A10R27	0757-0420	3	1	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A10R28	2100-0568	1		RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568
A10R29	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A10R30	0698-8827	4	3	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A10R31	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R32	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R33	0698-6983	9		RESISTOR 20.4K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2042-B
A10R34	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A10R35	0757-0464	5	1	RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-F
A10R36	0698-6320	8	2	RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A10R37	0698-8863	8	2	RESISTOR 5.2K .1% .125W F TC=0+-25	28480	0698-8863
A10R38	2100-0558	9	2	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	28480	2100-0558
A10R39	2100-3210	6		RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	28480	2100-3210
A10R40	0698-8863	8		RESISTOR 5.2K .1% .125W F TC=0+-25	28480	0698-8863
A10R41	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A10R42	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A10R43	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A10R44	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A10R45	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R46	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R47	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A10R48	0698-3454	3		RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A10R49	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R50	0698-4475	0	1	RESISTOR 9.76K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9761-F
A10R51	0698-3266	5		RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A10R52	2100-3253	7	1	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	28480	2100-3253
A10R53	0698-3266	5		RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A10R54	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A10R55	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
2425A TO 2635A A10R56	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
2637A AND ABOVE A10R56	0757-0405	4	1	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-TO-162R-F
A10R57	0698-6983	9		RESISTOR 20.4K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2042-B
A10R58	0698-6983	9		RESISTOR 20.4K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2042-B
A10R59	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A10R60	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R61	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A10R62	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A10R63	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	28480	2100-3212
A10R64	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A10R65	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A10R66	2100-0567	0	1	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	28480	2100-0567
A10R67	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A10R68	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A10R69	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A10R70	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R71	0698-3459	8	1	RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A10R72	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A10R73	2100-0558	9		RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	28480	2100-0558
A10R74	0698-7394	8	1	RESISTOR 698 .1% .125W F TC=0+-25	19701	MF4C1/8-T9-698R-R
A10R75	0698-6347	9	1	RESISTOR 1.5K .1% .125W F TC=0+-25	28480	0698-6347
A10R76	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A10R77	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A10R78-A10R82				NOT ASSIGNED		
A10R83	0698-3405	4	1	RESISTOR 422 1% .5W F TC=0+-100	28480	0698-3405

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10R84	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A10R85	0698-3407	6	3	RESISTOR 1.96K 1% .5W F TC=0+-100	28480	0698-3407
A10R86	0698-3407	6		RESISTOR 1.96K 1% .5W F TC=0+-100	28480	0698-3407
A10R87	0698-3407	6		RESISTOR 1.96K 1% .5W F TC=0+-100	28480	0698-3407
A10R88				NOT ASSIGNED		
A10R89				NOT ASSIGNED		
A10R90	0757-0816	1	1	RESISTOR 681 1% .5W F TC=0+-100	28480	0757-0816
A10R91-A10R100				NOT ASSIGNED		
A10R101	0757-1000	7	1	RESISTOR 51.1 1% .5W F TC=0+-100	28480	0757-1000
A10R102	2100-2010	2	1	RESISTOR-TRMR 10 20% C TOP-ADJ 1-TRN	73138	82PR10
A10R103	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A10R104	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A10R105	0757-0158	4	2	RESISTOR 619 1% .5W F TC=0+-100	28480	0757-0158
A10R106	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A10R107	0757-0158	4		RESISTOR 619 1% .5W F TC=0+-100	28480	0757-0158
A10R108	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A10R109	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A10TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10U1	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A10U2	1826-0203	8	1	IC 7815 V RGLTR TO-3	07263	7815KC
	2190-0007	2	2	WASHER-LK INTL T NO. 6 .141-IN-ID	28480	2190-0007
	2360-0195	0	5	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2360-0195
2451A AND ABOVE	0340-0875	9	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0875
2425A TO 2448A	0340-0858	8	1	INSULATOR-XSTR ALUMINUM HD-ANDZ	28480	0340-0858
A10U3	1820-2273	4	1	IC DRVR TTL OCTL	13606	UDN2981A
A10U4	1826-0367	5	1	IC 78M05C V RGLTR TO-39	04713	MC78M05CG
	1205-0095	0	1	HEAT SINK SGL TO-5/TO-39-CS	30161	3225B
A10U5	1820-0471	0	1	IC INV TTL HEX 1-INP	01295	SN7406N
A10U6	1826-0462	1		IC CONV 10-B-D/A 16-DIP-C PKG	04713	MC3410CL
A10U7	1820-1730	6	6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U8				NOT ASSIGNED		
A10U9	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U10	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U11	1826-0462	1		IC CONV 10-B-D/A 16-DIP-C PKG	04713	MC3410CL
A10U12	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U13	1826-1202	9		IC 7533SPC1DAC 8	28480	1826-1202
A10U14	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A10U15	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U16	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A10U17	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A10U18	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A10U19	1826-0753	3	2	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A10U20	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A10U21	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A10U22	1826-0759	9	2	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A10U23	1826-0759	9		IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A10U24	1826-0932	0		IC OP AMP PRCN 8-DIP-C PKG	06665	OP-27FZ
A10VR1	1902-0957	1	2	DIODE-ZNR 9.1V 5% DO-35 PD=.4W TC=+.069%	28480	1902-0957
A10VR2	1902-0957	1		DIODE-ZNR 9.1V 5% DO-35 PD=.4W TC=+.069%	28480	1902-0957
A10VR3	1902-0064	1	1	DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05%	28480	1902-0064
A10VR4	1902-3381	1	1	DIODE-ZNR 68.1V 5% DO-7 PD=.4W TC=+.079%	28480	1902-3381
A10VR5				NOT ASSIGNED		

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10VR6	1902-0953	7	1	DIODE-ZNR 6.2V 5% DO-35 PD=.4W TC=+.053%	28480	1902-0953
A10VR7	1902-0777	3	1	DIODE-ZNR 1N825 6.2V 5% DO-7 PD=.4W	04713	1N825
A10W1	1251-4670	2		CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
	1258-0209	9	2	JUMPER-REMOVABLE 2 POSITION; .200 IN	28480	1258-0209
2511A AND ABOVE						
A10W2	1251-4670	2		CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
	1258-0209	9	2	JUMPER-REMOVABLE 2 POSITION; .200 IN	28480	1258-0209
2425A TO 2509A						
A10W2				NOT ASSIGNED		

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11						
2511A AND ABOVE						
A11	08656-60177	2	1	MICROPROCESSOR/MEMORY/HP-IB ASSEMBLY	28480	08656-60177
2425A TO 2509A						
A11	08656-60127	2	1	MICROPROCESSOR/MEMORY/HP-IB	28480	08656-60127
A11C1	0180-2207	5	1	CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A11C2	0180-0229	7	5	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A11C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C4	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A11C5	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A11C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A11C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C10	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A11C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C16	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A11C17	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C20	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A11C21	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A11C22	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A11C23	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C24	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
2511A AND ABOVE						
A11J1	1252-5671	5		CONNECTOR 20-PIN M POST TYPE	28480	1252-5671
2425A TO 2509A						
A11J1	1251-5571	4		CONNECTOR 17-PIN M POST TYPE	28480	1251-5571
A11J2	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A11J3	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
2511A AND ABOVE						
A11J4	1252-0597	6	1	CONNECTOR 16-PIN M POST TYPE	28480	1252-0597
A11J5	1252-5719	2	1	CONNECTOR 26-PIN M POST TYPE	28480	1252-5671
2425A TO 2509A						
A11J4	1251-5855	7	1	CONNECTOR 16-PIN M POST TYPE	28480	1251-5671
A11J5	1251-5671	5	1	CONNECTOR 20-PIN M POST TYPE	28480	1251-55671
A11MP1	1400-0966	8		CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A11Q1	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A11R1	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A11R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R3	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A11R4	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A11R5	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A11R6	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A11R7	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A11R8	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A11R9	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A11R10	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A11R11	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A11R12	0698-7239	0	1	RESISTOR 1.33K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1331-F
A11R13	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A11R14	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A11R15	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A11R16	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A11S1	3101-2172	0	1	SWITCH-TGL DIP-RKR-ASSY SPDT .05A 30VDC	28480	3101-2172
A11S2	3101-2482	5		SWITCH-RKR DIP-RKR-ASSY 3PDT .05A 30VDC	28480	3101-2482
A11S3	3101-2135	5	1	SWITCH-RKR DIP-RKR-ASSY DPDT .05A 30VDC	28480	3101-2135
A11TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11U1	1820-2024	3	1	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A11U2	1820-1240	3	2	IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A11U3	1818-0701	4	2	IC NMOS 1024 (1K) STAT RAM 360-NS 3-S	04713	MCM68A10P
A11U4	1818-0701	4		IC NMOS 1024 (1K) STAT RAM 360-NS 3-S	04713	MCM68A10P
A11U5	1200-0567	1	1	SOCKET-IC 28-CONT DIP DIP-SLDR NOT SEPARATELY REPLACEABLE; P/O A9 ATTENUATOR REPLACEMENT KIT	28480	1200-0567
A11U6	1820-2102	8	1	IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
A11U7	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A11U8	1820-1759	9	4	IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A11U9	1820-2099	2	1	IC MICPROC NMOS 8-BIT	04713	MC6802P
A11U10	1820-2075	4	2	IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
	1200-0654	7	2	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A11U11	1820-1416	5	1	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A11U12	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A11U13	1820-1491	6	1	IC BFR TTL LS NON-INV HEX 1-INP	01295	SN74LS367AN
A11U14	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A11U15	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A11U16	1820-2219	8	1	IC MICPROC-ACCESS NMOS 8-BIT	04713	MC68488P
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A11U17	1820-1759	9		IC BFR TTL LS NON-INV OCTL	27014	DM81LS97N
A11U18	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A11U19	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A11U20	1820-1689	4	4	IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A11U21	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A11U22	1820-1240	3		IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A11U23	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A11U24	1820-1689	4		IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A11U25	1820-1689	4		IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A11U26	1820-1422	3		IC MV TTL LS MONOSTBL RETRIG	01295	SN74LS122N
A11U27	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A11U28	1820-1689	4		IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A11U29	1820-1568	8	1	IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A11U30	1820-2056	1		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS378N
A11U31	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A11VR1	1902-0983	3	1	DIODE-ZNR 1N4621 3.6V 5% DO-14 PD=.25W	01281	1N4621
A11Y1	0410-1180	0		CRYSTAL-QUARTZ 4.000 MHZ HC-18/U-HLDR	28480	0410-1180

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12						
2511A AND ABOVE						
A12				NOT ASSIGNED		
2425A TO 2509A						
A12	08656-60016	8	1	VOLTAGE REGULATOR ASSEMBLY	28480	08656-60016
A12C1	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A12C2	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A12C3	0180-0116	1	2	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A12C4	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A12C5	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A12C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A12J1	1251-5810	4	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-5810
A12MP1	1251-3402	6	8	CONNECTOR-SGL CONT SKT .04-IN-BSC-SZ RND	28480	1251-3402
A12MP2	08660-40002	6	4	INSULATOR TO3	28480	08660-40002

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A13						
2511A AND ABOVE						
A13				NOT ASSIGNED		
2425A TO 2509A						
A13	08656-60136	3	1	HP-IB CONNECTOR ASSEMBLY	28480	08656-60136
A13J1				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A13J2	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A13MP1	0380-0644	4	2	STANDOFF-HEX .327-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A13MP2	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A13MP3	2190-0034	5	17	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
A13MP4	2200-0109	8	2	SCREW-MACH 4-40 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13MP5	2260-0009	3		NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14						
2511A AND ABOVE A14				NOT ASSIGNED		
2425A TO 2509A A14	08656-60135	2	1	FILTER BANK ASSEMBLY	28480	08656-60135
A14J1	1251-5880	8	1	CONNECTOR 15-PIN M D SUBMINIATURE	28480	1251-5880
A14J2	1251-4966	9	2	CONNECTOR 8-PIN M POST TYPE	28480	1251-4966
A14J3	1251-4966	9		CONNECTOR 8-PIN M POST TYPE	28480	1251-4966

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A15						
2425A TO 2509A *A15*	0960-0448	6	1	LINE MODULE-FILTERED	28480	0960-0448
	0360-0001	5	4	TERMINAL-SLDR LUG LK-MTG FOR- 6-SCR	28480	0360-0001
	7121-4777	1	2	LABEL-INFORMATION .21-IN-WD 2.33-IN-LG	28480	7121-4777
2511A AND ABOVE *A15*	0960-0679	5	1	LINE MODULE-FILTERED	28480	0960-0679

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A16						
A16				10MHZ REFERENCE OSCILLATOR ASSEMBLY		
	0950-0411	2	1	10 MHZ; OVENIZED; LESS THAN 2.5 X	28480	0950-0411
	0360-0053	7	2	TERMINAL-SLDR LUG LK-MTG FOR- 10-SCR	28480	0360-0053
	8150-0447	6	1	WIRE 24 AWG BK 300V PVC 7X32 80C	28480	8150-0447
2511A AND ABOVE						
A16W1	08656-60166	9	1	CABLE-COAXIAL, REF. OSC./A16J1	28480	08656-60166
2425A TO 2509A						
A16W1	08656-60066	8	1	CABLE-COAXIAL, REF. OSC./A16J1	28480	08656-60066
A16W2	8120-2682	2	1	CABLE-COAXIAL, A16J1/J3	28480	8120-2682

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A17						
2511A AND ABOVE A17				NOT ASSIGNED		
2425A TO 2509A A17	08656-60081	7	1	FRONT FEEDTHRU ASSEMBLY	28480	08656-60081
	1251-3835	9	1	CONNECTOR 9-PIN M POST TYPE	28480	1251-3835

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A18						
2511A AND ABOVE A18				NOT ASSIGNED		
2425A TO 2509A A18	08656-60113	6	1	FRONT FEEDTHRU ASSEMBLY	28480	08656-60113
	1251-4244	6	1	CONNECTOR 11-PIN M POST TYPE	28480	1251-4244

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A19						
2511A AND ABOVE A19				NOT ASSIGNED		
2425A TO 2509A A19	08656-60122	7	1	REAR FEEDTHRU ASSEMBLY	28480	08656-60122
A19J1	1251-5922	9		CONNECTOR 14-PIN M POST TYPE	28480	1251-5922

See introduction to this section for ordering information.

* Indicates factory selected value

Table 6-3. Replaceable Parts

SERIAL PREFIX 2425A TO 2509A

MISCELLANEOUS PARTS

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
B1	3160-0447	2	1	FAN TBAX 45-CFM	28480	3160-0447
C1	0160-4900	7	19	CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C2	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C3	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C4	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C5	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C6	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C7	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C8	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C9	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C10	0160-4082	6		CAPACITOR-FDTHRU 1000PF 20% 200V CER	28480	0160-4082
C11	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C12	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C13	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C14	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C15	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C16	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C17	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C18	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C19	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C20	0160-4900	7		CAPACITOR-FDTHRU 1000PF +80 -20% 200V	72982	2425-011-X5U0-102-M
C21	0160-4898	2	2	CAPACITOR-FDTHRU 100PF +80 -20% 200V CER	72982	2425-011-X5U0-101-M
C22	0160-4898	2		CAPACITOR-FDTHRU 100PF +80 -20% 200V CER	72982	2425-011-X5U0-101-M
C23				NOT ASSIGNED		
F1	2110-0043	8	1	FUSE 1.5A 250V NTD 1.25X.25 UL (FOR 100, 120, 220, OR 240V OPERATION)	28480	2110-0043
FL1	08656-60005	5	1	BD AY BP FILTER	28480	08656-60005
FL2	9135-0099	3	4	FLTR LP .1G 200V	28480	9135-0099
	3050-0722	3	4	WASHER-FL MTLC NO. 8 .166-IN-ID	28480	3050-0722
FL3	9135-0099	3		FLTR LP .1G 200V	28480	9135-0099
	3050-0722	3		WASHER-FL MTLC NO. 8 .166-IN-ID	28480	3050-0722
J1	1250-0118	3	9	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "MOD INPUT/OUTPUT" (EXCEPT OPTION 002)	28480	1250-0118
	2190-0016	3	6	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J2	08662-60304	5	1	RF CONNECTOR ASSEMBLY "RF OUTPUT" (FRONT PANEL EXCEPT OPT 002)	28480	08662-60304
J2	1250-0538	1	1	RF CONNECTOR ASSEMBLY "RF OUTPUT" (P/O W23 NOT SEPARATELY REPLACEABLE OPTION 002 ONLY)	28480	1250-0538
J3	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "TIME BASE INPUT"	28480	1250-0118
	0360-1190	5	3	TERMINAL-SLDR LUG PL-MTG FOR- 3/8-SCR	28480	0360-1190
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J4	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "TIME BASE OUTPUT"	28480	1250-0118
	0360-1190	5		TERMINAL-SLDR LUG PL-MTG FOR- 3/8-SCR	28480	0360-1190
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J5	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "SEQ" (EXCEPT OPTION 002)	28480	1250-0118
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J6	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "MOD INPUT/OUTPUT" (OPTION 002 ONLY)	28480	1250-0118
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2425A TO 2509A		
L1	9100-2257	6	2	INDUCTOR RF-CH-MLD 820NH 10% .105DX.26LG	28480	9100-2257
L2	9100-2257	6		INDUCTOR RF-CH-MLD 820NH 10% .105DX.26LG	28480	9100-2257
L3	9135-0095	9	2	INDUCTOR 143UH 5% (STANDARD ONLY)	28480	9135-0095
L4	9135-0095	9		INDUCTOR 143UH 5% (OPTION 002 ONLY)	28480	9135-0095
MP1	08656-20100	7	1	FRAME, MACHINED	28480	08656-20100
MP2	5040-7202	9	1	TRIM STRIP, TOP FRONT	28480	5040-7202
MP3	5001-0439	8	2	TRIM STRIP, SIDE FRONT	28480	5001-0439
2425A TO 2451A MP4	08656-00004	6	1	COVER, TOP EXTERNAL	28480	08656-00004
2508A TO 2509A MP4	08656-00156	1	1	COVER, TOP EXTERNAL	28480	08656-00156
MP5	7120-8346	6	4	LABEL, "FRONT"	28480	7120-8346
MP6	08656-00034	4	1	HINGE, TOP	28480	08656-00034
MP7	1460-1761	9	2	SPRING-CPRSN .36-IN-OD 1.5-IN-OA-LG MUW	28480	1460-1761
MP8	2740-0003	5	18	NUT-HEX-W/LKWR 10-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP9	3050-0002	2	21	WASHER-FL MTLC NO. 10 .203-IN-ID	28480	3050-0002
MP10	0363-0159	0	2	RFI STRIP-FINGERS BE-CU ZINC PLATED	28480	0363-0159
MP11	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP12	08656-00115	2	1	RF COVER, TOP INTERNAL	28480	08656-00115
MP13	08656-40001	9	1	COVER, SIDE EXTERNAL	28480	08656-40001
MP14	5060-9803	2	2	STRAP HANDLE	28480	5060-9803
2425A TO 2451A MP15	08656-20102	9	2	HANDLE CAP, FRONT	28480	08656-20102
MP16	08656-20103	0	2	HANDLE CAP, REAR	28480	08656-20103
2508A TO 2509A MP15	5040-7234	7	2	HANDLE CAP, FRONT	28480	5040-7234
MP16	5040-7234	7	2	HANDLE CAP, REAR	28480	5040-7234
MP17	2680-0118	5	4	SCREW-MACH 10-32 .5-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP18				NOT ASSIGNED		
MP19				NOT ASSIGNED		
MP20	08656-00100	5	2	HINGE LOCK	28480	08656-00100
MP21				NOT ASSIGNED		
MP22	08656-00109	4	1	RF COVER, BOTTOM INTERNAL	28480	08656-00109
MP23	08656-00059	3	1	HINGE, BOTTOM	28480	08656-00059
2425A TO 2451A MP24	08656-00005	9	1	COVER, BOTTOM EXTERNAL	28480	08656-00005
2508A TO 2509A MP24	08656-00157	2	1	COVER, BOTTOM EXTERNAL	28480	08656-00157
MP25	08656-20101	8	2	FOOT, FRONT	28480	08656-20101
MP26	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP27	5040-7201	8	2	FOOT, REAR	28480	5040-7201
MP28	0360-1665	9	1	TERMINAL STRIP 3-TERM PHEN 1.13-IN-L	28480	0360-1665
MP29	2190-0010	7	3	WASHER-LK EXT T NO. 8 .168-IN-ID	28480	2190-0010
MP30	2510-0133	5	3	SCREW-MACH 8-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP31	08656-00079	7	4	COVER INTERNAL RF	28480	08656-00079
MP32	08656-00080	0	2	COVER INTERNAL RF	28480	08656-00080
MP33	08656-00081	1	2	COVER INTERNAL RF	28480	08656-00081
MP34	08656-00082	2	2	COVER INTERNAL RF	28480	08656-00082
MP35	08656-00083	3	2	COVER INTERNAL RF	28480	08656-00083
MP36	08656-00084	4	2	COVER INTERNAL RF	28480	08656-00084
MP37	08656-00086	6	4	COVER INTERNAL RF	28480	08656-00086
MP38	08656-00087	7	2	COVER INTERNAL RF	28480	08656-00087
MP39	08656-00101	6	2	MODULATION SHIELD	28480	08656-00101
MP40				NOT ASSIGNED		
MP41	08565-40011	1	1	L-HOLE GROMMET	28480	08565-40011
MP42				NOT ASSIGNED		
MP43	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
MP44	08656-00146	9	1	ATTENUATOR MOUNTING BRACKET	28480	08656-00146
MP45	2200-0101	0	1	SCREW-MACH 4-40 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2425A TO 2509A		
MP46	0380-0004	0	2	SPACER-RND .188-IN-LG .18-IN-ID (BETWEEN A18 AND CASTING,	00000	ORDER BY DESCRIPTION
MP47	2510-0049	2	2	SCREW-MACH 8-32 .5-IN-LG PAN-HD-POZI (ATTACHES A18 TO CASTING)	00000	ORDER BY DESCRIPTION
	08656-00037	7		WALL CLIP SEMI-RIGID	28480	08656-00037
MP49	08656-00039	9	1	CLIP FEEDTHRU MLPR	28480	08656-00039
MP50				NOT ASSIGNED		
MP51	08656-00148	1	1	HEAT SINK (P/O A6Q6)	28480	08656-00148
MP52-MP99				NOT ASSIGNED		
MP100	08656-00149	2	1	FRONT DRESS PANEL (EXCEPT OPTION 002)	28480	08656-00149
	08656-00150	5	1	FRONT DRESS PANEL (OPTION 002 ONLY)	28480	08656-00150
MP101	08731-210	2	1	LOCK NUT	28480	08731-210
MP102				NOT ASSIGNED		
MP103				NOT ASSIGNED		
MP104				NOT ASSIGNED		
MP105	3050-0032	8	7	WASHER-FL MTLC NO. 8 .189-IN-ID	28480	3050-0032
MP106	1400-1008	1	1	MOUNT-LED 0.120 IN ID; 0.187 IN OD	28480	1400-1008
MP107	2360-0185	8	1	SCREW-MACH 6-32 .5-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP108	2360-0196	1	1	SCREW-MACH 6-32 .375-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
MP109	08656-00147	0	1	RF CONNECTOR BRACKET	28480	08656-00147
MP110	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
MP111	2590-0016	1	1	HEX NUT	28480	2590-0016
MP112	1400-0510	8	1	CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
MP113	08656-40009	7	1	FOOT, LEFT REAR	28480	08656-40009
MP114	2190-0017	4	2	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP115	3050-0139	6	2	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
MP116	2580-0004	6	2	NUT-HEX-DBL-CHAM 8-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP117				NOT ASSIGNED		
MP118				NOT ASSIGNED		
MP119	08656-00007	1	1	REAR PANEL (EXCEPT OPTION 002)	28480	08656-00007
	08656-00095	7	1	REAR PANEL (OPTION 002 ONLY)	28480	08656-00095
MP120	08656-00049	1	1	REAR PANEL GASKET (EXCEPT OPTION 002)	28480	08656-00049
	08656-00096	8	1	REAR PANEL GASKET (OPTION 002 ONLY)	28480	08656-00096
MP121	2360-0115	4	2	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP122				NOT ASSIGNED		
MP123	08656-00047	9	1	CORNER BRACKET, REAR PANEL	28480	08656-00047
	2260-0009	3	4	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	2200-0103	2	18	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
MP124	08656-00048	0	1	GASKET, CORNER BRACKET, REAR PANEL	28480	08656-00048
MP125	1200-0043	8	3	INSULATOR-XSTR ALUMINUM	28480	1200-0043
MP126	7120-4295	6	1	LABEL "HAZARDOUS VOLTAGE"	28480	7120-4295
MP127	08656-00064	0	1	BRACKET, XTAL	28480	08656-00064
MP128	08656-40013	3	1	SERIES REGULATOR COVER	28480	08656-40013
MP129	0361-1098	4	1	RIVET-PUSH IN TRUSS HEAD; BLACK NYLON	28480	0361-1098
MP130	2360-0199	4	2	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP131	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
MP132	2190-0034	5		WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
MP133	2680-0073	1	4	SCREW-MACH 10-32 2-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP134	0590-1245	8	4	NUT-SHMET-U-TP 6-32-THD .017-IN-THK	00000	ORDER BY DESCRIPTION
MP135	08656-80005	7	1	FINGER GUARD, INTERNAL (OPTION 001 ONLY)	28480	08656-80005
MP136	2190-0018	5	13	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
MP137	2360-0195	0		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2360-0195
MP138	08656-40010	0	1	FOOT, RIGHT REAR	28480	08656-40010
MP139	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP140	3160-0300	6	1	FINGER GUARD	28480	3160-0300
MP141	2360-0302	1	3	SCREW-MACH 6-32 1.625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP142	2360-0203	1	8	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP143	08656-00116	3	1	FAN SHROUD	28480	08656-00116
MP144	6960-0002	4	1	HOLE PLUG (EXCEPT OPTION 002)	28480	6960-0002
MP145	1400-0249	0	17	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-S
MP146	2510-0316	6	56	SCREW-MACH 8-32 .375-IN-LG PAN-HD-POZI (ATTACH BOARDS TO CASTING)	28480	2510-0316

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

SERIAL PREFIX 2425A TO 2509A

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP147	3050-0172	7	12	WASHER-FL NM NO. 10 .203-IN-ID (BETWEEN A5 AND CASTING)	28480	3050-0172
MP148	3050-0066	8	11	WASHER-FL MTLC NO. 6 .147-IN-ID (BETWEEN A7 AND CASTING)	28480	3050-0066
MP149	3050-0172	7		WASHER-FL NM NO. 10 .203-IN-ID (BETWEEN BOARD AND CASTING)	28480	3050-0172
MP150	7120-1254	1	1	LABEL, HP LOGO	28480	7120-1254
MP151				NOT ASSIGNED		
MP152	7120-5911	5	1	LABEL, "CAUTION METRIC THREADED FASTNERS..."	28480	7120-5911
MP153	7121-4587	1		LABEL, VOLTAGE INFORMATION	28480	7121-4587
MP154	08656-00135	6	1	ATTENUATOR COVER	28480	08656-00135
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0117	6		SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
T1	9100-4412	9	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-4412
U1	1826-1181	3	1	IC V RGLTR-FXD-POS 14.7/15.3V TO-3 PKG	28480	1826-1181
U2	1813-0361	2	1	IC V RGLTR-FXD-POS 4.85/5.25V TO-3 PKG		
U3	1826-0169	5	1	IC V RGLTR TO-3	27014	LM320K-15
U4	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
W1	08656-60045	3	1	WIRING HARNESS SW/LED A1J1 TO A2J2	28480	08656-60045
W2	08656-60098	6	1	DISPLAY HARNESS A2J2 TO A18J1	28480	08656-60098
W3	08656-60020	4	1	CABLE ASSEMBLY LF/MULT L A3A1J1 TO A8J4	28480	08656-60020
W4	08656-60148	7	1	HARNESS A7J1, A3J1 TO C11-20	28480	08656-60148
W5	08656-60019	1	1	CABLE ASSEMBLY COAX (8) A3J8 TO A8J3	28480	08656-60019
W6	08656-60028	2	1	WIRING HARNESS OTPT LOP A6J1 TO A4J1	28480	08656-60028
W7	08656-60027	1	1	WIRING HARNESS RF/RFI A7J2 TO A6J4/FL2, FL3	28480	08656-60027
W8	08656-20022	2	1	CABLE SEMI-RIGID 6 FL1 TO A4	28480	08656-20022
W9	08656-20019	7	1	CABLE SEMI-RIGID 3 A8 TO A4	28480	08656-20019
W10	08656-20023	3	1	CABLE SEMI-RIGID 7 A8 TO A6	28480	08656-20023
W11	08656-60159	0	1	RIBBON CABLE ASSEMBLY CONTROL A10J3 TO A9AT1, A9AT2	28480	08656-60159
W12	08656-60158	9	1	CABLE ASSEMBLY SEMI RIGID HET RF A6J7 TO A9J1	28480	08656-60158
W13	08656-60157	8	1	CABLE ASSEMBLY SEMI RIGID HET IF A9J3 TO A6J6	28480	08656-60157
W14	08656-60156	7	1	CABLE ASSEMBLY SEMI RIGID ATTN IN A6J5 TO A9J2	28480	08656-60156
W15	08656-60033	9	1	WIRING HARNESS AUD PR A11J1 TO A10J1	28480	08656-60033
W16	08656-60095	3	1	MAIN HARNESS (EXCEPT OPTION 002)	28480	08656-60095
	08656-60096	4	1	MAIN HARNESS (OPTION 002 ONLY)	28480	08656-60096
W17	08656-60155	6	1	CABLE ASSEMBLY SEMI RIGID A9J4 TO FRONT PANEL "RF OUT"	28480	08656-60155
	08656-00166	3		RFI CLIP OUTPUT 1	28480	08656-00166
	08656-00167	4		RFI CLIP OUTPUT 2	28480	08656-00167
	3050-0169	2		WASHER-SPR CRVD NO.6 .143-IN-ID	28480	3050-0169
	3050-0098	6		WASHER-FL MTLC NO.2 .094-IN-ID	28480	3050-0098
	0520-0131	2		SCREW-MACH 2-56 .438-IN-LG PAN-HD-POZI	28480	0520-0131
W18	8120-2946	1	1	CABLE ASSEMBLY 20C 28 AWG A11J6 TO A13J1	28480	8120-2946
W19	08656-60097	5	1	WIRING HARNESS REG/THRU R-P A14J1 TO A12J1 REAR PANEL J3 "SEQ" (EXCEPT OPTION 002)	28480	08656-60097
	08656-60142	1	1	WIRING HARNESS REG/THRU REAR PANEL A14J1 TO A12J1 (OPTION 002 ONLY)	28480	08656-60142
W20	8120-1378	1	1	POWER CABLE 3C 18G 8	28480	8120-1378
W21	08656-60161	4	1	CABLE ASSEMBLY SEMI-RIGID, A9J4 TO W23	28480	08656-60161
W22	08656-60146	5	1	COAX CABLE ASSEMBLY A3J7 TO C21 (93)/A3J6 TO C22 (95)	28480	08656-60146
W23	08656-20117	6	1	CABLE ASSEMBLY SEMI-RIGID, W21 TO REAR PANEL (OPTION 002 ONLY)	28480	08656-20117

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2511A AND ABOVE		
				MISCELLANEOUS PARTS		
2511A TO 2639A B1	3160-0352	8	1	FAN TBAX 41-CFM 28VDC 1500KV-DIEL	28480	3160-0352
2649A AND ABOVE B1	3160-0512	2	1	FAN TBAX 38.8-CFM	28480	3160-0512
C1-9				NOT ASSIGNED		
C10	0160-4082	6		CAPACITOR-FDTHRU 1000PF 20% 200V CER	28480	0160-4082
F1	2110-0043	8	1	FUSE 1.5A 250V NTD 1.25X.25 UL (FOR 100, 120, OPERATION)	28480	2110-0043
F1	2110-0001	8	1	FUSE 1A 250V NTD 1.25X.25 UL (FOR 220, 240, OPERATION)	28480	2110-0001
	08656-00179	8		LABEL-INFORMATION...... "4 V. LINE +5-10%;....."	28480	08656-00179
FL1	08656-60005	5	1	BD AY BP FILTER	28480	08656-60005
J1	1250-0118	3	9	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "MOD INPUT/OUTPUT" (INCLUDES ATTACHING HARDWARE)	28480	1250-0118
	2190-0016	3	6	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J2	08662-60304	5	1	RF CONNECTOR ASSEMBLY "RF OUTPUT" (FRONT PANEL, EXCEPT OPTION 002) (INCLUDES ATTACHING HARDWARE)	28480	08662-60304
	2190-0104	0	1	WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
	2950-0132	6	1	NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	08731-210	2	1	LOCK NUT	28480	08731-210
J2	1250-1811	5		RF CONNECTOR ASSEMBLY "RF OUTPUT" (REAR PANEL, OPTION 002 ONLY) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
J3	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "TIME BASE INPUT" (P/O W22) (DOES NOT INCLUDE ATTACHING HARDWARE)	28480	1250-0102
J3MP1	2190-0068	5		WASHER-LK-INTL T 1/2 IN .505-IN-ID	28480	2190-0068
J3MP2	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
J4	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "TIME BASE OUTPUT" (P/O W24) (DOES NOT INCLUDE ATTACHING HARDWARE)	28480	1250-0102
J4MP1	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
J4MP2	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
J5	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM "SEQ"	28480	1250-0118
J5MP1	2190-0104	0		WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
J5MP2	2950-0043	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J6				NOT ASSIGNED		
J7	1251-6835	5	1	CONNECTOR 24-PIN F AMP CHAMP (HP-IB) (P/O W18)	28480	1251-6835
L1	9135-0095	9	1	INDUCTOR 143UH 5%	28480	9135-0095
MP1	08656-20139	2	1	FRAME, MACHINED	28480	08656-20139
MP2	5040-7202	9	1	TRIM STRIP, TOP FRONT	28480	5040-7202
MP3	5001-0439	8	2	TRIM STRIP, SIDE FRONT	28480	5001-0439
MP4	08656-00156	1	1	COVER, TOP EXTERNAL	28480	08656-00156
MP5	0340-1119	6	4	INSULATOR COVER TO-3	28480	0340-1119
MP6	08656-00034	4	1	HINGE, TOP	28480	08656-00034
MP7	1460-1761	9	2	SPRING-CPRSN .36-IN-OD 1.5-IN-OA-LG MUW	28480	1460-1761
MP8	2740-0003	5	24	NUT-HEX-W/LKWR 10-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP9	3050-0002	2	29	WASHER-FL MTLC NO. 10 .203-IN-ID	28480	3050-0002
MP10	0363-0159	0	2	RFI STRIP-FINGERS BE-CU ZINC PLATED	28480	0363-0159

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2511A AND ABOVE		
MP11	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP12	08656-00115	2	1	RF COVER, TOP INTERNAL	28480	08656-00115
MP13	0380-1760	7	2	STANDOFF 1.00L 4-40	28480	0380-1760
MP14	5060-9803	2	2	STRAP HANDLE	28480	5060-9803
	3050-0225	1	4	WASHER-FL MTLC 1/4 IN .265-IN-ID	28480	3050-0225
MP15	5041-6834	3	4	HANDLE CAP, FRONT AND REAR	28480	5041-6834
MP16	2740-0001	3	11	NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
MP17	0515-1239	2	4	SCREW-MACH M5X 0.8 12MM-LG	00000	ORDER BY DESCRIPTION
MP18	8160-0351	2	2	RFI GASKET MNL/NRPN 3.2-MM-OD 44-MM-LG	28480	8160-0351
MP19	08656-20112	1	2	RETAINER-RFI GASKET	28480	08656-20112
MP20	08656-00100	5	2	HINGE LOCK	28480	08656-00100
MP21	8160-0350	1	1	RFI-GASKET MNL/NPRN 3.2-MM-OD 25-MM-LG	28480	8160-0350
MP22	08656-00109	4	1	RF COVER, BOTTOM INTERNAL	28480	08656-00109
MP23	08656-00059	3	1	HINGE, BOTTOM	28480	08656-00059
MP24	08656-00157	2	1	COVER, BOTTOM EXTERNAL	28480	08656-00157
MP25	08656-20101	8	2	FOOT, FRONT	28480	08656-20101
MP26	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP27	5040-7201	8	2	FOOT, REAR	28480	5040-7201
MP28	08656-00170	9	1	LABEL, IN AM ADJ	28480	08656-00170
MP29	7120-8130	6	2	LABEL, CAUTION	28480	7120-8130
2511A TO 2639A ***MP30***	7120-8607	2		LABEL, METRIC/INCH HARDWARE	28480	7120-8607
2649A AND ABOVE ***MP30***				NOT ASSIGNED		
MP31	08656-00079	7	4	COVER INTERNAL RF	28480	08656-00079
MP32	08656-00080	0	2	COVER INTERNAL RF	28480	08656-00080
MP33	08656-00081	1	2	COVER INTERNAL RF	28480	08656-00081
MP34	08656-00082	2	2	COVER INTERNAL RF	28480	08656-00082
MP35	08656-00083	3	2	COVER INTERNAL RF	28480	08656-00083
MP36	08656-00084	4	2	COVER INTERNAL RF	28480	08656-00084
MP37	08656-00086	6	4	COVER INTERNAL RF	28480	08656-00086
MP38	08656-00087	7	2	COVER INTERNAL RF	28480	08656-00087
MP39	08656-00101	6	2	MODULATION SHIELD	28480	08656-00101
MP40	08656-00154	9	1	PC BOARD SHIELD	28480	08656-00154
MP41	0520-0131	2		SCREW-MACH 2-56 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP42	3030-0189	4		SCREW-SKT HD CAP 4-40 .25-IN-LG SST	00000	ORDER BY DESCRIPTION
MP43	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
MP44	3050-0098	6	1	WASHER-FL MTLC NO.2 .094-IN-ID	28480	3050-0098
MP45	2200-0101	0	4	SCREW-MACH 4-40 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP46	08656-00167	4	1	RFI CLIP	28480	08656-00167
MP47	08656-00166	3	1	RFI CLIP	28480	08656-00166
MP48	08656-00037	7		WALL CLIP SEMI-RIGID	28480	08656-00037
MP49	08656-00039	9	1	CLIP FEEDTHRU MLPR	28480	08656-00039
MP50	2360-0125	6	8	SCREW-MACH 6-32 .75-IN-LG PAN-HD-POZI	28480	2360-0125
2511A TO 2622A ***MP51***	08656-00148	1	1	HEAT SINK (P/O A6Q6)	28480	08656-00148
2623A AND ABOVE ***MP51***	1205-0657	0		TRANSISTOR HEATSINK STUD	28480	1205-0657
	0380-1894	8		SPACER .125-L .166-ID	28480	0380-1894
2511A TO 2639A ***MP52***	7100-1283	4	1	COVER-TRANSFORMER 2.0X2.6	28480	7100-1283
2649A AND ABOVE ***MP52***	7100-1305	1	1	COVER-TRANSFORMER 2.0X2.6	28480	7100-1305

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2511A AND ABOVE		
MP53	1400-0031	8	2	CLAMP-CABLE .375-DIA .5-WD NYL	28480	1400-0031
2511A TO 2639A						
MP54	08656-00151	6	1	REAR PANEL	28480	08656-00151
MP55	2360-0191	6	1	SCREW-MACH 6-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCR
2649A AND ABOVE						
MP54	08656-00180	1	1	REAR PANEL	28480	08656-00180
MP55	0570-1031	8		STUD-PRS-IN 6-32 UNC-2A .357-IN-LG STL	28480	0570-1031
	2420-0003	7		NUT-HEX-DBL-CHAM 6-32-THD 0.94-IN-THK	00000	ORDER BY DESCRIPTION
MP56	0360-0001	4	1	TERMINAL-SLDR LUG LK-MTG FOR- 6-SCR	28480	0360-0001
MP57	2420-0003	7	4	NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
MP58	2190-0006	1	4	WASHER-LK HLCL NO.6 .141-IN-ID	28480	2190-0006
MP59	3050-0227	3	4	WASHER-FL MTLC NO.6 .149-IN-ID	28480	3050-0227
MP60	6960-0001	3	1	PLUG-HOLE DOME-HD FOR .375-D-HOLE STL	28480	6960-0001
MP61	0380-0644	4	2	STANDOFF-HEX .327-IN-LG 6-32THD	00000	0380-0644
MP62	0624-0206	2	2	SCREW-TPG 6-32 .25-IN-LG PAN-HD-POZI STL	28480	0624-0206
MP63	1400-0054	5	2	CLAMP-CABLE .078-DIA .375-WD STL	28480	1400-0054
MP64	08656-20166	5	2	HP-IB SHIELD	28480	08656-20166
MP65	7120-8346	6	2	LABEL, FRONT (P/O MP12 AND P/O MP22)	28480	7120-8346
MP66-99				NOT ASSIGNED		
MP100	08656-00171	0	1	FRONT DRESS PANEL (EXCEPT OPTION 002)	28480	08656-00149
	08656-00172	1	1	FRONT DRESS PANEL (OPTION 002 ONLY)	28480	08656-00150
MP101	0400-0018	0	1	GROMMET-CHAN NCH .052-IN-THK-PNL	28480	0400-0018
MP102	2420-0003	7		NUT-HEX-DBL-CHAM 6-32THD .094-IN-THK	00000	2420-0003
MP103	2190-0105	1		WASHER-LK HLCL NO.6 .141-IN-ID	28480	2190-0105
MP104				NOT ASSIGNED		
MP105	3050-0032	8	7	WASHER-FL MTLC NO. 8 .189-IN-ID	28480	3050-0032
MP106	1400-1008	1	1	MOUNT-LED 0.120 IN ID; 0.187 IN OD	28480	1400-1008
MP107	2360-0185	8	1	SCREW-MACH 6-32 .5-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP108	2360-0183	6	2	SCREW-MACH 6-32 .75-IN-LG BDG-HD-SLT	00000	ORDER BY DESCRIPTION
MP109	08656-00147	0	1	RF CONNECTOR BRACKET	28480	08656-00147
2511A TO 2523A						
MP110				NOT ASSIGNED		
MP111				NOT ASSIGNED		
2528A AND ABOVE						
MP110	0380-1088	2	6	STANDOFF-HEX .438-IN-LG 4-40-THD	28480	0380-1088
MP111	2200-0111	2	6	SCREW-MACH 4-40 .5-IN-LG PAN-HD-POZI	28480	2200-0111
MP112	1400-0510	8	8	CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
MP113-120				NOT ASSIGNED		
MP121	2360-0115	4	3	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP122	2360-0117	6		SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP123				NOT ASSIGNED		
MP124				NOT ASSIGNED		
MP125	5001-5501	5	4	TRANSISTOR-SPCR TO3	28480	5001-5501
MP126				NOT ASSIGNED		
MP127	2200-0105	4	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP128	0380-0533	0	2	STANDOFF-HEX 1-IN-LT 4-40-THD .25-IN-A/F	28480	0380-0533
MP129	7120-4296	7	1	LABEL,WARNING	28480	7120-4296
MP130				NOT ASSIGNED		
MP131	2200-0103	2	19	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
MP132	2190-0034	5	12	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
MP133	2680-0073	1	4	SCREW-MACH 10-32 2-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2511A AND ABOVE		
MP134				NOT ASSIGNED		
MP135				NOT ASSIGNED		
MP136	2190-0018	5	13	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
MP137				NOT ASSIGNED		
MP138				NOT ASSIGNED		
MP139				NOT ASSIGNED		
MP140	3160-0309	5	1	FINGER GUARD	4N833	12601-43 UL VERSION
MP141				NOT ASSIGNED		
2511A TO 2639A MP142	2360-0203	1	7	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2649A AND ABOVE MP142	2360-0219	9	4	SCREW-MACH 6-32 1.375-IN-LG PN-HD-POZI	00000	ORDER BY DESCRIPTION
MP143				NOT ASSIGNED		
MP144	6960-0002	4	4	HOLE PLUG (EXCEPT OPTION 001)	28480	6960-0002
MP145				NOT ASSIGNED		
MP146	2510-0045	8	56	SCREW-MACH 8-32 .375-IN-LG PAN-HD-POZI (ATTACH BOARDS TO CASTING)	00000	ORDER BY DESCRIPTION
MP147	3050-0172	7	6	WASHER-FL NM NO. 10 .203-IN-ID (P/O A5 ATTACHING HARDWARE)	28480	3050-0172
MP148	3050-0139	6	4	WASHER-FL MTLC NO.8 .172-IN-ID (P/O A5 ATTACHING HARDWARE)	28480	3050-0139
MP149	08656-00168	5	1	ATTENUATOR WRENCH	28480	08656-00168
MP150	7120-1254	1	1	LABEL, HP LOGO	28480	7120-1254
MP151	2360-0199	4	6	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2511A TO 2639A MP152				NOT ASSIGNED		
2649A AND ABOVE MP152	2360-0203	1	3	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
P1	1251-7045	1	1	CONNECTOR 15-PIN F D TYPE	28480	1251-7045
	1252-1045	1	6	CONTACT-CONN U/W-SUB MIN-D FEM CRP	28480	1252-1045
	1252-0653	5	7	CONTACT-CONN U/W-SUB MIN-D FEM CRP	28480	1252-0653
T1	9100-4412	9	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-4412
U1	1826-1181	3	1	IC V RGLTR-FXD-POS 14.7/15.3V TO-3 PKG	28480	1826-1181
U2	1813-0361	2	1	IC V RGLTR-FXD-POS 4.85/5.25V TO-3 PKG		
U3	1826-0169	5	1	IC V RGLTR TO-3	27014	LM320K-15
U4	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231

See introduction to this section for ordering information.

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
	SERIAL PREFIX 2511A AND ABOVE					
W1	08656-60045	3	1	WIRING HARNESS SW/LED A1J1 TO A2J2	28480	08656-60045
W2	08656-60170	5	1	RIBBON CABLE ASSEMBLY, A2J1 TO W16P4	28480	08656-60170
W3	08656-60020	4	1	CABLE ASSEMBLY, COAX (8), A3A1J1 (60-110 MHZ) TO A8J4	28480	08656-60020
W4	08656-60169	2	1	RIBBON CABLE ASSEMBLY, A3J1 AND A7J1 TO W16P3	28480	08656-60148
W5	08656-60019	1	1	CABLE ASSEMBLY COAX (8) A3J8 TO A8J3	28480	08656-60019
W6	08656-60028	2	1	WIRING HARNESS OTPT LOP A6J1 TO A4J1	28480	08656-60028
W7	08656-60171	6	1	RIBBON CABLE ASSEMBLY, W16P2 TO A6J4 A7J2 TO A6J4/FL2, FL3	28480	08656-60171
W8	08656-20022	2	1	CABLE SEMI-RIGID, 690-740 MHZ, FL1 TO A4	28480	08656-20022
W9	08656-20019	7	1	CABLE SEMI-RIGID, 690-740 MHZ, A8 TO A4	28480	08656-20019
W10	08656-20023	3	1	CABLE SEMI-RIGID, 800 MHZ, A8 TO A6	28480	08656-20023
W11	08656-60159	0	1	RIBBON CABLE ASSEMBLY CONTROL A10J3 TO A9AT1 AND A9AT2	28480	08656-60159
W12	08656-60158	9	1	CABLE ASSEMBLY SEMI RIGID HET RF A6J7 TO A9J1	28480	08656-60158
W13	08656-60157	8	1	CABLE ASSEMBLY SEMI RIGID HET IF A9J3 TO A6J6	28480	08656-60157
W14	08656-60156	7	1	CABLE ASSEMBLY SEMI RIGID ATTN IN A6J5 TO A9J2	28480	08656-60156
W15	08656-60172	7	1	RIBBON CABLE ASSEMBLY, A11J1 TO A10J1	28480	08656-60172
W16	08656-60163	6	1	MAIN HARNESS	28480	08656-60163
	0360-0037	7		TERMINAL-SLDR LUG PL-MTG FOR- 6-SCR	28480	0360-0037
	0362-0227	1	4	CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ	28480	0362-0227
W16P1	1251-7044	0		CONNECTOR 15-PIN M D TYPE	28480	1251-7044
	1252-0311	2	14	CONTACT-CONN U/W-POST-TYPE M CRP	28480	1252-0311
W16P2	1252-0461	3	1	CONNECTOR 9-PIN M	28480	1252-0461
W16P3	1252-0004	0		CONNECTOR 9-PIN M	28480	1252-0004
W16P4	1252-0004	0		CONNECTOR 9-PIN M	28480	1252-0004
W16P5	1251-5207	3		CONNECTOR 16-PIN F POST TYPE	28480	1251-5207
	1251-4182	1	14	CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
W16P6	1251-4968	1		CONNECTOR 7-PIN F POST TYPE	28480	1251-4968
	1251-3411	7	6	CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3411
	1251-3966	7	18	CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3966
W16P7	1251-4968	1		CONNECTOR 7-PIN F POST TYPE	28480	1251-4968
	1251-3411	7		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3411
	1251-3966	7		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3966
W16P8	1251-3537	8		CONNECTOR 10-PIN F POST TYPE	28480	1251-3537
	1251-3966	7		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3966
W17	08656-60155	6	1	CABLE ASSEMBLY SEMI RIGID A9J4 TO FRONT PANEL "RF OUT"	28480	08656-60155
W18	08656-60173	8	1	RIBBON CABLE ASSEMBLY, REAR PANEL HP-IB CONNECTOR TO A11J5	28480	08656-60173
	1251-2544	5	1	CONN POST TYPE .100/PN-SPCT 26-CONT	28480	1251-2544
2511A TO 2608A W19	08656-60160	3	1	REGULATOR WIRE HARNESS, W16P1 TO P1	28480	08656-60160
2612A AND ABOVE W19	08656-60260	4	1	REGULATOR WIRE HARNESS, W16P1 TO P1	28480	08656-60260
2511A TO 2523A W19C1	0180-0197	8	1	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	28480	0180-0197
2528A AND ABOVE W19C1	0180-2620	6	1	CAPACITOR-FXD 2.2UF +-10% 50VDC TA	28480	0180-2620
W19C2	0180-0291	3	1	CAPACITOR-FXD 4UF +75-10% 12VDC AL	28480	0180-0291
W19C3	0180-1735	2	1	CAPACITOR-FXD .22UF +-10% 35VDC TA	28480	0180-1735
2511A TO 2608A W19C4	0180-2205	3	1	CAPACITOR-FXD .33UF +-10% 35VDC TA	28480	0180-2205
W19C5				NOT ASSIGNED		
2612A AND ABOVE W19C4	0180-0291	3	2	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150DI05X9035A2
	0360-0001	3	2	TERMINAL-SLDR LUG LK-MTG FOR- 6-SCR	28480	0360-0001
W19C5	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2

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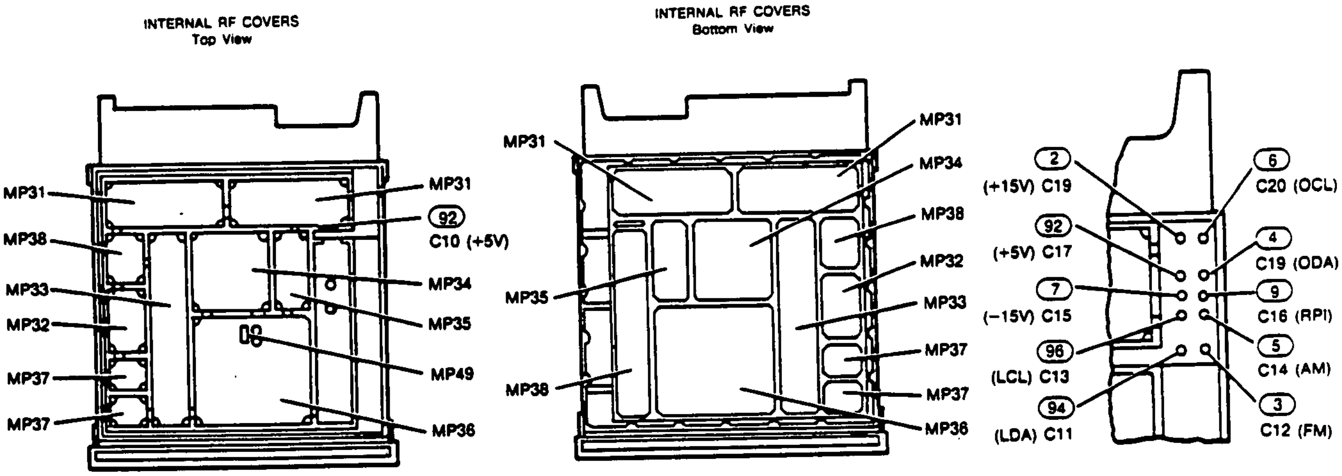
Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				SERIAL PREFIX 2511A AND ABOVE		
W19MP1	0360-0009	3	1	TERMINAL-SLDR LUG PL-MTG FOR- 6-SCR (P/O W19)	28480	0360-0009
W19MP2	1200-0630	9	4	SOCKET-XSTR 2-CONT TO-3 SLDR-EYE (P/O W19)	28480	1200-0630
W19P1	1252-0321	4		CONNECTOR RECT 15-PIN F (P/O W19)	28480	1252-0321
W19P2	1251-7044	0		CONNECTOR 15-PIN M D TYPE (P/O W19)	28480	1251-7044
W20	8120-1378	1	1	POWER CABLE 3C 18G 8	28480	8120-1378
W21	08656-60186	3	1	CABLE ASSEMBLY SEMI-RIGID, A9J4 TO W23 (OPTION 002 ONLY)	28480	08656-60186
W22	08656-60183	0	1	COAX CABLE ASSEMBLY (5), REAR PANEL J3 TO A3J6 "TIMEBASE INPUT" (INCLUDES J3)	28480	08656-60183
W23	08656-60187	4	1	CABLE ASSEMBLY SEMI-RIGID, W21 TO REAR PANEL (OPTION 002 ONLY)	28480	08656-60187
W24	08656-60184	1	1	CABLE ASSEMBLY COAX (3), A3J7 TO REAR PANEL J4 "TIMEBASE OUTPUT" (INCLUDES J4)	28480	08656-60184

See introduction to this section for ordering information. * Indicates factory selected value

Table 6-4. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75222
02114	FERROXCUBE CORP	SAUGERTIES NY	12477
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06383	PANDUIT CORP	TINLEY PARK IL	60477
06665	PRECISION MONOLITHICS INC	SANTA CLARA CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94042
13103	THERMALLOY CO	DALLAS TX	75234
13606	SPRAGUE ELECT CO SEMICONDUCTOR DIV	CONCORD NH	03301
16299	CORNING GLASS WKS COMPONENT DIV	RALEIGH NC	27604
17856	SILICONIX INC	SANTA CLARA CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
20932	EMCON DIV ITW	SAN DIEGO CA	92129
24046	TRANSITRON ELECTRONIC CORP	WAKEFIELD MA	01880
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN NL	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE NJ	
30161	AAVID ENGINEERING INC	LACONIA NH	03246
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE CA	92507
33095	SPECTRUM CONTROL INC	FAIRVIEW PA	16415
51642	CENTRE ENGINEERING INC	STATE COLLEGE PA	16801
51959	VICLAN INC	SAN DIEGO CA	92138
52063	EXAR INTEGRATED SYSTEMS INC	SUNNYVALE CA	94086
52763	STETTNER ELECTRONICS INC	CHATTANOOGA TN	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON CA	92634
74970	JOHNSON E F CO	WASECA MN	56093
75915	LITTELFUSE INC	DES PLAINES IL	60016
91506	AUGAT INC	ATTLEBORO MA	02703



NOTES:
1. ENCIRCLED NUMBERS INDICATE WIRING COLOR CODE.
2. INFORMATION IN PARENTHESIS INDICATES SIGNAL LINE BEING FILTERED.

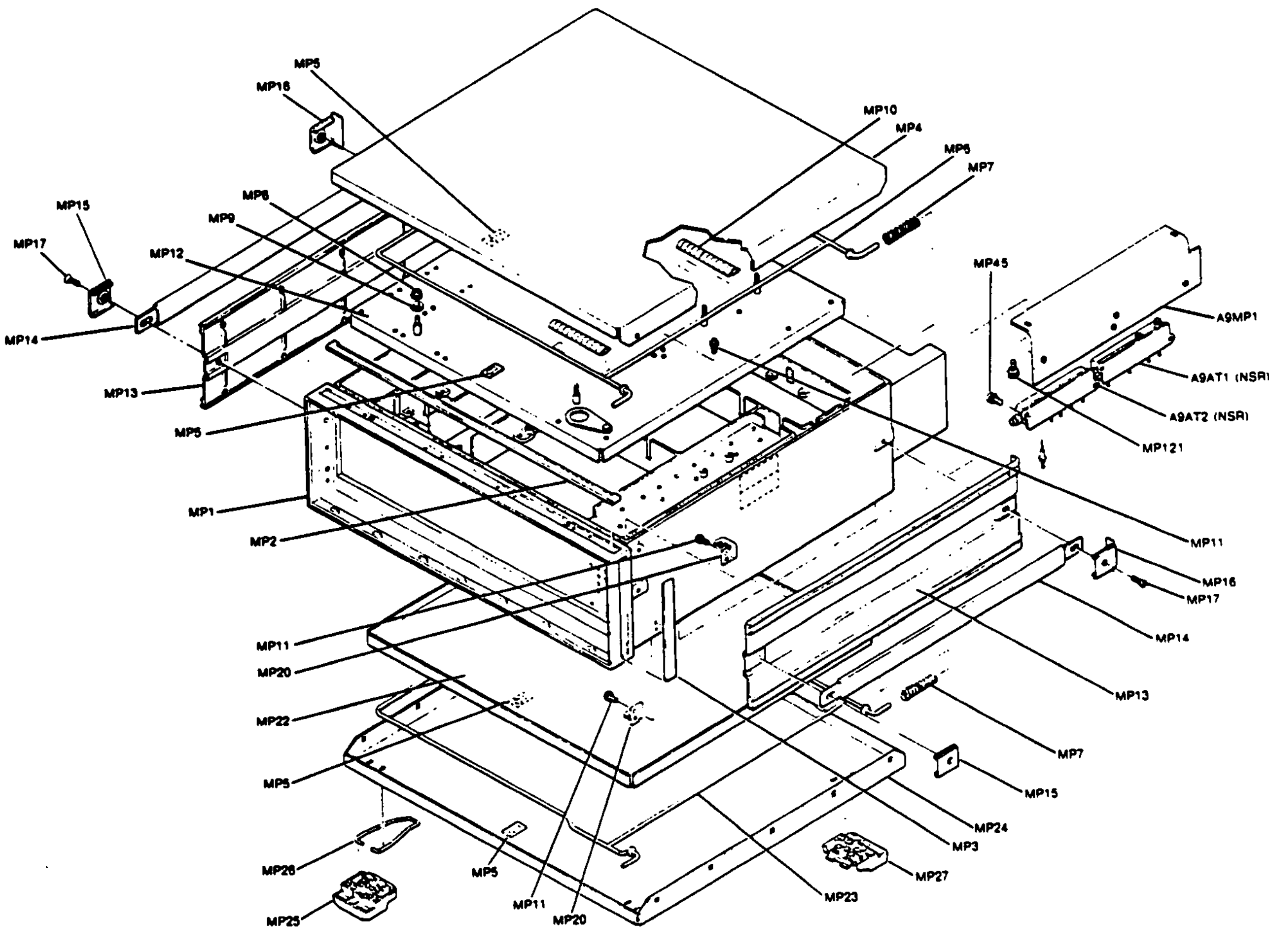


Figure 6-1 (2425A to 2509A). Cabinet, Parts Identification

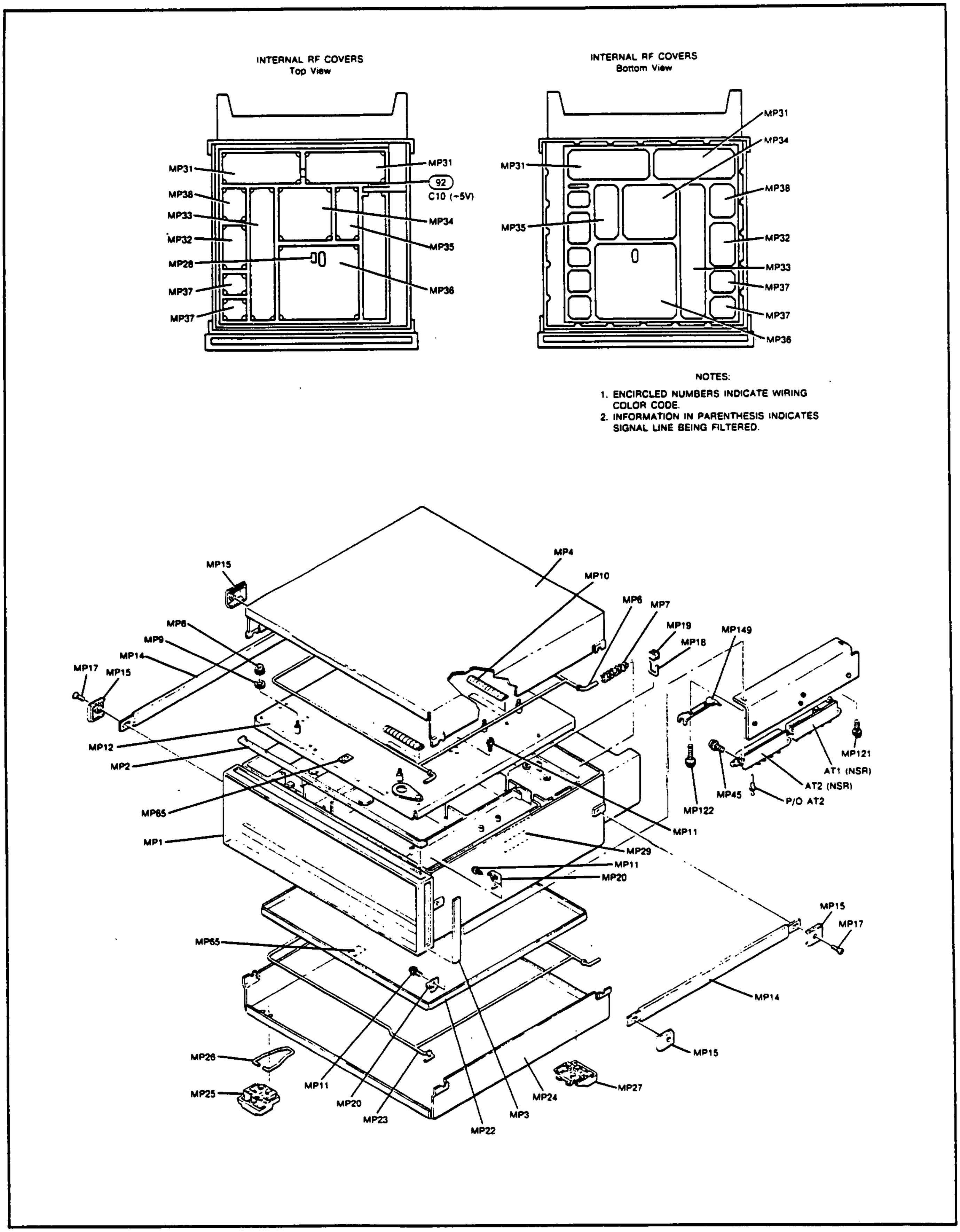


Figure 6-1 (2511A and above). Cabinet, Parts Identification

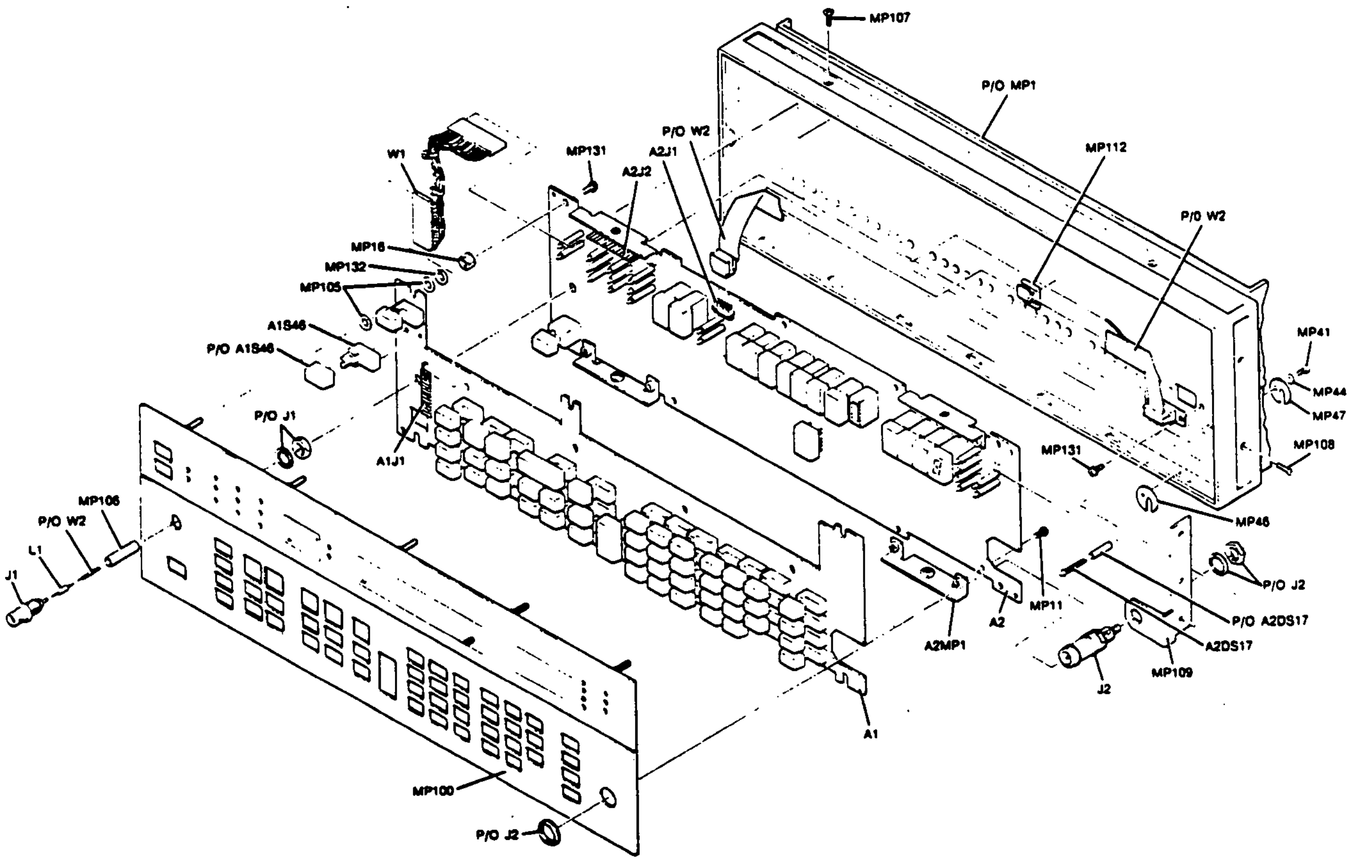
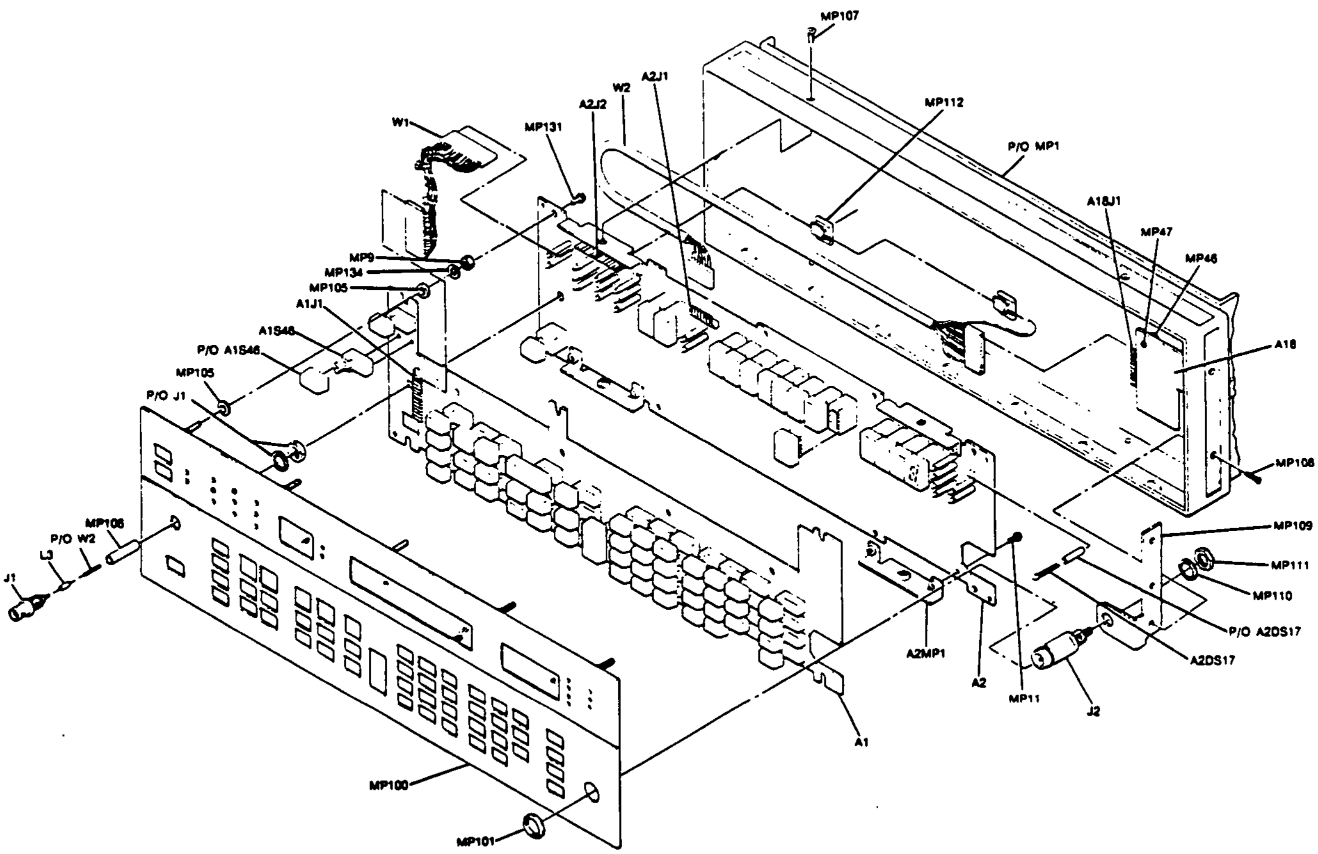


Figure 6-2 (2511A and above). Front-Panel, Parts Identification

Table 6-3. Replaceable Parts



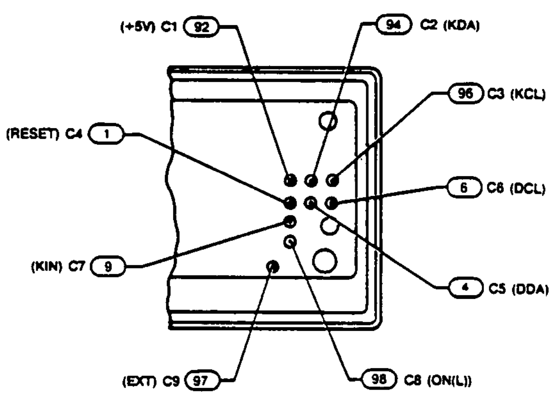


Figure 6-2 (2425A to 2509A). Front-Panel, Parts Identification

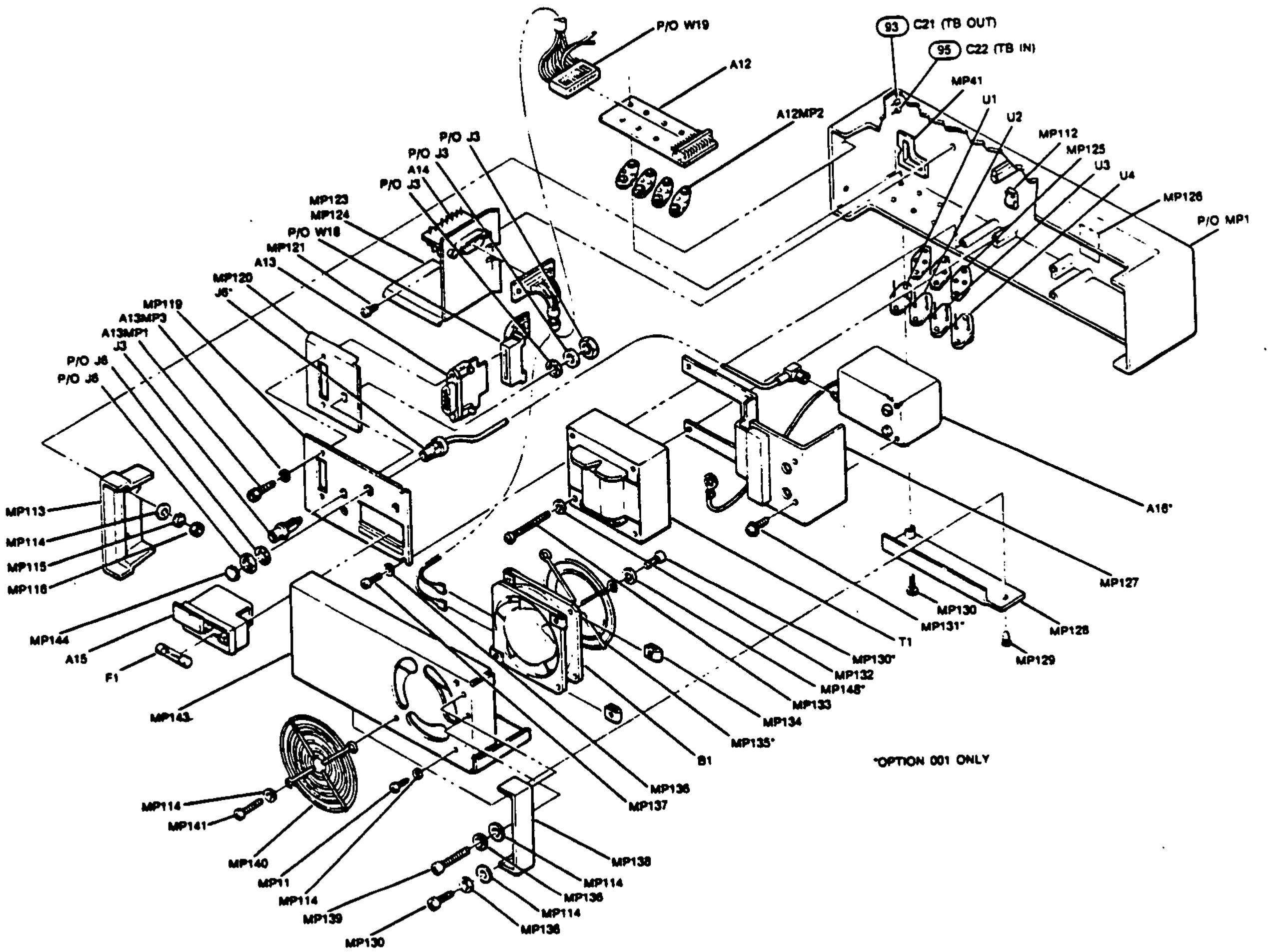


Figure 6-3 (2425A to 2509A). Rear-Panel, Parts Identification

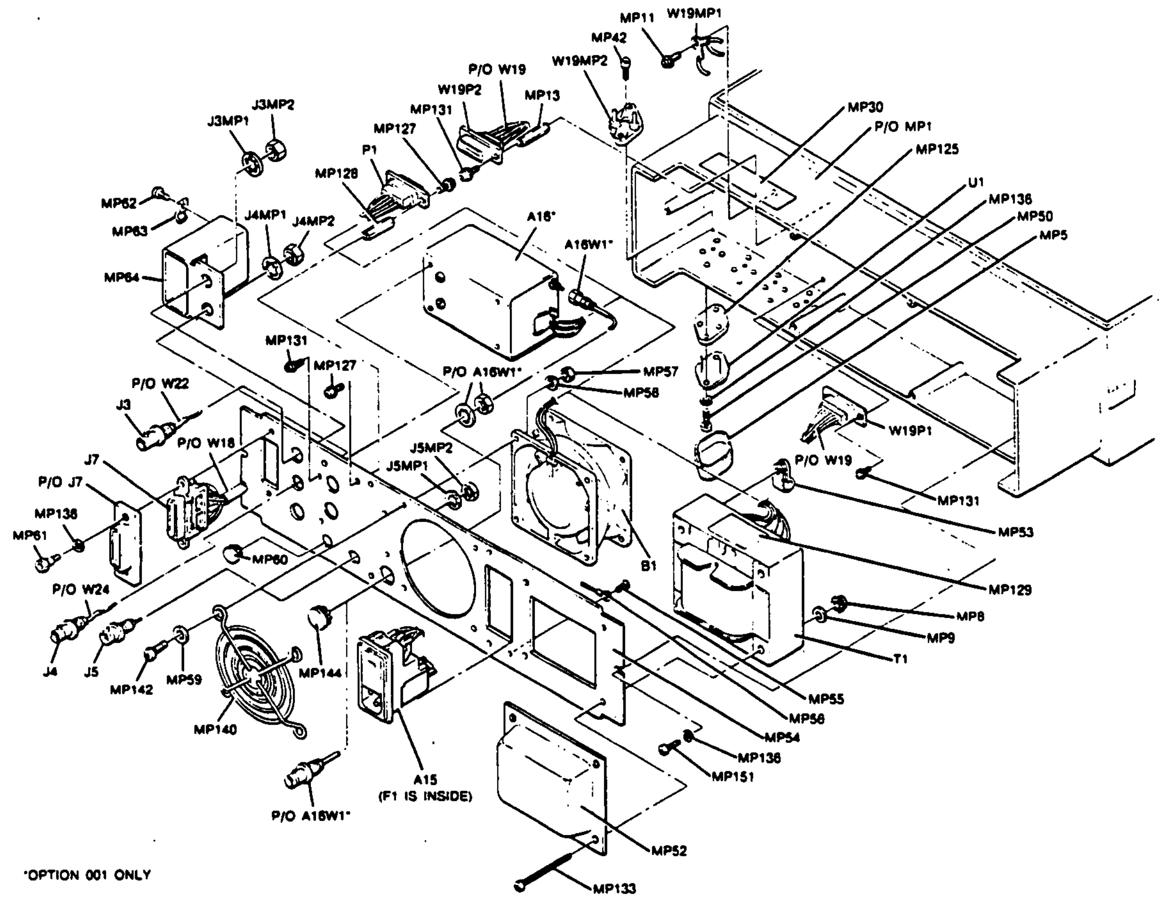


Figure 6-3 (2511A and above). Rear-Panel, Parts Identification

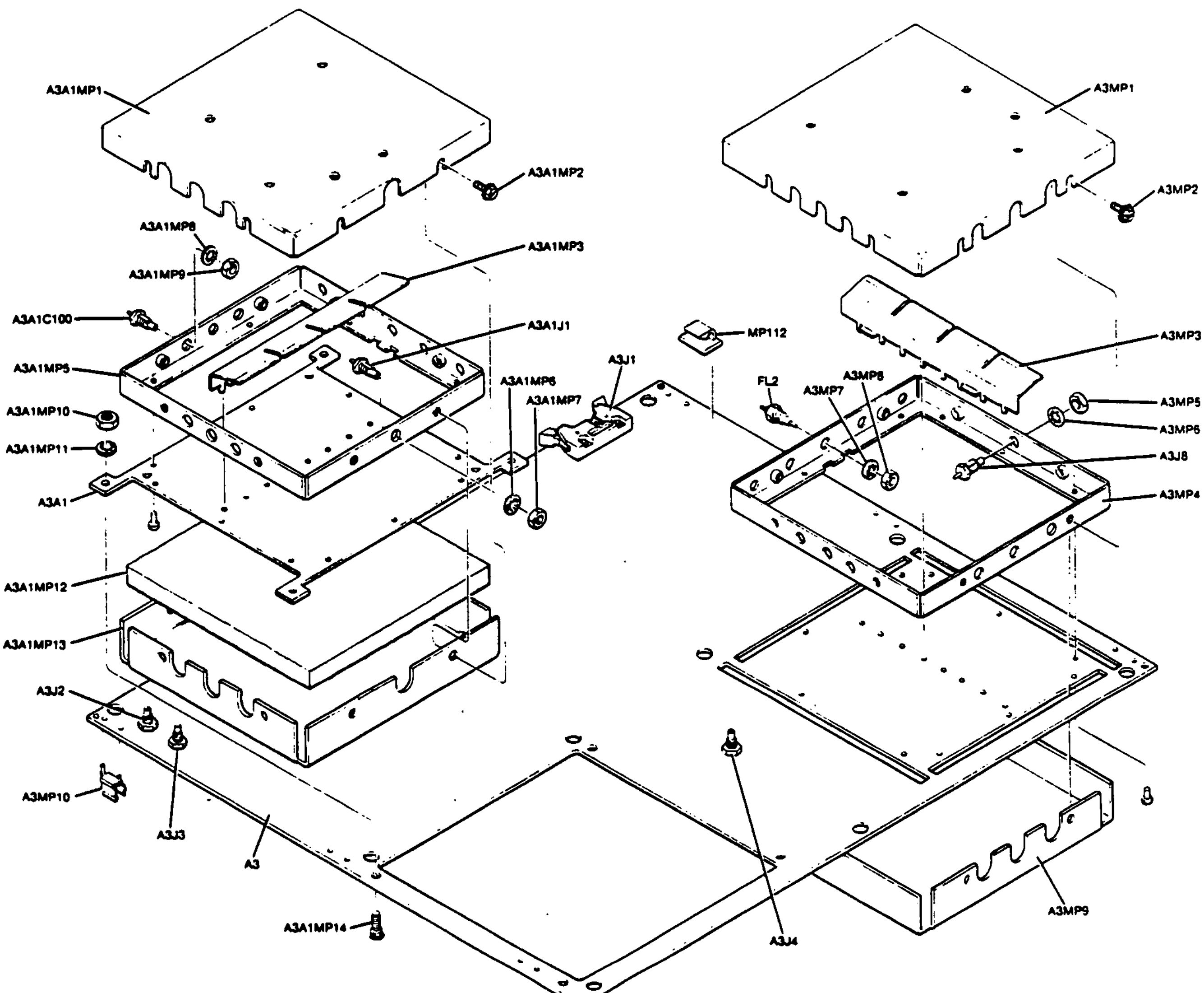


Figure 6-4 (2511A and above). Low Frequency Loop Assembly—A3, Parts Identification

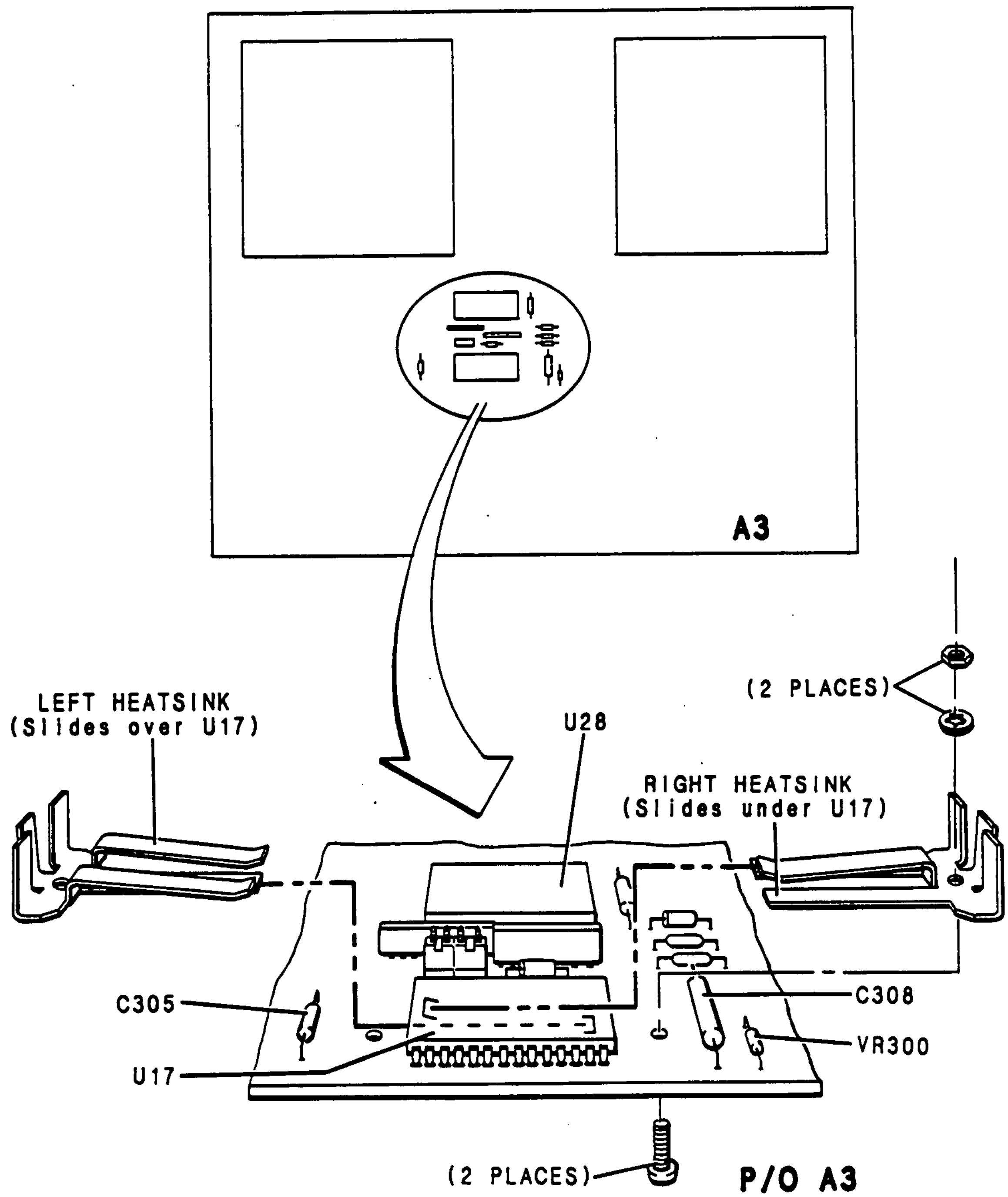


Figure 6-4 (2617A and above). Low Frequency Loop Assembly-A3, Parts Identification

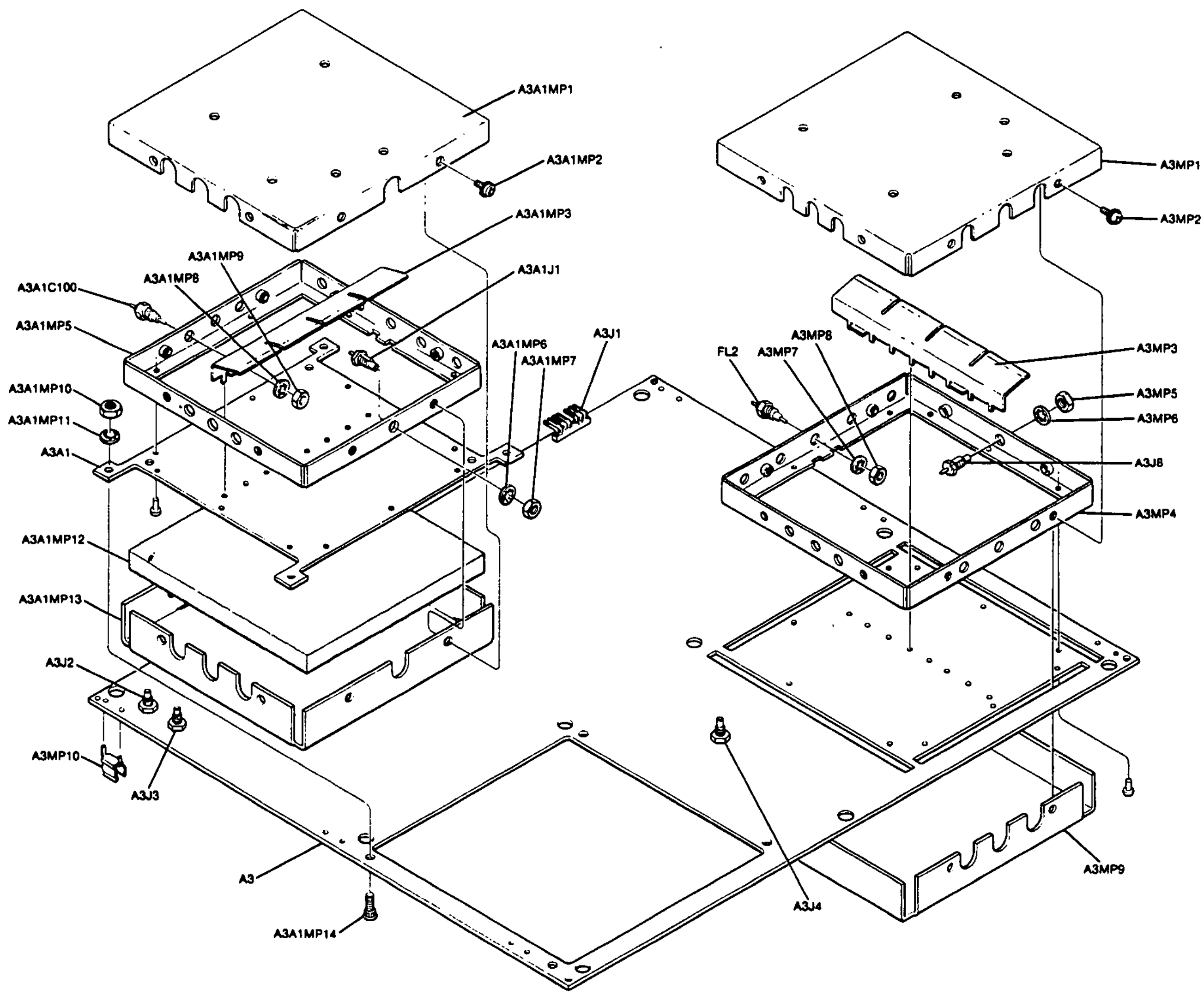


Figure 6-4 (2425A to 2509A). Low Frequency Loop Assembly—A3, Parts Identification

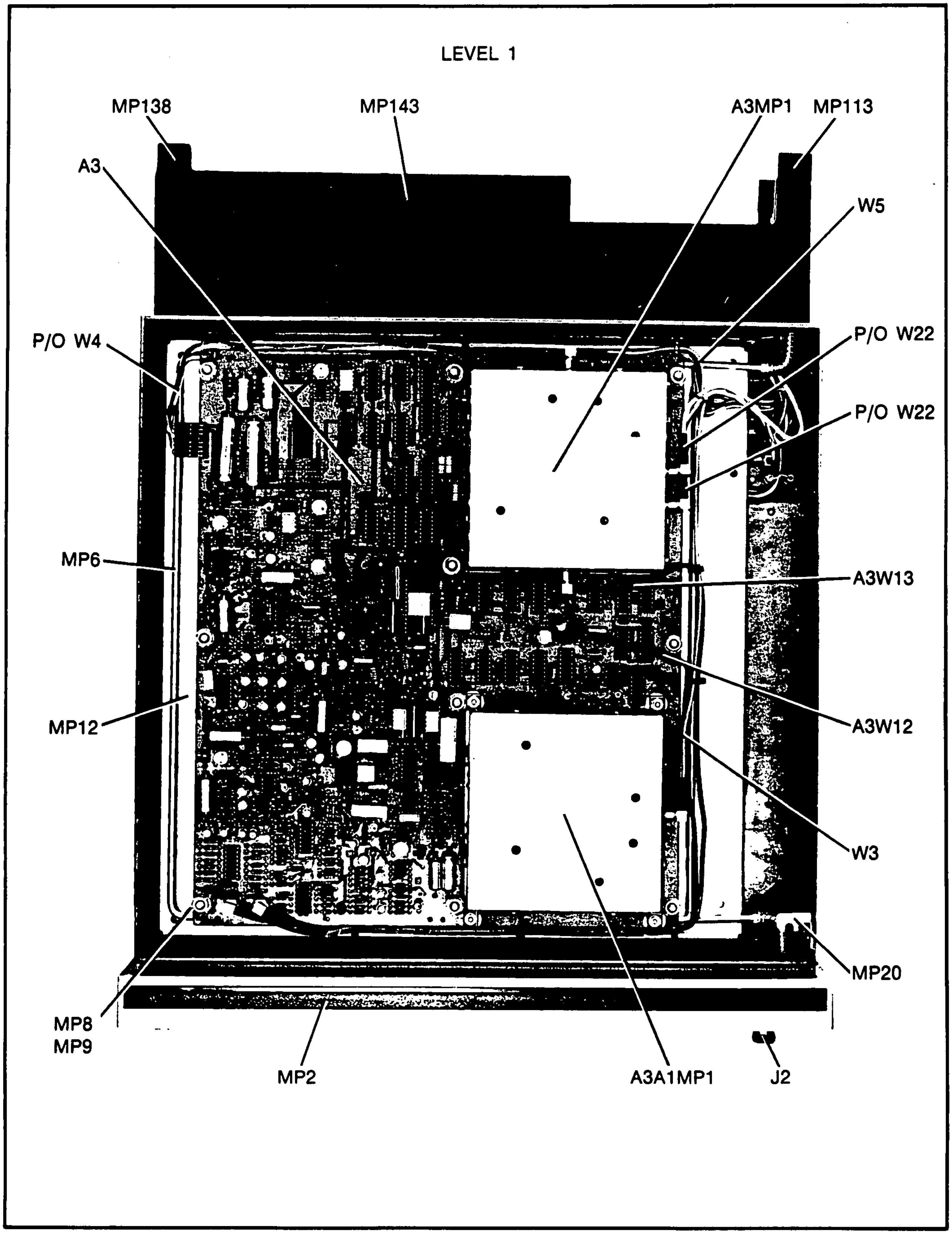


Figure 6-5 (2425A to 2509A). Top Internal View; Top Cover Removed

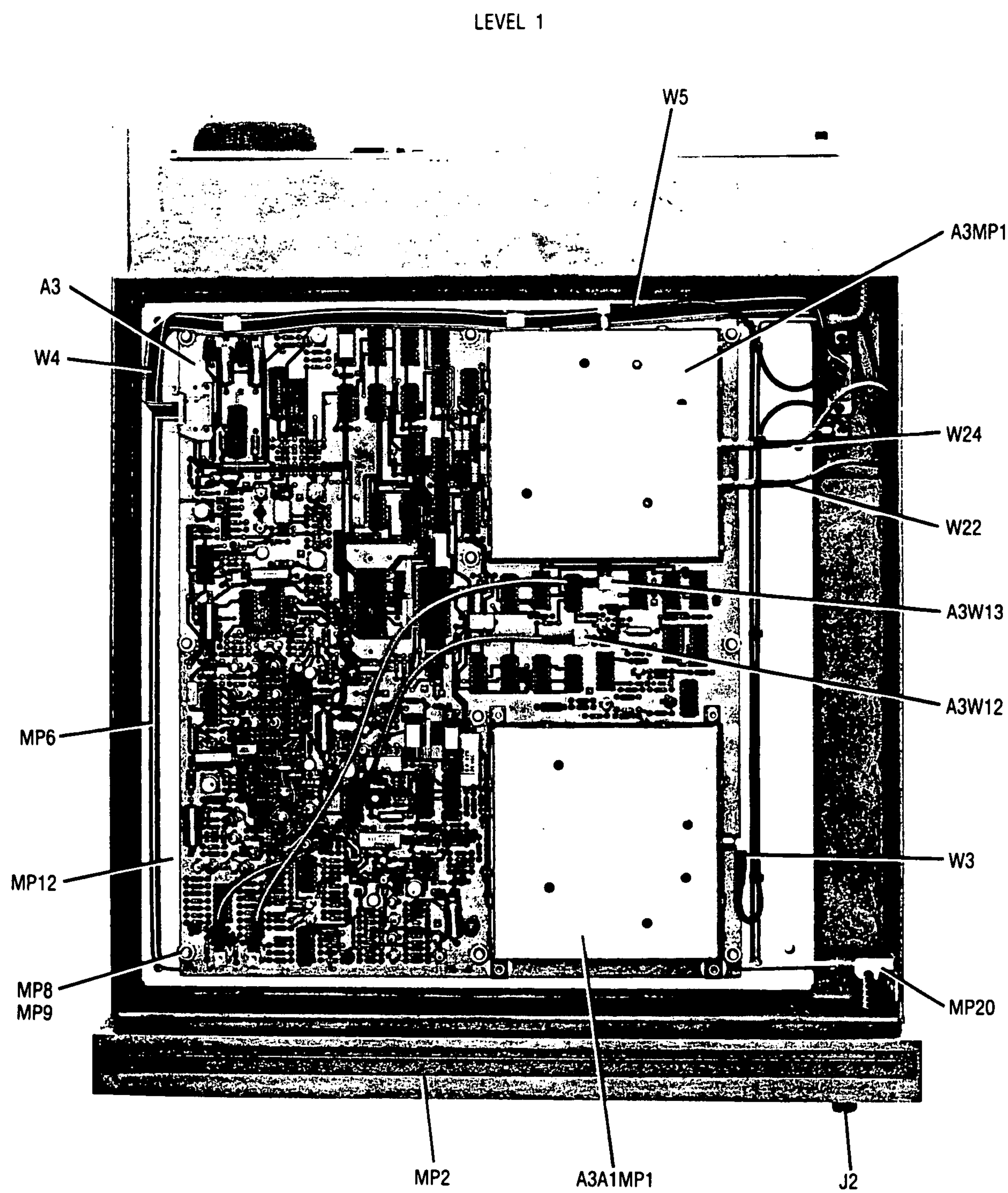


Figure 6-5 (2511A and above). Top Internal View; Top Cover Removed

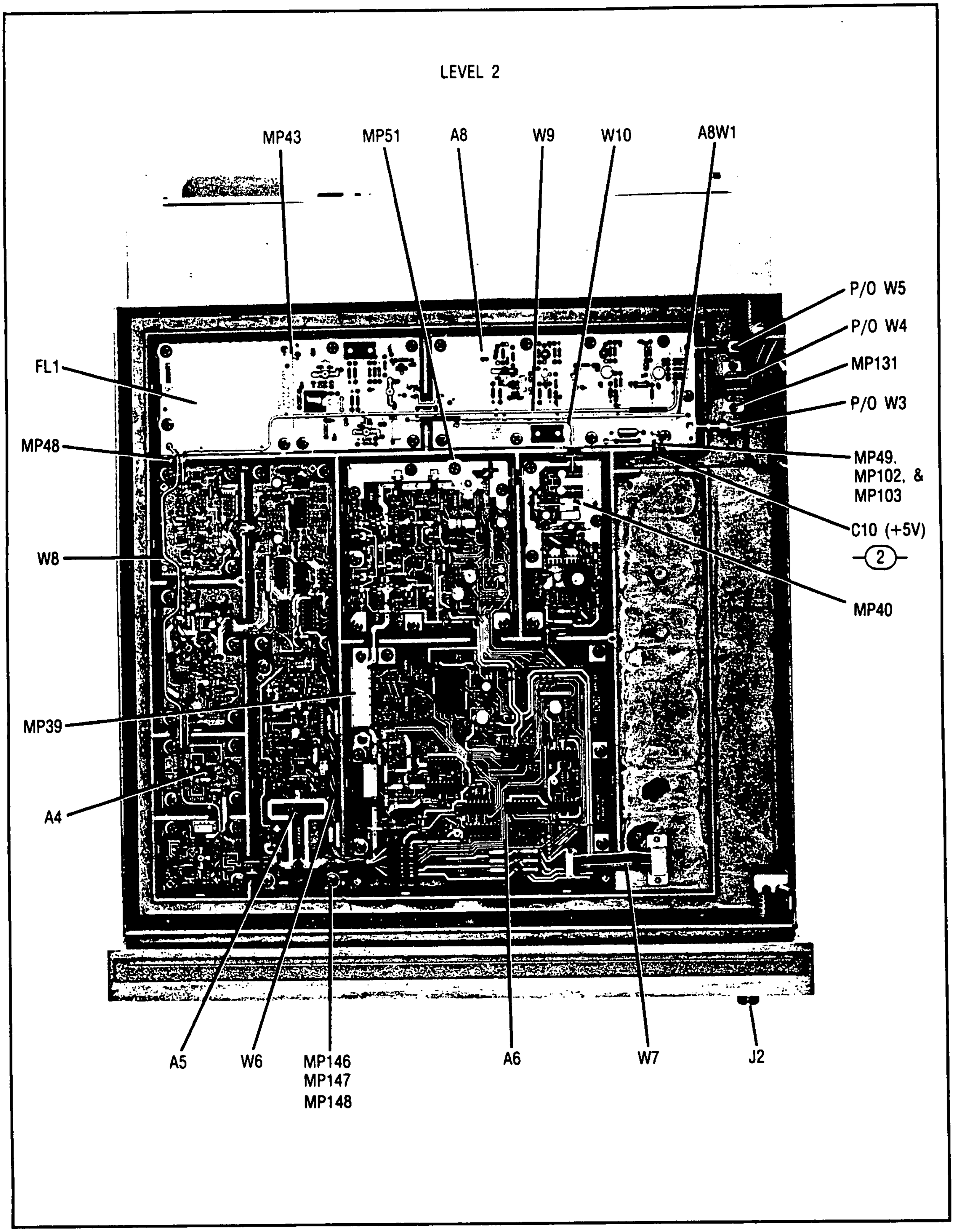


Figure 6-6 (2511A and above). Top Internal View; A3 Assembly in Service Position

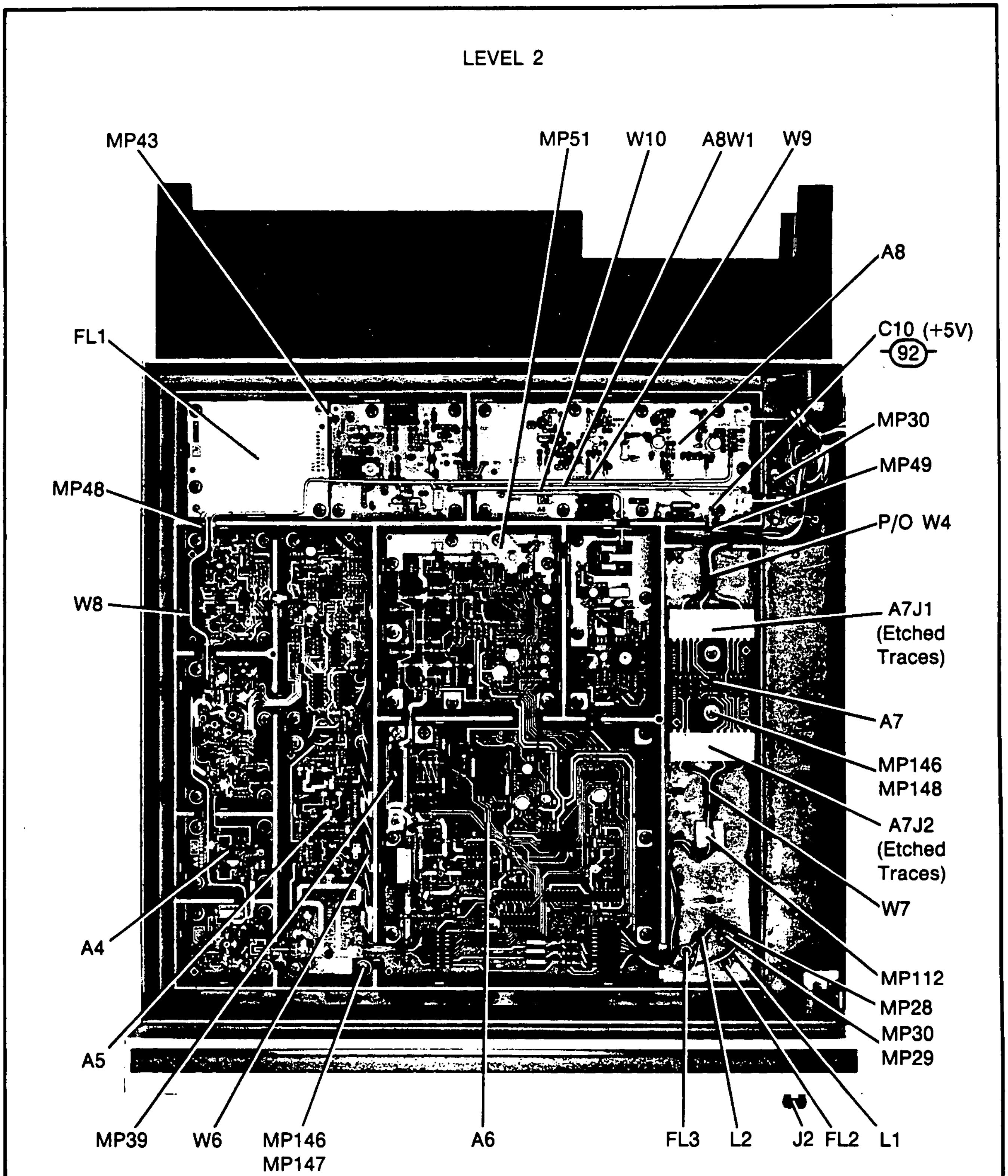


Figure 6-6 (2425A to 2509A). Top Internal View; A3 Assembly in Service Position

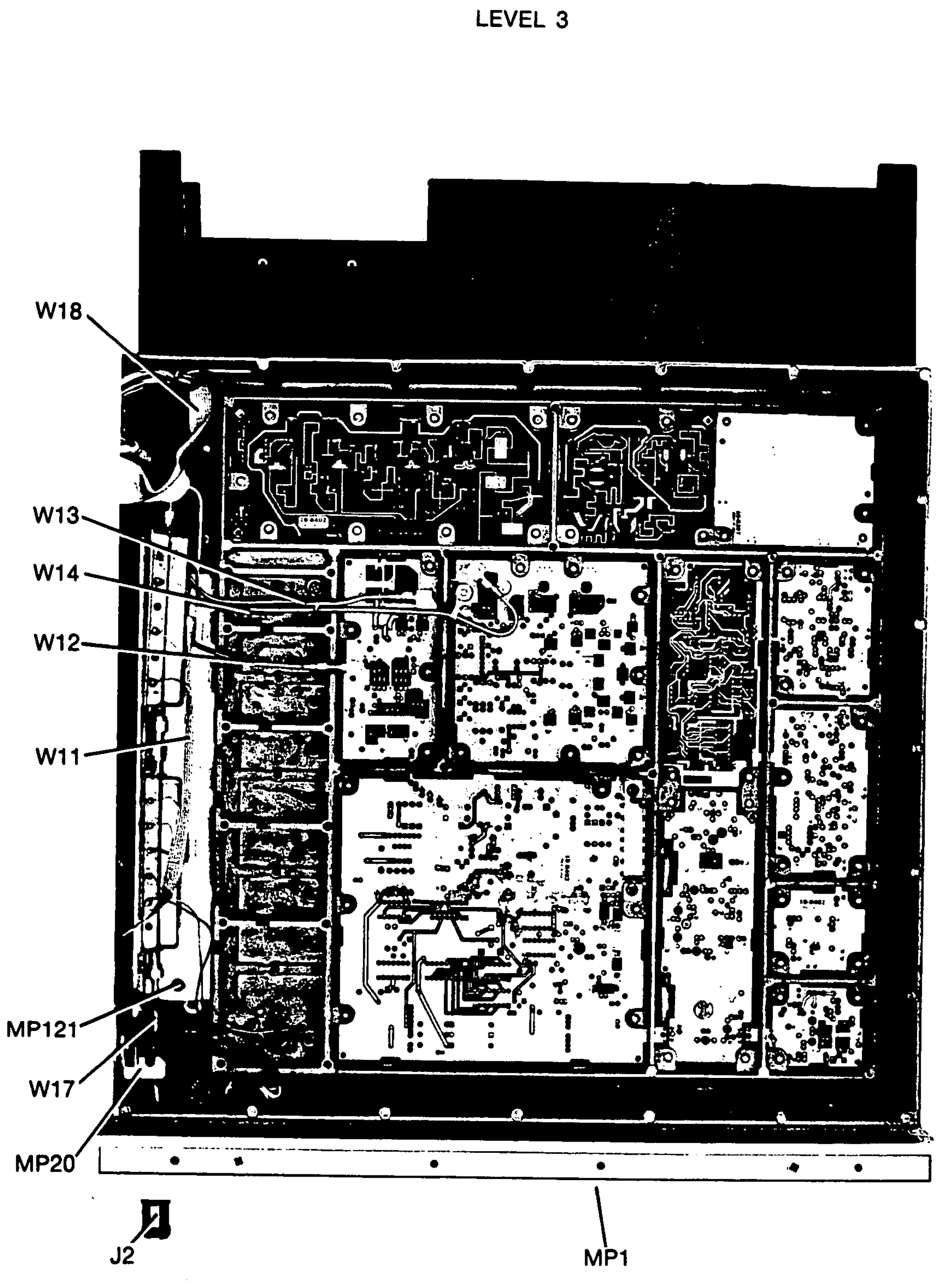


Figure 6-7 (2425A to 2509A). Bottom Internal View; A10/A11 Assemblies in Service Position

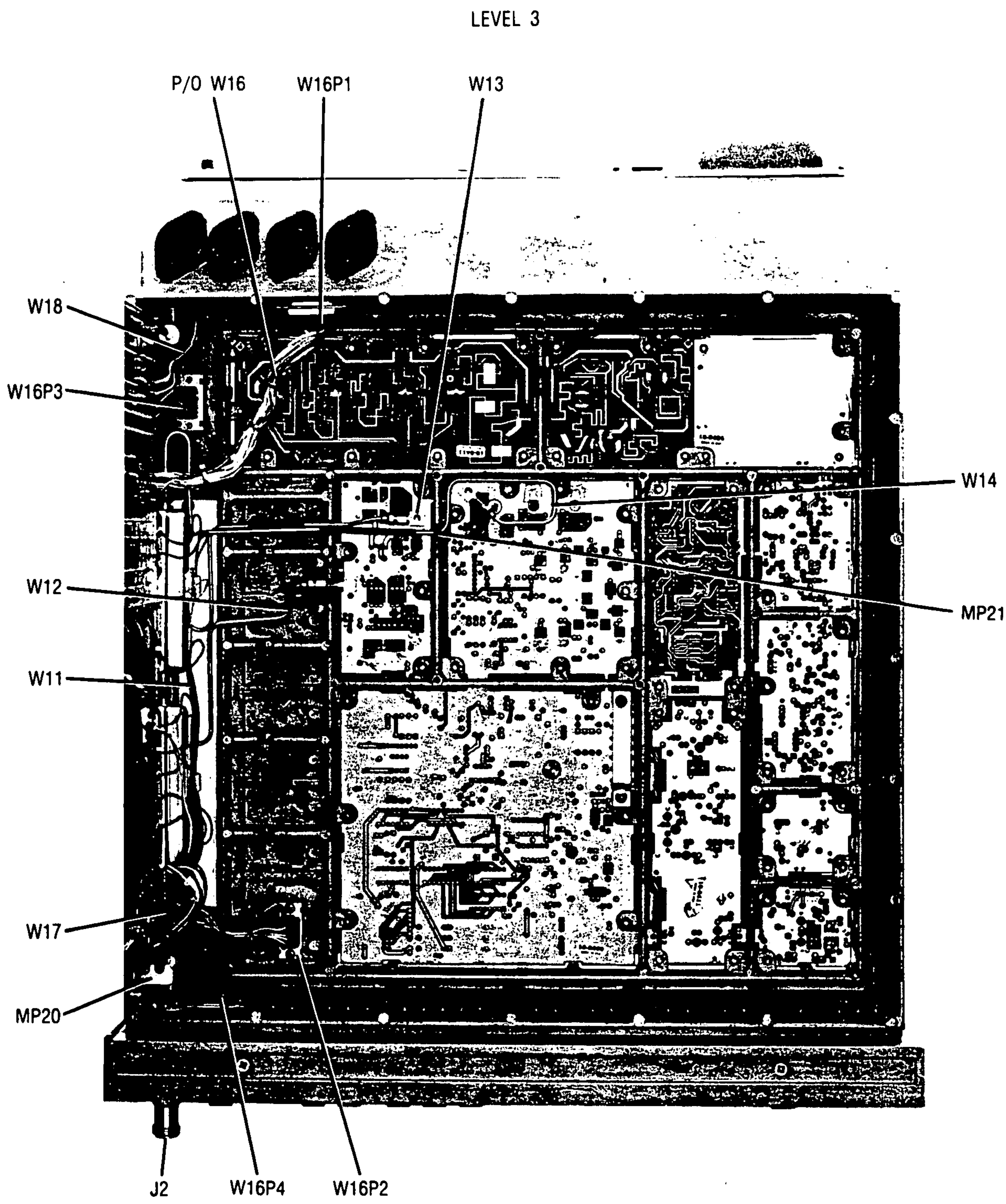


Figure 6-7 (2511A and above). Bottom Internal View; A10/A11 Assemblies in Service Position

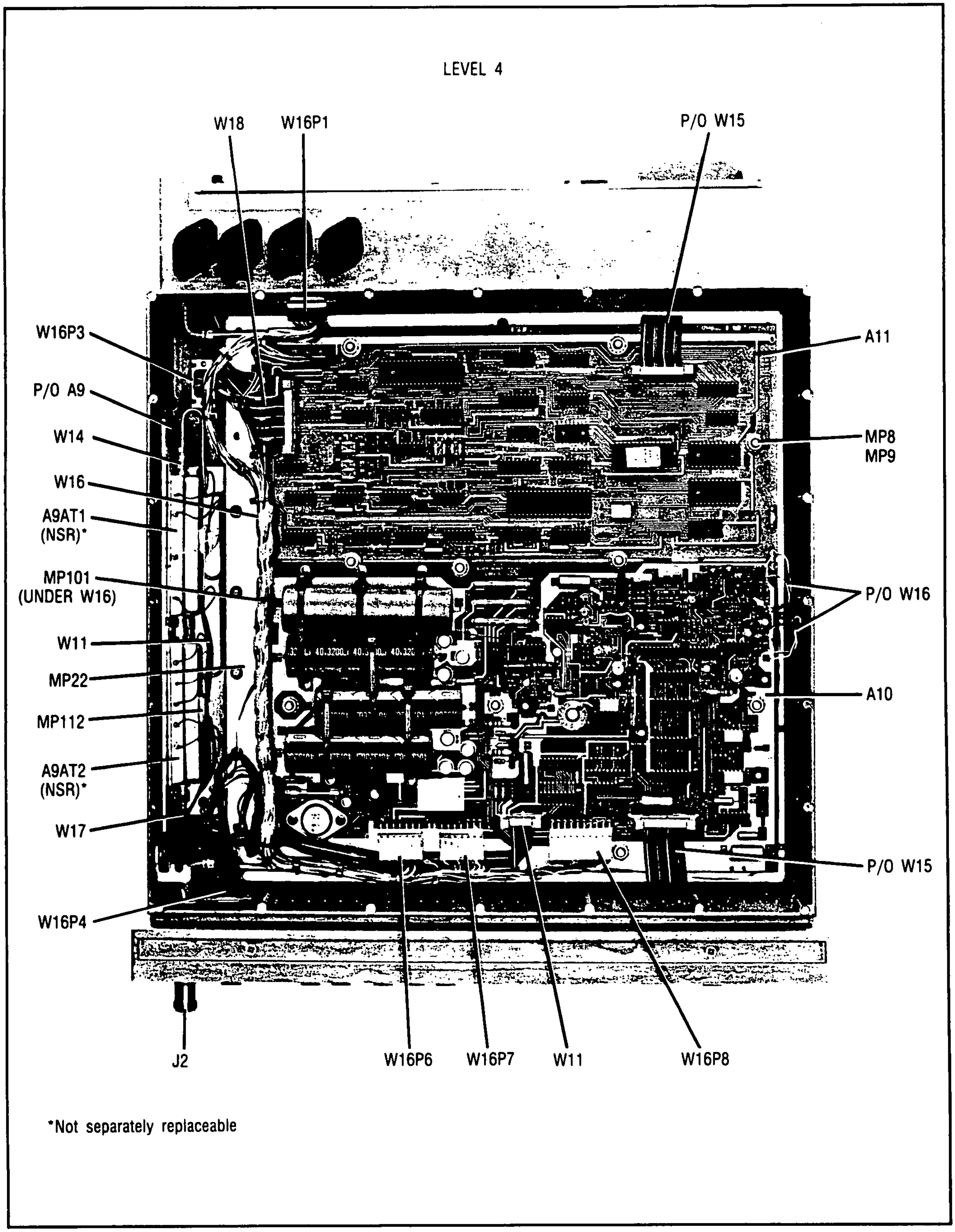
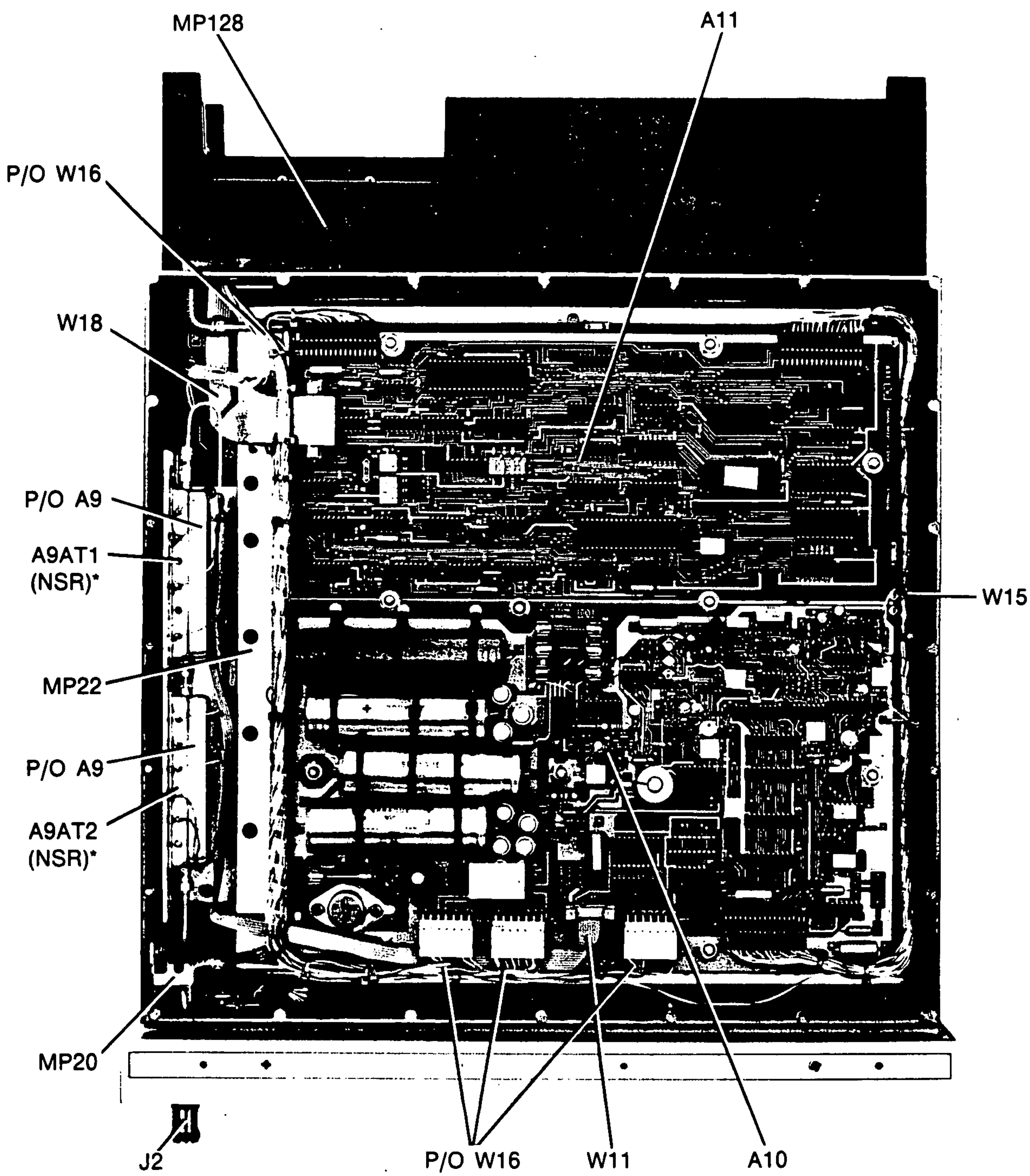


Figure 6-8 (2511A and above). Bottom Internal View; Bottom Cover Removed

LEVEL 4



*Not separately replaceable

Figure 6-8 (2425A to 2509A). Bottom Internal View; Bottom Cover Removed

SECTION VII
INSTRUMENT CHANGES

7-1. INTRODUCTION

This section contains any instrument modification recommendations and procedures that could improve the performance and reliability of your instrument. Refer to "Instruments Covered By This Manual" paragraph 1-4 in Section I for important information about serial number coverage.

7-2 INSTRUMENT MODIFICATION RECOMMENDATIONS AND PROCEDURES

This paragraph includes descriptions of changes to the Instrument stating the reasons why a part is added, deleted, or recommended as a replacement. The instrument modification recommendations and procedures are listed in order by serial number.

2447A - A6C40 is deleted because it may cause the High-Band Output Amplifier to resonate around 970 MHz. There is no adverse affect to the amplifier's response by removing A6C40.

2451A - A10U2 insulator part number is changed to help reduce manufacturing time.
- A10C44 is added to improve the operation of the Attenuator Regulator A10U2.
- A10C24 and A10C25 part numbers are changed because a more inexpensive part with similar specifications is available.

2506A - A6R9 is changed to a different resistive value to prevent potential oscillations in the DIVIDE-BY-TWO circuit when the RF ON/OFF switch is turned off and on.

2508A - MP4 and MP24 (external top and bottom covers) are changed to provide better RFI shielding.
- MP15 and MP16 (handle caps) are changed to a single part MP15; this change is to fit the handle caps to the new external top and bottom covers.

2509A - A6C63 and A6C64 are changed to prevent any oscillation that may occur in the ALC Amplifier A6U6. An oscillation could travel over the +15V supply line from A6U6 to the High-Band Output Amplifier resulting in a 16 MHz spur.

2511A - Instruments starting with this serial prefix are changed to help reduce manufacturing time.

2523A - Adding A6C71 improves SWR performance of the Heterodyne Section Low-Band Output Amplifier.

2528A - W19C1 (part of the -15V regulator) is changed to a capacitor with a higher voltage rating to improve reliability of the -15V regulator.

2530A - The part number of A5CR1 and A5CR2 is changed because the part is no longer available from the manufacturer.

7-2 INSTRUMENT MODIFICATION RECOMMENDATIONS AND PROCEDURES (cont'd)

2542A - A4C86 is changed to a different capacitive value to improve the operating characteristics of the 300 MHz Notch Filter. The new part is the recommended replacement and is backwards compatible for all instruments.

2549A - A3CR13, A3CR14, A3L4 are deleted, and A3R26 is changed to improve the operating characteristics of the 50 MHz Reference Oscillator.

2612A - W19 and W19C1 are replaced to prevent high frequency oscillation on the +5V regulator output.

2614A - A6CR12, A6CR25, A6CR28, A6CR34, A6R43 and A6C71 are changed to help reduce manufacturing time.

2617A - Add heat sink A3MP11 and associated hardware to dissipate heat on the Fractional-N IC A3U17.

2620A - A6C16 is changed to improve the voltage rating from +15V to +35V. A3R303 is changed to a different resistive value to improve the substrate bias on A3U17. C72 is added to the A6 Assembly to prevent intermittent oscillations in the DIVIDE-BY-TWO circuit at approximately 480 MHz.

2623A - A2J1 and A6J4 connectors have been changed to prevent loose connections. MP51 heatsink and associated hardware are changed to relieve stress on A6Q6. If heatsink MP51 is replaced, lock washer and screw must also be replaced.

2626A - A3R723 and A3R725 are changed to improve the adjustment range of the FM In-Band Gain Adjustment.

2635A - A4R52 is changed to a different resistive value to provide a greater range of adjustment for the Sideband Comparator.

2637A - A2DS1-20 part numbers are changed to accomodate a change to the manufacturing process.

- A10R56 is changed to a different resistive value to prevent OPAMP A10U19C from oscillating between 500-700 kHz in some instruments.

2639A - A6CR21 is changed to a different part to improve isolation of the main-band Voltage Tuned Filter.

- A6R46-47 are changed and A6R106-107 is added to restore maximum power performance to the High Band Output Amplifier as a result of changing the pin diode A6CR21.

2649A - MP30,52,54-55, part numbers are changed to accomodate manufacturing design modifications to the Rear Panel.

- B1 fan is changed to reduce noise levels and increase air flow in the instrument.

SECTION VIII
SERVICE

8-1. INTRODUCTION

This section contains information for troubleshooting and repairing the Signal Generator. Included are principles of operation, troubleshooting tests, repair procedures, and block and circuit diagrams.

8-2. SERVICE SHEETS

Circuit principles of operation and troubleshooting information is found in the pages directly preceding the block and circuit schematic diagram foldouts. The foldout pages are found in the last part of this section. They consist of component locator diagrams, block diagrams, notes, supplemental diagrams, associated information, and circuit schematic diagrams.

8-3. Principles of Operation

The principles of operation and related tables and diagrams are part of Service Sheets BD1 through BD4, and Service Sheets 1 through 25. A general statement followed by more specific information is included to aid in understanding the operation of circuitry in the Signal Generator.

8-4. Troubleshooting

The troubleshooting tests and checks are part of Service Sheets BD1 through BD4, and Service Sheets 1 through 25. These tests and checks are used to aid in the service and repair of the Signal Generator. Troubleshooting using signature analysis is found where verifying the operation of digital circuitry is necessary. See paragraphs 8-22 through 8-29 for further troubleshooting information.

8-5. Block Diagrams

The block diagrams are found on Service Sheets BD1 through BD4. BD1 is the overall block diagram that shows the major functional sections. BD1 serves as an index to the troubleshooting blocks, and as a starting point for troubleshooting.

The troubleshooting block diagrams are found on Service Sheets BD2 through BD4. Each troubleshooting block diagram shows the major circuits in their functional groupings. These blocks serve as indexes to the circuit schematic diagrams. The High Frequency Loop and Output Section is shown on BD2, the Low Frequency Loop on BD3, and the digital (control) circuits are on BD4.

8-6. Circuit Schematic Diagrams

The circuit schematic diagrams are found on Service Sheets 1 through 25. These diagrams, in functional groupings, are aids for understanding operation and for troubleshooting the Signal Generator. Refer to the paragraphs entitled Principles of Operation, and Troubleshooting for more information.

8-7. SAFETY CONSIDERATIONS

8-8. Before Applying Power

Verify that the instrument is set to match the available line voltage and that the correct fuse is installed (refer to paragraph 2-5). An uninterrupted safety earth ground must be provided from the main power source to the instrument input wiring terminals, power cord, or supplied power cord set.

8-9. Warnings and Cautions

Pay attention to WARNINGS and CAUTIONS. They must be followed for your protection and to avoid damage to the equipment.

WARNING

Maintenance described herein is performed with power supplied to the instrument and with the protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power supplied, the power should be removed.

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnection of the protective earth terminal will create a potential shock hazard that could result in personal injury. Grounding one conductor of a two conductor outlet is not sufficient. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative (i.e., secured against unintended operation).

If this instrument is to be energized via an autotransformer, make sure that the autotransformer's common terminal is connected to the earth terminal of the power source.

Capacitors inside the instrument can still be charged even if the instrument is disconnected from its source of supply.

Make sure that only 250 volt fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. Do not use repaired fuses or short-circuited fuseholders. To do so could create a shock or fire hazard.

CAUTION

Do not disconnect or remove any boards in the Signal Generator unless the instrument is unplugged. Some boards contain devices which can be damaged if the board is removed when the power is on. Use conductive foam when removing MOS devices from sockets. Use care when unplugging ICs from high-grip sockets.

8-10. SPECIAL HANDLING CONSIDERATIONS FOR STATIC SENSITIVE DEVICES

8-11. General

This information is provided to familiarize users of Hewlett-Packard instruments with special handling precautions for static sensitive devices. These precautions should be observed when servicing printed circuit boards or components that are static sensitive.

All schematics with circuit assemblies containing static sensitive components are designated with the international awareness symbol. This symbol indicates that special precautions apply when servicing these circuits. Following the precautions described in the following paragraphs could prevent damage to the circuit and its components.

8-12. Description

Static Sensitive Devices are electronic components that are susceptible to damage or complete destruction in the presence of a static discharge. While all electronic components are static sensitive to some degree, the possibility of damage due to electro-static discharge (ESD) becomes greater as the insulating materials in the components become thinner and as component densities increase. Depending on the magnitude of the charge, device substrates can be punctured or destroyed by contact or mere proximity of a static charge.

Static charges accumulate harmlessly in a person's body, therefore the charges can be passed on in numerous ways such as simple contact with the device, during separation of materials, or during normal motions of persons with static sensitive devices. In many cases, destructive static discharges (<4000 V) cannot be seen or felt. The results of this damage can cause degradation of device performance, early failure, or complete destruction of the device.

8-13. Device Classes

The following is a classification of the ESD sensitivity of components used in most Hewlett-Packard instruments:

CLASS I devices have a sensitivity range from 0 to 1000 volts. Devices in this range include microwave diodes (especially Schottky), BIFET and precision OP AMP (I_{OS}<50 nA, V_{OS}<1 mV), unprotected MOS (especially VLSI), MOS capacitors, advanced Schottky logic, junction FETs and low current SCRs (<.15A), microwave and VHF transistors and ICs, precision IC voltage regulators and resistors, low power resistors (<.05W), VLSICs with dual-level metalization, and Surface Acoustic Wave (SAW) devices.

CLASS II devices have a sensitivity range from 1000 to 4000 volts. Devices in this range include MOS ICs with internal protection (CMOS, NMOS, PMOS) and LSI ICs, Schottky rectifier diodes, linear ICs (bipolar), precision resistor networks, high speed bipolar logic (ECL, LS-TTL, S-TTL), varactor diodes, monolithic ceramic capacitors, RF Mixers and other RF devices utilizing diodes.

CLASS III devices have a sensitivity range from 4000 to 15000 volts. Devices in this range include small signal diodes, and transistors, low-speed bipolar logic (TTL, DTL), quartz and piezoelectric crystals, and thin and thick film resistors (<1/8W, ≥500k ohms).

8-14. Component Handling Precautions

a. Those persons servicing the instrument should use metal or conductive plastic wriststraps with a 1 Megohm series resistor connected to ground.

b. Packages should not be removed from their conductive or antistatic carriers until required and should only be removed by an operator that is grounded through a 1 Megohm series resistor. Devices that are removed should be placed in a conductive tray.

c. Metal parts of fixtures, tools, soldering irons, and table tops should be grounded to a common point.

d. Handling equipment, trays, table tops, and transport carts should be electrically conductive.

f. The circuit board should have a conductive strip placed on the board edge-connectors to short all the connections together.

8-15. RECOMMENDED TEST EQUIPMENT AND ACCESSORIES

Test equipment and test accessories required to maintain the Signal Generator are listed in the table of Recommended Test Equipment in Section I. Equipment other than that listed may be used if it meets the listed critical specifications.

8-14.1 Component Replacement Procedures

The A2, A3, A3A1, A6, A10, and A11 printed circuit board assemblies are manufactured using a Hot Air Leveled (HAL) process. The printed circuit board traces, pads and plated-through holes (PTH) are copper. While the process has several advantages over conventional processes, the printed circuit boards are more susceptible to broken traces, lifted pads, and damage to the plated-through holes. Therefore, additional care must be taken when replacing components on HAL printed circuit boards.

Listed below are soldering considerations that apply to all printed circuit boards:

- The temperature of the soldering iron tip and time the tip is in contact with the printed circuit board.
- The size and shape of the soldering iron tip.
- The pressure of the soldering iron tip on the pad.
- The operator's skill.

When replacing components on HAL printed circuit boards the following steps should also be taken.

1. Use a temperature controlled soldering iron set at a temperature of 600° F (315° C).

   Extensive tests were made by Hewlett-Packard using commercial brands of soldering irons. As a result of these tests, the recommended soldering iron was the HEXACON THERM-O-TRAC STATION #1000 with the FINGER GRIP SLEEVE 21 A-5 and solder tip #J 301X. During soldering, the tip temperature of the HEXACON THERM-O-TRAC STATION remained very stable.

2. Cut out the body of the component to be removed. (Leave leads as long as possible for easier removal.)

3. Apply heat to the lead only, add solder as required, slide tip down to the pad and remove solder with solder sucker.

CAUTION

Tip pressure on the pad is most critical and is totally operator dependent. Excessive tip pressure will damage or destroy the board. Do not use tin desoldering braid or solder wicking techniques on Hot Air Leveled boards.

The melting point of solder in the plated through hole (PTH) is reached in 2.5 seconds at tip temperature of 600° to 750° F (315° to 400° C). The *recommended* time for heat to be applied is **3 seconds.**

Keep the solder sucker clean and **do not** let the tip of the solder sucker hit the pad when removing solder. Breaking the lead loose can damage the PTH. If the lead is attached to the PTH after the solder has been removed, reheat the lead to remove it.

4. When soldering or desoldering multilead components, **do not** consecutively apply heat to adjacent leads. Distribute heat by skipping leads or crossing to opposite side of device.

8-16. SERVICE TOOLS, AIDS AND INFORMATION

8-17. Service Tools

There are unique tools available that will make servicing of this instrument easier. Service aids are provided in the instrument. Service information is provided in this manual. Information provided in the paragraph entitled Repair (found in this section) shows how the instrument is accessed for repair purposes. See Figure 8-1 for the recommended position for maintenance and servicing.

Pozidriv Screwdrivers. Many screws in the Signal Generator appear to be Phillips type, but are not. To avoid damage to the screw slots, Pozidriv screwdrivers should be used. HP 8710-0899 is the No. 1 Pozidriv. HP 8710-0900 is the No. 2 Pozidriv.

Tuning Tools. For adjustments requiring non-metallic tuning tools, use the HP 8710-0033 blade tuning tool or the HP 8710-1010 (JFD Model No. 5284) hex tuning tool. For other adjustments an ordinary small screwdriver or suitable tool is sufficient. No matter which tool is used, never force any adjustment control. This is especially critical when adjusting variable inductors or capacitors.

Heat Staking Tool. The front-panel pushbutton switches have small plastic pins protruding from the back. These tabs fit through holes in the keyboard printed circuit board and are melted down to hold the switch in place. This process is known as heat staking. The heat staking tool is a standard soldering iron with a special tip attached (refer to Figure 8-5, under paragraphs entitled Replacement of Key Cap and Pushbutton Switches).

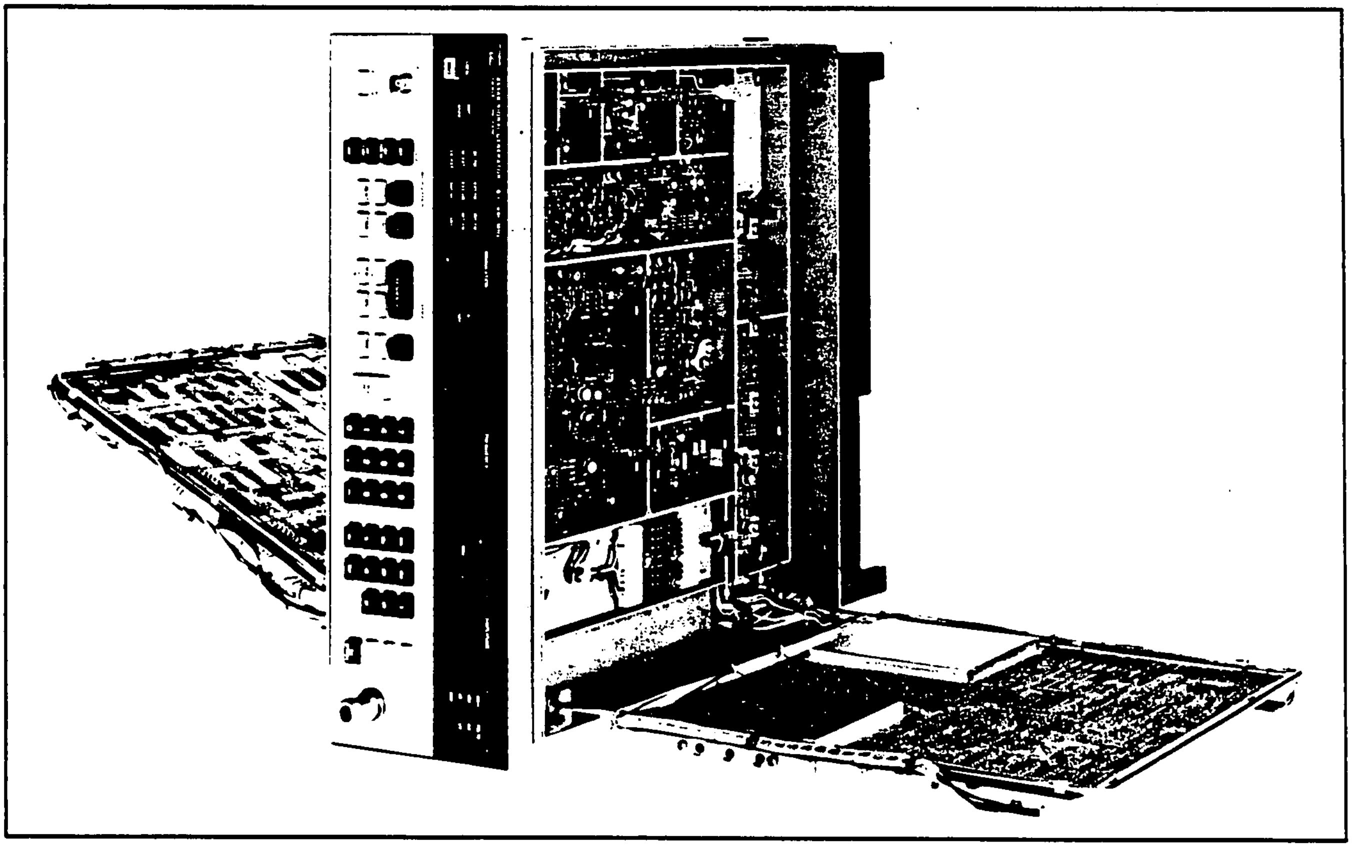


Figure 8-1. Recommended Position for Maintenance and Servicing

8-18. Parts and Cable Locations

The locations of individual components mounted on printed circuit boards or other assemblies are shown adjacent to the schematic diagram on the back of the preceeding Service Sheet. The part reference designator is the assembly designator plus the part designator. For example, A6R9 is R9 on the A6 assembly. For specific component descriptions and ordering information, refer to Table 6-3, Replaceable Parts, in Section VI. Illustrated parts breakdowns of chassis and frame parts, as well as assemblies and mechanical parts and cables, are shown in Figures 6-1 through 6-8.

Mechanical parts have reference designations that begin with the letters MP. Some mechanical parts, such as screws, are listed in the replaceable parts list below the part to which they fasten. To find the part number and description of mechanical part, find the part in one of the figures in Section VI or Section VIII. The part in the figure is labeled with its reference designator. Look up that reference designator in the table of Replaceable Parts. If the part is a fastener, such as a screw, nut, or washer and does not have an assigned reference designator, look to the figure for the part to which it fastens. Then, look up the fastened part in the parts list. Just below the fastened part, you will see the part numbers and descriptions of the desired fastener.

8-19. Test Points and Adjustment Locations

Most test points and adjustments are indicated on individual circuit board assemblies. Test points and adjustments can also be found on the component locator diagram adjacent to the assembly's schematic diagram.

8-20. Service Aids on Printed Circuit Boards

Service aids on printed circuit boards include test points, indicator lights, transistor and integrated circuit and relay designations, adjustment names, and assembly part numbers.

8-21. Other Service Documents

Service Notes, Manual Changes supplements, and other service literature are available through Hewlett-Packard. For further information, contact your nearest Hewlett-Packard office.

8-22. TROUBLESHOOTING

8-23. General

Instrument problems usually fall into three general categories: operator errors, instrument out of specification, and catastrophic failures. The troubleshooting strategy is different for each category. For more information refer to the table of Specifications in Section I and the detailed operating instructions found in Section III.

Operator Error. Apparent failures sometimes result from operator errors. These may take one of several forms. The operator may allow external influences which affect instrument operation. At times he may attempt to operate the instrument in an "out of specification" mode. Under certain circumstances the Signal Generator allows for out of specification operation. Under other conditions it does not.

A reverse power level greater than 1.0 watt (7.07 volts) coupled to the front-panel RF OUTPUT connector switches the output signal off and causes the Amplitude display to flash. This, however, is normal operation under the circumstances. The instrument has temporarily disconnected itself from the high power level that could do damage to internal circuits. To bring the instrument back to its normal operating mode, remove the high reverse power at the RF OUTPUT connector and enter a new output power level at the front-panel.

NOTE

The Reverse Power Protection provided by this circuit is adequate up to 25 watts (25 volts dc).

The Signal Generator does allow out of specification operation at frequencies below 0.1 MHz. The frequency is accurate but other specifications, such as RF output power level may be incorrect.

Not-allowed operation is generally indicated by displays that flash or default to the last valid entry. An example of the former is a flashing FM display that occurs when a frequency is changed to a range that will not allow wide deviation. To stop the flashing display, press the FM mode select button. This changes the FM deviation to a level that is acceptable.

Examples of not-allowed operation where the Signal Generator defaults to the last valid entry are: selecting an RF output level that is too high or selecting an AM depth that causes the maximum total RF output power level to be to high.

Instrument Out of Specification. If it is suspected that the instrument's operating parameters are out of tolerance, the abbreviated Performance Tests table in Section IV tells which test may be performed to verify proper operation. This table may also be used to determine which assembly requires adjusting and on what service sheet the adjustable components are located. The Post-Repair Adjustments table in Section V tells which adjustments are related and may also require adjustment. After adjustments are complete, perform the performance test(s) in Section IV. If the performance is still out of tolerance, refer to troubleshooting information. Although the problem may be solved very quickly by going to the service sheet where the adjustment is located, it is good practice to begin with the overall troubleshooting information found on Service Sheet BD1.

Catastrophic Failures. When a catastrophic failure occurs, begin troubleshooting on Service Sheet BD1. The information there is used to quickly isolate the problem to one of three major sections in instrument.

8-24. Strategy

Troubleshooting for the Signal Generator is organized into three levels. The overall troubleshooting level is where problems are isolated to the power supply or one of the functional sections. The functional section level of troubleshooting isolates the malfunction to the circuit level. At the circuit level, the problem is isolated to a stage within the circuits shown on the schematic. It is expected that further troubleshooting, to the component level, depends on the skill and experience of the troubleshooter.

8-25. Overall Troubleshooting (Service Sheet BD1)

Overall troubleshooting begins with verifying that the power-on sequence occurs properly. At this point, power supply problems become evident. The effect of inputs from the keyboard and an external computer are compared. It is possible to separate a digital or analog problem at this level. Digital problems are usually referred to Service Sheet BD4. Further troubleshooting determines which analog (phase lock) loop is defective. Problems here are referred to Service Sheet BD2 or BD3. If none of the sections or circuits above are defective, further troubleshooting isolates a malfunction in the special circuits.

8-26. Functional Section Troubleshooting (Service Sheets BD2-BD4)

Troubleshooting of the loop sections (Service Sheets BD2 and BD3) is done primarily from an analog viewpoint with the intent of isolating a malfunction to the circuit level. The digital section (Service Sheet BD4) continues with troubleshooting from Service Sheet BD1 but with the intent of isolating the problem to the circuit level.

8-27. Circuit Troubleshooting (Service Sheets 1-25)

The goal of troubleshooting at the previous service sheet level is to be confident that the problem is within the circuits shown by the schematic. Because of the interaction of the circuits in the Signal Generator, it may be necessary to refer to other service sheets to completely isolate a problem. Some of the circuits that are mostly analog have digital control circuits. In these cases, troubleshooting the digital circuits first is offered as an alternative.

When a problem is isolated to a stage, the ability of the one doing the troubleshooting is utilized to isolate the defective component.

8-28. Signature Analysis

Signature analysis is a simple method of verifying the operation of digital circuitry. When properly used, signature analysis can detect extremely subtle hardware faults. Signatures must identically match those given in the signature tables located with the Troubleshooting for that schematic. If everything is working correctly, signatures will all match exactly. If they do not match, by even one digit, something is wrong.

With the Generator's internal signature analysis routine, the signature analyzer's test probe is used to check nodes in the circuit under test. The signature analyzer converts the signals at the node into a four digit "signature", which it displays. The signature is then compared to the signature in the Troubleshooting table appropriate for that schematic. These two signatures must be identical.

Signature analysis can be sped up if the following considerations are kept in mind:

1. Make sure that every step is performed as described in the set-up procedure. That is, make sure that the clock, start, and stop connections and triggering are correct.
2. Double-check that the signatures are being taken at the correct node.
3. Make sure that the signature analyzer probe is making good contact with the pin being checked. Oxidation on pins can cause invalid signatures due to poor contacts.
4. When you think that you have found a bad signature, double check to make sure.
5. When checking a node, check that the unstable signature indicator is not blinking.

8-29. Additional Information

Additional troubleshooting information may be found in various locations in the manual. Reference is made to the information in the appropriate troubleshooting procedure. Examples of this information are the Power-On Sequence, the Basic Functional Checks, and the HP-IB Functional Checks which are all found in Section III.

8-30. REPAIR

8-31. Disassembly Procedures

For the most part, disassembling the Signal Generator is quite straightforward. Most of the procedures simply indicate the size, number, type, and general location of the mounting hardware. Where it is necessary, the procedures are more detailed. Table 8-1 indicates which procedure will give access to a particular assembly and which figure shows the location of a particular assembly. Reference to the appropriate exploded view in Section VI is included. If a circuit board within the main casting is to be removed from the Signal Generator, seek access to its component (top) side. To reassemble the Signal Generator, follow the procedures in the reverse order.

WARNING

Before beginning any disassembly procedure be sure that the line (Mains) voltage is disconnected.

Front-Panel Removal (2511A and above). Remove the knurled nut P/O J2 from the RF Output connector with a pair of soft jawed pliers (HP part number 8710-0986). Remove the top trim MP2 and four No. 2 pozidriv screws MP107 from the top and bottom edge of the front-panel casting. Pull the front-panel forward until it is free of the casting.

Front-Panel Removal (2425A to 2509A). Remove the knurled nut MP101 from the RF Output connector with a pair of soft jawed pliers (HP part number 8710-0986). Remove the top trim MP2 and four No. 2 pozidriv screws MP107 from the top and bottom edge of the front-panel casting. Pull the front-panel forward until it is free of the casting.

A1 Keyboard and A2 Display Assembly Removal (2511A and above). The front-panel has already been removed. Place the front-panel face down. To free the A2 Assembly, remove fourteen machine screws MP131 from the back of the circuit board with a No. 2 Pozidriv screwdriver. Unsolder the front-panel BNC connector wire and remove it from the cable clamp MP112 on the circuit side of A2. Remove the cable connectors at A2J1 and A2J2.

Remove the A1 assembly by first removing the eleven hex nuts MP16 which hold the assembly in place. Lift the assembly from the mounting lugs.

A1 Keyboard and A2 Display Assembly Removal (2425A to 2509A). The front-panel has already been removed. Place the front-panel face down. To free the A2 Assembly, remove fourteen machine screws MP131 from the back of the circuit board with a No. 2 Pozidriv screwdriver. Unsolder the front-panel BNC connector wire and remove it from the cable clamp MP112 on the casting wall. Remove the cable connectors at A2J1 and A2J2.

Remove the A1 assembly by first removing the eleven hex nuts MP9 which hold the assembly in place. Lift the assembly from the mounting lugs.

Table 8-1. Assembly Access Information

To Gain Access to an Assembly or Module	Perform Procedure(s)	For Disassembly Information Refer to Figure(s)
A1 and A2	Front-Panel Removal, and, if required, A1 Keyboard and A2 Display Assembly Removal	6-2
A3 (top)	Cover Removal, Top (Level 1 Access)	6-1, 6-4, 6-5
A3 (top and bottom)	Cover Removal, Top (Level 1 Access) A3 Assembly Service Position	6-1, 6-4, 6-5, 8-1
(2511A and above) A4, A5, A6 and A8 (top)	Cover Removal, Top (Level 1 Access) A3 Assembly Service Position Level 2 Access	6-1, 6-5, 6-6, 8-1
(2425A to 2509A) A4, A5, A6, A7, A8 (top), FL1, FL2, FL3, L1, and L2	Cover Removal, Top (Level 1 Access) A3 Assembly Service Position Level 2 Access	6-1, 6-5, 6-6, 8-1
A4, A5, A6, A8 (bottom), and A9	Cover Removal, Bottom (Level 4 Access) A10/A11 Assemblies Service Position Level 3 Access	6-1, 6-7, 6-8, 8-1
(2511A and above) A10 and A11 (top)	Cover Removal, Bottom (Level 4 Access)	6-1, 6-8
(2425A to 2509A) A10, A11 (top), and A17	Cover Removal, Bottom (Level 4 Access)	6-1, 6-8
A10 and A11 (top and bottom)	Cover Removal, Bottom (Level 4 Access) A10/A11 Assemblies Service Position	6-1, 6-8, 8-1
(2511A and above) A15, A16, B1 and T1	Rear-Panel Removal	6-3, 8-2
(2425A to 2509A) A12, A13, A14, and A15	Rear-Panel Removal	6-3, 8-2
(2425A to 2509A) A16, B1, T1	Fan Shroud Removal	6-3, 8-2

CAUTION

During reassembly, be sure that you reconnect A2J1 and J2 correctly. It is possible to reverse the connectors.

(2511A and above)

For reference, see Figure 6-2 for A2J1 reconnection, and note that the second pin of A2J2 is connected to a yellow wire. The pin numbers are etched on the circuit board.

(2425A to 2509A)

For reference, the second pins of both connectors are connected to yellow wires. The pin numbers are etched on the circuit board.

Cover Removal, Top and Bottom (Levels 1 and 4 Access) (2511A and above). Set the Signal Generator in its normal operating position. Free the handles by removing four No. 2 Pozidriv screws MP17.

Remove the front and rear handle caps (MP15) and the handles MP14. The top cover may now be lifted off for Level 1 access or the instrument may be turned over and the bottom cover lifted off for Level 4 access.

Cover Removal, Top and Bottom (Levels 1 and 4 Access) (2425A to 2509A). Set the Signal Generator in its normal operating position. Free the handles and side covers by removing four No. 2 Pozidriv screws MP17.

Remove the front and rear handle caps (MP15 and MP16) and the handles MP14. Push the side covers toward the Signal Generator's rear-panel to release the angled tabs that fit into the holes in the top and bottom covers. Remove the side covers. The top cover may now be lifted off for Level 1 access or the instrument may be turned over and the bottom cover lifted off for Level 4 access.

A3 Assembly Service Position. The top cover has been removed. Remove ten 10-32 inch nuts and washers (MP8 and MP9) from the top of the circuit board. Rotate the circuit board on the hinged carrier MP6 up and to the right. To lock the carrier in place, press the spring loaded hinge toward the rear of the instrument until it slides around the hinge lock MP20.

Level 2 Access. Remove two No. 2 Pozidriv screws MP11 from the top internal cover MP12. Lift the top internal cover up and out by the cover handles. Use a standard blade screwdriver to pry under each internal RF cover at the corners. Lift the cover from the casting.

NOTE

Insert all shield braid removed during disassembly into the appropriate space(s) in the casting wall before the internal RF covers are reinstalled.

DO NOT PRESS the internal RF covers all the way into the casting during reassembly. Make sure the top of the cover is the same level as the top of the casting.

A10/A11 Assemblies Service Position (2425A to 2523A). The bottom cover has been removed. Remove eleven 10-32 hex nuts and associated washers (MP8 and MP9) from the top of the circuit board. Raise the circuit board and hinged carrier MP23 up and to the left. To lock the carrier in place, press the spring loaded hinge toward the rear of the Signal Generator until it slides around the hinge lock MP20.

A10/A11 Assemblies Service Position (2528A and above). The bottom cover has been removed. Remove eleven 10-32 hex nuts and associated washers (MP8 and MP9) from the top of the circuit board.

Refer to Figure 8-1.1 to remove two standoffs (MP110) from the stationary screws (MP111) attached to W2, and then pull off W16P4.

Raise the circuit board and hinged carrier MP23 up and to the left. To lock the carrier in place, press the spring loaded hinge toward the rear of the Signal Generator until it slides around the hinge lock MP20. Plug W16P4 back in. The two standoffs which were removed, do not have to be put back on until reassembling A10/A11.

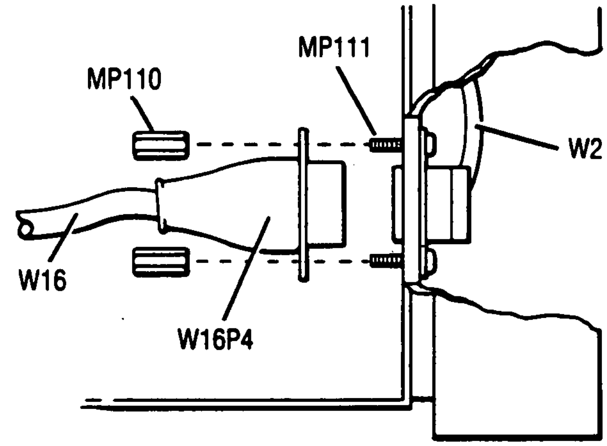


Figure 8-1.1 P/O A10/A11 Assembly Service Positioning

Level 3 Access. A10/A11 Assemblies have been locked into the service position. Remove seven No. 2 Pozidriv screws MP11 from the bottom internal cover MP22. Lift the bottom internal cover up and out by the cover handles. Access to individual boards is achieved by using a standard blade screwdriver to pry under each internal RF cover at the corners.

NOTE

DO NOT PRESS the internal RF covers all the way in. Make sure the top of the cover is the same level as the top of the casting.

Rear-Panel Removal (2511A and above). Position the Signal Generator so you are facing the rear-panel as shown in Figure 8-2.

1. Remove six No.2 Pozidriv screws and lockwashers (items 1).
2. Pull the rear-panel away from the casting.
3. If the rear-panel is to be completely removed from the instrument, disconnect the TB IN (W22) and TB OUT (W24) coax cable assemblies from the A3 assembly. Also, remove the HP-IB ribbon cable (W18) from the A11 assembly. The connectors for these three cables will pass through the instrument's casting.
4. When reinstalling the rear-panel, reverse the preceding procedure.

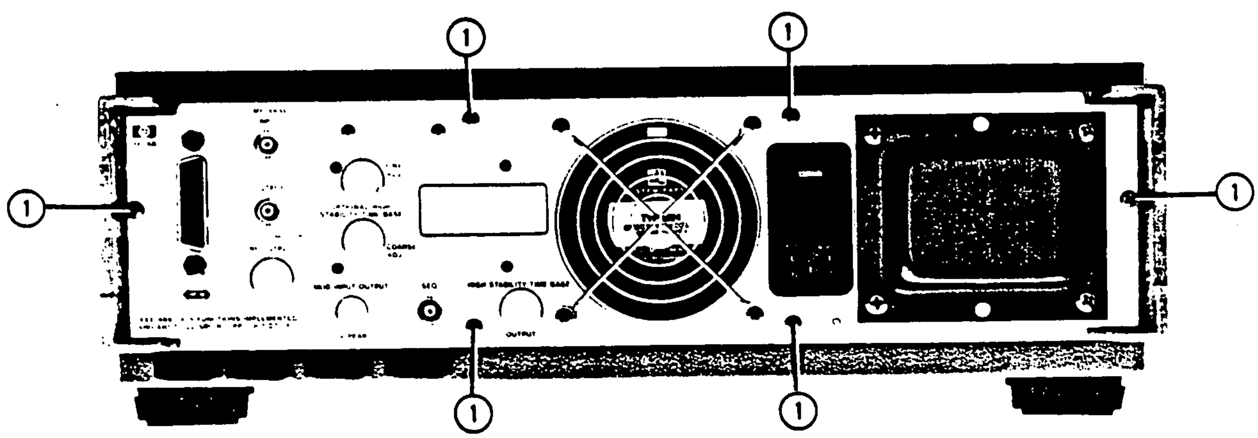


Figure 8-2 (2511A and above). Rear-Panel Removal

Rear-Panel Removal (2425A to 2509A). Position the Signal Generator so you are facing the rear-panel as shown in Figure 8-2.

1. Free the left rear foot (item 1) by removing two No. 2 Pozidriv screws, washers, lockwashers, and hex nuts (items 2).
2. Free the rear-panel (item 4) by removing three No. 2 Pozidriv screws and lockwashers (items 3).
3. Pull the rear-panel away from the casting.
4. Remove the flat ribbon cable connector from the HP-IB Connector Assembly.

CAUTION

While reinstalling the rear-panel, be sure the thin wall metal gasket MP120 is not twisted or bent against the top, bottom or side of the machined frame (casting) MP1.

5. While reinstalling the rear-panel, reverse the steps of the preceding procedure.

Fan Shroud Removal (2425A to 2509A). Position the instrument so you are facing the rear-panel as shown in Figure 8-2.

1. Free the fan shroud by removing two No. 2 Pozidriv screws, lockwashers and flatwashers (items 5) on the fan shroud MP143 (item 7), and by removing one No. 2 Pozidriv screw, lockwasher and flatwasher on the right rear foot MP138 (item 6).
2. Pull the fan shroud back from the Signal Generator's machined frame (casting) MP1.
3. Removing the plastic pin MP129 (refer to Figure 6-3) that attaches the series regulator cover to the fan shroud, and removing two wires connected to the fan completely frees the fan shroud from the Signal Generator.

NOTE

Removing the transformer frees the bracket holding the Option 001 10 MHz Reference Oscillator if it has been installed.

CAUTION

Be sure that none of the wires within this assembly are crushed between the casting and the transformer while reinstalling the transformer. With Option 001 installed, it may be necessary to remove the rear-panel to ensure that no damage occurs.

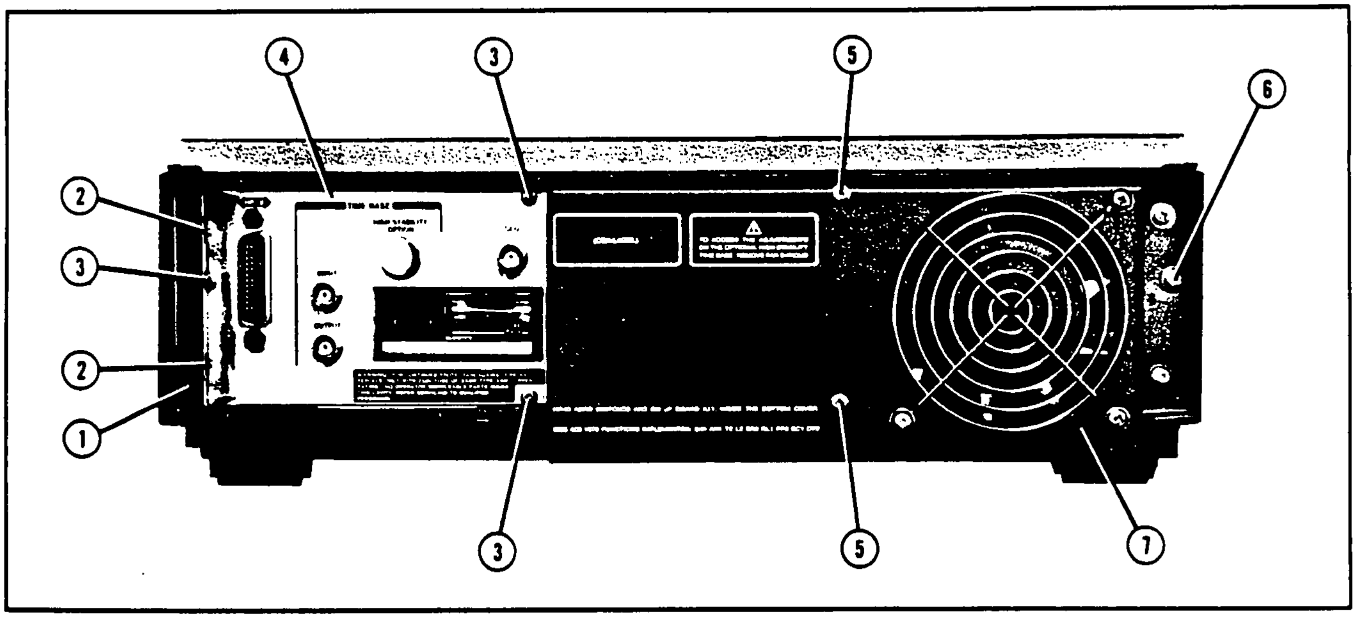


Figure 8-2 (2425A to 2509A). Rear-Panel and Fan Shroud Removal

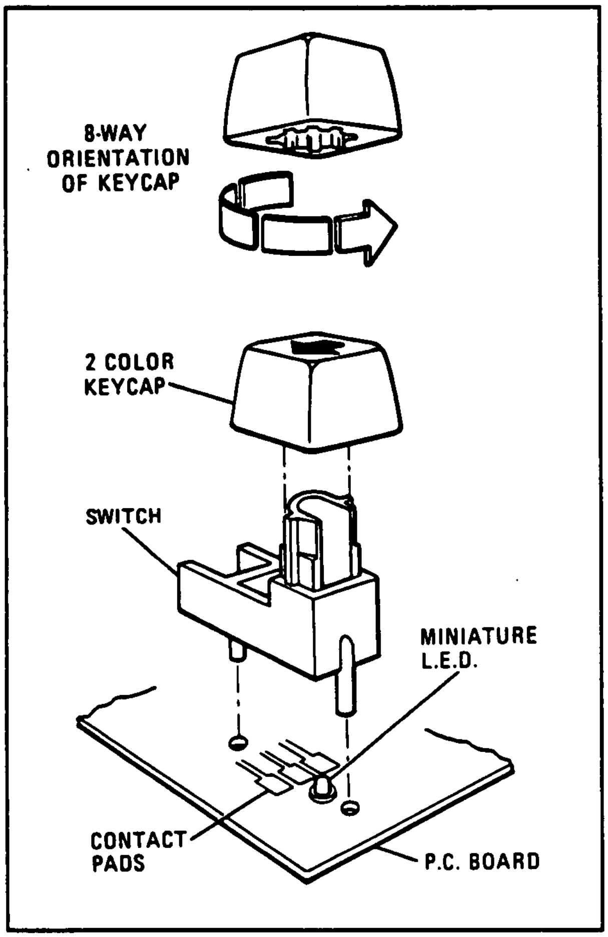


Figure 8-3. Front-Panel Pushbutton Switch Assembly

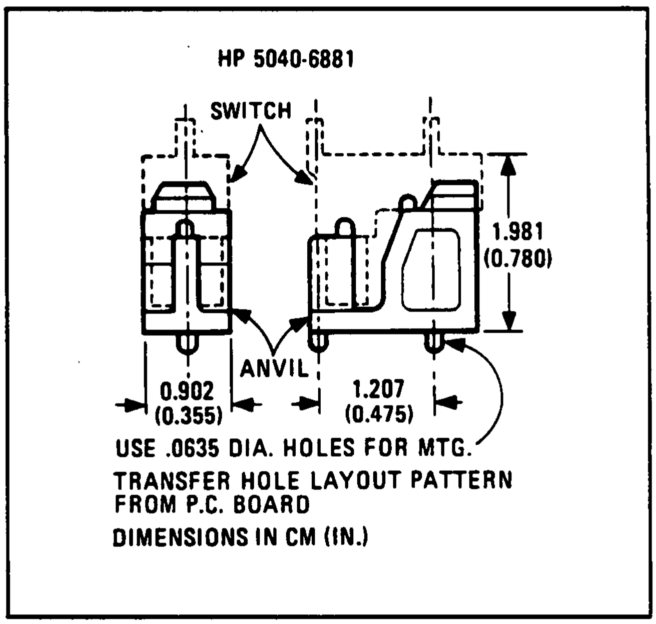
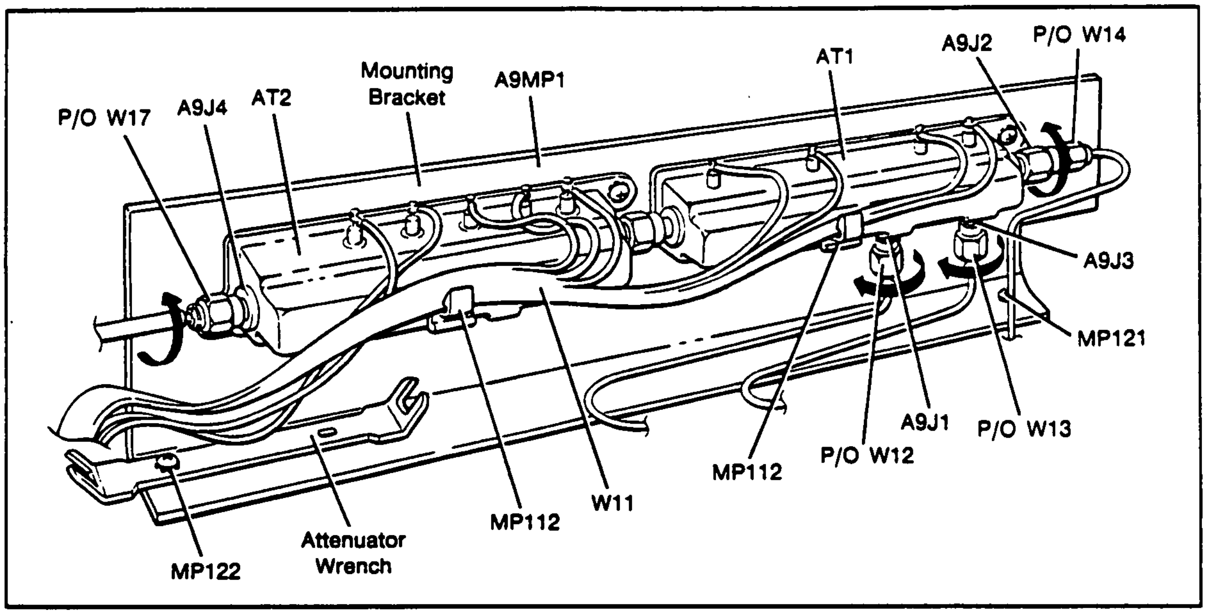


Figure 8-4. Pushbutton Switch Support Anvil



Attenuator Assembly A9 (2425A and above)

Attenuator Removal (2425A and above). Position the Signal Generator so you are facing the instrument's front-panel.

CAUTION

Do not attempt to remove attenuator AT1 and AT2 from the mounting bracket A9MP1 while the unit is still in the Signal Generator.

1. Unplug the Signal Generator from Mains power.
2. Follow the Cover Removal, Top and Bottom procedure in paragraph 8-31 to get to Level 4 of the instrument.
3. Make sure the Signal Generator is in the same position as indicated by the Attenuator Assembly A9 figure shown above.
4. Unsolder **W11** from **AT1** and **AT2**. Remove W11 from retainer clips **MP112**.
5. Free the **Attenuator Wrench** by removing one No.2 Pozidriv screw **MP122**.
6. Free the attenuator **Mounting Bracket** by removing one No.2 Pozidriv screw **MP121**.
7. Use the attenuator wrench to disconnect **W14** from **A9J2**. Rotate A9J2 as indicated by the direction of the arrow.
8. Use the attenuator wrench to disconnect **W17** (W21 for Option 002) from **A9J4**. Rotate the nut connecting W17 to A9J4 as indicated by the direction of the arrow.
9. Use the attenuator wrench to disconnect **W12** from **A9J1**. Rotate the nut connecting W12 to A9J1 as indicated by the direction of the arrow.
10. Use the attenuator wrench to disconnect **W13** from **A9J3**. Rotate the nut connecting W13 to A9J3 as indicated by the direction of the arrow.
11. Remove the Attenuator Assembly A9 from the instrument by rotating the mounting bracket over W12 and W13.

8-32. Replacement of Key Cap and Pushbutton Switches.

Key Cap Replacement. Removing a front-panel key cap may be easily done in one of two ways. 1) If the front-panel has been removed (refer to the Front-Panel Removal procedure), use a small flat blade screwdriver to press on the switch side of the key cap while working it from side-to-side with your fingers. 2) Removing the key cap without opening the instrument is done as follows. Grasp the key cap firmly with pliers. Work it from side-to-side while pulling away from the panel.

NOTE

The pliers may damage the key cap unless the jaws are covered with a protective material.

Be sure the key cap is aligned properly before snapping into place. Note that the key cap has 8 possible positions (refer to Figure 8-3).

Switch Replacement. The front-panel switches have a very high cycle life. However, if one becomes faulty and needs replacement, follow the procedure outlined below:

1. Remove the front-panel (refer to the Front-Panel Removal Procedure).

2. Remove the key cap as indicated above.

3. Remove the switch by chipping away the melted plastic tabs on the circuit side of the keyboard which hold the switch in place.

4. To assure long life and reliable electrical performance, the circuit board contact traces (which are found underneath the switch) should be clean and free of surface imperfections. Clean the switch contact pads before installing a new switch.

5. For reliable operation, any method of assembly must assure that the switch is mounted tightly against the pc board. To facilitate the heat staking operation, specially molded support anvils HP 5040-6882) can be ordered. Refer to Figure 8-4.

NOTE

The following operation should be done in a well ventilated area. If the heat staking tip is too hot, the plastic will vaporize and emit fumes. These fumes, however, are non-toxic.

6. To assure proper switch assembly, verify that the switch is pushed firmly against the circuit board, and with the hot (440°C or 825°F) staking tip (refer to Figure 8-5) push down on each of the posts (2) of the switch. Each post should take about one second to stake. With the proper cycle, the post should turn a darker color and in about ten seconds, return to its original bright red color. The correctly staked post should have a smooth round "rivet" like top (refer to Figure 8-6).

CAUTION

Do not disturb the assembly for at least 10 seconds after heat staking.

If not enough heat is applied, the plastic tends to stick to the tip of the iron.

If too much heat is applied the plastic will fume profusely, the "rivet" will be irregularly shaped, and the plastic will be permanently discolored.

If the staking tool is worn or flaked, it will cause a misshaped rivet and/or a contamination deposit on the surface.

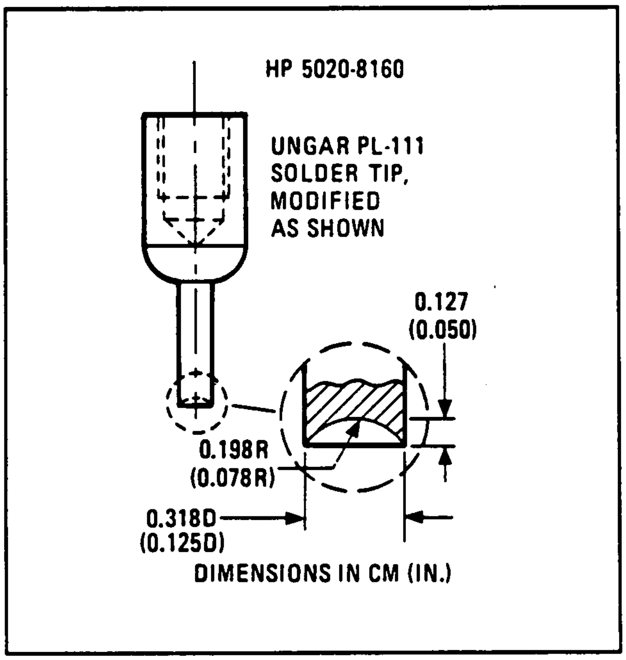


Figure 8-5. Heat Staking Tip

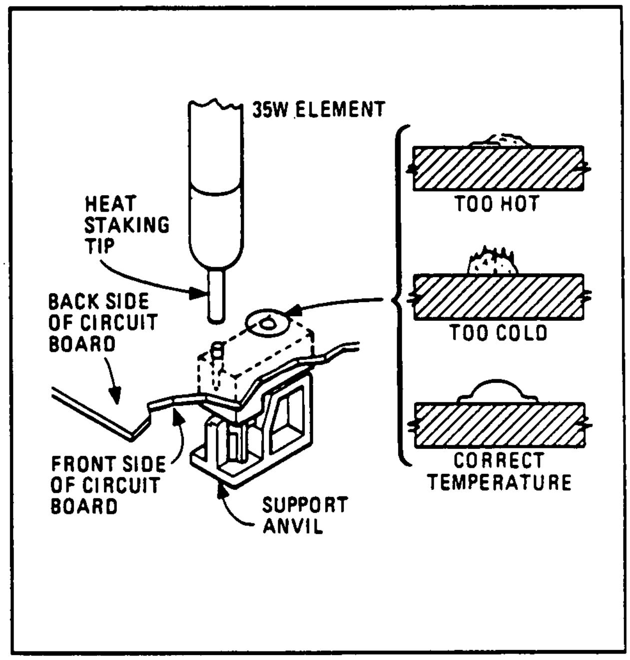


Figure 8-6. Typical Assembly for Heat Staking Operation

8-33. Factory-Selected Components (*)

Some component values are selected at the time of final checkout at the factory (see Table 5-1). These values are selected to provide optimum compatibility with associated components. These components are identified on individual schematics and the parts list by an asterisk (*).

8-34. Manual Updating

Production changes to this Signal Generator made after the publication date of this manual are indicated by a change in the serial number prefix. Changes to this manual's information are recorded by serial number prefix, and are found on the addition and replacement pages. Hewlett-Packard offers a **DOCUMENTATION UPDATE SERVICE** that provides you with addition and replacement pages. Correctly inserted, these pages will bring your manual up to date. For more information, refer to paragraph 1-4.

8-35. Etched Circuits (Printed Circuit Boards)

The etched circuit boards in the Signal Generator have plated-through holes which make a solderable path through to both sides of the insulating material. Soldering can be done from either side of the board with equally good results. When soldering to any circuit board, keep in mind the following recommendations:

1. Avoid unnecessary component substitution. Substitution can result in damage to the circuit board and/or adjacent components.

2. Do not use a high power soldering iron on etched circuit boards. Excessive heat may lift a conductor or damage the board.

3. Use a suction device or wooden toothpick to remove solder from component mounting holes. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL FOR THIS PURPOSE. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR. Refer to Table 8-2 for information on available tools for working on etched circuit boards.

8-36. MOS and CMOS Integrated Circuit Replacement

MOS and CMOS integrated circuits are used in this instrument. They are prone to damage from both static and transients and must be handled carefully. Refer to paragraph 8-10 Special Handling Considerations for Static Sensitive Devices for further information. When working on the Signal Generator, keep in mind the following recommendations to avoid damaging these sensitive components.

1. Do not remove any board unless the Signal Generator has been unplugged.

2. When removing a socketed MOS and CMOS device from an assembly, be careful not to damage it. Avoid removing devices from these sockets with pullers. Instead, use a small screwdriver to pry the device up from one end, slowly pulling it up one pair of pins at a time.

3. Once a MOS or CMOS device has been removed from an assembly, immediately stick it into a pad of conductive foam or other suitable holding medium.

4. When replacing a MOS or CMOS device, ground the foam on which it resides to the instrument before removing it. If a device requires soldering, make sure that the assembly is lying on a sheet of conductive foam, and that the foam and soldering iron tip are grounded to the assembly. Apply as little heat as possible.

5. Before turning the instrument off, remove any large ac sources which may be driving MOS switches.

Table 8-2. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended	HP Part No.
Soldering Tool	Soldering, Heat Staking	Wattage: 35W Tip Temp.:390-440°C (735-825°F)	Ungar No. 135 Ungar Division Eldon Ind. Corp. Compton, CA 90220	8690-0167
Soldering Tip	Soldering, Unsoldering Heat Staking	Shape: Chisel* Shape: Cupped	Ungar PL113* HP 5020-8160 or modified Ungar PL111 (see Figure 8-5)	8690-0007 5020-8160
De-Soldering Aid	To remove molten solder from connection	Suction Device	Soldapullt by Edsyn Co., Van Nuys, CA 91406	8690-0060
Solder	Component replacement; Circuit Board repair wiring	Rosin (flux) core, high tin content (63/37 tin/lead), 18 gauge (SWG) 0.048 in. diameter preferred.		8090-0607

*For working on circuit boards; for general purpose work, use No. 555 Handle (8690-0261) and No. 4037 Heating Unit 47½-56½ W (HP 8690-0006); tip temperature of 850-900°F, and Ungar No. PL113 ⅛" chisel tip.

8-37. RETROFITTING OPTION 001

Option 001 may be retrofitted to the Signal Generator after taking delivery. Refer to Section I for the description and part numbers under the paragraphs entitled Options.

8-38. SCHEMATIC SYMBOLOGY AND OPERATING PRINCIPLES

8-39. Schematic Diagram Notes

Table 8-3, which precedes the foldouts, summarizes the symbology used in presenting many devices found in the Signal Generator.

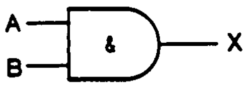
8-40. Basic Logic Symbology

The logic symbols used in this manual are based on the Institute of Electrical and Electronic Engineers (IEEE) IEEE-STD 91-1984, "Graphic Symbols for Logic Functions". A summary of this symbology is provided to aid in interpreting these symbols.

Gates and Qualifiers. This section includes a brief description of the basic symbols used on the service sheets (see Figure 8-7), a summary of indicator symbols (see Figure 8-8), dependency notation (see Figure 8-9), control blocks (see Figure 8-10), and a summary of symbology for some of the more complex devices.

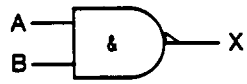
Qualifiers are that portion of a device symbol that denotes the logic function. For example, "&" denotes the AND function. See Figure 8-7 for a summary of the basic logic symbols and their qualifiers.

AND GATE

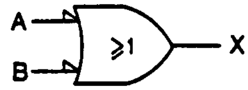


A	B	X
H	H	H
H	L	L
L	H	L
L	L	L

NAND GATE

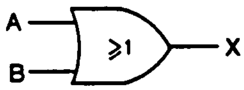


OR GATE WITH INVERTED INPUTS



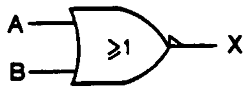
A	B	X
H	H	L
H	L	H
L	H	H
L	L	H

OR GATE

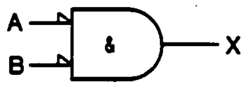


A	B	X
H	H	H
H	L	H
L	H	H
L	L	L

NOR GATE

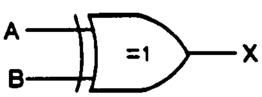


AND GATE WITH INVERTED INPUTS



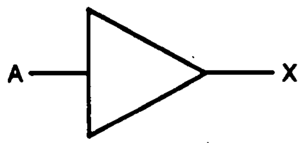
A	B	X
H	H	L
H	L	L
L	H	L
L	L	H

EXCLUSIVE-OR GATE

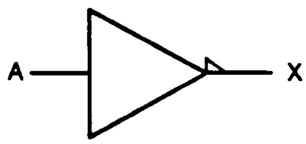


A	B	X
H	H	L
H	L	H
L	H	H
L	L	L

BUFFER



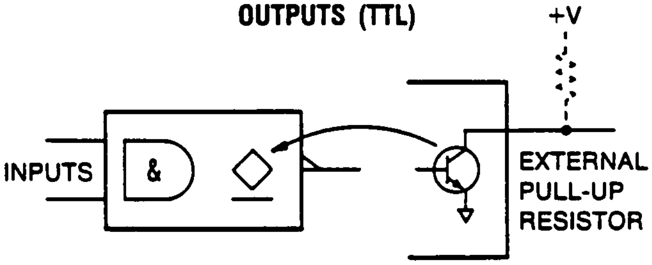
A	X
H	H
L	L



A	X
H	L
L	H

INVERTER

OPEN COLLECTOR OUTPUTS (TTL)



OPEN EMITTER OUTPUTS (ECL)

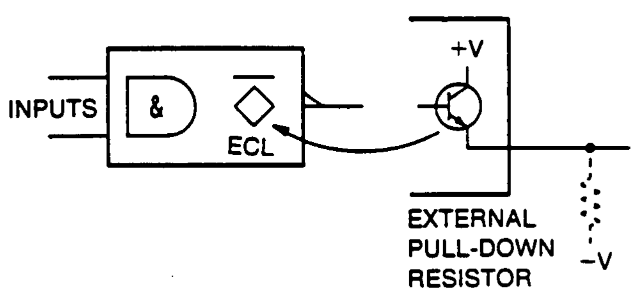
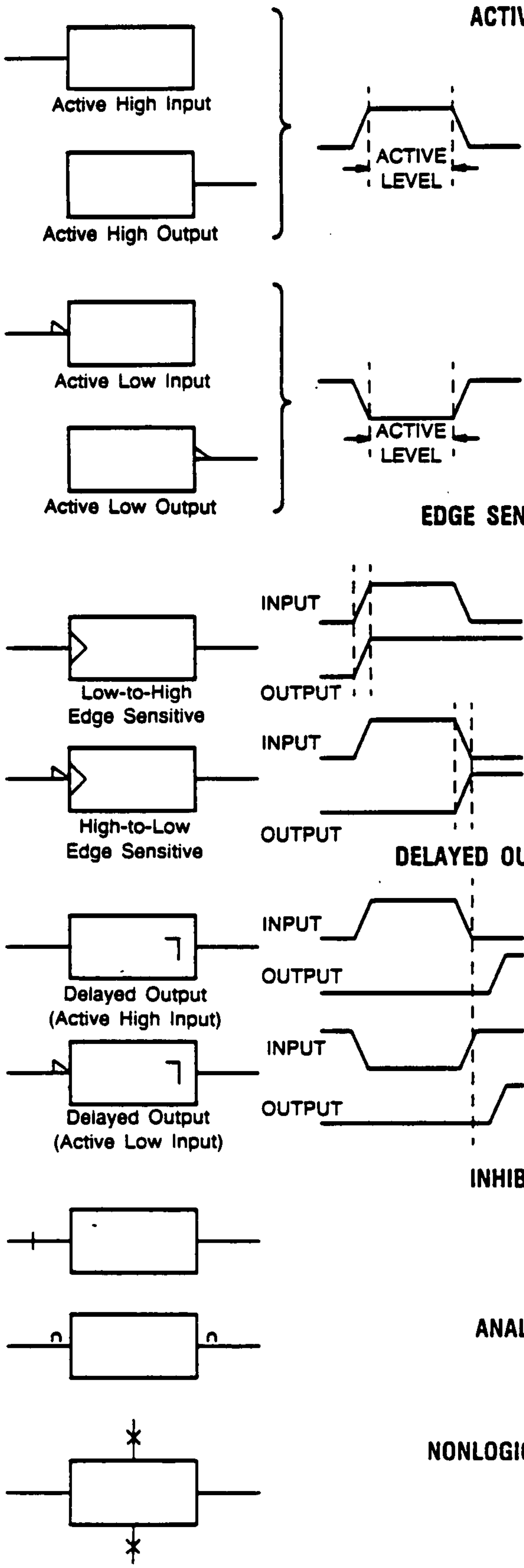


Figure 8-7. Basic Logic Symbols and Qualifiers



ACTIVE LEVELS

ACTIVE HIGH inputs and outputs are indicated by the absence of the polarity indicator symbol.

ACTIVE LOW inputs and outputs are indicated by the presence of the polarity indicator symbol (⊾).

EDGE SENSITIVE INPUTS

EDGE SENSITIVE (low-to-high) inputs are indicated by the presence of the dynamic indicator symbol (—▷).

EDGE SENSITIVE (high-to-low) inputs are indicated by the presence of both the dynamic indicator and the polarity indicator symbols (⊾▷).

DELAYED OUTPUT RESPONSE

OUTPUT DELAY indicator symbol (┐) shows that the output becomes effective *after* the input signal returns to its inactive state.

INHIBIT INPUTS

INHIBIT indicator symbol (+) indicates an input that, when active, inhibits (blocks) the output(s) from achieving their active states (the outputs remain inactive).

ANALOG LINES

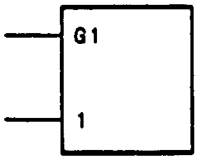
ANALOG indicator symbol (∩) indicates a line that has an analog input or output.

NONLOGIC CONNECTION

The Nonlogic Connection symbol (X) indicates a connection that does not carry any logic information.

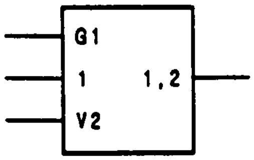
Figure 8-8. Indicator Symbols

AND



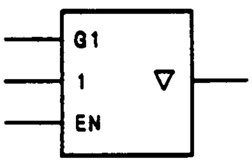
The input that controls or gates other inputs is labeled with a C or a G, followed by an identifying number.
The controlled or gated input or output is labeled with the same number. In this example, 1 is controlled by G1.

OR



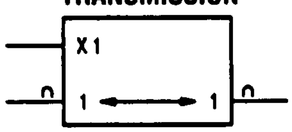
When a V input is active, the output will be in its active state. With the V input inactive, the device functions as if the V input doesn't exist.

ENABLE



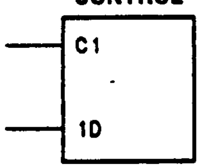
When the EN input is active, the output is enabled to function normally. When the EN input is inactive, the three-state output (▽), in this case, becomes a high impedance, effectively removing that device from the circuit.

TRANSMISSION

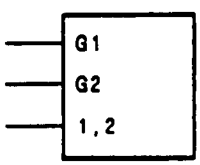


When the X1 input is active, the associated input-output pair are bi-directionally connected together. When X1 is inactive, the connection is broken.

CONTROL

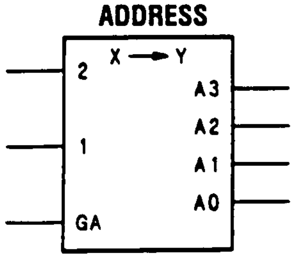


When the controlled or gated input or output already has a functional label (D is used here), that label will be prefixed by the identifying number.



If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear separated by commas.

ADDRESS



When GA is active, the active address line (0 through 3) is the decoded value of the 1 and 2 binary inputs. When the controlled address lines have a functional value, that value will be prefixed by the identifying letter.

Figure 8-9. Dependency Notation

Indicator Symbols. Indicator symbols identify the active state of a device's input or output, as shown in Figure 8-8.

Dependency Notation. Dependency Notation simplifies symbols for complex integrated circuit elements by defining the interdependencies of inputs or outputs without actually showing all the elements and interconnections involved (see Figure 8-9). The dependent input or output is controlled by a similarly numbered dependency input labeled C, G, V, EN, X or M as explained in Table 8-3.

Common Control Block. The Control block is used in conjunction with an array of related symbols in order to group common logic lines. A quad D-type Flip-Flop with reset can be redrawn as shown in Figure 8-10. Note that individual Flip-Flop symbols can be used when flip-flops are functionally scattered around the schematic (i.e. not used as a quad unit).

Complex Device Symbology. Figures 8-11 through 8-14 show how the basic symbols can be combined to illustrate behavior of fairly complex devices. Two symbols may share a common boundary parallel or perpendicular to the direction of the signal flow. There is generally no logic connection across a horizontal line, but there is always an implied logic connection across a vertical line. Notable exceptions to this rule are the horizontal lines beneath control blocks and between sections of shift registers and counters (dividers).

Shift Register. The control block shown in Figure 8-11 is used to show common inputs to a Bidirectional Shift Register. Input "a" has two functions common to one pin. When input "a" is high, parallel-loading of the D-type flip-flops (1,3D) is enabled after high-to-low transition of the clock input (C3). During parallel-loading, entry of serial data is inhibited. When input "a" is low, one input to the top D-type flip-flop (2,3D) is enabled to shift data "m" units after high-to-low transition of the clock input (C3). Input "b" is active during the high-to-low transition of the clock input. Input "b" loads all four flip-flops (1,3D) in parallel, and the top flip-flop input (2,BD) in serial. Notice that "⟶ m" means shift contents to the right or down by "m" units. Note: if m=1 "m" may be omitted. Input "c", active-low, enables normal logic levels of the "4" outputs to drive loads or bus lines. The "4" outputs are disabled by a high logic level at input "c". The "4" outputs then present a high impedance state represented by the three-state symbol " ▽ ". Input "d", active-low, is a common reset.

Up/Down Counter. The control block shown in Figure 8-12 is used to show common inputs to a Presettable Decade Up/Down Counter. Input "a", active-low, outputs each flip-flop on a low-to-high level transition of the clock. Input "b" has two functions common to one pin. When input "b" is high, the direction of count is down. When input "b" is low, the direction of count is up. Input "c" has two functions common to one pin. Input "c" is an edge-triggered control input for the count up/down output "e" and a control input for the ripple clock output "f". Input "d", active-low, enables the four data inputs (5D) to accept a count up/down number in BCD.

Quad D-Type Latch. The control block shown in Figure 8-13 is used to illustrate a Quad D-type Latch. It has a common active-low reset (R), and a common edge-triggered control input (C1). There is only one dependency relationship; the controlling input is numbered and the controlled functions have the control dependency notation (1D) next to them.

Analog Switch. The analog switch is a bidirectional device, as indicated by the double-ended arrow (see Figure 8-14). The X1 input is the gate. X1 indicates that the input and output (both labeled "1") are dependent on this input.

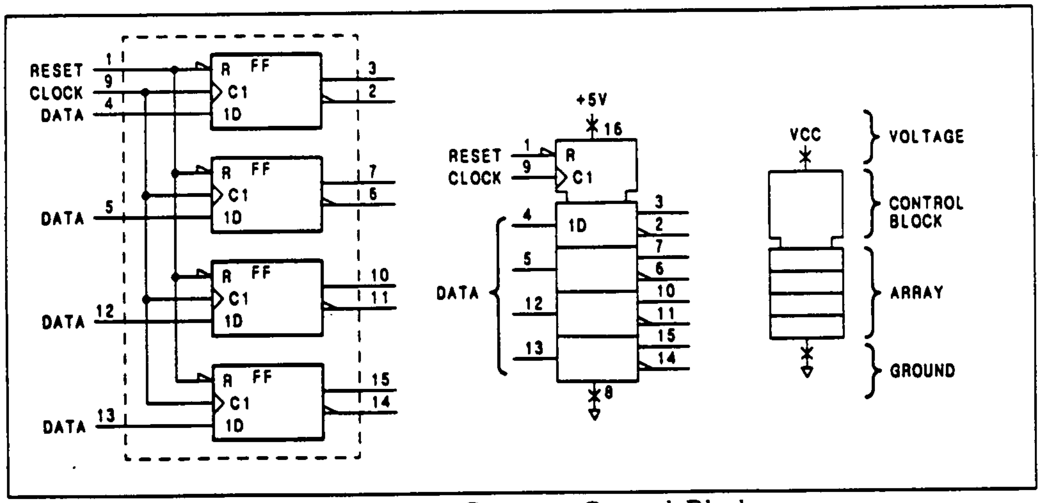


Figure 8-10. Common Control Block

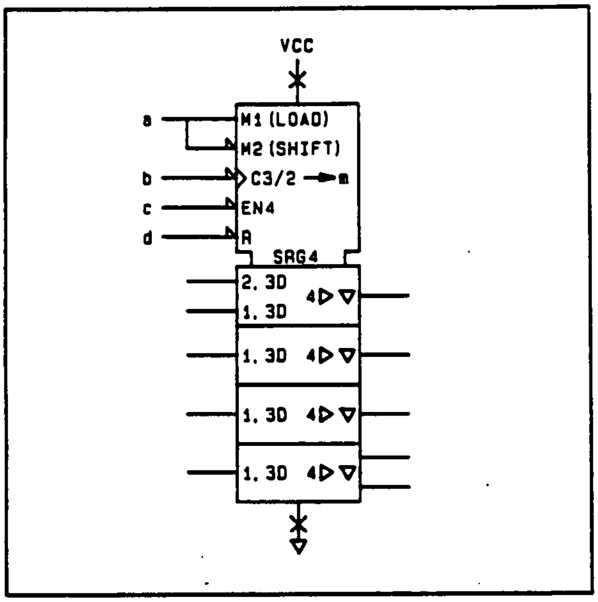


Figure 8-11. Shift Register

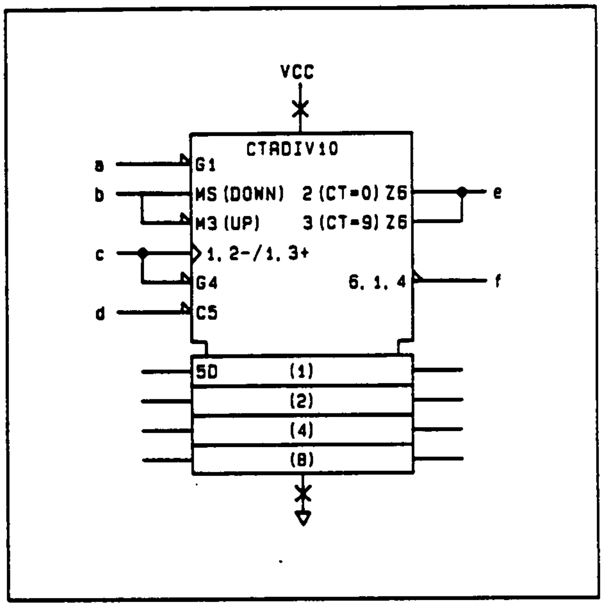


Figure 8-12. Up/Down Counter

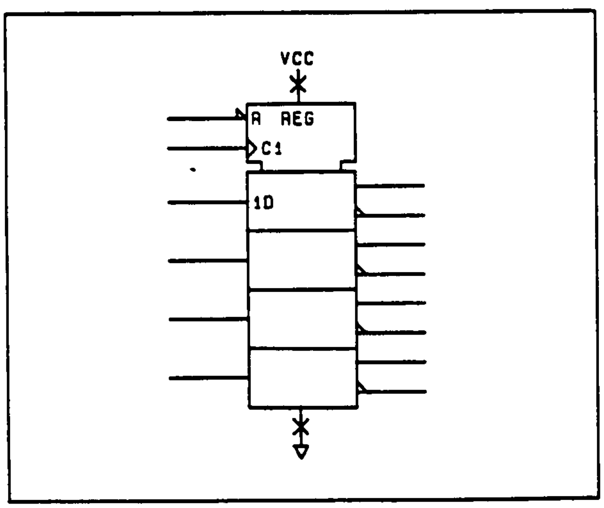


Figure 8-13. Quad D-Type Latch

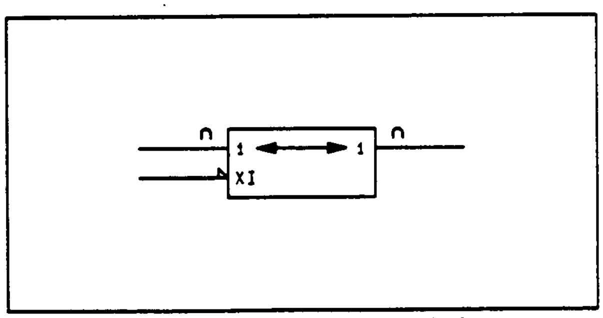


Figure 8-14. Analog Switch

8-41. Complex Logic Symbology and Operating Principles.

Microprocessor. For information regarding this device, refer to the Principles of Operation for Service Sheet 17.

Random Access Memory (RAM). See Figure 8-15. This device provides temporary storage for up to 128 eight-bit words. Memory words are addressed on the address bus "A". Inputs "1,G2" and "1,G3" have two functions common to one pin. When the input is high, data is written into memory; when the input is low, data is read from memory. This device is active only when the six inputs to "&" are active. With all six inputs to "&" active the device is enabled as indicated by "EN1". Note that the input and output lines for each data bit are the same.

Read Only Memory (ROM). See Figure 8-16. This device provides permanent storage for up to 16,384 eight-bit words. Memory words are addressed by the address bus "A". When both control inputs "&" are active (low), the output of the ROM is enabled. When any one of the "&" inputs are inactive, the output is forced into an inactive (high impedance) state.

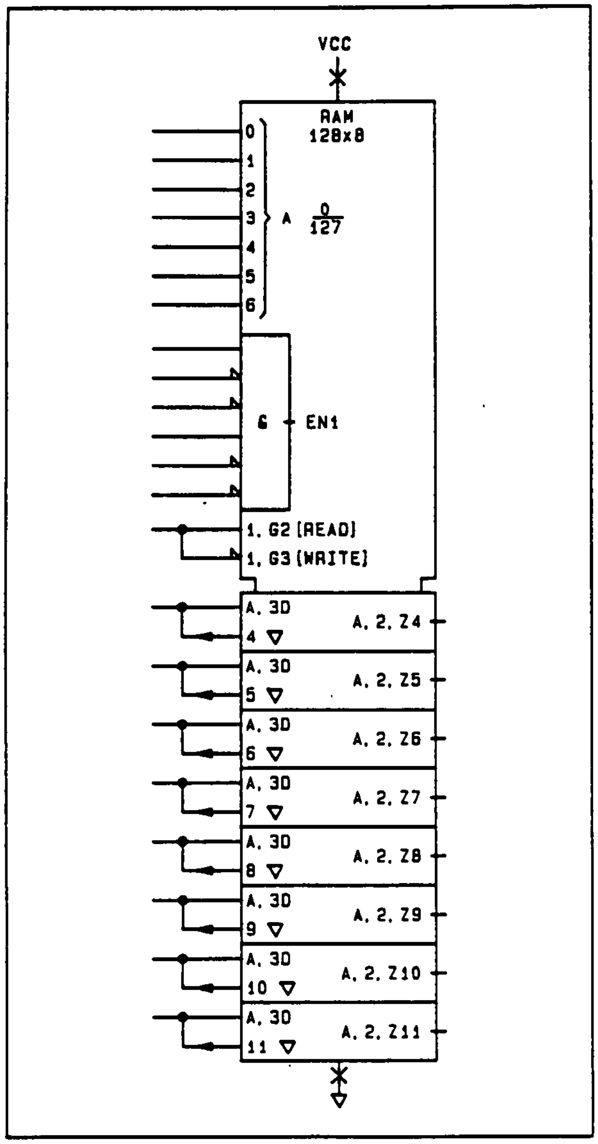


Figure 8-15. Random Access Memory

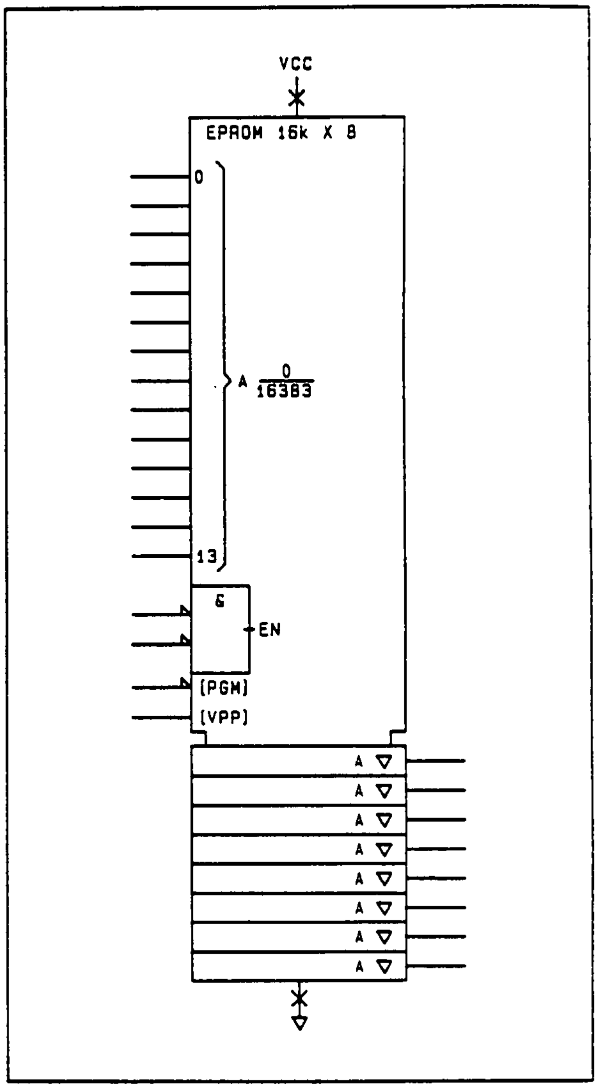


Figure 8-16. Read Only Memory

Multiple Bus Transceivers. See Figure 8-17. This device is used as an interface between the Signal Generator's interface adapter and data bus. If input "EN1" is low, the device passes data from the left inputs side "A" to the right outputs side "B". If input "EN2" is high, the device passes data from the right inputs side "B" to the left outputs side "A". Data input/output "A" and "B" is a representation of how the subsequent logic-blocks are configured. If G3 is high, no data can be passed (all inputs and outputs are driven to a high impedance state). When G3 is low, the device is enabled.

General Purpose Interface Adapter (GPIA). See Figure 8-18. The GPIA interfaces a microprocessor through the instrument interface, and a computer controller through the HP-IB interface. Data flow between the Signal Generator's microprocessor circuits and the interface bus occurs via D0-D7 Data bus lines and the IB0-IB7 signal lines. Each allows bidirectional data transfer. The signal lines pass ASCII data (8-bits).

The HP-IB mode is selected by placing a low on chip select "CS". The read/write and address (register select) lines "RS0", "RS1", and "RS2" select data and control information which flows to and from the microprocessor circuits on the data bus. The clock is derived from the microprocessor's system clock. The interrupt request "IRQ" is set low to interrupt microprocessor operation for data or control inputs. The address select enable "ASE" enables the address output to the data lines. "RESET" initializes the chip. For this Signal Generator, "DMA REQUEST", "TRIG", "T1", "T2", "R1", and "R2" are not used. "DMA GRANT" must be grounded to enable the chip.

The handshake control lines "DAV", "RFD", and "DAC" are explained in more detail on Service Sheet 20. The bus management lines, attention "ATN", service request "SRQ", remote enable "REN", interface clear "IFC", and end of information or identify "EOI", are used to control information to and from the Signal Generator. Refer to Section III, HP-IB Functional Checks for information relating to these lines under various control configurations.

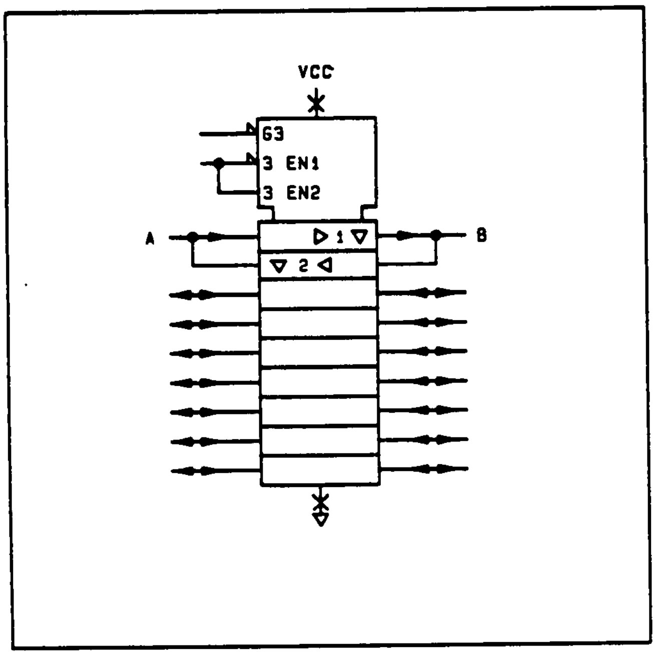


Figure 8-17. Multiple Bus Transceiver With 3-State Output

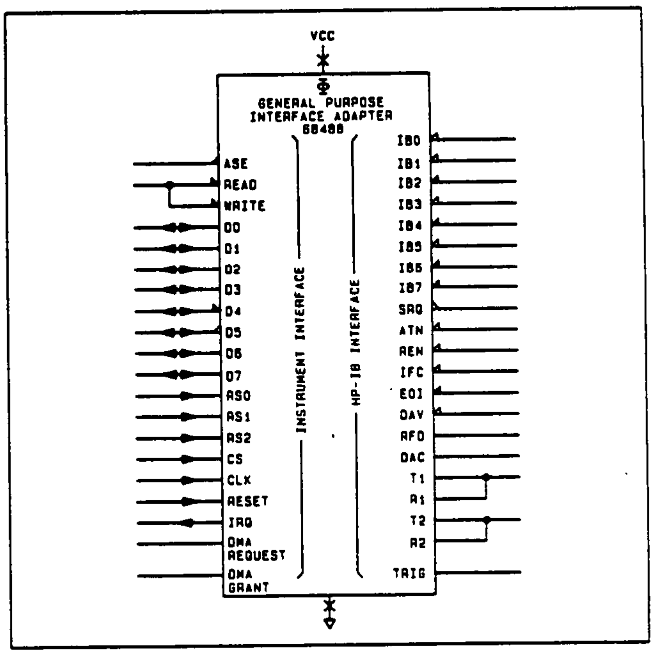


Figure 8-18. General Purpose Interface Adapter

BCD-to-Seven-Segment Latch/Decoder/Driver. See Figure 8-19. This device latches and decodes BCD data to drive the individual segments of a seven-segment common cathode display. The BCD code is latched into four flip-flops when "C1" goes low. The BCD data is converted to a decimal code, and then to the seven-segment code.

The seven-segment output is enabled by a low on control input "[LAMP TEST]" and when two conditions exist together: 1) when the binary data is equivalent to decimal 0-9 and 2) when "[BLANKING]" is high. When "[BLANKING]" is low, the outputs are disabled and the display is blanked. When "[LAMP TEST]" is low at "Power-On" all seven output lines are high to test all segments of the display.

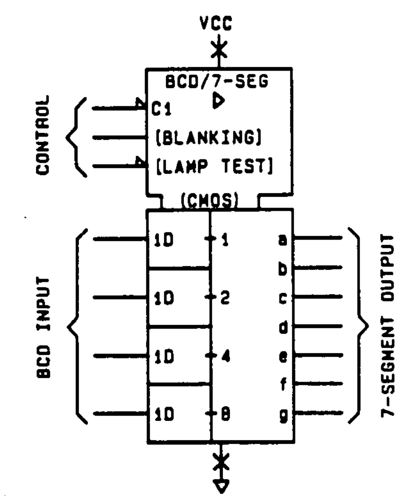


Figure 8-19. BDC-to-Seven-Segment Latch/Decoder/Driver

8-42. Linear Device Operating Principles

Operational Amplifiers. The source of gain in an operation amplifier can be characterized as an ideal differential voltage amplifier having low output impedance, high input impedance, and very high differential gain. The output of an operational amplifier is proportional to the difference in the voltages applied to the two input terminals. In use, the amplifier output drives the input voltage difference close to zero through a feedback path.

When troubleshooting an operational amplifier circuit, measure the voltages at the two inputs; the difference between these voltages should be less than 10 mV. (Note: This troubleshooting procedure will not work for operational amplifiers which are configured as comparators.) A difference voltage much greater than 10 mV indicates trouble in the amplifier or its external circuitry. Usually, this difference is several volts and one of the inputs is very close to one of the supply voltages (e.g., +15V or -15V).

Next, check the amplifier's output voltage. It will probably also be close to one of the supply voltages (e.g., ground, +15V or -15V). Check to see that the output conforms to the inputs. For example, if the inverting input is more positive than the non-inverting input, the output should be negative; if the non-inverting input is more positive than the inverting input, the output should be positive. If the output conforms to the inputs, check the amplifier's external circuitry. If the amplifier's output does not conform to its inputs, it is probably defective.

Figures 8-20, 8-21, and 8-22 show typical operational amplifier configurations. Figure 8-20 shows a non-inverting buffer amplifier with a gain of 1. Figure 8-21 is a non-inverting amplifier with a gain determined by R1 and R2. Figure 8-22 is an inverting amplifier with gain determined by R1 and R2.

Comparators. Comparators are used as level sense amplifiers, switch drivers, pulse height discriminators, and voltage comparators. A voltage reference is connected to one of the amplifier's inputs as shown in Figures 8-23 and 8-24. When the other input signal voltage crosses the reference, the output is switched to the opposite polarity; the output remains at this polarity until the input signal re-crosses the reference.

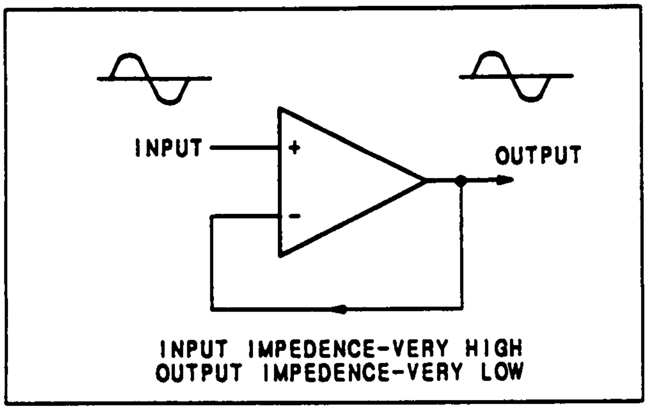


Figure 8-20. Non-Inverting Amplifier (Gain = 1)

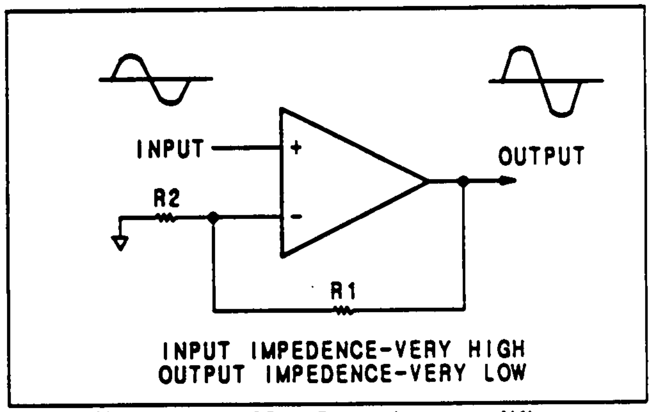


Figure 8-21. Non-Inverting Amplifier (Gain = 1 + R1/R2)

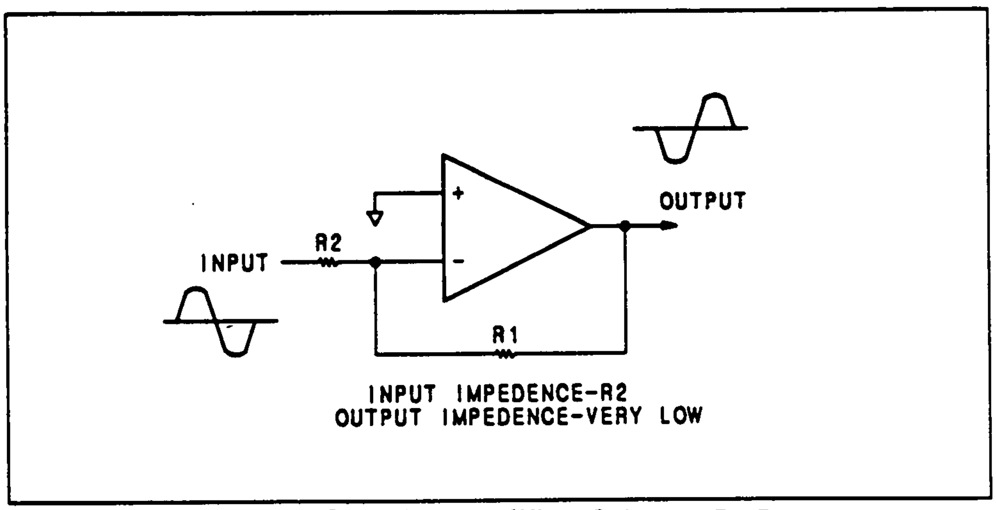


Figure 8-22. Inverting Amplifier (Gain = −R1/R2)

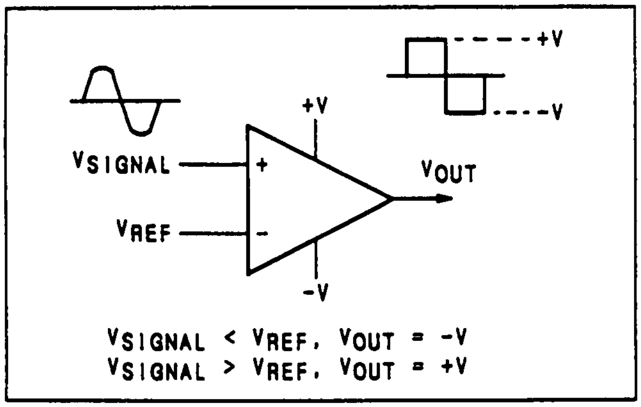


Figure 8-23. Non-Inverting Comparator

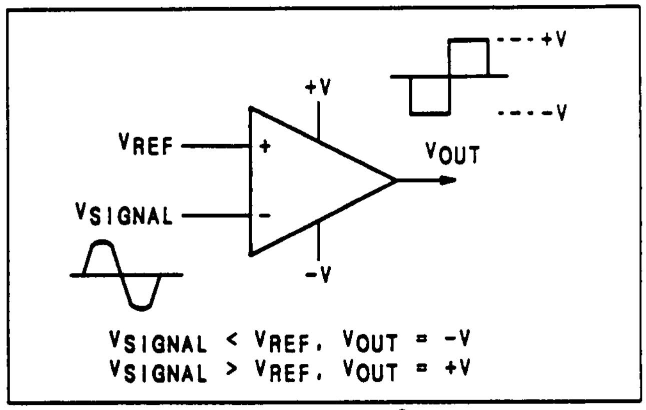


Figure 8-24. Inverting Comparator

Table 8-3. Schematic Diagram Notes (1 of 8)

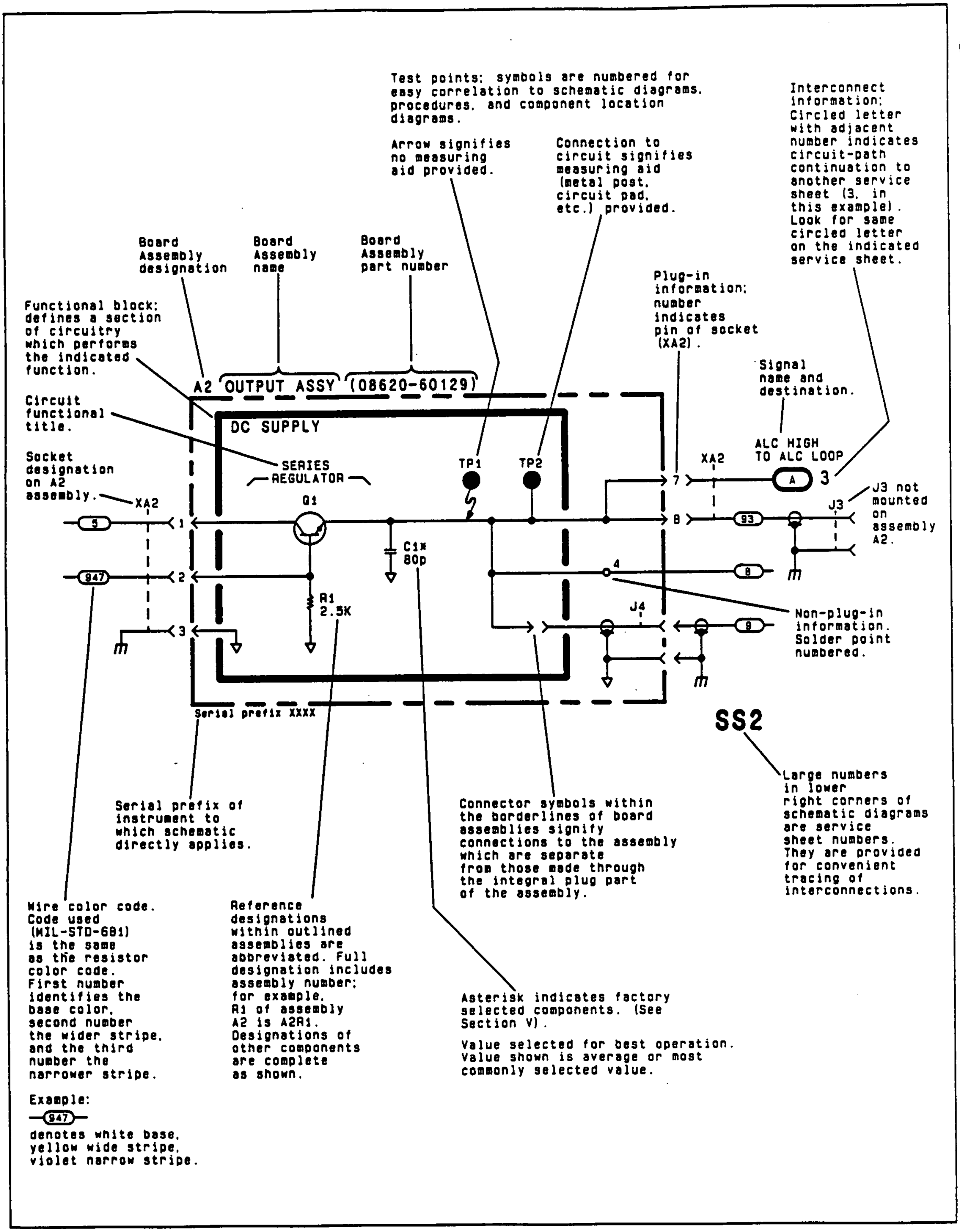


Table 8-3. Schematic Diagram Notes (2 of 8)

Values for all components are marked in units of farads, henries, and ohms unless otherwise specified.

*	Asterisk denotes a factory-selected value. Value shown is typical. See Section V.
	Tool-aided adjustment. Manual control.
	Encloses front-panel designation.
	Encloses rear-panel designation
	Circuit assembly borderline.
	Other assembly borderline.
	Heavy line with arrows indicates path and direction of main signal.
	Heavy dashed line with arrows indicates path and direction of main feedback.
	Indicates stripline (i.e., RF transmission line above ground).
CW	Wiper moves toward cw with clockwise rotation of control (as viewed from shaft or knob).
TP1	Numbered Test Point measurement aid provided.
	Encloses wire or cable color code. Code used is the same as the resistor color code. First number identifies the base color, second number identifies the wider stripe, and the third number identifies the narrower stripe, e.g., 947 denotes white base, yellow wide stripe, violet narrow stripe.
	A direct conducting connection to earth, or a conducting connection to a structure that has a similar function (e.g., the frame of an air, sea, or land vehicle).
	A conducting connection to a chassis or frame.
	Common connections. All like-designation points are connected.
A 12	Letter = off-page connection. Number = Service Sheet number for off-page connection. In the example, signal flow is continued on Service Sheet 12, at the point marked
1 THIS PAGE	Number (only) = on-page connection.

Table 8-3. Schematic Diagram Notes (3 of 8)

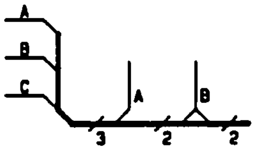
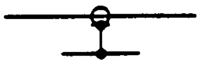
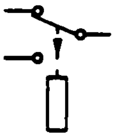
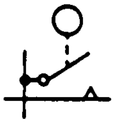
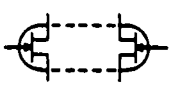
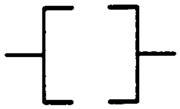
	Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.
	Coaxial or shielded cable.
	Ferrite bead. (Increases the self-inductance of the conductor passing through the bead.)
	Relay. Contact moves in direction of arrow when energized.
	Indicates a pushbutton switch with a momentary (ON) position.
	Feedthrough capacitor. (Acts as a feedthrough terminal when mounted on a chassis or a frame.)
	Indicates a PIN diode.
	Indicates a current regulation diode.
	Indicates a voltage regulation diode.
	Indicates a capacitive (varactor) diode.
	Indicates a Schottky (hot-carrier) diode.
	Light-emitting diode.
	Multiple transistors in a single package—physical location of the pins is shown in package outline on schematic.
	Identification of logic families as shown (in this case, ECL).

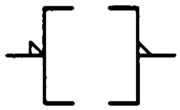
Table 8-3. Schematic Diagram Notes (4 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

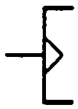
Input and Output Indicators



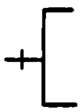
Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



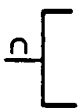
Polarity Indicator—The active state is a relatively low voltage level.



Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.

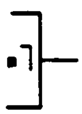


Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.

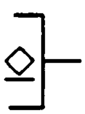


Analog Input—Input that is a continuous signal function (e.g., a sine wave).

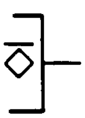
Polarity Indicator used with Inhibit Indicator—Indicates that the relatively low level signal inhibits (blocks) the active state outputs of a digital device.



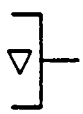
Output Delay—Binary output changes state only after the referenced input (m) returns to its inactive state (m should be replaced by appropriate dependency or function symbols).



Open Collector Output.



Open Emitter Output.



Three-state Output—Indicates outputs can have a high impedance (disconnect) state in addition to the normal binary logic states.

Table 8-3. Schematic Diagram Notes (5 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Combinational Logic Symbols and Functions

Σ	Summing Junction—Outputs added together at a common point.
&	AND—All inputs must be active for the output to be active.
≥1	OR—One or more inputs being active will cause the output to be active.
≥m	Logic Threshold—m or more inputs being active will cause the output to be active (replace m with a number).
=1	EXCLUSIVE OR—Output will be active when one (and only one) input is active.
=m	m and only m—Output will be active when m (and only m) inputs are active (replace m with a number).
=	Logic Identity—Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).
▷	Amplifier—The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).
X/Y	Signal Level Converter—Input level(s) are different than output level(s).
↔	Bilateral Switch—Binary controlled switch which acts as an on/off switch to analog or binary signals flowing in both directions. Dependency notation should be used to indicate affecting/affected inputs and outputs. Note: amplifier symbol (with dependency notation) should be read to indicate unilateral switching.
X→Y	Coder—Input code (X) is converted to output code (Y) per weighted values or a table.
(Functional Labels)	The following labels are to be used as necessary to ensure rapid identification of device function.
MUX	Multiplexer—The output is dependent only on the selected input.
DEMUX	Demultiplexer—Only the selected output is a function of the input.
CPU	Central Processing Unit

Table 8-3. Schematic Diagram Notes (6 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions

1 	Monostable—Single shot multivibrator. Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.
G 	Oscillator—The output is a uniform repetitive signal which alternates between the high and low state values. If an input is shown, then the output will be active if an only if the input is in the active state.
FF	Flip-Flop—Binary element with two stable states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.
T	Toggle Input—When active, causes the flip-flop to change states.
S	Set Input—When active, causes the flip-flop to set.
R	Reset Input—When active, causes the flip-flop to reset.
J	J Input—Analogous to set input.
K	K Input—Analogous to reset input.
D	Data Input—Always enabled by another input (generally a C input—see Dependency Notation). When the D input is dependency-enabled, a high level at D will set the flip-flop; a low level will reset the flip-flop. Note: strictly speaking, D inputs have no active or inactive states—they are just enabled or disabled.
+m	Count-Up Input—When active, increments the contents (count) of a counter by "m" counts (m is replaced with a number).
−m	Count-Down Input—When active, decrements the contents (count) of a counter by "m" counts (m is replaced with a number).
→m	Shift Right (Down) Input—When active, causes the contents of a shift register to shift to the right or down "m" places (m is replaced with a number).
←m	Shift Left (Up) Input—When active, causes the contents of a shift register to shift to the left or up "m" places (m is replaced with a number).

NOTE

For the four functions shown above, if m is one, it is omitted.

(Functional Labels)	The following functional labels are to be used as necessary in symbol build-ups to ensure rapid identification of device function.
mCNTR	Counter—Array of flip-flops connected to form a counter with modules m (m is replaced with a number that indicates the number of states: 5 CNTR, 10 CNTR, etc.).

Table 8-3. Schematic Diagram Notes (7 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions (Cont'd)

REG	Register—Array of unconnected flip-flops that form a simple register or latch.
SREG	Shift Register—Array of flip-flops that form a register with internal connections that permit shifting the contents from flip-flop to flip-flop.
ROM	Read Only Memory—Addressable memory with read-out capability only.
RAM	Random Access Memory—Addressable memory with read-in and read-out capability.

Dependency Notation

Cm	Control Dependency—Binary affecting input used where more than a simple AND relationship exists between the C input and the affected inputs and outputs (used only with D-type flip-flops).
Gm	Gate (AND) Dependency—Binary affecting input with an AND relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or letter (the identifier).
Vm	OR Dependency—Binary affecting input with an OR relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or the letter (the identifier).
mAm	Address Dependency—Binary affecting inputs of affected outputs. The m prefix is replaced with a number that differentiates between several address inputs, indicates dependency, or indicates demultiplexing of address inputs and outputs. The m suffix indicates the number of cells that can be addressed.
ENm	Enable Dependency—Binary affecting input which, when active enables all outputs. When inactive open-collector and open-emitter outputs are off, and three-state outputs are at an external high impedance state. When the enable input affects only certain inputs and outputs, they will be numbered to indicate the logic connection.
Xm	Transmission Dependency—Binary affecting input which bidirectionally connects dependent inputs and outputs.
Mm	Mode Dependency—Binary affecting input used to indicate that the effects of particular inputs and outputs of an element depend on the mode in which the element is operating. The m is replaced with a number or letter (the identifier).
Zm	Interconnection Dependency—Indicates the existence of internal logic connections between inputs, outputs, internal inputs, and/or internal outputs. The m is replaced with a number (the identifier).
,	Comma—AND Function.
/	Slant—OR Function.

NOTE

The identifier (m) is omitted if it is one—that is, when there is only one dependency relationship of that kind in a particular device. When this is done, the dependency indicator itself (G, C, EN, or V) is used to prefix or suffix the affected (dependent) input or output.

Table 8-3. Schematic Diagram Notes (8 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

	Miscellaneous
	Schmitt Trigger—Input characterized by hysteresis; one threshold for positive going signals and a second threshold for negative going signals.
Active	Active State—A binary physical or logical state that corresponds to the true state of an input, an output, or a function. The opposite of the inactive state.

SERVICE SHEET BD1

MODEL 8656B SIGNAL GENERATOR

PRINCIPLES OF OPERATION

General. The Signal Generator can be conceptually broken down into three subsections. The block diagrams of the individual subsections are illustrated on the following Service Sheets.

BD2 - High Frequency and Output Section
BD3 - Low Frequency and FM Section
BD4 - Microprocessor, Keyboard, and Display Section

The Signal Generator uses frequency synthesis to generate a carrier frequency range of 100 kHz to 990 MHz. Its output amplitude is leveled and calibrated from +13 to -127 dBm. AM and/or FM functions can be individually selected. The carrier frequency, output amplitude, and modulation functions can be remotely programmed via the HP-IB.

Frequency synthesis translates a stable, accurate reference into an output signal of a different frequency. The output frequency can have a finite number of values within a frequency range. The resolution of the synthesizer determines the spacing between the discrete values that the output frequency can assume. All output frequencies retain the same accuracy and stability as the reference signal.

When using the indirect synthesis method of generating output frequencies, phase lock loops are locked to a signal from a crystal controlled reference oscillator. The two phase lock loops used in the Signal Generator generate signals which are combined to produce the instrument's frequency range (100 kHz to 990 MHz). Every output frequency starts as a signal in the basic oscillator frequency band (494 to 990 MHz) and is divided or heterodyned in the output section if required. The broad frequency range is generated in the following four bands:

1. 100 kHz to 123.5 MHz (Heterodyned)
2. 123.5 to 247 MHz (Divide by 4)
3. 247 to 494 MHz (Divide by 2)
4. 494 to 990 MHz (Divide by 1 or Basic Band)

High Frequency and Output Section. The Frequency Multiplier multiplies the 50 MHz reference signal by 16 to obtain an 800 MHz signal. It also mixes the 800 MHz with the 60 to 110 MHz output of the low frequency loop to provide a frequency between 690 and 740 MHz in steps of 10 Hz and to phase lock the high frequency loop. As a result, the 50 MHz Reference Oscillator is the only signal whose noise is multiplied and added to the output. By using a narrowband of frequencies (690 to 740 MHz) to phase lock the high frequency loop, the possibility of spurious signals is reduced. The 800 MHz is also sent to the Output Section and mixed with specific frequencies in the basic band (800.1 to 923.5 MHz) to obtain the heterodyne band of frequencies (100 kHz to 123.5 MHz).

SERVICE SHEET BD1 (cont'd)

The high frequency feedback loop phase locks the 494 to 990 MHz basic band VCO. A frequency from the oscillator is mixed with a frequency between 690 and 740 MHz from the Frequency Multiplier. Both the upper and lower sidebands from the Mixer are used to obtain Intermediate Frequencies (IF) in 50 MHz steps from 0 to 250 MHz. Any frequency in the 494 to 990 MHz range can be selected by adding or subtracting the appropriate IF frequency (e.g., 690 to 740 + 250 = 940 to 990 MHz, 694 to 740 - 200 = 494 to 540 MHz). The IF frequency is sampled by the output of the Pulse Generator that is driven by the 50 MHz Reference Oscillator signal. Correction voltage from the sampler tunes the high frequency VCO to correct for frequency error. The VCO is phase locked to an oscillator in the low frequency loop with only a 50 MHz tuning range (60 to 110 MHz) which in turn is phase locked to the 50 MHz reference through a programmable divider. Noise from the high frequency VCO is corrected for in the wideband phase lock loop. Therefore, the main contributor of noise and residual FM is the 60 to 110 MHz low frequency VCO.

The Output Section translates the 494 to 990 MHz basic band frequencies to all other frequencies by dividing (123.5 MHz to 990 MHz) or heterodyning (100 kHz to 123.5 MHz). It controls the RF output amplitude, and filters and amplifies the oscillator and dividers output.

Each of the divide by 1, 2, and 4 bands is one octave (i.e., 494 to 990 MHz for the divide by 1 band, 247 to 494 MHz for the divide by 2 band, and 123.5 to 247 MHz for the divide by 4 band). Each Voltage Tuned Filter's band-width is also one octave and tuned by a voltage derived from the high frequency VCO's tune voltage. The filters therefore track the oscillator's frequency and are biased on only when that band is selected. This selection of filters provides better isolation and filtering of the out-of-band spurious and harmonic frequencies.

Output level is stepped in 10 dB steps by an electromechanical step attenuator. Output level changes less than 10 dB are controlled by the input to the ALC Amplifier from the Level DAC. The ALC Amplifier has two inputs. One is the detected output voltage to level the output. The other is the sum of the amplitude modulation voltage and the level voltage (for level changes less than 10 dB and level correction for frequency response). The output of the ALC Amplifier controls the current through the PIN Modulator which controls the fine level attenuation and amplitude modulation of the output.

When triggered, the reverse power protection circuit opens a relay in series with the output. Limiting diodes sense reverse power and provide the voltage to open the relay and protect the output circuits during the time delay until the relay opens.

Internal modulation signals of 400 Hz or 1 kHz for amplitude and frequency modulation from the Audio Oscillator can be used, or external amplitude and frequency modulation can be selected at the front-panel. The internal and external modulation signals are converted by the AM% DAC and the FM Dev DAC. The Signal Generator's output can be simultaneously amplitude and frequency modulated by either the 400 Hz or 1 kHz internal signals and an external signal or any combination thereof. However, only one amplitude modulation and one frequency modulation level can be used. The carrier frequency modulation is generated in the low frequency loop which allows for RF output FM deviation up to 99 kHz for output frequencies that are not divided. These frequencies are the heterodyne band (100 kHz to 123.5 MHz) and the basic band (494 to 990 MHz). The amplitude modulation signal is applied to the ALC Amplifier.

SERVICE SHEET BD1 (cont'd)

Low Frequency and FM Section. The 50 MHz Reference Oscillator is a crystal oscillator. Its output phase locks the VCOs, and is also divided down to provide the 1 MHz time base. The rear-panel TIME BASE OUTPUT is a jumper-selectable frequency of 1, 5, or 10 MHz that is divided from the 50 MHz Reference Oscillator and can be used as a stable reference for other instruments.

For Option 001, a 10 MHz temperature-stabilized crystal oscillator is used. A phase lock loop is established between the crystal oscillator and the internal reference for greater accuracy and stability. An external reference of 1, 5, or 10 MHz may also be used to phase lock the 50 MHz Reference Oscillator. However, the jumper-selected frequency of 1, 5, or 10 MHz must be the same as the external frequency. The 50 MHz reference signal is distributed and translated by frequency doublers and mixers to provide reference signals at other frequencies.

The 60 to 110 MHz low frequency VCO is tracked by the high frequency basic band oscillator's frequency. The low frequency VCO is tuned to the correct frequency by the Microprocessor and is locked to the 50 MHz Reference Oscillator. Depending upon the frequency, the Reference Oscillator and the low frequency VCO signals are both divided down to 100 kHz. This output is used to phase lock the VCO.Any phase difference between the two signals is converted to a voltage, sampled, and applied to the VCO to correct its frequency. The low frequency loop's VCO is frequency modulated outside the loop bandwidth and phase modulated inside the loop bandwidth. The VCO is tuned over its 50 MHz range in 10 Hz steps. It therefore steps the 690 to 740 MHz signal, generated by mixing the 60 to 110 MHz with the 800 MHz in the Frequency Multiplier Mixer, in 10 Hz steps.

Microprocessor, Keyboard, and Display Section. The Microprocessor controls the information on the address and data bus, thereby controlling all digital data throughout the instrument. The Microprocessor with its associated read only memory (ROM), random access memory (RAM), input/ output (I/O), and decoder circuits processes the front-panel keyboard inputs, the HP-IB inputs, and all displayed information.

Digital data sent to the High Frequency and Output Section performs the following functions:

a. Controls the Voltage-Controlled Oscillator (VCO) lock point.

b. Turns off the correct IF notch filter to pass the specified IF frequency and lock the VCO at the correct frequency.

c. Corrects the output level for frequency response.

d. Changes attenuation in less than 10 dB increments.

e. Controls the amplitude modulation of the carrier.

f. Selects the heterodyne frequencies, and the divide-by-one, two, or four band as required.

g. Sets attenuation in 10 dB steps.

h. Resets the Reverse Power Relay.

SERVICE SHEET BD1 (cont'd)

Digital data sent to the Low Frequency and FM Section determines the frequency modulation of the carrier and the frequency resolution of the output (10 Hz).

Two high and low frequency data words are serially sent to the High Frequency and Output Sections, and the Low Frequency and FM Section. The serial data is strobed into the correct registers by decoding the address bus bits. Parallel data is also sent to the High Frequency and Output Section to select AM, FM, and level control; to select the frequency bands; and to select the amount of attenuation in the step attenuator.

SERVICE SHEET BD1

TROUBLESHOOTING

The troubleshooting checks on this service sheet are used to isolate a malfunction to one of the three major functional assemblies. The checks are easy to perform and provide much key information. In most instances the checks isolate a failure to either a hardware or a software (controller) problem. The comments associated with each procedure summarize the information known as a result of passing or failing the check. The checks should be done in order.

Troubleshooting Help

Section II, Line Voltage and Fuse Selection
Section III, Operator's Checks, and Power-On Sequence

√1 Line Check

Procedure. Remove the Signal Generator's bottom cover. Refer to Disassembly Procedures under Repair in Section VIII. After the bottom cover is removed, connect the line voltage.

Normal Indications.

1. Set the POWER switch to the ON position. The three light emitting diodes (LEDs) on the A10 Audio Power Supply Assembly are lighted indicating that the regulated supplies are operating. This does not mean that the supply voltages are within the required tolerance.

2. The front-panel AMPLITUDE Display should show -127 dBm with the output amplitude increment at 10 dB. Press the output amplitude increment key (up-arrow). The AMPLITUDE Display changes 10 dB for each time the up-arrow or down-arrow is pressed. The attenuator latches receive power from the +15.9 volt regulated supply for driving the attenuator.

Abnormal Indications. If an abnormal indication occurs:

1. Check rear-panel line fuse and line voltage selector.

2. Measure individual regulated supplies and unregulated supply. If necessary, go to Service Sheet 25 Troubleshooting.

√2 Power-Up Check

Procedure. Switch the POWER switch to STBY and back to ON. Check the front-panel annunciators (LEDs) and display segments.

SERVICE SHEET BD1 (cont'd)

Normal Indications. All front-panel indicators are lighted for approximately 1.5 seconds to provide a visual inspection of each front-panel annunciator and display segment.

1. All the display segments will display the number eight, and the most significant AMPLITUDE digit will be a one.

2. When the power-on subroutine is completed, the MODULATION Display will be off, the FREQUENCY Display will be set to 100.00000 MHz, and the AMPLITUDE Display set to -127.0 dBm.

Abnormal Indications. If an abnormal indication occurs, that is:

1. The LEDs stay lighted and display segments remain eights, and one, go to Service Sheet BD4.

2. The LEDs stay lighted and the numerical displays are all zeros.

   a. Check for a noisy +5 Vdc power supply. If necessary, go to Service Sheet 25 Troubleshooting.

   b. Check the Microprocessor clock. Go to Service Sheet 17 Troubleshooting.

3. An LED or display segment does not show the correct output. Check the display's associated components and drive circuits. Go to Service Sheets 22 or 23 Troubleshooting (FREQUENCY Display problem) or Service sheet 22 or 24 Troubleshooting (MODULATION or AMPLITUDE Display problem).

4. A RAM or ROM error code is displayed in the FREQUENCY Display. Refer to Table 3-1 Power-On Error Codes to identify where the problem is.

√3 **Frequency and Amplitude**

Procedure. Set the Signal Generator as follows:

Frequency .... 100 MHz (power-on condition)
Amplitude .... 0 dBm
Modulation .... Off (power-on condition)

1. Check the RF Output frequency and output amplitude.

Normal Indications.

1. The RF output frequency is phase locked at 100 MHz; the output amplitude is 0 dBm ±1.0 dB.

2. The FREQUENCY Display is 100 MHz; the AMPLITUDE Display is 0 dBm.

SERVICE SHEET BD1 (cont'd)

Abnormal Indications. If an abnormal indication occurs that is:

1. The AMPLITUDE or FREQUENCY Display is not 0 dBm or 100 MHz respectively, go to Service Sheet BD4 Troubleshooting.

2. The RF output frequency is not phase locked, go to Service Sheet BD2 or BD3 Troubleshooting.

3. The RF output frequency is incorrect, go to Service Sheet BD2 Troubleshooting.

4. The output amplitude is incorrect, go to Service Sheet BD2 Troubleshooing.

√4 Modulation

Procedure. Set the Signal Generator as follows:

Frequency .... 100 MHz (power-on condition)
Amplitude .... 0 dBm
Modulation .... AM 50%, and FM 50 kHz
Source .... 1 kHz (Int.)

1. Check amplitude and frequency modulation at the RF OUTPUT connector J2.

Normal Indications.

1. The MODULATION Display shows 50% or 50 kHz, and the MODULATION LEDs 1kHz, INT AM, INT FM will be lighted (depending on last input).

2. Modulation at the RF OUTPUT connector, J2, should be 50% AM and 50 kHz FM deviation at a 1 kHz rate.

Abnormal Indications. If abnormal indications occur, that is:

1. The MODULATION Display is incorrect, go to Service Sheet BD4 Troubleshooting.

2. The amplitude modulation level is incorrect, go to Service Sheet BD2 Troubleshooting.

3. The frequency modulation level is incorrect, go to Service Sheet BD2 or BD3 Troubleshooting.

4. The modulation rate is incorrect, go to Service Sheets 6 and 7 Troubleshooting.

SERVICE SHEET BD2

HIGH FREQUENCY AND OUTPUT SECTION

PRINCIPLES OF OPERATION

A8 Frequency Multiplier Assembly. The Frequency Multiplier Assembly multiplies the 50 MHz reference signal by 16 to obtain an 800 MHz signal. The reference signal is doubled four times for frequencies of 100, 200, 400, and 800 MHz. The output of each multiplier is passed through a bandpass filter for the output frequency of that stage to filter out the harmonics and subharmonics generated by the multiplier.

The 800 MHz signal is applied to the A6 Output Assembly and mixed with specific basic band frequencies (800.1 to 923.5 MHz) when output frequencies in the heterodyne band (100 kHz to 123.5 MHz) are selected. It is also applied to the Frequency Multiplier Buffer Amplifier No.1. The signal is amplified and then mixed with the 60 to 110 MHz output from the A3 Low Frequency Loop Assembly (see BD3). The output from the Mixer is a frequency between 690 and 740 MHz that is used to phase lock the high frequency loop. Before a frequency between 690 and 740 MHz is sent to the A4 High Frequency Loop Assembly, it is amplified by two Buffer Amplifiers and filtered by the Bandpass Filter. The 690 to 740 MHz Bandpass Filter filters out the 800 MHz and the Mixer products of 860 to 910 MHz. The Compensation Network is adjusted for a flat frequency response of ±1.5 dB at the input of the A4 High Frequency Loop Assembly.

A4 High Frequency Loop Assembly. The High Frequency Loop Assembly phase locks the 494 to 990 MHz basic band VCO on the A5 High Frequency Oscillator Assembly. The output from this oscillator passes through the 1100 MHz Low-Pass Filter, Buffer Amplifier No.2, and the 450 MHz High-Pass Filter before being mixed with a frequency between 690 and 740 MHz from the A8 Frequency Multiplier Assembly. Both the upper and lower sidebands from the Mixer are used to obtain Intermediate Frequencies (IF) phase lock signals in 50 MHz steps from 0 to 250 MHz. The IF phase lock signal passes through the 260 MHz IF Input Filter and is amplified by the IF Buffer Amplifier. The notch filter for the specific IF is not selected which allows that IF signal to pass through the Notch Filters. The IF signal is then sampled at a 50 MHz rate by a pulse from the Pulse Generator that is driven by the 50 MHz Reference Oscillator signal. The output of the Sampling Bridge is a correction voltage proportional to the phase difference of the IF and 50 MHz reference signals. The correction voltage is amplified by the Sampler Amplifier, filtered by the 13 MHz Low-Pass Filter and applied to the Loop Amplifier. It is then fed back to correct the frequency of the VCO on A5.

The dc notch is not selected, and the IF Buffer Amplifier is not biased on when the high frequency VCO output is 690 to 740 MHz. The Mixer then functions as a phase detector with both inputs at the same frequency. The Mixer's output is now a voltage proportional to the phase difference of the two inputs. All other circuits function as previously described in the high frequency loop.

The eight bit data word used to control the high frequency loop is clocked serially into the HF Loop Data Storage /Drivers circuit. Five bits control the dc, 50, 100, 150, 200, and 250 MHz notch filters. Of these, the 150 and 200 MHz bits also control the Gain Compensation to compensate for the nonlinearity of the VCO frequency change with voltage. Another bit selects the Search Amplifier reference so the Loop Amplifier ramp will be in the direction required to sweep the VCO and phase lock the loop without sweeping the VCO to one end and then back to the lock frequency. The last two bits are for the Sideband Logic that prevents the VCO from

SERVICE SHEET BD2 (cont'd)

locking at the wrong frequency. This is necessary because both the upper and lower sidebands from the Mixer are used for the IF frequencies of 50, 100, 150, 200 and 250 MHz to phase lock the 494 to 990 MHz VCO frequencies.

A5 High Frequency Oscillator Assembly. The High Frequency Oscillator generates the instrument's 494 to 990 MHz basic band frequencies. The Voltage-Controlled Oscillator (VCO) is tuned and locked by the A4 High Frequency Loop Assembly. The output of the VCO is amplified by Buffer Amplifier No. 1 and then applied through a 6 dB Pad to the High Frequency Loop Assembly to phase lock the VCO. It is also applied directly to the A6 Output Assembly.

A6 Output Assembly. The Output Assembly translates the 494 to 990 MHz baseband frequencies by dividing (123.5 to 990 MHz) or heterodyning (100 kHz to 123.5 MHz) the basic band frequencies. Each of the divide by 1, 2, and 4 bands is one octave. The output of the dividers passes through the PIN diode Modulator to the Voltage-Tuned Filters. Each filter's bandwidth is also one octave and tuned by the VCO tune voltage. The filters therefore track the VCO frequency and are biased on only when that band is selected. This selection of filters provides better isolation and filtering of the out-of-band spurious and harmonic frequencies.

An eight-bit data word is clocked serially into the Output Section Data Storage/Drivers circuit. Three bits control the dividers and the Voltage-Tuned Filters. The other two bits are used to select CW, to clock the Reverse Power Sense circuit, and to turn the RF off and on.

The output from the Voltage-Tuned Filters is amplified by the High-Band Output Amplifier and applied to the Output Detector and the A9 Attenuator Assembly. Output level changes (when the accumulated change is less than 10 dB referenced from +7 dBm) are controlled by the input to the ALC Amplifier from the digital to analog converter (DAC) on the A10 Audio/Power Supply Assembly. The ALC amplifier has two inputs. One is the detected output voltage to level the output. The other is the sum of the amplitude modulation voltage and the level voltage (for level changes less than 10 dB and level correction for frequency response). The output of the ALC amplifier controls the current through the PIN diodes of the PIN Modulator which controls amplitude modulation and level into the output attenuator (-8 to +20 dBm).

When output frequencies from 100 kHz to 123.5 MHz are selected, the A9 Attenuator Assembly switches to the A6 Output Assembly where the output frequencies of 800.1 to 923.5 MHz are mixed (heterodyned) with the 800 MHz from the A8 Frequency Multiplier Assembly. The difference frequency of 100 kHz to 123.5 MHz is filtered by a low-pass Diplex Filter, amplified by the Low-Band Output Amplifier, and returned to the A9 Attenuator Assembly.

A9 Attenuator Assembly. The Attenuator Assembly is an electronically driven electromechanical step attenuator that steps the output 120 dB in 10 dB steps. The output circuits are reverse power protected for inputs up to 50 watts. A voltage level of 3 volts will trigger the circuit and open the reverse power relay within the attenuator assembly. When a reverse power condition is detected by the Reverse Power Sense circuit, the RPI bit is generated to interrupt the Microprocessor. The AMPLITUDE Display will flash to indicate that a reverse power condition has been detected. The reverse power relay remains open until the source of reverse power is removed and the AMPTD key is pressed. At that time, the RCL bit, from the Output Data Storage/Drivers circuit on A6, resets the relay.

Five of the seven data bits from the Attenuator Control circuits on the A10 Audio/Power Supply Assembly control the attenuator pads to attenuate the output signal by the amount selected. The remaining two bits control the heterodyne select sections of the Attenuator Assembly.

SERVICE SHEET BD2 (cont'd)

A10 Audio/Power Supply Assembly. The amplitude modulation, frequency modulation and level circuits portion of the Audio/ Power Supply Assembly are shown on BD2. The external modulation signal level must be set at the source and, the output of the External Modulation Buffer is monitored by the Over and Under Modulation Comparators which control the HI EXT and LOW EXT LEDs (not shown) on the front-panel to indicate when the input is too high or low.

The modulation signals are applied to the FM Deviation Summing Amplifier and to the AM% Summing Amplifier. On the A10 Audio/Power Supply Assembly, the internal and external frequency modulation signals are applied to the FM Deviation Summing Amplifier, converted by the FM Deviation DAC (programmed by the FM Deviation Control Data from the Microprocessor), and amplified by the FM Deviation Amplifier. The output of the AM% Summing Amplifier is used as a reference voltage by the AM% DAC. The digitally controlled output of the AM% DAC is summed with the dc level voltage from the Level DAC and applied to the input of the AM Reference Summing Amplifier. The AM reference is applied to the ALC Amplifier on A6.

Five 8-bit data words are strobed into the Modulation Control Latches each time a front-panel or HP-IB modulation entry is made. These data words are used to control all modulation functions, the level of the modulation signals, and the reference level voltage applied to the ALC loop.

SERVICE SHEET BD2

TROUBLESHOOTING

General

Procedures for checking the High Frequency and Output Section of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, e.g., ⟨√2⟩.

Troubleshooting Help

Service Sheet BD1
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Adapter Probe .... HP 1250-1598
Adapter N(f) to BNC(m) .... HP 1250-0077
Adapter BNC(f) to BNC(f) .. HP 1250-0080
Cable BNC(m) to SMC(f) .... HP 08662-60075

⟨√1⟩ RF Output and Attenuator Check

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Connect the sensor module to the Signal Generator's RF OUTPUT connector.

5. Verify that the RF output frequency is locked at 500 MHz with an output amplitude of 0 dBm.

   a. If the signal is unlocked perform ⟨√3⟩.

   b. If there is no output, perform ⟨√2⟩.

   c. If the output amplitude is not 0 dBm ±3.0 dB, continue with ⟨√1⟩ step 6.

SERVICE SHEET BD2 (cont'd)

6. Reduce the Signal Generator's output amplitude in 10 dB steps to -50 dBm. The output amplitude should change 10 dB for each step.

   a. If the output amplitude does not change in 10 dB steps, go to Service Sheet 8 Troubleshooting.

   b. If the output amplitude changes in 10 dB steps, perform √2.

7. Set the Signal Generator's frequency to 100 MHz. If there is no RF output frequency or if it's low, go to Service Sheet 5 Troubleshooting.

√2 Output Assembly Check

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   a. For amplitude measurements...

   Measurement .... RF POWER
   Display .... LOG

   b. For frequency measurements...

   Measurement .... FREQ

3. When making amplitude measurements, zero the measuring receiver and wait for the zero LED to go out.

4. Measure amplitude and frequency at the assembly input A6TP1 and output A6J5 with the measuring receiver (see Service Sheet 4).

   a. If the input is correct (500 MHz and -3 to +4 dBm), but the output level is low (less than -1.5 dBm measured by disconnecting coax cable W14 from A6J5), or if the frequency is incorrect, go to Service Sheet 4 Troubleshooting.

   b. If the input amplitude or frequency is wrong, go to Service Sheet 1 Troubleshooting.

5. Set the Signal Generator's frequency to 300 MHz and then 150 MHz. Measure the output of the assembly with the measuring receiver. If the output level is low or the frequency is not 300 or 150 MHz, check the Output Control Section (see Service Sheet 5 Troubleshooting).

SERVICE SHEET BD2 (cont'd)

√3 Frequency Multiplier

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Measure the 50 MHz input directly from W5 with the measuring receiver (see Service Sheet 3). If either the level (+16 to +19 dBm) or the frequency (50 MHz) is incorrect, go to Service Sheet 16 Troubleshooting.

5. Measure the 60 to 110 MHz input (100 MHz) directly from W3 with the measuring receiver. If either the level (-9 to -7 dBm) or the frequency (100 MHz) is incorrect or unlocked, go to Service Sheet BD3 Troubleshooting.

6. Measure the output (690 to 740 MHz) of the FL1 Bandpass Filter. If either the level (<-5.0 dBm) or the frequency (700 MHz) is incorrect, go to Service Sheet 3 Troubleshooting. If both level and frequency are correct, go to Service Sheet 1 or Service Sheet 2 Troubleshooting.

√4 Audio/Power Supply

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... AM 50%
   Source .... 1 kHz (Int.)

2. Set the measuring receiver as follows:

   Measurement .... AM

3. Connect the measuring receiver to the Signal Generator's RF OUTPUT connector.

4. Measure the amplitude modulation. It should be 50% ±5%. If the modulation level is incorrect, go to Service Sheet 7 Troubleshooting (control circuits) or Service Sheet 4 Troubleshooting (ALC PIN modulator).

SERVICE SHEET BD2 (cont'd)

5. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... FM 50 kHz
   Source .... 1 kHz (Int.)

6. Set the measuring receiver as follows:

   Measurement .... FM

7. Measure the frequency modulation. It should be 50 kHz ±2.5 kHz. If the modulation level is incorrect, go to Service Sheet 7 Troubleshooting (control circuits) or Service Sheet BD3 Troubleshooting.

SERVICE SHEET BD3

LOW FREQUENCY LOOP AND FM SECTION

PRINCIPLES OF OPERATION

Fractional-N Phase Lock Loop Overview. The Low Frequency Loop is a Fractional-N phase lock loop. The Low Frequency Loop VCO can be locked at fractional frequencies of the 100 kHz Reference. A VCO fractional frequency is any frequency that is not a whole number, integer, multiple of the reference. The VCO's frequency range is 60 to 110 MHz. When the VCO frequency is 100 MHz, its frequency is an integer multiple of the 100 kHz reference (100 kHz x 1000) = 100 MHz. When the VCO frequency is 100.01 MHz, its frequency is not an integer multiple of the 100 kHz reference (100 kHz x 1000.1) = 100.01 MHz, a fractional frequency.

The hardware needed to build a divider that can divide by a fractional number is more complex than the hardware needed to build an integer only divider. The method used is to have a integer divider that can be switched between two divide numbers (N and N-1) so the average divide number has a fractional part. From the example, N = 1000.1, the divider would divide by 1000 for 9 times and 1001 for 1 time.

Figure 1 illustrates the basic Phase Lock Loop. The Phase Detector compares the Voltage Controlled Oscillator (VCO) output signal to the Reference signal. A Tune Voltage proportional to the phase difference between the two signals is produced. The Tune Voltage is filtered by the Low Pass Filter to suppress noise and high frequency components. The Tune Voltage corrects the VCO's frequency so it phase tracks the Reference. For this loop to lock the VCO and the Reference must be at the same frequency. For the loop to lock at multiple integer frequencies of the VCO a Divide-By-N circuit must be added as shown in Figure 2. The VCO can now produce a discrete range of frequencies all phase locked to the Reference.

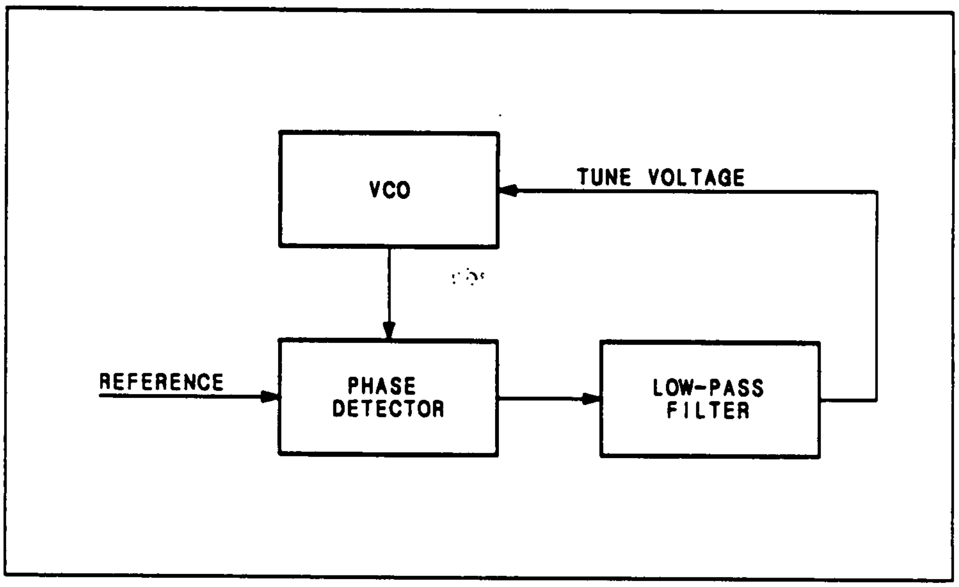


Figure 1. Basic Single Frequency Phase Lock Loop

SERVICE SHEET BD3 (cont'd)

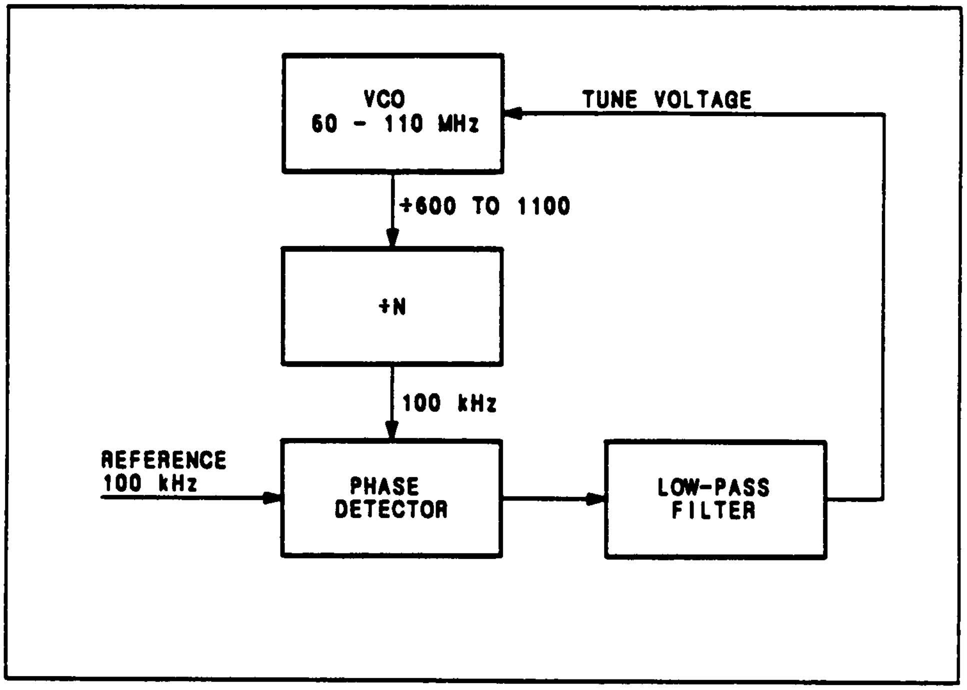


Figure 2. Basic 100 kHz Step Phase Lock Loop

A Fractional-N loop is a modified Divide-By-N loop and can lock at frequencies that are not integers of the Reference. It can lock at fractional multiples of the Reference. For Fractional-N loops the N in N.F. represents the integral multiple, the Divide-By-N number. The F represents the fractional part of the VCO's offset frequency with respect to the integral frequency. With our fixed Reference frequency of 100 kHz, the VCO's frequency can be changed in 100 kHz steps, (100 kHz x N) = VCO frequency, the VCO's integral part. When the VCO's frequency is a fractional frequency, the VCO is continually advancing in phase with respect to the Divide-By-N number N times the Reference. When the phase of the VCO has advanced one cycle the loop divides by N-1 to remove a VCO cycle. In the following example, a VCO cycle is removed every 10 reference cycles.

The Reference frequency is 100 kHz, the divide number is 1000.1, and the VCO frequency is 1000.01 MHz, a fractional multiple (1000.1) of the reference. Without the removal of a VCO cycle every 10 cycles the VCO will advance one cycle (refer to Table 1), and the output voltage of the Phase Detector would continue to increase. The loop would not lock. The continual removal of a VCO cycle means that the output of the Phase Detector is a sawtooth waveform. The waveform increases linearly because of the advancing phase of the VCO. When a cycle is removed it drops to a fixed voltage, canceling the phase advancement of one cycle. With one cycle (360°) removed, the Phase Detector returns to 0° phase output (refer to Figure 3).

SERVICE SHEET BD3 (cont'd)

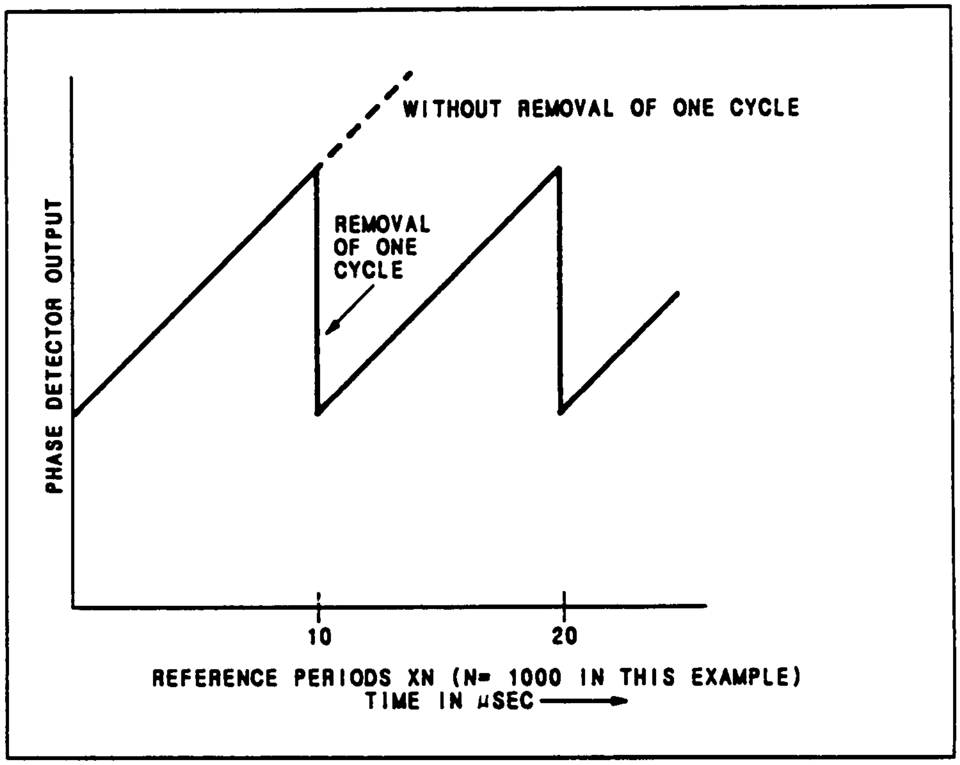


Figure 3. The Output of the Phase Detector Shown. Here is a Sawtooth Riding on a dc Voltage.

Since one cycle must be removed from the VCO each time its phase advances one cycle on the VCO's integral part (100 kHz x N), a Remove Cycle circuit is added in Figure 4. If a VCO cycle is removed each time its output advances one cycle of phase, the average frequency applied to the Divide-By-N block is 100 kHz x N, and the average frequency applied to the Phase Detector is 100 kHz.

A method of determining when the VCO has advanced one cycle of phase is needed. The Remove Cycle circuit can then be triggered to remove a cycle. The fractional part of the VCO frequency determines the time required for the oscillator's frequency to advance one cycle of phase in reference to 100 kHz x N. The time required is the period of F and corresponds to a number of reference periods. In the example, the Signal Generator's frequency is 100.01 MHz. The divide number is 1000.1, N = 1000 and F = .1 .

The fractional part of the frequency is stored in the Fractional Register, and then added to a second register each reference cycle. The second register, the Phase Accumulator, contains the total number of degrees the phase of the VCO has advanced at any point in time. The Fractional Register, Phase Accumulator, and Add Circuit are added as shown in Figure 5.

SERVICE SHEET BD3 (cont'd)

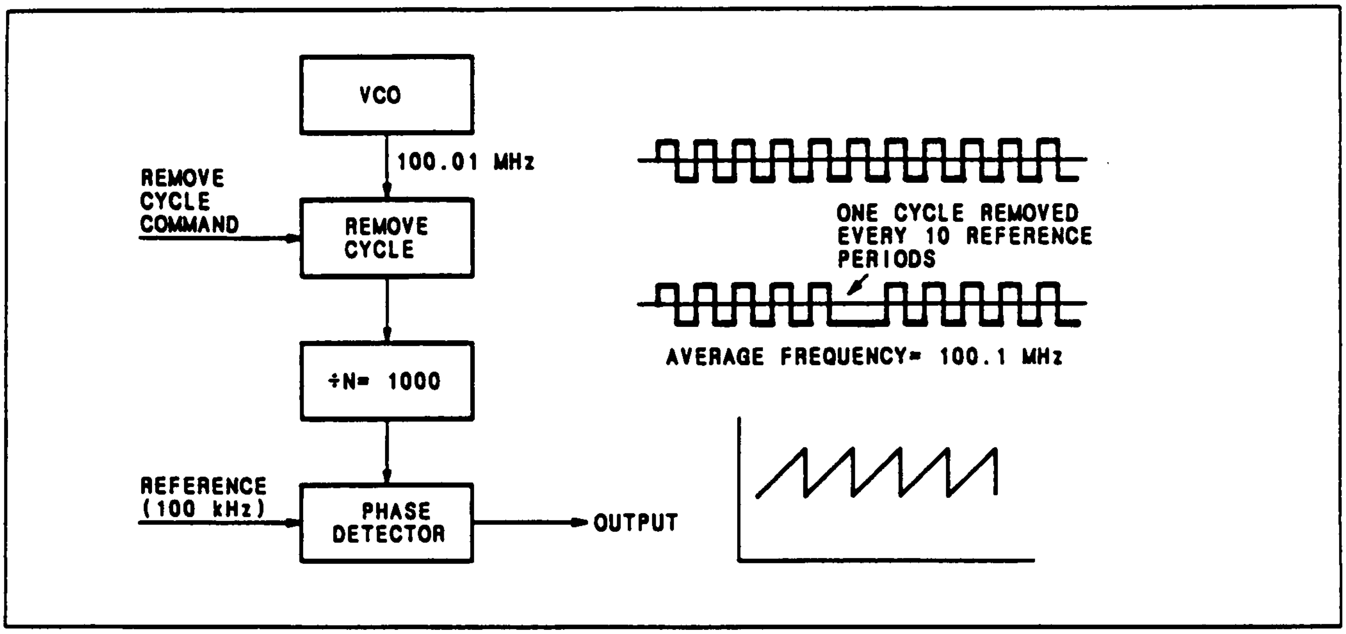


Figure 4. The Basic Block Diagram of a Modified Divide-by-N Loop With a Pulse Remover Added to Allow the VCO to Operate at a Fractional Frequency

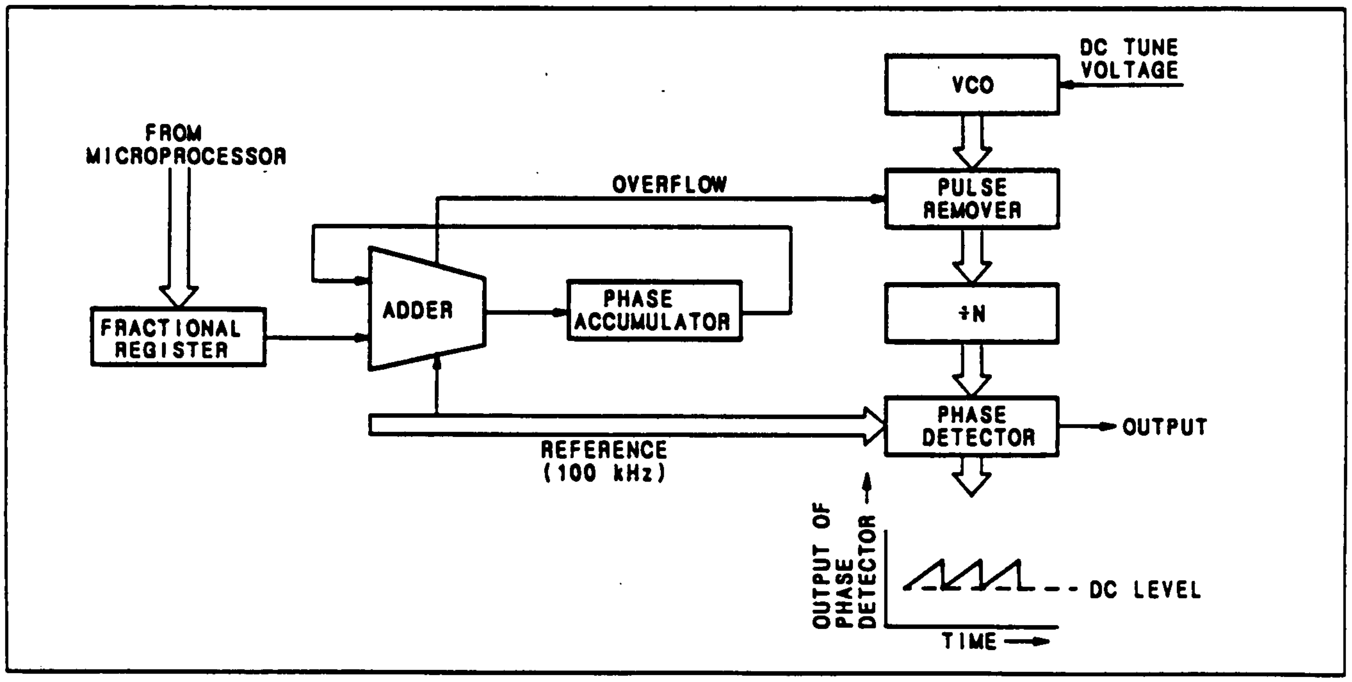


Figure 5. Fractional-N Loop Showing a Phase Register Used to Trigger the Removal of one VCO Cycle (or Pulse)

SERVICE SHEET BD3 (cont'd)

During the reference cycle, that the VCO advances one full cycle of phase, the Phase Accumulator reaches unity. For example, the oscillator has gone 1000.1 cycles in one reference cycle, 10 uSec, 2000.2 cycles in two reference cycles, and so on. The Phase Accumulator contains 0.1 after one reference cycle, 0.2 after the second, and etc. When unity is reached, the register overflows. The VCO has advanced one cycle of phase and the overflow bit instructs the Remove Cycle circuits to remove a cycle from the VCO.

The open-loop Phase Detector output is sawtooth on some dc voltage level as shown in Figure 5. A voltage controlled oscillator requires a clean dc tuning voltage for a stable output signal. A sawtooth signal on the dc tuning voltage will cause frequency modulation of the VCO's output. The sawtooth signal must be removed from the tuning voltage. The output of the Phase Detector is a voltage that at some value, rises to an increased value, and returns to the value started with when the cycle repeats. Figure 6 shows the waveform generated by the Phase Detector.

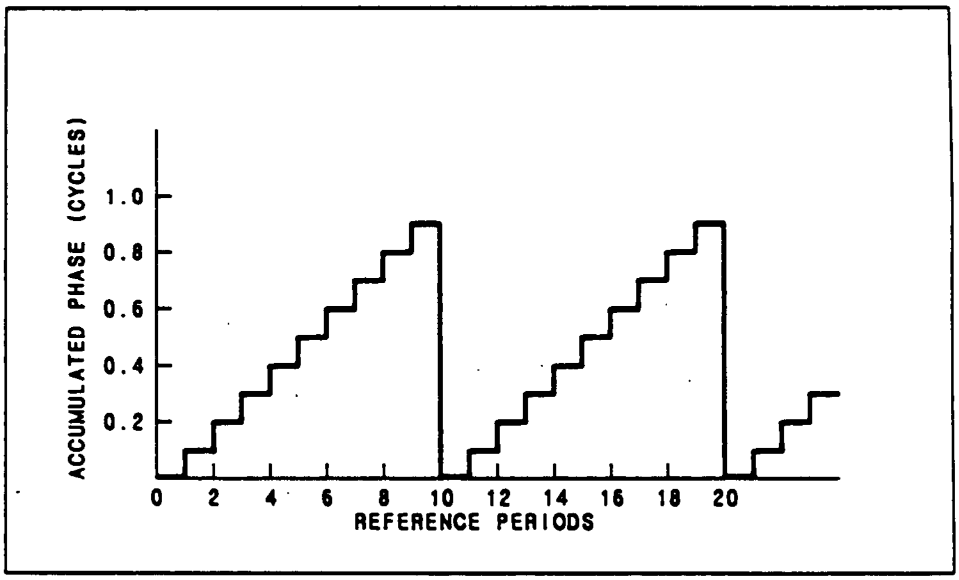


Figure 6. Phase Detector Waveform

The technique used to eliminate this unwanted sawtooth waveform is to generate a waveform with the same shape but opposite in polarity, and sum it with the Phase Detector output. This cancels the unwanted waveform leaving only the dc voltage to tune the VCO. It is possible to generate a waveform of the opposite polarity because the shape of the unwanted waveform can be predicted exactly. The Analog Phase Interpolation (API) circuit in Figure 7 is added to determine the voltage on each reference cycle to sum with the output of the Phase Detector.

SERVICE SHEET BD3 (cont'd)

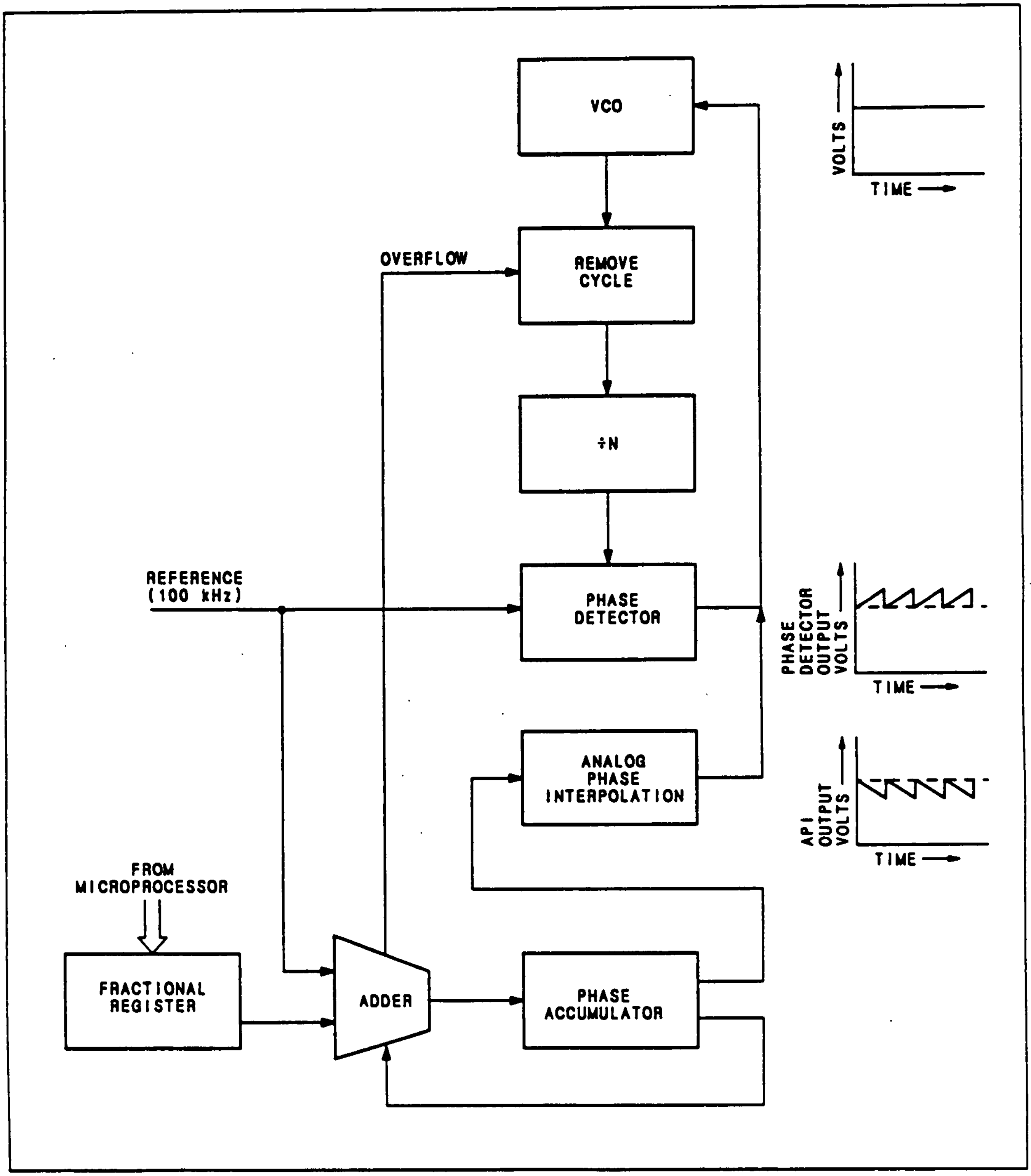


Figure 7. Simplified Diagram of a Fractional-N Phase Lock Loop

SERVICE SHEET BD3 (cont'd)

A3 Low Frequency Loop Assembly. The 50 MHz Reference Oscillator is a crystal oscillator that is used to phase lock the Voltage Controlled Oscillators. Its output is divided down to provide the 100 kHz Reference to the Phase Detector. The rear-panel TIME BASE OUTPUT signal is a jumper selectable frequency of 1, 5, or 10 MHz divided from the 50 MHz Reference Oscillator and coupled through the Crystal Phase Lock Circuit. For Option 001, a 10 MHz temperature-stabilized crystal oscillator is installed in the Signal Generator. The Option 001 oscillator output is available at the rear-panel TIME BASE HIGH STABILITY OPTION connector (not shown). When connected to the TIME BASE INPUT connector, a phase lock is established between the high stability oscillator and the 50 MHz Reference Oscillator. The switched 5 MHz is the clock that generates the 400 nSec pulses required for DCFM and ACFM (in-band) Reset Timing.

Digital data is written from the main Microprocessor to the Low Frequency Loop Microprocessor when its frequency is changed, when frequency modulation (AC or DC) is selected, turned off, changed or calibrated. The digital data consists of instructions and data. Instructions select frequency modulation and controls when a frequency modulation calibration is performed. Instruction and data is sent from the Low Frequency Loop Microprocessor to the Fractional-N Controller which handles all instruction and data to lock the Low Frequency Frequency Loop at fractional frequencies (refer to the Low Frequency Loop Timing Diagram Figure 8). The Fractional-N Controller converts the data to its nine's compliment and transfers the data to the Divide-By-N Latches. The nine's compliment data is used by the Divide-By-N Counters, clocked by the Chip Clock output of the Prescaler, to generate the VCO Divide-By-N.F. 100 kHz pulse input to the Phase Detector. The output pulse of the Phase Detector determines the length of time Phase Detector current is active and the voltage output of the Loop Integrator. The output of the Loop Integrator is stored on the Sample and Hold Capacitor and corrects the output frequency of the VCO.

After the correction voltage is stored on the Sample and Hold Capacitor, the Fractional-N Controller sets the Bias Control active to reset the Loop Integrator. The Loop Integrator is reset by the Bias Current that supplies current to the Loop Integrator. If the frequency of the VCO is a fractional frequency, VCO frequency not an integer multiple of 100 kHz, the Analog Phase Interpolation (API) outputs from the Fractional-N Controller are active for a varying amount of time when Bias is active. The API Currents are summed with the Bias Current to determine the voltage reset point of the Loop Integrator. The voltage is dependent on the phase difference between the 100 kHz reference and the VCO Divided-By-N.F. that is the result of the VCO's frequency being a fractional frequency.

A cycle is added or removed at the Prescaler to change its modulus from 10 to 9 or 11. A remove cycle is latched into the Cycle Add/Remove Latches and gated to the Prescaler by the Fractional-N Controller to generate fractional frequencies, and by the FM Digital circuits to control Frequency Modulation. An add cycle is latched into the Cycle Add/Remove Latches by the FM Calibration circuits, and by the FM Digital Control circuits to control Frequency Modulation. FM calibration is necessary to ensure that the FM deviation does not vary with oscillator frequency. Calibration is performed by offsetting the frequency of the VCO by 200 kHz, and then removing the off-set. Any difference in voltage is detected by the Tune Voltage Sampler, converted by the A/D to set the bits of the FM Cal DAC.

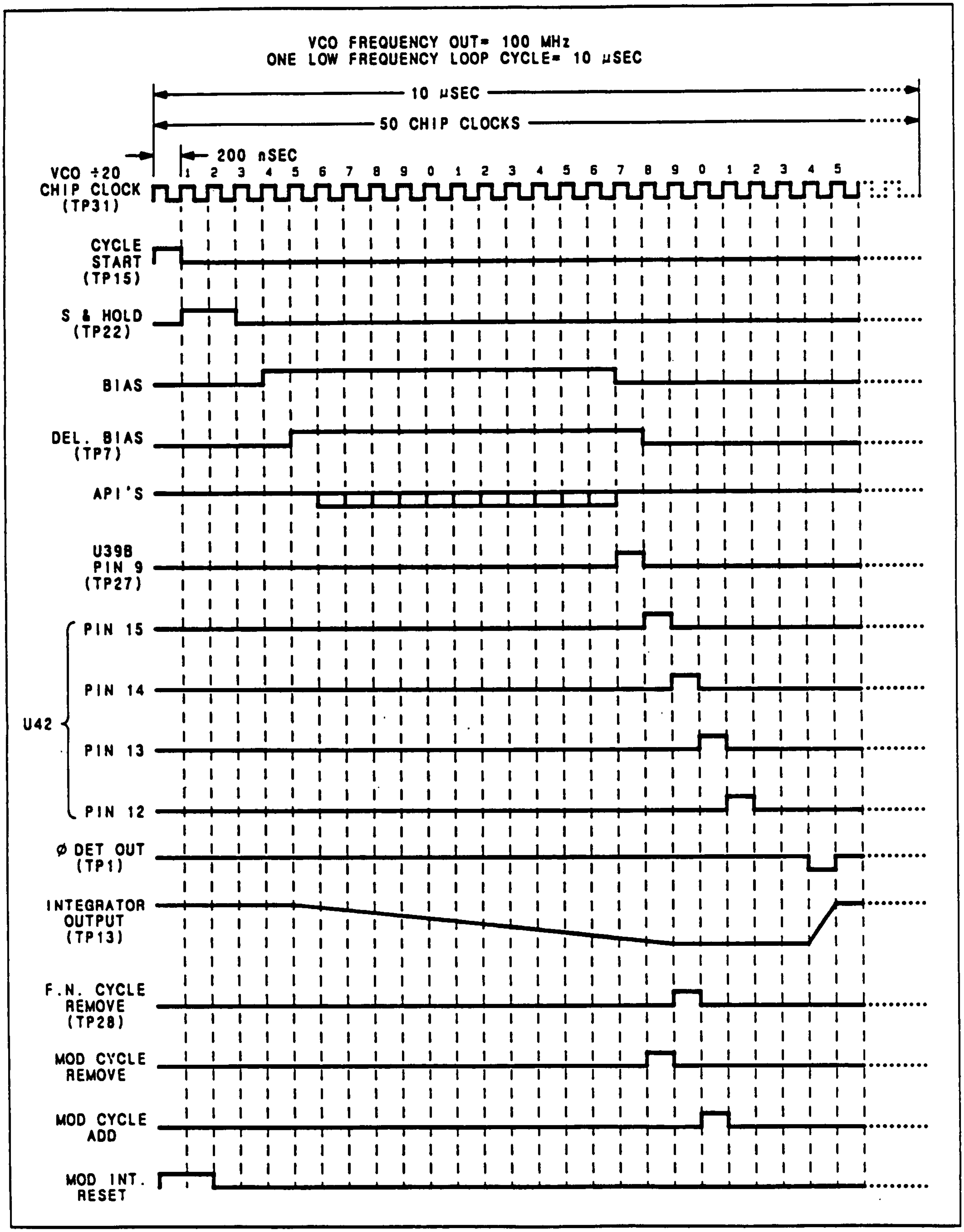


Figure 8. Low Frequency Loop Timing Diagram

SERVICE SHEET BD3 (cont'd)

To have continuous Frequency Modulation both in the band width and out of the band width of the Low Frequency Loop, the Low Frequency Loop VCO is Phase Modulated in the loop bandwidth. The modulation signal is converted to phase by the FM to ΦM Integrator and summed with the current to the Loop Integrator. When the output of the FM to ΦM Integrator crosses the high threshold, the High Threshold Comparator is set and a Remove Cycle control pulse is generated. When the output of the Integrator crosses the low threshold, the Low Threshold comparator is set and an Add Cycle control pulse is generated. The Remove or Add Cycle pulse is gated to the Prescaler and a cycle is removed or added to the VCO Divide-By-N.F. signal. When a cycle is removed or added, a precise current is directed to the FM to ΦM Integrator. Just enough charge is removed from or added to the Integrator to offset the 360° of phase caused by removing or adding a cycle by the Prescaler.

The FM Reset Timing and currents reset the Integrator. The Up/Down Counters and Phase Deviation DAC keep track of the number of times, and the direction the Integrator is reset. The Up/Down Counters and Phase Deviation DAC reconstruct a staircase voltage approximation of the total VCO phase offset caused by the modulation Remove or Add Cycle control inputs to the Prescaler.

Table 1. Phase Relationship of the Integral Part of the VCO Frequency Times N Relative to its Fractional Part as Expressed in Phase Advancement

No. of Ref. Periods (F_{ref} = 100 kHz = 0.1 MHz)	No. of Completed Cycles of		Phase Advancement on N.F on $N \times F_{ref}$
	$N \times F_{ref}$* = 100 MHz (N = 1000)	N.F** = 100.01 MHz	
1	1000	1000.1	0.1 cycle of phase
2	2000	2000.2	0.2 cycle of phase
3	3000	3000.3	0.3 cycle of phase
4	4000	4000.4	0.4 cycle of phase
⋮	⋮	⋮	⋮
9	9000	9000.9	0.9 cycle of phase
10	10000	10001.0	1 full cycle of phase (360°)
11	1000	1000.1	0.1 cycle of phase

*$N \times F_{ref}$ = Integer part of the VCO frequency.
**N.F = Integer and fractional part of the VCO frequency.

SERVICE SHEET BD3

TROUBLESHOOTING

Procedures for checking the Low Frequency Loop and FM Sections of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, e.g., √2.

Troubleshooting Help

Service Sheet BD1
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Oscilloscope .... HP 1740A
Oscilloscope Probe .... HP 10040A
Function Generator .... HP 3311A

Low Frequency Loop Lock Check

The Low Frequency Loop can be checked from the front-panel to determine if the loop is locked or unlocked. Enter the Keyboard-Invoked Tests and run Test 6 to determine the loop's condition. When the loop is locked a "1" is shown in the FREQUENCY Display window, and when it's unlocked a "0" is shown.

- Enter the Keyboard-Invoked Tests by first pressing the "SHIFT" key, and then pressing the "INCR SET" key. A "1" should be shown in the MODULATION Display window.

- Press the "AMPTD" up-arrow key until a "6" is shown in the MODULATION Display window. Test 6, the Low Frequency Loop Lock Test, is ready to run.

- Press the "INCR SET" key to start the test. A "1" is shown in the FREQUENCY Display when the loop is locked. A "0" is shown in the FREQUENCY Display when the loop is unlocked.

- To exit Test 6, press the "AMPTD" up-arrow key once. A "00" should be shown in the AMPLITUDE Display window.

- To exit the Keyboard-Invoked Tests, press the "AMPTD" up-arrow key until a "7" is shown in the MODULATION Display window.Then press the "INCR SET" key; the instrument is initialized as in Power-On.

The red LED, A3DS500 on the Low Frequency Loop Assembly (refer to Service Sheet 13), is lit when the loop is unlocked.

SERVICE SHEET BD3 (cont'd)

√1 50 MHz Reference Oscillator Checks

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0.0 dBm
   Modulation .... Off

2. Connect the Signal Generator's TIME BASE OUTPUT (J4) on the rear-panel to the measuring receiver's INPUT. With the Signal Generator's Time Base jumper in the 10 MHz position check that the frequency at J4 is 10 MHz. If the frequency is not correct, go to step 3.

3. Connect the measuring receiver to the 50 MHz Reference output by removing W5 from A3J8. The frequency at A3J8 should be 50 MHz and the power level +16 to +19 dBm. If the frequency or level is not correct, go to Service Sheet 16.

4. Select Frequency Modulation at the front-panel, press the FM key. Check the switched 5 MHz at feedthrough capacitor A3C28 with an oscilloscope. If the 5 MHz square wave is not correct go to Service Sheet 16.

5. Check the 100 kHz Reference pulse to the Phase Detector at connector A3J5 with the oscilloscope. The pulse is a ringing ±4 volt, 0.1 uSec pulse (including ringing) and occurs every 10 uSec. If the pulses are not present go to Service sheet 16.

√2 VCO Tune Voltage and FM Checks

1. Connect the digital multimeter to feedthrough capacitor A3C101 or A3W6 and measure the dc voltage. It should be from 0 Vdc to +3 Vdc with the frequency set to 500 MHz (Low Frequency Loop VCO's frequency is 100 MHz). If the voltage is not correct go to Service Sheet 14.

2. Increment the Signal Generator's frequency up and down 5 MHz which increments the Low Frequency Loop VCO's frequency up and down 5 MHz. The VCO Tune Voltage should change approximately 1.2 volts for each step. Return the Signal Generator to 500 MHz. If the Low Frequency Loop VCO's voltage and frequency change is not correct go to Service Sheet 14.

3. Connect the digital multimeter to feedthrough capacitor A3A1C101 (the +13 Vdc power supply for the Low Frequency Loop VCO). The votage should be +13 ±2 Vdc with the noise less than 0.03 Vpkpk. If the voltage or noise is not correct, go to Service Sheet 9 or Service sheet 25 (+15 Vdc power supply).

SERVICE SHEET BD3 (cont'd)

4. Connect the oscilloscope to feedthrough Capacitor A3A1C100 or A3W6 and set the Signal Generator's modulation to 1 kHz INT, FM, 99 kHz deviation. The modulation signal should be approximately 0.05 Vpkpk. If it is not correct, go to Service Sheet 14.

5. Connect the measureing receiver to A3A1J1 (VCO output). The frequency should be 100 MHz and the power level -9 to -7 dBm. If it is not correct go to Service Sheet 9.

√3 Divider and Prescaler Checks

1. Check the Low Frequency Loop VCO's frequency at A3TP29. The frequency should be 100 MHz (Signal Generator's frequency 500 MHz). If the frequency is not correct go to Service Sheet 10.

2. Check the Low Frequency Loop VCO's frequency Divided-By-2 at A3TP30 and divided-by-20 at A3TP31. If either frequency is not correct go to Service Sheet 10.

3. Set the Signal Generator's frequency to 500.0011 MHz. Check the Remove Cycle pulse input at A3W8. If the pulse is not present go to Service Sheet 11.

4. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... Any
   Moulation .... ACFM, 99 kHz
   Source .... EXT

5. Set the function generator as follows:

   Function .... Square Wave
   Frequency .... 100 Hz
   Output Level .... 1 V/P (HI and LO LED's out)

6. Check the Add Cycle pulse at A3W7. If the pulse is not present go to Service Sheet 11.

√4 Digital Control, Remove and Add Cycle, and Divide-By-N Counters Checks

1. Check the Cycle Start pulse at A3TP15. Refer to Figure 8 Low Frequency Loop Timing Diagram. If the pulse is not present go to Service Sheet 11.

2. Check the VCO Divided-By-N.F., 100 kHz pulses, at A3J4. It should be a narrow approximately +2 volt pulse every 10 uSec. If the pulse is not present go to Service Sheet 11.

SERVICE SHEET BD3 (cont'd)

√5 Integrator Set and Reset Checks

1. Check the +1 to -1 volt waveform at A3TP1 every 10 uSec. If it is not correct go to Service Sheet 13.

2. Check the voltage waveform output of the Integrator at A3TP13. Refer to Figure 8. If the waveform is not correct go to Service Sheet 12.

3. Check the Bias Control pulse at A3TP10. Refer to Figure 8 (Bias Pulse). If the pulse is not correct go to Service Sheet 11.

4. Check the API Control at A3TP7. TP7 should be Approximately +1 volt, one Chip Clock less than the Bias Pulse. Refer to Figure 8. If the pulse is not correct go to Service Sheet 11.

√6 Frequency Modulation (In-Band) Checks

1. In-band frequency modulation is checked with the Low Frequency Loop locked.

2. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... Any
   Modulation .... ACFM, 5kHz
   Source .... EXT

3. Set the oscilloscope as follows:

   TIME/DIV .... 2 mSec
   DISPLAY .... Channel A
   TRIGGER .... Channel A
   Channel A VOLTS/DIV .... 0.2, dc

4. Set the function generator as follows:

   Function .... Square Wave
   Frequency .... 100 Hz
   Output Level .... 1 V/P (HI and LO LED's out)

5. Connect the oscilloscope to A3TP3. If the waveform at TP3 is not the same as shown in Figure 9 go to Service Sheet 15.

SERVICE SHEET BD3 (cont'd)

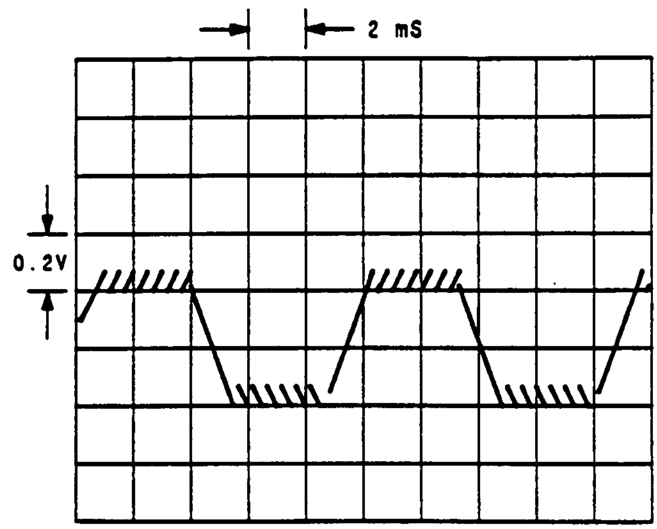


Figure 9. Oscilloscope Display of TP3 (dc Coupled), Signal Generator's Frequency 950 MHz, Modulation EXT FM 5 kHz Deviation (100 Hz Square Wave)

√7 Frequency Modulation Calibration Checks

1. Connect the oscilloscope to A3TP14. Verify that the voltage changes when the Signal Generator's frequency is incremented 10 MHz above and below 500 MHz. If the voltage does not change go to Service Sheet 14.

SERVICE SHEET BD4

MICROPROCESSOR, KEYBOARD, AND DISPLAY SECTION

PRINCIPLES OF OPERATION

A1 Keyboard Assembly. The Keyboard Assembly consists of 48 pushbuttons or keys hardwired in an 8-row by 6-column matrix. Whenever a key is pressed, a row line is connected to a column line. This causes a keyboard interrupt to be issued to the Microprocessor. When the Microprocessor is interrupted, the row and column data is strobed into the Keyboard Data Latch/Shift Register and then serially shifted over the data bus to the Microprocessor.

A11 Microprocessor, Memory, and HP-IB Assembly. The data bus (D0 through D7) consists of eight bidirectional lines which are used to transfer 8-bit, positive-true data to and from the Microprocessor. The Microprocessor reads data from memory, the keyboard, and the HP-IB interface. Information on the data bus is buffered as it enters or leaves the Microprocessor. The Read/Write signal (R/W) from the Microprocessor is used to control the direction of data transfer on the data bus. This signal is buffered by one of the Microprocessor Control Line Buffers.

The address bus (A0 through A15) consists of sixteen unidirectional lines which are used to transfer the 16-bit, positive-true address from the Microprocessor. These address bits are buffered and then used to enable the Interface Bus Select Decoder and to address the ROM and RAM locations. In addition, the buffered address bits are decoded to produce control strobes for modulation, attenuation, and serial I/O. The Serial I/O Control changes six bits of parallel data into serial data and clocks this data to the high frequency loop and output section (see BD2), the low frequency loop (see BD3), and the display. It also clocks serial input data from the keyboard to the Microprocessor.

The Halt input to the Microprocessor halts program execution, and the Reset input starts the Microprocessor from a power-down condition. This signal sequence is used during initial power-up of the instrument, after a power failure has occurred, or after TP12 RESET is momentarily touched to ground (see Service Sheet 17). When the Microprocessor is reset, it enters its power-up subroutine to initialize the instrument.

The Maskable Interrupt Request input to the Microprocessor is used to interrupt program execution. Maskable interrupts occur whenever a key on the keyboard is pressed, a reverse power condition is detected, or an active low is on the rear-panel connector J5 (SEQ). The three maskable interrupts plus the four status conditions (i.e., Over Modulation, Under Modulation, HP-IB Interrupt, and LF Loop Ready) all provide status inputs to the Interrupt Processing circuit which puts the instrument status information on the data bus. The Signal Generator memory consists of 128 bytes of RAM and 16K bytes of ROM. The program used to control the operation of the Signal Generator is stored in the ROM.

All HP-IB data input/output, control, and handshake signals are buffered before being applied to the HP-IB General Purpose Interface Adapter.

A2 Display Assembly. Sixteen bits of serial display data (DDA) are sent from the Microprocessor to the Display Address and Data Shift Registers. Six of the bits are decoded to produce the twelve display strobes and two keyboard strobes. The keyboard strobes are used to strobe column and row data from the keyboard while the display strobes are used to strobe modulation, frequency, and amplitude display data into their respective control drivers and latches. The display data is decoded and latched to drive the applicable 7-segment display or LED annunciator.

SERVICE SHEET BD4

TROUBLESHOOTING

General

Procedures for checking the Microprocessor, Keyboard, and Display sections of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, e.g., ⟨√3⟩.

Troubleshooting Help

Service Sheet BD1
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

HP-IB Controller .... Any
HB-IB Interface .... Any
Measuring Receiver .... HP 8902A

⟨√1⟩ Power-On Sequence

1. Press the POWER switch from STBY to ON to initiate an internal memory check. This check tests for a failure in ROM (Read Only Memory) and in RAM (Random Access Memory). During this check, all front-panel indicators light for approximately 1.5 seconds to provide a quick visual inspection of each front-panel annunciator and display segment. All the display segments will display the number eight except the most significant AMPLITUDE digit which will be a number one. If a memory failure is detected, a RAM or ROM error code will be displayed in the FREQUENCY Display window. The error code remains displayed until any front-panel key is pressed. Refer to Table 3-1 for a listing of the Power-On Error Codes. If the memory check was successful, the front-panel indicators will display a carrier frequency of 100.00000 MHz, an output amplitude of -127.0 dBm, and no modulation. All annunciators (except dBm) remain off. Table 1 lists the conditions of the Signal Generator as a result of a successful initialization sequence.

Table 1. Initialized Conditions

Parameter	Initialized Condition
Carrier Frequency	100.00000 MHz
Output Amplitude	−127.0 dBm
AM Depth	0%
FM Peak Deviation	0.0 kHz
Carrier Frequency Increment	10.00000 MHz
Output Amplitude Increment	10.0 dB
AM Depth Increment	1%
FM Peak Deviation Increment	1.0 kHz
Coarse and Fine Tune Pointer	10.00000 MHz
Sequency Counter	0
All 10 Storage Registers	100.00000 MHz and −127.0 dBm with no modulation

SERVICE SHEET BD4 (cont'd)

If the power-on sequence was not completed successfully, see Troubleshooting for Service Sheets 17 and 19. Perform signature checks for both Service Sheets.

√2 **Keyboard and HP-IB Checks**

1. Connect the measuring receiver to the Signal Generator's RF OUTPUT connector.

2. Connect the HP-IB controller to the Signal Generator's HP-IB connector.

3. Enter modulation, frequency and amplitude data from the Signal Generator's keyboard and from the controller.

   a. If the RF output modes follow the data entered, but one or more of the displays do not, go to Service Sheets 22 and 23 or 24. Troubleshoot the appropriate strobes, latches, drivers and displays.

   b. If the displays follow the data entered but one or more of the RF output modes do not, go to the Troubleshooting sections for Service Sheets BD2, BD3, or 18.

   c. If the output modes and displays follow data entered from the keyboard but not the HP-IB controller, go to Service Sheet 20 Troubleshooting .

   d. If the output and displays follow data entered from the HP-IB controller but not the keyboard, go to Service Sheet 21 Troubleshooting.

SERVICE SHEET 1

HIGH FREQUENCY OSCILLATOR AND IF

PRINCIPLES OF OPERATION

General

The Voltage Controlled Oscillator (VCO) oscillates over a range of 494 to 990 MHz. It is tuned over this range by a -7.5 to +12 volt triangular wave signal. The output signal passes through a power splitter and is coupled to the RF Dividers (on the way to the RF Output) and to the High Frequency Loop Assembly.

Within the High Frequency Loop, the VCO signal is mixed with the phase locked signal (690-740 MHz). As the VCO is searching for its lock point, the mixer generated sidebands pass through a bank of selectable notch filters. The appropriate filter is turned off thus allowing the selected Intermediate Frequency (IF) sideband to pass. The sampling bridge phase-compares the sideband (a multiple of 50 MHz) with a 50 MHz reference signal. When the correct sideband appears at the sampling bridge, the output from the Loop Amplifier (which up to now has been a continuously changing voltage) becomes a fixed voltage. This voltage sets the High Frequency Loop phase lock point. For more information, refer to the Search and Loop Amplifiers in Service Sheet 2.

Voltage Controlled Oscillator

The tune voltage ramp and the phase lock voltage are supplied to the varicaps CR1 and CR2 by the Loop Amplifier in conjunction with the Search Amplifier. This voltage is coupled into the VCO by the low-pass filter composed of L5, L6 and C10. The low-pass filter also isolates the VCO. Varicaps CR1 and CR2 tune the tank circuit which includes inductor L8. Capacitors C11, C13 and C14 provide RF ground for the tank circuit. Varicap bias voltage of approximately -7.5 Vdc is obtained from voltage divider R20, R21 and the -15V (F2) supply. The output of the tank circuit is coupled into the VCO transistor Q3 by capacitor C15*. (C15* is a factory selected value, refer to Table 5-1.) Transistor Q3 is dc biased by R20, R21, L10 and R23. Inductor L11 causes a negative resistance to appear at the emitter of Q3 while C18 removes the negative resistance effect of L11 at low frequencies. Resistor R22 and capacitor C20 moderate the negative resistance effect looking into the emitter and reduce the Q of L11. Capacitors C19 and C21 bypass RF frequencies and power supply noise to ground. Power supply noise or other noise will frequency modulate the oscillator output.

Buffer Amplifier No. 1

Output of the VCO is coupled to the base of Q2 through capacitors C1, C5 and the 6 dB isolation pad R3, R4, and R5. The collector current of Q3 flows through R1 and R2 to dc bias the base of Q1. Since the emitter of Q1 is also connected to the +15V (F4) supply by R6, the emitter voltage will be approximately 0.6 Vdc more positive than the base. The current in resistor R6 is determined by the voltage difference between the +15 volt supply and the voltage at the emitter of Q1. The current through R6 takes two paths. One path for the current is into the emitter of Q1 and out at its collector. This current is multiplied by the common-base current gain of Q1 which is approximately one. This is the base current for Q2. The other path for the current from R6 flows through R8 and L3 and is the collector current for Q2. The actual base and collector currents depend on the DC current gain of Q2. Therefore, the total current from R6 is the sum of the base current and collector current of Q2. This is equal to the emitter current of Q2. The result is that the bias circuitry gives accurate and stable control of the emitter current of Q2.

SERVICE SHEET 1 (cont'd)

Inductor L4 is used to match the collector to the output. Inductor L2, resistor R9, and capacitor C7 are for collector-to-base feedback. Capacitor C9 is a frequency compensation capacitor for Q2 emitter resistors R10 and R11. Capacitors C2, C3, C4, and C6 are filter capacitors.

Power Splitter

Output of Q2 is coupled to the Power Splitter by capacitor C8 and a 2 dB pad which consists of R12, R13, and R14. One output of the Power Splitter goes to the RF Dividers which are located on the A6 Assembly. The other output of Power Divider goes through the 6 dB pad which consists of R16, R17, R19, and C17 to Buffer Amplifier #2 which is located on the A4 assembly. This output is used to phase lock the VCO. Coupling capacitor C17 passes the RF signal and blocks the +15V (F5) from inductor L12 which also acts to block the RF signal. The RF signal and +15V (F5) are both connected to Buffer #2 by the same wire. The Power Splitter also serves to isolate the RF output path from the 690-740 MHz input to Mixer U1.

Buffer Amplifier No.2

Output of the A5 Assembly is ac coupled to the base of Q2 through 1100 MHz Low-Pass Filter composed of L6, L7, L8, L9, C9, C10, and C11. Capacitor C14 blocks the +15V (F5) from the A5 Assembly. Resistors R4 and R5 form the voltage divider to dc bias the base of Q1. The current in resistor R8 is determined by the voltage difference between the +15 Vdc supply and the voltage at the emitter of Q1. The current though R8 takes two paths. One path is into the emitter of Q1 and out at its collector. This current is multiplied by the common-base current gain of Q1 which is approximately one. This is the base current for Q2. The other path for the current from R8 flows through R15 and L13 and is the collector current for Q2. The actual base and collector current depends on the dc current gain of Q2. Therefore, the total current from R8 is the sum of the base current and collector current to Q2. This is equal to the emitter current of Q2. The result is that the bias circuit gives accurate and stable control of the emitter current of Q2. Inductor L14 is used to match the collector to the output. Inductor L12, resistor R16 and capacitor C18 are for collector to base feedback. Capacitor C13 and C15 are filter capacitors. Buffer Amplifier #2 amplifies the VCO's 494-990 MHz signal to about +5 dBm. The signal is then ac coupled through the 450 MHz high-pass filter C21, C22, C23, L17, and L18 to one input of Mixer U1. The other input of Mixer U1 is a 690 to 740 MHz signal of approximately -2 dBm from the Frequency Multiplier Assembly A8. The factory selected pad, that consists of resistors R6*, R7*, and R10* reduces this signal to -8 dBm. The difference frequencies from Mixer U1 are passed through the 260 MHz Low-Pass Filter which consists of inductors L19, L21, L26 and capacitors C33, C36, C38, and C41. The output of Mixer U1 is terminated by C30 and R23. C43 and L28 form a notch filter which is tuned to 300 MHz.

IF Buffer Amplifier

One of the IF sideband frequencies from Mixer U1 is phase-compared to the 50 MHz Reference to phase lock the High Frequency Loop. Refer to Table 1 for a listing of these signals. Table 2 can be used with Table 1 to find the sideband for any frequency selected. At the 0 MHz (dc) frequency, the Mixer acts as a phase detector. The IF Buffer Amplifier transistors Q3 and Q4 are biased off until one of the Notch Filters is selected (turned off). When a notch filter control line is pulled low by the output of the IF Drivers (See Service Sheet 2), the selected notch filter is turned off by biasing on one of the diodes CR7, CR8, CR9, CR10, or CR11 which shorts out the series capacitor of the notch filter C53, C61, C64, C67, or C70. The notch filter that is turned

SERVICE SHEET 1 (cont'd)

off then becomes a parallel tuned circuit. It now is a bandpass filter for the selected IF frequency. When the selected diode is biased on, current is drawn from the +15 Vdc supply through resistor R29 which biases on transistor Q4. Transistor Q4 will bias transistors Q3 and Q5 on. Q3 will amplify the IF signal by approximately 6 dB and Q5 will ground any dc voltage from Mixer U1. Resistor R31 provides collector to base feedback in the IF Buffer Amplifier and resistor R39 and capacitor C50 increase the gain at the high IF frequencies to compensate for the increased losses in the input and output filters.

The DC Notch Filter Q5 is used when the VCO's frequency to Mixer U1 is from 690 to 740 MHz (the same as the input from the Frequency Multiplier Assembly A8). The two frequencies track and the mixer functions as a phase detector. The mixer's dc output voltage is proportional to the phase difference of the two inputs. The output of Mixer U1 looks into a high impedance and not into 50 ohms since the DC Notch Filter and the IF Buffer Amplifier are turned off. Consequently, the voltage level is 6 dB higher in the dc notch range. Since transistors Q3, Q4 and Q5 are all off, Q5 does not ground the dc voltage from Mixer U1. The dc voltage is sampled and fed back to keep the VCO locked.

Table 1. Loop and IF Sideband Frequencies

High Frequency VCO Output (MHz)	Difference Frequencies from Mixing LF Loop Output and 800 MHz (MHz)	'Not Selected' IF Sideband (MHz)
494-540	694-740	−200
540-590	690-740	−150
590-640	690-740	−100
640-690	690-740	−50
690-740	690-740	DC
740-790	690-740	+50
790-840	690-740	+100
840-890	690-740	+150
890-940	690-740	+200
940-990	690-740	+250

Table 2. RF Output versus HF Loop Output

Output Divider Mode	Output Frequency (MHz)		Bandwidth (MHz)			
			Total		IF Sideband	
	RF	HF Loop	RF	HF Loop	RF	HF Loop
÷1/Heterodyne	0.1-123.5	800.1-923.5	123.4	123.4	50	50
÷4	123.5-247	494-988	123.5	494	12.5	50
÷2	247-494	494-988	247	494	25	50
÷1	494-990	494-990	496	496	50	50

SERVICE SHEET 1 (cont'd)

Sampling Bridge and Pulse Generator

The output of the IF Buffer Amplifier or the DC Notch Filter is the input to be sampled by the Sampling Bridge. The 50, 100, 150, 200 or 250 MHz IF frequency is filtered by the 300 MHz Notch Filter (C85, C86 and L40) and the IF Output Filter (L20, L22, L27, C35, C37, C80, and C81). Resistor R24 and capacitor C79 provide a 50 ohm impedance looking into the Sampling Bridge. The 50 MHz Reference Oscillator drives the Sampling Bridge. The 50 MHz, +7.8 to +11.8 dBm reference signal is applied to transformer T1. Resistors R1, R2 and R3 form a 2 dB pad and inductor L11 and capacitor C12 are used for impedance matching. T1 is the input to the Pulse Generator where 50 MHz pulses are generated by biasing the step recovery diode CR2 on and off. The IF input to the Sampling Bridge is sampled every 20 ns for 1.5 ns. When CR2 is biased off, inductors L15 and L16 turn the Sampling Bridge on for 1.5 ns. The sampled output is stored in capacitors C28 and C29, and the dc voltage is applied to the 13 MHz Low-Pass Filter through R27. When the level of the voltage from the sampler is changing at a rate greater than 80 Hz, the voltage is coupled through C29 and C34 to the 13 MHz Low-Pass Filter. FET Q6 provides a high impedance for the sampling bridge to drive, and transistor Q7 provides a low impedance output to drive the 13 MHz Low-Pass Filter. The Sampler Amplifier, which consists of Q6 and Q7, is a voltage follower feedback amplifier which functions to increase the bandwidth of the sampler. Transistor Q7 and FET Q6 are always turned on. Approximately 5 mA flows through R22 and Q6 providing 0.6 Vdc between the base and emitter to bias Q7 on. The sampled voltage is stored in capacitor C29 and C28 which is connected to the gate of Q6. For a small voltage change on the gate of Q6 more current must go through R26 to produce the voltage change at the collector-source junction of Q6 and Q7. A portion of the current is supplied by Q6 and the remainder is collector current from Q7. This voltage change is also coupled through C16 to increase the sampler bandwidth.

SERVICE SHEET 1

TROUBLESHOOTING

Procedures for checking circuits of the A5 High Frequency Oscillator Assembly and P/O A4 High Frequency Loop Assembly are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., ⟨√1⟩. Fixed voltages are shown on the schematic inside a hexagon, e.g., ⟨2V±0.2V⟩. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Digital Multimeter .... HP 3466A
Frequency Counter .... HP 5328A
Adapter Probe .... HP 1250-1598
Adapter N(f) to BNC(m) ..... HP 1250-0077
Adapter BNC(f) to BNC(f) ... HP 1250-0080
Cable BNC(m) to SMC (f) .... HP 08662-60075

⟨√1⟩ **Voltage Tuned Oscillator Check**

1. Check the bias voltage on A5Q3.

2. Connect the frequency counter to A5TP5 using the appropriate cables and adapters.

3. Connect the frequency counter's time base to the Signal Generator's TIME BASE INPUT.

4. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

5. Verify that the oscillator frequency is within ±1000 Hz, and that the TUNE voltage is within tolerance for each frequency shown in Table 3.

SERVICE SHEET 1 (cont'd)

Table 3. VCO Frequency versus Tune Voltage

Oscillator Frequency (MHz)	Typical Tune* Voltage (Vdc)	Tune Voltage* Tolerance (Vdc)
500.0000	−6.515	−6.9 to −6.0
510.0000	−6.328	−6.7 to −5.8
520.0000	−6.127	−6.5 to −5.6
530.0000	−5.912	−6.3 to −5.4
540.0000	−5.688	−6.1 to −5.6
550.0000	−5.450	−5.9 to −5.0
715.0000	−0.905	−3.0 to +2.5
990.0000	+6.945	+2.5 to +12

*Voltage measured at TUNE signal location (white/black/orange wire).

√2 **Buffer Amplifier No. 1**

1. Check the bias voltages on transistor A5Q1 and Q2.

2. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... −10 dBm
   Modulation .... Off

3. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

4. Zero the measuring receiver and wait for the zero LED to go out.

NOTE

The mismatch caused by insertion of the 50 ohm input impedance Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

5. Connect the sensor module to the test points indicated in Table 4 by using the appropriate cables and adapters. Verify that the power levels are correct.

SERVICE SHEET 1 (cont'd)

√3 Buffer Amplifier No. 2

1. Check the bias voltages on A4Q1 and Q2.
2. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

3. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

4. Zero the measuring receiver and wait for the zero LED to go out.
5. Connect the sensor module to the test points indicated in Table 5 by using the appropriate cables and adapters. Verify that the power levels are correct.

√4 IF Input Filter

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

3. Zero the measuring receiver and wait for the zero LED to go out.
4. Connect the sensor module to the test points indicated in Table 6 by using the appropriate cables and adapters. Verify that the power levels are correct.

√5 IF Buffer Amplifier

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Measure and verify the voltages shown in Table 7.

SERVICE SHEET 1 (cont'd)

3. Disconnect the TUNE voltage to the A5 High Frequency Oscillator Assembly. Measure the voltage at TP8. It should be 0.000 ±0.005 Vdc.

√6 Notch Filters

1. Set the Signal Generator as follows:

Frequency .... 500 MHz
Amplitude .... -10 dBm
Modulation .... Off

2. Connect the frequency counter to TP8 by using the appropriate cables and adapters.

3. Measure and verify the IF Output Filter select voltages in Table 8.

√7 Pulse Generator, Sampling Bridge

1. Set the Signal Generator as follows:

Frequency .... 500 MHz
Amplitude .... -10 dBm
Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

Measurement .... RF POWER
Display .... LOG

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Connect the sensor module to the test points indicated in Table 9 by using the appropriate cables and adapters. Verify that the power levels are correct.

5. Ground A4TP13 (refer to Service Sheet 2) and disconnect the TUNE voltage to the High Frequency Oscillator Assembly A5. Remove the 93 wire from the feedthrough capacitor A4C44 to pin 5 of A4U5A. Verify that the voltage at the feedthru A4C44 is 0.000 ±0.010 Vdc.

Table 4. Buffer Amplifier No. 1 Power Levels

Test Point	Power Level (dBm)		Circuit Opened By
	Closed Circuit	Open Circuit*	
A5TP1	−4.00 to −10.00	+2.00 to −4.00	Remove jumper to A4
A5TP2	+6.45 to +0.45	+8.00 to +2.00	Remove jumper to A6
A5TP3	+4.45 to −1.55	+7.15 to +1.15	Remove jumper to A4
A5TP5	+3.65 to −2.35	+4.50 to −1.50	Unsolder base of A5Q2

*The circuit is opened by unsoldering one end of the component(s) or jumpers and lifting the unsoldered end from the printed circuit board.

SERVICE SHEET 1 (cont'd)

Table 5. Buffer Amplifier No. 2 Power Levels

Test Point	Power Level (dBm)		Circuit Opened By
	Closed Circuit	Open Circuit*	
A4TP2	−5.0 to −11.0	—	—
A4TP3	−1.5 to −9.5	−2.0	Remove A4R6 and R7
A4TP4	+5.5 to −0.5	—	—

*The circuit is opened by unsoldering one end of the component(s) or jumpers and lifting the unsoldered end from the printed circuit board.

Table 6. IF Input Filter Power Levels

Test Point	Power Level (dBm)		Circuit Opened By
	Closed Circuit	Open Circuit*	
A4TP5	−15.5 to −19.5	−11.5 to −15.5	Disconnect A4C30, L19
A4TP6	−18.0 to −22.0	−14.0 to −18.0	Disconnect A4C47, L30

*The circuit is opened by unsoldering one end of the component(s) and lifting the unsoldered end from the printed circuit board.

Table 7. IF Buffer Amplifiers Biasing

Signal Generator Frequency	Bias A4Q3 (Vdc)			Bias A4Q4 (Vdc)			Bias A4Q5 (Vdc)		
	E	B	C	E	B	C	E	B	C
500 MHz	+0.14	+0.89	+4.82	+10.47	+9.79	+2.27	0.00	+0.74	grd
700 MHz	0.00	0.00	+14.06	+14.06	+14.06	0.00	0.00	0.00	grd

SERVICE SHEET 1 (cont'd)

Table 8. IF Output Filter Select Voltages

Signal Generator Frequency (MHz)	IF Output Filter Select Voltage* (Vdc) at IF SEL Inputs					Frequency at A4TP8 (MHz)
	250	200	150	100	50	
500	14.0	0.9	14.0	14.0	14.0	200
550	14.0	14.0	0.9	14.0	14.0	150
600	14.0	14.0	14.0	0.9	14.0	100
650	14.0	14.0	14.0	14.0	0.9	50
940	0.9	14.0	14.0	14.0	14.0	250
700	14.0	14.0	14.0	14.0	14.0	DC

*IF Filter 'not selected' when voltage is 0.9 Vdc.

Table 9. Pulse Generator and Sampling Bridge Power Levels

Test Point	Power Level (dBm)		Circuit Opened By
	Closed Circuit	Open Circuit*	
A4TP8	−9.0 to −13.0	—	—
A4TP9	+11.8 to +7.8	+15.0 to +11.0	Disconnect A4R1, R2

*The circuit is opened by unsoldering one end of the component(s) and lifting the unsoldered end from the printed circuit board.

SERVICE SHEET 2

HIGH FREQUENCY LOOP AMPLIFIER AND CONTROL

PRINCIPLES OF OPERATION

General

The Loop Amplifier, U5A, functions as an integrator within the loop bandwidth (less than 50 kHz). The Search Amplifier, U5B, functions as a comparator. When the search mode is entered, the input from the sampler (positive input to U5A) begins to change. The comparator input U5B-pin 3 follows the output of U5A. When the reference level (-3.75 Vdc) is reached, the comparator output switches to the opposite polarity which places a voltage differential across C73. C73 begins to discharge and the voltage again approaches the comparator's reference level. This continued action of the comparator and integrator produces a linear triangle waveform. It is used to sweep the voltage controlled oscillator across its frequency range while searching for the loop lock point. When phase lock occurs, the input voltage from the sampler becomes a dc level. The input to the comparator no longer changes, the switching action of U5B stops, and the sweeping output of U5A (the VCO's tune voltage) stops. The VCO output frequency is now essentially fixed and phase locked.

Loop and Search Amplifiers

The Loop Amplifier, U5A, is a non-inverting unity gain amplifier for frequencies greater than 50 kHz, and an integrator for frequencies less than 50 kHz. The phase lock loop does not require additional gain above 50 kHz for phase lock operation. The input signal level from the sampler is at a higher level than necessary for the Voltage Controlled Oscillator's sensitivity. Resistor R72 and capacitor C78 reduce this level by 6 dB. Since the Loop Amplifier does not have any dc feedback, the dc gain is open loop. AC feedback is by capacitor C73. The higher frequencies are coupled directly to the VCO Tune line through capacitor C77. The VCO Tune line applies the TUNE voltage to the Voltage Controlled Oscillator across R70, R71 and R54 and to the positive input of Search Amplifier U5B through resistor R69.

Search Amplifier U5B functions as a comparator. The negative input of U5B is fixed at approximately -3.75 Vdc by resistor R73 and R74. The voltage at pin 1 will be near either -14 Vdc or +14 Vdc. This change in voltage of U5B will be integrated by U5A to generate both a negative and positive "ramp" VCO Tune Voltage to sweep the Voltage Controlled Oscillator. Therefore, U5A and U5B form a triangle wave generator with an output from U5A that will sweep from approximately -7.5V to +12V.

See the waveforms in Figure 1. The loop is unlocked and the positive input to U5B is more positive than -3.75 Vdc. The output of U5B is switched to +14 Vdc. The VCO is swept across its frequency range (990 to 494 MHz). At time T1 the comparator U5B has just changed state. CR16 is biased on and CR17 is biased off. At time T2 the positive input to U5B becomes more negative than the negative input and the output switches to -14V, CR16 is biased off, CR17 is on and the positive input to U5B is pulled to -8.7V. During this time the instrument would normally have locked. At time T3 the positive input to U5B becomes more positive than the negative input and the output changes to +14V, CR16 is biased on, CR17 is biased off and the positive input of U5B is pulled to +6 volts. This cycle is repeated until a locked voltage is received from the sampler.

SERVICE SHEET 2 (cont'd)

Under normal circumstances, the maximum lock time is one ramp or 1.5 ms. When the lock point is reached the output voltage of the Sampling Bridge and Sampling Amplifier will be a dc voltage to lock the loop and fix the VCO frequency. The Loop and Search Amplifiers stop functioning as a triangle wave generator. The voltage on the Tune line is fixed except for small changes. The positive input to U5B is fixed and the output will stay at -14 or +14 Vdc, and the negative input to U5A has an offset voltage of 20 mVdc from the current flow through R62, R59, R76, R58, and R55. U5C acts as a unity gain buffer between the offset adjust and U5A. The offset voltage prevents the loop from locking at invalid lock points.

The SEARCH SELect logic control from the Microprocessor is connected to the negative input of U5B. This reference input sets the output of the Search Amplifier to either +14 volts or -14 volts. Thus the Loop Amplifier integrator "ramp" will be in the right direction for phase lock in the minimum time (1.5 ms maximum). For example, if the VCO frequency is 500 MHz and is changed to 600 MHz, the sweep should go up in frequency from 500 MHz to 600 MHz. The logic level of SEARCH SEL will be high which sets the output of U5B to -14 volts and causes the Tune voltage to sweep the VCO up in frequency.

Sideband Comparators

Sideband comparator U5D and exclusive-OR gates U6A-D determine if the instrument will lock at a frequency above or below 715 MHz. The 715 MHz adjustment sets the reference voltage equal to the positive input of U5D with the instrument set to 715 MHz. Let's look at an example where an input frequency of 900 MHz is selected. The Low Frequency Loop oscillator is tuned to 100 MHz. The 200 MHz Notch Filter is 'not selected' This action passes only the 200 MHz IF sideband. All the other sidebands are 'selected' which effectively filters them out. The input frequency to the mixer A4U1 (refer to Service Sheet 1) will be 700 MHz. The VCO frequency is being swept since the loop is not locked. At the previous frequency, the VCO was tuned to 494 MHz. As the VCO sweeps through 500 MHz, the IF is 200 MHz and the loop wants to lock. SIDEBAND C SEL is set to logic level one, which passes the sideband above 715 MHz. This prevents the loop from locking below 715 MHz. As the VCO sweeps up to 900 MHz, the 700 MHz input is subtracted from the VCO frequency to yield the 200 MHz intermediate frequency and the loop locks.

Under the preceding conditions, both inputs to exclusive-OR gate U6D will be high so the output is low. Both inputs to U6A will be low so the output is low. Both inputs to U6B will then be low (output of U6A and U6D) so the output will be low. CR18 will be on and TP16 is approximately +0.6 Volts so CR19 will be off. The VCO sweep voltage will be in a positive direction so the negative input to sideband comparator U5D is also swept in the positive direction. The 715 MHz adjustment is adjusted so at 715 MHz both inputs to U5D are equal. Therefore, with CR19 off, the positive input to U5D is fixed by divider R51, R52, R53 between +15 and -15 volts. So below 715 MHz the positive input will be more positive than negative input of U5D. Output of U5D will be approximately +12 volts and the corresponding input to exclusive-OR gate U6C will be high. The output will be high which turns on Sideband Switch Q10 and grounds the phase detector output to the low impedance output of U5C. The VCO can not lock at 500 MHz. As the VCO sweeps through 715 MHz, the output of comparator U5D switches, the output of U6C goes low and Q10 is turned off allowing the loop to lock.

SERVICE SHEET 2 (cont'd)

Gain Compensation

Frequency change of the VCO is not linear with respect to voltage. Transistors Q8 and Q9 are used to compensate for this non-linear relationship. The collector of Q9 is low (0 volts dc) when the 200 MHz IF Notch Filter is 'not selected'; the collector of Q8 is low when the 150 MHz IF Notch Filter is 'not selected'. Both the base-emitter junctions of Q8 and Q9 will be forward biased when the VCO frequency is below 715 MHz; the output of U5D will be +12 Vdc. Resistors R56 and R57 are a voltage divider for the dc bias voltage to the base of Q8 and Q9. When the VCO frequency is 500 MHz, Q9 is biased on and resistor R67 and C75 increase the attenuation of the VCO tune voltage. When the VCO frequency is 550 MHz, Q8 is biased on and resistor R68 and capacitor C76 increase the attenuation of the VCO tune voltage.

SERVICE SHEET 2

TROUBLESHOOTING

Procedures for checking part of the A4 High Frequency Loop Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., √1 . Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V . Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A

√1 HF Loop Data Storage/Drivers

1. Set the Signal Generator as follows:

   Frequency 500kHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Enter frequencies in order as listed in Table 1 beginning with 500 MHz.

3. Measure the digital voltage levels at the outputs of U2, U3 and U4 as indicated.

√2 Exclusive-OR Gate A4U6

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Measure the digital voltage levels at each frequency listed in Table 2.

SERVICE SHEET 2 (cont'd)

*Table 1. IF Notch Filter Select**

Signal Generator Frequency (MHz)	Digital Level**							
	SEARCH SEL (H)	IF SEL (H) Notch Filters					Sideband	
		250	200	150	100	50	C SEL	B SEL
500	L	H	L	H	H	H	L	H
550	H	H	H	L	H	H	L	H
600	H	H	H	H	L	H	L	H
650	H	H	H	H	H	L	L	H
700	H	H	H	H	H	H	L	L
900	H	H	L	H	H	H	H	L
950	H	L	H	H	H	H	H	L
800	L	H	H	H	L	H	H	L

*A notch filter that is selected "filters out" that IF sideband. Therefore, the required IF sideband filter is 'not selected' in order to pass the required frequency.

**Digital Levels are as follows: A4U4 H>+2 Vdc L<+0.5 Vdc, A4U2 H>+3.5 Vdc L<+1.5 Vdc and A4U3 H>+13 Vdc L<+0.5 Vdc.

Table 2. A4U6 Digital Voltage Levels

Signal Generator Frequency (MHz)	U6A-Pin			U6B-Pin			U6C-Pin			U6D-Pin		
	1	2	3	4	5	6	8	9	10	11	12	13
500	H	L	H	H	H	L	L	H	H	H	L	H
900	L	L	L	L	L	L	L	L	L	L	H	H
715	L	L	L	L	H	H	L	H	H	H	L	H

√3 Search Amplifier, Loop Amplifier, Sideband Comparator, and Sideband Switch

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... −10 dBm
   Modulation .... Off

2. Disconnect the TUNE voltage to the VCO.

3. Verify that the waveforms of Figure 1 are correct.

SERVICE SHEET 2

TROUBLESHOOTING USING SIGNATURE ANALYSIS

This is an alternate method of troubleshooting Service Sheet 2 circuits. Note that digital information from the Microprocessor and related circuits must pass through the circuits shown on Service Sheet 5 before they get to circuits on Service Sheet 2. Be sure that the signatures on Service Sheet 5 are correct before trying to isolate an incorrect signature in these circuits. If signatures on these circuits are correct, the problem may be in the controlled circuits. In this case, use the troubleshooting information preceding this paragraph or refer to the troubleshooting information found on Service Sheet BD2.

Test Equipment

Signature Analyzer .... HP 5005A

Purpose. Verify correct data transfer from the Microprocessor to the High Frequency Loop.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "SA4" (A11TP10, refer to Service Sheet 18).
3) START to "SA5" (A11TP13, refer to Service Sheet 18).
4) STOP to "SA5" (A11TP13, refer to Service Sheet 18).

Set the controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) On the A6 Output Assembly board, short TP5 and TP6 to TP4 (refer to Service Sheet 5).

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

SERVICE SHEET 2 (cont'd)

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature in Table 3 is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to each node indicated in Table 3. Verify that each signature is correct and stable.

Disconnect the jumpers between A6TP5 and A6TP6 to A6TP4. Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

Table 3. High Frequency Loop Signatures

Note	Correct Signature	Comments
+5V	F84P	
U4 #3*	F84P	SIPO CLK
U4 #2*	744F	HF DATA
U4#4 U2#2	HA4C	SRCH SEL
U4#5 U2#4	PH25	250 MHZ
U4#6 U2#6	U692	200 MHZ
U4#7 U2#10	UC49	150 MHZ
U4#14 U2#15	UHA4	100 MHZ
U4#13 U2#12	7PH2	50 MHZ
U4 #11	13C0	SIDEBAND B
U4 #12	CU69	SIDEBAND C

*This signature is the same as the +5V signature; the probe should blink.

SERVICE SHEET 2 (cont'd)

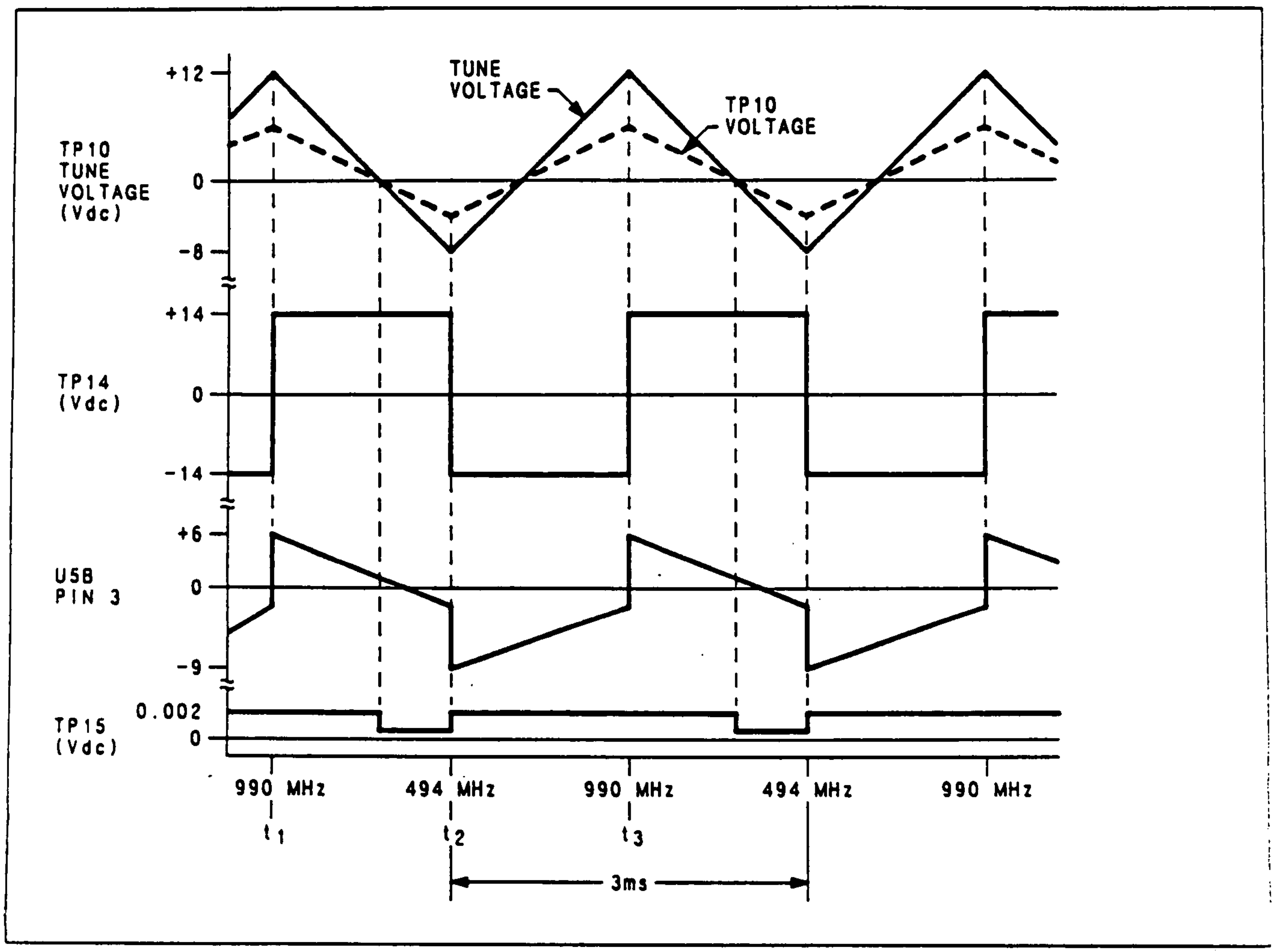


Figure 1. Unlocked High Frequency Loop Waveforms

SERVICE SHEET 3

FREQUENCY MULTIPLIER

PRINCIPLES OF OPERATION

General

The 50 MHz reference is multiplied by 16 to 800 MHz. It is mixed with the phase locked 60 to 110 MHz signal from the Low Frequency Loop Assembly. The Mixer's output is amplified and applied to a Bandpass Filter that passes the difference frequency 690 to 740 MHz. The input frequencies to the Mixer are phase locked to the 50 MHz reference. Therefore, the Mixer's output serves as a reference to lock the High Frequency Loop. The 800 MHz output is also applied to the Output Assembly (refer to Service Sheet 5).

Frequency Multiplier

The 50 MHz +16 to +19 dBm input from the Reference Oscillator is applied to the Power Splitter consisting of R1, R2, R3, and R4. One output of the Power Splitter goes to the Sampling Bridge of the High Frequency Loop (shown on Service Sheet 1). The other output is ac coupled by C2 to Q8, the first multiplier stage. Subsequently, the 50 MHz is doubled four times to a frequency of 800 MHz.

Each of the four multiplier stages (Q8, 7, 6, and 5) is dc biased so the transistor operates in its non-linear region thus generating harmonics. The output of each stage is filtered by a bandpass filter at 100, 200, 400, or 800 MHz. This passes the doubled frequency and filters out the input frequency and other harmonics. Since the stages are electrically equivalent, only the first stage will be discussed in detail. Note, however, that the 800 MHz filter utilizes printed circuit trace capacitors and inductors instead of discrete capacitors and inductors.

Resistors R5 and R6 divide the +5 Vdc supply voltage to dc bias the base of Q8 at approximately +1.0 Vdc without the 50 MHz signal connected. Resistor R7 is the emitter bias resistor. Capacitor C6 bypasses the ac emitter signal to ground. Inductor L2 is an RF choke, capacitor C3 is an RF bypass and capacitor C4 ac couples the output to the 100 MHz Bandpass Filter. The 800 MHz output of the last multiplier stage Q5 is applied to the 800 MHz Bandpass Filter on the output Assembly A6 (shown on Service Sheet 5) and to Buffer Amplifier No. 1.

Buffer Amplifier No. 1/Mixer U1

The 800 MHz signal is coupled to the base of Q3 through resistor R11, the circuit board transmission line, and capacitor C13. The transmission line serves to isolate Q3 from the input. DC current flows through resistors R14 and 15 to dc bias the base of Q4. Since the emitter of Q4 is also connected to the +5V(F) supply by resistor R18, the emitter voltage will be approximately 0.6 Vdc more positive than the base. The current through resistor R18 is determined by the voltage difference between the +5 Vdc supply and the voltage at the emitter of Q4. The current through R18 takes two paths. One path is into the emitter of Q4 and out at its collector. This current minus the base current of Q4 is the base current of Q3. The other path for the current from R18 flows through L12 and into the collector of Q3. The base to collector current ratio depends on the dc current gain of Q3. Therefore, the total current from R18 is equal to the emitter current of Q3. Inductor L11 is an RF choke while L12 serves as a matching element. Capacitors C15, C20, C21, and C58 are RF bypass capacitors. Capacitor C24 ac couples the output of Buffer Amplifier No.1 to Mixer U1. The other input to Mixer U1 is the 60 to 110 MHz from the Voltage Controlled Oscillator (refer to Service Sheet 9). The difference output of 690 to 740 MHz is ac coupled to Buffer Amplifier No. 2.

SERVICE SHEET 3 (cont'd)

Buffer Amplifiers No. 2 and 3

The dc current flowing through resistors R25 and R26 dc biases the base of Q2 at approximately 2.0 Vdc. Resistor R27 is the emitter bias resistor and capacitors C36 and C37 are the emitter resistor bypass to ground. Inductor L24 is an RF choke while capacitors C38 and C39 are RF bypass capacitors. L23, L25 and C41 all serve as matching elements. The output of Buffer Amplifier No. 2 is ac coupled to the Compensation Network by capacitor C41. The Compensation Network is adjusted to keep the 690 to 740 MHz flatness within ±1.5 dB. The signal is ac coupled to Buffer Amplifier No. 3 which functions the same as Buffer Amplifier No. 2. The output of the buffer amplifier passes through Bandpass Filter FL1 which passes the difference frequencies (between 690 and 740 MHz) from the Mixer, and filters and eliminates all the other frequencies. A frequency between 690 and 740 MHz goes to the Mixer in the High Frequency Loop (refer to Service Sheet 1) to serve as a phase locked reference for the A5 Voltage Controlled Oscillator.

SERVICE SHEET 3

TROUBLESHOOTING

Procedures for checking circuits of the A8 Frequency Multiplier Assembly are given below. The areas or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., √3 . Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V . Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Digital Multimeter .... HP 3466A
Adapter-Probe .... HP 1250-1598
Adapter N(f) to BNC(m) .... HP 1250-0077
Adapter BNC(f) to BNC(f) .... HP 1250-0080
Cable BNC(m) to SMC(f) .... HP 08662-60075

√1 Multiplier Stages Bias Voltages

1. Set the Signal Generator to any frequency.

2. Measure and verify the bias voltages as indicated in Table 1 with and without the 50MHz Reference Oscillator input signal connected.

√2 RF Levels

1. Set the Signal Generator as follows:

   Frequency .... Any
   Amplitude .... Any
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... Off

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Check the 50 MHz Reference Oscillator input to the Frequency Multiplier Assembly. Disconnect coax cable W5 from A8J8, and connect the sensor module to A3J8 using the appropriate cables and adapters. The level should be +16 to +19 dBm and the frequency should be 50 MHz ±100 Hz.

SERVICE SHEET 3 (cont'd)

Table 1. Multiplier Stages Bias Voltages

Transistor	50 MHz Input Signal (Vdc)	
	Connected	Not Connected
Q8-E (J2-Pin 2)	+0.8	+0.23 to 0.47
Q8-B	+1.0	+1.0
Q8-C	+5.0	+5.0
Q7-E (J2-Pin 4)	+0.8	+0.23 to 0.47
Q7-B	+1.0	+1.0
Q7-C	+5.0	+5.0
Q6-E (J2-Pin 6)	+0.8	+0.23 to 0.47
Q6B	+1.0	+1.0
Q5-E (J2-Pin 8)	+0.8	+0.23 to 0.47
Q5-B	+1.0	+1.0
Q5-C	+5.0	+5.0

5. Reconnect W5 to the A3 assembly.

6. Check the 60 to 110 MHz Low Frequency Loop input to the Frequency Multiplier Assembly. Disconnect coax cable W3 from A3A1J1, and connect the sensor module to W3 using the appropriate cables and adapters. The level should be -9 to -7 dBm.

7. Reconnect W3 to the A3 assembly.

8. Table 2 shows power levels at various points and the conditions for measurement. Verify that each level is within the required range by connecting the sensor module to each point using the appropriate cables and adapters.

NOTE

The mismatch caused by insertion of the 50 ohm input impedance Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

SERVICE SHEET 3 (cont'd)

Table 2. RF Power Levels

Conditions	RF Power Levels (dBm) at Measurement Locations				
	W10	TP3	TP2	TP1	A8 Output to FL1
All Cables Connected	+7 to +1	+8 to +2	+8 to +2	−20 to −14	+6 to +0
W10 Not Connected	+9 to +5	+9 to +5	+9 to +5	—	—
Jumper Removed	—	—	—	−14 to −10	—
Filter Not Connected	—	—	—	—	+5 to +1

SERVICE SHEET 4

OUTPUT

PRINCIPLES OF OPERATION

General

The 494 to 990 MHz signal from the High Frequency Oscillator is input to the RF Dividers. The signal is divided by one, two or four depending on the frequency selected at the front-panel. The signal passes through the PIN Diode Modulator to the inputs of the Voltage-Tuned Filters. The signal is passed through one of the three filters as determined by the selected frequency. The filter output is amplified and coupled to the output attenuator and the Automatic Level Control (ALC) Loop.

In the ALC loop, the RF signal level is detected and compared to the dc component of the AM Reference level input. The difference is amplified and coupled back to the PIN Modulator which acts as a current controlled attenuator. The loop serves to hold the output at a constant level.

RF Dividers

The 494 to 990 MHz oscillator output signal from the High Frequency Loop Buffer Amplifier (-3 to +4 dBm) is applied to the Output Assembly. The signal is ac coupled by C1 into the RF Dividers where it is divided by one, two or four depending on the output frequency selected at the front-panel. The RF Dividers divide-by-one when an output frequency from 494 to 990 MHz, or less than 123.5 MHz is selected. The RF Divider divides-by-two when an output frequency from 247 to 494 MHz is selected. It divides-by-four when an output frequency from 123.5 to 247 MHz is selected.

When the RF Divider is configured to divide-by-one, the logic output of the Band Select Drivers for a divide-by-one is set low by the third bit of RF Word 2, (refer to Service Sheet 5). With the divide-one control line low, diodes CR3 and CR4 are turned on and the signal is coupled by C13 to the PIN Modulator. CR1 is turned on and the input at pin 4 of U1 is disabled.

In the divide-by-two configuration, the second bit of RF Word 2 sets the divide-by-two control line low and diodes CR2 and CR5 are turned on. With diode CR2 turned on, C2 couples the input signal to U1 where it is divided by two. The output at pin 10 of U1 is dc coupled to Q1. The output of Q1 is coupled to the PIN (diode) Modulator by C11 and C12. Inductors L6, L7, L8, L14, and L16 are RF chokes that pass the dc control voltages and block the RF voltages.

In the divide-by-four configuration, the first bit of RF Word 2 sets the divide-by-four control line low and diodes CR2, CR6 and CR7 are turned on. The input signal is applied to U1 which functions the same as in the divide-by-two mode. The output at pin 11 of U1 is applied to the input of the second divider pin 7 of U2. Divider U2 is activated when CR6 is turned on so U2 pin 9 is pulled low. The output of U2 is coupled by C14 and C21 to the PIN Modulator.

PIN Modulator

The PIN Modulator consists of three series PIN diodes CR13, CR14 and CR18. There is a 20 ohm transmission line between CR13 and CR14 and between CR14 and CR18. PIN diodes function as current controlled RF resistors where the RF resistance is inversely proportional to the current through the diodes. Approximately 50 mA of current through the diodes causes them to appear as shorts, and the 20 ohm transmission lines causes a small mismatch resulting in an insertion loss of about 2 dB between the modulator's input and output.

SERVICE SHEET 4 (cont'd)

With less than 50 mA, the diodes appear as resistors of several hundred ohms. The transmission line appears as a large capacitance. In this condition the frequency response would roll off at 6 dB/octave for a total of 18 dB for the three octaves. The input inductor L17 and resistor R16, the output inductor L18, resistor R19 and capacitor C23 function to compensate the frequency response by increasing the input and output impedance at the higher frequencies. At the lower frequencies the impedance is a few hundred ohms with a small reactance in series which decreases the gain at the lower frequencies. The modulator flatness over the three octaves is reduced to approximately ±3 dB.

The PIN Modulator is enclosed in a waveguide-beyond-cutoff filter that isolates the input from the output and provides 70 dB of dynamic range.

Voltage-Tuned Filters

Three voltage-tuned low-pass filters pass the 123.5 to 990 MHz output of the PIN Modulator to remove the harmonics generated by the dividers and oscillator. Each filter covers one octave of the frequency range; therefore, the harmonics are not passed to the Output Amplifier. The tune voltages for all the filter's are derived from the VTF TUNE line of the A4 Assembly's Loop Amplifier (refer to Service Sheet 2). The VTF TUNE voltage is dependent on the frequency selected and is offset, amplified, and applied to the correct Voltage-Tuned Filter by the VTF Drivers (part of the A6 Assembly, refer to Service Sheet 5). The +3 to +15 volts that tunes each Voltage-Tuned Filter, tracks the TUNE voltage for the VCO as the oscillator is tuned from 494 to 990 MHz. Since the Voltage-Tuned Filters are low-pass filters, it is not a problem if the filter selected is tuned to its highest frequency before the Voltage Controlled Oscillator reaches its highest frequency.

The VTF Drivers turn on the selected input and output diodes of the Voltage-Tuned Filters. These are CR20 and CR36, CR19 and CR35 or CR21 and CR34. The current that biases on the input and output diodes is returned to the -15 volt supply by the Voltage-Tuned Filters input resistors R21 and R98 and output resistor R29.

When a Voltage-Tuned Filter is not selected, the varactor diodes and parallel diodes at the input and output are forward biased by the current through R24, R25 or R26. This tends to increase the isolation of the unused filters. Note that the input and output diodes are biased off. Inductors L22, L23 and L24 are RF chokes.

The VTF TUNE voltage of +3 to +15 volts will vary the capacitance of the varactors approximately 7 to 32 pF in the 247 To 494 MHz Voltage-Tuned Filter and the 123.5 To 247 MHz Voltage-Tuned Filter, and approximately 3.5 to 8 pF in the 494 To 990 MHz Voltage-Tuned Filter.

Output Amplifier

The output of the Voltage-Tuned Filters is ac coupled to the Output Amplifier by capacitors C33. Capacitors C28 matches the output of the Voltage-Tuned Filters to the input of the High-Band Output Amplifier.

The High-Band Output Amplifier functions as a two stage amplifier with 26 dB of gain from 123.5 MHz to 990 MHz. The first stage consisting of transistor Q2 has 8 dB of gain. The second stage consisting of transistors Q3 and Q6 has 18 dB of gain. The two transistors function together for flat gain over the required frequency range.

SERVICE SHEET 4 (cont'd)

The first stage is a common emitter feedback amplifier. The collector of Q2 is biased at +5 volts and its base is biased 4.3 volts below the collector by zener diode CR47. Resistor R34 and inductor L31 provide a dc path for base current and with capacitor C34 provides collector-to-base feedback. Collector-to-base feedback maintains a constant gain and impedance at lower frequencies. The emitter of Q2 has three chip resistors (R37, R38 and R39), and a bypass capacitor C35. The three resistors are used to reduce the inductance at the emitter, and the capacitor provides some emitter bypassing at high frequencies to improve flatness.

The second stage circuits of Q3 and Q6 function together for flat gain frequency response over the frequency range of 123.5 MHz to 990 MHz. Transistor Q3 and its circuits are a common emitter feedback amplifier. The collector of Q3 is also biased at +5 volts and the circuit components have the same function as those of transistor Q2. The collector-to-base feedback of Q3 is increased and gives it a lower input and output impedance. Transistor Q6 and its circuits is a common emitter feedback amplifier. Transistor Q7 provides active bias for Q6. Transistor Q7 is biased on by +9.6 volts divided from +15V (F2) by resistors R48 and R49. Q7 emitter voltage is then approximately +10.2 volts and current flow through Q6 will influence this emitter voltage. A current flow increase through Q6 decreases the emitter voltage. This reduces the current through Q7 reducing the bias voltage at the base of Q6. Therefore, the current through Q7 is reduced. The net effect is that Q6 provides negative feedback to Q7.

The Output Amplifier is ac coupled by C43 to the attenuator (through R54 and C70), and to the Output Detector of the ALC Amplifier. Resistor R54 and capacitor C70 approximates a 50 ohm output impedance. The power level of -8 to +20 dBm from the Output Amplifier is measured at connector J5.

ALC Loop

The Output Detector of the ALC Amplifier detects RF voltage at the output of the High-Band Output Amplifier. The level of the detected voltage (at U6-pin 3) is forced by the gain of the ALC loop to be identical to the loop's reference voltage (at U6-pin 2). Since the ALC loop is used for negative feedback to the PIN Modulator, any variations in the detected voltage is compensated for to keep the RF level constant. Therefore, the Output Amplifier must be an RF voltage source and have zero ohms impedance. Resistor R53 provides a small amount of isolation between the detector diode CR39 and the Output Amplifier, and it rolls off the detector output by about 2 dB over the frequency range 123.5 to 990 MHz. The gain of the Output Amplifier increases about 2 dB and the attenuator losses increase about 2 dB over this range. This helps to keep the output flat without correction. Capacitor C37 couples the RF to detector diode CR39 and stores the dc charge. Inductor L38 and capacitor C36 filter out the RF present on the dc voltage.

Detector Bias. Transistors Q9 and Q13 bias on diodes CR38 and CR39. The transistors are biased on by the resistor divider network of R40, R41 and R42. Q9 biases on CR38 and is the current source for CR38. Q13 biases on CR39 and sinks the current from both CR38 and CR39 to the -15 Vdc supply. The Detector Adjustment (DET ADJ) R35 is adjusted for identical currents flowing through CR38 and CR39. When the Detector Adjustment is adjusted correctly there is a voltage difference of approximately 54 mV between the cathodes of the two diodes. This is the ideal offset voltage for the diode detector when the detector is operating linearly. Diode CR38 also temperature compensates the detector.

SERVICE SHEET 4 (cont'd)

ALC Amplifier. The dc voltage at the collector of Q9 is equal to the peak voltage of the RF output of the Output Amplifier except for the roll off of R53 and C37. This dc voltage is the positive input to the ALC Amplifier, U6. The voltage to the negative input is the dc level correction voltage, and the amplitude modulation voltage when AM modulation is selected from the Audio/Power Supply, A10. The negative input voltage is shaped by resistors R27, R30, R31, R99, R100 and diodes CR31, CR43, CR44, CR45, and CR37. For very low levels, the input voltage characteristic should approximate the square law region of the detector. (The square law region is the non-linear portion of the detector's current-versus-voltage curve. In this region the change in current is proportional to the square of the change in voltage.) If the voltages to the inputs are the same, there is very little distortion.

When AM or FM Modulation is selected, Continuous Wave Select (refer to Service Sheet 5) opens switches K1A and K1B. CW SEL closes K1A and K1B when the RF output is a continuous wave. K1A (closed) allows R22 and C25 to form a one poll low-pass filter. K1B (closed) puts C27 in parallel with C26 to reduce the bandwidth of the ALC Amplifier The output of the ALC Amplifier controls the current and resistance of the PIN Modulator (jumper W1 in the W1A position).The Modulation Shaper circuit (R17, R18, and diodes CR15, CR16, and CR17) compensates for the non-linearity of the PIN Modulator diodes to give a linear output. When the jumper W1 is in the W1B position, the PIN Modulator current is fixed and the ALC Loop is open for service.

SERVICE SHEET 4

TROUBLESHOOTING

Procedures for checking part of the A6 Output Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √3. Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V. Transistor bias voltages are shown without tolerances

A6 Output Assembly replacement boards are shipped without the PC Board Shield A6MP2. If this part is needed see the Replaceable Parts list Table 6-3 for ordering.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustment Procedures

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A
Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Adapter Probe .... HP 1250-1598
Adapter N(f) to BNC(m) .... HP 1250-0077
Adapter BNC(f) to BNC(f) .... HP 1250-0080
Cable BNC(m) to SMC(f) .... HP 08662-60075

√1 RF Dividers

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

NOTE

The mismatch caused by insertion of the 50 ohm input impedance Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Measure the voltages, power levels and signal as shown in Tables 1 and 2 for each front-panel frequency setting.

SERVICE SHEET 4 (cont'd)

Table 1. RF Divider Voltages

Signal Generator Frequency (MHz)	Divider Voltages (Vdc)			Voltages at Q1 (Vdc)			Signal at TP1	
	÷1 SEL	÷2 SEL	÷4 SEL	E	B	C	Level (dBm)	Frequency (MHz)
500	+0.2	+14	+14	+5.0	+4.3	+.004	+8.0 to −3.0	500
300	+14	+0.2	+14	+4.4	+3.8	+.012	+8.0 to −3.0	600
200	+14	+14	+0.2	+4.4	+3.8	+.012	+8.0 to −3.0	800

Table 2. RF Divider Chip Inputs

Signal Generator Frequency (MHz)	Voltages (Vdc) on	
	U1-Pin 4	U2-Pin 9
500	+1.5	+5.0
300	+2.0	+5.0
200	+2.0	+1.0

√2 Voltage-Tuned Filter

1. Set the Signal Generator as follows:

   Frequency .... 900 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Check the voltages in Table 3 for each front-panel frequency setting. If the loop is not locked, the signal will be a triangular wave.

3. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

SERVICE SHEET 4 (cont'd)

4. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

5. Zero the measuring receiver and wait for the zero LED to go out.

6. Connect the sensor module to the test points as indicated in Table 4 by using the appropriate cables and adapters. Verify that the power levels are correct with jumper W1A in both the closed (W1A), and the open (W1B) positions.

7. Reconnect all components disconnected as a result of following directions given in Table 4. Remove jumper W1, to open the ALC loop, and measure the dc voltage at TP2. It should be -2.0 ±0.5 Vdc.

√3 High-Band Output Amplifier

1. Check bias voltages on transistors Q2, Q3, Q6, and Q7.

2. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

3. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

4. Check the power level at J5 by disconnecting coax cable W14, and connecting the sensor module to J5 with the appropriate cables and adapters. The power level should be +1.5 dBm ±2.0 dB.

5. Change the Signal Generator's output amplitude to +13 dBm.

6. Check the power level at J5. The power level should now be +14.0 dBm ±2.0 dB.

7. Verify that the frequency at J5 is 500.000 MHz ±2 kHz.

SERVICE SHEET 4 (cont'd)

Table 3. Voltage Tuned Filter Control Voltages

Signal Generator Frequency (MHz)	VTF TUNE Voltage (Vdc)		
	123.5 to 247 MHz Collector Q12	247 to 494 MHz Collector Q11	494 to 990 MHz Collector Q10
900	−0.5	−0.5	+14.0
600	−0.5	−0.5	+8.5
350	−0.5	+12.9	−0.5
300	−0.5	+8.5	−0.5
200	+14.2	−0.5	−0.5
150	+8.5	−0.5	−0.5

Table 4. ALC Loop Level Measurements

Test Point	Circuit Opened By*	Power Level (dBm)	
		Jumper W1 Closed, W1A Position	Jumper W1 Opened, W1B Position
TP2	—	−14 to −25	−13 to −18
TP2	Disconnect C24	−2 to +3	−6 to −10
TP3	—	−21 to −31	−10 to −15
TP3	Disconnect C33	−11 to −21	−7 to −11

*The circuit is opened by unsoldering one end of the component(s) and lifting the unsoldered end from the printed circuit board.

J4 ALC Amplifier

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... +13 dBm
   Modulation .... Off

2. Check the voltages at the stated locations and for the various output amplitudes listed in Table 5.

SERVICE SHEET 4 (cont'd)

Table 5. ALC Amplifier Voltage Levels

Amplitude (dBm)	Test Point Measurement (Vdc)		
	J3-Pin 3	J3-Pin 15 and J3-Pin 16	J3-Pin 4*
+13	−1.4 to −6.4	+2.7 to +2.9	L
+10	−1.1 to −4.1	+1.9 to +2.1	L
+5	−1.5 to −4.0	+1.0 to +1.1	L
0	−1.2 to −3.7	+0.5 to +0.6	L
−3	−1.1 to −3.6	+0.45 to +0.55	L
−5	−1.5 to −4.0	+1.0 to +1.2	L

*Signal Generator must be in CW mode. Low is <+0.8 Vdc; K1 is closed.

3. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... −10 dBm
   Modulation .... AM 50%
   Source .... 1 kHz (Int.)

4. Using the oscilloscope check the waveforms and the logic level as indicated in Figure 1.

Test Point	Waveform
J3 Pin 15 and J3 Pin 16	+1.1 Vdc +0.7 Vdc +0.3 Vdc
J3 Pin 3	−1.76 Vdc −2.0 Vdc −2.24 Vdc
J3 Pin 4	Logic level high >2.0 Vdc, K1 should be open

Figure 1. ALC Amplifier Waveforms and Logic Level

SERVICE SHEET 5

HETERODYNE AND OUTPUT CONTROL

PRINCIPLES OF OPERATION

General

When the RF Output frequency is between 0.1 and 123.5 MHz, the Divide-By-1/Heterodyne mode is selected. The High Frequency Loop's oscillator frequency, in this case between 800.1 and 923.5 MHz, is mixed with the 800 MHz reference signal. The difference frequencies from the Mixer are those that fall within the required RF Output frequency band.

The VTF TUNE input is translated by the VTF Drivers to voltages that will tune each of the three Voltage-Tuned Filters (refer to Service Sheet 4). The filter selected determines the RF divider mode.

Serial Output Data (ODA) is clocked into the Band Select Shift Register (U7) and on via the HDA line to the Search/IF/Sideband Shift Register (refer to Service Sheet 2). The output of U7 enables the appropriate RF Divider mode, and the CW mode of operation.

Heterodyne Section

A frequency input between 0.1 and 123.5 MHz selects the Divide-By-1/Heterodyne mode. The RF signal (between 800.1 and 923.5 MHz) from the High Band Output Amplifier on the A6 Output Assembly goes to the A9 Attenuator and is switched to the Heterodyne Section. Switching occurs at front-panel frequencies of 123.5999 MHz when incrementing up and 123.4000 MHz when incrementing down. After mixing with the 800 MHz reference, the Diplexed Filter passes the difference frequencies while attenuating the other mixing products. The 0.1 to 123.5 MHz signal is applied to the step attenuator in the A9 Assembly before being coupled to the front-panel RF OUTPUT connector.

A frequency from 800.1 MHz to 923.5 MHz at a level from -7 to +15 dBm, vernier dependent, is switched to the Heterodyne Section and applied to the Mixer A6U11 through an adjustable pad. The pad, consisting of resistors R55, R56, R57, R58 and C56, is adjustable from 20 to 24 dB. The pad reduces the signal into the mixer to a maximum of -7 dBm which prevents spurious signal generation. The other input to the Mixer is a fixed frequency of 800 MHz at +1 to +7 dBm. The 800 MHz enters the Output Assembly through an 800 MHz Bandpass Filter where it is coupled to the Mixer. The difference output frequencies (0.1 to 123.5 MHz) are passed by the Diplexed Filter to the Low-Band Output Amplifier. The input of the filter is diplexed by C57 and R59 to give a good match at all frequencies and to reduce spurious signals, primarily from the summed mixing product. The output of the filter is ac coupled to the Low-Band Output Amplifier by capacitor C52. The value of C52 provides the best signal coupling while preventing amplifier transistors Q15 and Q16 from being reverse biased when the instrument is turned on.

Resistors R64, R62, and R60 form a voltage divider used to dc bias Q15. The voltage divider also contains RF choke L50. Resistors R67, R70, and R72 in the emitter of Q15 provide series feedback. By using these three resistors, the inductance in the emitter current path is reduced. Resistor R68 completes the emitter's dc return and capacitor C55 is the ac path to ground.

SERVICE SHEET 5 (cont'd)

The output of Q15 is dc coupled to the base of Q16. Resistors R69 and R84 provide dc voltage for the collector of Q16. Inductors L52 and L53 are RF chokes. The emitter circuit components R77, R78, R81, R82, and C47 have the same function as those components of Q15. Resistor R85 and capacitor C49 are a low Q series resonant circuit used to increase the gain of Q16 at the higher frequencies.

The output of Q16 is ac coupled to the A9 Attenuator by capacitor C59. The 383 ohm resistor, R65, lowers the Q of the Diplexed Filter. The Low-Band Output Amplifier provides 30 dB of gain ±0.5 dB to restore the RF signal to the same level as input but at the lower frequency.

VTF Drivers and Band Select

The VTF TUNE voltage from the A4 Assembly's Loop Amplifier is applied through voltage divider R71 and R73 to the negative input of U3. This variable tune voltage, -7.5 to +12 volts, is dependent upon the frequency selected. The resistors, which act as a voltage divider, offset the input voltage. Operational amplifier U3, transistor Q5 and their associated components, further offset the input voltage. The resulting VTF TUNE voltage varies between +3 and +15 volts. The voltage at the positive input of U3 (the collector voltage of Q5 divided by resistors R75 and R76) is compared to the negative input of U3. Transistor Q5 is a power amplifier that increases the current capability to turn on the input and output diodes of the selected Voltage-Tuned Filter (refer to Service Sheet 4).

Resistors R90 and R91, R86 and R87, and R79 and R80 provide dc bias for transistors Q10, Q11 and Q12 respectively. Transistors Q10, Q11, and Q12 are biased on by bits 5, 6, and 7 of High Frequency Word 2. High Frequency Word 2 is received by the Band Select Shift Register from the Microprocessor via the Serial Output Data line (ODA). When the fifth, sixth or seventh bit of the frequency word selects 0 Vdc, diodes CR42, CR41 or CR40 will be forward biased. This turns on transistor Q10, Q11, or Q12 to supply the VTF Tune Voltage. The three bits also select one of the three RF Dividers on Service Sheet 4, thereby determining the RF Divider mode.

SERVICE SHEET 5

TROUBLESHOOTING

Procedures for checking part of the A6 Output Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √3. Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V ±0.2V. Transistor bias voltages are shown without tolerances.

A6 Output Assembly replacement boards are shipped without the PC Board Shield A6MP2. If this part is needed see the Replaceable Parts list Table 6-3 for ordering.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustment Procedures

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A
Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Adapter Probe .... HP 1250-1598
Adapter N(f) to BNC(m) .... HP 1250-0077
Adapter BNC(f) to BNC(f) .... HP 1250-0080
Cable, BNC(m) to SMC(f) .... HP 08662-60075

√1 Heterodyne Section

1. Set the Signal Generator as follows:

   Frequency .... 100 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurment .... RF POWER
   Display .... LOG

SERVICE SHEET 5 (cont'd)

NOTE

The mismatch caused by insertion of the 50 ohm input impedance Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Connect the sensor module to the test points indicated in Table 1 by using the appropriate cables and adapters. Verify that the power levels and frequencies are correct.

Table 1. Heterodyne Section Power Levels

Test Point	Power Level (dBm)	Frequency (MHz)
W10	+7.0 to +3.5	800.00
J6	−2.5 to −4.5	900.00
J7	−3.0 to −4.0	100.00

√2 Output Section Data Storage/Driver

1. Set the Signal Generator as follows:

Frequency .... 500 MHz
Amplitude .... -10 dBm
Modulation .... Off

2. Measure the voltage at J3-pin 4 (CW SEL). It should be +0.2 Vdc (low).

3. Set the Signal Generator as follows:

Frequency .... 500 MHz
Amplitude .... -10 dBm
Modulation .... AM 50%
Source .... 1 kHz (Int.)

4. Measure the voltage at J3-pin 4 (CW SEL). It should be +5.0 Vdc (high).

SERVICE SHEET 5 (cont'd)

5. Measure voltages at the J3 test points and change the front-panel frequency settings as indicated in Table 2.

Table 2. Band Select Shift Register and Driver Voltages

Front-Panel Frequency (MHz)	Voltage Measured at J3 (Vdc)		
	÷1 SEL at Pin 8	÷2 SEL at Pin 5	÷4 SEL at Pin 7
500	+0.2	+14	+14
300	+14	+0.2	+14
200	+14	+14	+0.2

6. Measure J3-Pin 12. It should measure $\leq$+0.2 Vdc with the Signal Generator POWER switch set to ON.

√3 VTF Drivers

1. Set the Signal Generator as follows:

Frequency .... 900 MHz
Amplitude .... -10 dBm
Modulation .... Off

2. Measure voltages at the collectors of Q10, Q11, and Q12 as shown in Table 3 and change the front-panel frequency as indicated. If the High Frequency Loop is not locked the voltage will be a triangular wave.

Table 3. Voltage Tuned Filter TUNE Voltages

Front-Panel Frequency (MHz)	VTF TUNE (Vdc)		
	Q12-Collector (123.5 to 247 MHz)	Q11-Collector (247 to 494 MHz)	Q10-Collector (494 to 990 MHz)
900	−0.5	−0.5	+14
600	−0.5	−0.5	+8.5
494	−0.5	−0.5	+4.9
350	−0.5	+12.9	−0.5
300	−0.5	+8.5	−0.5
200	+14.2	−0.5	−0.5
150	+8.5	−0.5	−0.5

SERVICE SHEET 5 (cont'd)

3. Remove the TUNE voltage to the A5 Voltage Controlled Oscillator (refer to Service Sheet 1). The loop is then unlocked. The waveforms shown in Figure 1 should occur on the stated connector and pin.

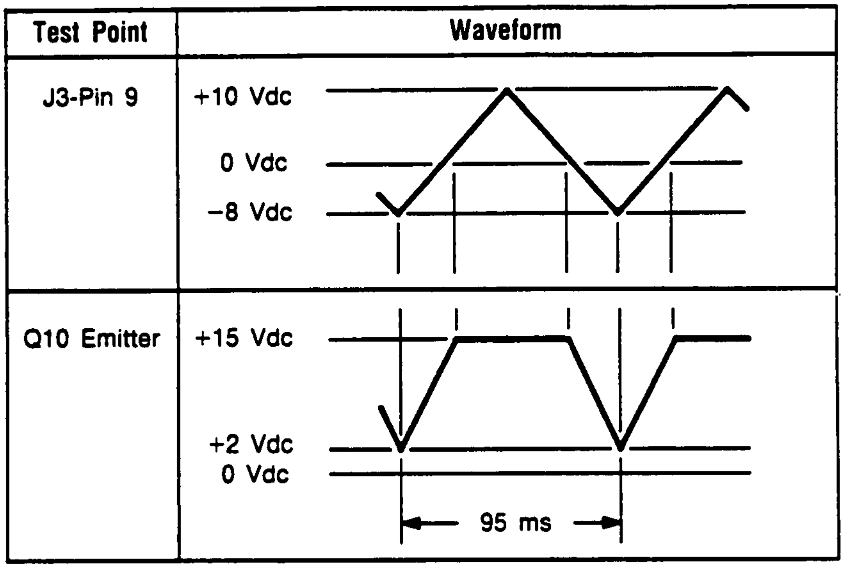


Figure 1. Waveforms with HP Loop Unlocked

SERVICE SHEET 5

TROUBLESHOOTING USING SIGNATURE ANALYSIS

This is an alternate method of troubleshooting the Service Sheet 5 (and Service Sheet 2) circuits. If the signatures for these circuits are correct, the problem may be in the controlled (analog) circuits. In this case, use the preceding troubleshooting information. Remember that a malfunction could be on the control (digital) circuits of Service Sheet 2. If the problem is definitely in the Output or High Frequency Loop circuits, you may wish to refer to BD2.

Test Equipment

Signature Analyzer .... HP 5005A

Purpose. Verify correct data transfer from the Microprocessor to the Output Assembly.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "SA4" (A11TP10, refer to Service Sheet 18).
3) START to "SA5" (A11TP13, refer to Service Sheet 18).
4) STOP to "SA5" (A11TP13, refer to Service Sheet 18).

Set the signature analyzer controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) On the A6 Output Assembly board, short TP5 and TP6 to TP4 (ground).
2) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
3) Set switch A11S1B to the DIAG position (refer to Service Sheet 17).

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature in Table 4 is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to each node indicated in Table 4. Verify that each signature is correct and stable.

SERVICE SHEET 5 (cont'd)

Table 4. Band Select Shift Register Signatures

Node	Correct Signature	Comments
+5V	F84P	
U7#3*	F84P	SIPO CLK
U7#2	6UPP	DATA IN
U7#4 U4#2	P9C5	÷4 BND
U7#5 U4#4	74HA	÷2 BND
U7#6 U4#6	3A6H	÷1 BND
U7#7 U4#15	9H36	CW BIT
U7#14 U4#12	029U	RF OFF

*This signature is the same as the +5V signature but the signature analyzer's probe should blink.

Disconnect the jumpers between A6TP5 and A6TP6 to A6TP4. Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 6

MODULATION CONTROL LATCHES AND MODE SELECT

PRINCIPLES OF OPERATION

General

Encoded data output from the Microprocessor is input to Modulation Control Latches. This data is used to control the RF output amplitude level versus the frequency correction The data also controls the amplitude and frequency modulation signals.

Amplitude Control

Output data from the Microprocessor controls the 0.1 dB steps of output amplitude level across 10 dB (the range selected by each step of the 10 dB Step Attenuator) with an extended range of 11 dB, it controls the overrange of +10 dB added to the highest range and the overrange of -3 dB added to the lowest range, and it controls the level correction for frequency. The latter uses the extended 11 dB range. This means that the output amplitude range (attenuator steps of 10 dB) is never changed for level correction. Refer to Table 1.

When a new output amplitude level is selected, the Microprocessor controls the change so that the final level is always approached from a lower level. For example, if the vernier level is at its minimum and the output level is decreased by 1 dB, the 10 dB Step Attenuator will increase attenuation by 10 dB. The vernier level then increases the level input to the attenuator by 9 dB to complete the change. The 9 dB increase will never occur first. For the same reason, a 1 dB increase with the vernier set to maximum causes a 9 dB decrease in level followed by a 10 dB decrease in attenuation in the Step Attenuator. After the output amplitude is changed, the level correction for frequency is made.

Ten bits of Microprocessor data is strobed into Modulation Control Latches U7 and U10 by strobes MSTB1 and MSTB2 from Address Decoder U2 (refer to Service Sheet 18). The data bits, X0-X9, are then applied to the Level Digital-To-Analog Converter (DAC) U6 (refer to Service Sheet 7).

Modulation Control

Data from the Microprocessor selects AM, FM or both AM and FM, internal modulation sources of 400 or 1000 Hz, and/or external modulation. External AC FM and external DC FM can not be selected at the same time. Data from the Microprocessor also controls AM depth and FM deviation levels.

AM % Latch

Ten bits of Microprocessor data is clocked into Modulation Control Latches U10 and U12 by strobes MSTB2 and MSTB3 from the Address Decoder U2 (refer to Service Sheet 18). The data bits, Y0-Y9, are then applied to the AM% DAC U11 (refer to Service Sheet 7).

SERVICE SHEET 6 (cont'd)

Table 1. RF Amplitude Ranges

Overrange	Amplitude Range		Vernier Range Level (dBm)	10 dB Step Attenuator Pads in Use
	Normal	Extended		
Yes	+17.0 to −127.0	+17.0 to −4.0	+17.0 to −4.0	None
No	−3.6 to −13.5	−3.0 to −14.0	+7.0 to −4.0	10
No	−13.6 to −23.5	−13.0 to −24.0	+7.0 to −4.0	20
No	−23.6 to −33.5	−23.0 to −34.0	+7.0 to −4.0	30A
No	−33.6 to −43.5	−33.0 to −44.0	+7.0 to −4.0	30A, 10
No	−43.6 to −54.5	−43.0 to −54.0	+7.0 to −4.0	30A, 20
No	−54.6 to −64.5	−53.0 to −64.0	+7.0 to −4.0	30A, 30B
No	−64.6 to −74.5	−63.0 to −74.0	+7.0 to −4.0	30A, 30B, 10
No	−74.6 to −84.5	−73.0 to −84.0	+7.0 to −4.0	30A, 30B, 20
No	−84.6 to −94.5	−83.0 to −94.0	+7.0 to −4.0	30A, 30B, 30C
No	−93.6 to −103.5	−93.0 to −104.0	+7.0 to −4.0	30A, 30B, 30C, 10
No	−103.6 to −113.5	−103.0 to −114.0	+7.0 to −4.0	30A, 30B, 30C, 20
Yes	−113.6 to −123.5	−113.0 to −127.0	+7.0 to −7.0	30A, 30B, 30C, 20, 10

FM Latch

Ten bits of Microprocessor data is clocked into Modulation Control Latches U12 and U15 by strobes MSTB3 and MSTB4 from the Address Decoder U2 (refer to Service Sheet 18). The data bits, Z0-Z9, are then applied to the FM Deviation DAC U13 (refer to Service Sheet 7).

Level range select bit is latched into U15. It controls the gain of the AM-Reference Summing Amplifier U20A (refer to Service Sheet 7). The Level range bit is set high when the vernier output level is greater than +7.0 dBm. The Het bit controls Q4.

Modulation Function Latch

Eight bits of Microprocessor data is clocked into the Modulation Function Latch U18 by strobe MSTB5 from the Address Decoder U2 (refer to Service Sheet 18). The data bits (active high) are then applied to the appropriate comparator for the modulation function selected (refer to Service Sheet 7).

Audio Oscillator Control Buffer

The Audio Oscillator is enabled by a high from either the INT AM or INT FM data bits. Both bits are applied to U5. The output of U5 enables the Audio Oscillator U21A (refer to Service Sheet 7).

SERVICE SHEET 6 (cont'd)

Ext FM Mode Select

Data bits AC FM and EXT FM are gated through NOR gates U17A, B, C and D. The two bits are gated together so that external AC FM is turned off when external DC FM is selected. The EXT FM data bit is high when external FM is selected. The AC FM data bit is high when external AC FM is selected and low when external DC FM is selected. Both data bits are low when external FM is off. The output at pin 13 of U17D is high when external DC FM is selected, and the output at pin 4 of U17B is high when external AC FM is selected.

SERVICE SHEET 6

TROUBLESHOOTING

Procedures for checking part of the A10 Audio/Power Supply Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1. Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter ...... HP 3466A

√1 P/O Modulation Control Latches, Level

1. Data bits latched into the Level Latches A10U7 and U10, can vary for each instrument. This is because the level correction data can be different for each instrument. The Level Latches are checked using Signature Analysis.

√2 P/O Modulation Control Latches, AM%

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... AM 1%
   Source .... 1 kHz (Int.)

2. Measure the voltage levels as indicated in Table 2 for each of the front-panel AM % settings.

Table 2. AM% Control Voltage Levels

Front-Panel AM%	Measure the Voltage* as Indicated at									
	A10U10						A10U12			
	6	9	12	15	16	19	2	5	6	9
1	L	L	L	L	L	L	L	L	H	L
5	L	L	L	L	L	L	H	L	L	H
10	L	L	L	L	L	H	L	L	H	H
20	L	L	L	L	H	L	L	H	H	L
50	L	L	L	H	L	H	H	H	H	L
60	L	L	L	H	H	H	L	L	L	H
70	L	L	H	L	L	L	L	H	L	L
99	L	L	H	L	H	H	H	L	H	H

*Low is ≤0.8 Vdc; High is ≥2.0 Vdc.

SERVICE SHEET 6 (cont'd)

J3 P/O Modulation Control Latches, FM Deviation

1. Set the Signal Generator as follows:
   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... FM 1 kHz
   Source .... 1 kHz (Int.)
2. Measure the voltage levels as indicated in Table 3 for each of the front-panel FM settings.

Table 3. FM Deviation Control Voltage Levels

Front-Panel FM (kHz)	Measure the Voltage* as Indicated at									
	A10U12				A10U15					
	12	15	16	19	2	5	6	9	12	15
1	L	L	L	L	H	H	L	L	H	H
5	L	H	L	L	L	L	L	L	L	L
10	H	L	L	L	L	L	L	L	L	L
20	H	H	H	H	H	H	H	H	H	H
50	L	H	L	L	L	L	L	L	L	L
80	L	H	H	L	L	H	H	L	L	H
99	L	H	H	H	H	H	H	L	H	L

*Low is ≤0.8 Vdc; High is ≥2.0 Vdc.

J4 P/O Modulation Control Latches, Function

1. Set the Signal Generator as follows:
   Frequency .... 500 MHz
   Amplitude .... -10 dBm
2. Measure the voltage levels as indicated in Table 4 for each of the front-panel Modulation Source settings. The AM depth or FM deviation for each front-panel Modulation Source setting can be between 0-99 % or 0-99 kHz respectively.

Table 4. Function Control Voltage Levels

Front-Panel FM (kHz)	Measure the Voltage* as Indicated at										
	A10U18								A10U17		A10U15
	2	5	6	9	12	15	16	19	4	13	19
Int 1 kHz AM	H	H	L	H	L	L	L	L	L	L	L
(Int AM Off)	—	—	—	—	—	—	—	—	—	—	—
Int 400 Hz FM	H	L	H	H	L	H	L	L	L	L	L
(Int FM Off)	—	—	—	—	—	—	—	—	—	—	—
Ext AM	L	L	L	H**	L	H	H	L	L	L	L
(Ext AM Off)	—	—	—	—	—	—	—	—	—	—	—
Ext AC FM	L	L	L	H	L	H	L	H	H	L	L
Ext DC FM	L	L	L	H	L	L	L	H	L	H	L
Amp +10 dBm	L	L	L	H	L	H	L	L	L	L	H

*Low is ≤0.8 Vdc; High is ≥2.0 Vdc.
**Internal 400 Hz bit. Frequency Pin 9 remains high until 1 kHz source is selected with Modulation Function.

SERVICE SHEET 6

TROUBLESHOOTING USING SIGNATURE ANALYSIS

This is an alternate method of troubleshooting the circuits of Service Sheet 6. If these signatures are incorrect, recall that the data strobes are decoded by the circuitry of Service Sheet 18 and the data is output from the Microprocessor which is on Service Sheet 17. If these signatures are correct, and the problem does not seem to be related to modulation, return to Service Sheet BD4 for further digital troubleshooting. If the problem seems to be related to a modulation problem, continue troubleshooting on this Service Sheet or refer to Service Sheet BD2 Troubleshooting.

Test Equipment

Signature Analyzer 5005A

Purpose. To verify correct transfer of encoded data and strobe information from the Microprocessor to the modulation control latches.

Set-up. connect the signature analyzer as follows:

1) GND as close to the circuitry being probed as possible. Bad grounding can cause unstable signatures.
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to "SA1" (A11TP7, refer to Service Sheet 18).
4) STOP to "SA2" (A11TP8, refer to Service Sheet 18).

Set the signature analyzer controls as follows:

1) START- Positive Edge
2) STOP- Negative Edge
3) CLOCK- Negative Edge

Set the Signal Generator as follows:

1) Disconnect ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than address 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0, A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the HP-IB address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

SERVICE SHEET 6 (cont'd)

NOTE

With Careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5 V signature in Table 6 is incorrect, this has probably happened. Restart the test by briefly connecting A1ITP12 (RESET) to A1ITP3 (GND). Then briefly connect A1ITP4 (NMI) to A1ITP3 (GND).

Probe. Connect the signature analyzer probe to each node indicated in Tables 5 through 9. Verify that the signature is correct and stable.

NOTE

Disconnect any external modulation from the MOD INPUT/OUTPUT connector. In case of unstable or incorrect signatures, ground the data probe as close as possible to the node being tested.

Incorrect signatures could be due to:

1) Data to latch problem (data bus).
2) Strobe to latch problem.
3) Latch problem.
4) TO1 (TP13) or TO2 (A2TP14) shorted to ground on the display board (refer to Service Sheet 22).

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reconnect ribbon cable W11 to A10J3.

Table 5. AM/Level Control Signatures

Node	Correct Signature	Comments
+5V	H6H5	Lev DAC
U7#2	5713	
U7#5	3UA1	
U7#6	PF25	
U7#9	8953	
U7#12	U314	
U7#15	28HU	
U7#16	1PCP	
U7#19	P5H2	
U10#2	C33C	
U10#5	UCUU	

SERVICE SHEET 6 (cont'd)

Table 6. AM% Control Signatures

Node	Correct Signature	Comments
U10#6	48U0	AM DAC
U10#9	H934	
U10#12	5449	
U10#15	H3CA	
U10#16	6U7U	
U10#19	37P1	
U12#2	5869	
U12#5	05A7	
U12#6	PU57	
U12#9	P580	

Table 7. FM Deviation Control Signatures

Node	Correct Signature	Comments
+5V	H6H5	FM DAC
U12#12	50P3	
U12#15	3P3A	
U12#16	681U	
U12#19	6U79	
U15#2	15A4	
U15#5	0AU5	
U15#6	5599	
U15#9	F65U	
U15#12	9467	
U15#15	U761	
U15#19	7H7C	Level Range

Table 8. Audio Oscillator Control Signatures

Node	Correct Signature	Comments
+5V	H6H5	
U18#2	1821	OSC OUT
U18#5	52HC	INT AM
U18#6	7P3H	INT FM
U18#9	3CU7	OSC FREQ
U18#12	199A	FM RANGE
U18#15	AA00	AC FM
U18#16	7FCP	EXT AM
U18#19	4HFF	EXT FM

Table 9. Modulation Strobe Signatures

Node	Correct Signature	Comments
+5V	H6H5	
U7#11	58AP	U7 Strobe
U10#11	57F4	U10 Strobe
U12#11	97CC	U12 Strobe
U15#11	A5FP	U15 Strobe
U18#11	P1H1	U18 Strobe

SERVICE SHEET 7

FM AND AM MODULATION CONTROL, AND RF AMPLITUDE CONTROL

PRINCIPLES OF OPERATION

General

Data from the Modulation Control Latches is used to control the RF output amplitude level in fine steps, and the RF output amplitude level versus frequency correction. The data also controls the amplitude and frequency modulation signals.

RF Output Amplitude Control

Ten data bits latched into Modulation Control Latches U7 and U10 (refer to Service Sheet 6) are applied to the Level Digital-to-Analog Converter (DAC) U6. The digitally controlled output of the Level DAC adjusts the reference voltage input from the unity-gain Level Buffer U20B. This dc voltage controls the vernier output level. The output voltage is applied to the AM Reference Summing Amplifier U20A.

When amplitude modulation is selected, the Level DAC voltage is summed with the AM % DAC voltage, and applied to A6U6 of the Automatic Level Control (ALC) Amplifier (refer to Service Sheet 4).

The Microprocessor determines when the vernier output level is greater than +7.0 dBm. At this time the Level Range select bit is set high, and the output of U20D goes to approximately -15 V. FET switch Q7 opens increasing the gain of AM-Reference Summing Amplifier U20A. This allows for the higher output levels. At -127 dBm the output amplitude level vernier's range is extended to -7 dB.

AM Modulation Control

Ten data bits latched into Modulation Control Latches U10 and U12 (refer to Service Sheet 6) are applied to the AM % DAC U11. The digitally controlled output level of the AM % DAC adjusts the input modulation signal from the AM % Summing Amplifier U20C to the level that modulates the RF signal to the depth selected. The output signal is ac coupled by C22 to the unity-gain AM Offset Buffer U14. The AM Offset Adjustment at R73 nulls any dc offset of the modulation signal. The amplitude modulation signal is then summed with the level voltage at U20A as discussed above.

Internal AM Select. Internal AM is selected when the data bit latched into pin 5 of U18 is high (refer to Service Sheet 6). The high output (INT AM) to the positive input of the Internal AM Select comparator U22B, being more positive than +2V (R) at the negative input, switches its output to approximately 0.0 V. FET switch Q9 is turned on. When Q9 is on, the output of the Audio Oscillator U21A is then ac coupled by C16 through resistor R58 to the AM % Summing Amplifier U20C.

External AM Select. External AM is selected when the data bit latched into pin 16 of U18 is high (refer to Service Sheet 6). The high output (EXT AM) switches the output of the External AM Select comparator U22A to approximately 0.0 V. FET switch Q8 is turned on. When Q8 is on, the external modulation signal from the External Modulation Buffer U24 is then applied to the AM % Summing Amplifier U20C through resistor R57.

SERVICE SHEET 7 (cont'd)

FM Modulation Control

Ten data bits latched into the Modulation Control Latches U12 and U15 (refer to Service Sheet 6), are applied to the FM Deviation DAC U13. The digitally controlled output level of the FM deviation DAC adjust the input modulation signal from the FM Deviation Summing Amplifier U16 for the level that frequency modulates the RF output to the FM Deviation Amplifier U19C.

Internal FM Select. Internal FM is selected when the data bit latched into pin 6 of U18 is high (refer to Service Sheet 6). The high output (INT FM) switches the output of the Internal FM Select comparator U22D to approximately 0.0 V. FET switch Q6 is turned on. When Q6 is on, the output of the Audio Oscillator U19A is ac coupled by C16 through resistor R33 to the FM Deviation Summing Amplifier U16.

External FM Select. External AC FM or DC FM is selected by the data bits latched into pin 15 (AC FM) and pin 19 (EXT FM) of U18, and gated through NOR gates U17 (refer to Service Sheet 6). The high output at pin 4 of U17B switches the output of the External AC FM Select comparator U22C to approximately 0.0 V. FET switch Q5 is turned on. When Q5 is on, the external ac modulation signal from the External Modulation Buffer U24 is ac coupled by C7 and C10 through resistor R26 to the FM Deviation Summing Amplifier U16. The high output at pin 13 of U17D switches the output of the External DC FM Select comparator U19A to approximately 0.0 V. FET switch Q11 is turned on. When Q11 is on, the external dc modulation signal from the External Modulation Buffer U24 is dc coupled by resistor R25 to the FM Deviation Summing Amplifier U16. External AC FM and external DC FM can not be selected at the same time.

Audio Oscillator Section

When only internal modulation is selected, the data bit latched into pin 2 of U18 is high (refer to Service Sheet 6). The high output (AUDIO OSC OUT) switches the output of Audio Oscillator Out comparator U23B to approximately 0.0 V. FET switch Q10 is turned on. When Q10 is on, the 400 Hz or 1 kHz internal Audio Oscillator output through buffer amplifier U21B and C4 and C5 is applied to the MOD INPUT/OUTPUT connector on the front-panel.

The internal Audio Oscillator's frequency is enabled by a high latched into pins 5 or 6 of U18. These two bits (INT AM and INT FM) are each applied to Audio Oscillator Buffer U5 (refer to Service Sheet 6). The low output (AOE) of U5 enables the internal Audio Oscillator U21A.

The internal Audio Oscillator's frequency of 400 Hz or 1 kHz is selected by the data bit latched into pin 8 of U18. For 1 kHz the FREQ line is low; for 400 Hz it is high. The high output switches the output of Audio Frequency Select comparator U23A to approximately 0.0 V. FET switch Q12 is turned on and capacitor C8 is bypassed. This increased capacitance switches the Audio Oscillator's frequency to 400 hz. If 1 kHz is selected, Q12 is turned off by a low on the FREQ line to U23A, and C8 is left in the oscillator's circuit. The peak output of the Audio Oscillator is approximately +7.5 volts as determined by VR3, CR3, and CR4. These components form the feedback path for the positive input of U21A.

SERVICE SHEET 7 (cont'd)

Modulation Calibration. Internal and external modulation is calibrated only if the modulation signal from the internal Audio Oscillator or the external MOD INPUT/OUTPUT connector is equal to +1.00 Vpeak ±0.05 Vpeak. The amplitude from the internal Audio oscillator is adjusted by R28 OSC ADJ.

Over/Under Modulation Comparators

The input amplitude level at the MOD INPUT/OUTPUT connector must be set by the external source. The input amplitude level is monitored by the Over/Under Modulation comparators U23C and D. When the modulation input signal is high, comparator U23C switches its output from -15 V to 0.0 V. The monostable multivibrator U1A is enabled. The output at pin 13 goes high for approximately 0.45 Sec. As long as the input is enabled by the high modulation signal, the multivibrator continues to output the pulse.

The HI (H) pulse from the multivibrator is applied to the Service Request Register A11U6 (refer to Service Sheet 17). The Microprocessor receives this status bit over the data bus when the inputs to the Service Request Register are clocked in by the status strobe. The HI EXT LED is turned on.

When the modulation input signal is low, the output of comparator U23C and D are both approximately -15 V. The monostables are not enabled. The active high output of U1A is low and the active low output of U1B is high. The high output of U1B is applied to the Service Request Register, and the LO EXT LED is turned on.

When the modulation input signal is 1 Vpeak, the output of comparator U23D is switched high which enables the monostable multivibrator U1B. The high output at pin 12 is set low, and the LO EXT LED is turned off.

SERVICE SHEET 7

TROUBLESHOOTING

Procedures for checking part of the A10 Audio/Power Supply Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., ⟨√1⟩.

Troubleshooting Help

Service Sheet BD4
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A

⟨√1⟩ Level DAC, AM Reference Summing Amplifier

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... 0 dBm
   Modulation .... Off

2. Measure and verify the voltages shown in Table 1 at test point J6 pin 12 (AM). Change the RF output amplitude level from the front-panel as indicated.

NOTE

Voltages measured may differ from the voltages shown in Table 1 because of level correction. The voltage change for each step from 0.0 to +13.0 dBm is consistent.

Table 1. Level Control Voltages versus Front-Panel Amplitude

Front-Panel Amplitude (dBm)	Test Point J6 Pin 12 (Vdc)
0.0	0.6
+5.0	1.1
+10.0	1.9
+13.0	2.8

SERVICE SHEET 7 (cont'd)

√2 AM % DAC, AM Offset Buffer

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... AM 1%
   Source .... 1 kHz (Int.)

2. Measure and verify the voltages shown in Table 2 at test point J6 pin 12 (AM). Change the AM% depth from the front-panel as indicated.

Table 2. AM% Control Voltage Levels

Front-Panel AM%	Test Point J6 Pin 12 (Vrms)
1	0.0045
5	0.023
10	0.046
20	0.092
50	0.229
70	0.321
99	0.453

√3 FM Deviation DAC, FM Deviation Amplifier

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... FM 1 kHz
   Source .... 1 kHz (Int.)

2. Measure and verify the voltages shown in Table 3 at test point J6 pin 8. Change the FM deviation from the front-panel as indicated.

Table 3. FM Deviation Control Voltage Levels

Front-Panel FM (kHz)	Test Point J6 Pin 8 (Vrms)
1	0.022
5	0.110
10	0.221
20	0.440
50	1.099
70	1.536
99	2.171

SERVICE SHEET 7 (cont'd)

<J4> Comparators, FET Switches

1. Set the Signal Generator as follows:

   Frequency .... 500 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Select the front-panel Modulation Source functions as indicated in Table 4. Measure and verify the voltages shown for the associated comparator.

Table 4. Voltage Checks

Function Selected	Comparator	Comparator Output (Vdc)	FET Switch	Open/ Closed
Int 1 kHz, AM	U22B	0.0	Q9	closed
Int 400 Hz	U23A	+0.0	Q12	closed
Audio Osc Out	U23B	+5.0	Q10	closed
Int FM	U22D	0.0	Q6	closed
Ext AC FM	U22C	0.0	Q7	closed
Ext DC FM	U19A	+14.0	Q11	closed
Ext AM	U22A	0.0	Q8	closed
Amplitude +10 dBm	U20D	−13.0	Q7	open
FM Range (<21 kHz)	U19D	+14.0	Q2	open
Ext AM No Input	U23D	−13.0	J6 Pin 14 J6 Pin 15	L H
Ext AM 1 Vpk Input	U23D	−13.0	J6 Pin 14 J6 Pin 15	H L

SERVICE SHEET 8

ATTENUATOR, ATTENUATOR CONTROL, AND REVERSE POWER PROTECTION

PRINCIPLES OF OPERATION

General

Encoded data from the Microprocessor is clocked into the Heterodyne/Pad Control Latch, and continuously applied to the Heterodyne/Pad Driver. Control signals enable the heterodyne mode (at frequencies from 0.1 to 123.5 MHz), and add or remove attenuation from the RF output signal depending upon the Amplitude selected.

If excessive power from an external source is connected to the RF OUTPUT connector, the Reverse Power Protection circuits cause a relay in series with the output to open.

Attenuator Control

Frequencies of 123.5 to 990 MHz and levels of -8 to-20 dBm from the Output Assembly, A6, are applied to the Attenuator assembly, A9. The first two attenuator relays HET A and HET B switch the input signal out to the Output Assembly and return the signal to the attenuator in the Heterodyne mode when output frequencies of 0.1 to 123.5 MHz are selected. The attenuator has five attenuator pads, one each of 10 and 20 dB and three each of 30 dB for a total of 120 dB. The correct attenuator pads are selected by the Data Word from the Microprocessor. The data word is latched into A10U9 by strobe ASTB1. The attenuator relay pads or heterodyne relays are not selected and held closed by the high output of the Hrterodyne/Pad Driver A10U3. The Heterodyne/Pad Control Latch U9 outputs are applied to the Heterodyne/Pad Driver U3 where the active high outputs are connected to the attenuator's relay solenoids. Each high output of the driver switches the attenuator relay, and the RF output then by-passes the attenuator pad (thru-line position).

Reverse Power Protection

The reverse power limiter/detector within the attenuator prevents reverse power levels from damaging the Attenuator or Output Amplifiers. The limiter/detector's two zener diodes limit the maximum voltage on the transmission line to ±5Vpk. The zener diodes detect positive and negative voltages on the transmission line and store the detected voltage on capacitors. The voltage stored on one of the capacitors is coupled to the negative input of A6U10A in the Reverse Power Sense circuits by resistor divider A6R103, and A6R92. U10A functions as a voltage comparator where the positive input reference voltage is approximately +2.5 Vdc by resistors A6R93 and 94 divided from the +5V(F1) supply voltage for the reference voltage. When the negative input to comparator A6U10A becomes more positive than the +2.5 V reference, which is a detected voltage greater than +2.75 V, the output of A6U10A switches to approximately -15 Vdc. The current through A6R95 fixes the voltage at J-K Flip-Flop A6U9 at approximately 0.0 V which resets the flip-flop. The active low output of A6U9 is high and biases

SERVICE SHEET 8 (cont'd)

transistor A6Q14 off and removes the current through the reverse power relay within the attenuator. This opens the relay in the transmission line removing the external input. When the output of A6U9 opens the relay, the active high output of A6U9 provides a reverse power interrupt, RPI, to the Microprocessor. The Microprocessor services the interrupt causing the AMPLITUDE Display to flash. The keyboard is locked up except for the Amplitude controls thus alerting the operator of a reverse power condition. The relay remains open until a new output level is entered. The output clock from the Microprocessor clocks the Data Timeout One-Shot A6U8 (refer to Service Sheet 5) generating a 2 ms Reverse Power Clock, RCL, which toggles (sets) A6U9 (refer to Table 1). The active low output turns on A6Q14 energizing the relay If the reverse power condition was not removed, the detector detects the condition as before, re-opening the relay.

Table 1. A6U9 Operation

Set	Reset	CLK (RPCL) to J-K	Outputs	
			Active High	Active Low
H	L	X	L	H
H	H	↑	Toggle	Toggle

SERVICE SHEET 8

TROUBLESHOOTING

Procedures for checking part of the A6 Output Assembly circuits, the A9 Attenuator, and part of the A10 Audio/Power Supply Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1. Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD2
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A
DC Power Supply .... HP 6215A
Signature Analyzer .... HP 5005A

√1 Attenuator Control

1. A data word is latched into A10U9 by ASTB1. The outputs of the latches are applied to the Heterodyne/Pad Driver A10U3 where the active-high outputs are connected to the attenuator solenoids (relay closed, thru-line position). Data low, relay open, RF output through attenuator pad.

2. High data bits to Control Latch A10U9 select the attenuator thru-line on A9AT1 and/or A9AT2.

3. The high data bits at the Control Latch, and the active high outputs of the Driver are checked using an oscilloscope They are low for each attenuator pad and heterodyne switch selected.

4. Set the Signal Generator as follows:

   Frequency .... 100 MHz
   Amplitude .... -5 dBm
   Modulation .... Off

5. The attenuator pads are selected as shown in Table 2. The heterodyne switches are selected for output frequencies 100 kHz to 123.5 MHz. Measure the appropriate attenuator control line with the oscilloscope and change the front-panel Amplitude setting as indicated.

SERVICE SHEET 8 (cont'd)

Table 2. Step Attenuator Switching

Amplitude Entered at Front-Panel	Attenuator Pads Selected	Low	
		A10U9 Pin	A10U3 Pin
−5 dBm	10 dB	12	14
−15 dBm	20 dB	16	12
−25 dBm	30 dB (A)	19	11
−55 dBm	30 dB (A) and (B)	15, 19	13, 11
−85 dBm	30 dB (A), (B) and (C)	9, 15, 19	15, 13, 11

6. The attenuator can be checked by entering the Keyboard-Invoked Test subroutine Test 1. This test allows for manual actuation of the attenuators. Front-panel keys 0-5 are used in this test and correspond directly to HP-IB codes A0-A5. Refer to Table 3 for the key and attenuator pad affected when actuated.

- Enter the Keyboard-Invoked Tests by first pressing the "SHIFT" key, and then pressing the "INCR SET" key. A "1" should be shown in the MODULATION Display window.

- Press the "INCR SET" key to start attenuator actuation Test 1. A "0" is shown in the FREQUENCY Display window. This corresponds to Key "0" shown in Table 3, all attenuator pads out.

- Press front-panel keys 1-5 to test each attenuator pad, or press key 0 for all attenuator pads out (refer to Table 3).

- To exit the Keyboard-Invoked Tests, press the "AMPTD" up-arrow key until a "7" is shown in the MODULATION Display window. Then press the "INCR SET" key; the Signal Generator is initialized as in Power-On.

Table 3. Attenuator Actuation Keys

Key	Attenuator/Switch
0	All Out
1	1st 30 dB Pad
2	20 dB Pad
3	2nd 30 dB Pad
4	10 dB Pad
5	3rd 30 dB Pad

√2 **Reverse Power Protection**

1. Set the Signal Generator as follows:

Frequency .... 500 MHz
Amplitude .... −10 dBm
Modulation .... Off

SERVICE 8 (cont'd)

2. Set the dc power supply to +20 Vdc, turn the power supply OFF, and connect it to the RF OUTPUT connector. Then turn the power supply ON. (Dependant upon the rise time of the power supply output voltage.)

3. Measure and verify the voltages shown in Table 4.

Table 4. Reverse Power Protection Operating Voltages

Reverse Power Relay	A6U10A Pin 6	Test Point J3 Pin 11	Test Point J3 Pin 10	A6Q14 (Vdc)		
				E	B	C
Closed	+4.5 Vdc	+4.5 Vdc	+0.2 Vdc	+5.0	+4.3	+5.0
Open	+4.5 Vdc*	+4.5 Vdc*	+5.0 Vdc	+5.0	+5.0	+0.0

*The output of comparator U10A-Pin 6 will be low only for the time required to open the reverse power relay.

4. Disconnect the dc power supply from the Signal Generator and press the AMPTD key at the front-panel. Check for the Reverse Power Clock at A6U9 pin 12. The Reverse Power Clock toggles the J-K Flip-Flop, biasing A6Q14 on, and closes the reverse power relay in the Attenuator.

SERVICE SHEET 8

TROUBLESHOOTING USING SIGNATURE ANALYSIS

This is an alternate method of troubleshooting the circuits of Service Sheet 8. If Service Sheet 8 signatures are incorrect, recall that the data strobe is decoded on the circuitry of Service Sheet 18 and the data comes from the Microprocessor of Service Sheet 17. If these signatures are correct and the problem does not seem to be related to 10 dB step attenuation or a 0.1 to 123.5 MHz RF output signal, you may want to return to Service Sheet BD4 for further digital troubleshooting. If the previously mentioned problems require further investigation, continue to troubleshoot on this service sheet or refer to Service Sheet BD2.

Purpose. To verify correct transfer of encoded data and strobe information from the Microprocessor to the Attenuator Control Latch.

Setup. Connect the signature analyzer as follows:

1) GND as close to circuitry being probed as possible. Bad grounding can cause unstable signatures.
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to "SA1" (A11TP7, refer to Service Sheet 18).
4) STOP to "SA2" (A11TP8, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-POSITIVE EDGE
2) STOP-NEGATIVE EDGE
3) CLK-NEGATIVE EDGE

Set the Signal Generator as follows:

1) Disconnect ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly.
2) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than address 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the HP-IB address switches.

SERVICE SHEET 8 (cont'd)

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature in Table 5 is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analizer probe to each node indicated in Tables 5 and 6. Verify that each signature is correct and stable.

NOTE

In case of unstable or incorrect signatures, ground the data probe as close as possible to the node being tested.

Table 5. Heterodyne/Pad and Thru Line Control Signatures

Node	Correct Signature	Comments
+5V (F)	H6H5	
U9#2	FP66	HET/PAD
U9#5	FP66	Control
U9#6	FP66	Latch
U9#9	U274	
U9#12	PCH2	
U9#15	7A42	
U9#16	8301	
U9#19	8FFP	

An incorrect signature could be due to:

1) Data to latch problem (data bus).
2) Strobe to latch problem.
3) Latch problem.
4) TO1 (A2TP13) or T02 (A2TP14) shorted to ground on the display board (refer to Service Sheet 22).

SERVICE SHEET 8 (cont'd)

Table 6. Heterodyne/Pad and Thruline Strobe Signatures

Node	Correct Signature	Comments
+5V	H6H5	
U9#11	8685	U9 STROB

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reconnect the attenuator ribbon cable W11 to A10J3. Reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 9

LOW FREQUENCY LOOP VOLTAGE CONTROLLED OSCILLATOR

PRINCIPLES OF OPERATION

General

The Low Frequency Voltage Controlled Oscillator (VCO) and Limiter Amplifier generate, amplify and limit the 60 to 110 MHz signal that is mixed with 800 MHz on the Multiplier Assembly. The TUNE voltage to the VCO is controlled by data from the Microprocessor. The VCO is phase locked to the reference oscillator.

60 to 110 MHz VCO

The VCO, Q1, is a Hartley Oscillator. The amount of positive feedback from the collector to the emitter is predetermined by the taps on the inductor L103. Two inductors L101 and L103 used in the VCO are spiral printed circuit board traces. The +13 Vdc is a clean stable voltage to bias the VCO and Limiter Amplifier circuits.

The base of Q1 is biased by resistors R100 and R101, and the emitter by resistor R104. Inductor L101 suppresses any high frequency oscillations and capacitors C102 and C105 ac couple the signal to the base and emitter of Q1. Capacitors C103 and C107 are by-pass capacitors.

The 60 to 110 MHz VCO output is dependent upon the VCO TUNE voltage. The VCO's output is ac coupled by C110 to Limiter Amplifier Q2.

Limiter Amplifier

The base of Q2 is biased by resistors R106 and R107, and the emitter by R109 and R110. R109 supplies some negative feedback but R110 does not since it is by-passed by C113. The inductive bead E100 reduces gain at high frequencies.

The output of Q2 is dc coupled to buffer amplifier limiter Q3. The bias voltages of Q3 are set by Q2. Feedback from the collector to base of Q3 is by diodes CR101 and CR102 and capacitor C115. The diodes limit the feedback and restrict the collector voltage swing to ±0.6V to provide a constant output level.

The output of the Limiter Amplifier is ac coupled by capacitor C120 to the Buffer Amplifier Q47 shown on Service Sheet 10, and by capacitor C104 to the 110 MHz Low-Pass Filter. Resistors R102, R103, and R105 form a 2 dB pad which isolates the Limiter Amplifier from the 110 MHz Low-Pass Filter. This makes the filter impedance nearer 50 ohms at all VCO frequencies.

110 MHz Low-Pass Filter

Capacitors C109 and C108, and inductor L106 form a series resonant circuit for adjusting the VCO for minimum roll-off at 110 MHz. Capacitor C119 and inductor L114 form a series resonant circuit for adjusting the frequency response of the 60 to 110 MHz Filter. At resonance, R112 and R113 reduce the series impedance for increased output. This is tuned to vary the output level at 110 MHz (flatness). The filter passes 60 to 110 MHz and rejects 120 MHz and above.

SERVICE SHEET 9

TROUBLESHOOTING

Procedures for checking the A3A1 Low Frequency Loop Oscillator circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1 . Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V . Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A
Adapter Probe .... HP 1250-1598
Adapter N(f) to BNC(m) ...... HP 1250-0077
Adapter BNC(f) to BNC(f) .... HP 1250-0080
Cable BNC(m) to SMC(f) ...... HP 08662-60075

√1 Voltage Controlled Oscillator, Limiter Amplifier and 110 MHz Low-Pass Filter

1. Set the Signal Generator as follows:

   Frequency .... 80 MHz
   Amplitude .... -10 dBm
   Modulation .... Off

2. Set the measuring receiver with the sensor module precalibrated as follows:

   Measurement .... RF POWER
   Display .... LOG

3. Zero the measuring receiver and wait for the zero LED to go out.

4. Change the Signal Generator's frequency to 90 MHz. This ensures the frequency of the Low Frequency Loop VCO to be 60 MHz.

5. Measure frequency and power levels at each point indicated in Table 1.

NOTES

When probing the VCO with the covers removed, a frequency shift may be introduced.

SERVICE SHEET 9 (cont'd)

Table 1. VCO Frequency, Power Output and TUNE Voltage

Frequency (MHz)		VCO Tune Voltage (Vdc) (at C100)	Power Level (dBm)	
Front-Panel Setting	VCO Output (at J1)		at TP2	at J1
90	60	+11.0 to +9.0	+6.8 to +4.8	−7.7 to −9.7
85	65	+10.0 to +8.0	+7.0 to +5.0	−7.5 to −9.5
80	70	+9.0 to +7.0	+7.0 to +5.0	−7.3 to −9.3
75	75	+9.0 to +5.0	+7.2 to +5.2	−7.3 to −9.3
70	80	+8.0 to +4.0	+6.5 to +4.5	−7.5 to −9.5
65	85	+7.0 to +3.0	+6.2 to +4.2	−7.5 to −9.5
60	90	+6.0 to +2.0	+5.9 to +3.9	−7.5 to −9.5
55	95	+6.0 to 0.0	+5.7 to +3.7	−7.5 to −9.5
50	100	+5.0 to −1.0	+6.0 to +4.0	−7.8 to −9.8
45	105	+4.0 to −2.0	+6.2 to +4.2	−8.0 to −10.0
40	110	+2.5 to −3.5	+5.8 to +3.8	−8.4 to −10.4

SERVICE SHEET 10

LOW FREQUENCY LOOP DIVIDE-BY-2, AND PRESCALER

PRINCIPLES OF OPERATION

General

The VCO's output, 60 to 110 MHz, passes through Buffer Amplifier Q47, and is divided-by-2 at U46A. The output frequency of the Divide-By-2 circuit is 30 to 55 MHz, and is the clock for the Prescaler. The Prescaler divides the 30 to 55 MHz frequencies by 9, 10 or 11. The Prescaler is a variable 4 to 6 bit ring-counter followed by a divide-by-2 circuit. In the divide-by-10 mode, the ring-counter is set to modulus 5, and the Divide-By-2 circuit makes the total divisor equal to 10. In the divide-by-11 mode, the ring-counter is set to modulus 6 for one cycle, and to modulus 5 for another cycle of the Prescaler. After 2 cycles, the result is a divide-by-11. In the divide-by-9 mode, the ring-counter is set to modulus 4 for one cycle, and to modulus 5 for another cycle of the Prescaler. After 2 cycles, the result is a divide-by-9.

The modulus of the ring-counter is controlled by the Remove Cycle, and the Add Cycle control inputs. A high on the Remove Cycle control input changes the modulus of the Prescaler to 6, by controlling the K input of U54A. As long as the Remove Cycle control input is high, the modulus of the Prescaler is 6 for one cycle, and 5 for another cycle; the Prescaler divides-by-11. A high on the Add Cycle control input changes the modulus to 4, by controlling the K input of U54B. As long the Add Cycle control input is high, the modulus of the Prescaler is 4 for one cycle, and 5 for another cycle; the Prescaler divides-by-9. If both inputs are high, the Prescaler modulus is 4 (an unwanted state).

The Remove and Add Cycle inputs are used for the following purposes:

- The Remove Cycle, divide-by-11, is set high by the Fractional-N IC to generate fractional frequencies, and by the FM Digital circuits to control frequency modulation.
- The Add Cycle, divide-by-9, is set high by the FM Calibration circuits and by the FM Digital circuits to control frequency modulation.

Buffer Amplifier and Divide-By-2

The VCO's output, 60 to 110 MHz, is ac coupled by C204 to the base of Buffer Amplifier Q47. Q47 is dc biased at the collector for approximately +3.5 Vdc. The VCO's input voltage causes the collector voltage to cross valid ECL logic levels <+3.3 V and >+4.2 V. The ECL high and low output clocks the Divide-By-2 master-slave D flip-flop U46A on each low to high transition. Thus, the output of U46A toggles dividing the input frequency by 2, and making the output frequency 30 to 55 MHz. Transistor Q51 translates the ECL logic levels to TTL logic levels. The output of U46A toggles Q51 on and off changing its collector voltage from approximately 0 Vdc (TTL low), to approximately +3.5 Vdc (TTL high). Buffer Driver Q56 buffers the output of Q51, and with U51D provides the drive required for the Prescaler.

Prescaler

The 30 to 55 MHz output clocks the Prescaler. U49, U50, and U54 have their set and reset inputs disabled; thus, their output state is dependent upon the J, K, and clock inputs.

SERVICE SHEET 10 (cont'd)

Divide-By-10

The Prescaler divides-by-10 when the Add Cycle control input, and the Remove Cycle control input are both low. The ring-counter modulus is 5 for all cycles of the Prescaler. The timing diagram for this mode is shown in Figure 1.

The J inputs to U55A and U55B are low, and the K, set, and reset inputs are hard-wired high. U55A and U55B are clocked on the high to low transition of U50A's Q output, the output of the ring-counter. The high K and low J inputs of U55A and U55B sets their Q outputs low and not Q outputs high, but only after the ring-countc has completed a cycle and is reset. After the first Prescaler cycle the output state of U55A ana U55B does not change when clocked. The inputs to U51B are both high, its output and the K input of U54A is low. With the J input of U54A connected to +5 Vdc, its Q output is clocked high on the next VCO divide-by-2 clock at time T1. The inputs to U51C are high at pin 9 and low at pin 8, its output and the K input of U54B is low. Since the J input to U54B was just clocked high, the next clock pulse at time T2 sets its output high. The output of U54A remains high until the Remove Cycle control input is set high. The high Q output of U54B is clocked through the ring-counter to the Q output of U50A at time T3. The low output of U50A sets the input of U51C at pin 9 low, its output and the K input of U54B is set high. The K inputs of U49A, U49B and U50A are set high by the Q output of U50A, on the next VCO Divide-By-2 clock their Q outputs are all toggled low at time T4. The output of the ring-counter sets the J and K inputs of the Divide-By-2 flip-flop U50B high. U50B is toggled at the end of each ring-counter cycle when both J and K inputs are high at time T4. The Q output of U54A remains high, and on the next clock the Q output of U54B is clocked high at time T5 and the high is clocked through to U50A. The cycle is repeated until a high is received at the Remove or Add Cycle control input instructing the Prescaler to remove or add a cycle.

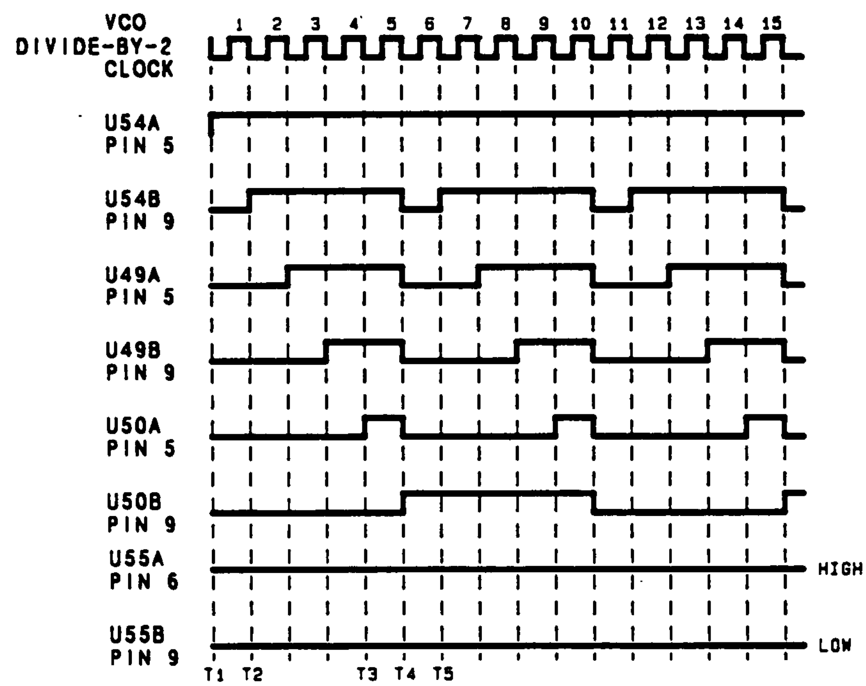


Figure 1. Divide-By-10 Timing Diagram

SERVICE SHEET 10 (cont'd)

Divide-By-11

The Prescaler divides-by-11 when the Remove Cycle control input is high, and the Add Cycle control input is low. The ring-counter's modulus is changed to 6 for one cycle, and to 5 for the next cycle of the Prescaler. The timing diagram for the divide-by-11 mode is shown in Figure 2.

With the J and K inputs to U55A high, when clocked the outputs toggle for each Prescaler cycle. The ring-counter's modulus also toggles from 6 to 5 each Prescaler cycle, and the Prescaler divides-by-11. This cycle is repeated until the Remove Cycle control input is set low. U55A is clocked on the high to low transition of U50A's Q output, at T2 the end of the Prescaler cycle. At time T1 the input at pin 5 of U51B is high, and the input at pin 6 is low. The K input to U54A is low and remains low until the not Q output of U55A is clocked low at time T2. The ring-counter remains in modulus 5 for the next cycle of the Prescaler. The K input to U54A is still low and at time T2 its Q output remains high. The Q output of U54B is toggled low, the not Q output of U55A is toggled low, and the Q output of U50B is toggled high. The VCO frequency is divided-by-5. At time T3, the Q output of U50A is high, and the not Q output is low. Both inputs to U51B are low, its output and the K input of U54A is high. The J and K inputs to U54A are both high and, its Q output is toggled low by the next clock at time T4. The K inputs of U49A, U49B, and U50A are set high by the high Q output of U50A. The next VCO Divide-By-2 clock at time T4 toggles their Q outputs low. The Q output of U50A also sets the J and K inputs of the Divide-By-2 J/K flip-flop U50B high at time T3. Its output is toggled low at time T4. The Q output of U54A remains low for one clock cycle, and is clocked high at time T5. The J and K inputs of U54B, U49A, U49B and U50A remain low. Their output does not change states when they are clocked. On the next clock, U54A's Q output is toggled high and is clocked through the ring-counter to the output of U50A. The modulus was changed to 6 for this Prescaler cycle with the added clock to toggle U54A. Figure 2 shows the 6 clock cycles between time T4 and T6. The high Remove Cycle control input is set low and the J input of U55A is low. The Q output of U50A clocks the not Q output of U55A high at time T4. The K input of U54A is low, and its output remains high. The ring-counter's modulus is changed to 5 at time T6, and remains in modulus 5 until an active Remove or Add Cycle control input is received.

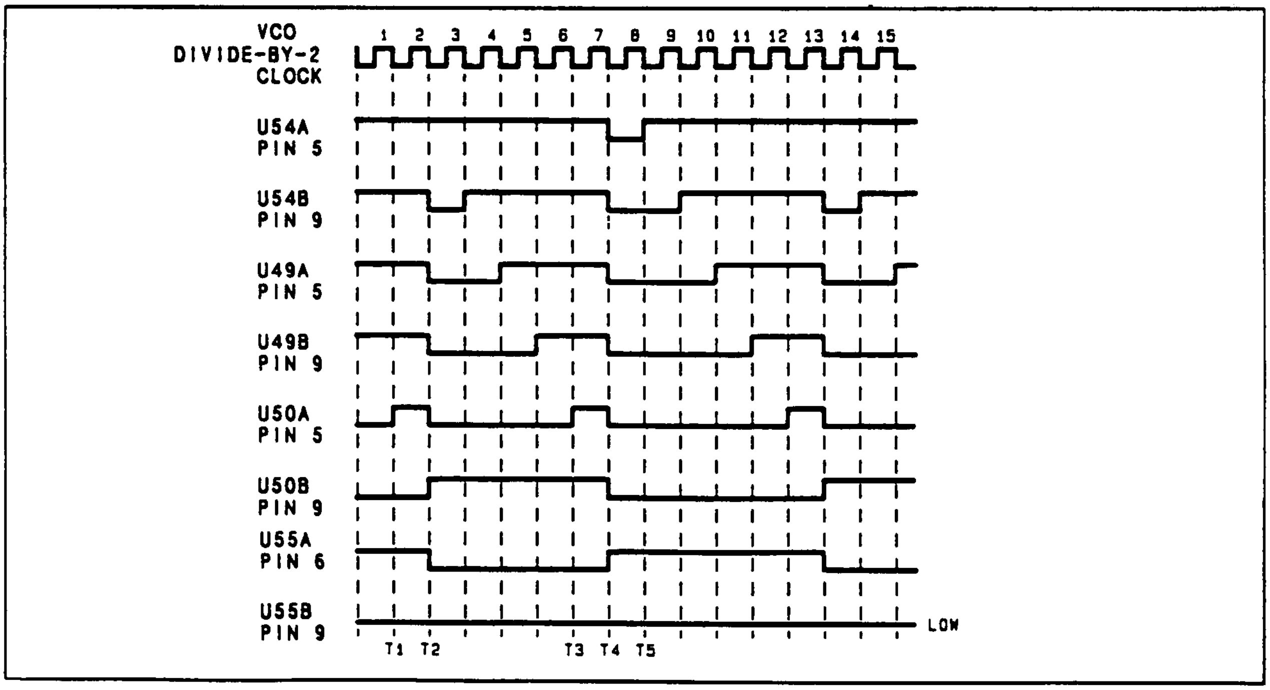


Figure 2. Divide-By-11 Timing Diagram

SERVICE SHEET 10 (cont'd)

Divide-by-9

The Prescaler divides-by-9 when the Add Cycle control input is high, and the Remove Cycle control input is low. The ring-counter's modulus is changed to 4 for one cycle, and to 5 for the next cycle of the Prescaler. The timing diagram for the divide-by-9 mode is shown in Figure 3.

With the J and K inputs to U55B high, when clocked, the outputs toggle for each Prescaler cycle. The ring-counter's modulus also toggles from 4 to 5, and the Prescaler divides-by-9. This cycle is repeated until the Add Cycle control input is set low. At time T1, both inputs to U51C are low and its output is high. The K input to U54B is still high at time T2. At time T2 the Q output of U55B is toggled high, and the Q output of U50A is toggled low. The ring-counter's modulus is still 5. The K input to U54A remains low, and its output remains high. The Q output of U54B is toggled low. The Q output of U55B is toggled high, and the Q output of U50B is toggled high. At time T3, the Q output of U50A is high, and not Q output is low. One input of U51C at pin 9 is low, the input at pin 8 is high, set high by the Add Cycle input latched into U55B at time T2. The output of U51C the K input of U54B goes low. The Q output of U54B will not change when clocked at time T4. The K inputs of U49A, U49B and U50A are set high by the high Q output U50A at time T3. The VCO Divide-By-2 clock at time T4 toggles their Q outputs low, and toggles the Q output of U50B low. The ring-counter's modulus is 4. The Q output of U54B is not reset low at time T4. The Q output of U49A is toggled low for one cycle at time T4, and high at time T5. The high Q output of U49A is clocked through to the Q output of U50A at time T6. The high Add Cycle input is removed, and the Q output of U55B is clocked low at time T4. Both inputs to U51C are low at time T6. U51C's output, the K input to U54B is high. Therefore, on the same clock that toggled the Q outputs of U49A, U49B, and U50A low, the output of U54B is toggled low at time T7. On the next clock the Q output of U54B is clocked high, and the high is clocked through to U50A. The ring-counter's modulus is changed to 5 at time T7, and remains in modulus 5 until an active Remove or Add Cycle control input is received.

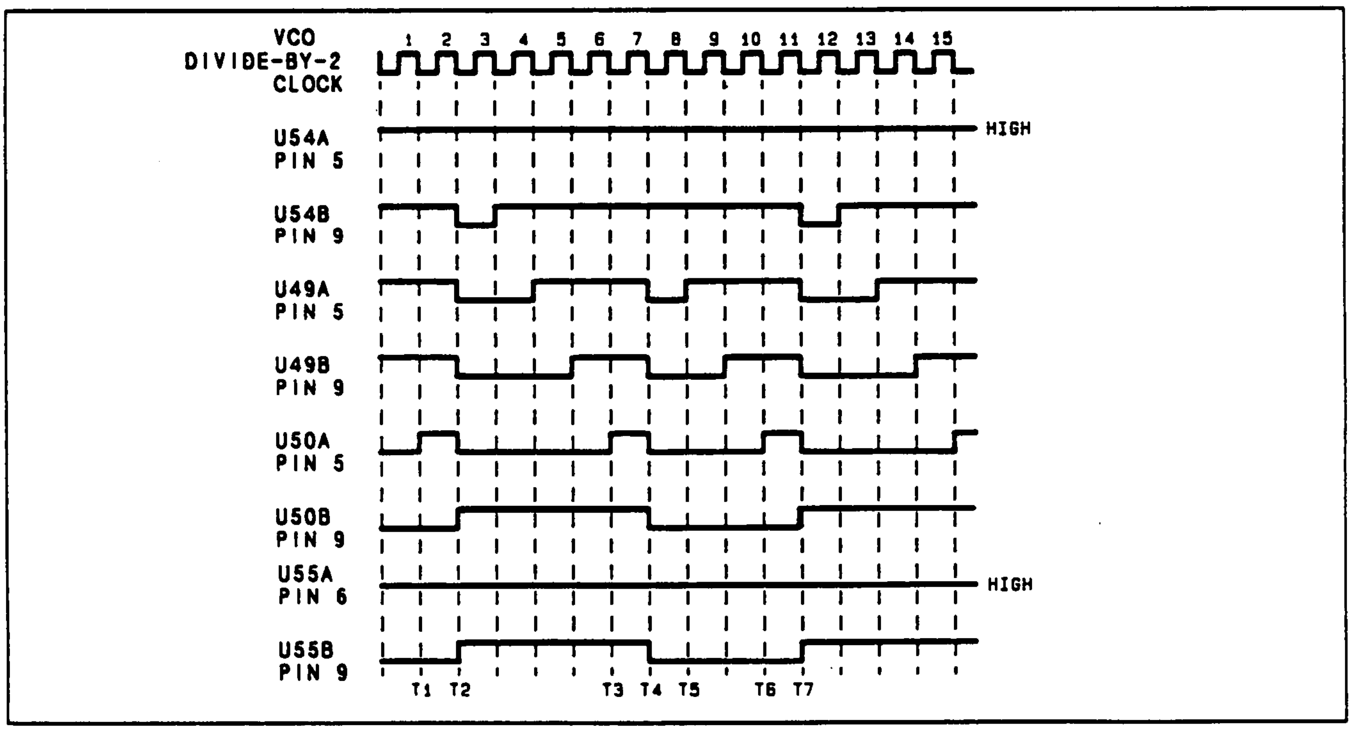


Figure 3. Divide-By-9 Timing Diagram

SERVICE SHEET 10

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. Areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1. When the Low Frequency Loop is locked, the frequency at Test Points 29, 30, and 31 are shown on the schematic.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Frequency Counter .... HP 5328A
Oscilloscope .... HP 1740A

√1 Buffer Amplifier

1. Remove jumper A3W6 (refer to Service Sheet 14). The VCO TUNE voltage goes to approximately 0.0 volts.

2. Connect the frequency counter to A3TP29 and measure the VCO frequency. The VCO frequency should be 100 MHz ±7 MHz.

NOTE

The ground connection to the counter probe must be as short as possible. If the counter does not count the 100 MHz, check the signal with the oscilloscope. Signal level is approximately 0.6 Vpp at A3TP29, and at ECL levels (low < +3.3 V, high >+4.2 V).

√2 Divide-BY-2 and ECL to TTL

1. Connect the frequency counter to A3TP30 and measure the VCO frequency divided-by-2.

2. If the frequency is not correct, the outputs of Q51, and U51D should be checked.

   a. Q51's base VCO frequency is divided-by-2 and is at approximately 2.2 to 3.4 Vpp.
   b. Q51's collector voltage is at approximately 0.0 to 2.4 Vpp.
   c. U51D at pin 13 is approximately 1.0 to 3.4 Vpp.

SERVICE SHEET 10 (cont'd)

√3 Prescaler

1. Connect the frequency counter to A3TP31, and measure the VCO frequency divided-by-20.

2. If the frequency is not correct, check the frequencies shown in Tables 1, 2 and 3. The frequencies shown in the tables are approximate, and are dependent upon the frequency of the Low Frequency Loop VCO when the VCO TUNE voltage input is approximately 0.0 volts.

NOTE

Jumper A3W6 must be removed and VCO TUNE voltage is approximately 0.0 volts. The VCO frequency should be 100 MHz ±7 MHz (refer to check 1). In the active state, the outputs of the J/K flip-flops are changing and not fixed at a TTL high or a TTL low.

Table 1. Prescaler J/K Flip-Flop Output Add and Remove Cycle Controls Inactive Low

J/K Flip-Flops	J/K Flip-Flops Output	
	State	Frequency
U55A Pin 6	Inactive	—
U55B Pin 9	Inactive	—
U54A Pin 5	Inactive	—
U54B Pin 9	Active	10 MHz
U49A Pin 5	Active	10 MHz
U49B Pin 9	Active	10 MHz
U50A Pin 5	Active	10 MHz
U50B Pin 9	Active	5 MHz

3. Remove A3W8, and connect U55A pin 3 to +5 Vdc. The frequencies in Table 2 are approximate, and are dependent upon the Low Frequency Loop VCO frequency when the VCO TUNE voltage input is grounded.

SERVICE SHEET 10 (cont'd)

Table 2. Prescaler J/K Flip-Flop Output Add Cycle Control Inactive Low and Remove Cycle Control Active High

J/K Flip-Flops	J/K Flip-Flops Output	
	State	Frequency
U55A Pin 6	Active	4.5 MHz
U55B Pin 9	Inactive	—
U54A Pin 5	Active	4.5 MHz
U54B Pin 9	Active	9 MHz
U49A Pin 5	Active	9 MHz
U49B Pin 9	Active	9 MHz
U50A Pin 5	Active	9 MHz
U50B Pin 9	Active	4.5 MHz

4. Remove A3W7, and connect U55B pin 11 to +5 Vdc. The frequencies in Table 3 are approximate, and are dependent upon the Low Frequency Loop VCO frequency when the VCO TUNE voltage input is grounded.

Table 3. Prescaler J/K Flip-Flop Output Add Cycle Control Active High and Remove Cycle Control Inactive Low

J/K Flip-Flops	J/K Flip-Flops Output	
	State	Frequency
U55A Pin 6	Inactive	—
U55B Pin 9	Active	5.5 MHz
U54A Pin 5	Inactive	—
U54B Pin 9	Active	5.5 MHz
U49A Pin 5	Active	11 MHz
U49B Pin 9	Active	11 MHz
U50A Pin 5	Active	11 MHz
U50B Pin 9	Active	5.5 MHz

SERVICE SHEET 11

LOW FREQUENCY LOOP FRACTIONAL-N, DIVIDE-BY-N, AND DIGITAL TIMING LOGIC

PRINCIPLES OF OPERATION

General

Serial data is generated by the main Microprocessor A11U9 (refer to Service Sheet 17) it writes data to the Serial I/O Control Register A11U30 (refer to Service Sheet 18). Pin 2 of the Serial I/O Control Register is the data bit for the Serial I/O Data Bus Serial Low Frequency Loop data is passed through the LF Loop Serial Data Bus Buffer A11U29A (refer to Service Sheet 18) when it is enabled. Serial Data is transferred to the Low Frequency Loop when its frequency is changed, when frequency modulation (AC or DC) is selected, turned off, changed or calibrated, or when phase is incremented or decremented. An Out-Of-Lock status bit is transferred from the Low Frequency Loop to the Microprocessor Assembly during diagnostic tests. An automatic indication that the Low Frequency Loop is out-of-lock is displayed on the A3 assembly by a lit LED. Serial LF Loop Data (LDA) is clocked into the LF Loop Microprocessor A3U28 by the LF Loop Clock (LCL). Serial LF Loop Data is clocked into the LF Loop Microprocessor by active low LCL pulses. At the completion of the data transfer, the LF Loop Serial Data Bus Buffer is disabled and the LF Loop Clock is discontinued. Timing for data transfer and clock generation is firmware controlled.

Microprocessor

Serial LF Loop Data written to the LF Loop Microprocessor, U28 at pin 9, consists of instructions and data. The LF Loop Microprocessor uses a firmware routine to input the serial data, and to handle all timing constraints. Instructions and data transferred to the LF Loop Microprocessor tell the LF Loop what operations to perform. For example, some instructions select frequency modulation and calibration. Instructions and data sent to the Fractional-N Controller tell it what operation to perform. The LF Loop Microprocessor stores the data sent over the serial data bus and very quickly transfers it to the Fractional-N Controller as a series of four-bit words. The first word transferred is always an instruction followed by a 70 uSec wait to assure that Fractional-N Controller has received a Cycle Start Pulse. Sixteen data words are then sent followed by an instruction word to define the data, and an instruction to terminate the data transfer.

The Microprocessor has three I/O Ports. Two eight-bit ports PA, PB and one four-bit port PC. The eight-bits of I/O port PA and four-bits of I/O port PB function as outputs. PA0 (pin 20) through PA3 (pin 23) transfer instructions and data words to the Fractional-N Controller, U17. PA4 (pin 24) is the external clock (EXT CLK) that clocks the data words into the Fractional-N Controller, and PA5 (pin 25) is the instruction valid (INST VLD) input that clocks the instructions into the Fractional-N Controller. Outputs PA6 (pin 26), PA7 (pin 27) and PB0 through PB3 (pins 12 through 15) enable frequency modulation, turn frequency modulation off, select DC FM and activate B+C(L) and S(L)/H1 control lines for frequency modulation calibration. The other four PB I/O Ports function as inputs. TP18 (PB5) and TP17 (PB6) are connected to ground to initiate microprocessor controlled service routines. The LF Loop Microprocessor mode input TP26 must also be grounded. TP16 (PB7) is not used. See Table 1 for further information.

SERVICE SHEET 11 (cont'd)

Table 1. LF Loop Microprocessor Initiated Tests

Test Point Grounded	TP26 Grounded	LF Loop Microprocessor Test Initiated
	Yes	Increment Signal Generator's frequency by 10 MHz. An FM calibration is performed every 100 mSec until ground is removed.
TP17	Yes	Signature Analysis
TP18	Yes	Low Frequency Loop VCO's frequency is set to 66.80001 MHz
TP19	No	No FM calibration with VCO's frequency changed, switching speed is increased.

With TP19 (PB4) connected to ground and TP26 not grounded the frequency switching speed is increased by eliminating the FM calibration cycle. Jumper W2 connecting the B+C(L) to U22 (refer to Service Sheet 14), must be removed also. The FM Calibration DAC (U34) is then set to 75% of its range. To exit the service routines, the instrument's POWER switch is set to STBY and then to ON.

An external 4 MHz crystal Y300 is directly connected to the LF Loop Microprocessor (pins 4 and 5). Capacitor C301 is used to keep the frequency stable. The Microprocessor converts the 4 MHz crystal to a 1 MHz clock.

The LF Loop Microprocessor can be RESET by briefly shorting TP21 (Reset) to TP20 (ground). The mode input for the LF Loop Microprocessor is the PC2 input (pin 10). The mode input is high for normal Low Frequency Loop operation. The special Low Frequency Loop service mode is entered when the instrument is powered up with the mode input TP26 grounded. Then, the LF Loop Microprocessor will not receive data or clock inputs from the main Microprocessor (A11U9). TP26 is grounded when TP17 or 18 are grounded to access the Low Frequency Loop service routines.

Fractional-N Controller

Six of the eight inputs to the Fractional-N Controller (U17) are the four data inputs (C1-C4), the instruction valid input (INST VLD), and the external clock input (EXT CLK). The other two inputs are the chip clock input (CHIP CLK), and the cycle start input (CYCLE START). CHIP CLK is the LF Loop VCO frequency divided-by-20, and is the output of the Prescaler at pin 9 of U50B. The Chip Clock frequency varies from 3.0 to 5.5 MHz and is the clock for the Fractional-N Controller. Cycle Start is the LF Loop VCO frequency divided-by-N.F. (refer to BD3).Cycle Start is synchronized with the Chip Clock by the Cycle Start Synchronization flip-flop U19A. The Cycle Start input initiates a Fractional-N Controller cycle. The Cycle Start pulse is one Chip Clock long (refer to the Low Frequency Loop Timing Diagram Figure 1). At the termination of the Cycle Start pulse, the Sample and Hold pulse at pin 11 is active for two Chip Clocks. The Low Frequency Loop VCO control voltage from the integrator is stored on the Sample and Hold Capacitor C519 (refer to service sheet 13). One Chip Clock after the Sample and Hold Pulse is terminated, the Bias Pulse at pin 10 is active for thirteen Chip Clocks. The Bias

SERVICE SHEET 11 (cont'd)

pulse is synchronized with the Chip Clock at flip-flop U6B (refer to service sheet 12), initiating the Delayed Bias Pulse. During the Bias Pulse, a current resets the LF Loop Integrator. The Integrator is readied for the next output from the Phase Detector. The Fractional-N Controller Analog Phase Interpolation (API) outputs, at pins 2 through 6, are active during the Bias Pulse. Each of the five API outputs is pulse width modulated to sum the correct current into the Integrator to compensate for Fractional-N (F.N) variations in phâse differences. F.N phase difference variations occur when the LF Loop VCO frequency is not an even multiple of the 100 Khz reference. The Fractional-N Controller keeps track of the F.N phase difference between the VCO divided-by-N.F. and the 100 Khz reference. When the phase difference changes by 360/N degrees, the Prescaler is instructed to remove a cycle. A cycle is removed by the Prescaler to compensate for fractional frequencies. A cycle is removed or added by the Prescaler when frequency modulating at large modulation indexes (m). The LF Loop Integrator is reset during the Bias Pulse by the Bias Current. Therefore, all Chip Clocks must be of equal length when Bias Current is on, and the Prescaler does not remove or add cycles. The Bias Pulse directs the Bias Current to the Integrator and closes the API FET switches (refer to Service Sheet 12). When the FET switches are open, the API currents are directed to the Phase Detector and FM Current Switches (refer to Service Sheets 13 and 14). Otherwise the API currents are directed to the API switches. The Integrator is reset before the next input from the Phase Detector is received. The Fractional-N Controller determines the pulse width of the API Pulses, and terminates the API Pulses one Chip Clock before the end of the Bias Pulse (refer to the Low Frequency Loop Timing Diagram Figure 1). The pulse width of the negative API Pulses varies when a fractional frequency is selected. A fractional frequency is any LF Loop frequency that is not an even multiple of the 100 Khz reference. The timing of the Remove Cycle input to the Prescaler is initiated when the API 1 pulse goes high. The data sent to the Fractional-N Controller includes the divide number for the Divide-By-N Counters, U24, U30, and U36. The data is received as a four bit BCD number, changed to its 9's complement and sent serially least significant digit first to the 9's complement latches U23 and U29. The data is clocked into the latches by the Fractional-N Controller's divide-by-N clock output. The nine's complement data is then loaded into the divide-by-N counters each 100 Khz cycle of the Low Frequency Loop, every 10 uSec. U24, U30, and U36 function as up counters, their faster mode of operation.

Divide-By-N

General. The Divide-By-N Counters use "Prescaler Counting" to divide the Low Frequency Loop VCO's frequency to 100 kHz pulses. The VCO frequencies of 60 MHz to 110 MHz are divided-by-N.F. (N.F. refers to the possible fractional division ratios using Fractional-N technology) to output a pulse every 10 uSec. Prescaler counting does not require the use of high speed counters for direct counting. The VCO's frequency is divided-by-2 and the Prescaler divides this frequency by 11 when the 100 kHz counter is counted, and by 10 otherwise.

Remove Cycle. Figure 2 shows the output of the counters when the Signal Generator's RF output is 800.2 MHz. The frequency of the Low Frequency Loop VCO is 99.80 MHz; 49 Chip Clocks are required for the 10 uSec Low Frequency Loop cycle. The VCO frequency of 99.80 MHz divided-by-2 is 49.90 MHz. Less two 1 MHz counts for Cycle Start Synchronization, and reloading data into the Counters will give a divide number of 479 to the 100 kHz VCO Divided-By-N.F. input to the Phase Detector. The 9's complement of 479 is 520. At the completion of the Cycle Start Pulse (U19A), the first seven Chip Clocks count the 1 MHz counter from 2 to 9 . This counter is then repeatedly counted from 0 to 9, ten Chip Clocks, for the remaining Chip Clocks in a 10 uSec cycle. Four clocks from the 1 MHz counter count the 10 MHz counter from 5 to 9, and nine Chip Clocks count the 100 Khz counter from 0 to 9 once each Low frequency Loop cycle.

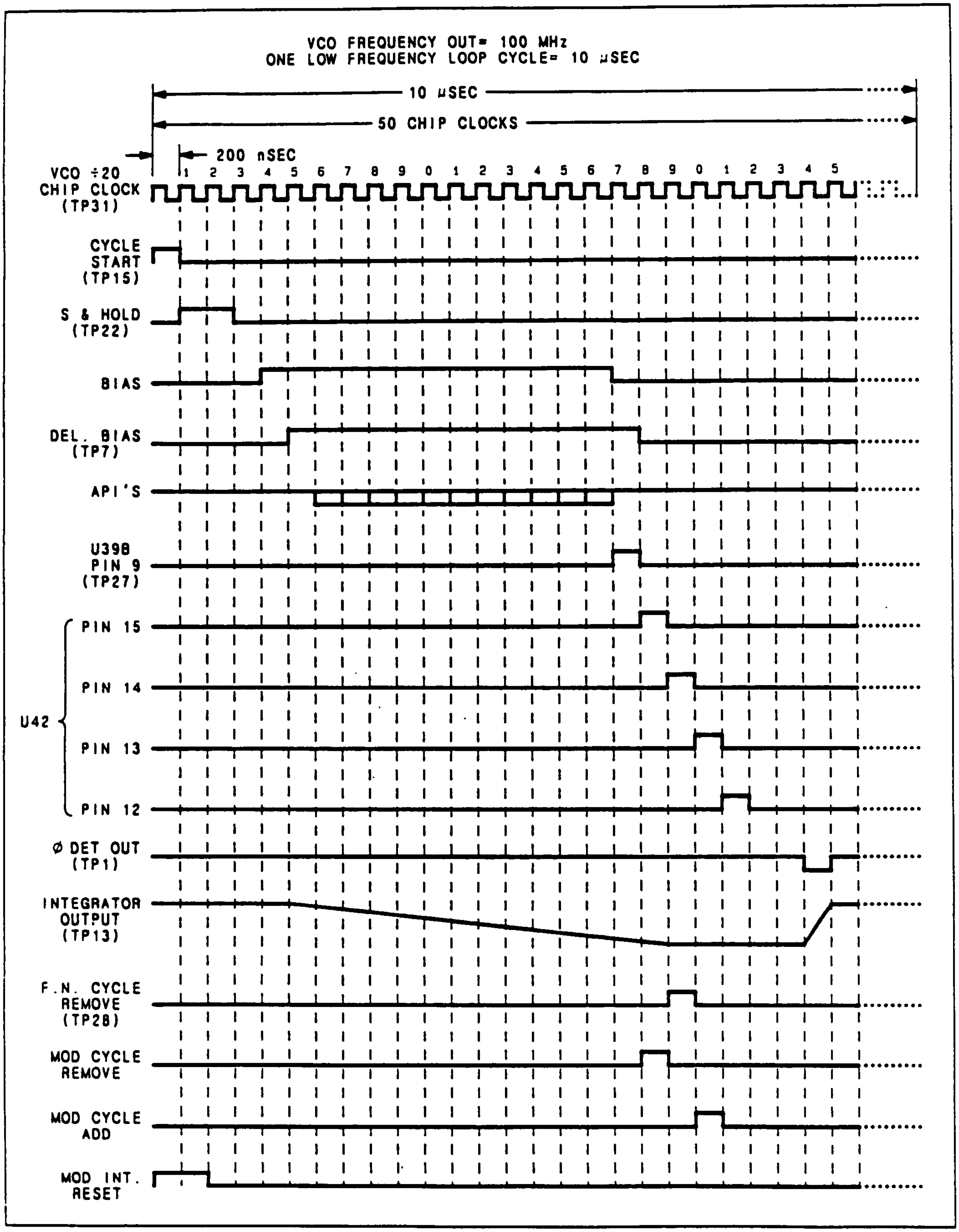


Figure 1. Low Frequency Loop Timing Diagram

SERVICE SHEET 11 (cont'd)

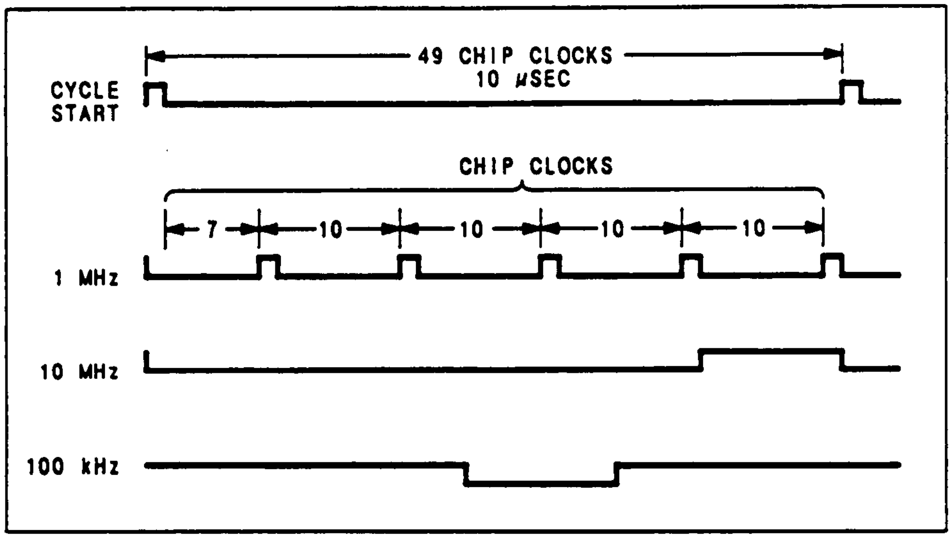


Figure 2. Counter Timing

The Chip Clock is the Low Frequency Loop VCO frequency divided-by-20 or divided-by-22. The VCO frequency is divided-by-22 when the 100 Khz counter is counting and the Prescaler's modulus is 11. The frequency of the Chip Clock is 4.990 MHz for 40 Chip Clocks and each clock is 0.2004 u Sec. The frequency of the Chip Clock is 4.536 MHz for 9 Chip clocks and each clock is 0.22044 uSec. (0.2004 uSec x 40) + (0.22044 uSec x 9) = 10 uSec.

The 9's complement data held in the Latches (9's Compliment) is loaded into the 100 Khz, 1 MHz, and 10 MHz up Counters when their load input at pin 11 is set low. When the counters are loaded their carry output at pin 12 is set low. The enable input at pin 4 of the 100 kHz counter is active low and is controlled by its carry output at pin 12. The enable input at pin 4 of the 1 MHz counter is tied low and is therefore active. The enable input, at pin 4, of the 10 MHz counter is controlled by the Ripple Count output of the 1 MHz counter at pin 13. The Chip Clock input to the counters will begin to count the 100 kHz and 1 Mhz counters up as soon as the data is loaded. At this time the 10 MHz Counter is not enabled to count. Refer to the Counter Timing diagram Figure 2. The 100 kHz Counter is enabled when its carry output is low. The carry output is set low on each cycle when the data is reloaded. The low carry output at pin 12 is connected to the enable input at pin 4. The low carry output that enables the 100 kHz Counter also is gated through the remove cycle gates of U41A, U41B, and U51A to set the Remove Cycle input to the Prescaler high. Each cycle of the Prescaler that the Remove Cycle input is high, the VCO Divided-By-2 input is divided by 11. The Chip Clock counts the 100 kHz counter up to nine. The carry output and enable input are set high, and the counter is disabled until the next Low Frequency Loop cycle. The high carry output sets the output of U41A low and the low is gated through the remove cycle gates to set the Remove Cycle input to the Prescaler low.

SERVICE SHEET 11 (cont'd)

When the 1 MHz counter, U30, is counted up to nine, its ripple count output at pin 13 goes low and the 10 MHz counter is enabled for one count. Each time the 1 MHz counter is counted up to nine, the 10 MHz counter is counted up one count. The carry output of U30, the 1 MHz counter, at pin 12 goes high for one count. The high output is one input to AND gate U18C The 1 MHz counter continues to count and the 10 MHz counter is counted up to nine. The carry output at pin 12 is high. Both inputs to AND gate U18C are high at this time and its output is high. The D input to U19A is set high and on the next Chip Clock the Q output is set high initiating the Cycle Start Pulse. The not Q output of U19A is low and the load enable input at pin 11 for the 1 MHz and the 10 MHz counters is low. The data in Latch, U23, is loaded in the 1 MHz and 10 MHz counters. The two counters are ready for the next Low Frequency Loop cycle. The carry output of the counters is set low when they are reloaded. The inputs to AND gate U18C are low and the output of U18C is returned to the low state. On the next Chip Clock, the outputs of U19A are set pin 5 low and pin 6 high terminating the Cycle Start pulse and disabling the 1 MHz and 10 MHz counters load input. The Cycle Start Synchronization circuit, U18C and U19A synchronize the Cycle Start pulse with the Chip Clock which is required for high speed operation of the counters. The synchronization takes two Chip Clocks, and the number loaded into the 1 MHz counter is two less. When the RF output frequency of the Signal Generator is 733.2 MHz, the frequency of the Low Frequency Loop VCO's frequency is 66.8 MHz. The nine's complement loaded into the latches is 685. The Low Frequency Loop VCO frequency is divided-by-2 (refer to Service Sheet 10), for a frequency of 33.4 MHz. Then 2 MHz is subtracted for Cycle Start Synchronization, 33.4 MHz - 2.0 MHz = 31.4 MHz. The nine's complement of 314 is 685.

Digital Timing Logic

The Cycle Start pulse is received by the Fractional-N Controller, and a Low Frequency Loop cycle is started. The Fractional-N Controller sends out the Sample and Hold, Bias, and API outputs as previously described. When the negative API 1 pulse is terminated, the low to high transition clocks the Edge Detector's U39A output at pin 5 high. The high output is applied to the D input of U39B. U39B's output at pin 9 is clocked high, and its output at pin 8 low by the next Chip Clock. The low output at pin 8 is applied to the Reset input of U39A at pin 1, and the output at pin 5 of U39A is reset low. The D input of U39B then goes low. On the next Chip Clock, the output at pin 9 of U39B is set low and the output at pin 8 high. The positive pulse which was generated from pin 9 of U39B is applied to the Timing Latches shift register U42 at pin 2. The pulse is clocked through the shift register, by the Chip Clock(L), to the outputs at pins 15, 14, 13, and 12. The output at pin 15 sets U43B's input pin 5 high and, enables a frequency modulation remove cycle high input at pin 4 to be gated to the Prescaler. The output at pin 14 sets U43D's input at pin 12 high, and enables a Fractional-N remove cycle high input at pin 13 to be gated to the Prescaler. The output at pin 13 sets U43C's input at pin 9 high, and enables a frequency modulation add cycle high input at pin 10 to be gated to the Prescaler. The output at pin 13 is also applied to the J input of Synchronization J/K flip-flop U47A to resynchronize the Low Frequency Loop VCO Divide-By-N.F. input to the Phase Detector. The output at pin 12 is applied to the D input of U44B. On the next Chip Clock, the high D input is clocked to the output at pin 9, and the output at pin 8 is clocked low. The output's of U44B are at this state for one cycle of the Chip Clock(L). The high output pulse from pin 9 of U44B is applied to the NOR gates U41A, and U35D to set their outputs low. The low output of U35D resets Cycle Remove Latch U38B. The low output pulse of U44B at pin 8 resets Cycle Add/Remove Latches U38A, and U44A. It also resets the Cycle Start Synchronization flip-flop U19A, and enables the load input at pin 11 of the 100 kHz counter

SERVICE SHEET 11 (cont'd)

The instructions to add or remove a cycle are latched into the Cycle Add/Remove Latches U38A, U38B and U44A. Cycles are added or removed during frequency modulation. Cycles are also removed when the Low Frequency Loop VCO is operating at a fractional frequency. The Fractional-N Controller U17 determines when a cycle is removed for fractional frequencies. The active Cycle Remove output at pin 12 clocks the Remove Cycle Latch U44A. The D input at pin 1 of U44A is tied high and is clocked to the output at pin 5. This is one input to AND gate U43D. As described above the output at pin 14 of the Shift Register U42 gates the output of U43D high which gates the output of NOR gate U41B low. The low output of U41B gates the output of U51A high and the Prescaler removes a cycle.

The High Threshold and Low Threshold inputs are activated during frequency modulation (refer to service sheet 15). The High Threshold cycle remove control is the D input at pin 12 of the Cycle Remove Latch U38B. The high D input is clocked to its output at pin 9 by the Cycle Start pulse. The output at pin 9 is one input to AND gate U43B, and is the Remove Cycle input to the FM Digital Circuits. As described above the output at pin 15 of the Shift Register U42 gates the output of U43B high which gates the output of NOR gate U41B low. The low output of U41B gates the output of U51A high and the Prescaler removes a cycle. Refer to the Timing Diagram Figure 1. The Low Threshold cycle add control is the D input at pin 2 of Cycle Add Latch U38A. The high D input is clocked to its output at pin 5 by the Cycle Start pulse. The output at pin 5 is one input to AND gate U43C, and is the Add Cycle input to the FM Digital Circuits. As described above the output at pin 13 of the Shift Register U42 gates the output of U43C high, and the Prescaler adds a cycle.

Synchronization

The Synchronization J/K flip-flop's U47A and U47B resynchronize the Low Frequency VCO Divided-By-N.F. output pulse to the Phase Detector (refer to Service Sheet 13). As described above, the output at pin 13 of Shift Register U42 is applied to the J input of J/K flip-flop U47A at pin 3. The K input is then low. The next high to low transition of Chip Clock(L) clocks the output at pin 5 high and the output at pin 6 low. The high output at pin 5 is applied to the J input of J/K flip-flop U47B at pin 11. The K input at pin 12 is then low. The high to low transition of the VCO Divide-By-2 input at pin 13 clocks the output at pin 9 high. The output at pin 5 of U47A is also its K input at pin 2. The J input was set low when the high pulse of the Shift Register U42 was clocked through the register. The next high to low transition of Chip Clock(L) clocks the output at pin 5 low and the output at pin 6 high. The next high to low transition of the VCO Divide-By-2 input clocks the output at pin 9 of U47B low. When the output at pin 9 of U47B is high, transistor Q48 is turned off. The collector is connected to ground through resistor R308 and R500 (refer to Service Sheet 13). The output of Q48 is approximately 0.0 Vdc. On the high to low transition of U47B's pin 9 output, Q48 is turned on and its output is pulsed to approximately +4 volts. The Phase Detector is clocked on the low to high transition of the output of Q48. Capacitor C312 turns transistor Q48 on and off very quickly.

SERVICE SHEET 11

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., ⟨√1⟩ . Troubleshooting is done on the LF Loop Microprocessor using Signature Analysis. The LF Loop's Microprocessor troubleshooting routines are used to check the Fractional-N Controller and the Divide-By-N Counters.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Signature Analyzer .... HP 5005A
Function Generator .... HP 3312A
Frequency Counter .... HP 5328A
Oscilloscope .... HP 1740A
Oscilloscope Probe .... HP 10040A

⟨√1⟩ Low Frequency Loop Microprocessor

Setup. Connect the signature analyzer as follows:

1) GND as close to the circuitry being probed as possible. Bad grounding can cause unstable signatures.
2) CLK to DSA CLK A3TP24
3) START to DSA S/S A3TP25
4) STOP to DSA S/S A3TP25

Set the signature analyzer's controls as follows:

1) CLK Positive Edge
2) START Positive Edge
3) STOP Negative Edge

CAUTION

The LF Loop Clock input (LCL) at pin 2 and the LF Loop Data input (LDA) at pin 9 from the A11 Assembly must be opened before A3TP17 and A3TP26 are connected to ground. Open LCL and LDA inputs by removing W16 from A11J4. The LF Loop Microprocessor U28 does not require data from the main Microprocessor to run the signature analysis checks.

SERVICE SHEET 11 (cont'd)

Set up the Signal Generator as follows:

1) Connect A3TP26 to A3TP20 (ground).
2) Connect A3TP17 to ground. Use the jumper provided.
3) Turn the Signal Generator's POWER switch to ON.

The alternate Microprocessor signatures at pins 14 and 20 to 27 check the input at pins 2, 8 to 11 and 16 to 19. When the input is low, the signature at the related pin is the alternate signature.

Probe. Connect the signature analyzer probe to each node indicated in Table 2. Verify that each signature is correct and stable.

After the signatures are taken, remove A3TP26 and A3TP17 from ground. Store the jumper between the ground pins of A3TP16-19. Turn the Signal Generator's POWER switch to STBY and then back to ON.

Table 2. Low Frequency Loop Microprocessor Signatures

Node A3U28 Pin	Normal Signature	Alternate Signature	Alternate Signature Determining Factor
#1	0000	——	
#2	7U39	0000	Pin tied low
#3	7U39	——	
#6	0000	——	
#7	7U39	——	
#8	0000	——	
#9	0000	7U39	Pin pulled high
#10	7U39	0000	Pin tied low
#11	7U39	0000	Out of lock LED on
#14	0021	0020	Pin 2 low
#15	0010	40C5	RAM error
#16	7U39	0000	Pin tied low
#17	7U39	0000	Pin tied low
#18	7U39	0000	Pin tied low
#19	7U39	0000	Pin tied low
#20	2050	2052	Pin 8 low
#21	102C	1029	Pin 9 low
#22	0816	0814	Pin 10 low
#23	0408	040A	Out of lock LED on
#24	0201	0205	Pin 16 low
#25	0106	0102	Pin 17 low
#26	0085	0081	Pin 18 low
#27	0044	0040	Pin 19 low
#28	7U39	——	

SERVICE SHEET 11 (cont'd)

J2 Fractional-N and Latches

1. Set the Signal Generator's POWER switch to STBY.

2. Connect A3TP26 to A3TP20 (ground). Connect A3TP18 to ground using the jumper provided.

3. Set the Signal Generator's POWER switch to ON.

4. The LF Loop's Microprocessor troubleshooting routine is now entered as a result of completing step 2. The 9's complement data loaded into the Divide-By-N Counters is 685, and the LF Loop VCO's frequency is set to 66.8 MHz.

5. If the LF Loop VCO's frequency is not 66.8 MHz, check the 9's complement data loaded into the 9's Complement Latches. The 9's compliment data should be as follows:

   - 100kHz DIGIT: U29 pin 2 (H), pin 7 (L), pin 10 (H), pin 15 (L)
   - 1 MHz DIGIT: U23 pin 12 (L), pin 15 (L), pin 16 (L), pin 19 (H)
   - 10 MHz DIGIT: U23 pin 2 (L), pin 5 (H), pin 6 (H), pin 9 (L)

6. Use the oscilloscope to check that the API outputs of U17 at pins 2 to 6 pulse low every 10 uSec.

7. Use the oscilloscope to check that the Bias output of U17 at pin 10 pulses low for 13 Chip Clocks every 10 uSec.

J3 Counters and Cycle Start Synchronization

1. Remove jumper A3W6 (refer to service sheet 14). The VCO TUNE voltage goes to approximately 0.0 volts.

2. Connect the frequency counter to A3TP29 (60 to 110 MHz) (refer to Service Sheet 10) and measure the VCO frequency. The VCO frequency should be 100 MHz ±7 MHz.

3. Subtract the VCO frequency from 1050 MHz and select the difference frequency as the RF output frequency of the Signal Generator to 5 significant digits, i.e. 950.73 MHz.

   - RF Output Frequency = (800 - VCO) +Notch Filter Frequency
   - The Notch Filter Frequency is 250 MHz
   - RF output Frequency = 800 - VCO + 250 = 1050 - VCO
   - The 9's complement data in the 9's Complement Latches is the data required to lock the Low Frequency Loop VCO.

SERVICE SHEET 11 (cont'd)

4. Set the Oscilloscope as follows:

   TRIGGER .... Channel B
   TIME/DIV .... 1.0 uSec
   DISPLAY .... ALT
   Channel A VOLTS/DIV 0.2
   Channel B VOLTS/DIV 0.2

5. Connect Channel B to A3TP15 (CYCLE START), and Channel A to pin 12 of each Counter A3U24, U30, and U36. Figure 2 shows the oscilloscope display for the 1 MHz, 10 MHz, and 100 kHz Counters for a VCO frequency of 99.8 MHz. With a VCO frequency of 100 MHz ±7 MHz the oscilloscope display of the Counter output is the same except for timing.

√4 Edge Detector, Timing Latches, and Synchronization

1. Remove jumper A3W6 (refer to Service Sheet 14). The VCO TUNE voltage goes to approximately 0.0 volts.

2. Timing pulse generation and clocking is checked.

3. Set the Oscilloscope as follows:

   TRIGGER .... Channel B
   TIME/DIV .... 0.2 uSec
   DISPLAY .... ALT
   Channel A VOLTS/DIV 0.1
   Channel B VOLTS/DIV 0.1

4. Connect Channel A to A3TP31 (CHIP CLOCK) (refer to Service Sheet 10), and Channel B to A3TP27 (START SHIFT). The Start Shift pulse should be present and have a pulse width of one Chip Clock.

5. With the Channel A probe, check that the pulse is clocked through the Timing Latches, U42, U44B and Synchronization flip/flop U47. The VCO divide-by-N.F. output of Q48 is a narrow pulse.

√5 Cycle Add/Remove Latches and Add/Remove Cycle Gates

1. Remove jumper A3W6 (refer to Service Sheet 14). The VCO TUNE voltage goes to approximately 0.0 volts.

2. The 100 kHz Counter remove cycle pulse is checked.

SERVICE SHEET 11 (cont'd)

3. Set the Oscilloscope as follows:

   TRIGGER .... Channel B
   TIME/DIV .... 0.2 uSec
   DISPLAY .... ALT
   Channel A VOLTS/DIV .... 0.1, DC
   Channel B VOLTS/DIV .... 0.1, DC

4. Connect Channel B to A3TP27 (START SHIFT), and check that the 100 KHz Counter remove cycle pulse is gated through U41A, U41B and U51A.

5. Set the function generator as follows:

   RANGE 1
   FUNCTION .... SQUARE WAVE
   FREQUENCY .... 10 Hz

6. Connect the function generator to the Signal Generator's MOD INPUT/ OUTPUT connector.

7. Set the Signal Generator as follows:

   Frequency .... Any
   Amplitude .... Any
   Modulation .... FM 3 kHz
   Source .... External

8. Connect Channel B to A3TP15 (CYCLE START), and check that the Add and Remove Cycle pulses are gated through U38A, U38B, U43C, U43B, U51A and U41B.

NOTE

The intensity of the oscilloscope will have to be turned up to set the Add and Remove Cycle pulses.

SERVICE SHEET 12

LOW FREQUENCY LOOP ANALOG PHASE INTERPOLATION (API), CURRENT SOURCES, CURRENT SUMMING, AND BIAS

PRINCIPLES OF OPERATION

General

The Bias pulse from the Fractional-N Controller U17 is the D input at pin 12 of D flip-flop U6B. CHIP CLOCK at pin 11 clocks the high D input of U6B to the output at pin 9, Delayed Bias. The Bias and Delayed Bias pulses remain high for 13 CHIP CLOCK pulses. The Fractional-N Controller sets its BIAS output high one Chip Clock after its Sample and Hold output was set inactive (low). The Integrator's correction voltage has been stored on the Sample and Hold capacitor. See Figure 1, the Low Frequency Loop Timing Diagram. The Integrator is reset before the next phase correction input is received from the Phase Detector. The Delayed Bias Pulse resets the Integrator by directing Bias Current to the Integrator.

BIAS CONTROL

Bias pulse off. The Bias pulse from the Fractional-N Controller is off, low. The low Delayed Bias output at pin 9 of U6B sets the base of emitter follower Q33 to approximately -1.6 volt. The emitter voltage is approximately -1.0 volt. Bias current-steering diode CR405 is turned on, and CR506 is turned off (refer to Service Sheet 13). The Bias Current is directed to the Bias Control transistor Q33.

Bias Pulse On. The Bias pulse from the Fractional-N Controller is on, high. The high Delayed Bias output at pin 9 of U6B sets the base of Q33 to approximately +3.0 volts. The emitter voltage increases to approximately +3.7 volts. Q33's increased positive emitter voltage turns Bias Current steering diodes CR405 off and CR506 on. The Bias Current is directed to the Integrator.

CURRENT ROUTING CONTROL

The base of Q28 is biased at approximately +5 Vdc from the +5 Vdc (F2) supply voltage through resistor R408. The collector of Q25 is connected to -15 Vdc (F1). The base voltage of Q18 is biased at approximately +1.2 Vdc divided from the +15 Vdc by resistors R424 and R426 to ground.

Bias Pulse Off. The Bias pulse from the Fractional-N Controller is off, low. The low Delayed Bias pulse output at pin 9 of U6B turns off Q28. The emitter voltage of Q28 is approximately +5 volts, divided from the +15 Vdc supply voltage by resistors R411 and R413. The dc bias for Q25 is divided from the -15 Vdc (F1) supply voltage by resistors R416 and R417 to ground. The base voltage of Q25 is approximately -1.9 volts. Q25 is turned on since its emitter is connected to +15 Vdc by R421. The voltage on the emitter is approximately -1.2 volts. The emitter voltage of Q25 is also the emitter voltage of Q18, and the negative emitter voltage turns Q18 off. Its collector voltage is -7.5 volts, divided from the -15 Vdc (F1) supply voltage by resistors R422 and R423 to ground. The -7.5 volts is connected to the gates of FET switches, Q15, Q16, and Q17 turning them off. With the FET switches turned off the current for the current sources of U3 is directed to Q3 and Q21 (refer to Service Sheet 15), and Q5 (refer to Service Sheet 13).

SERVICE SHEET 12 (cont'd)

Bias Pulse On. The Bias pulse from the Fractional-N Controller is on, high. The high Delayed Bias pulse output at pin 9 of U6B turns on Q28. When the Delayed Bias pulse goes high, the emitter voltage of Q28 increases to approximately +5.7 volts. Transistor Q28 is turned on and the collector voltage increases to approximately +5.7 volts. The collector voltage of Q28 is the base voltage for Q25, and is used to turn Q25 off. Q25 is turned off during the Bias pulse. With Q25 turned off its emitter voltage goes positive. The emitter voltage of Q25 is also the emitter voltage of Q18, and is used to turn Q18 on. When Q18 is turned on, its collector increases from approximately -7.5 volts to approximately +2 volts. The three FET switches, Q15, Q16, and Q17 are turned on. The current for the current sources from U3 is directed from the three API transistors, Q22, Q23, and Q24. The API transistors Q22 (API 1), Q23 (API 2), and Q24 (API 3) are turned on. When the the API transistors are turned on API current steering diodes CR400, CR401 and CR403 are turned off.

During the Bias pulse from the Fractional-N Controller the Analog Phase Interpolation (API) pulses are also active. The API pulses are controlled by the Fractional-N Controller. The API pulses control the amount of phase correction current subtracted from the Bias Current during the Bias pulse. The Bias Current resets the Integrator after the Integrator voltage has been stored on the Sample and Hold capacitor (refer to Service Sheet 13). The Integrator's voltage is dependent on the phase difference between the VCO and the reference signals. The Fractional-N Controller controls the pulse duration for each of the 5 API signals. When the Low Frequency Loop VCO is tuned to a whole number, multiple of 100 kHz, the API pulses are active for a fixed length of time during each Bias pulse. The phase of the Low Frequency Loop VCO is not changing in relation to the 100 kHz reference. The length of the API pulses change when the Phase Increment mode is selected, and the phase of the RF output is incremented.

When the Low Frequency VCO is operating at a fractional frequency, the length of time each API pulse is active varies from one cycle to the next cycle. The Low Frequency Loop VCO is not tuned to a whole number multiple of 100 kHz. The API pulses when viewed with an oscilloscope are not nice and steady, but are changing each cycle. The phase between the Low Frequency Loop VCO divided-by-N.F. and the 100 kHz reference is continually changing. When the phase difference between the 100 kHz reference, and the VCO divided-by-N.F. signals changes by 360 degrees, a cycle is removed by the Prescaler. The Fractional-N Controller measures the phase difference between the VCO divided-by-N.F. and the reference signals, and it controls the Prescaler. Each time a cycle is removed by the Prescaler, the phase difference between the VCO and reference returns to the same nominal offset.

The API pulses compensate for the Fractional-N phase changes between the Low Frequency Loop VCO and the reference. When the Bias pulse is high, the Integrator is reset. API current is subtracted from the Bias Current. The API pulses are active low and the Integrator's output voltage is offset. The Integrator's output voltage is offset to compensate for the Phase Detector's output that results from the fractional frequency phase difference between the VCO Divided-By-N.F., and the 100 kHz reference.

When transistor Q22 is turned off by the API 1 pulse, the API 1 current steering diode CR400 is turned on. API 1 current to Current Buffer Q7 and part of Current Source U3 is summed with the Bias Current at Current Summing Amplifier U7. The two currents are summed together for the length of time the API 1 pulse is active. Q22 is turned on, turning off CR400 and steering the API 1 current through Q22.

SERVICE SHEET 12 (cont'd)

The API pulses are active low and are controlled by the Fractional-N Controller. The D input to U6A, part of the API Digital Control circuits, is high when API 1 is not active. The high D input is clocked to the output at pin 5 by the Chip Clock. The +15 Vdc is divided by R405 and R409 to the +5 V at U6A pin 5. The base of Q22 is approximately +6 volts. Its emitter voltage is approximately +5.4 volts. Q22 is turned on, and CR400 is turned off since the anode of CR400 is connected to the virtual +5 Vdc summing node through resistor network of R435, R439, and R415A and B. A low API 1 pulsed input at pin 2 of U6A is clocked to the output at pin 5. The +15 Vdc is divided to approximately 0 V at pin 5 by R405 and R409. The base of Q22 is approximately +3 volts, and the emitter voltage wants to decrease to turn on Q22. But when its voltage gets to approximately +4.4 V CR400 is turned on. Q22 is turned off until the API 1 pulse returns high. Transistors Q23 and Q24 operate the same for API 2 and 3 currents. The amount of the API currents is precisely controlled by the current sources, by the adjustments, and by resistor R415.

The four Current Sources of U3, and the three Current Buffers Q7, Q8 and Q9 are always turned on. The base of all transistors in U3 are biased at -8.2 Vdc, and are controlled by the 6.2 volt Zener diode VR401, and the diode voltage drop of CR404. Their emitter voltages are then -8.8 Vdc. Each Current Source produces a precise amount of current determined by the voltage drop of each emitter resistor (1.15K for 5.4 mA, 2.3K for 2.7 mA, and 12.1K for 0.5 mA). When API 1 is active, the 5.4 mA of the Current Source is divided by resistors R435, R439, and R415A and B. The current summed with the Bias Current is approximately 54 uA. The actual value of the current is adjusted by R439 for minimum API 1 spurs. When API 2 is active, the 2.7 mA of the Current Source is divided by resistors R432, and R415C and F. The current summed with the Bias Current is approximately 5.4 uA. The actual value of the current is adjusted by R432 for minimum API 2 spurs. When API 3 is active the 2.7 mA of the Current Source is divided by resistors R452, R51, and R415D and E. The current summed with the Bias Current is approximately 0.54 uA. The actual value of the current is adjusted by R452 for minimum API 3 spurs. When API 4 is active, the low output of U8 at pin 7 causes a current to flow from the +5 Vdc to the low at pin 7. The current is divided by resistors R429, R414, and R406. The current summed with the Bias Current is approximately 50 nA. The actual value of the API 4 current is adjusted by R414 for minimum API 4 spurs. When API 5 is active, the low output of U8 at pin 10 causes a current to flow from the +5 Vdc to the low at pin 10. The current is divided by resistors R436, and R441. The current summed with the Bias Current is approximately 5.0 nA. The API 5 current is not adjustable.

The API currents are summed with the Bias Current at the Current Summing Amplifier U7. The currents are summed into the virtual +5 Vdc node at pin 2 of U7, and all of the current flows through FET Q26 to the Integrator. This all occurs during the Bias pulse. The length of time that the Bias pulse is active varies depending upon the Low Frequency Loop's VCO's frequency, 60 to 110 MHz. After 12 Chip Clocks the API pulses are all turned off, and at the completion of the 13th Chip Clock the Bias pulse is turned off. The Integrator is reset and ready for the next input from the Phase Detector. When the Bias pulse is turned off, the Delayed Bias pulse at pin 9 of U6B also goes low. Q33 is turned on, CR405 is turned on, and CR506 is turned off. The Bias Current flows through Q33. The FET switches Q15, Q16, and Q17 are turned off by the -7.5 volts at the collector of Q18.

A Bias Current of 0.5 mA is continually provided by Q27, and is controlled by the 0.5 mA from the Current Source U3 and Q14. Transistor Q14 senses variations in the +5 Vdc summing node and compensates for the variations. The +5 Vdc of the summing node must be kept constant to prevent spurs on the RF output of the Signal Generator.

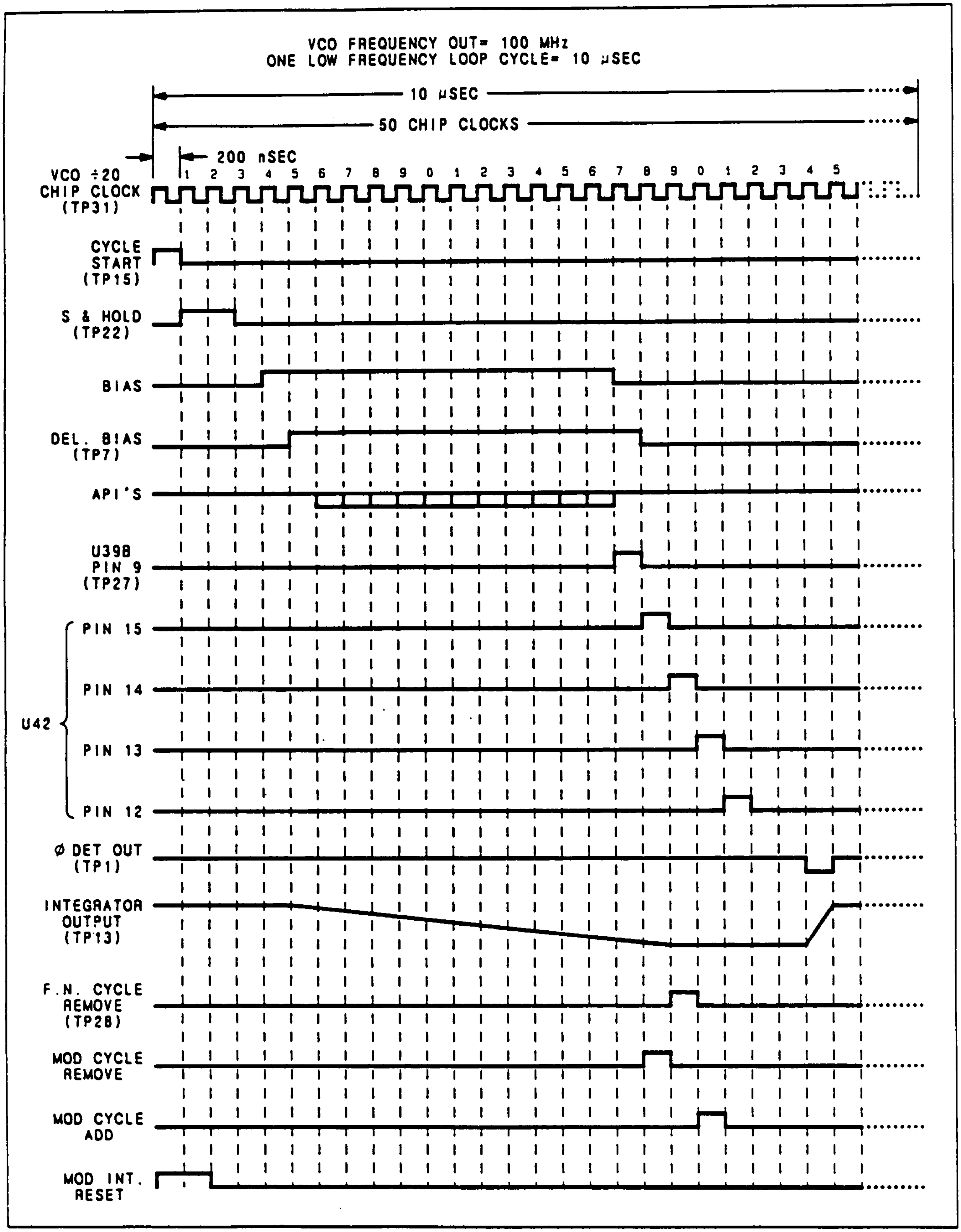


Figure 1. Low Frequency Loop Timing Diagram

SERVICE SHEET 12

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1 . Transistor bias voltages are shown without tolerances. If the Low Frequency Loop does not lock, circuit problems could be in the Bias Control, in the Current Routing Control, in the Current Sources, in the API 1 current or in the Bias Current. If spurious signals (spurs) are high, the problem could be in the Current Routing of API Currents or in the API Current Sources.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A
Oscilloscope Probe .... HP 10040A

√1 Bias Control and P/O Current Routing Control

1. Check the Bias pulse at pin 12 of U6B, and the Delayed Bias pulse at pin 9. The pulses are at TTL levels and 13 Chip Clocks long. If the Low Frequency Loop is not locked, and the pulses are still 13 Chip Clocks long, but the pulse width changes as the frequency of the Chip Clock changes, refer to Figure 1 and continue with check 1.

2. The pulse at TP10 (BIAS SW) is a TTL high during the Bias pulse, and should be the same pulse width as the Bias pulse. Bias Current steering diode CR405 is turned off.

3. The pulse at TP7 (DELAYED BIAS) is approximately 0 V during the Bias pulse, and approximately -7.5 V when the Bias pulse is off.

4. Transistor Q28 is on, Q25 is off, and Q18 is on during the Bias pulse.

√2 API Digital Control and P/O Current Routing Control

1. Enter a frequency of 100 MHz from the Keyboard. The Low Frequency Loop does not have to be locked.

2. Check the low API pulses at the outputs of U6A and U8. The pulses are at TTL levels and 12 Chip Clocks long. If the loop is not locked, the pulses are still 12 Chip Clocks long but vary as the frequency of the Chip Clock changes.

3. Check that transistors Q22, Q23, and Q24 are turned off and API current steering diodes CR400, CR401, and CR403 are turned on when their API pulses are active low.

SERVICE SHEET 12 (cont'd)

√3 Current Sources and Current Dividers

1. Enter a frequency of 100 MHz from the Keyboard.
2. Measure the dc voltages for the Current Sources and the Current Buffers.
3. Measure the voltage drop across the Current Source's emitter resistors and calculate the current through the resistors.
4. Measure for a voltage drop across resistors R415A, B, C, D, E, F, when the API pulses are active low.

√4 Current Summing and Bias

1. Measure the dc voltages of Q14, Q27, and Q26.
2. Measure the reference voltage +5 V(Ref).

SERVICE SHEET 13

LOW FREQUENCY LOOP PHASE DETECTOR, INTEGRATOR, AND SAMPLE AND HOLD

PRINCIPLES OF OPERATION

General

The Phase Detector determines the phase difference between the VCO Divide-By-N.F., and reference inputs. The VCO Divide-By-N.F. input pulse is the Low Frequency Loop VCO's frequency divided by an integer (N.), and a fractional part (F.) for fractional frequencies (refer to BD3). The Phase Detector's output pulse width is proportional to the phase difference between the VCO Divide-By-N.F., and the reference inputs. The pulse width determines the length of time current is supplied by the Integrator to ramp its output voltage up. The Sample and Hold circuits stores the Integrator's output voltage on the Sample and Hold Capacitor. The voltage stored on the Sample and Hold Capacitor is the tune voltage for the Low Frequency Loop VCO.

Phase Comparator

The Phase Comparator determines the phase difference between the VCO Divide-By-N.F. input and the Reference input. The pulse width of the Phase Detector output represents the phase difference between the two input signals. The phase of the VCO Divide-By-N.F. leads the phase of the reference when the loop is locked. The clock enable inputs at pins 6 and 11 of ECL Master-Slave Dual D flip-flop U1A and U1B are dc biased just below the ECL low threshold, <3.3 V, by dividing the +5 Vdc. The +5 Vdc is divided by resistors R502 and R504 for U1A, and resistors R503 and R505 for U1B. The common clock input at pin 4 of U1A and pin 9 of U1B are both held low by internal pull-down resistors. With the common clock inputs low, U1A and U1B are clocked on the low to high transition of the clock enable inputs at pin 6 of U1A and pin 11 of U1B. The logic levels at each D input is clocked to the Q open emitter outputs. The Low Frequency Loop VCO's output frequency is divided to narrow pulses at a 100 kHz rate. Resistor R500 is an approximate 50 ohm termination for the VCO Divide-By-N.F. input pulses, and capacitor C500 ac couples the pulses to the clock enable input at pin 6 of U1A. U1A is clocked on the low to high transition, and when high resets U1B. The set input at pin 12 of U1B, and the reset input at pin 4 of U1A are held low by internal pull-down resistors. Resistor R501 is an approximate 50 ohm termination for the 100 kHz Reference input, and capacitor C501 ac couples the Reference to the clock enable input at pin 11. The Reference input clocks U1B on the low to high transition, and when high it sets U1A.

VCO Divide-By-N.F. Leads Reference

The VCO Divided-By-N.F. input pulses at a 100 kHz rate leads the 100 kHz Reference input in normal operation. When the Low Frequency Loop is locked and the VCO's frequency is 100 MHz, the 100 kHz pulses lead the Reference pulses by approximately 8 degrees, 0.22 uSec. When the VCO's frequency is 60 MHz, the VCO Divide-By-N.F. pulses leads the Reference pulses by approximately 13 degrees, 0.37 uSec.

SERVICE SHEET 13 (cont'd)

When the VCO Divide-By-N.F. input leads the Reference input, normal operation, the VCO Divide-By-N.F. input at pin 6 clocks U1A on the low to high transition. When high, the VCO Divide-By-N.F. pulse resets U1B. When U1B is reset the output at pin 15 is low, and the output at pin 14 is high. The low D input at pin 7 of U1A is then clocked to the output at pin 2 and is applied to the D input at pin 10 of U1B. The Reference pulse at pin 11 of U1B clocks the low D input of U1B to the output at pin 15 and sets U1A. The output at pin 2 of U1A is set high and the output at pin 3 is set low. The next VCO Divide-By-N.F. input pulse clocks the low D input of U1A to the output at pin 2, and resets the output at pin 15 of U1B low. Therefore, the output at pin 15 of U1B is always low when the VCO Divide-By-N.F. input leads the Reference input. Refer to the Timing VCO Divide-By-N.F. Leads Reference Figure 1.

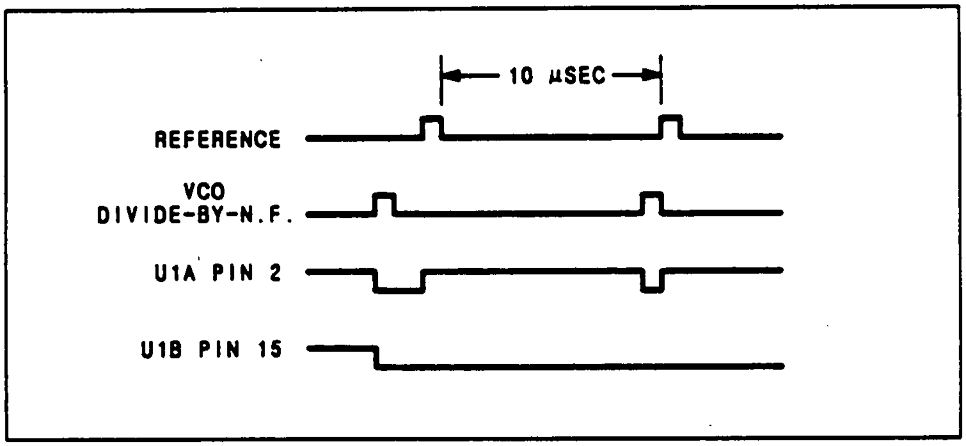


Figure 1. Timing VCO Divide-By-N.F. Leads Reference

The low output at pin 15, and the high output at pin 14 of U1B is the bias voltage for differential switch transistors Q1 and Q2. The low output at pin 15 turns Q1 on, and the high output at pin 14 turns Q2 off. CR503 is turned on, and CR505 is turned off. The diodes remain in this condition unless the Reference input pulse leads the VCO Divide-By-N.F. pulse.

The VCO Divide-By-N.F. pulse clocks the low D input to the output at pin 2 of U1A, and the output at pin 3 of U1A high. The low output at pin 2, and the high output at pin 3 of U1A is the base voltage for differential switch Q12 and Q4. The low output at pin 12 turns Q12 on, and the high output at pin 3 turns Q4 off. With no current through Q4, the bias voltage on the base of Q5 is approximately -0.4 volts and the emitter voltage is then approximately -1.0 volts. The -1.0 volts turns CR502 off, and turns CR504 on. The anode voltage of CR504 is approximately 0.0 V. When the Bias pulse and API pulses are inactive (refer to Service Sheet 12), the 5.4 mA's of API 1 current is directed from the node between diodes CR502 and CR504. With CR504 on, the Integrator supplies current for the API 1 current source. The Integrator's output voltage is ramped to a voltage dependent upon the phase error between the VCO Divide-By-N.F. input and the Reference input. The Reference pulse sets U1A's output at pin 2 high and the output at pin 3 low. Transistor Q12 is turned off, and Q4 is turned on. The current through Q4 biases the base of Q5 at approximately +1.0 volts, and the emitter voltage is approximately +1.0 volts. The +1.0 volts turns on CR502, and API 1 current is then supplied by Q5. When CR502 is turned on, CR504 can not be turned on. Refer to the Low Frequency Loop Timing Diagram Figure 7.

SERVICE SHEET 13 (cont'd)

Reference Leads VCO Divide-By-N.F.

The VCO Divided-By-N.F. input pulses at a 100 kHz rate leads the 100 kHz Reference input pulses in normal operation. If the Reference pulses leads the VCO Divide-By-N.F. pulses, the speed up circuit of Q1 and Q2 will tune the VCO until the VCO Divide-By-N.F. input leads the Reference input. When the Reference input leads the VCO Divide-By-N.F. input, the Reference clocks U1B on the low to high transition and when high it sets U1A. The high D input at pin 10 of U1B is clocked to the output at pin 15, and the output at pin 2 of U1A is set high. The VCO Divide-By-N.F. input will clock the high D input of U1A to the output at pin 2, and will reset U1B. The output at pin 15 of U1B is then reset low. The next Reference input clocks the high D input of U1B to the output at pin 15, and set the output at pin 2 of U1A high. Therefore, the output at pin 2 of U1A remains high as long as the Reference input leads the VCO Divide-By-N.F. input. Refer to Figure 2.

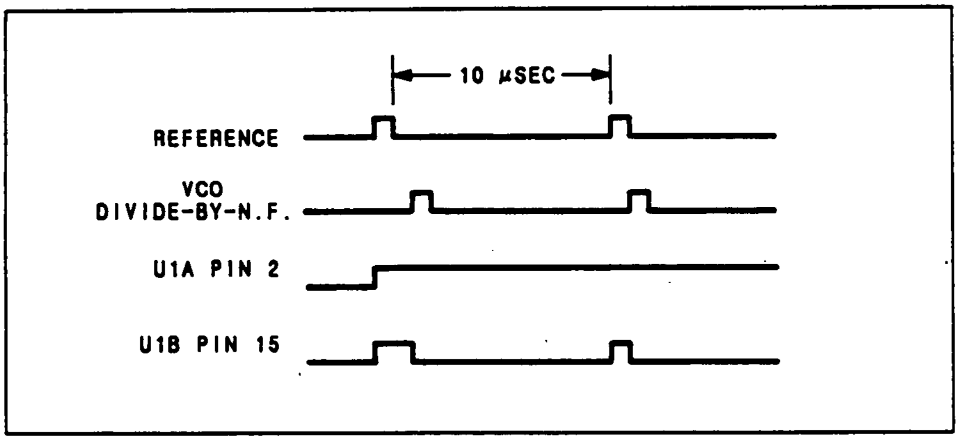


Figure 2. Timing Reference Leads VCO Divide-By-N.F.

The speed up circuit consists of differential switch Q1 and Q2, and diodes CR503 and CR505. The speed up circuit tunes the frequency of the VCO quickly until the VCO Divide-By-N.F. input to the Phase Comparator leads the Reference. The high output at pin 15, and low output at pin 14 of U1B is the base voltage for the differential switch. The Reference input clocks the output at pin 15 high, and the output at pin 14 low. The high output at pin 15 turns Q1 off, and the low output at pin 14 turns Q2 on. The collector voltage of Q2 rises above 0.0 V. CR503 is turned off, and CR505 is turned on. Current is directed through CR505 to the Integrator and the VCO's frequency is increased. The VCO Divide-By-N.F. input resets the output at pin 15 of U1B low, and the output at pin 14 high. Q1 is turned on and Q2 is turned off. With no current through Q2, CR503 is turned on and CR505 is reverse biased at approximately 0.5 V. The speed up circuit is active (on) until the VCO Divide-By-N.F. input leads the Reference input.

The high output at pin 2, and low output at pin 3 of U1A is the base voltage for the differential switch, transistors Q12 and Q4. The output at pin 2 remains high, and Q12 is off and Q4 is on. The current through Q4 biases the base of Q5 at approximately +2.0 V, and the emitter is biased at approximately +1.0 V. The +1.0 V turns CR502 on to supply current to the API 1 current source. When CR502 is turned on, CR504 can not be turned on. All current going to the Integrator is from the speed up circuit.

SERVICE SHEET 13 (cont'd)

This condition exists until the VCO Divide-By-N.F. input leads the Reference input, and lasts for a number of milliseconds. The number of milliseconds is dependent upon the amount the VCO frequency is changed.

Unlock Detection Comparators

The Low Frequency Loop Unlock Detection Comparators, U9A and U9B, detect when the loop is unlocked, light the unlock LED, and sends an Out Of Lock (L) input to the Low Frequency Loop Microprocessor. The positive input at pin 4 of U9A is fixed at approximately -0.3 Vdc divided from -15 Vdc by resistors R525 and R527. The negative input at pin 10 of U9B is fixed at approximately +0.87 Vdc divided from +5 Vdc by resistors R524 and R526. Resistor R521 and capacitor C504 average the voltage at the collector of Q2 to detect an out of lock condition. Resistor R523 and capacitor C507 average the voltage at the emitter of Q5 to detect an out of lock condition. When the loop is unlocked, either the negative input at pin 5 of U9A can go positive or the positive input of U9B can go negative switching their output low detecting an out of lock condition. The comparator's output that is switched low is dependent upon which input is leading. If the Reference input pulse is leading the VCO Divide-By-N.F. input pulse, comparator U9A is switched. If the VCO Divide-By-N.F. pulse is leading, the Reference pulse U9B is switched. The negative input of U9A is approximately -0.5 V when the loop is locked and changes to approximately +0.6 when the loop is unlocked. The Reference leads the VCO Divide-By-N.F.. The positive input at pin 9 of U9B is approximately +1.0 V when the loop is locked and changes to approximately -1.0 V when the loop is unlocked. The VCO Divide-By-N.F. leads the Reference. In either case, the LED is turned on, and the Out Of Lock (L) input to the Microprocessor is low.

Integrator

The Integrator is a wide bandwidth fast settling Operational Amplifier and consists of dual FET U32, transistors Q29, Q30, and Q31. The Integrator's output voltage is determined by parallel capacitors C508 and C509, and the input current. There are two current inputs to the Integrator, Bias Current and Phase Detector controlled API 1 Current. After the Integrator's output voltage has been sampled by the Sample and Hold Circuits, Bias Current ramps the Integrator's output voltage down to reset the Integrator. The Phase Detector's output pulse controls the length of time API 1 Current is supplied by the Integrator. The Integrator's output voltage is ramped up to a voltage dependent on the pulse width of the Phase Detector's output. The pulse width is determined by the phase difference between the VCO Divide-By-N.F. and the input pulses.

FET Q32, is a common source, unity gain, high input impedance Buffer Amplifier for the Differential Pair Q31C and Q31D. The gate at pin 3 of the dual FET Q32, is connected to ground, and the gate at pin 6 is fixed at approximately 0.0 V by feedback around the operational amplifier. The sources at pins 4 and 1 are biased slightly above ground by approximately 1 mA of current through resistors R529, R540, and the FET's. The bias voltage for the dual FET sources is also the base voltage for the Differential Pair Q31C and Q31D, and sets their bias conditions. Current through Q31C and Q31D is approximately 4 mA each. The input at pin 6 of Q32 appears amplified and inverted at the collector of Q31C and drives the emitter of Q30 like a common base amplifier. The input also appears amplified but not inverted at the collector of Q31D, and drives the base of Q30 like a common emitter amplifier. Driving both the emitter and the base increases the dc gain of the stage. Bias for Q30 is set by the collector currents of Q31C and Q31D. Transistor Q29, is an active load and current source for Q30. Q29 has a high output impedance so the load that Q30 sees is primarily the input impedance of the Darlington dual

SERVICE SHEET 13 (cont'd)

emitter follower output stage Q31A and Q31B. Transistor Q30 supplies most of the voltage gain of the amplifier. At higher frequencies the gain is reduced by capacitor C513 shunting part of the signal to ground. Additional compensation is provided by capacitor C510 which shunts high frequency signals on the collector of Q31D (base of Q30) to ac ground. Although Q30 is driven as a common emitter and common base amplifier, at higher frequencies Q30 functions only as a common base amplifier with all of its input at the emitter. Emitter follower Q31A is biased by approximately 3 mA of current through resistor R559. Emitter follower Q31B is biased by approximately 6 mA of current 1 mA through resistor R556 and 5 mA to the Sample and Hold Circuit. The output impedance of an emitter follower can look inductive and cause ringing when driving capacitive loads. To correct for this condition, RC networks of R557, C516 and R565, C518, connected to the output of the emitter followers Q31A and Q31B, makes their output impedance look resistive at high frequencies.

Frequency Compensation RC Circuit of resistor R534 and capacitor C511 add Integrator gain at low frequencies and improves the stability of the phase lock loop.

Sample and Hold

The Sample and Hold Circuit is activated by the Sample and Hold pulse, active high for two Chip Clocks, from the Low Frequency Loop Fractional-N Controller. (Refer to Service Sheet 11, and the Timing Diagram Figure 7.) At the termination of the Phase Detector pulse, the Integrator's output voltage is representative of the phase difference between the VCO Divide-By-N.F., and the Reference input pulses to the Phase Detector. The first two Chip Clocks of each cycle, activates the Sample and Hold Circuit, and the Integrator's voltage is stored on the Sample and Hold capacitor C519. The VCO is then phase locked to the correct frequency.

The TTL high (>+2.0 volts) Sample and Hold Pulse from the Fractional N Controller, turns Q44 off. Its base voltage is changed from approximately -0.6 volts to approximately +1.5 volts. When transistor Q44 is turned off, transistors Q40 and Q41 are also turned off. When transistors Q40 and Q41 are off, the two FET switches Q34 and Q37 are closed (turned on). The Integrator's output voltage is then applied to capacitor C512 and to the Sample and Hold Capacitor C519. The capacitors then charge to the output voltage of the Integrator. Transistor Q43 is turned on when transistor Q44 is turned off. Q43's base voltage changes from 0.0 volts to approximately +0.3 volts. When transistor Q43 is on, transistor Q39 and Q42 are also turned on.

When the Sample and Hold pulse is terminated, the base of transistor Q44 changes from approximately +1.5 volts to approximately -0.6 volts. Q44 is turned on. The base voltage of transistors Q40 and Q41 is less negative, and they are turned on. When Q40 and Q41 are turned on, the gate of FET switches Q34 and Q37 is 8 volts to 10 volts below their source voltage. The FET switches are opened (turned off). The Integrator's output voltage at this time is not sampled. Transistor Q43 is turned off when transistor Q44 is turned on. Q43's base voltage changes from approximately +0.3 volts to 0.0 volts. When transistor Q43 is off, transistors Q39 and Q42 are also turned off. One transistor of each differential pair, Q39 and Q40, Q41 and Q42, Q43 and Q44, is on while the other transistor is off. With one transistor of the differential pairs always on, there is a constant current through their emitter resistors R542, R560, R544, and a constant voltage on their emitters.

SERVICE SHEET 13 (cont'd)

Capacitor C517 reduces a spur caused by the gate to drain capacitance of FET switch Q37. The gate to drain capacitance of Q37 provides an ac path to the Sample and Hold Capacitor C519 each time FET switch Q37 is closed.

The gate voltage is changed at the start of each Sample and Hold pulse, and FET switch Q37 is closed. Differential pair Q41 and Q42 are always in opposite states of on and off. Capacitor C517 provides an ac path to the Sample and Hold Capacitor and an equal but opposite polarity pulse is applied to C519. Resistor R562 is adjusted so that the pulses are equal, and since they are opposite in polarity the pulses cancel. The adjustment of R562 determines the voltage at the collector of Q42 and the amplitude of the pulse.

FET switches Q34 and Q37 must be biased when they are switched on during the Sample and Hold cycle. They are biased where Vgs is just below 0.0 volts. The output voltage of the Integrator is at the correct level to bias Q34, and the Sample and Hold voltage on C519 is at the correct level to bias Q37. When the Low Frequency Loop is locked, the two voltages are equal. The Integrator's voltage is connected to the gate of Q34 by resistor R541, and the Integrator's cycle is shown by the waveform at TP 11. Figures 3 and 4 show the waveform at TP11 and TP12 with the Low Frequency Loop locked and a Signal Generator RF output frequency of 950 MHz. In Figures 5 and 6, the Signal Generator's RF output is 990 MHz. The voltage level shifts as the VCO's TUNE VOLTAGE is changed to tune its frequency 100 MHz to 60 MHz.

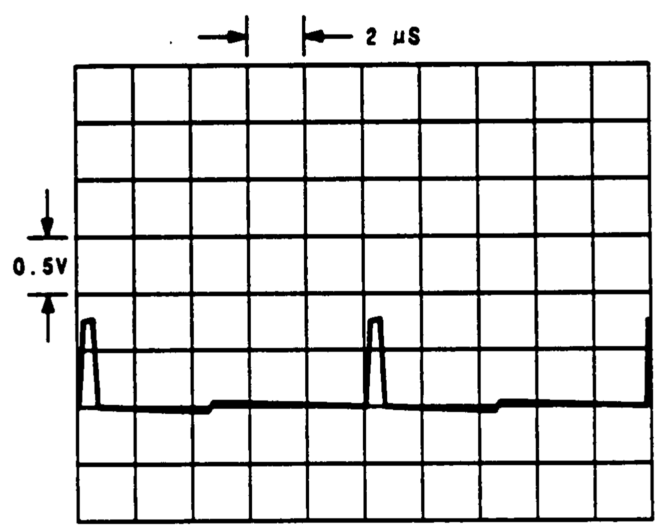


Figure 3. Oscilloscope Display of TP11 (dc coupled), W3 in W3A position, Low Frequency Loop locked, Signal Generator's frequency 950 MHz.

SERVICE SHEET 13 (cont'd)

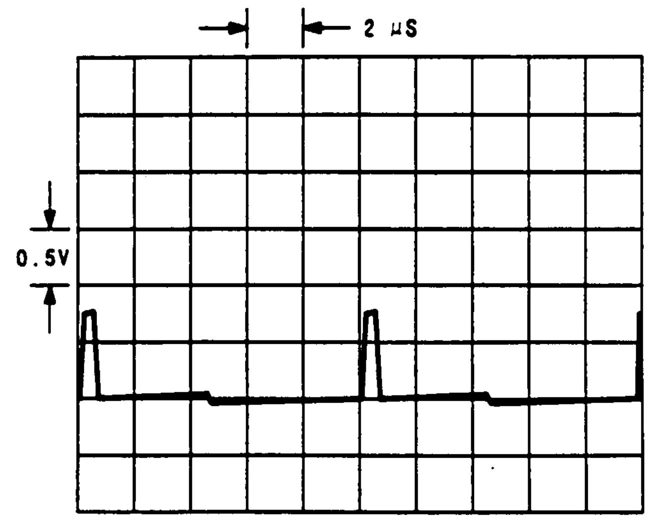


Figure 4. Oscilloscope Display of TP12 (dc coupled), W3 in W3A position, Low Frequency Loop locked, Signal Generator's frequency 950 MHz.

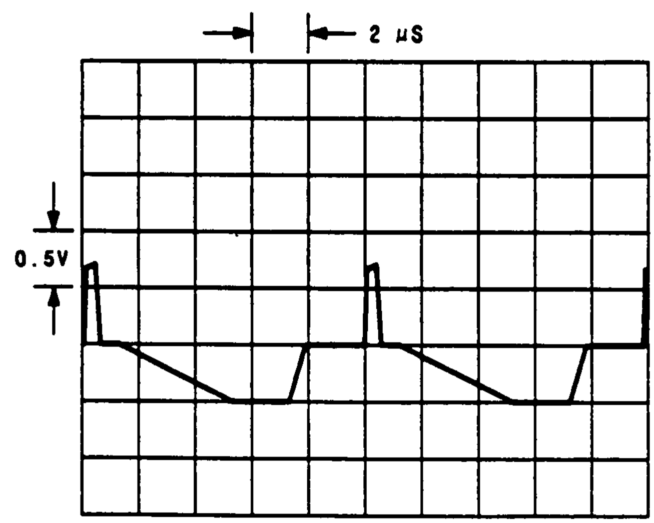


Figure 5. Oscilloscope Display of TP11 (dc coupled), W3 in W3A position, Low Frequency Loop locked, Signal Generator's frequency 990 MHz.

SERVICE SHEET 13 (cont'd)

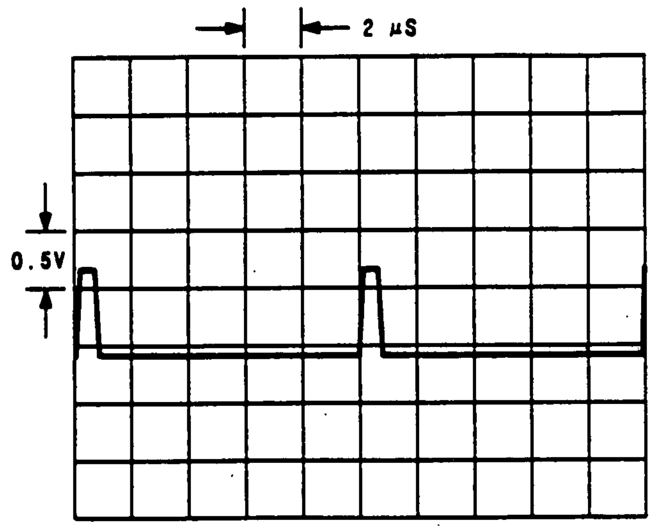


Figure 6. Oscilloscope Display of TP12 (dc coupled), W3 in W3A position, Low Frequency Loop locked, Signal Generator's frequency 990 MHz.

To apply the Sample and Hold voltage to the gate of Q37 is more difficult. By connecting the source of Q37 to the collector resistors of Q41 and Q42 the Sample and Hold voltage would be connected to the gate of Q37. However, one transistor of the differential pair Q41 and Q42 is always on and the Sample and Hold Capacitor C519 would be quickly discharged through either Q41 or Q42. The voltage on the Sample and Hold Capacitor must be constant between samples so that the VCO frequency does not change. To prevent the voltage on C519 from changing, C519 is connected to a unity gain high input impedance Buffer Amplifier U21. The output of the Buffer Amplifier is connected through transistor Q38 back to the collector resistors of Q41 and Q42. The Sample and Hold voltage biases the gate of Q37 during the Sample and Hold pulse, and will not discharge the Sample and Hold Capacitor C519. Transistor Q38 reduces the amount of current U21 must supply. The output of U21 is also the TUNE VOLTAGE for the Low Frequency Loop VCO, and the Pedestal adjustment is adjusted for a continuous Sample and Hold voltage.

Two FET switches Q34 and Q37 are used to reduce feedthrough of the Integrator's voltage when the FET switches are off. With the FETs turned off there is still approximately 1 to 2 pF of source to drain capacitance. The FET's source to drain capacitance form an ac voltage divider with capacitors C512 and C519 isolating the Integrator's changing voltage during the time of each cycle that the Sample and Hold operation is turned off. If the feedthrough was not reduced, there would be high 100 kHz and API spurs.

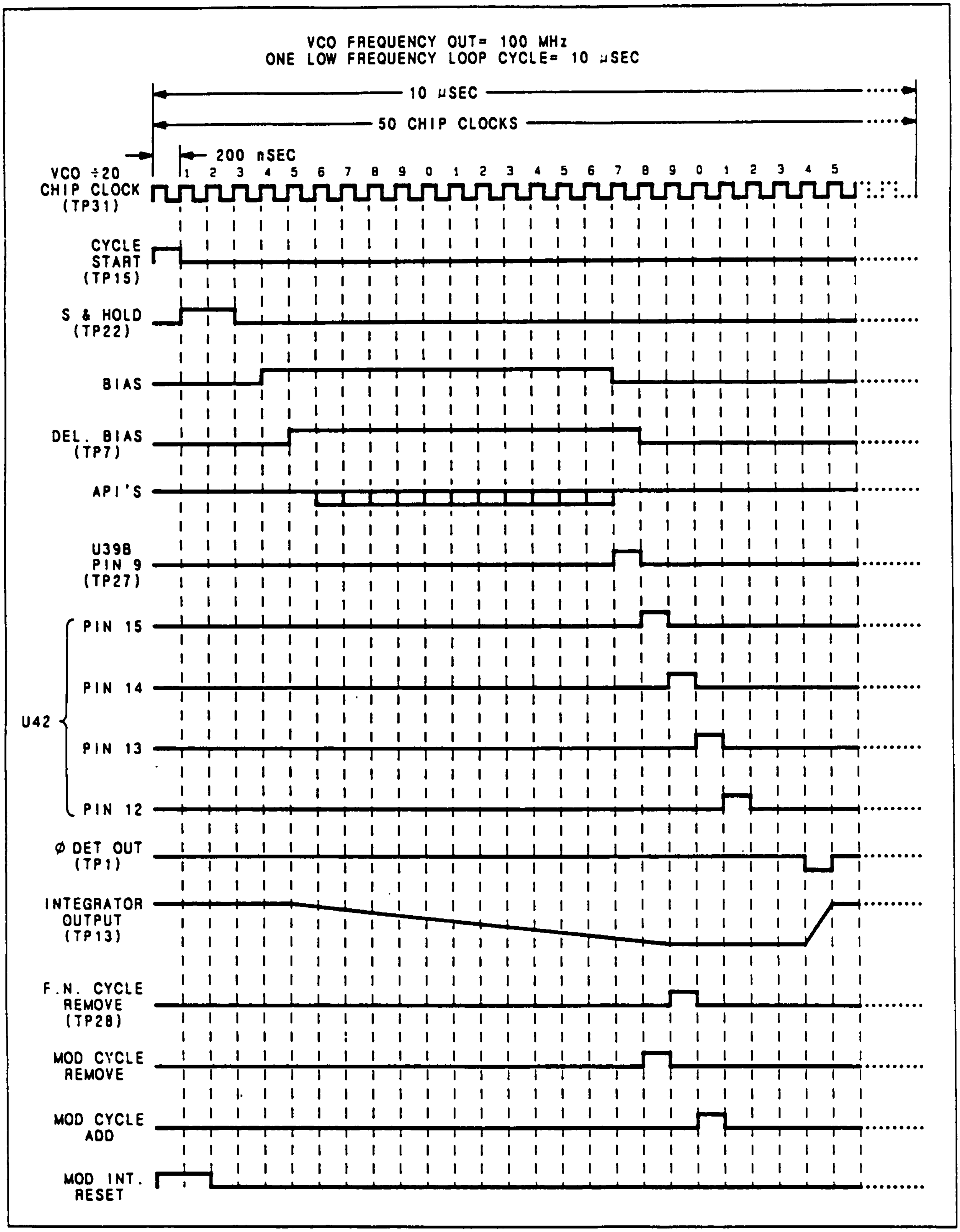


Figure 7. Low Frequency Loop Timing Diagram

SERVICE SHEET 13

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √1. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A
Frequency Counter .... HP 5328A
Function Generator .... HP 3311A

√1 Phase Detector, Integrator, Sample and Hold

1. The Phase Detector, Integrator, and Sample and Hold circuits are checked for proper operation with the Low Frequency Loop unlocked.

2. Remove jumper A3W6 (refer to Service Sheet 14). The TUNE VOLTAGE input to the Low Frequency Loop VCO at feedthrough capacitor C100 goes to approximately 0.0 V (refer to Service Sheet 9).

3. Set the RF output frequency of the Signal Generator to 950.00 MHz.

4. Check for the VCO Divide-By-N.F., and the 100 kHz Reference pulses at pin 6 and pin 11 of U1. The pulses are ECL logic, appear every 10 μSec, and are narrow. They must be present for the Phase Detector to work.

5. Set the Signal Generator's frequency increment to 10 MHz.

6. Set the Oscilloscope as follows:

   TRIGGER .... Channel A
   TIME/DIV .... 1.0 uSec
   DISPLAY .... Channel A
   Channel A VOLTS/DIV .... 0.5, dc

7. Connect Channel A to TP23. If the voltage displayed on the oscilloscope is +10 volts, increment the Signal Generator's frequency DOWN 10 MHz. The voltage on the oscilloscope should change to −10 volts. If the voltage displayed is −10 volts increment the frequency up and voltage should change to +10 volts.

8. The voltage on the oscilloscope should change from +10 volts to −10 volts as the frequency is incremented UP and DOWN 10 MHz. The Phase Detector, integrator and Sample and Hold circuits are all working correctly. The +10 volts to −10 volts is the maximum swing of the Integrator.

SERVICE SHEET 13 (cont'd)

⟨√2⟩ Phase Detector

1. With the Low Frequency Loop VCO and Signal Generator set-up the same as for steps 2 through 3 of ⟨√1⟩, the Phase Detector is checked.

2. Increment the frequency UP 10 MHz. The VCO Divide-By-N.F. input is leading the Reference input.

3. Set the Oscilloscope as follows:

   TRIGGER .... Channel A
   TIME/DIV .... 10 uSec
   DISPLAY .... Channel A
   Channel A VOLTS/DIV .... 0.05, dc

4. Connect Channel A to TP1 (PHASE DET). The pulses at TP1 should be from +1 volt to -1 volt and are unstable since the loop is not locked.

5. If the pulses are not present at TP1, check that the output of U1A is changing between ECL high and low.

6. Check that the base of Q4, and Q12 is being pulsed from approximately +3 volts to approximately +4 volts. Check that the base of Q5 is being pulsed from approximately -0.6 volts to approximately +2 volts. Check that the base of Q6 is being pulsed from approximately -2 volts to approximately +0.6 volts.

7. Pin 9 of U9B is also pulsed, and the out of lock LED (DS500) is on.

8. Connect Channel A to TP2 (SPEEDUP) and increment the Signal Generator's frequency DOWN 20 MHz. The Reference input is leading the VCO Divide-By-N.F. input.

9. The pulses at TP2 should be from -0.7 volts to +4.0 volts and are unstable since the loop is not locked.

10. If the pulses are not present at TP2, check that the output of U1B is changing between ECL high and low.

11. Check that the base of Q1 and Q2 is being pulsed from approximately +3 volts to approximately +4 volts.

12. Pin 5 of U9A is also pulsed and the out of lock LED (DS500) is on.

13. Reinstall jumper A3W6.

SERVICE SHEET 13 (cont'd)

√3 **Integrator**

1. Remove jumper A3W1 from position W1A and install A3W1 in position W1B. Remove A3W3 from the W3A position.

2. Measure the transistor voltages according to Table 1.

Table 1. Integrator Voltages with W1 in W1B Position

Transistor	Emitter (Vdc)	Base (Vdc)	Collector (Vdc)
Q31C	Pin 10, −0.75	Pin 9, −0.025	Pin 8, +12.5
Q31D	Pin 12, −0.75	Pin 13, −0.025	Pin 14, +12.0
Q30	— +12.5	— +11.9	— +1.3
Q29	— −13.2	— −12.5	— +1.3
Q31A	Pin 3, +0.5	Pin 2, +1.2	Pin 1, +14.0
Q31B	Pin 5, −0.007	Pin 6, +0.6	Pin 7, +14.0

3. Connect a 100 kHz 0.1 V Pk/Pk square wave from the function generator to A3W1.

4. Connect Channel A of the oscilloscope to TP13. The output at TP13 should be a square wave 0.2 V Pk/Pk.

5. Reinstall A3W1 to position W1A (normal operation).

√4 **Sample and Hold**

1. Install A3W3 in the W3B position. +5 V(F2) is thus connected to the input of the Sample and Hold circuit.

2. Connect Channel A of the oscilloscope to TP23. The output at TP23 should be +5 volts.

3. If +5 volts is not present at TP23, check the Sample and Hold pulse at TP22 (SAMPLE). Verify that the waveform in Figure 8 is correct.

4. Verify that the waveform in Figure 9 is correct.

5. Verify that the waveform in Figure 10 is correct.

6. Reinstall A3W3 in the W3A position.

SERVICE SHEET 13 (cont'd)

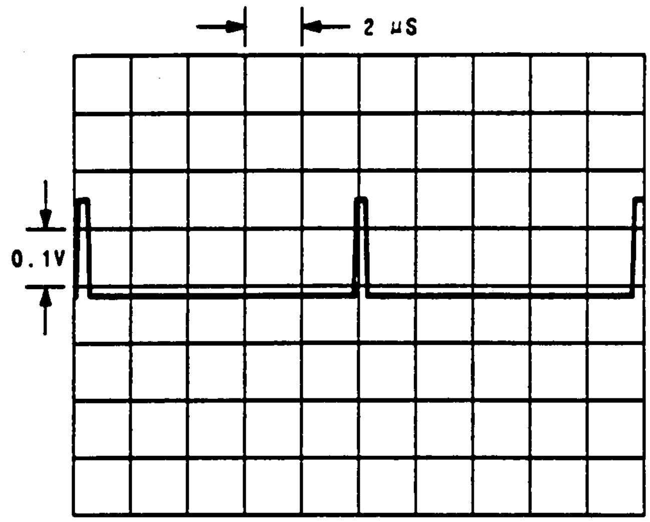


Figure 8. Oscilloscope Display of TP22 (dc coupled), Sample and Hold Pulse, W6 removed, Signal Generator's frequency is 950 MHz, Low Frequency Loop is unlocked.

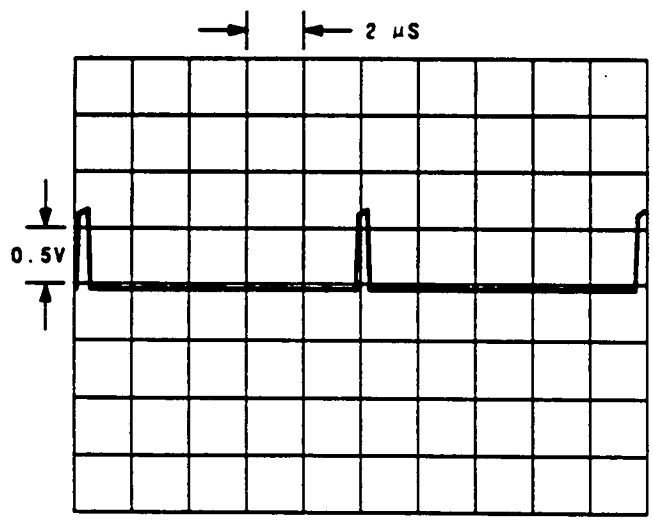


Figure 9. Oscilloscope Display of TP11 (dc coupled), W3 in position W3B (service position), Signal Generator's frequency 950 MHz.

SERVICE SHEET 13 (cont'd)

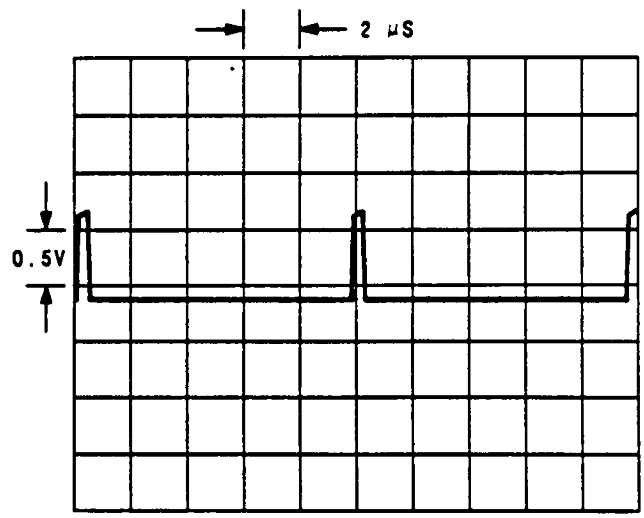


Figure 10. Oscilloscope Display of TP12 (dc coupled), W3 in position W3B (service position), Signal Generator's frequency 950 MHz.

SERVICE SHEET 14

LOW FREQUENCY LOOP
FREQUENCY MODULATION CALIBRATION

PRINCIPLES OF OPERATION

General

The voltage-to-frequency conversion of the Low Frequency Loop's VCO is dependent upon its output frequency. The purpose of FM Calibration is to make the VCO gain seen by the Low Frequency Loop appear constant. To guarantee calibrated frequency modulation at all frequencies, the loop must compensate for the VCO's nonlinear gain. The VCO Tune Voltage, and the Frequency Modulation signal are summed together at the FM Summing Amplifier U33A. The Low Frequency Loop adjusts the level of the inputs to the VCO by setting the bits of the FM Calibration DAC. The adjusted level at the output of the Current-To-Voltage Converter is the level required to lock the VCO at the correct frequency, and to have calibrated frequency modulation. An FM calibration is performed and the FM Calibration DAC is set each time the Low Frequency Loop VCO's frequency crosses a predetermined boundary, every 200 kHz.

When the Signal Generator's RF output frequency is changed, and the VCO's frequency crosses a 200 kHz boundary, the Low Frequency Loop data is latched into the Latches (refer to Service Sheet 11). The Low Frequency Loop's Microprocessor sets the Add Cycle input to the Prescaler high, divide-by-9. The loop adds two cycles and the frequency of the VCO is offset 200 kHz, F-200 kHz. The FM Calibration circuits stores the Tune Voltage on capacitor C604. Immediately after the Tune Voltage is sampled, the Add Cycle input to the Prescaler is set low and the VCO returns to the frequency it was set to before the 200 kHz offset. The Tune Voltage difference between the 200 kHz offset, and the correct VCO frequency is detected by capacitor C604. The difference of the two tune voltages is input to the Analog-To-Digital Converter U22. The analog input voltage and the internal reference voltage determines the digital data, and stores the data in its DAC. The digital output sets the gain of the FM Calibration DAC U34 from 0.46 to 0.97.

The Offset Current circuits sums in an offset voltage at the output of the FM Calibration DAC U34. The Offset Voltage reduces the voltage required at the input of the DAC to tune the Low Frequency Loop VCO over its frequency range of 60 MHz to 110 MHz.

FM Summing, D to A Conversion

The Low Frequency Loop VCO's Tune Voltage is filtered by the 5 kHz Low Pass Filter, R608 and C607, and is connected through input resistor R609 to the input of the FM Summing Amplifier U33A at pin 1. The 5 kHz Low Pass Filter filters digital noise. The frequency modulation signal is summed at the input of U33A with the VCO's dc Tune Voltage. When frequency modulation is selected at the front-panel or over the HP-IB, the two inputs are summed together. When FM is not selected, the FM Enable input from the microprocessor is set high and switches U13A and U13D are both off. When Frequency Modulation is selected the FM Enable input at pin 1 of U13A and pin 16 of U13D is low. The two switches are closed and the

SERVICE SHEET 14 (cont'd)

frequency modulation input is summed with the VCO Tune Voltage. Tune Voltage gain of the FM Summing Amplifier is approximately 1.3, and FM signal gain is approximately 0.37. The VCO Tune Voltage is applied to the Vref input at pin 15 of the FM Calibration DAC U34. The bits of the DAC are set during the FM Calibration cycle. The Tune Voltage input is attenuated by the DAC and is dependent on the DAC bits set. The output current of the DAC at pin 1 is converted to a voltage by the Current-To-Voltage Converter U33B. The Tune Voltage output of U33B at pin 10 is applied to the Lag-Lead circuit of R619, R621 and C620 to attenuate the DAC and amplifier noise by 28 dB. The output tunes the Low Frequency Loop VCO to the correct frequency, corrects for phase errors, and frequency modulates the VCO when FM is enabled. The VCO Tune Voltage is also applied to Inverting Amplifier U27B for FM Calibration.

Diode CR601 and transistor Q45 assure a voltage difference of approximately 1.6 volts between the +13 Vdc line and the VCO tune on power up. The voltage across the VCO's varactor diode CR100 (refer to Service Sheet 9), is 1.6 volts on power up for the VCO to oscillate.

FM Calibration

FM Calibration compensates for the non-linearity of the VCO's varactor diode. The varactor diode change the frequency of the VCO a different amount for a fixed change in tune voltage as the VCO is tuned over its frequency range. The FM Calibration cycle sets the VCO's gain by setting the bits of the FM Calibration DAC. The VCO gain seen by the Low Frequency Loop appears constant over its frequency range of 60 MHz to 110 MHz. The FM Calibration Cycle is initiated each time the frequency of the Low Frequency Loop VCO crosses a predetermined boundary of 200 kHz.

During the FM Calibration cycle, the following sequence of events occur controlled by the Low Frequency Loop Microprocessor. Figure 1 shows the timing diagram of the FM Calibration cycle.

At time T1, the Low Frequency Loop Microprocessor U28 (shown on Service Sheet 11), sets the DCFM bit high. DCFM is enabled.

At time T2, the FM Enable bit is set high. If frequency modulation was enabled, it is disabled. The output of the Current-To-Voltage Converter U33B is always connected through resistor R601 to the input of of the Inverting Amplifier U27B at pin 7. The FM Calibration bit from the Microprocessor sets the add cycle bit high. The Low Frequency Loop VCO's frequency is offset by 200 kHz. The S(L)/H1 is set low and the base voltage of Q36 is changed to approximately -0.7 volts divided from the -15 Vdc supply voltage to the low input by resistors R602 and R603. Q36 is biased on and FET switch Q35's gate voltage is approximately 0.0 volts turning Q35 on. The offset VCO Tune Voltage is stored on capacitor C604. The B+C(L) bit is set high. The high input at pin 11 of the Analog-To-Digital Converter blanks and opens its outputs, and readies U22 for the next analog to digital conversion. With the digital output of U22 tri-stated (open), the data input to the FM Calibration DAC is determined by the pull up resistors of R615 to +5 Vdc and pull down resistor R616 to ground. The FM Calibration DAC bits 0 through 6 and 8 are high and bit 7 is low. The FM Calibration DAC U34 is set at 0.75 of its maximum value of 1.0 or 191/256.

SERVICE SHEET 14 (cont'd)

By time T3, the frequency of the Low Frequency Loop's VCO has settled to a frequency of F-200 kHz. The 200 kHz offset is the result of the active Add Cycle high input to the Prescaler to divide its input by nine. The S(L)/H1 bit is set high by the Low Frequency Loop Microprocessor and the voltage at the base of Q36 changes to approximately +1.4 volts. Q36 is biased off and the gate voltage of FET switch Q35 changes to approximately -12.0 Vdc divided from -15 Vdc to ground by resistors R605 and R606. Q35 is turned off, opened. The tune voltage for the VCO frequency of F-200 kHz is stored on capacitor C604.

At time T4, the FM Calibration add cycle bit is reset low, and the Prescaler divides-by-10. The frequency of the VCO moves to and settles at frequency F. The VCO Tune Voltage has changed by the amount that was required to offset the VCO's frequency by 200 kHz. The change in the Tune Voltage is detected by capacitor C604 and applied through the Tune Voltage Step Amplifier U14 to the analog input at pin 13 of Analog-To-Digital Converter U22. With the FET switch Q35 open, the output of capacitor C604 is connected to a high impedance, and any change at the input is a change at the output. The voltage across the capacitor must remain constant. There is not a current path for C604 with Q35 open.

At time T5, the voltage at the output of capacitor C604 is amplified by the Tune Voltage Step Amplifier U14 and applied to the analog input at pin 13 of the Analog-To-Digital Converter.

Diode CR600 and Zener Diode VR601 prevent the analog input at pin 13 of the Analog-To-Digital Converter from going below approximately +3 volts. If the input was allowed to go to 0 volts, the bits to the the FM Calibration DAC could all be set to 0. The DAC would be set for maximum attenuation and the loop would not lock.

At time T6, the B+C(L) bit is reset low. On the high to low transition, the Analog-To-Digital Converter U22 starts a new conversion. The Analog-To-Digital Converter is an 8-bit successive approximation A/D Converter consisting of a DAC, voltage reference, clock, comparator, successive approximation register, and output buffers. The Analog-To-Digital Converter's internal reference voltage is compared to the analog input voltage by the internal successive approximation register to set the bits of the internal DAC. The bits latched in the internal DAC are the inputs for the FM Calibration DAC. The output is dependent upon the analog input. With the offset control input at pin 15 of U22 connected to ground, U22 is operating in the unipolar mode. The A/D's input voltage range is 0.0 Vdc to +10.0 Vdc. The time required for an A to D conversion by U22 is 40 uSec.

At time T7, the FM Enable bit is returned to the state it was at before the FM Calibration cycle was initiated. As shown in the FM Calibration Timing Diagram Figure 1, the FM Enable bit is set low. Frequency modulation is enabled.

At time T8, the DCFM bit is returned to the state it was at before the FM Calibration cycle was initiated. As shown in the FM Calibration Timing Diagram Figure 1, the DCFM bit is set low. DCFM is disabled. The FM Calibration cycle is complete.

SERVICE SHEET 14 (cont'd)

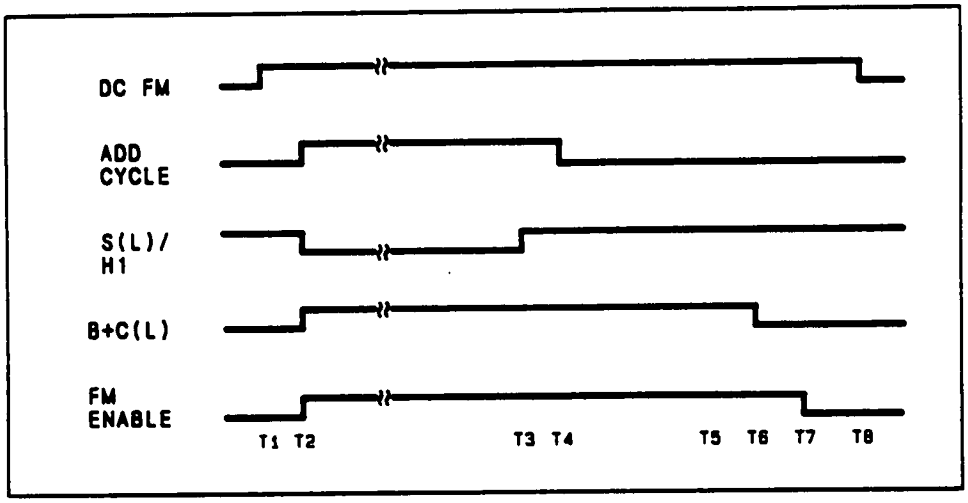


Figure 1. FM Calibration Timing Diagram

Offset Current

The Low Frequency Loop VCO has the maximum Hz/Volt tuning sensitivity at 60 MHz. This requires that the FM Calibration DAC setting be 0.5 of its range. The VCO tuning voltage for 60 MHz is approximately +10.0 volts. With the DAC set at 0.5, the voltage input to the DAC would have to be +20.0 volts. The +20.0 volts is greater than the possible output voltage swing of the circuits operational amplifier. The Offset Current circuits compensate for this problem by summing in an offset voltage proportional to the VCO's frequency at the input of the Current-To-Voltage Converter U33B. The D0 and D1 bits from the 10 MHz counter's latch are used to determine if 3 volts, 6 volts or 9 volts is summed at the input of U33B. The two bits determine if diodes CR602 and CR603 are turned on or off. When the diodes are off, the D0 and D1 data bits at pin 8 of U13B, and pin 9 of U13C are low and the switches are closed. The +5 Vdc at pins 7 and 10 of U13B and U13C is switched through the switches to bias diodes CR602 and CR603 off. When the D0 and D1 data bits are high, the diodes are on and an offset voltage is summed into the input of U33B. Data bit D0 controls CR603, and when D0 is high, CR603 is biased on and current through R623 sums 3 volts offset into the input of U33B. Data bit D1 controls CR602 and when D1 is high, CR602 is biased on and current through R622 sums 6 volts offset into the input of U33B. When the VCO frequency is 60 MHz, the D0 and D1 data bits are both high. Diodes CR602 and CR603 are biased on and 9 volts offset is summed into the input of U33B. The 9 volts offset voltage is summed with the output of the FM Calibration DAC. The VCO Tune Voltage for an output frequency of 60 MHz is approximately +10 volts. The gain of the DAC is set at 0.46, and the DAC input voltage is only -2.2 Vdc. The offset voltage summed into the input of U33B varies from the +9 volts to 0 volts as the VCO is tuned across its frequency range. The offset voltage is 9 volts for VCO frequencies from 60 MHz to 64 MHz, 6 volts 64 MHz to 84 MHz, 3 volts 84 MHz to 104 MHz, and 0 volts 104 MHz to 110 MHz.

SERVICE SHEET 14

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., √3.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A

√1 FM Summing

1. Remove jumper W3 from the W3A position, and install it in the W3B position (refer to Service sheet 13). Remove jumper W6 from the A3 Assembly. +5 Vdc is connected to the input of the Sample and Hold circuits by W3. When the Sample and Hold circuits are working correctly, +5 Vdc is input to the FM Summing Amplifier.

2. Set the Oscilloscope as follows:

   TRIGGER .... Channel A
   TIME/DIV .... 1.0 mSec
   DISPLAY .... Channel A
   VOLTS/DIV .... 0.2, dc

3. Connect Channel A to pin 12 of U33A. If the amplifier is operating correctly, the output voltage of U33A is approximately -6.8 volts.

4. Set the Signal Generator as follows:

   Frequency .... Any
   Amplitude .... Any
   Modulation .... FM 50 kHz
   Source .... 1 kHz (Int.)

5. Set the oscilloscope's Channel A display to ac and 0.05 VOLTS/DIV.

6. Connect Channel A to pin 12 of U33A. Check the oscilloscope for a 1 kHz signal of approximately 0.1 volts Pk/Pk.

7. If a modulation signal is not present, check the Out-Of-Band FM Input switches by inserting a 1 kHz, 10 mV signal at hard-wired jumper W11.

SERVICE SHEET 14 (cont'd)

J2 D to A Conversion

1. With jumper W3 in the W3B position as for J1, remove jumper W2 the B+C(L) input to U22, and remove jumper W4 the offset input to U33B. With the outputs of U22 open, the input to the FM Calibration DAC U34 is determined by resistors R615 and R616.

2. Set the digital multimeter function to dc and Range to Auto.

3. Connect the digital multimeter to jumper W6 at the output of U33B.

4. Ground the inputs of the FM Calibration DAC at pins 4, 6, 7, 8, 9, 10 and 11, and connect pin 5 to +5 Vdc one at a time. The dc voltage level on the digital multimeter will changes as each pin 4, 6, 7, 8, 9, 10 and 11 are connected to ground, and as pin 5 is connected to + 5 Vdc.

NOTE

When the least significant bits are grounded, the voltage change is only a few millivolts.

5. Reinstall the jumpers W2, W3, and W4 (put W3 in the W3A position).

J3 FM Calibration

1. The FM Calibration circuits are checked by placing the Low Frequency Loop in the repeatable FM Cal mode. An FM Calibration is performed every 100 mSec.

2. With the instrument ON, connect TP26 to ground (refer to Service Sheet 11). Increment the Signal Generator's frequency by 10 MHz. The Signal Generator will then be in the repeatable FM Cal mode.

3. Remove jumper W6 and connect a 100 Hz, 100 mV peak signal to the input of U27B at pin 7. This connection can be made at the socket of jumper W6, VCO Tune input.

4. The 100 Hz input causes the input to the Analog-To-Digital Converter to change, and the output bits to change.

5. Set the oscilloscope as follows:

   TRIGGER .... Channel A
   TIME/DIV .... 10 mSec
   DISPLAY .... Channel A
   VOLTS/DIV .... 0.2, dc

SERVICE SHEET 14 (cont'd)

6. Check the S(L)/H1 and B+C(L) inputs. Pulses are TTL level and at every 100 mSec.

7. Check that Q36 is pulsed on and off and that the Gate voltage of Q35 is switched from approximately 0 volts to approximately -15 volts. Q35 is gated on and off.

8. Connect Channel A to W2, B+C(L), input. Connect Channel B to TP14. The signal at TP14 is randomly pulsed high when the B+C(L) input is low.

9. Connect Channel B to the output of the Analog-To-Digital Converter at pins 2 through 9. The output bits randomly change when the B+C(L) input is low. The Analog-To-Digital Converter does a conversion.

10. Remove the ground from TP26. Reinstall W6, and turn the Signal Generator to STBY, and back to ON to exit the FM Cal mode.

√4. Offset Current

1. Remove jumper W1 from the W1A position, and install W1 in the W1B position (refer to Service Sheet 13).

2. Jumper W4 must be installed.

3. The voltage input to the FM Calibration DAC at pin 15 is 0.0 volts. The output of the Current-To-Voltage Converter is the offset voltage from the Offset Current as the Signal Generator's frequency is changed.

4. Set the Signal Generator as follows:

   Frequency .... 45 MHz

5. If the offset voltages shown in Table 1 for W6 (pin 1), at the input of U33B, are correct the voltages for U13 are correct. Change the Signal Generator's frequency as indicated in Table 1 and measure the voltage levels as indicated.

Table 1. Input and Output Voltage of Offset Circuits

Signal Generator Frequency (MHz)	U13 and W6 With W4 Installed				
	Pin 8	Pin 9	Pin 6	Pin 11	W6 Pin 1
45	0	0	+5	+5	0
50	+5	0	0	+5	+3
70	0	+5	+5	0	+6
88	+5	+5	0	0	+9

SERVICE SHEET 15

LOW FREQUENCY LOOP IN-BAND FREQUENCY MODULATION

PRINCIPLES OF OPERATION

General

Phase detector range, integrator range, and phase lock loop bandwidth are limitations of frequency modulation in a phase lock loop. These limitations are overcome with the addition of circuits to add a cycle and remove a cycle of the Low Frequency Loop's VCO frequency at the Prescaler, and to precisely reset the Integrator (refer to Service Sheet 13). The FM input is applied to Integrator U5. When the output of Integrator U5 crosses the high threshold, +1.9 volt, the High Threshold Comparator is set and a Remove Cycle control pulse is generated. The Remove Cycle control pulse is gated to the Prescaler, and a cycle is removed from the VCO Divided-By-N.F. signal. When the output of the integrator crosses the low threshold, 0 volts, the Low Threshold Comparator is set and an Add Cycle control pulse is generated. The Add Cycle control pulse is gated to the Prescaler, and a cycle is added to the VCO Divided-By-N.F. signal. When a cycle is removed or added, a precise current is directed to the FM Integrator U5. Just enough charge is added to or removed from the Integrator to offset the 360 degrees of phase caused by adding or removing a cycle by the Prescaler.

The FM section operates in a sampled mode. At the time each sample is taken the effects of the Remove Cycle or Add Cycle and the resetting of the integrator have settled. When DC FM is selected and a dc voltage is applied to the MOD INPUT/OUTPUT connector, the dc voltage offsets the VCO frequency a proportional amount. The drift of Integrator U5, without feedback, offsets the VCO center frequency when a dc voltage is not present at the MOD INPUT/OUTPUT connector. With ac FM, it is desirable to frequency modulate the VCO and keep the center frequency locked to a stable reference.

To prevent integrator U5's offset currents from being translated into a frequency shift during ac FM, a feedback voltage to the integrator proportional to the phase offset of the Low Frequency Loop VCO is needed. The Up/Down Counters and DAC reconstruct a staircase voltage approximation of the total VCO phase offset caused by the frequency modulation Remove Cycle and Add Cycle control inputs to the Prescaler. This voltage is fed-back to the integrator. The resistor network of R722, R726, and R734 provides feedback to fill in the spaces between the steps.

The FM Reset Timing and Current Switches reset the Integrator. The Up/Down Counters, Phase Deviation DAC, and Current-To-Voltage Converter keep track of the number of times and the direction which Integrator U5 is reset. The High and Low Threshold Comparators determine when the Integrator is reset and when a frequency modulation remove or Add Cycle control pulse is generated. Figure 1 shows the timing diagram for square wave in-band frequency modulation.

SERVICE SHEET 15 (cont'd)

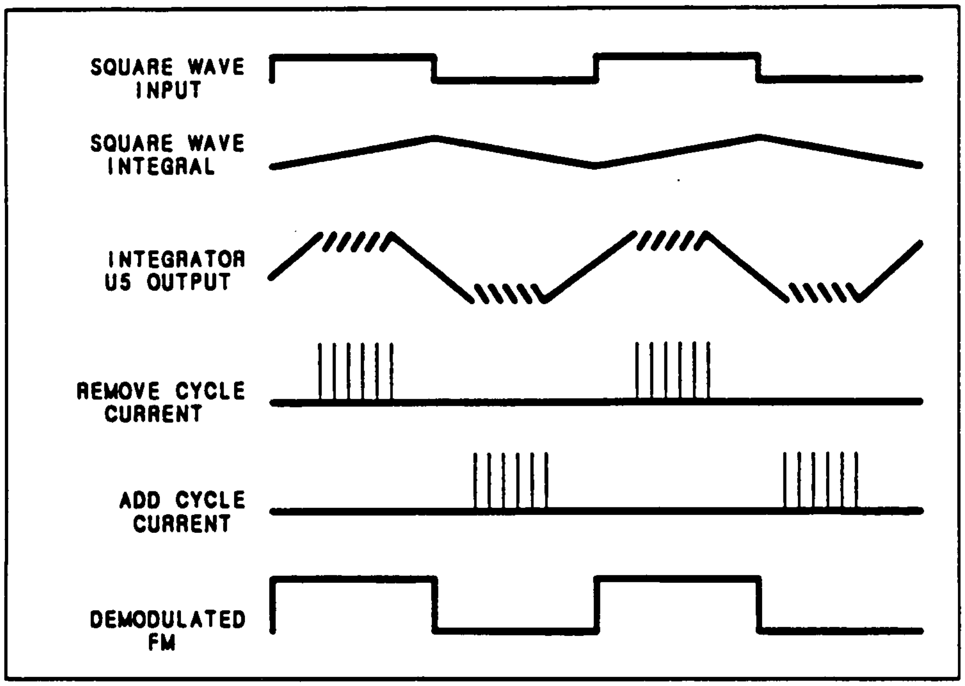


Figure 1. 10 Hz Square Wave In-Band Modulation

FM Control Gates and Switches

The FM OFF instruction from the Microprocessor U28 at pin 27 (refer to service sheet 11), is high when FM is off. With FM selected the FM OFF input at pin 2 of NOR gate U15A is low and the output at pin 1 is high. The load input at pin 11 of the Up/Down Counters, U20, U26, and U32, is high and data at the inputs is not loaded into the Counters. The high output of U15A is also the input of U15B at pin 5 and sets the Buffered FM OFF output at pin 4 low. The low Buffered FM OFF to switch U4B at pin 8 closes the switch to connect the output of the Integrator U5 at pin 6 to the base of Q10.

The DC FM instruction from the Microprocessor U28 at pin 26 is high when DC FM is selected. When the DC FM instruction is high Up/Down Counter U20 is disabled and switch U4A is opened. When the DC FM instruction is low and DC FM is not selected, the Up/Down Counters are enabled, and switch U4A is closed.

Threshold Comparators

The output of Integrator U5 is applied to the input of the High and Low Threshold Comparators U10 and U11. When the integrated voltage is approximately +2 volts the High Threshold Comparator's output is switched from low to high. The high output is latched into the Remove Cycle flip-flop U38B (refer to Service Sheet 11). The output of U38B is gated at the correct time in each Low Frequency Loop cycle for the Prescaler to remove a cycle and to clock D flip-flop U25A on the low to high transition. When the integrated voltage is approximately 0 volts, the Low Threshold Comparator's output is switched from low to high. The high output is latched into the Add Cycle flip-flop U38A (refer to Service Sheet 11). The output of U38A is gated at the correct time in each Low Frequency Loop cycle for the Prescaler to add a cycle and to clock D flip-flop U25B on the low to high transition.

SERVICE SHEET 15 (cont'd)

FM Reset Timing

The FM Reset Timing D flip-flops U31 and U37 are clocked at pins 3 and 11 by the 5 MHz Reference input, divided from the 50 MHz Reference (refer to Service Sheet 9). The 5 MHz Reference input is directed to the FM Reset Timing flip-flop's when frequency modulation is selected. The low to high transition of Remove Cycle flip-flop U38B's output at pin 9, clocks the high D input at pin 2 of U25A to the output at pin 5. The output at pin 5 is the D input for U31A, and is clocked to the output at pin 5 by the 5 MHz Reference. The output at pin 5 of U31A is the D input at pin 12 of U31B, and the high input is clocked to the output at pin 9 on the next low to high transition of the 5 MHz Reference. The output at pin 8 of U31B is clocked low, and U25A is reset (the output at pin 5 is low and output at pin 6 is high). The low output at pin 5 of U25A is clocked through U31A and U31B. The output at pin 9 of U31B was set high, and after two cycles of the 5 MHz Reference it is set low. The high output pulse width of U31B at pin 9 is 400 nSec, two cycles of the 5 MHz Reference clock. U25A, U31A and U31B generate a 400 nSec pulse each time a Remove Cycle control pulse is generated by the High Threshold Comparator U10. During the 400 nSec pulse a precise positive current (from the API 2 current source and current mirror) resets Integrator U5. The 400 nSec pulse from U31B is also one input to NOR gate U15C, and when high the output of U15C at pin 10 is low. At the termination of the 400 nSec pulse, the output of U15C goes high and clocks the Up/Down Counter U20 up one count on the low to high transition. The output of U25A at pin 6 had set the output at pin 8 of U19B low, and enabled the Up/Down Counters to count up when clocked.

The low to high transition from the output of U38A at pin 5 (refer to service sheet 11) clocks the high D input at pin 12 of U25B to the output at pin 9. U25B, U37A and U37B generate a precise 400 nSec pulse each time an Add Cycle control pulse is generated by the Low Threshold Comparator U11. They function the same as U25A, U31A, and U31B, described above, to generate a 400 nSec pulse. During the 400 nSec pulse a precise negative current from the API 3 current source resets Integrator U5. The 400 nSec pulse from U37B is also one input to NOR gate U15C, and when high the output of U15C at pin 10 is low. At the termination of the 400 nSec pulse, the output of U15C goes high and will clock the Up/Down Counter U20 down one count on the low to high transition of the pulse. The output of U25B at pin 8 had reset the output at pin 8 of U19B high, and enabled the Up/Down Counter to count down when clocked.

Up/Down Control

The Up/Down Control, U19B, for the Up/Down Counters of U20, U26, and U32 is controlled by U25A and U25B. When U19B's output at pin 8 is set low by U25A, the Counters are enabled to count up. When U19B's output at pin 8 is reset high by U25B the Counters are enabled to count down. The D flip-flop U25A is clocked each time the High Threshold Comparator's output at pin 7 of U10 is switched high, and the Prescaler removes a cycle. U25A is clocked by the output of U38B. U19B is set and the Up/Down Counters are enabled to count up. The D flip-flop U25B is clocked each time the Low Threshold Comparator's output at pin 7 of U11 is switched high, and the Prescaler adds a cycle. U25B is clocked by the output of U38A. U19B is reset, and the Up/Down Counters are enabled to count down.

Up/Down Counters

The Up/Down Counters counts up each time an FM Remove Cycle control pulse is generated, and counts down each time an FM Add Cycle control pulse is generated. The Up/Down Counters are enabled to count when the DC FM instruction from the microprocessor U28 at pin 26 is low. FM is selected but DC FM is not selected. The enable input at pin 4 of U20 enables the counter to count on each clock from U15C.

SERVICE SHEET 15 (cont'd)

The data inputs of the Up/Down Counters are connected to +5 Vdc except bit 10 at pin 1 of U32, and it is connected to ground. The input data is loaded into Up/Down Counters each time Frequency Modulation is selected. The DAC is set to 512, one-half of its maximum value of 1024. The FM OFF instruction from the Low Frequency Loop Microprocessor U28 at pin 27 is low when FM is selected. The low FM OFF instruction is one input to NOR gate U15A at pin 2. Its other input is connected to ground and the output goes high. The input data to the counter is loaded on the low to high transition of U15A's output.

FM Deviation DAC and Current-to-Voltage Converter

Ten output bits of the Up/Down Counters set the bits of the Phase Deviation DAC U16 to 512. The input to the DAC increases when the Counters are counted up for an FM Remove Cycle, and decreases when the Counters are counted down for an FM Add Cycle. The output current of the DAC changes as the bits are changed by the Counters. The output current of the DAC controls the output voltage of the Current-To-Voltage Converter U12 from -5 volts to +5 volts. When the Counters are loaded, the DAC is set at one half of its maximum value and the output voltage is approximately 0.0 volts. The Current-To-Voltage Converter's voltage output is input to Integrator U5 through the resistor network of R704, R726, and R734 as a current. The current input to the Integrator represents the net number of FM Remove Cycles and Add Cycles or the amount the phase of the Low Frequency Loop VCO has been shifted for Frequency Modulation. Each time a cycle is removed or added 360 degrees of phase, one cycle, of the VCO's frequency divided-by-2 is removed or added by the Prescaler. The Up/Down Counters keeps track of the number of cycles that have been removed or added. The output of the DAC reconstructs the remove or add voltage step to the loop Integrator of Service Sheet 13.

Current Switches

For the duration of the 400 nSec pulse, initiated by a Remove Cycle control pulse from the High Threshold Comparator U10 through the Remove Cycle D flip-flop U38B and generated by U25A and U31A/B, a precise positive current is applied to the Integrator U5 to reset its output voltage. The positive 400 nSec pulse biases the base of Q11 at approximately +0.3 volts and the emitter is then approximately +1.0 volts. Diode CR706 is turned off and diode CR707 is turned on. The positive current from the Current Mirror, transistors Q20 and Q21, is directed through the Integrator. The Current Mirror changes the negative API 3 current to a positive current When the 400 nSec FM Reset Pulse is not active, the bias on the base of Q11 is approximately -1.3 volts and the emitter is approximately -0.6 volts. Diode CR706 is turned on and diode CR707 is turned off. The Current is directed through transistor Q11.

For the duration of the 400 nSec pulse, initiated by a Add Cycle control pulse from the Low Threshold Comparator U11 through the Add Cycle D flip-flop U38A and generated by U25B and U37A/B, a precise negative current is applied to Integrator U5 to reset its output voltage. The negative 400 nSec pulse biases the base of Q3 at approximately -0.3 volts, and the emitter is approximately -1.0 volts. Diode CR704 is turned off and diode CR705 is turned on.

Negative API 2 current is directed through the Integrator. When the 400 nSec FM reset pulse is not active, the bias on the base of Q3 is approximately +1.3 volts and the emitter voltage is Approximately +0.6 volts. Diode CR704 is turned on and diode CR705 is turned off. API 2 current is directed through transistor Q3.

SERVICE SHEET 15 (cont'd)

Integrator

When AC FM or DC FM is selected, switches U4C and D are closed. The frequency modulation signal is applied to the FM Summing Amplifier U33A (Service Sheet 14), and to Integrator U5. In a phase lock loop, frequency modulation within the loop bandwidth is canceled and phase modulation within the loop bandwidth is passed. Both properties are used in the Low Frequency Loop for flat frequency modulation by Integrator U5 converting the frequency modulation signal to phase modulation. The phase output of the Integrator is summed at the virtual +5 volt node of the Current Summing Amplifier U7 (refer to Service Sheet 12). Each Low Frequency Loop cycle, AC FM or DC FM selected and within the bandwidth of the Low Frequency Loop, the output of the Integrator is summed with the Bias Current and API Current to offset the VCO tune voltage phase modulating the VCO. All components of the modulation signal within the loop bandwidth phase modulate the VCO and all components outside the loop bandwidth frequency modulate the VCO. The result is continuous modulation.

The 400 nSec pulses from the current switches directs a positive or negative current to reset the Integrator. The Integrator is reset during frequency modulation when its output voltage reaches the high or low threshold voltage. During the same Low Frequency Loop cycle the Integrator is reset, a cycle is removed or added by the Prescaler dependent upon the output voltage of the Integrator being at the high or low threshold. The Prescaler removes or adds a cycle, and the 400 nSec of current resets the Integrator's output voltage to remove or add 2 cycles, 720 degrees, from the Low Frequency Loop VCO (one cycle, 360 degrees, of the VCO Divide-By-2 frequency added or removed at the Prescaler). The output of Integrator U5 is summed with the Bias and API currents at the virtual +5 volts node of the Current Summing Amplifier in-band modulation. The Low Frequency Loop Integrator (refer to Service Sheet 13), is offset by the current from U5 to compensate for the 2 cycles removed or added. The phase of the Low Frequency Loop VCO is continuous when cycles are removed or added for frequency modulation.

The Up/Down Counters and Phase Deviation DAC, U16 with resistors R704, R726 and R734 provide dc current feedback to Integrator U5. When DC FM is selected, the feedback circuits are disabled. The high DC FM input disables the Up/Down Counter U20 and opens switch U4A. The Integrator, Threshold Comparator's, Reset Timing, and current switches are still active. With the feedback resistors disabled, the Integrator has dc offset in the DC FM mode of operation.

SERVICE SHEET 15

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are shown below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., ⟨√3⟩.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Oscilloscope .... HP 1740A
Oscilloscope Probe .... HP 10040A
Function Generator .... HP 3311A

⟨√1⟩ FM Digital Circuits, In-Band Analog

1. The FM Integrator and In-Band Analog circuits are checked for proper operation with the Low Frequency Loop locked.

2. Set the Signal Generator as follows:

   Frequency .... 950 MHz
   Amplitude .... Any
   Modulation .... AC FM, 5 kHz
   Source .... EXT

3. Set the Oscilloscope as follows:

   TIME/DIV .... 2 mSec
   DISPLAY .... Channel A
   TRIGGER .... Channel A
   Channel A VOLTS/DIV .... 0.2, dc

4. Set the Function Generator as follows:

   Function .... Square Wave
   Frequency .... 100 Hz
   Output Level .... 1 V/P (HI and LO EXT LED's out)

5. Connect Channel A to TP3 (ΦM INPUT). Verify that the oscilloscope display shown in Figure 2 is correct. If the waveform is not correct continue with ⟨√2⟩.

SERVICE SHEET 15 (cont'd)

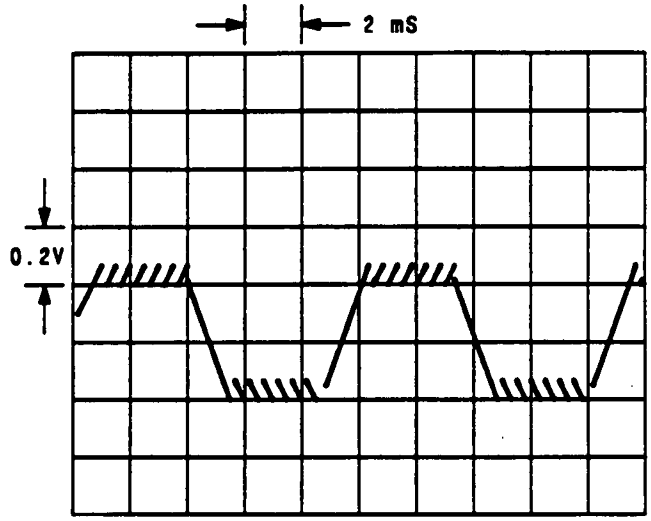


Figure 2. Oscilloscope Display of TP3 (dc coupled), Signal Generator's frequency 950 MHz, modulation EXT FM 5 kHz deviation (100 Hz square wave).

⟨√2⟩ FM Control Gates and Switches

1. Set up the Signal Generator, oscilloscope, and function generator as shown in ⟨√1⟩.

2. Check that the DC FM inputs at pin 4 of U20 and at pin 1 of U4A are low, and that switch U4A is closed.

3. Check that the FM OFF input at pin 2 of U15A is low, that the output at pin 1 of U15A is high, and that the output at pin 4 of U15B is low. Check that switch U4B is closed.

4. Check that the FM Enable inputs at pin 9 of U4C and pin 16 of U4D are low, and that switches U4C and U4D are closed.

⟨√3⟩ FM Reset Timing

1. Set up the Signal Generator, oscilloscope, and function generator as shown in ⟨√1⟩.

2. Check for the 5 MHz Reference input at pin 3 of U31A, the Remove Cycle input at pin 3 of U25A, and the Add Cycle input at pin 11 of U25B.

SERVICE SHEET 15 (cont'd)

3. Change the oscilloscope Time/Div to 0.2 uSec. Check for the positive 400 nSec Remove Cycle pulse at pin 9 of U31B, and the negative 400 nSec Add Cycle pulse at pin 8 of U37B.

4. Check that the Set (pin 10), and Reset (pin 13) inputs to Up/Down Control U19B are gated low for 200 nSec, and that the output at pin 8 is gated.

5. Check that the output of NOR gate U15C is gating to count the Counter U20 up or down.

√4 Up/Down Counters, Phase Deviation DAC, Current-To-Voltage Converter

1. Set-up the Signal Generator, oscilloscope, and function generator as shown in √1.

2. Set the modulation on the Signal Generator to OFF.

3. Check the input to the Phase Deviation DAC U16. The input at pin 4 is low, and the inputs at pins 5 through 13 are high.

4. Check that the voltage at TP4 (OFFSET ZERO) is approximately 0.0 volts.

5. Set the Signal Generator as follows:

   Modulation .... FM, 99 kHz
   Source .... EXT

6. Verify that the oscilloscope displays the same waveform as shown in Figure 3.

√5 Current Switches

1. Set-up the Signal Generator and function generator as shown in √1.

2. Set the Oscilloscope as follows:

   TIME/DIV .... 0.2 uSec
   TRIGGER .... Channel A
   DISPLAY .... Channel A
   Channel A VOLTS/DIV ...... 0.1, dc

3. Connect Channel A to TP5 (POSITIVE CURRENT), and check for a 400 nSec pulse from -1.5 volts to +0.3 volts.

4. Set the oscilloscope to trigger on negative slope. Connect Channel A to TP6 (NEGATIVE CURRENT), and check for a 400 nSec pulse from +1.5 volts to -0.3 volts.

5. Connect Channel A between diodes CR706 and CR707. Verify that the oscilloscope displays the same waveform as shown in Figure 4.

SERVICE SHEET 15 (cont'd)

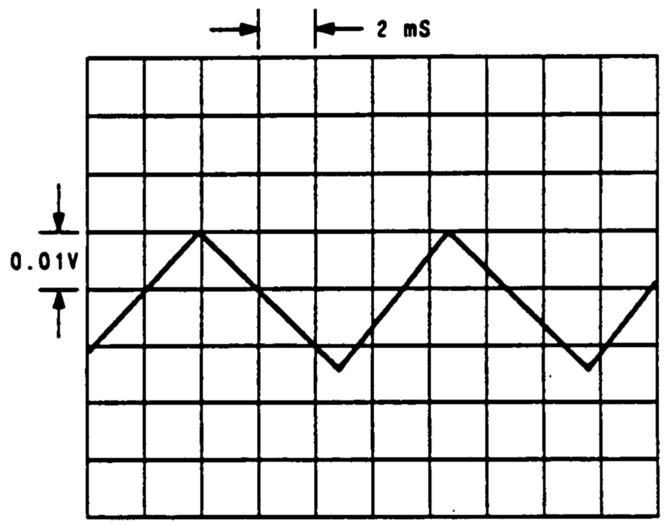


Figure 3. Oscilloscope Display of TP4 (dc coupled), Signal Generator's frequency 950 MHz, modulation EXT FM 99 kHz deviation (100 Hz square wave).

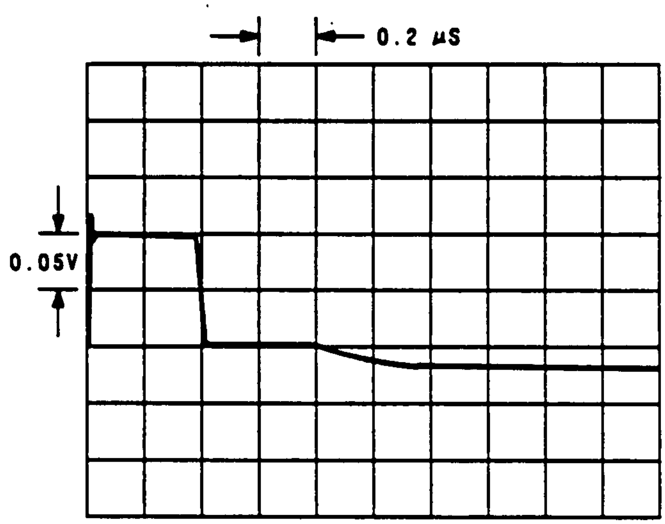


Figure 4. Oscilloscope Display between diodes CR706 and CR707 (dc coupled), Signal Generator's frequency is 950 MHz, modulation EXT FM 99 kHz deviation (100 Hz square wave).

SERVICE SHEET 15 (cont'd)

6. Set the oscilloscope to trigger on negative slope. Connect Channel A between diodes CR704 and CR705. Verify that the oscilloscope displays the same waveform as shown in Figure 5.

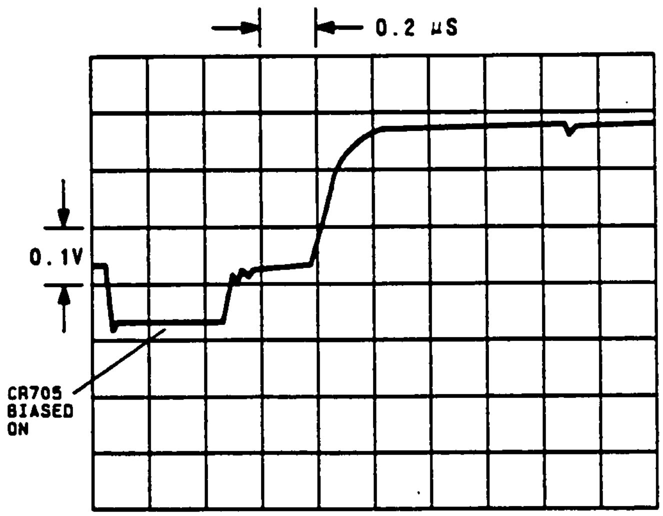


Figure 5. Oscilloscope Display between diodes CR704 and CR705 (dc coupled), Signal Generator's frequency is 950 MHz, modulation EXT FM 99 kHz (100 Hz square wave).

√6. Integrator, High and Low Threshold Comparators

1. Set-up the Signal Generator, oscilloscope, and function generator as shown in √1.

2. Connect Channel A to TP3 (ΦM INPUT), and verify that the waveform shown in Figure 6 is correct.

SERVICE SHEET 15 (cont'd)

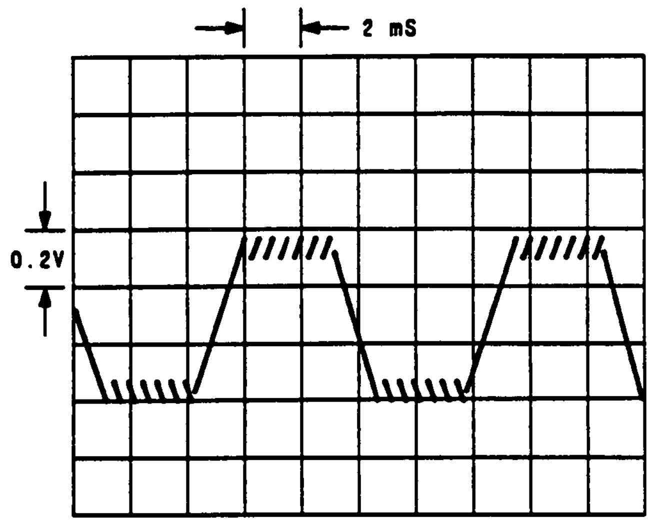


Figure 6. Oscilloscope Display of TP3 (dc coupled), Signal Generator's frequency 950 MHz, modulation EXT FM 5 kHz deviation (100 Hz square wave).

3. Connect Channel A to TP8 (HIGH THRESHOLD). Sets of pulses from approximately 0.0 volts to approximately +4.5 volts should be displayed.

4. Connect Channel A to TP9 (LOW THRESHOLD. Sets of pulses from approximately 0.0 volts to approximately +4.5 volts should be displayed.

5. Connect Channel A to TP3, and Channel B to pin 3 of U25A. There should be a Remove Cycle pulse for every high threshold reset of the Integrator.

6. Connect Channel A to TP3, and Channel B to pin 11 of U25B. There should be an Add Cycle pulse for every low threshold reset of the Integrator.

SERVICE SHEET 16

LOW FREQUENCY LOOP 50 MHZ REFERENCE OSCILLATOR, AND PHASE LOCK LOOP

PRINCIPLES OF OPERATION

General

50 MHz Reference Oscillator

The 50 MHz Reference Oscillator, Q50, is a common-base crystal controlled oscillator. The amount of positive feedback is predetermined by the taps on inductor L7. Inductor L7 is a spiral printed circuit board trace.

The base of Q50 is biased by resistor R24 at approximately 0 Vdc. The emitter is biased by resistors R25 and R26. This closes the dc current path for the emitter current of Q50 and also closes the tank circuit. The tank circuit consists of the crystal Y1, varactor diode CR15, printed circuit board inductor L7, and capacitors C21 and C23. The output frequency can be adjusted by R22 (TIME BASE ADJ) which controls the voltage across the varactor diode CR15 thereby changing the capacitance of the tank circuit. This tune voltage is applied through resistors R21, R23 and RF chokes L5 and L6. The output level is peaked by capacitor C21 (50 MHZ LEVEL ADJ). Capacitors C18, C19, C20, C24, C25 and C26 are bypass capacitors.

Time Base Divider

The output of the 50 MHz Reference Oscillator is ac coupled by C30 to the Frequency Multiplier Assembly shown on Service Sheet 3. The output is also ac coupled by capacitor C11 to common-base Time Base Buffer Q55. The output of Q55 clocks the Divide-By-10 circuit U53 at pin 7. This divider is made up of a divide-by-5 and a divide-by-2 circuit. Note that the set inputs are all tied low. The output, 10 MHz at pin 4, is the 50 MHz divide-by-5. The 10 MHz output at pin 4 clocks the divide-by-2 circuit at pin 12, and its output is 5 MHz.

The 5 MHz outputs, at pins 14 and 15 of U53, clocks the ECL-To-TTL Converter transistors Q54 and Q53. Q54 converts the ECL logic levels to TTL logic levels and Q53 provides the current drive. The TTL output of Q53 clocks the Divide-By-5 circuit U48A and its output is 1 MHz at pin 6.

The 1 MHz output of U48A clocks the divide-by-2 section of U48B and its 500 kHz output at pin 13 clocks the divide-by-5 section. The output of U48B at pin 9 is 100 kHz.

One of the three divided output frequencies, 10, 5, or 1 MHz may be selected to phase lock the reference oscillator to an internal (Option 001) or external time base. The resistor jumper is shipped in the 10 MHz position and must be moved to the 5 or 1 MHz position depending upon the frequency of the external time base. The Time Base Output follows the frequency selected by the jumper.

The Time Base output is applied to pin 11 of Exclusive-Or gate U40C. Its other input is tied to +5 Vdc. The output from pin 14 is the input phase shifted 180 degrees. The signal is then detected by diode CR18 and ac coupled to the Time Base Output J4.

SERVICE SHEET 16 (cont'd)

100 kHz Reference

The 100 kHz Reference output of U48B clocks the Synchronization D flip-flop U52A, and its output is synchronized with the 5 MHz output of Q53 by U52B. The Pulser circuit, capacitor C27 and transistor Q52, change the output of U52B to a narrow pulse.

5 MHz Switch

The 5 MHz switch transistor Q49 is controlled by the FM OFF input (refer to Service Sheet 15). When frequency modulation is not selected, the FM OFF input is high and Q49 is biased off. When frequency modulation is selected, the FM OFF input is low and Q49 is biased on and off by the 5 MHz input from Q53. The 5 MHz output at the emitter of Q49 clocks the FM Reset Timing D flip-flops (refer to Service Sheet 15).

Reference Phase Lock Circuit

The Time Base Input signal is ac coupled by C6 to resistor R1, and the positive and negative peak limiting diodes of CR1 and CR2. The input is then ac coupled by capacitor C10 to pin 7 of Exclusive-Or gate Buffer U40B. The input goes to ac ground by resistors R2 and R3 and capacitor C9. The output is connected through the resistor R7 to the resistor P/O R8 and diode CR3. CR3 detects the Time Base Input signal, and applies the voltage to the positive input of External Reference Detector U45B. The positive input is increased so it is more positive than the negative input, and the output of U45B switches to +15 Vdc, detecting the presence of a Time Base Input. When the output of U45B switches to +15 Vdc the phase lock operational amplifier U45A is activated by turning off diode CR6 and turning on diode CR11. The inputs of comparator U45B are connected to U40B pin 3, the Exclusive-Or gate output. Diode CR4 temperature compensates CR3.

The Time Base Input signal from U40B pin 3 is connected to U40A pin 4. The other input, pin 5, is the divided output of the 50 MHz Reference Oscillator. The signal is divided to 10, 5 or 1 MHz depending on the Time Base Input frequency and the subsequent jumper placement. This Exclusive-or gate serves as a phase detector with its change in output voltage being proportional to the phase difference of the two inputs. The output is coupled to the 50 MHz Reference Oscillator which serves to phase lock the oscillator to the Time Base Input signal. The correction voltage to U45A is amplified and applied to the oscillator tank circuit through diode CR10. CR10 is turned on when comparator U45B turns CR6 off, and the negative input of U45B changes to approximately +3 volts. The positive input is fixed and the output goes from +15 Vdc to approximately -7 volts. CR10 is turned on as are diodes CR7 and CR8 when the phase difference is large enough. Resistor R14 is bypassed which moves the reference oscillator to the correct frequency.

SERVICE SHEET 16

TROUBLESHOOTING

Procedures for checking part of the A3 Low Frequency Loop Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., ⟨√3⟩. Fixed voltages are shown on the schematic inside a hexagon, e.g. ⟨2V ±0.2V⟩. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD3
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A

⟨√1⟩ Reference Phase Lock Circuit

Measure the voltage shown in Table 1. With an external reference oscillator connected to the Time Base Input or with the internal reference oscillator installed, the 50 MHz oscillator should be phase locked.

Table 1. Crystal Phase Lock Circuit Voltages

Operating Mode		Voltages (dc and ac) on									
		U40-Pin				U45B-Pin			U45A-Pin		
		7	5	2	3	5	6	7	3	2	1
Phase Locked	Vdc	+3.8	+3.8	+3.8	+4.0	+4.0	+3.7	+13	+4	+4	−10
	Vpk	0.4	0.4	0.4	0.4	0.01	0.01	0.01	0.08	0	0.02
Not Phase Locked	Vdc	+3.8	+3.8	+3.8	+3.8	+3.5	+3.7	−13	+4	+3	+14
	Vpk	0.02	0.4	0.2	0.05	0.01	0.01	0.005	0.02	0	0.008

⟨√2⟩ 50 MHz Reference Oscillator

1. Verify that Q50's bias voltages are correct.

2. Measure the oscillator output at TP33 (50MHZ).

SERVICE SHEET 16 (cont'd)

√3 Time Base Dividers

1. Measure the TIME BASE OUTPUT signals at J7.

2. Measure the 5 MHz signal at pin 15 of U53.

3. Measure the 5 MHz signal at pin 14 of U53 and at TP32.

4. Measure the 1 MHz signal at pin 6 of U48A.

5. Measure the 500 kHz signal at pin 13 of U48B.

6. Measure the 100 kHz signal at pin 9 of U48B.

√4 100 kHz Reference

1. Check the 100 kHz signal at pin 5 of U52A, and at pin 9 of U52B.

2. Check the 100 kHz output pulse of Q52 at J5. The pulse is narrow and approximately 1.5 Vpk.

√5 5 MHz Switch

1. Select Frequency Modulation at the Signal Generator's front-panel and check for a low FM OFF input to FL4.

2. Check that transistor Q49 is biased on.

3. Measure for a 5 MHz signal at feedthrough capacitor C28.

NOTE

A residual FM problem at the RF output may be due to residual FM from the 50 MHz Reference Oscillator. Measuring residual FM of the Reference Oscillator using the test setup found in Section IV may be inconclusive. The residual FM of the measuring instrument (HP 8902A Measuring Receiver) is normally greater than that of a Reference Oscillator that is operating properly. All connectors to the 50 MHz Oscillator must be tight to prevent noise on the 50 MHz signal.

SERVICE SHEET 17

MICROPROCESSOR INTERRUPT PROCESSING, AND RESTART

PRINCIPLES OF OPERATION

Microprocessor

Instrument functions are controlled by the Microprocessor U9 as it executes the program instructions stored in ROM (read only memory). The function of the Microprocessor's data bus, address bus, and each of its input/output lines is discussed in the following paragraphs:

Data Bus. The data bus (D0 through D7) consists of 8 bidirectional data lines which transfer 8-bit, positive-true data bytes to and from the Microprocessor (pins 26 through 33). The 3-state lines can be high, low, or at the high impedance state depending on the individual data bit or its buffering conditions. The Microprocessor reads data from memory, the keyboard, the HP-IB interface, etc., via the data bus under the control of its monitor program. Data is written onto the data bus for the displays, RF and modulation circuitry, etc. Information on the data bus is buffered as it enters or exits the Microprocessor. For additional information, refer to the discussion on Data Bus Buffering that follows.

Read/Write Control. The Read/Write signal from the Microprocessor (R(H)/W(L) at pin 34) controls the direction of data transfer on the data bus. When the Microprocessor is halted or available to accept data, this signal is high (indicating that the Microprocessor is in the "read" state). When data is being transferred out onto the data bus, this signal is low (indicating that the Microprocessor is in the "write" state). This signal is buffered by one of the Microprocessor Control Line Buffers in U13A. The buffered Read/Write signal controls the direction of data transfer: through the Data Bus Buffers in U10, to or from RAM memory (refer to Service Sheet 19), and to or from the HP-IB Interface Buffers in U12 (refer to Service Sheet 20).

Address Bus. The address bus (A0 through A15) consists of 16 unidirectional lines which transfer a 16-bit, positive-true address from the Microprocessor (pins 9 through 20 and 22 through 25). After exiting the Microprocessor, information on the address bus is buffered and decoded to produce control strobes for level, modulation, attenuation, and serial I/O data (refer to Service Sheet 18). These buffered address bits are also decoded to select RAM, or ROM memory locations (refer to Service Sheet 19) or one of the HP-IB General Purpose Interface Adapter U16 ports (refer to Service Sheet 20).

Valid Memory Address. The Microprocessor's Valid Memory Address signal (VMA at pin 5) indicates that data on the address lines is valid. Data is valid when VMA is active (high). VMA is buffered by U13A to enable decoding of level and modulation, attenuator, and serial I/O control strobes (refer to Service Sheet 18), and decoding and selection of ROM and RAM memory locations (refer to Service Sheet 19).

System Clock. An external 4 MHz crystal Y1 is directly connected to the Microprocessor (pins 38 and 39). The Microprocessor's internal divide-by-4 circuit develops the 1 MHz system clock E (pin 37). Capacitors C16 and C22 are used to keep the clock frequency stable.

Memory Ready. The Microprocessor's Memory Ready input (MR at pin 3) is tied to +5V to enable the 1 MHz system-clock rate.

SERVICE SHEET 17 (cont'd)

RAM Enable. The Microprocessor's RAM Enable input (RE at pin 36) is tied to +5V through S1D to power the internal 128 bytes of RAM. These bytes are at hexadecimal memory locations 0000 through 007F.

Standby. The Microprocessor's Standby input (STBY at pin 35) is tied to +5V to provide power to the Microprocessor's first 32 bytes of internal RAM. These bytes are at hexadecimal memory locations 0000 through 001F.

Halt. The Microprocessor's Halt input (HALT at pin 2) suspends program execution. When HALT is active (low), the Microprocessor completes the execution of its current instruction, the address bus remains fixed at the address of the next instruction, and all 3-state lines (including the data bus) go to their high- impedance state. Program execution continues when HALT goes inactive (high). For additional information on the control of this line, refer to the discussion on Restart Circuitry that follows.

Reset. The Microprocessor's Reset input (RESET at pin 40) starts the Microprocessor from a power-down condition. This condition exists during initial start-up of the instrument, after a power failure or power supply glitch has occurred, and when the RESET Test Point 12 is momentarily connected to ground. When RESET is active (low), the Microprocessor becomes inactive. When RESET is inactive (high), the internal program counter is loaded with the contents of hexadecimal memory locations FFFE and FFFF. These contents direct program execution to the power-up subroutine. For additional information on the control of this input, refer to the discussion on Restart Circuitry that follows.

Non-Maskable Interrupt. The Microprocessor's Non-Maskable Interrupt input (NMI at pin 6) interrupts program execution. When NMI is active (low), the Microprocessor finishes executing its current instruction, and saves its current status. Then the Microprocessor's internal program counter is loaded with the contents of hexadecimal memory locations FFFC and FFFD. These contents direct program execution to the non-maskable interrupt subroutine. For this Signal Generator, the non-maskable interrupt is used to invoke the Signal Generator's signature analysis subroutine. For additional information on the control of this input, refer to the discussion on Interrupt Processing that follows.

Maskable Interrupt Request. The Microprocessor's Maskable Interrupt Request input input (IRQ at pin 4) will also interrupt program execution. When IRQ is active (low), and the interrupt mask bit of the internal condition code register is not set, the Microprocessor finishes executing its current instruction. Then its internal program counter is loaded with the contents of hexadecimal memory locations FFF8 and FFF9. These contents direct program execution to the maskable-interrupt subroutine. For additional information on the control of this input (refer to the discussion on Interrupt Processing that follows).

Data Bus Buffering

Data is transferred (positive-true) to and from the Microprocessor on the bidirectional, 8-bit data bus. Information on the data bus is buffered after it exits or before it enters the Microprocessor. The 3-state, bidirectional Data Bus Buffers in U10 provide asynchronous, 2-way communication between the data bus and the Microprocessor. During normal operation, rocker switch S1D is set to NRM causing the enable input of U10 (pin 19) to be pulled low through the inverter U18A. The enable input of the 3-state buffer U29B is also pulled low through U18A (refer to the discussion on Interrupt Processing that follows).

SERVICE SHEET 17 (cont'd)

The direction of data transfer through U10 is controlled by the state of the buffered Read/Write line from the Microprocessor, and by the Data Bus Buffers Read/Write Enable line from the Address Decoders (refer to Service Sheet 18).These two signals are ANDed together by U23A. When the direction-controlling input of U10 (pin 1) is high, information is transferred from the data bus to the Microprocessor (a "read" operation). When this input is low, information is transferred from the Microprocessor to the data bus (a "write" operation).

When U1 is enabled (refer to Service Sheet 18), data bus information is written to the Modulation Control Latches / Mode Selects on the Audio Power Supply Assembly A10 (refer to Service Sheet 6). When U1 is disabled, the data bus information is not written to the Audio Power Supply Assembly.

Sixteen bits of serial keyboard data are transferred from the storage registers on the Display Assembly A2 to the Microprocessor via bit 0 of the data bus (refer to Service Sheet 21). During the keyboard read subroutine, the Keyboard Serial Data Bus Buffer U29D is enabled to couple the serial, keyboard data to the bit 0 input of U10. Buffer enabling occurs when the Microprocessor issues and decodes hexadecimal address 01FA (refer to Service Sheet 18).

HARDWIRED NOP

The hard-wired NOP (no operation) instruction is a service features of this instrument. This 8-bit instruction steps the Microprocessor through its ROM addresses during ROM testing or troubleshooting. When the Microprocessor receives a NOP instruction, its program counter advances once for every two clock cycles without affecting any other operations. The 8 inputs to the 3-state buffer U15 are hard-wired in a configuration to provide the NOP instruction (00000001) to the Microprocessor. During normal operation, rocker switch S1D is set to NRM, (high input at pin 1) disabling the outputs of U15. During ROM testing, S1D is set to ROM to enable the outputs of U15, which places the hard-wired NOP instruction on the data bus. U10 is disabled as a result of U18A inverting the low set up by S1D, which pulls pin 19 high. Disabling U10 inhibits the NOP instruction from being transferred to any circuitry but the Microprocessor.

Restart Circuitry

Two methods are employed to reset or halt the Microprocessor. They occur:

1. During power-up initialization.

2. During service via TP12 (RESET) on the A11 Assembly.

As soon as Mains Power is applied and the +5V supply comes up, zener diode VR1 begins to conduct. When VR1 conducts, transistor Q1 is biased on to pull low the input to the monostable U26 (pin 1). With U26 pin 1 low, the output at pin 6 goes low for approximately 150 ms to reset the Microprocessor. Capacitor C10 sets the pulse timing for U26. When the Microprocessor is reset, it enters its power-up subroutine to initialize the instrument. In the event of a power supply transient or the +5V supply voltage dropping below +4.22V, Q1 will turn off causing a high at the input of U18E. The TTL high then inverted to a low by U18E issues a halt to the Microprocessor via the HALT(L) line. Once the power supply has recovered, another reset is issued to initialize the instrument.

SERVICE SHEET 17 (cont'd)

Momentarily grounding TP12 (RESET) will also cause the Microprocessor to halt and execute a reset operation after 150 ms. The instrument's configuration is first stored in RAM. And then, after power-up initialization is complete, the instrument is reconfigured to its state before reset.

There is no reset operation available via HP-IB, however, the STBY and ON functions are available (refer to Table 3-9).

Interrupt Processing

As previously mentioned, there are two methods employed to interrupt normal program execution, namely maskable and nonmaskable interrupts. When either type of interrupt is detected, the Microprocessor finishes executing its current instruction before program execution is directed to the respective interrupt subroutine.

Maskable interrupts occur whenever a key on the keyboard is pressed, a reverse-power condition is detected, or an active-low switch closure is applied through the rear-panel sequence connector J5. Whenever one of these conditions is detected and latched, the Microprocessor's Interrupt Request input line (IRQ at pin 4) is forced active (low). The Microprocessor then issues and decodes hexadecimal address 01FC in order to examine (via the data bus) the contents of the Service Request Register U6. The Microprocessor can then determine which one of the three maskable interrupts has occurred. U6 functions as a 3-state buffer. During program execution of the maskable interrupt subroutine, the Microprocessor first checks for a reverse-power interrupt (D7 active low), then a sequence interrupt (D1 and D2 active low), and finally a keyboard interrupt (D2 active low). The methods used to detect and latch the three maskable interrupts are discussed in the following paragraphs.

Keyboard Interrupt. Whenever one of the keys on the Keyboard Assembly A1 is pressed, a keyboard interrupt KIN(L) is issued to the Microprocessor/Memory/HP-IB Assembly A11 (refer to Service Sheet 21). This active-low interrupt is applied to connector J4 at pin 14 and then gated through U23D and U23B to direct-set flip-flop U27A causing the output at pin 6 to go low. This flip-flop debounces the leading edge of KIN and latches the occurrence of the keyboard interrupt. The latched keyboard interrupt is gated through U23C and the enabled, 3-state buffer U29B to generate an interrupt request IRQ(L). U29B is enabled at pin 4 through the inverting driver U18A as long as rocker switch S1D is set to NRM.

When the key is released, KIN is high and U23D pin 12 is pulled high by resistor R1. After an approximate 33 ms delay produced by the RC network of R2 and C2, capacitor C2 charges to pull U23D pin 13 high. This delay debounces the trailing edge of KIN. Once the keyboard interrupt is processed, the Microprocessor issues and decodes hexadecimal address 01FB to clock U27A clear by the KIC input. Clearing U27A clears the keyboard interrupt.

Reverse-Power Interrupt. A reverse-power interrupt RPI(L) occurs when a reverse power condition is detected and latched by the reverse-power-sense circuitry on the Output Assembly A6 (refer to Service Sheet 8). This active-low interrupt is applied through the LC filter of L7 and C7 on the RFI Assembly A7 and through the feedthrough capacitor C16 to connector A11J4 pin 10. Normally, with no interrupt present, U23C pin 10 is pulled high through resistor R8. When a reverse-power interrupt occurs, it is gated through U23C and the enabled 3-state buffer U29B to generate an interrupt request IRQ(L). U29B is enabled at pin 4 through the inverting driver U18B as long as rocker switch S1D is set to NRM.

SERVICE SHEET 17 (cont'd)

Sequence Interrupt. A sequence interrupt SQI(L) occurs when an active-low switch closure is applied through the rear-panel connector J5 and through the feedthrough capacitor A14C8 to connector A11J4 pin 3. This interrupt is handled in much the same manner as the keyboard interrupt. Normally, with no interrupt present, U23B pin 4 is pulled high through resistor R5 and inverters U11A and U11B. A 33 ms delay is produced by the RC network of R3 and C4 to debounce the leading edge of SQI. When a sequence interrupt occurs, it is gated through U23B pin 4 to direct-set flip-flop U27A causing the output at pin 6 to go low. This flip-flop latches the occurrence of the sequence interrupt. The latched-sequence interrupt is gated through U23C and the enabled 3-state buffer U29B to generate an interrupt request IRQ(L). U29B is enabled at pin 4 through the inverting driver U18B as long as rocker switch S1D is set to NRM.

When the switch closure is removed, U23B pin 4 is pulled high as soon as capacitor C4 charges. The delay produced by the RC network of R5 and C4 debounces the trailing edge of SQI. Once the sequence interrupt is processed, the Microprocessor issues and decodes hexadecimal address 01FB to clock U27A clear. Clearing U27A clears the sequence interrupt.

The Microprocessor's Non-Maskable Interrupt input line (NMI at pin 6) is normally pulled high through resistor R10. During signature analysis troubleshooting, this edge-triggered line is momentarily grounded to abort normal program execution and to direct program execution to the non-maskable, interrupt subroutine.

In addition to buffering the three maskable interrupts, the Service Request Register U6 also buffers four status lines which monitor various instrument conditions. These conditions include the state of the LF Loop Out-Of-Lock LFR(L) line (refer to Service Sheet 11), the state of the HI(H) and LO(H) lines from the Over and Under Modulation Comparators (refer to Service Sheet 7), and the state of the HP-IB Interrupt Request IBI(L) line (refer to Service Sheet 20). During normal program execution, the Microprocessor issues and decodes hexadecimal address 01FC to strobe the contents of U6 onto the data bus. If one of these four conditions is active when the Microprocessor strobes U6, it executes the necessary instructions to service that condition.

SERVICE SHEET 17

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 17 when a defect seems to be related to the Microprocessor. The only troubleshooting information provided is signature analysis. If nothing definite is discovered in performing these checks, refer to Service Sheet 19 (ROM and RAM test) or consider the other possibilities listed on Service Sheet BD4.

Troubleshooting Help

Service Sheet BD4
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Signature Analyzer .... HP 5005A

Test 1. Address Check

Purpose. Verify ability of the Microprocessor to run through entire address range.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to "ADR 15" (A11TP5, refer to Service Sheet 18).
4) STOP to "ADR 15" (A11TP5, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1D in the ROM position.

Probe. Connect the signature analyzer probe to each node indicated in Table 1. Verify that each signature is correct and stable.

After the signatures are taken, reset switch A11S1D back to the NRM position.

SERVICE SHEET 17 (cont'd)

Table 1. Microprocessor Address Signatures

Node	Correct Signature	Comments
+5V U9#35	0001	Address Lines
A0 U9#9	5555	
A1 U9#10	CCCC	
A2 U9#11	7F7F	
A3 U9#12	5H21	
A4 U9#13	0AFA	
A5 U9#14	UPFH	
A6 U9#15	52F8	
A7 U9#16	HC89	
A8 U9#17	2H70	
A9 U9#18	HPPO	
A10 U9#19	1293	
A11 U9#20	HAP7	
A12 U9#22	3C96	
A13 U9#23	3827	
A14 U9#24	755U	
A15 U9#25*	0000	
+5V	0001	Buffered Address Lines
A0 J3#2	5555	
A1 J3#3	CCCC	
A2 J3#4	7F7F	
A3 J3#5	5H21	
A4 J3#6	0AFA	
A5 J3#7	UPFH	
A6 J3#8	52F8	
A7 J3#9	HC89	
A8 J3#10	2H70	
A9 J3#11	HPP0	
A10 J3#12	1293	
A11 J3#13	HAP7	
A12 J3#14	3C96	
A13 J3#15	3827	
A14 J3#16	755U	
A15 J2#5*	0000	

*Even though the signature equals zero, the probe tip should blink.

SERVICE SHEET 17 (cont'd)

Test 2. Data Bus Verification

Purpose. To test the Microprocessor and circuit board digital logic.

Setup. Connect the signature analyzer as follows:

1) Put GND as close as possible to the circuitry being probed. Bad grounding can cause unstable signatures.
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) ST/SP to "SA1" (A11TP7, refer to Service Sheet 18)
4) QUAL to "VMA" (A11TP6, refer to Service Sheet 19).

Set the signature analyzer controls as follows:

1) FUNCTION SIGNATURE-QUAL
2) START-POSITIVE EDGE
3) STOP-NEGATIVE EDGE
4) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Disconnect ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the L/K position.
3) Set switch A11S1B to the DSA position.

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than address 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature in Table 1 is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

SERVICE SHEET 17 (cont'd)

Probe. Connect the signature analyzer probe to the node indicated in Table 2. Verify that each signature is correct and stable.

Table 2. Microprocessor Data Bus Signatures

Node	Correct Signature	Comments
+5V	7986	Data Bus Signatures are subject to setting of HP-IB address switches.
D0 U9#33*	A4C9	
D1 U9#32	641A	
D2 U9#31	2U0P	
D3 U9#30	F941	
D4 U9#29	A522	
D5 U9#28	363A	
D6 U9#27	07FC	
D7 U9#26	A63A	
+5V	7986	Buffered Data Bus Signatures are subject to setting of HP-IB address switches.
D0 J2#16*	A4C9	
D1 J2#15	641A	
D2 J2#14	2U0P	
D3 J2#13	F941	
D4 J2#12	A522	
D5 J2#11	363A	
D6 J2#10	07FC	
D7 J2#9	A63A	

*This signature may vary from unit-to-unit due to difference in one-shot timing of A2U28B. If SA6 (A11TP14) is connected to SA7 (A2TP1), the signature should read the same as above.

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reconnect ribbon cable W11 to A10J3.

NOTE

If the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Set the front-panel POWER switch to STBY and back to ON.

SERVICE SHEET 18

ADDRESS BUFFERING AND DECODING, SERIAL I/O AND CONTROL

PRINCIPLES OF OPERATION

General

The circuits of Service Sheet 18 control the major functions of the Signal Generator. This circuitry has direct control on almost all of the analog functions of the instrument; such as frequency, amplitude, and modulation. Address data from the Microprocessor is decoded; the accompanying data from the data bus (either series or parallel) is manipulated to set various output modes, levels, and frequencies. In addition, many functions that are strictly digital (such as control of keyboard, display, and data bus) are decoded by the Address Decoders.

Address Decoders

Demultiplexer U19 is enabled via VMA(H), SELE(L), and E(L). Once enabled, address lines A7, A8, and A9 are decoded. U19 outputs the Data Bus Buffer Read/Write Enable signal, signature analyzer enable signals, and enable signals for demultiplexers U2 and U22.

Both U2 and U19 are enabled by U19, E(H), and A3(L). Address line A3 determines whether U2 or U19 is active. Address lines A0, A1, and A2 are decoded into control signals. The outputs of U2 are strobe lines which control modulation and attenuation data. The outputs of U22 are series data control strobes to the Serial I/O Control, and Microprocessor related control signals to Service Sheet 17.

Serial I/O Control

The Clock/Strobe Enable Flip-Flop U27B enables the Clock/Strobe Generator U31. U31 controls the flow of serial data for the keyboard, the display, the output, and the low-frequency phase lock loops.

Serial I/O Control Register U30 passes encoded information received from the Data Bus to the Serial I/O Data Bus, and to U31.

SERVICE SHEET 18

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 18 when a defect seems to be related to the Display, Keyboard, or control of the other major sections of the instrument. Examples are the High Frequency Loop, the Output Section and the Low Frequency Loop. If the signatures shown in the tables are correct but the problem is related to another major section of this instrument, refer to:

1) Service Sheet BD2 for Output or High Frequency Loop 1 problems

2) Service Sheet BD3 for Low Frequency Loop problems.

If the signatures are incorrect, the circuits of Service Sheets 17, 19, 20 or 21 (the Microprocessor, ROM and RAM, the Keyboard or the HP-IB Interface) may be defective. As a last resort, return to Service Sheet BD4 or possibly Service Sheet BD1 and consider the other possibilities shown.

Test Equipment

Signature Analyzer .... HP 5005A

Purpose. To verify transmission of encoded addresses, and data from the Microprocessor through the decoders, strobe generators and registers.

Setup. Connect the signature analyzer as follows:

1) Put GND as close to the circuitry being probed as possible. Bad grounding can cause unstable signatures.
2) CLK to "E" (A11TP1-1, refer to Service Sheet 19).
3) START to "SA1" (A11TP7, refer to Service Sheet 18).
4) STOP to "SA2" (A11TP8, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-POSITIVE EDGE
2) STOP-NEGATIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Disconnect ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

SERVICE SHEET 18 (cont'd)

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing, it is possible to get the Microprocessor into a program sequence other than that intended for signature analysis. If the +5V signature in Table 1 is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to each node as indicated in Table 1. Verify that the signature is correct and stable as shown.

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reconnect ribbon cable W11 to A10J3.

NOTE

If the HP-IB address switch was changed, reset the address switch back to its original position. Reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 18 (cont'd)

Table 1. Interface Signatures

Node	Correct Signature	Comments
+5V	H6H5	
U19#7	UA17	
U19#12*	8690	SA CLK(RF)
U22#7	330C	SER CLK EN
U22#9	6H08	SER CLK EN
U27#9	42H7	SER LATCH
U31#11	6468	
U31#12	6F77	
+5V	H6H5	
U31#14	C45F	
U31#15	2841	
U30#2	5401	
U30#5	UC8P	
U30#7	9PPA	
U30#10	75UP	
U30#15*	7064	SA Strobe/Stop
U29#8*	FP00	
U29#9*	FP00	
+5V	H6H5	
U2#15	58AP	A10U7 strobe
U2#14	57F4	A10U10 strobe
U2#13	97CC	A10U12 strobe
U2#12	A5FP	A10U15 strobe
U2#11	P1H1	A10U18 strobe

*This node is only used to control the signature analyzer during the display and RF interface test.

SERVICE SHEET 19

MEMORY

PRINCIPLES OF OPERATION

General

The memory circuits, except for the Microprocessor's internal Random Access Memory (RAM) are shown on Service Sheet 19. The individual RAM is selected by direct addressing. The Read Only Memory (ROM) is selected by indirect addressing, and by means of the Enable and Valid Memory Address lines.

RAM

Valid Memory Address, VMA(L), and enable, E(H), are inputs that enable RAMs, U3 and U4. Address A13 and A14 must be low while A7 and A8 determine which RAM is selected. The Read/Write mode is selected by the control signal placed on pin 16. The memory location in each RAM is selected by addresses A0 through A6. The RAM input/output is connected directly to the data bus D0 through D7.

Interface Bus Select Decoder

The Interface Bus Select Decoder, U7, is selected by a low on the Valid Memory Address line. Address lines A12, A13, and A14 are decoded to select the Interface Bus Select line IB SEL (L) (refer to Service Sheet 20).

ROM

ROM U5 is enabled by E(L), and A14(L) gating through U21B making line OE(L) active. To complete U5 enable requirements, VMA(L) is input to U5. Addresses A0 through A13 select the ROM memory location. The outputs of ROM U5 are connected directly to the Data Bus D0 through D7.

SERVICE SHEET 19

TROUBLESHOOTING USING KEYBOARD-INVOKED TEST 5 OR USING SIGNATURE ANALYSIS

Troubleshooting is done to the circuits of Service Sheet 19 when a defect seems to be related to the ROM or RAM circuits. The ROM troubleshooting information provided is firmware initiated tests on power-on, and keyboard-invoked tests. The RAM troubleshooting information provided is done using signature analysis. If nothing definite is discovered in performing these checks, refer to Service Sheet 17 or consider the other possibilities listed on Service Sheet BD4.

Test Equipment

Signature Analyzer .... HP 5005A

Test 1. Microprocessor and ROM Functional Checks

NOTE

Replacing the ROM can only be done by purchasing the A9 Attenuator Replacement Kit. Attenuation calibration data is located in the ROM. Therefore, the ROM can not be checked with Signature Analysis. ROM signatures change as firmware changes.

Purpose. Verify that ROM 1 is correctly operating.

Procedure. Follow the proceeding steps to identify any problems in ROM 1, or in the supporting circuitry to it.

1. Verify enabling of ROM 1 by checking that U18F pin 12, A11TP2 (ROM), and U18C pin 6 (VMA) are toggled.

2. When the POWER switch is set to ON an internal memory check is initiated. If a memory failure is detected, a RAM or ROM error code is shown in the FREQUENCY Display window. The error code remains displayed until any front-panel key is pressed. Refer to Table 1 "Power-On Error Codes" for the codes and the respecitve faults.

Table 1. Power-On Error Codes

Error Code	Fault	Address
10	Microprocessor RAM Error	0000-007F
11	RAM 1 Error	0080-00FF
12	RAM 2 Error	0100-017F
20	ROM Error 1st 4K	4000-4FFF
21	ROM Error 2nd 4K	5000-5FFF
22	ROM Error 3rd 4K	6000-6FFF
23	ROM Error 4th 4K	7000-7FFF
30	RAM and ROM Error	

SERVICE SHEET 19 (cont'd)

3. The ROM can be checked by entering the Keyboard-Invoked Test subroutine Test 5. The checksum of each 4K section of ROM is checked and an error code displayed if appropriate. The test will halt if a failure occurs after checking the entire memory. If an error does not occur, the test is repeated and a pass number in the AMPLITUDE Display is incremented.

- Enter the Keyboard-Invoked Tests by first pressing the "SHIFT" key, and then pressing the "INCR SET" key.
- Press the "AMPTD" up-arrow key until a "5" is shown in the MODULATION Display window. Test 5, ROM Test, is ready to run.
- Press the "INCR SET" key to start the test. The test will repeat until stopped.
- Press the "AMPTD" up-arrow key to stop the test.
- If the ROM is malfunctioning an error code will be shown in the FREQUENCY Display window. Refer to Table 2 for a list of the error codes.
- To exit the Keyboard-Invoked Tests, press the "AMPTD" up-arrow key until a "7" is displayed in the MODULATION Display window. Then press the "INCR SET" key; the Signal Generator is initialized as in Power-On.

Table 2. Keyboard-Invoked ROM Test Error Codes

Error Code	Fault	Address
50	ROM Error 1st 4K	4000-4FFF
51	ROM Error 2nd 4K	5000-5FFF
52	ROM Error 3rd 4K	6000-6FFF
53	ROM Error 4th 4K	7000-7FFF
55	Multiple ROM Errors	

Test 2. Microprocessor and RAM Functional Check Using Signature Analysis.

Purpose. To verify the ability to write and read to the three RAM. (RAM 3 is located in the Microprocessor U9; refer to Service Sheet 17.)

SERVICE SHEET 19 (cont'd)

NOTES

An abbreviated RAM check is performed at power-on. If a memory failure is detected, a RAM error code is shown in the FREQUENCY Display window. The error code remains displayed until any front-panel key is pressed. Refer to Table 3-1 "Power-On Error Codes" for the appropriate error codes.

It is possible to have a defective RAM and not have the error code displayed. If a failure occurs an attempt to display the error code in the FREQUENCY Display is made. The RAM itself is used to display the error code. The RAM may not have the ability to do so.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to "SA1" (A11TP7, refer to Service Sheet 18).
4) STOP to "SA4" (A11TP10, refer to Service Sheet 18)

Set the signature analyzer's controls as follows:

1) START-POSITIVE EDGE
2) STOP-NEGATIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Disconnect attenuator ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the R/R position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

The front-panel display does not change when this test is running.

SERVICE SHEET 19 (cont'd)

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature is incorrect this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to data lines D0-D7 at J2 (refer to Service Sheet 17). Verify that the RAM Data Transfer Signatures as indicated by Table 3 are correct.

An incorrect signature may indicate:

1) Improper setup
2) RAM program aborting
3) ROM program is incorrect (+5V signature is incorrect).
4) Incorrect addressing to RAM
5) Defective RAM.

NOTE

Go to Service Sheet 17 to test the addressing.

Table 3. RAM Data Transfer Signatures

Node	Correct Signature
+5V	C888
D0	3U02
D1	489H
D2	1560
D3	9A3A
D4	58U6
D5	9038
D6	35C7
D7	98HF

1) If the Signal Generator powers up without a ROM error code, then the program is correct.

2) If the +5V signature is correct, then the program is running.

Reset switch A11S1B back to the DIAG position, and reconnect ribbon cable W11 to A10J3.

SERVICE SHEET 19 (cont'd)

Test 3. Microprocessor and Individual RAM Functional Check Using Signature Analysis

Purpose. To test the data transfer of individual RAM.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to test points as indicated in Table 4.
4) STOP to test points as indicated in Table 4.

Set the signature analyzer controls as follows:

1) START-POSITIVE EDGE
2) STOP-NEGATIVE EDGE
3) CLK-NEGATIVE EDGE

Set the Signal Generator as follows:

1) Disconnect attenuator ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the R/R position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

The front-panel display does not change when this test is running.

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to the data lines D0-D7 at J2 (refer to Service Sheet 17). Verify that the individual RAM data transfer signatures are correct as indicated in Table 4.

SERVICE SHEET 19 (cont'd)

Table 4. Individual RAM Data Transfer Signatures

Node	Correct Signature	Comments
+5V	CU45	RAM 1 (U4)
D0	30H4	
D1	C372	STRT-SA.2
D2	5P69	STP-SA.3
D3	A585	
D4	5846	
D5	875F	
D6	CCFC	
D7	HPFU	
+5V	A2FP	RAM 2 (U3)
D0	4542	
D1	CU9P	STRT-SA.3
D2	1U1H	STP-SA.4
D3	F6P0	
D4	273C	
D5	AAU1	
D6	P5FA	
D7	669F	
+5V	1217	RAM 3 (U9 internal)
D0	66F4	
D1	356C	STRT-SA.1
D2	6F15	STP-SA.2
D3	0H43	
D4	4PC8	
D5	C2F6	
D6	17HU	
D7	C316	

Reset switch A11S1B back to the DIAG position, and reconnect the attenuator ribbon cable W11 to A10J3, and reset the Signal Generator by pressing the "SHIFT" key and then pressing the "0" key.

SERVICE SHEET 20

HP-IB INTERFACE

PRINCIPLES OF OPERATION

General

Inputs to the Signal Generator from the external controller are in the form of encoded control and data information. Control information is input to the Signal Generator via five control lines (four are used in this instrument) and three handshake lines. The control lines allow the controller to gain the Signal Generator's attention and impart other appropriate control information. The handshake lines provide asynchronous control information for data transfer between a talker (computer controller) and the listener (Signal Generator).

In the handshake mode, the Signal Generator first indicates when it is ready to listen (receive data). The controller responds by indicating when the data that appears on the data lines, DI01 through DI08, is valid. The Signal Generator then indicates to the controller when the data has been accepted.

Data transferred to the Signal Generator contains all the information required to control each mode of operation. It also contains the level or frequency information for each mode; for example, an AM depth of 50%, an RF output amplitude of -10 dBm, and a frequency of 100 MHz.

The HP-IB Address Switch Buffer U17 sends the Signal Generator's internally-set HP-IB address to U16 via the data lines when enabled by the HP-IB General Purpose Interface Adapter U16. The HP-IB Interface Buffers are enabled when IB Sel and Enable are low simultaneously. The ORing action of U21D enables U12 when IOB Sel (low) is active. The Read/Write mode determines if data is written onto or read from the Data Bus. Note that the Read/Write line is tied in parallel to the HP-IB Interface Buffers U12, and the HP-IB Interface Adapter U16.

HP-IB Data Bus and Control/Handshake Buffers

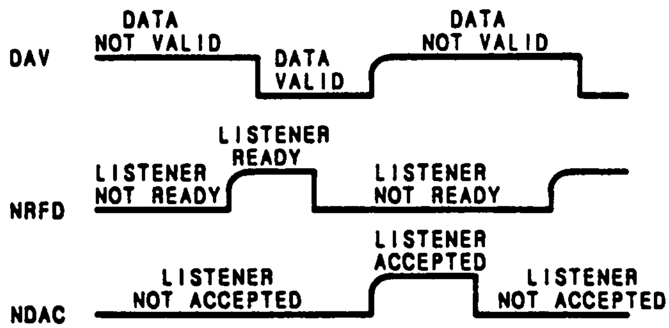
The HP-IB Data Bus and Control/Handshake Buffers are permanently enabled by hard-wire connections to ground. The HP-IB Data Bus output buffers are disabled (pins 3, 5, 11 and 13 of U28 and U24 are tied high) since the Signal Generator functions as a listener only. The Signal Generator does not have the capability to issue a service request (SRQ on U16 pin 23 and U25 pin 15 is not connected). The only outgoing signals are the handshake control lines NRFD and NDAC. See Figure 1 for more information about the HP-IB Handshake Control.

HP-IB Interface Adapter

The Interface Adapter U16 provides interfacing between the HP-IB connections to the external controller and the Signal Generator's digital circuits. The address select, ASE (L),and HP-IB Interrupt Request, IBI (L), are generated as a result of inputs from the external controller.

The Microprocessor, under the control of the HP-IB subroutines stored in ROM, outputs control and address signals to U16 to control the data input from the external controller. Interface Bus Select, IB SEL (L), selects the HP-IB mode. Addressing to register select lines RS0, RS1 and RS2 is input to U16 on A0, A1 and A2. Data and control information is thus selected to flow to and from the Microprocessor circuits on the data bus. Read/Write, R(H)/W(L), determines if data is written onto the data lines D0 through D7 or if the internal address is read by U16.

SERVICE SHEET 20 (cont'd)



Start with the talker waiting for the listener to release NRFD (not ready for data) indicating it is ready.

When the listener is ready, NRFD goes high (false). The talker then places valid data on DIO1 through DIO8 and sets DAV (data valid) low (true).

NRFD then goes low (true) and the talker waits for the listener to indicate it has accepted the data (or ignored it) by releasing the NDAC (not data accepted) to a high (false, i.e., data is accepted).

The talker sets DAV high (false) and again waits for the listener to release NRFD.

(NOTE that if ATN is true, all instruments on the bus must handshake regardless of whether they are talkers, listeners, or bystanders. Being in remote or local has nothing to do with handshaking. If ATN is false, they only handshake if addressed.)

Figure 1. Simplified HP-IB Handshake Between a Talker (Computer Controller) and One Listener (Signal Generator)

SERVICE SHEET 20

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 20 when a defect seems to be related to the HP-IB circuits. If the signatures are all correct, the instrument interface circuits from U16 to the Microprocessor are probably functional. Refer to paragraph 3-18 "HP-IB Functional Checks" in Section III to verify proper operation of the HP-IB interface circuits. This includes data, control, and handshake connections to the computer controller. Do not overlook the possibility that the HP-IB address switches are set to an address other than what was expected. The address switch setting may be checked by pressing the front-panel "SHIFT" key, and then holding the "LOCAL" (ADRS) key. As a last resort return to Service Sheet BD4 and consider the other possibilities shown.

Purpose. To verify transmission of data from the Microprocessor to the HP-IB General Purpose Interface Adapter A11U16.

Setup. Connect the signature analyzer as follows:

1) GND as close as possible to the circuitry being probed. Bad grounding can cause unstable signatures.
2) CLK to "E" (A11TP11, refer to Service Sheet 19).
3) START to "SA1" (A11TP7, refer to Service Sheet 18).
4) STOP to "SA2" (A11TP8, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-POSITIVE EDGE
2) STOP-NEGATIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Disconnect attenuator ribbon cable W11 from A10J3 on the Audio/Power Supply Assembly (refer to Service Sheet 8).
2) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
3) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than address 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0, and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the HP-IB address switches.

SERVICE SHEET 20 (cont'd)

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to each node indicated in Table 1. Verify that each signature is correct and stable.

Table 1. Interface Signatures

Node	Correct Signature
+5V	H6H5
U12#19	39A7
U16#4	6514
U16#7	69F8
U16#8	0444
U16#9	36A9
U16#10	FF2C
U16#11	U939
U16#12	P71U
U16#13	FH9F
U16#14	652F

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Reconnect attenuator ribbon cable W11 to A10J3. Reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

NOTE

If the HP-IB address switch was changed, reset the address switch to the original address. Then, set the front-panel POWER switch to STBY and back to ON.

SERVICE SHEET 21

KEYBOARD AND ENCODER

PRINCIPLES OF OPERATION

Keyboard Encoding (A1 and A2)

The Keyboard Assembly A1 is composed of 48 pushbuttons or keys. They are hard-wired in an 8-row by 6-column matrix. With no keys pressed, each of the 8-row lines are pulled high (+5V) through an 470 ohm resistor and each of the 6-column lines are pulled low (0V) through an 820 ohm resistor. The resultant keyboard data is shown in Table 1.

Whenever a key is pressed, a row line is connected to a column line through the dividing network of the 470 ohm and 820 ohm resistors (located on the Display Assembly A2). As long as the key remains pressed, the column line remains high and the keyboard interrupt remains issued to the Microprocessor by the Keyboard Interrupt Generator U19.

When the Microprocessor is interrupted, it enters its keyboard-read subroutine. A 5 *us* keyboard strobe (KSTB1) is decoded (refer to Service Sheet 22) to strobe the high bit found on Col 1 through Col 6 into the Key Column Data Latch/Shift Register U18. The column data consists of seven low bits and one high bit (refer to Table 1 and Service Sheet 21). The high bit is in the bit position that is associated with the column position of the pressed key.

Table 1. Keyboard Data (KDA) With No Keys Pressed

	Column Data (A2U18)								Row Data (A2U3)							
Pin Number	11	12	13	14	3	4	5	6	11	12	13	14	3	4	5	6
Bit Position	15*	14*	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Keyboard Data	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

*Bits 14 and 15 (U18 pins 11 and 12) are hard-wired low.

Once the column data is latched, the Microprocessor issues a Read Key Row Data (RKRD) signal (refer to Service Sheet 24) forcing all 6-column lines low so that the row data can be read. When the column lines are all forced low, the row line associated with the pressed key is also forced low. (Forcing the column lines low also disables the keyboard interrupt.) Next, another 5 *us* keyboard strobe (KSTB2) is decoded (refer to Service Sheet 22) to strobe Row 1 through Row 8 into the Key Row Data Latch/Shift Register U3. The row data consists of seven high bits and one low bit. The low bit is in the bit position that is associated with the row of the pressed key. Once the row data is latched, the Microprocessor clears RKRD.

The Microprocessor is now ready to receive keyboard data via the Serial Keyboard Data line (KDA). A parallel-to-serial conversion takes place as each row bit is shifted out of U3 (pin 9), and each column bit is shifted out of U18 (pin 9) into U3 (pin 10). After 16 keyboard clocks (KCL), all 16 bits of keyboard data is shifted to the Microprocessor. If the FREQUENCY key had been pressed, the resultant keyboard data sent to the Microprocessor would be as shown in Table 2.

SERVICE SHEET 21 (cont'd)

Table 2. Keyboard Data (KDA) With Frequency Key Pressed

	Column Data (A2U18)								Row Data (A2U3)							
Pin Number	11	12	13	14**	3	4	5	6	11	12**	13	14	3	4	5	6
Bit Position	15*	14*	13	12**	11	10	9	8	7	6**	5	4	3	2	1	0
Keyboard Data	0	0	0	1**	0	0	0	0	1	0**	1	1	1	1	1	1

*Bits 14 and 15 (U18 pins 11 and 12) are hard-wired low.
**Pressed key location.

Decoupling. Capacitors C1 through C10 filter the +5V supply to the Display Assembly circuitry.

SERVICE SHEET 21

TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 18 when a malfunction seems to have occurred on the keyboard or display. Perform the Troubleshooting Using Signature Analysis on Service Sheets 17, 18, and 19 before attempting to troubleshoot these circuits using this procedure. Procedures for checking the A1 Keyboard Assembly, and part of the A2 Display Assembly are given below. The areas or points to check are marked on the schematic by a hexagon with a checkmark and a number inside, e.g., ⟨√1⟩.

Troubleshooting Help

Service Sheet BD4
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

Test Equipment

Oscilloscope .... HP 1740A

⟨√1⟩ Keyboard Interrupt and Serial Keyboard Data Output to Microprocessor

1. Press any front-panel key.

2. Verify that a negative going pulse of about 5 volts occurs at A2TP10 (KIN) each time a key is pressed.

3. Verify that at least one pulse train about 16-bits long occurs at A2TP9 (KDA).

⟨√2⟩ Control Inputs from Microprocessor

1. Press any front-panel key.

2. Verify that a series of keyboard clock pulses appear on A2TP7 (KCL).

3. Verify that keyboard strobes appear on A2TP5 (RKRD), A2TP6 (KSTB 1), and A2TP8 (KSTB 2). Note that the signal on A2TP5 comes from the Amplitude Annunciator Latch A2U43 (shown on Service Sheet 24). The strobes for A2U43 as well as the strobes seen on A2TP6 and A2TP8 come from the strobe decoders A2U25 (shown on Service Sheet 22).

⟨√3⟩ Key Column Data Lines

1. Press a front-panel key.

2. Verify that the column data line which includes the pressed key is a positive-going pulse. The other column data lines should remain low.

SERVICE SHEET 21 (cont'd)

J4 Key Row Data Lines

1. Press a front-panel key.

2. Verify that the row data line that includes the pressed key is a negative-going pulse. The other row data lines should remain high.

SERVICE SHEET 21

TROUBLESHOOTING USING KEYBOARD-INVOKED TEST 4 OR USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 18 when a defect seems to be related to the keyboard. If nothing definite is discovered in performing the keyboard-invoked test or signature analysis on this service sheet, consider the other possibilities shown on Service Sheet BD4. Remember that the serial data from the keyboard encoding circuits does pass through the data bus buffers on the way to the Microprocessor (refer to Service Sheet 17). Also, several of the strobes, clocks, and control signals are decoded on the circuits of Service Sheet 18. The Load Keyboard Data Strobes are decoded on the circuits of Service Sheet 22. The Read Key Row Data Strobe is latched into A2U43 and is shown coming from Service Sheet 24.

Purpose. Verify transmission of encoded addresses from Keyboard to Microprocessor.

Refer to the paragraph 8-30 entitled "REPAIR" for front-panel keyboard disassembly instructions.

Keyboard-Invoked Test Procedure

The front-panel keyboard can be checked by entering the Keyboard-Invoked Test subroutine Test 4. This test allows for checking of the actual code which the Microprocessor (A11U9) sees when individual keys are pressed. Running this test will verify correct operation of the front-panel and supporting circuitry to the Microprocessor or will identify two problem areas as follows:

1) If the key code is incorrect when any front-panel key is pressed, but the last key code shown in the FREQUENCY Display remains, then the last pressed key is at fault.

2) If the key code is incorrect when any front-panel key is pressed, then the supporting circuitry to the Microprocessor is at fault (refer to Service Sheets 17 and 21).

- Enter the Keyboard-Invoked Tests by first pressing the "SHIFT" key, and then pressing the "INCR SET" key. A "1" should be shown in the MODULATION Display window.

- Press the "AMPTD" up-arrow key until a "4" is shown in the MODULATION Display window. Test 4, Keyboard Key Test, is ready to run.

- Press the "INCR SET" key to start the test. A "26" should be shown in the FREQUENCY Display window.

- Use Table 3, Keyboard Key Codes, to verify keyboard operation.

SERVICE SHEET 21 (cont'd)

- Whenever the "AMPTD" up-arrow or down-arrow key is pressed it is understood that the test is to be exited. A "00" is shown in the AMPLITUDE Display window, and the correct key code is shown in the FREQUENCY Display window. If the test was not meant to be exited, pressing the "INCR SET" key will immediately reinvoke Test 4.

- To exit the Keyboard-Invoked Tests, press the "AMPTD" up-arrow key until a "7" is shown in the MODULATION Display window. Then press the "INCR SET" key; the Signal Generator is initialized as in Power-On.

Table 3. Keyboard Key Codes

Value Decimal	Key Name	Value Decimal	Key Name
01	RF OFF/ON	25	0
02	LOCAL	26	INCR SET
03	RECALL	27	1
04	µV	28	DOWN AMPT (↓)
05	STORE	29	4
06	mV	30	UP AMPT (↑)
07	SEQ	31	7
08	V	32	AMPTD
09	EMF	33	DOWN FM (↓)
10	←	34	FINE TUNE
11	dB	35	DOWN FREQ (↓)
12	%	36	UP FREQ (↑)
13	dBf	37	COARSE TUNE
14	kHz	38	UP FM (↑)
15	dBm	39	FREQUENCY
16	MHz	40	FM
17	—	41	DOWN AM (↓)
18	.	42	OFF
19	3	43	SHIFT
20	2	44	INT 1 kHz
21	6	45	UP AM (↑)
22	5	46	INT 400 Hz
23	9	47	AM
24	8	48	EXT

Signature Analysis Procedure

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "SA4" (A11TP10, refer to Service Sheet 18).
3) START to "SA5" (A11TP13, refer to Service Sheet 18).
4) STOP to "SA5" (A11TP13, refer to Service Sheet 18).

SERVICE SHEET 21 (cont'd)

Set the signature analyzer's controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) Short "T02" (A2TP14) to ground (refer to Service Sheet 22).
4) Connect "SA6" (A11TP14, refer to Service Sheet 18) to "SA7" (A2TP1, refer to Service Sheet 22).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to "KDA" (A2TP9). Verify that each signature as indicated in Table 4 is correct and stable.

SERVICE SHEET 21 (cont'd)

Table 4. Keyboard Signatures

Key	Correct Signature
+5V	F84P
NO KEY	3FUA
LOCAL	1F38
SHIFT	89P3
EXT	0802
INT 400 Hz	4P01
INT 1 kHz	560H
OFF	363U
AM	35UF
AM UP	C9UA
AM DOWN	A2CA
FM	68U5
FM UP	2PU6
FM DOWN	F24H
FREQUENCY	550C
COARSE TUNE	H90H
FINE TUNE	56F8
FREQ UP	36UA
FREQ DOWN	P914
AMPTD	A91A
AMP UP	PU19
AMP DOWN	U715
INCR SET	9727
7	94P4
4	18P2
1	28UC
0	03A2
8	2AF5
5	6FF6
2	74FA

Key	Correct Signature
NO KEY	3FUA
.	14U8
9	173C
6	9C3H
3	AC24
-	807H
MHz	2H7A
kHz	6C79
NO KEY	3FUA
%	7375
←	1347
dBm	1084
dBf	9F82
dB	AF9C
EMF	87F2
V	2205
NO KEY	3FUA
mV	6406
µV	7F0A
SEQ	1UUC
STORE	93UH
RECALL	A3P4
RF OFF/ON	88CH

Reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Remove the short from "T02" (A2TP14) to ground, and disconnect "SA6" (A11TP14) from "SA7" (A2TP1).

If the HP-IB switch was changed, reset the address switch to the original address. Then set the front-panel POWER switch to STBY and back to ON.

SERVICE SHEET 22

DISPLAY CONTROL

PRINCIPLES OF OPERATION

Display Control

Sixteen bits of serial display data (DDA) are sent from the Microprocessor via the Serial I/O control circuits (refer to Service Sheet 18) to Display Data Shift Registers U24 and U23 respectively. Six of the eight bits stored in U24 are decoded to produce twelve display strobes (DSTB1 through DSTB12) and two keyboard strobes (KSTB1 and KSTB2). DSTB1 through DSTB3 are used to strobe modulation display data (refer to Service Sheet 24), DSTB5 through DSTB8 and DSTB12 are used to strobe frequency display data (refer to Service Sheet 23), DSTB8 through DSTB11 are used to strobe amplitude display data (refer to Service Sheet 24), and the two keyboard strobes (KSTB1 and KSTB2) are used to strobe column and row data from the keyboard (refer to Service Sheet 21). Strobe decoding takes place in the Display and Keyboard Strobe Decoders U26 and U25. The decoder outputs remain high until all 16 bits of display data are shifted in and settled.

Display data is shifted into the two shift registers by the display clock (DCL). Each transition of the display clock triggers U28A which forms part of the Serial Data Entry Timing Control circuitry. This circuitry is used to ensure that the data has at least 72 uSec to settle after the last clock pulse clocks the sixteenth data bit into U24. When U28A times out, it clocks U28B which goes high for 5 uSec to cause the bits stored in U24 to be decoded. During the period that the strobe is active (low), the display data stored in U23 will be decoded and latched to drive the respective 7-segment display or LED annunciator (refer to Service Sheets 23 and 24).

Frequency display decimal point drive is developed when display data bits 2 through 7 (DD2-DD7) are strobed into the Frequency Display Decimal Point Latches U30 by DSTB4. The Microprocessor ensures that only one of these bits is active (low) at any given time (except during the power-up subroutine). When one of these bits is active (low), the associated decimal point control line (U6 through U11-Pin 9) will be pulled high through the associated network resistor (R6A, R7A, R8A, R9A, R10A, and R11A) to light the respective decimal point (refer to Service Sheet 23). When the bits are inactive (high), the stored output will be inverted by the associated Frequency Display Decimal Point Driver U21B through U21G. This will cause the associated decimal point control line (U6 through U11-Pin 9) to be pulled low to inhibit the respective decimal point from being lit.

SERVICE SHEET 22

TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 22 when a malfunction seems to have occurred in the keyboard or display. Perform the Troubleshooting Using Signature Analysis on Service Sheets 17, 18, and 19 as well as the Troubleshooting on Service Sheet 21 before attempting to troubleshoot these circuits using this procedure Procedures for checking part of the A2 Display Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., ⟨√1⟩.

Test Equipment

Oscilloscope .... HP 1740A

⟨√1⟩ Display Clocks

1. Verify that the display changes and/or the correct strobe occurs with each keystroke as shown in Table 1.

Table 1. Active Display Strobe versus Change in Displayed Information

Display Strobe	Change in Displayed Information
DSTB1	HP-IB annunciators REMOTE or ADDRESS Modulation decimal point Modulation annunciators % or kHz DC FM annunciator
DSTB2	Modulation annunciators: EXT AM, INT AM, EXT FM, INT FM, HI EXT, LO EXT, 400 Hz or 1 kHz
DSTB3	Modulation digits 1 or 2
DSTB4	Frequency decimal point
DSTB5	Frequency digit 1 or 2
DSTB6	Frequency digit 3 or 4
DSTB7	Frequency digit 5 or 6
DSTB8	Frequency digit 7 or amplitude digit 2
DSTB9	Amplitude digit 3 or 4
DSTB10	Amplitude digit 1, amplitude digit decimal point or the amplitude sign (plus or minus)
DSTB11	Amplitude annunciators: dBm, dBf, dB, EMF, V, mV, or μV or RKRD* (Read Key Row Data)
DSTB12	Frequency digit 8
KSTB1	any key*
KSTB2	any key*

*DSTB11 (due to RKRD), KSTB1 and KSTB2 are strobed each time a key is pressed.

SERVICE SHEET 22 (cont'd)

⟨√2⟩ Serial Data Entry and Timing

1. Verify that U28B pin 5 goes high for 5 μSec but 72 μSec after the last clock pulse ends.

2. Verify that a clock pulse train occurs at A2TP11 (DCL) for each keystroke.

SERVICE SHEET 22

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 22 when a defect seems to be related to the front-panel displays or keyboard operation. The troubleshooting provided is signature analysis although looking at the various displays or realizing that the problem is due to a keyboard malfunction may provide more information about a possible defect. If all the signatures on this service sheet are correct, take another look at the symptoms which brought you to this service sheet. Determine if the problem may be related to circuitry contained on Service Sheets 21, 23 or 24. If any signatures on this service sheet are incorrect, recall that the data and strobes, clocks, and other control signals are passed through circuitry of Service Sheet 18 before arriving here. As a last resort, return to Service Sheet BD4 and consider the other possibilities shown.

Test Equipment

Signature Analyzer .... HP 5005A

Test 1. Display Data Transmission Check

Purpose. To verify transmission of encoded display data from the Microprocessor to the Display Address and Display Data Shift Registers.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) CLK to "SA4" (A11TP10, refer to Service Sheet 18).
3) START to "SA5" (A11TP13, refer to Service Sheet 18).
4) STOP to "SA5" (A11TP13, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) Connect a jumper from T02 (A2TP14) to ground (refer to Service Sheet 22).
4) Connect a jumper between SA6 (A11TP14, refer to Service Sheet 18), and SA7 (A2TP1, refer to Service Sheet 22).

SERVICE SHEET 22 (cont'd)

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTE

With careless probing it is possible to get the Microprocessor into a program sequence other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then connect A11TP4 (NMI) to A11TP3 (GND).

Probe. Connect the signature analyzer probe to each node shown in Table 2. Verify that each signature is correct and stable.

Table 2. Display Data Signatures

Node	Correct Signature	Comments
+5V	F84P	
U24#8*	F84P	DISP CLK
U24#1	6UPP	DISP DATA
U24#3	8A0H	
U24#4	HCH1	
U24#5	F06F	
U24#6	F672	
U24#10	05C8	
U24#11	2235	
U24#12	6UH4	
U24#13	37PA	
U23#3	2UAU	
U23#4	7241	
U23#5	P6U4	
U23#6	A161	
U23#10	890U	
U23#11	FH78	
U23#12	C382	
U23#13	7758	

*Probe tip should blink.

SERVICE SHEET 22 (cont'd)

If troubleshooting is completed and the signatures are taken, reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Disconnect the jumper from T02 (A2TP14) to ground, and disconnect the jumper between SA6 (A11TP14) and SA7 (A2TP1). Also, if the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Then reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

Test 2. Display Strobe Data Transmission and Decoder Check.

Purpose. To verify transmission of encoded display strobe data from the Microprocessor through the Display Strobe Decoders.

Setup. Connect the signature analyzer as follows:

1) CLK to "E" (A11TP11, refer to Service Sheet 19).
2) START to "SA1" (A11TP7, refer to Service Sheet 18).
3) STOP to "SA2" (A11TP8, refer to Service Sheet 18).

Set the signature analyzer's controls as follows:

1) START-OUT
2) STOP-IN
3) CLK-IN

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) Connect a jumper between T02 (A2TP14) and ground (refer to Service Sheet 22).
4) Connect a jumper between SA6 (A11TP14, refer to Service Sheet 18), and SA7 (A2TP1, refer to Service Sheet 22).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

SERVICE SHEET 22 (cont'd)

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTES

With careless probing, it is possible to get the Microprocessor into a program routine other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

All LEDs should be cycling on and off rapidly.

Probe. Connect the signature analyzer probe to each node shown in Table 3. Verify that each signature is correct and stable.

Table 3. Display and Keyboard Strobe Signatures

Node	Correct Signature*	Comments
+5V	H6H5	
U26#7	C524	
U26#9	FU10	
U26#10	66UF	
U26#11	1F0A	
U26#12	5A73	
U26#13	P3HA	
U26#14	A128	
U26#4	FP00	
U26#6	H6H5	no blink
+5V	H6H5	
U25#9	H161	
U25#10	CP72	
U25#11	93AH	
U25#12	PH45	
U25#13	FF4P	
U25#14	8H64	
U25#4	FP00	
U25#6	H6H5	no blink

*Probe tip should blink.

SERVICE SHEET 22 (cont'd)

If troubleshooting is completed and the signatures are taken, reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Disconnect the jumper from T02 (A2TP14) to ground, and disconnect the jumper between SA6 (A11TP14) and SA7 (A2TP1). Also, if the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Then reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

Test 3. Decimal Point Data Transmission Check

Purpose. To verify transmission of encoded decimal point data from the Microprocessor to the Frequency Display Decimal Point Latch.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) START to "SA5" (A11TP13, refer to Service Sheet 18).
3) STOP to "SA5" (A11TP13, refer to Service Sheet 18).
4) CLK to "SA4" (A11TP10, refer to Service Sheet 18)

Set the signature analyzer's controls as follows:

1) START-IN
2) STOP-OUT
3) CLK-IN

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) Connect a jumper between T02 (A2TP14) and ground (refer to Service Sheet 22).
4) Connect a jumper between SA6 (A11TP14, refer to Service Sheet 18), and SA7 (A2TP1, refer to Service Sheet 22).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

SERVICE SHEET 22 (cont'd)

NOTES

With careless probing, it is possible to get the Microprocessor into a program routine other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

All LEDs should be cycling on and off rapidly

Probe. Connect the signature analyzer probe to each node shown in Table 4. Verify that each signature is correct and stable.

Table 4. Decimal Point Signatures

Node	Correct Signature	Comments
+5V	F84P	
U30#2	F9H9	FR DP 3
U30#5	8C19	FR DP 2
U30#7	54PH	FR DP 1
U30#10	7903	FR DP 4
U30#12	A44F	FR DP 5
U30#15	5FC5	FR DP 6

If troubleshooting is completed and the signatures are taken. reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Disconnect the jumper from T02 (A2TP14) to ground, and disconnect the jumper between SA6 (A11TP14) and SA7 (A2TP1). Also, if the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Then reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 23
FREQUENCY DISPLAYS

General

Eight 7-segment, common-cathode devices U6 through U13 are used to display the frequency in megahertz. They are also used to display the frequency increment value, to display power-on error codes, and to display information for the keyboard-invoked tests. The decimal points associated with frequency digits 1 through 6 are the only decimal points that can be lit. The frequency display decimal point drive circuitry has been previously discussed (refer to Service Sheet 22). Frequency Digits 7 and 8 have their decimal point control line (U12 and U13-Pin 9) tied low which inhibits them from being lit.

Eight Latch/Decoder/Drivers U31 through U38 decode frequency display data, store the decoded data, and drive the associated frequency display digit. The associated resistor networks R6 through R13 are used to limit the amount of drive current applied to the display digit. As previously mentioned 16 bits of serial display data are sent from the Microprocessor to the display circuitry (refer to Service Sheet 22). After a serial-to-parallel conversion, the eight most-significant bits are stored in the Display Data Shift Register U23, and the eight least-significant bits are stored in the Display Address Shift Register U24. Six of the eight display address bits are decoded to produce twelve displa strobes and two keyboard strobes. Display strobes DSTB5 through DSTB8 and DSTB12 are used to strobe the frequency display data (DD0 through DD7) into the Latch/Decoder/Drivers. DSTB8 also strobes the display data for Amplitude Digit 2 at the same time it strobes the display data for Frequency Digit 7 (refer to Service Sheet 24). When a strobe is decoded, it will go low for 5 uSec to latch a half byte (4 bits) of frequency display data into the associated Latch/Decoder/Driver. Each Latch/Decoder/Driver is hard-wired to decode and drive the associated digit to display numerals 0 through 9, otherwise the digit remains blanked.

SERVICE SHEET 23

TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 23 when a malfunction seems to be associated with the FREQUENCY Display. Determine if the malfunction occurs in single digits, pairs (such as frequency digits 1 and 2, 3 and 4, and 5 and 6, or multiple digits including the amplitude and/or modulation digits. If multiple digit displays are incorrect, be sure to:

1) Perform the Troubleshooting Using Signature Analysis on Service Sheets 17, 18 and 19

2) Then, perform the Troubleshooting on Service Sheets 21 and 22.

If pairs of digits are incorrect, suspect the shift registers shown on Service Sheet 22 If single digits are incorrect, continue troubleshooting on this service sheet for amplitude or modulation display problems.

Procedures for checking part of the A2 Display Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., √1.

Test Equipment

Oscilloscope .... HP 1740A

√1 Frequency Display Digital Drive Levels versus Visual LED Outputs.

1. Verify that the 7-segment drive logic levels from the Latch/Decoder/Drivers matches the visual output for the equivalent segment.

2. Verify that the decimal point drive from the latch and drivers (refer to Service Sheet 22) matches the visual decimal point output.

SERVICE SHEET 23

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 23 when a defect seems to be related to the RF FREQUENCY Display. If nothing definite is discovered in performing these signature analyzer checks, consider the other possibilities shown on Service Sheet BD4. If any of the signatures are incorrect, recall that the data passes through circuitry on Service Sheets 18 and 22 before arriving here.

Test Equipment

Signature Analyzer .... HP 5005A

Purpose. To verify transmission of encoded display data from the Microprocessor to the frequency display drivers.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) START to "SA5" (A11TP13, refer to Service Sheet 18).
3) STOP to "SA5" (A11TP13, refer to Service Sheet 18).
4) CLK to "SA4" (A11TP10, refer to Service Sheet 18)

Set the signature analyzer's controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).
2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).
3) Connect a jumper between T02 (A2TP14) and ground (refer to Service Sheet 22).
4) Connect a jumper between SA6 (A11TP14, refer to Service Sheet 18), and SA7 (A2TP1, refer to Service Sheet 22).

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

SERVICE SHEET 23 (cont'd)

Table 1. Frequency Display Data Signatures

Node	Correct Signature	Comments	Node	Correct Signature	Comments
+5V	F84P		+5V	F84P	
U31#9	54A0	FR DIG 1	U35#9	UH23	FR DIG 5
U31#10	0H80		U35#10	7880	
U31#11	09FF		U35#11	4135	
U31#12	1HAA		U35#12	55PC	
U31#13	01H8		U35#13	A492	
U31#14	FU58		U35#14	AP11	
U31#15	3A9C		U35#15	8F6F	
+5V	F84P		+5V	F84P	
U32#9	H9PA	FR DIG 2	U36#9	2C1A	FR DIG 6
U32#10	1353		U36#10	3168	
U32#11	UA1C		U36#11	UUU9	
U32#12	PFF5		U36#12	26HP	
U32#13	25F6		U36#13	PHP1	
U32#14	4AH1		U36#14	1U22	
U32#15	5554		U36#15	82C0	
+5V	F84P		+5V	F84P	
U33#9	7059	FR DIG 3	U37#9	9F11	FR DIG 7
U33#10	3P0P		U37#10	1F17	
U33#11	13PC		U37#11	8582	
U33#12	C4P5		U37#12	PUHF	
U33#13	6PC6		U37#13	HUU9	
U33#14	133P		U37#14	A360	
U33#15	CC02		U37#15	6847	
+5V	F84P		+5V	F84P	
U34#9	F3A2	FR DIG 4	U38#9	F845	FR DIG 8
U34#10	C22P		U38#10	F59U	
U34#11	P8U9		U38#11	899F	
U34#12	U339		U38#12	032A	
U34#13	U1H0		U38#13	PH8F	
U34#14	9209		U38#14	6697	
U34#15	2659		U38#15	H71C	

SERVICE SHEET 23 (cont'd)

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTES

With careless probing, it is possible to get the Microprocessor into a program routine other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

All LEDs should be cycling on and off rapidly.

Probe. Connect the signature analyzer probe to each node shown in Table 1. Verify that each signature is correct and stable.

If troubleshooting is completed and the signatures are taken, reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Disconnect the jumper from T02 (A2TP14) to ground, and disconnect the jumper between SA6 (A11TP14) and SA7 (A2TP1). Also, if the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Then reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 24

AMPLITUDE, MODULATION, AND ANNUNCIATOR DISPLAYS

Modulation Display

Two 7-segment, common-cathode devices U4 and U5 are used to display the level of modulation, either the AM depth in percent or the FM peak deviation in kilohertz. They are also used to display the modulation increment value as well as the internally-set decimal HP-IB address. The decimal point associated with Modulation Digit 1 is the only decimal point that can be lit. Modulation Digit 2 has its decimal point control line (U5 Pin 9) tied low which inhibits it from being lit. Decimal point drive is developed when display data bit 5 (DD5) is strobed into the HP-IB/Modulation Annunciator Latches U1 by DSTB1. When DD5 is active (low), the decimal point control line of Modulation Digit 1 (U4-Pin 9) will be pulled high by resistor R14B from the +5V power supply to light the decimal point. When DD5 is inactive (high), the stored output will be inverted by the MD1dp Driver U21A. This will cause the decimal point control line of Modulation Digit 1 (U4 Pin 9) to be pulled low to inhibit the decimal point from being lit.

Two Latch/Decoder/Drivers U27 and U29 are used to decode modulation display data, store the decoded data, and drive the associated modulation display digit. The associated resistor networks R14 and R16 are used to limit the amount of drive current applied to the display digit. As previously mentioned (refer to Service Sheet 22), 16 bits of serial display data are sent from the Microprocessor to the display circuitry. After a serial-to-parallel conversion, the eight most-significant bits are stored in the Display Data Shift Register U23 and the eight least-significant bits are stored in the Display Address Shift Register U24. Six of the eight display address bits are decoded to produce twelve display strobes and two keyboard strobes. Display strobe DSTB3 is used to strobe the modulation display data (DD0 through DD7) into the two Latch/Decoder/Drivers. When the strobe is decoded, it will go low for 5 uSec to latch a half byte (4 bits) of modulation display data into the associated Latch/Decoder/Driver. Each Latch/Decoder/Driver is hard-wired to decode and drive the associated digit to display only numerals 0 through 9 (otherwise the digit remains blanked)

Modulation/HP-IB Annunciators

There are eleven LED annunciators associated with the MODULATION Display. These annunciators light to indicate modulation units, source selection, or an external source over or under range condition. In addition, there are two LED annunciators used to indicate remote operation status. As in the case of the other displays, 16 bits of serial display data are sent from the Microprocessor, parallel converted, stored, and decoded. Modulation and HP-IB annunciator display data bits are always active low. Display strobe DSTB1 is used to strobe modulation or HP-IB annunciator display data (DD2 through DD7) into the Modulation/HP-IB Annunciator Latches U1, and DSTB2 is used to strobe modulation annunciator display data (DD0 through DD7) into the Modulation Annunciator Latches U2. When a strobe is decoded, it will go low for 5 uSec to latch the modulation or HP-IB annunciator display data. When the stored bit is active (low), the associated LED annunciator DS1 through DS12, and DS20 will light as current is drawn through the associated network resistors R15 and R27.

SERVICE SHEET 24 (cont'd)

Amplitude Display

One 5-segment, universal "+1" device U14 and three 7-segment, common-cathode devices U15 through U17 are used to display the RF output amplitude level. They are also used to display the amplitude increment value, as well as the current contents of the sequence counter. The decimal points associated with Amplitude Digits 1 through 3 are the only decimal points that can be lit Amplitude Digit 4 has its decimal point control line (U17-Pin 9) tied low which inhibits it from being lit. Decimal point drive is developed when display data bits 2, 3, and 4 are strobed into the Amplitude Display Latches U39 by DSTB10. The Microprocessor ensures that only one of these bits is active (low) at any given time (except during the power-up subroutine). When one of these bits is active (low), the associated decimal point control line (U14-Pin 8, U15-Pin 9, or U16-Pin 9) will be pulled high through the series resistor R12A, R17A, or R18A to light the respective decimal point. When the bits are inactive (high) the stored output will be inverted by the associated decimal point driver U22D, U22E, or U22F. This will cause the associated decimal point control line (U14-Pin 8, U15-Pin 9, or U16-Pin 9) to be pulled low to inhibit the respective decimal point from being lit.

Plus or minus sign drive is produced in much the same manner as that used to light the amplitude display decimal points. The minus sign, which is part of Amplitude Digit 1, lights when display data bit 6 (DD6) is strobed into U39 by DSTB10. When DD6 is active (low), the minus sign control line (U14-pin 4) is pulled low through the series resistor R19 to light the minus sign. The plus sign requires that display data bits 6 and 7 (DD6 and DD7) both be strobed into U39 by DSTB10. Just as in the case of the minus sign when DD6 is active (low), the horizontal segment of the plus sign will light. In addition, when DD7 is active (low), the two vertical segment control lines (U14-pins 2 and 6) will be pulled high through the series resistor R21 to light the two vertical segments of the plus sign display. When DD7 is inactive (high), the stored output will be inverted by the AD1 Sign Driver U22B. This will cause the two vertical segment control lines (U14-pins 2 and 6) to be pulled low to inhibit the two vertical segments of the plus sign display from being lit.

Three Latch/Decoder/Drivers U40 through U42 are used to decode amplitude display data, store the decoded data, and drive the associated amplitude display digit. The associated resistor networks R17, R18, and R23 are used to limit the amount of drive current applied to the display digit. As previously mentioned (refer to Service Sheet 22), 16 bits of serial display data are sent from the Microprocessor to the display circuitry. After a serial-to-parallel conversion, the eight most-significant bits are stored in the Display Data Shift Register U23 and the eight least-significant bits are stored in the Display Address Shift Register U24. Six of the eight display address bits are decoded to produce twelve display strobes and two keyboard strobes. Display strobes DSTB8 and DSTB9 are used to strobe the amplitude display data (DD0 through DD7) into the three latch/decoder/drivers. When a strobe is decoded, it will go low for 5 us to latch a half byte (4 bits) of amplitude display data into the associated Latch/Decoder/Driver. Each Latch/Decoder/Driver is hard-wired to decode and drive the associated digit to display numerals 0 through 9, otherwise the digit remains blanked.

SERVICE SHEET 24 (cont'd)

Amplitude Annunciators

There are seven LED annunciators associated with the AMPLITUDE Display. These annunciators light to display amplitude units information. As in the case of the other displays, 16 bits of serial display data are sent from the Microprocessor, parallel converted, stored, and decoded. Amplitude annunciator display data bits are always active low Display strobe DSTB11 is used to strobe amplitude annunciator display data (DD1 through DD7) into the Amplitude Annunciator Latches U43. When the strobe is decoded, it will go low for 5 uSec to latch the amplitude annunciator display data. When the stored bit is active (low), the associated LED annunciator DS13 through DS19 will light as current is drawn through the associated network resistor R22.

Display strobe DSTB11 is also used to strobe display data bit 0 (DD0) into the Amplitude Annunciator Latches U43 to force all six keyboard column lines low so that the row data can be read (refer to Service Sheet 21). When DD0 is active (high) a signal to read key row data (RKRD) will be issued to the keyboard encoding circuitry. This signal remains stored until the row data has been latched, then it will be cleared by the Microprocessor.

SERVICE SHEET 24

TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 24 when a malfunction seems to be associated with the Amplitude or Modulation Displays. Determine if the malfunction occurs in single digits, pairs (such as amplitude digits 3 and 4, digit and the decimal point, and so forth. Refer to Table 1 on Service Sheet 22 for reference, or if the malfunction occurs with multiple digits (including the amplitude and/or modulation digits) be sure to:

1. Perform the Troubleshooting Using Signature Analysis on Service Sheets 17, 18, and 19.

2. Then, perform the Troubleshooting on Service Sheets 21 and 22.

If pairs of digits are incorrect, perform the troubleshooting on Service Sheet 22. If single digit displays are incorrect, continue troubleshooting on this service sheet for amplitude or modulation display problems.

Procedures for checking part of the A2 Display Assembly circuits are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., √1.

Test Equipment

Oscilloscope .... HP 1740A

√1 Amplitude and Modulation Display Digital Drive Levels versus Visual LED Output

1. Verify that the 7-segment drive logic level from the Latch/Decoder/Drivers matches the visual output for the equivalent segment.

2. Verify that the decimal point drive from the latches and drivers matches the visual decimal point output.

√2 Annunciator's Digital Drive Levels versus Visual LED Outputs

1. If the digital drive level is low, the LED output should be lit.

SERVICE SHEET 24

TROUBLESHOOTING USING SIGNATURE ANALYSIS

Troubleshooting is done on the circuits of Service Sheet 24 when a defect seems to be related to the modulation, amplitude or annunciator displays. If nothing definite is discovered in performing these signature analyzer checks, consider the other possibilities shown on Service Sheet BD4. If any of the signatures are incorrect, recall that the display and strobe data transfer passes through circuitry on Service Sheets 18 and 22 before arriving here.

Test Equipment

Signature Analyzer .... HP 5005A

Purpose. To verify transmission of encoded display data from the Microprocessor to the modulation, amplitude and annunciator display drivers.

Setup. Connect the signature analyzer as follows:

1) GND to "GND" (A11TP3, refer to Service Sheet 17).
2) START to "SA5" (A11TP13, refer to Service Sheet 18).
3) STOP to "SA5" (A11TP13, refer to Service Sheet 18).
4) CLK to "SA4" (A11TP10, refer to Service Sheet 18)

Set the signature analyzer's controls as follows:

1) START-NEGATIVE EDGE
2) STOP-POSITIVE EDGE
3) CLK-NEGATIVE EDGE

Set up the Signal Generator as follows:

1) Set switch A11S1C to the L/K position (refer to Service Sheet 17).

2) Set switch A11S1B to the DSA position (refer to Service Sheet 17).

3) Connect a jumper between T02 (A2TP14) and ground (refer to Service Sheet 22).

4) Connect a jumper between SA6 (A11TP14, refer to Service Sheet 18), and SA7 (A2TP1, refer to Service Sheet 22).

SERVICE SHEET 24 (cont'd)

NOTE

If the Signal Generator's HP-IB address switch has been set to anything other than 07, the signatures taken in this test will be incorrect. In this case, reset the address switches to A1=1, A2=1, A3=1, A4=0 and A5=0. Refer to paragraph 2-8 "HP-IB Address Selection" for the procedure to change the address switches.

Initialize. Briefly connect A11TP4 (NMI) to A11TP3 (GND) (refer to Service Sheet 17).

NOTES

With careless probing, it is possible to get the Microprocessor into a program routine other than that portion intended for signature analysis. If the +5V signature is incorrect, this has probably happened. Restart the test by briefly connecting A11TP12 (RESET) to A11TP3 (GND). Then briefly connect A11TP4 (NMI) to A11TP3 (GND).

All LEDs should be cycling on and off rapidly.

Probe. Connect the signature analyzer probe to each node shown in Tables 1, and 2. Verify that each signature is correct and stable.

Table 1. Decoded Amplitude Signatures

Node	Correct Signature	Comments
+5V	F84P	
U39#2	P401	AP DIG 1
U39#5	9CA4	AP±
U39#7	2AFA	
U39#10	620C	AP DP 1
U39#12	580P	AP DP 2
U39#15	22FC	AP DP 3
+5V	F84P	
U40#9	UP60	AP DIG 2
U40#10	9P35	
U40#11	4CH5	
U40#12	PH98	
U40#13	AA91	
U40#14	71F0	
U40#15	0276	
+5V	F84P	
U42#9	0U7H	AP DIG 4
U42#10	7P96	
U42#11	CH03	
U42#12	8291	
U42#13	180P	
U42#14	1732	
U42#15	19P2	

SERVICE SHEET 24 (cont'd)

Table 2. Decoded Annunciator Signatures

Node	Correct Signature	Comments
+5V	F84P	
U1#2	4PF5	MD DP 1
U1#5	046A	ADRS
U1#7	49UH	RMT
U1#10	27FA	%
U1#12	C73C	kHz
U1#15	61PO	DC FM
+5V	F84P	
U2#2	FP81	HI EXT
U2#5	34C1	EXT FM
U2#6	3U35	LO EXT
U2#9	352H	EXT AM
U2#12	8405	1 kHz
U2#15	AFPC	INT AM
U2#16	UCFP	INT FM
U2#19	4489	400 Hz
+5V	F84P	
U43#2	3C63	dB
U43#5	7HC8	dBf
U43#6	FU7A	EMF
U43#9	962P	dBm
U43#12	P54A	RD KY WRD
U43#15	UCU0	VOLTS
U43#16	PHCC	mV
U43#19	8U6F	μV

If troubleshooting is completed and the signatures are taken, reset switch A11S1C back to the R/R position, and switch A11S1B back to the DIAG position. Disconnect the jumper from T02 (A2TP14) to ground, and disconnect the jumper between SA6 (A11TP14) and SA7 (A2TP1). Also, if the HP-IB address switch was changed, reset the address switch (Service Sheet 20) to the original address. Then reset the Signal Generator by pressing the "SHIFT" key, and then pressing the "0" key.

SERVICE SHEET 25

POWER SUPPLY

PRINCIPLES OF OPERATION

General

The six dc power supplies are +24 Vdc unregulated, +15.9 Vdc regulated, +15 Vdc regulated, +5 Vdc regulated, +5 Vdc regulated (standby/memory), and -15 Vdc regulated. The +15.9V is for the Heterodyne Pad Driver (Attenuator). There are two types of overvoltage protection circuits. The first limits the unregulated voltage input to the ±15 volt supplies. The second type limits the voltage out of the +5 volt supply to the Signal Generator's circuits.

+24V Unregulated Supply and +15.9 Vdc Regulated Supply

The ac voltages from the secondary of the power transformer are rectified by diodes A10CR8 and CR9 for the +24 Vdc unregulated voltage. The unregulated +24 volts supplies current to the crystal oven's heater when the high stability time base, Option 001 is installed. The unregulated +24 volts is regulated by series regulator A10U2 to +15.9 volts for the Heterodyne/Pad Driver A6U3 only.

Regulated +15, +5, and -15 Volt Supplies

The ac voltages from the secondary of the power transformer are rectified by diodes A10CR10, CR11,CR12, and CR13 for the +15 and -15 Vdc unregulated voltages. The +5 volts dc supply's unregulated voltage is from rectifiers located within the rear-panel. Relay A10K1 is de-energized when the front-panel POWER switch is in the STBY position and the lines to the series regulator are opened.

Diodes A10CR14, CR15, and CR16 protect the series regulators, U1, U2, and U3. If the output voltage of the series regulators goes more positive than the unregulated input voltage the diodes are turned on. This keeps the regulators from being reverse biased if an output is connected to a higher voltage.

The overvoltage protection circuit at the input of the +15 and -15V power supplies (A10VR4, R84, C27 and Q3) protects the supplies from excess line voltage. The unregulated voltages for the +15 and -15 Vdc supplies are about +25 and -25 Vdc. The 68.1 volt zener diode A10VR4 and its accompanying components is connected between the two supplies. The normal voltage across the zener diode is approximately 50 Vdc. When the voltage exceeds the threshold of 68.1 volts, the zener turns on. Current is drawn through A10R84 which charges A10C27 until A10Q3 fires. Then the line fuse blows.

The +5V Crowbar (overvoltage protection) circuit consists of A10VR6, R103, R104 and Q1. The circuit protects the +5 volt supply if is is shorted to the +15 Vdc supply or other positive voltage greater than the threshold voltage of A10VR6 (+6.2 volts). In this situation, A10VR6 turns on and draws enough current through A10R103 to fire A10Q1. This blows the +5 volt supply fuse.

SERVICE SHEET 25 (cont'd)

LED's A10DS1, DS2, DS3, DS4,and DS5 are lit when the power supplies are providing an output voltage. Resistors A10R109, R105, R106, R107, and R108, respectively, set the current through the LEDs. Inductors A10L1, L2, and L3 and capacitors A10C26, C28, C30, C35, C36, C37, C38, C39, and C40 isolate and filter the associated supplies.

The +5V (STBY/MEMORY) voltage, is regulated by series regulator A10U4 and filtered by A10C42. The Standby/Memory voltage is switched to RAM A11U3 by A11S1A (refer to Service Sheet 19).

SERVICE SHEET 25

TROUBLESHOOTING

Procedures for checking the circuits shown on Service Sheet 25 are given below. The area or points to check are marked on the schematic by a hexagon with a check mark and a number inside, e.g., √3. Fixed voltages are shown on the schematic inside a hexagon, e.g., 2V±0.2V. Transistor bias voltages are shown without tolerances.

Troubleshooting Help

Service Sheet BD1
Table 4-1. Abbreviated Performance Tests
Table 5-2. Post-Repair Adjustments

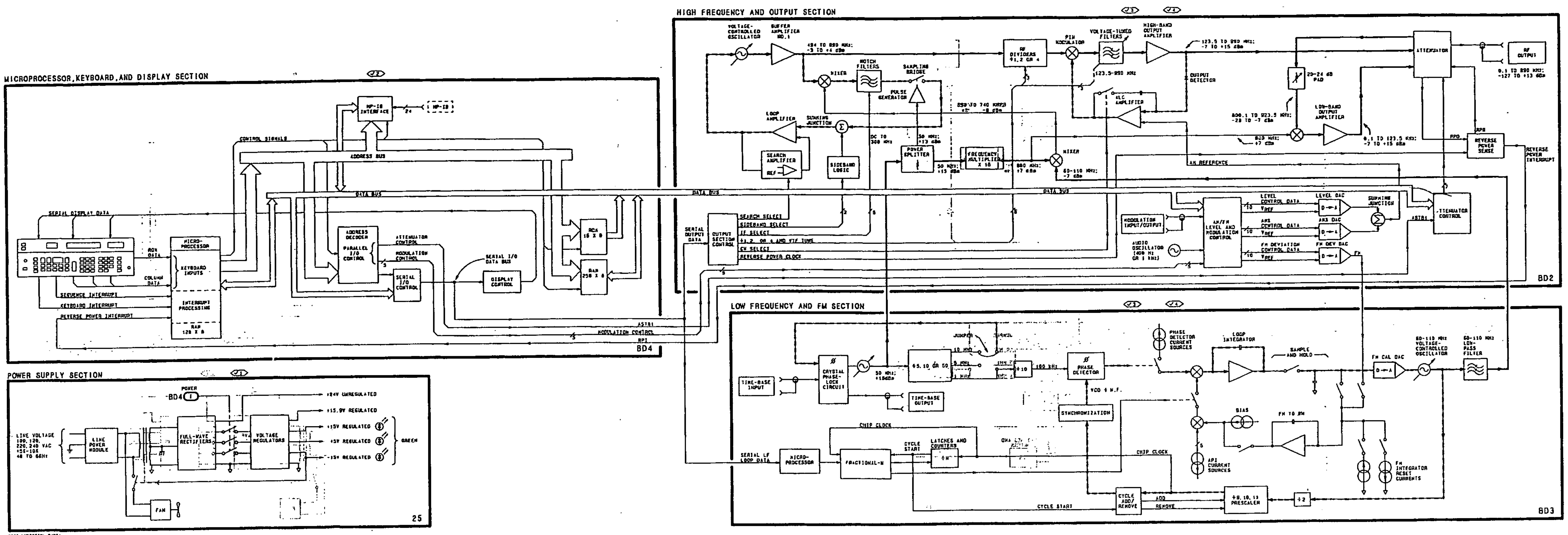
Test Equipment

Digital Multimeter .... HP 3466A
Oscilloscope .... HP 1740A

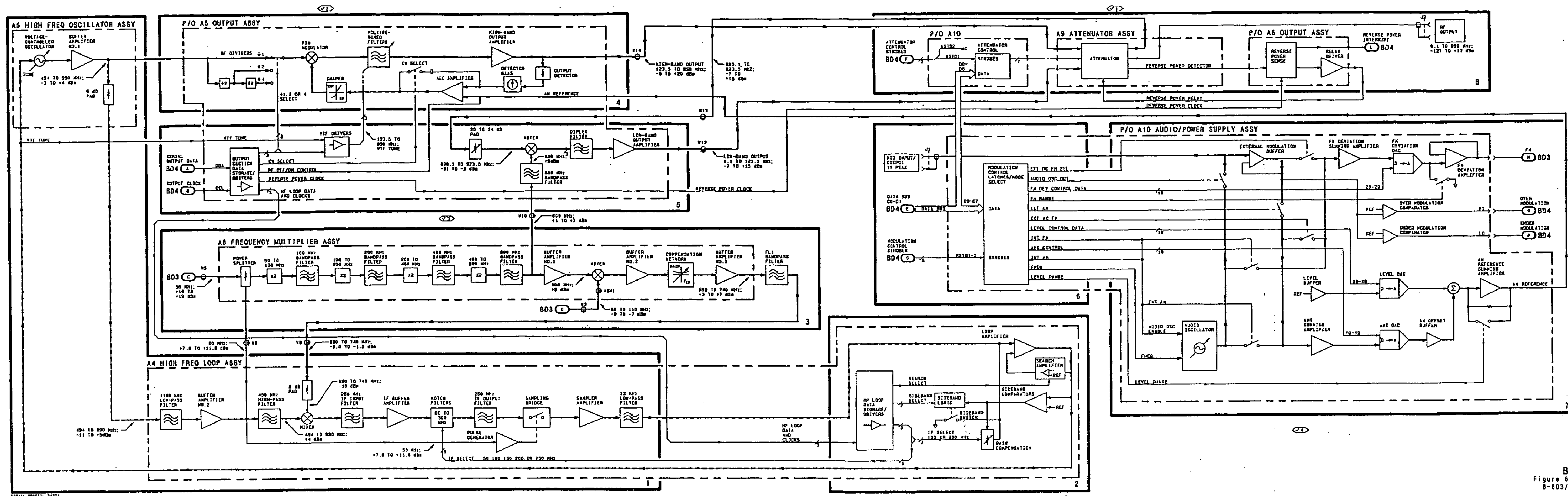
√1 Verify that the voltages shown in Table 1 are correct.

Table 1. Power Supply Measurements

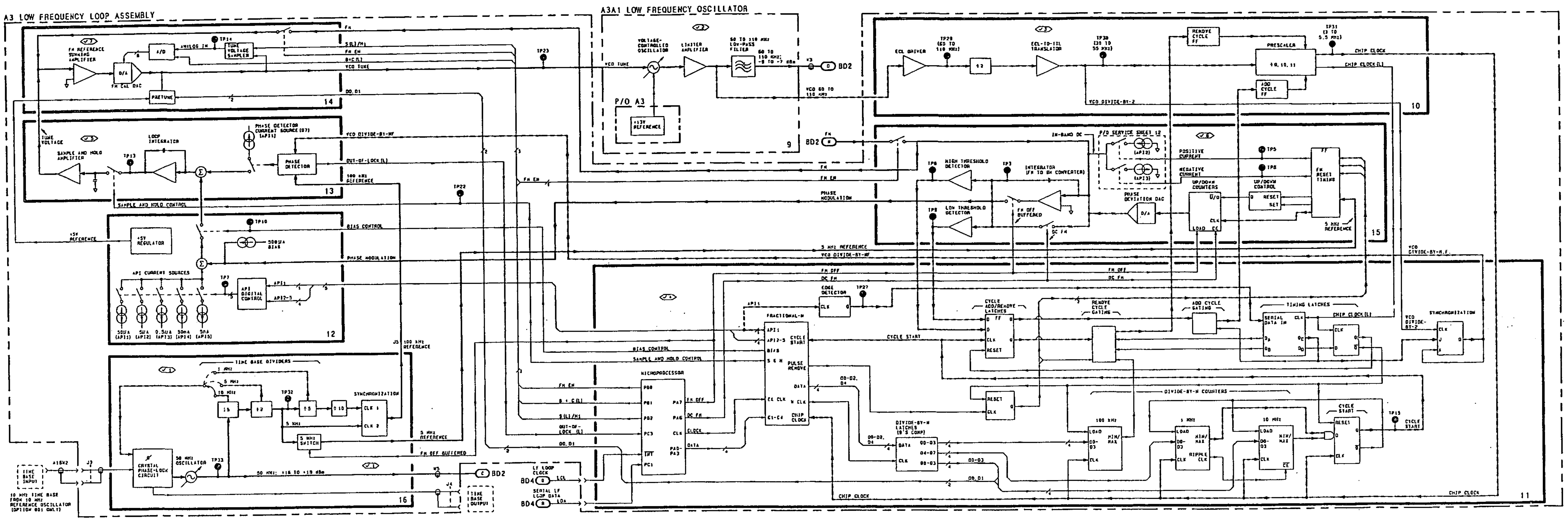
Volts	On Test Point J6-Pin:						
	11	13	9	3	10	2	16
Vdc Vp-p	+19 to +25 4.0	+17 to +13 0.01	+11 3.0	+5.6 to +5.2 0.01	−19 to −25 3.0	−13 to −17 0.01	+13 to +17 0.01



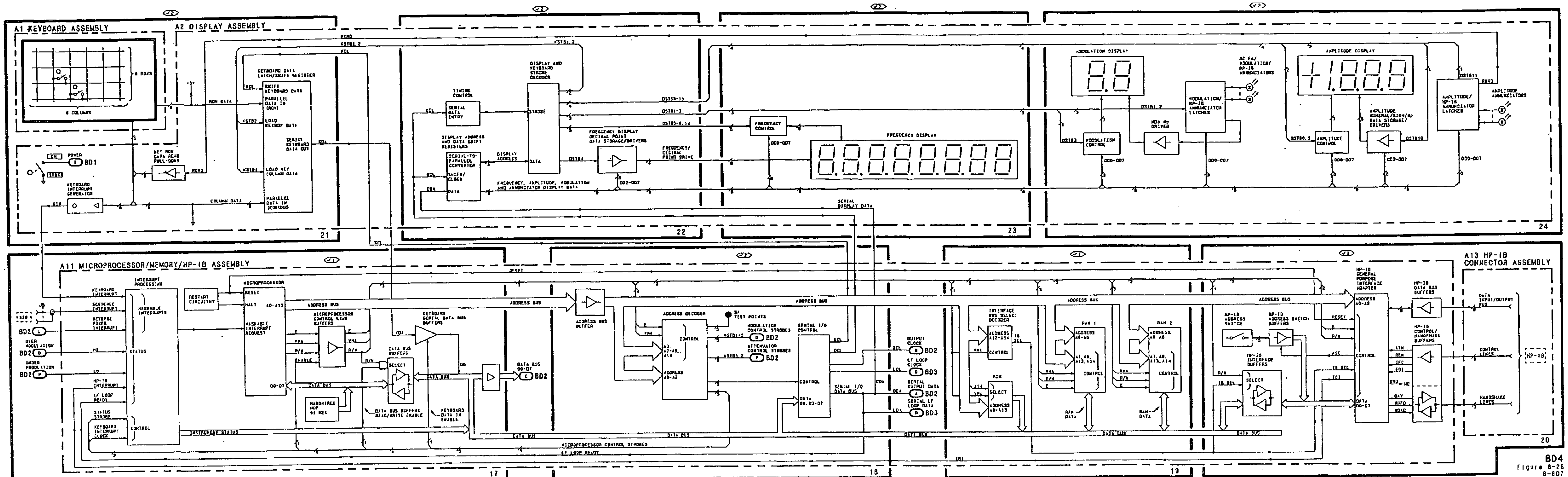
BD1
Figure 8-25
8-801/802



BD2
Figure 8-26
8-803/804



BD3
Figure 8-27
8-805/806



BD4
Figure 8-28

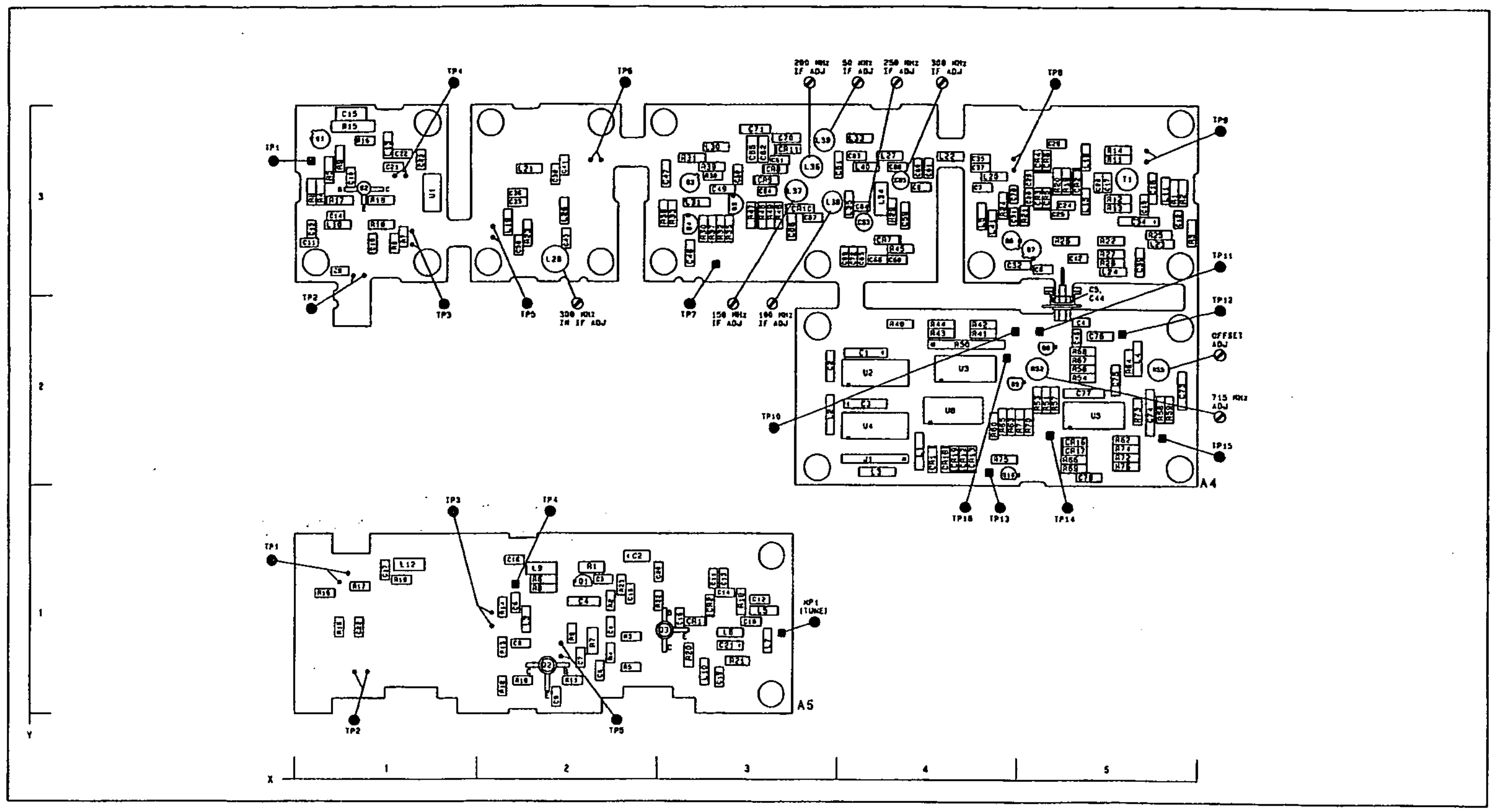
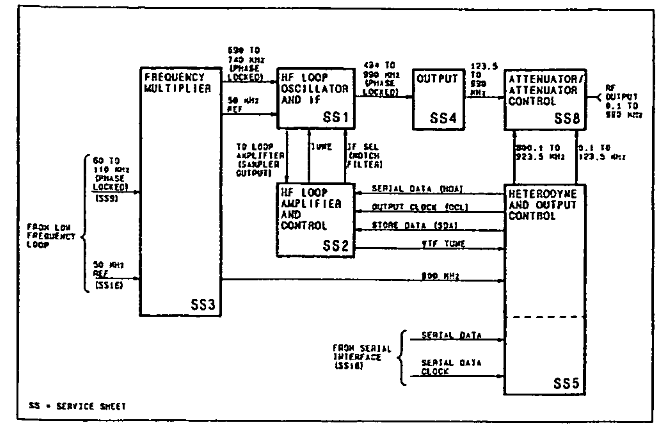


Figure 8-29. Service Sheet 1 Information

Component Locator



Reference Block Diagram

Component Coordinates

A4

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	4,2	C34	5,3	C83	4,3	L22	4,3	R7	1,3	R42	4,2
C2	3,2	C35	4,3	C84	4,3	L23	5,3	R8	1,3	R43	4,2
C3	4,2	C36	2,3	C85	4,3	L24	5,3	R9	1,3	R44	4,2
C4	5,2	C37	4,3	C86	4,3	L26	2,3	R10	1,3	R45	4,3
C5	5,3	C38	2,3			L27	4,3	R11	5,3	R46	3,3
C6	5,3	C39	5,3			L28	2,3	R12	5,3	R47	3,3
C7	4,3	C41	2,3	CR1	4,2	L30	3,3	R13	5,3	R48	3,3
C8	4,3	C42	5,3	CR2	5,3	L31	3,3	R14	5,3	R49	3,3
C9	1,3	C43	2,3	CR3	5,3	L33	4,3	R15	1,3		
C10	1,3	C44	5,3	CR4	5,3	L34	4,3	R16	1,3		
C11	1,3	C45	5,2	CR5	5,3	L35	4,3	R17	1,3	T1	5,3
C12	5,3	C47	3,3	CR6	5,3	L36	3,3	R18	1,3		
C13	1,3	C48	3,3	CR7	4,3	L37	3,3	R19	5,3		
C14	1,3	C49	3,3	CR8	3,3	L38	3,3	R20	5,3	TP1	1,3
C15	1,3	C50	3,3	CR9	3,3	L39	3,3	R21	5,3	TP2	1,3
C16	5,3	C51	4,3	CR10	3,3	L40	4,3	R22	5,3	TP3	1,3
C17	5,3	C53	4,3	CR11	3,3	L41	4,3	R23	2,3	TP4	1,3
C18	1,3	C58	4,3					R24	4,3	TP5	2,3
C19	5,3	C60	4,3					R25	5,3	TP6	2,3
C20	5,3	C61	3,3	J1	4,2	Q1	1,3	R26	5,3	TP7	3,3
C21	1,3	C62	3,3			Q2	1,3	R27	5,3	TP8	4,3
C22	1,3	C63	4,3			Q3	3,3	R28	5,3	TP9	5,3
C23	1,3	C64	3,3	L1	4,2	Q4	3,3	R29	4,3		
C24	5,3	C65	3,3	L2	3,2	Q5	3,3	R30	3,3		
C25	5,3	C66	4,3	L3	4,2	Q6	4,3	R31	3,3	U1	1,3
C26	5,3	C67	3,3	L4	5,2	Q7	5,3	R32	3,3		
C28	5,3	C68	3,3	L10	1,3			R33	3,3		
C29	5,3	C69	4,3	L11	5,3			R35	3,3		
C30	2,3	C70	3,3	L13	1,3	R1	5,3	R36	3,3		
C31	4,3	C71	3,3	L15	5,3	R2	5,3	R37	3,3		
C32	4,3	C72	4,3	L18	5,3	R3	5,3	R38	3,3		
C33	2,3	C79	4,3	L19	2,3	R4	1,3	R39	3,3		
		C80	4,3	L20	4,3	R5	1,3	R40	4,2		
		C81	4,3	L21	2,3	R6	1,3	R41	4,2		

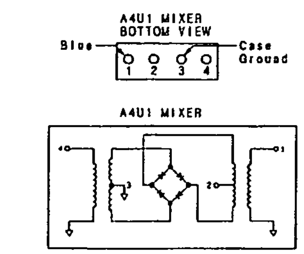
A5

COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	2,1	L7	3,1	R21	3,1
C2	2,1	L8	2,1	R22	3,1
C3	2,1	L10	3,1	R23	2,1
C4	2,1	L12	1,1		
C5	2,1			TP1	1,1
C6	2,1	MP1	3,1	TP2	1,1
C7	2,1			TP3	2,1
C8	2,1			TP4	2,1
C9	2,1	Q1	2,1	TP5	2,1
C10	3,1	Q2	2,1		
C11	3,1	Q3	3,1		
C12	3,1				
C13	3,1	R1	2,1		
C14	3,1	R2	2,1		
C15	3,1	R3	2,1		
C16	2,1	R4	2,1		
C17	1,1	R5	2,1		
C18	2,1	R6	2,1		
C19	3,1	R7	2,1		
C20	3,1	R8	2,1		
C21	3,1	R9	2,1		
C22	1,1	R10	2,1		
		R11	2,1		
		R12	2,1		
		R13	2,1		
CR1	3,1	R14	2,1		
CR2	3,1	R15	1,1		
		R16	1,1		
		R17	1,1		
L3	2,1	R18	3,1		
L5	3,1	R19	1,1		
L6	3,1	R20	3,1		

MICROPROCESSOR, KEYBOARD AND DISPLAY SECTION **BD4**

NOTES

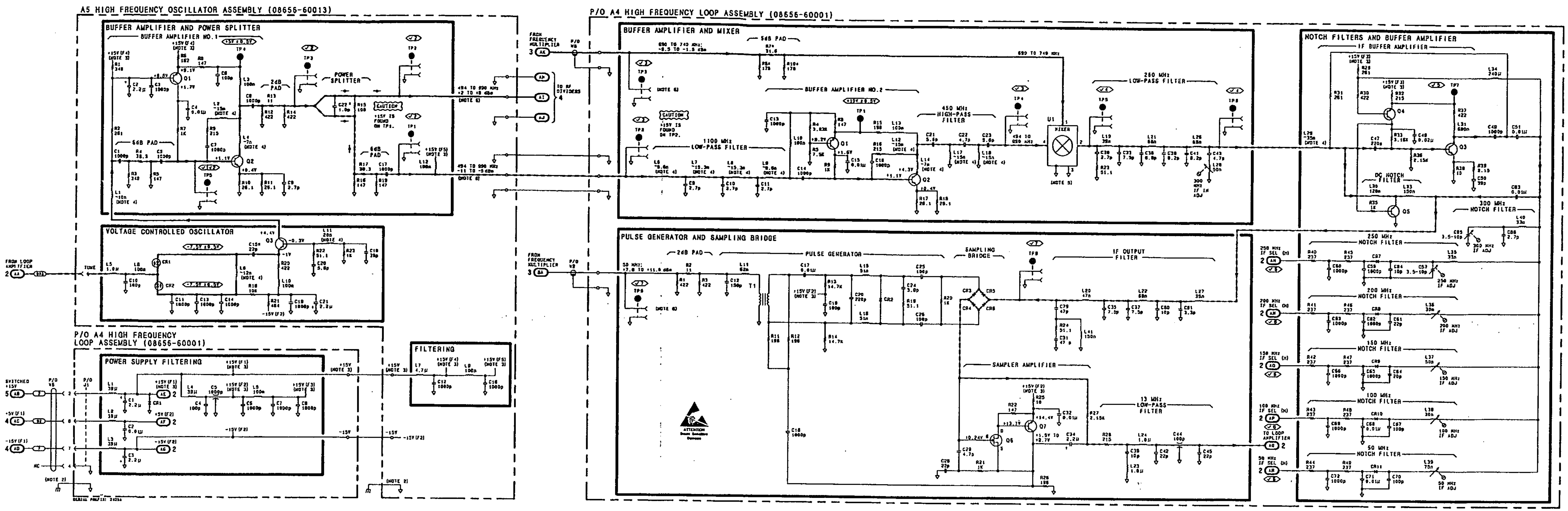
1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. The POWER switch programmatically controls the application of +15V to the high frequency oscillator and loop assemblies.
4. Printed circuit trace inductor.
5. Bottom view and schematic diagram of A4U1 are as follows:



6. The mismatch caused by insertion of the 50 ohm input Impedance Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

* Indicates factory selected part. Typical value shown. Refer to Section V for selection procedure.

Schematic General Information



SS1
Figure 8-30
Schematic
Diagram
8-809

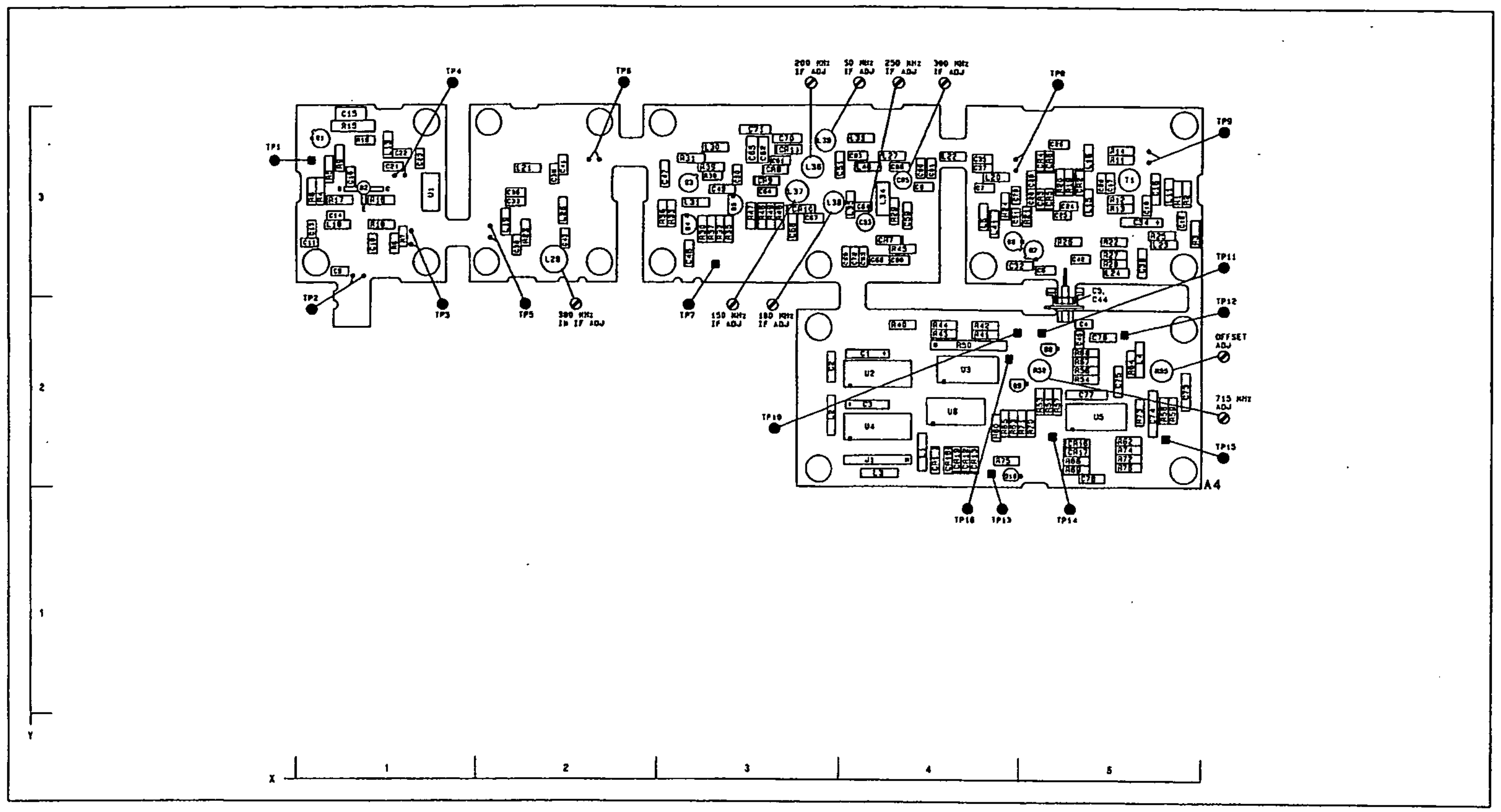
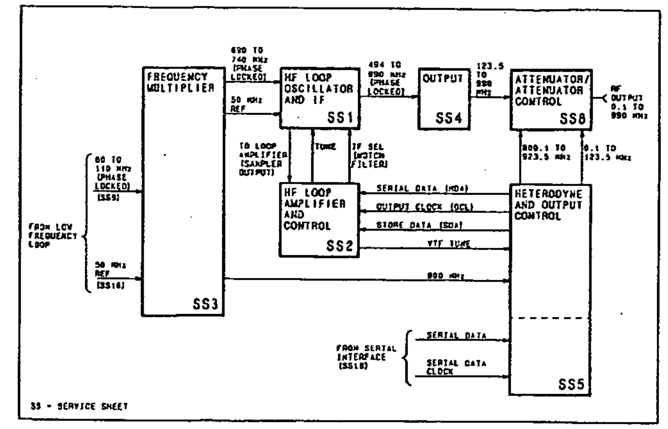


Figure 8-31. Service Sheet 2 Information

Component Locator



Reference Block Diagram

Component Coordinates

A4 COMP	X,Y
C73	5,2
C74	5,2
C75	5,2
C76	5,2
C77	5,2
C78	5,2
CR12	4,2
CR13	4,2
CR16	5,2
CR17	5,2
CR18	4,2
CR19	4,2
J1	4,2
Q8	5,2
Q9	5,2
Q10	4,2
R50	4,2
R51	5,2
R52	5,2
R53	5,2
R54	5,2
R55	5,2
R56	5,2
R57	5,2
R58	5,2
R59	5,2
R60	4,2
R62	5,2
R63	4,2
R64	5,2
R65	4,2
R70	5,2
R71	5,2
R73	5,2
R74	5,2
R75	4,2
R76	5,2
TP10	4,2
TP11	5,2
TP12	5,2
TP13	4,2
TP14	5,2
TP15	5,2
TP16	4,2
U2	4,2
U3	4,2
U4	4,2
U5	5,2
U6	4,2

P/O A4,A5 HIGH FREQUENCY OSCILLATOR AND IF **SS1**

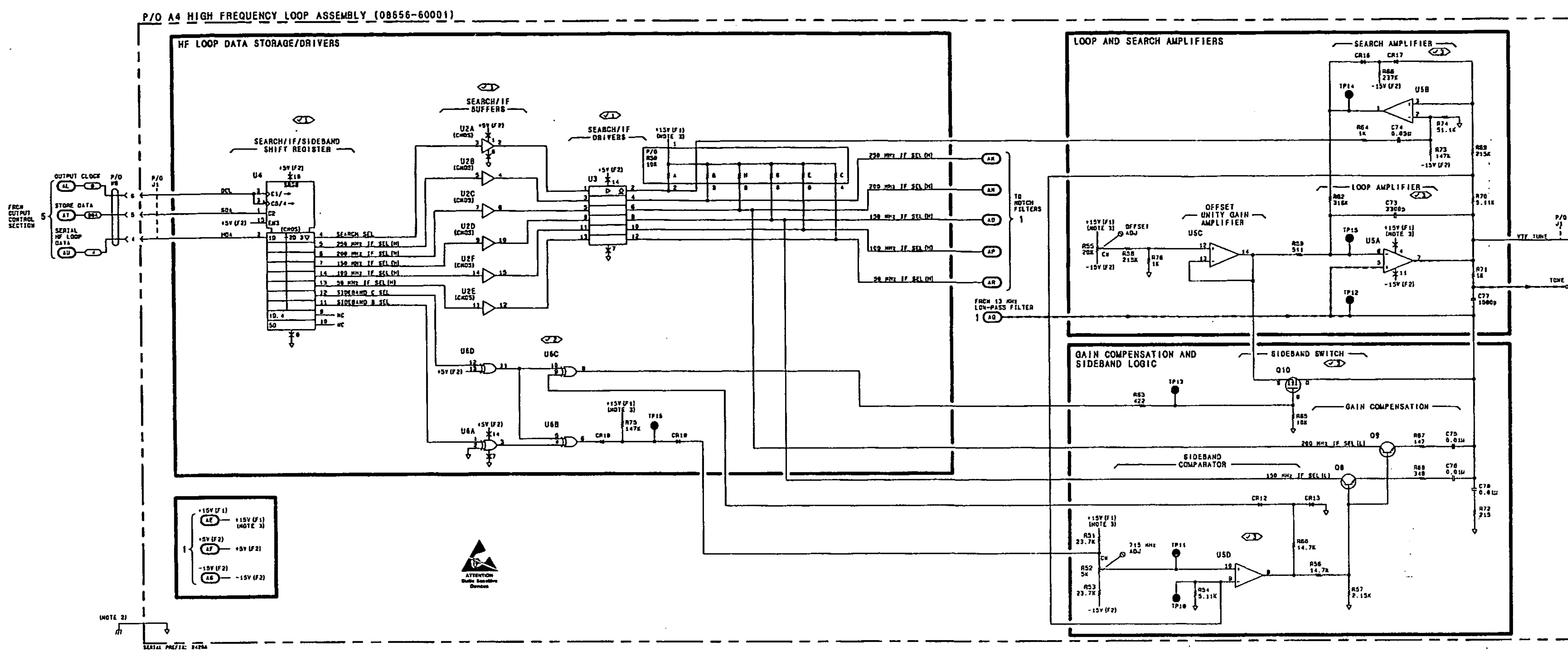
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. The POWER switch programatically controls the application of +15V to the high frequency oscillator and loop assemblies.

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Schematic General Information



SS2
Figure 8-32
Schematic
Diagram
8-811

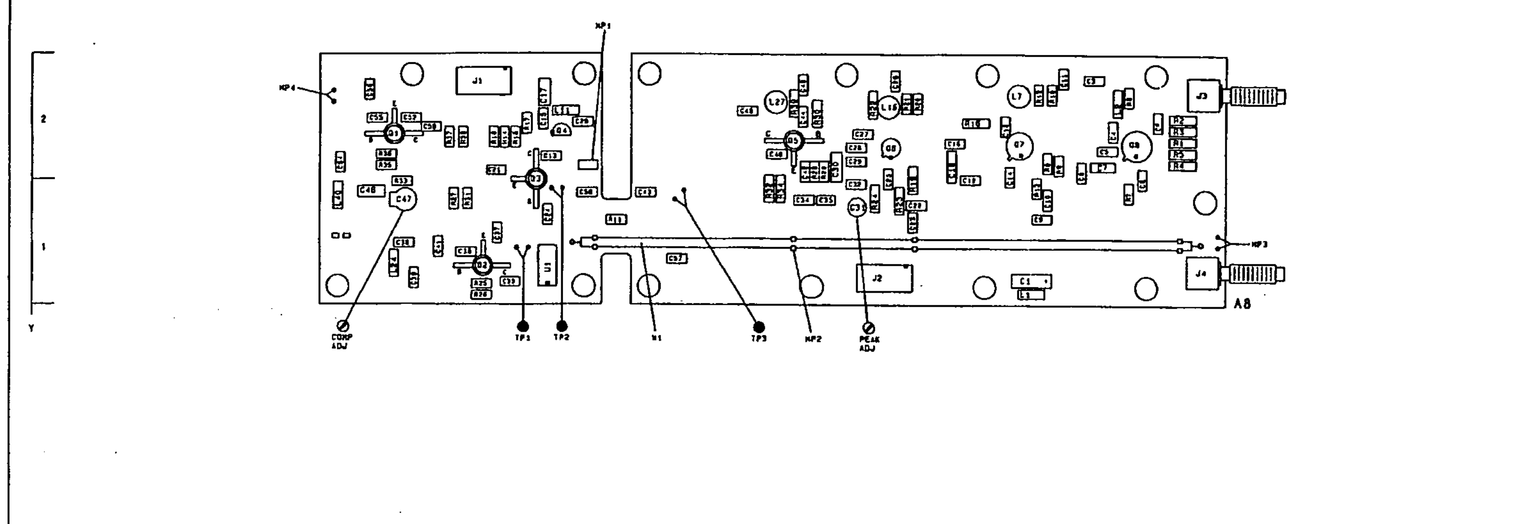
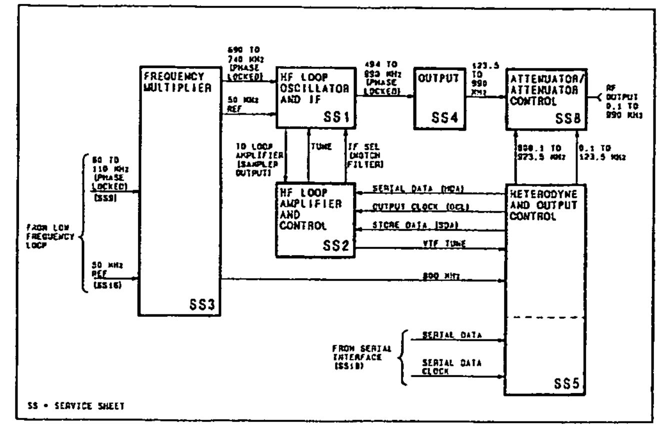


Figure 8-33. Service Sheet 3 Information

Component Locator



Reference Block Diagram

Component Coordinates

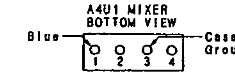
A8 COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	4,1	C33	1,1	L1	4,1	R7	5,1	TP1	2,1
C2	5,2	C34	3,1	L2	5,2	R8	4,2	TP2	2,1
C3	5,2	C35	3,1	L7	4,2	R9	4,2	TP3	2,1
C4	5,2	C36	1,1	L11	2,2	R10	4,2		
C5	5,2	C37	1,1	L18	4,2	R11	2,1		
C6	5,1	C38	1,1	L24	1,1	R12	4,2	U1	2,1
C7	5,2	C39	1,1	L27	3,2	R13	4,1		
C8	5,2	C40	3,2	L40	1,1	R14	1,2		
C9	4,1	C41	1,1			R15	2,2	W1	2,1
C10	4,1	C42	3,2			R16	4,2		
C11	5,2	C43	2,1	MP1	2,2	R17	2,2		
C12	4,2	C44	3,2	MP2	3,1	R18	1,2		
C13	2,2	C45	3,2	MP3	5,1	R19	4,1		
C14	4,1	C46	1,1	MP4	1,2	R20	4,2		
C15	2,2	C47	1,1			R21	4,2		
C16	4,2	C48	3,2			R22	3,2		
C17	2,2	C50	1,2	Q1	1,2	R23	4,1		
C18	4,2	C52	1,2	Q2	1,1	R24	3,1		
C19	4,1	C54	1,2	Q3	2,1	R25	1,1		
C20	2,2	C55	1,2	Q4	2,2	R26	1,1		
C21	1,2	C56	1,2	Q5	3,2	R27	1,1		
C22	4,1	C57	2,1	Q6	4,2	R28	3,2		
C23	4,1	C58	2,1	Q7	4,2	R29	3,2		
C24	2,1			Q8	5,2	R30	3,2		
C25	4,1					R31	1,1		
C26	4,2	J1	1,2			R32	3,1		
C27	3,2	J2	4,1	R1	5,2	R33	1,1		
C28	3,2	J3	5,2	R2	5,2	R34	3,1		
C29	3,2	J4	5,1	R3	5,2	R35	1,2		
C30	3,2			R4	5,2	R36	1,2		
C31	3,1			R5	5,2	R37	1,2		
C32	3,1			R6	5,2	R38	1,2		
						R39	3,2		

P/O A4 HIGH FREQUENCY LOOP AMPLIFIER AND CONTROL **SS2**

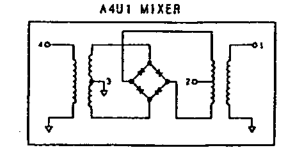
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Printed circuit trace inductor.
3. Printed circuit trace capacitor.
4. Service test point. Pin of dual-in-line test socket J1 or J2.
5. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
6. PC board shipped with jumper installed. In for normal operation. Out for service.
7. L7, 16, and 27 present an impedance >1200 ohms at 120MHz to 650 mhz and >900 ohms at 650MHz to 1300MHz.
8. Bottom view and schematic diagram of A4U1 are as follows:

A4U1 MIXER BOTTOM VIEW



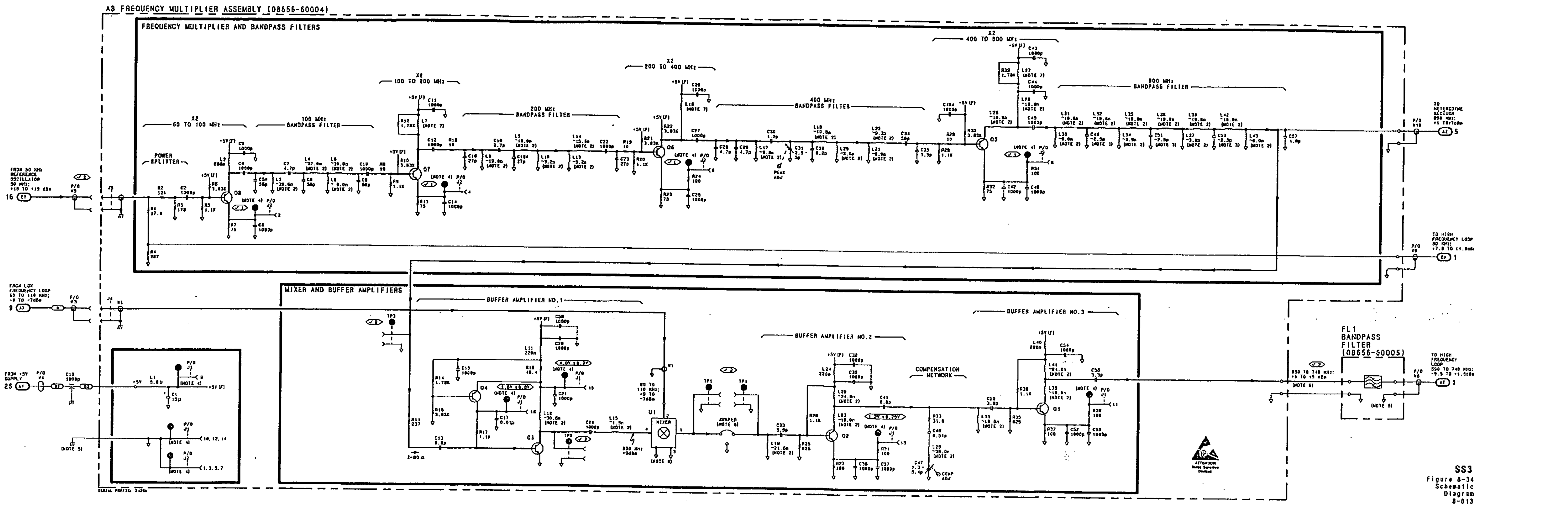
A4U1 MIXER



9. The mismatch caused by insertion of the 50 ohm input Impedence Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

* Indicates factory selected part. Typical value shown. Refer to Section V for selection procedure.

Schematic General Information



SS3
Figure 8-34
Schematic
Diagram
8-813

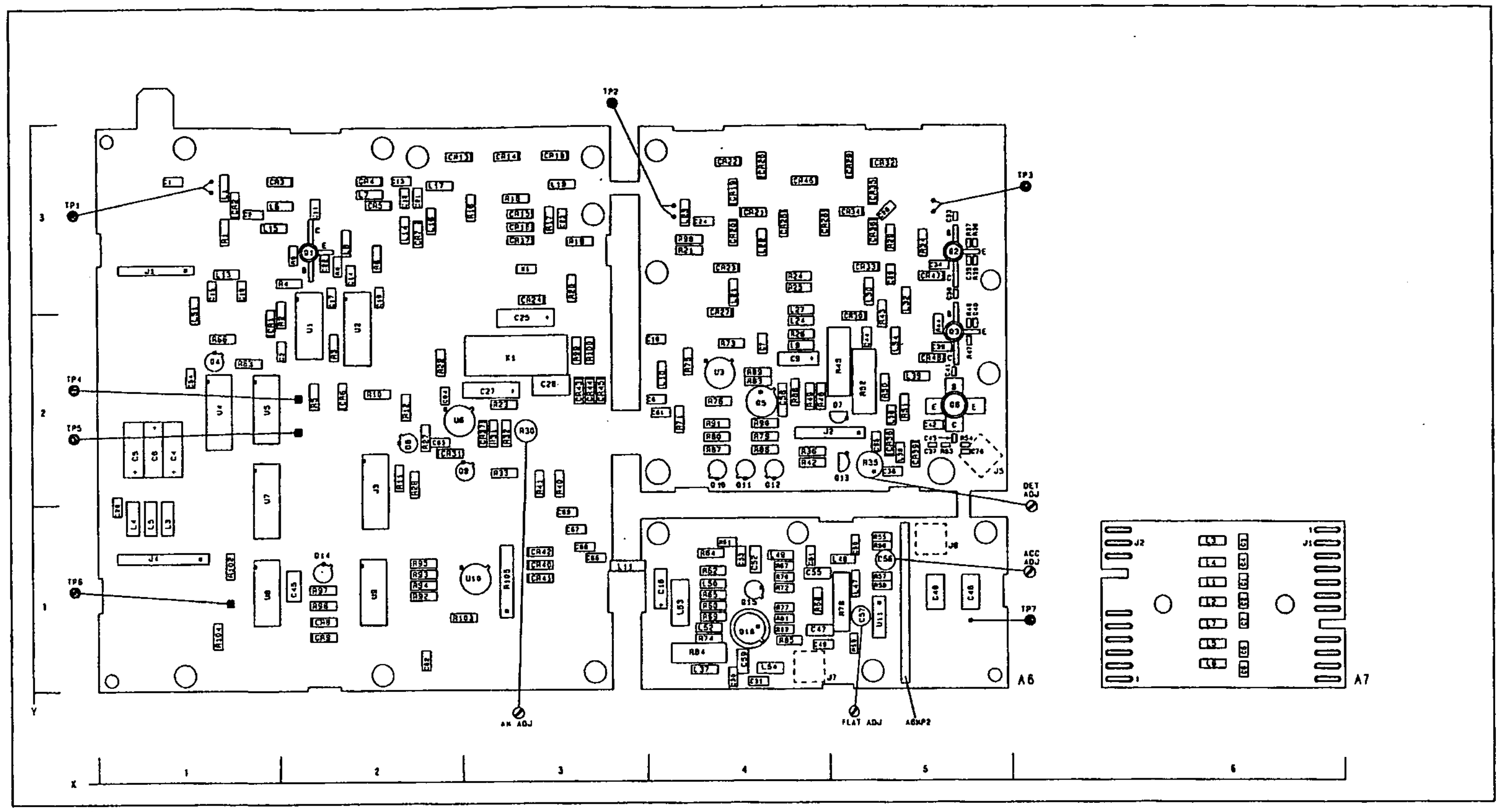
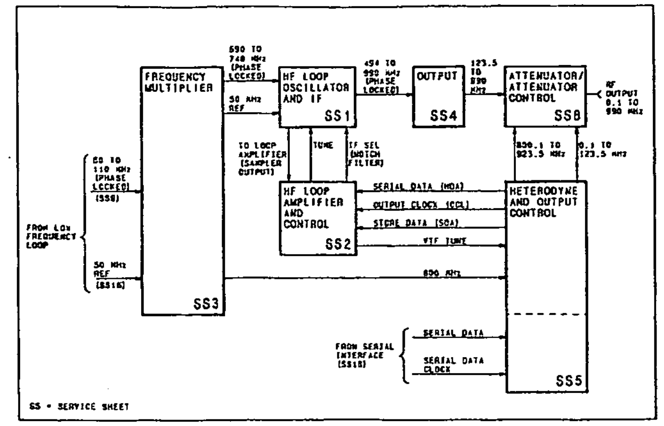


Figure 8-35. Service Sheet 4 Information

Component Locator



Reference Block Diagram

Component Coordinates

A6

COMP	X,Y
C1	1,3
C2	1,3
C3	1,2
C4	1,2
C5	1,2
C6	1,2
C7	4,2
C8	4,2
C9	4,2
C10	4,2
C11	2,3
C12	2,3
C13	2,3
C14	2,3
C15	1,3
C16	4,1
C17	2,3
C18	2,3
C19	1,3
C20	1,1
C21	2,3
C22	2,3
C23	3,3
C24	4,3
C25	3,2
C26	3,2
C27	3,2
C28	5,3
C29	5,3
C33	5,3
C34	5,3
C35	5,3
C36	5,2
C37	5,2
C38	5,3
C39	5,2
C40	5,2
C41	5,2
C42	5,2
C43	5,2
C44	5,2
C61	4,2
C62	2,1
C63	2,2
C64	2,2
C65	5,2
C70	5,2
CR1	1,2
CR2	1,3
CR3	1,3
CR4	2,3
CR5	2,3
CR6	2,2
CR7	2,3
CR13	2,3
CR14	3,3
CR15	3,3
CR16	3,3
CR17	3,3
CR18	3,3
CR19	4,3
CR20	4,3
CR21	4,3
CR22	4,3
CR23	4,3
CR24	3,3
CR25	4,3
CR26	4,3
CR27	4,2
CR28	4,3
CR29	5,3
CR30	5,2
CR31	2,2
CR32	5,3
CR34	5,3
CR35	5,3
CR36	5,3
CR37	3,2
CR38	5,2
CR39	5,2
CR43	3,2
CR44	3,2
CR45	3,2
CR46	4,3
CR47	5,3
CR48	5,2
J1	1,3
J2	4,2
J3	2,2
J4	1,1
J5	5,2
K1	3,2
L1	1,3
L3	1,1
L4	1,1
L5	1,1
L6	1,3
L7	2,3
L8	2,3
L9	4,2
L10	4,2
L11	3,1
L13	1,3
L14	2,3
L15	1,3
L16	2,3
L17	2,3
L18	3,3
L21	4,3
L22	4,3
L23	4,3
L24	4,2
L27	4,3
L30	5,3
L32	5,3
L34	5,2
L36	3,2
L38	5,2
L39	5,2
XP2	5,1
Q1	2,3
Q2	5,3
Q3	5,2
Q6	5,2
Q7	5,2
Q8	2,2
Q9	3,2
Q13	5,2
R1	1,3
R2	2,2
R3	2,2
R4	2,3
R5	2,2
R6	2,3
R8	2,3
R9	2,3
R10	2,2
R11	2,2
R12	2,2
R16	3,3
R17	3,3
R18	3,3
R19	3,3
R20	3,3
R21	4,3
R22	2,2
R23	3,2
R24	4,3
R25	4,3
R26	4,2
R27	2,2
R28	2,2
R29	5,3
R30	3,2
R31	3,2
R32	3,2
R33	3,2
R34	5,3
R35	5,2
R36	4,2
R37	5,3
R38	5,3
R39	5,3
R40	3,2
R41	3,2
R42	4,2
R43	5,2
R44	5,2
R45	5,2
R46	5,2
R47	5,2
R48	4,2
R49	4,2
R50	5,2
R51	5,2
R52	5,2
R53	5,2
R54	5,2
R98	4,3
R99	3,2
R100	3,2
TP1	1,3
TP2	4,3
TP3	5,3
U1	2,2
U2	2,2
U6	2,2
W1	3,3

A7

COMP	X,Y
C1	6,1
C2	6,1
C3	6,1
C4	6,1
J1	6,1
L1	6,1
L2	6,1
L3	6,1
L4	6,1

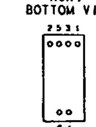
P/O A8 FREQUENCY MULTIPLIER **SS3**

NOTES

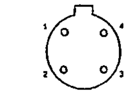
1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. Service test point. Pin of single in-line test posts J2 or dual in-line test socket J3.
4. Inductor includes PC trace and parasitic inductance of diodes.
5. Matched for temperature characteristics.
6. 100 ohm transmission line 1.5 centimeters long.
7. 100 ohm transmission line 1.1 centimeters long.
8. 120 ohm transmission line 3 centimeters long.
9. 120 ohm transmission line 4 centimeters long.
10. Nominal value of RF choke is 2.5-6uH.
11. Printed circuit trace inductor.
12. The mismatch caused by insertion of the 50 ohm input impedence Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

* Indicates factory-selected part. Typical value is shown. Refer to Section V for selection procedure.

A6K1
BOTTOM VIEW



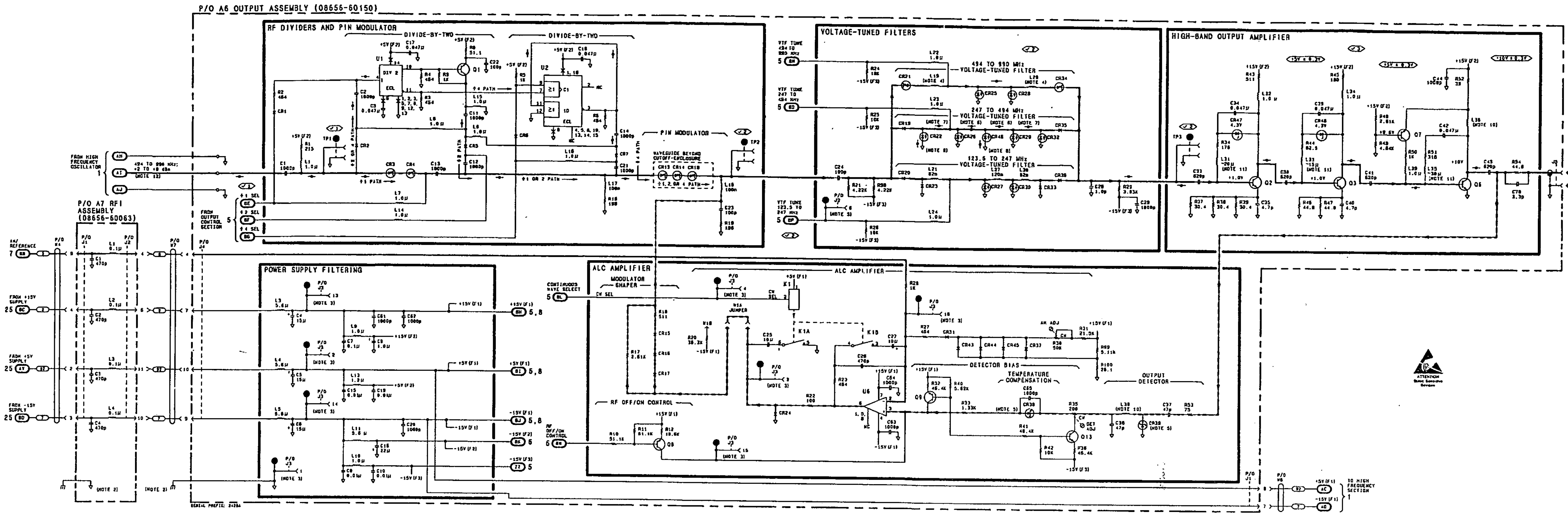
A6U1
TOP VIEW



LOGIC LEVELS

	TTL	ECL	EECL
HIGH	>2V	>+4.2V	>+5.1V
LOW	<0.8V	<+3.3V	<+4.7V
< IS MORE NEG. THAN > IS MORE POS. THAN			
OPEN	HIGH	LOW	LOW
GROUND	LOW	HIGH	HIGH

Schematic General Information



SS4
Figure 8-36
Schematic Diagram
8-815

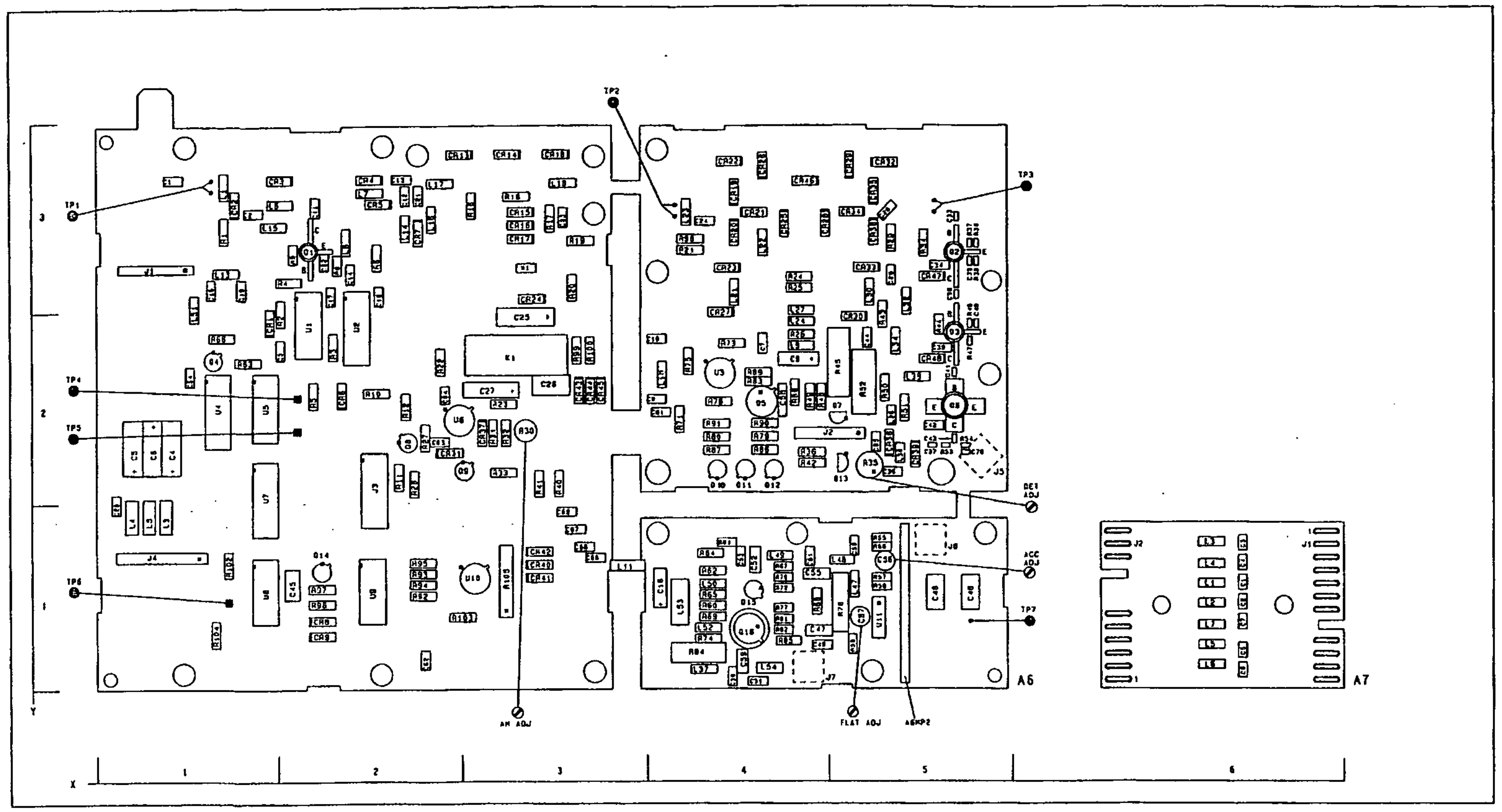
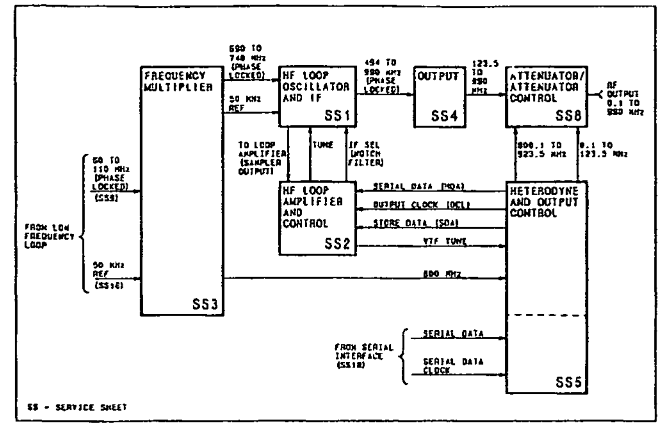


Figure 8-37. Service Sheet 5 Information

Component Locator



Reference Block Diagram

Component Coordinates

A6 COMP	X,Y
C30	4,1
C31	4,1
C45	2,1
C46	5,1
C47	4,1
C48	5,1
C49	4,1
C50	5,1
C51	4,1
C52	4,1
C53	4,1
C54	1,2
C55	4,1
C56	5,1
C57	5,1
C58	4,2
C59	4,1
C66	3,1
C67	3,1
C68	3,1
C69	3,1
CR40	3,1
CR41	3,1
CR42	3,1
J1	1,3
J2	4,2
J3	2,2
J4	1,1
J6	5,1
J7	4,1
L37	4,1
L47	5,1
L48	5,1
L49	4,1
L50	4,1
L51	1,2
L52	4,1
L53	4,1
L54	4,1
MP2	5,1
Q4	1,2
Q5	4,2
Q10	4,2
Q11	4,2
Q12	4,2
Q15	4,1
Q16	4,1
R55	5,1
R56	5,1
R57	5,1
R58	5,1
R59	5,1
R60	4,1
R61	4,1
R62	4,1
R63	1,2
R64	4,1
R65	4,1
R66	1,2
R67	4,1
R68	4,1
R69	4,1
R70	4,1
R71	4,2
R72	4,1
R73	4,2
R74	4,1
R75	4,2
R76	4,2
R77	4,1
R78	5,1
R79	4,2
R80	4,2
R81	4,1
R82	4,1
R83	4,2
R84	4,1
R85	4,1
R86	4,2
R87	4,2
R88	4,2
R89	4,2
R90	4,2
R91	4,2
R102	1,1
R105	3,1
TP4	2,2
TP5	2,2
TP6	1,1
TP7	5,1
U3	4,2
U4	1,2
U5	1,2
U7	1,2
U8	1,1
U11	5,1

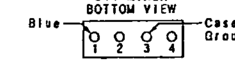
A7 COMP	X,Y
C5	6,1
C6	6,1
J1	6,1
J2	6,1
L5	6,1
L6	6,1

P/O A6, P/O A7 OUTPUT **SS4**

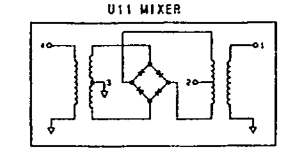
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. Service test point. Pin of single in-line test posts J2 or dual in-line test socket J3.
4. Bottom view and schematic diagram of U11 are as follows:

U11 MIXER BOTTOM VIEW

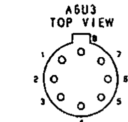


U11 MIXER



5. Printed circuit trace inductor.
6. PC board shipped with jumper removed. Out for normal operation. In for service
7. This component is mounted on non-inductive beads (HP P/N 4330-0145) thereby selecting the desired lead inductance. If the component is changed, be sure to include the beads with the new part.
8. The mismatch caused by insertion of the 50 ohm input impedence Adapter Probe into the 50 ohm transmission line (at the RF Test Points), decreases power level readings. At some frequencies the decrease is 3 dB, and at others it is less than 3 dB.

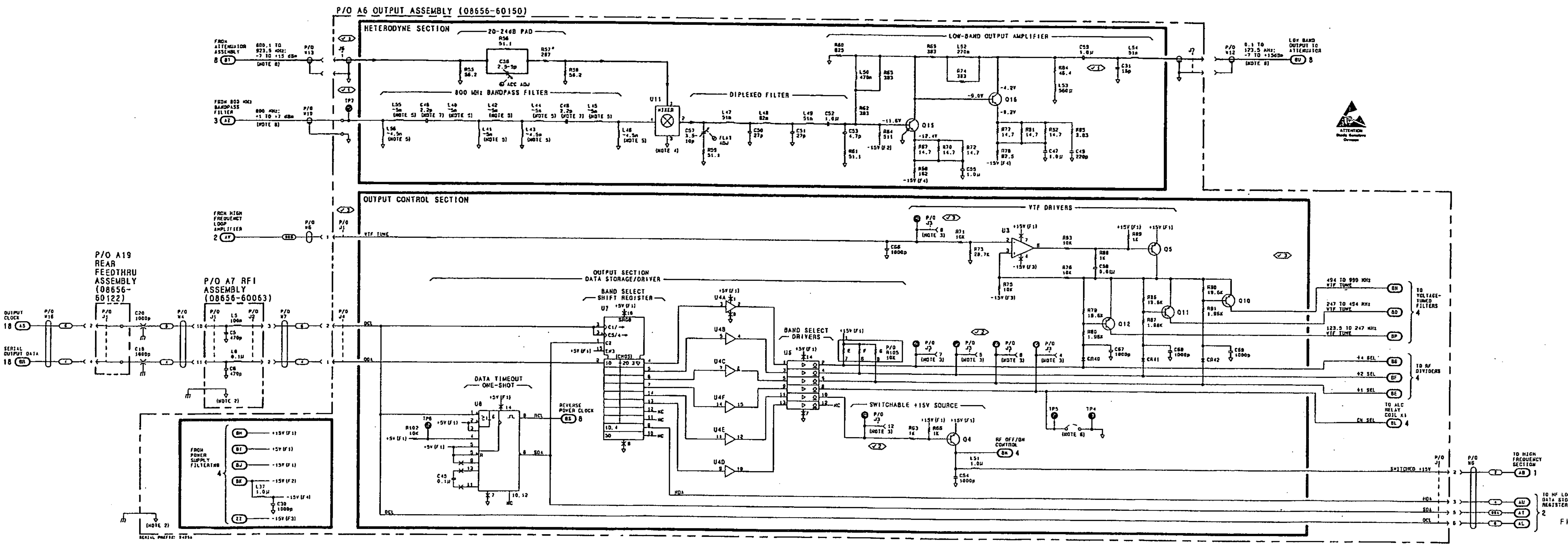
A6U3 TOP VIEW



LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Schematic General Information



SS5
Figure 8-38
Schematic
Diagram
8-817

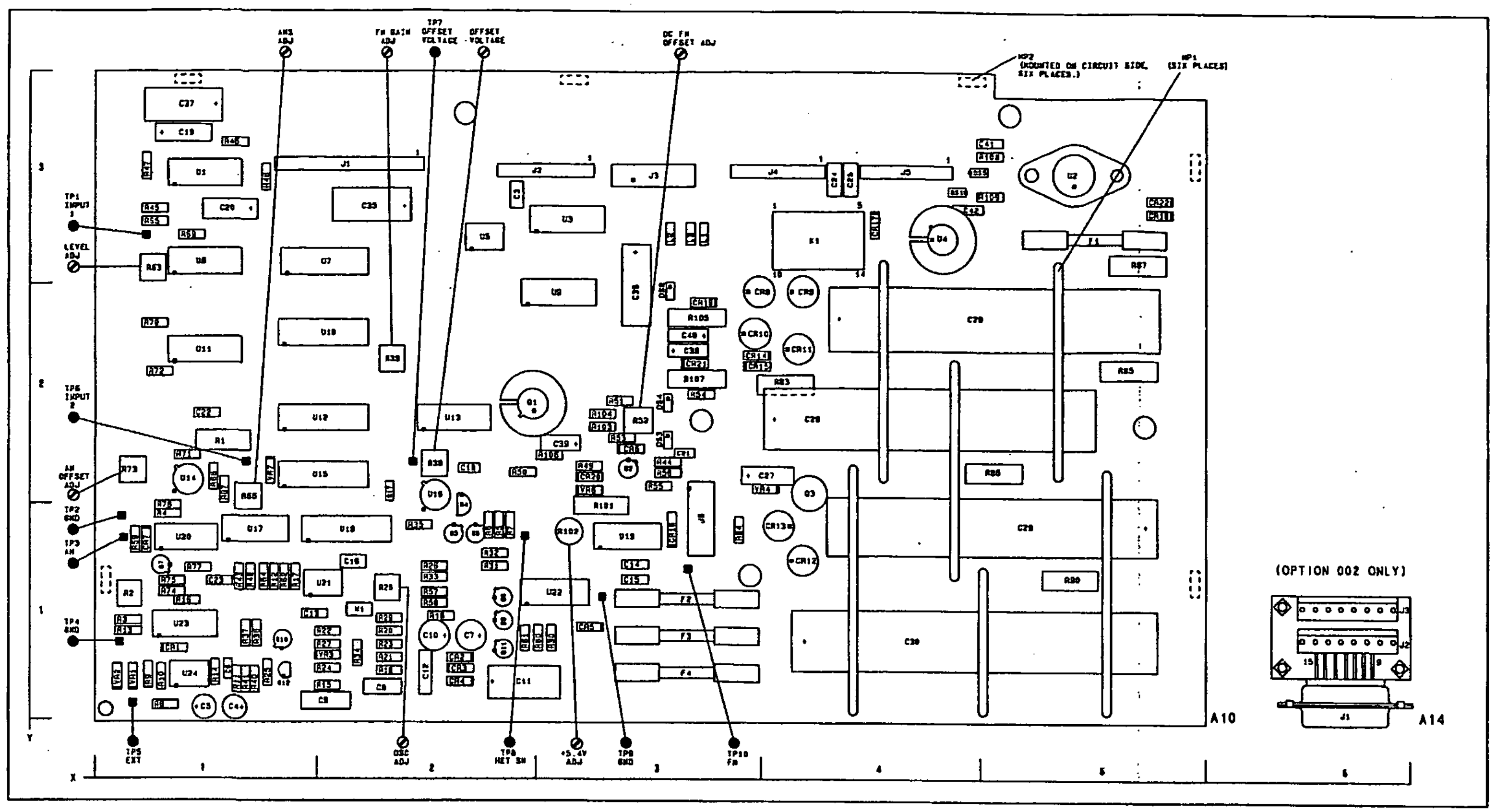
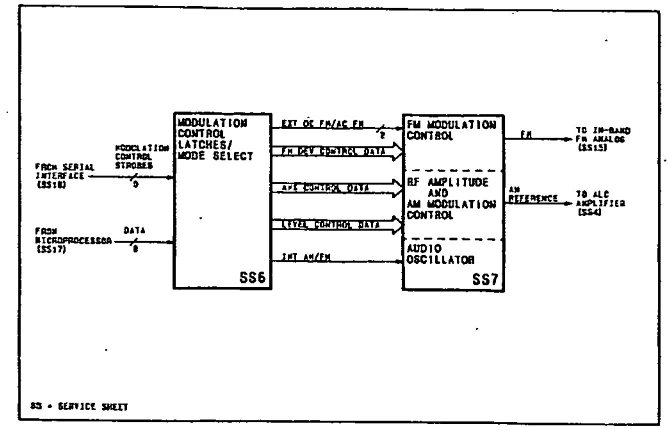


Figure 8-39. Service Sheet 5 Information

Component Locator



Reference Block Diagram

Component Coordinates

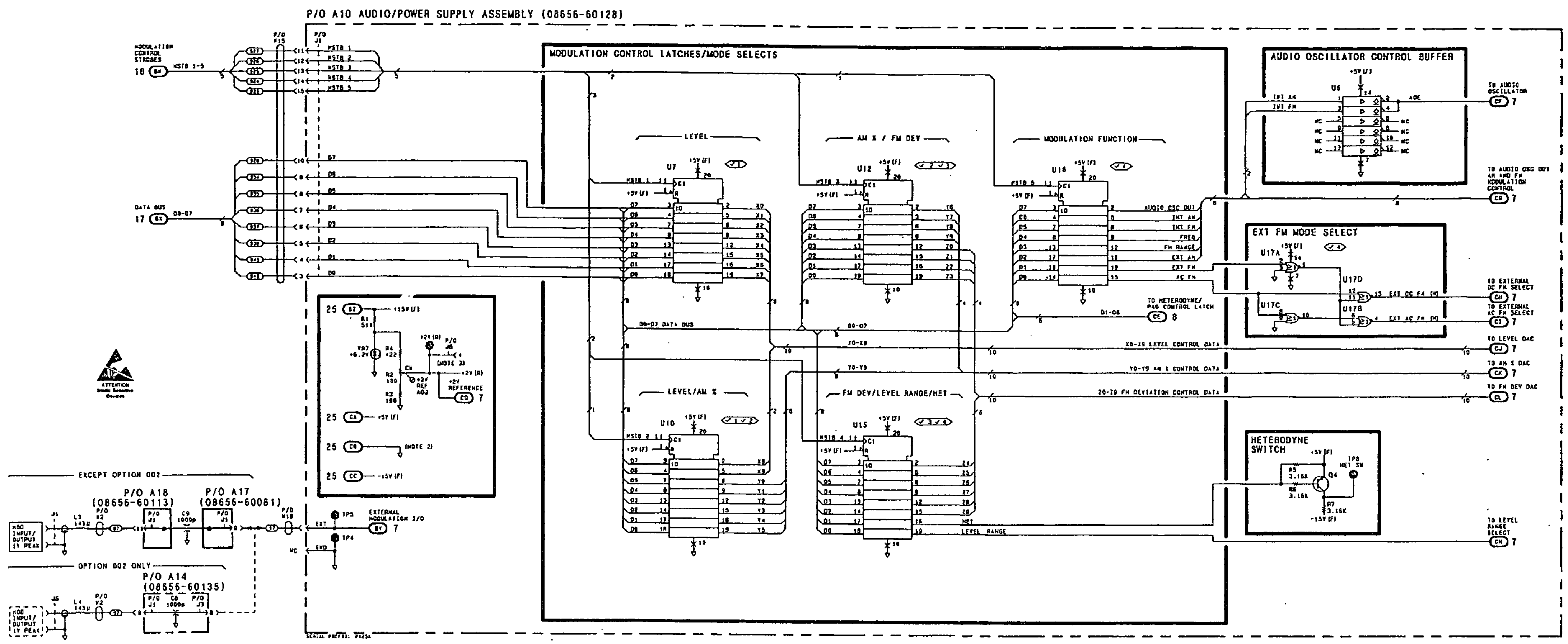
A10 COMP	X,Y
MP1	5,3
MP2	5,3
Q4	2,1
R1	1,2
R2	1,1
R3	1,1
R4	1,1
R5	2,1
R6	2,1
R7	2,1
TP4	1,1
TP5	1,1
TP8	2,1
U5	2,3
U7	2,3
U10	2,2
U12	2,2
U15	2,2
U17	1,1
U18	2,1
VR7	1,2

P/O A6, P/O A7 HETERODYNE AND OUTPUT CONTROL **SS5**

NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A10J5-1 and 5 connections and mechanical contact through nuts holding PC board to frame.
3. Service test point. Pin of dual in-line test socket J6.

Schematic General Information



SS6
Figure 8-40
Schematic
Diagram
8-819

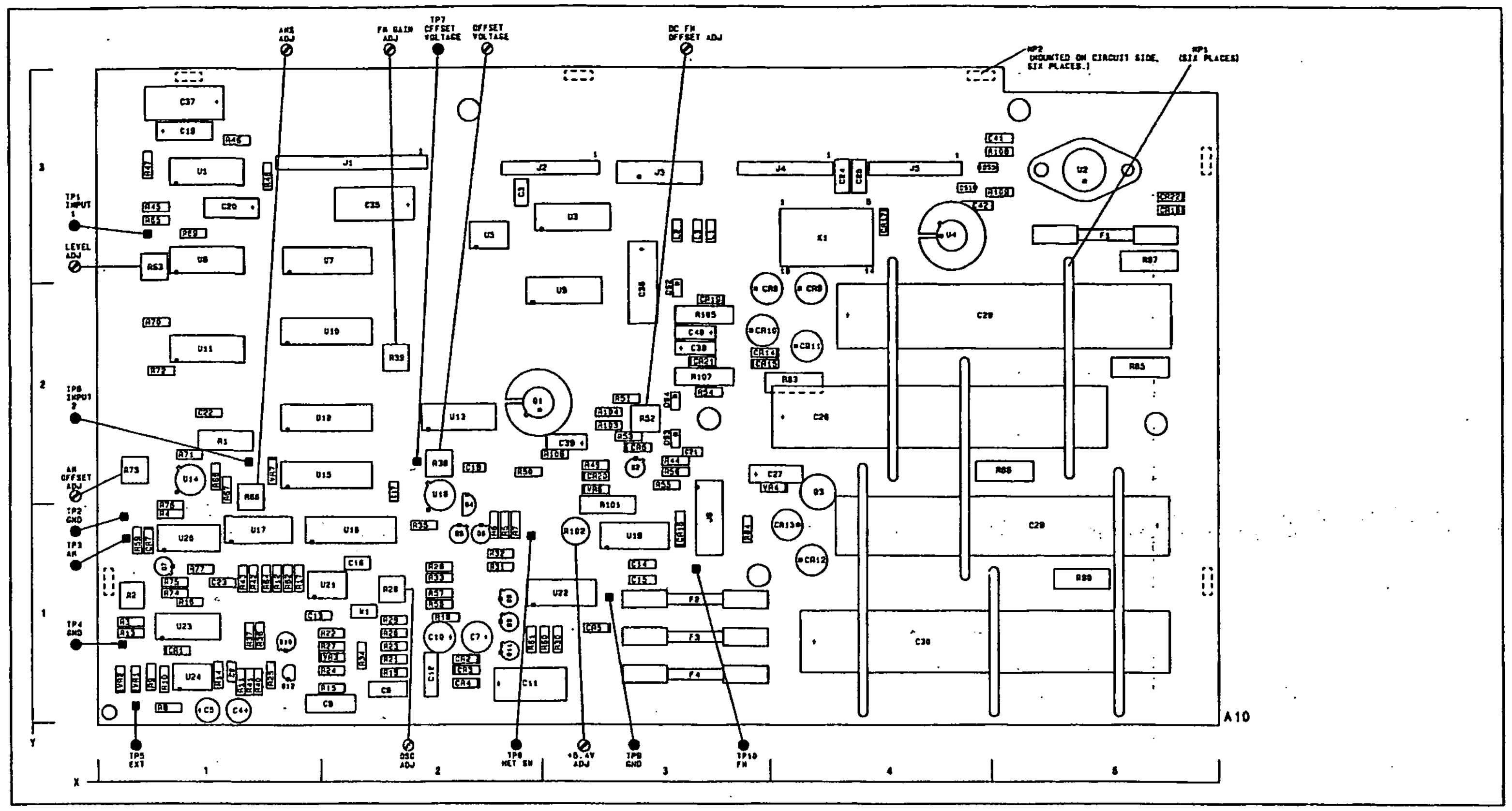
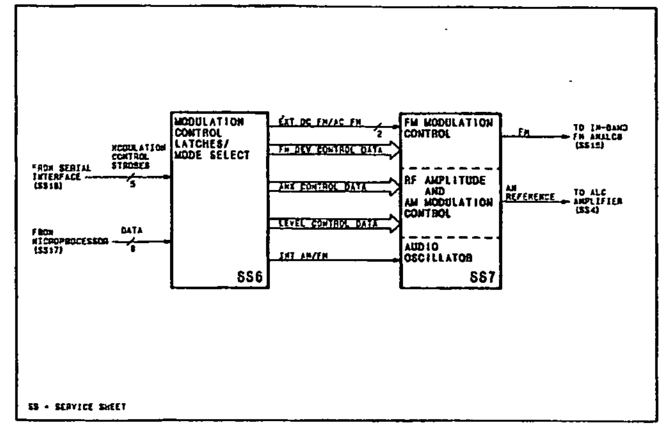


Figure 8-41. Service Sheet 7 Information

Component Locator



Reference Block Diagram

Component Coordinates

A10 COMP	X,Y
C4	1,1
C5	1,1
C6	1,1
C7	2,1
C8	2,1
C9	2,1
C10	2,1
C11	2,1
C12	2,1
C13	1,1
C14	3,1
C15	3,1
C16	2,1
C17	2,2
C18	1,3
C20	1,3
C21	3,2
C22	1,2
C23	1,1
CR1	1,1
CR2	2,1
CR3	2,1
CR4	2,1
CR5	3,1
CR6	3,2
CR7	1,1
J1	2,3
J6	3,1

COMP	X,Y
MP1	5,3
MP2	5,3
Q2	3,2
Q5	2,1
Q6	2,1
Q7	1,1
Q8	2,1
Q9	2,1
Q10	1,1
Q11	2,1
Q12	1,1
R8	1,1
R9	1,1
R10	1,1
R11	1,1
R12	1,1
R13	1,1
R14	1,1
R15	2,1
R16	1,1
R17	1,1
R18	2,1
R19	2,1
R20	2,1
R21	2,1
R22	2,1
R23	2,1
R24	2,1

COMP	X,Y
R25	1,1
R26	2,1
R27	2,1
R28	2,1
R29	2,1
R30	3,1
R31	2,1
R32	2,1
R33	2,1
R34	2,1
R35	2,1
R36	1,1
R37	1,1
R38	2,2
R39	2,2
R40	1,1
R41	1,1
R42	1,1
R43	1,1
R44	3,2
R45	1,3
R46	1,3
R47	1,3
R48	1,3
R49	3,2
R50	2,2
R51	3,2
R52	3,2
R53	3,2
R54	3,2
R55	3,2
R56	3,2

COMP	X,Y
R57	2,1
R58	2,1
R59	1,1
R60	2,1
R61	2,1
R62	1,1
R63	1,3
R64	1,1
R65	1,3
R66	1,2
R67	1,2
R68	1,2
R69	1,3
R70	1,2
R71	1,2
R72	1,2
R73	1,2
R74	1,1
R75	1,1
R76	1,1
R77	1,1
TP1	1,3
TP2	1,1
TP3	1,1
TP6	1,2
TP7	2,2
TP8	3,1
TP10	3,1

COMP	X,Y
U1	1,3
U8	1,3
U11	1,2
U13	2,2
U14	1,2
U16	2,2
U19	3,1
U20	1,1
U21	2,1
U22	3,1
U23	1,1
U24	1,1
VR1	1,1
VR2	1,1
VR3	2,1
W1	2,1

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y

P/O A10 MODULATION CONTROL LATCHES AND MODE SELECT **SS6**

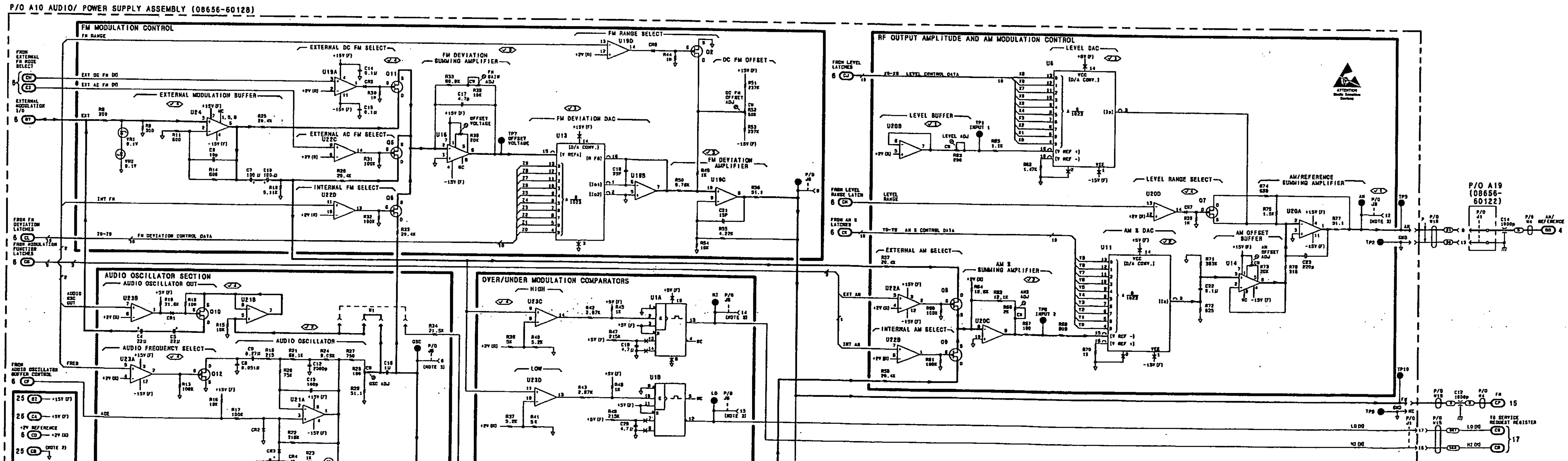
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A10J5-1 and 5 connections and by mechanical contact through nuts holding PC board to frame.
3. Service test point. Pin of dual in-line test socket J6.

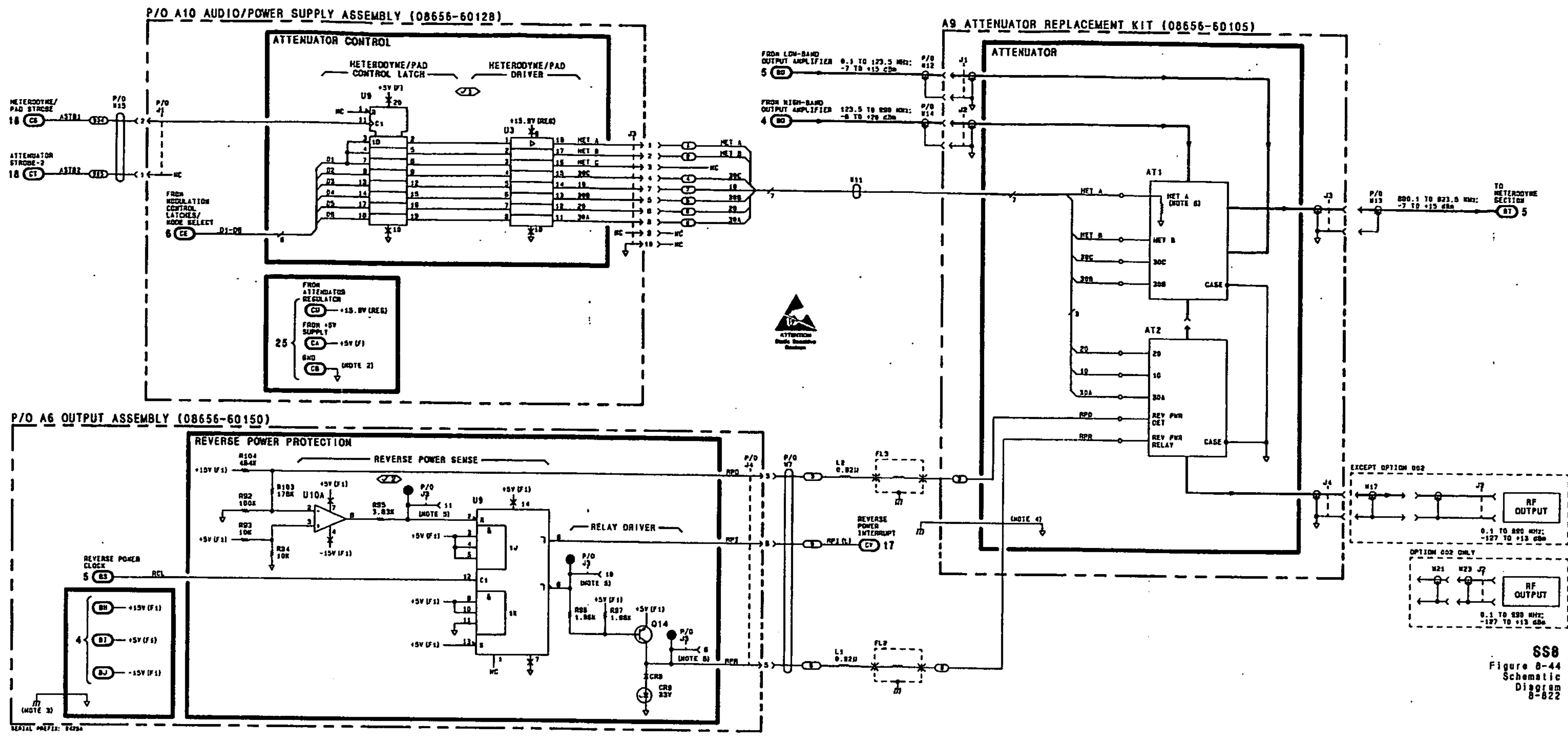
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

Schematic General Information



SS7
Figure 8-42
Schematic
Diagram

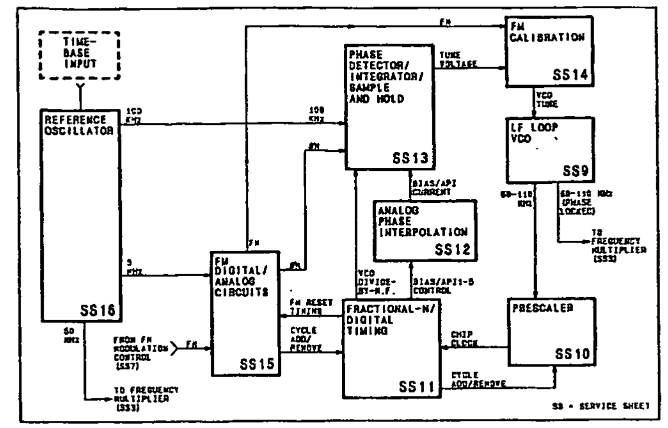


SS8
Figure 8-44
Schematic
Diagram
8-822

NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. Printed circuit trace inductor.

Schematic General Information

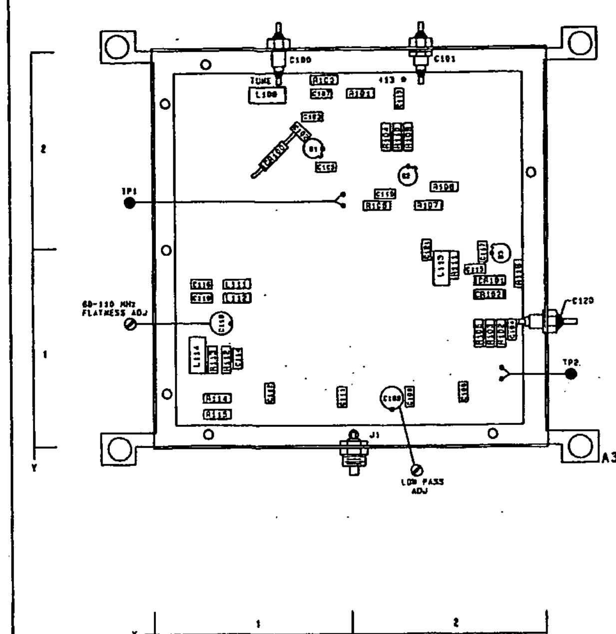


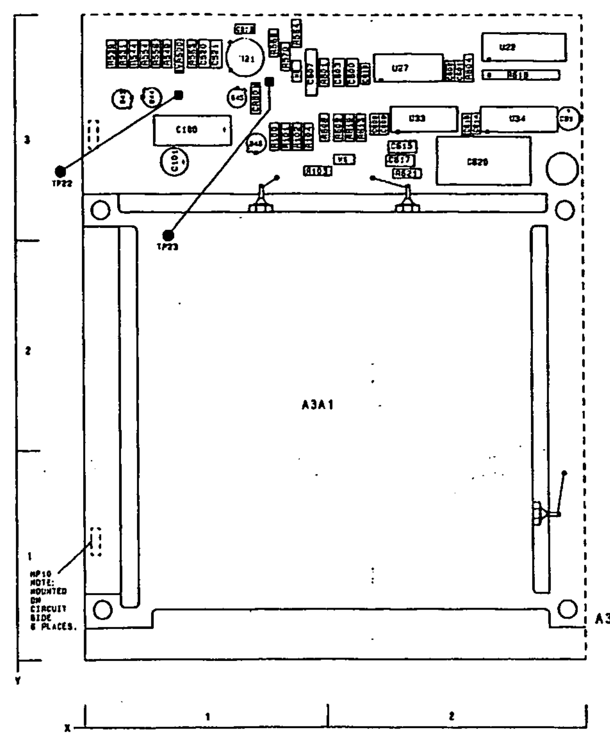
Reference Block Diagram

Component Coordinates

A3A1 COMP	X,Y	COMP	X,Y	A3 COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C100	1,2	L100	1,2	C100	1,3												
C101	2,2	L111	1,2	C101	1,3												
C102	1,2	L112	1,1														
C103	1,2	L113	2,1	Q48	1,3												
C104	2,1	L114	1,1														
C105	1,2			R100	1,3												
C106	2,1	Q1	1,2	R101	1,3												
C107	1,2	Q2	2,2	R102	1,3												
C108	2,1	Q3	2,1	R104	1,3												
C109	2,1																
C110	2,2	R100	1,2														
C111	1,1	R101	2,2														
C112	1,1	R102	2,1														
C113	2,2	R103	2,1														
C114	1,1	R104	2,2														
C115	2,1	R105	2,1														
C116	1,1	R106	2,2														
C117	2,1	R107	2,2														
C118	1,1	R108	2,2														
C119	1,1	R109	2,1														
C120	2,1	R110	2,2														
C121	2,1	R111	2,1														
		R112	1,1														
		R113	1,1														
CR100	1,2	R114	1,1														
CR101	2,1	R115	1,1														
CR102	2,1	R116	2,1														
J1	2,1	TP1	1,2														
		TP2	2,1														

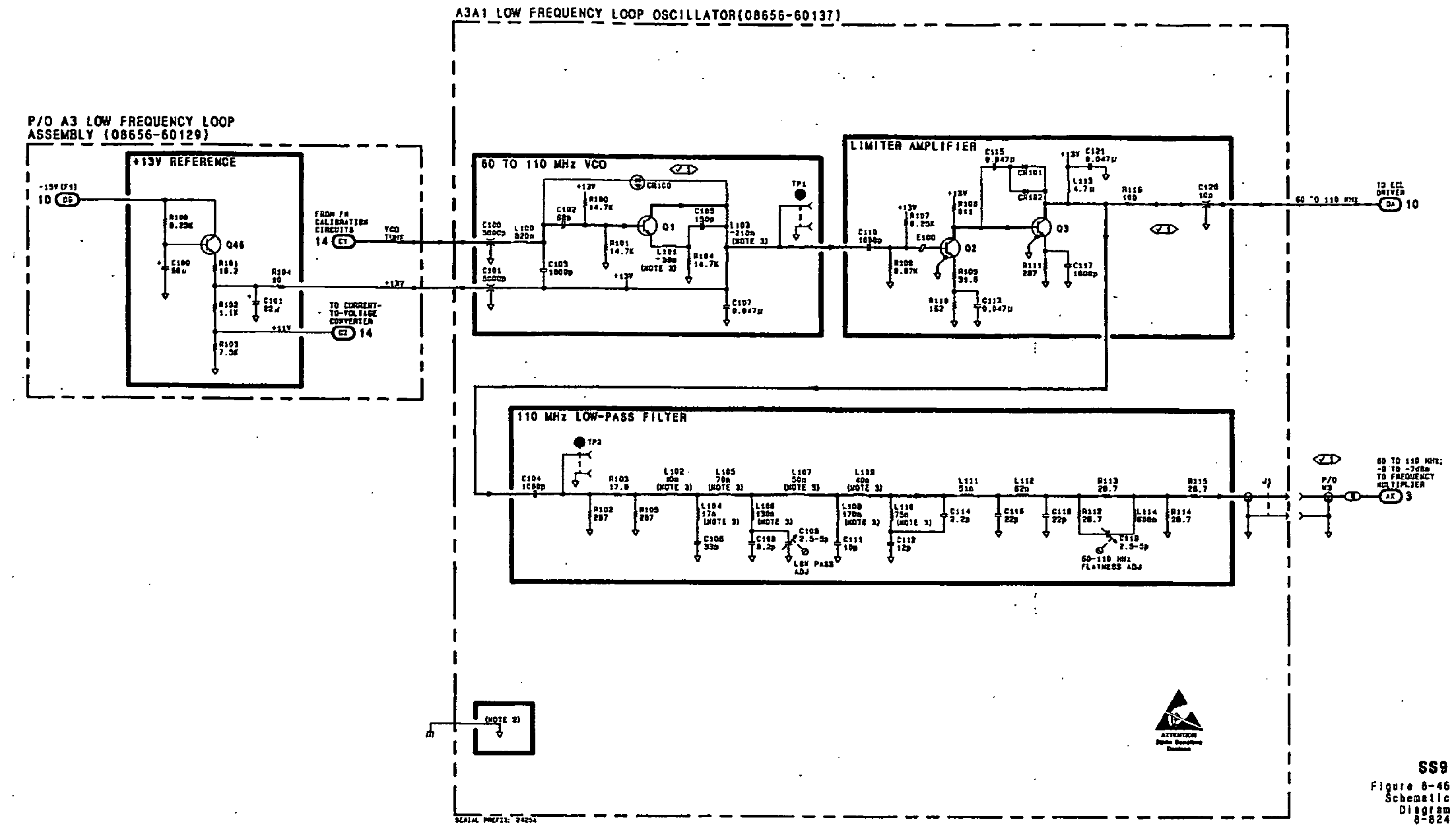
A9, P/O 10, P/O A6 — ATTENUATOR, ATTENUATOR CONTROL AND REVERSE POWER PROTECTION **SS8**





Component Locator

Figure 8-45. Service Sheet 9 Information



SS9

Figure 8-46
Schematic
Diagram
8-824

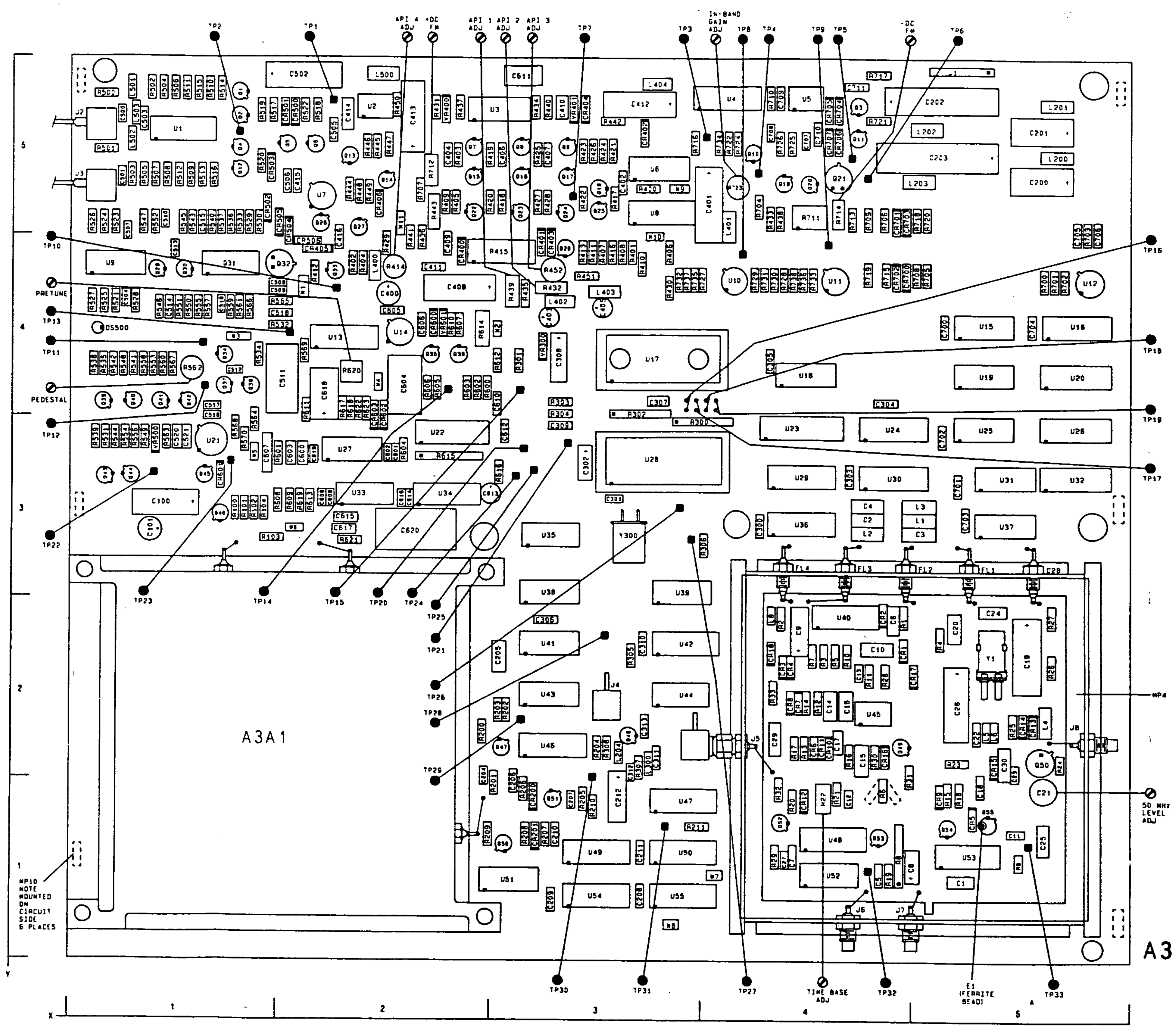
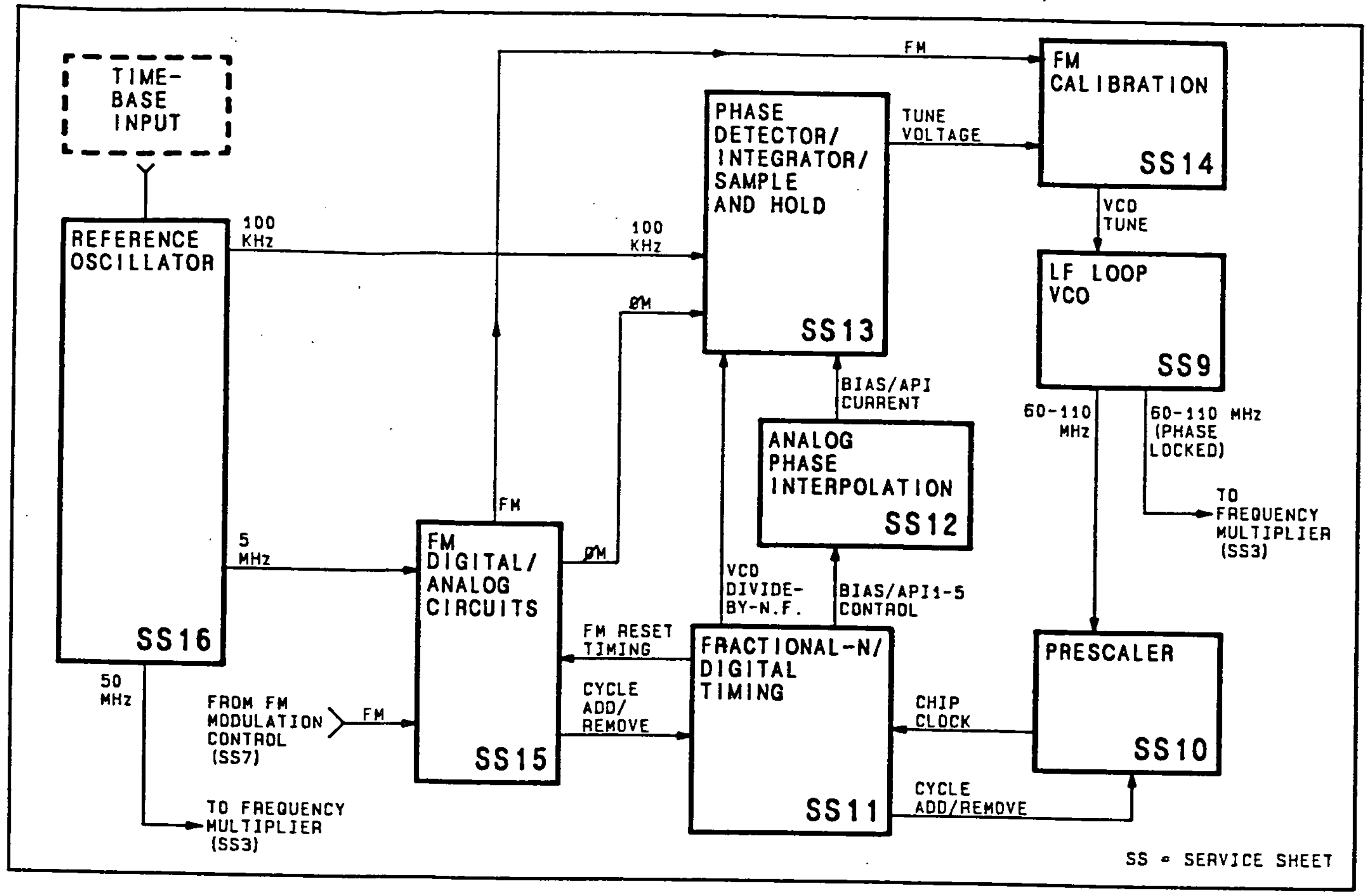


Figure 8-47. Service Sheet 10 Information

Component Locator



Reference Block Diagram

Component Coordinates

A3																	
COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C200	5.5	R204	3.2														
C201	5.5	R205	3.1														
C202	5.5	R206	3.1														
C203	5.5	R207	3.1														
C204	2.2	R208	3.1														
C205	3.2	R209	2.1														
C206	3.1	R210	3.1														
C207	3.1	R211	3.1														
C208	3.1																
C209	3.1	TP29	3.2														
C210	3.1	TP30	3.2														
C211	3.1	TP31	3.1														
C212	3.1																
		W7	4.1														
CR200	3.1	W8	3.1														
CR201	3.1																
		U46	3.2														
J1	5.5	U49	3.1														
		U50	3.1														
L200	5.5	U51	3.1														
L201	5.5	U54	3.1														
L202	5.5	U55	3.1														
L203	5.5																
L204	3.2																
Q47	3.2																
Q51	3.1																
Q56	3.1																
R200	2.2																
R201	3.1																
R202	3.2																
R203	3.2																

P/O A3, A3A1 LOW FREQUENCY LOOP VOLTAGE CONTROLLED OSCILLATOR **SS9**

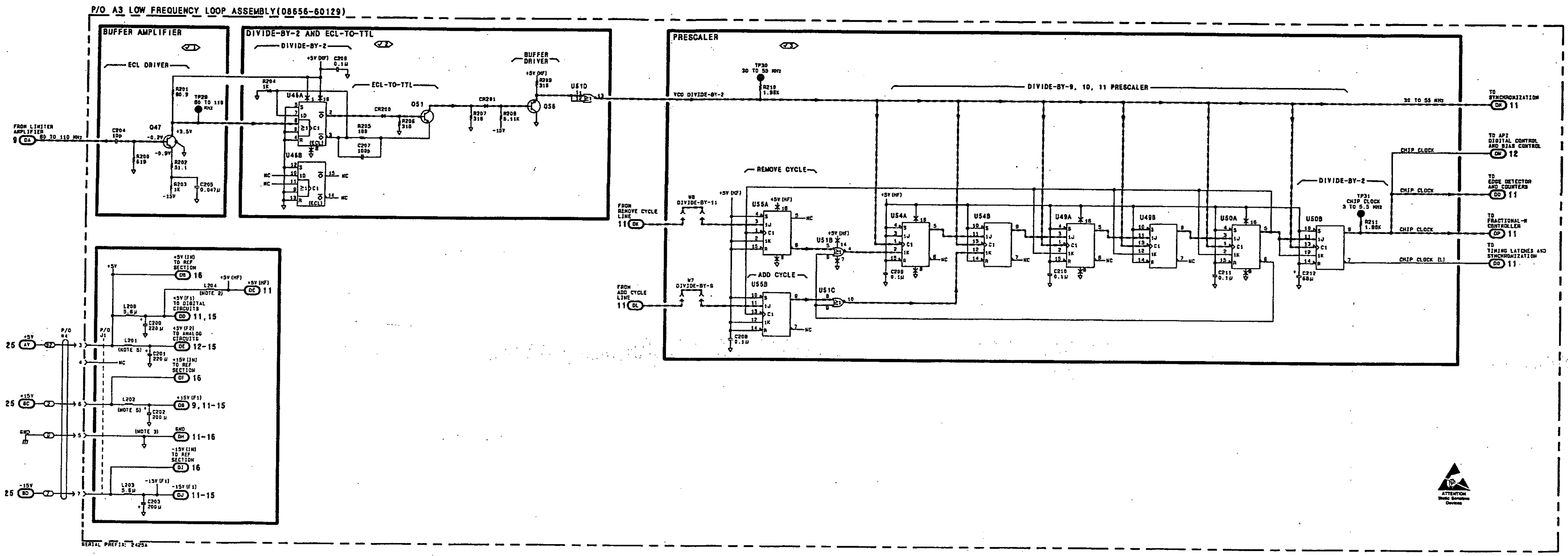
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Nominal value of RF choke is 2.5-6uH.
3. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
4. Reference designations on this service sheet C, CR, L and R have numbers ranging from 200 to 299 only.
5. Wide-band RF choke approximately 6uH.

LOGIC LEVELS

	TTL	ECL
HIGH	>2V	>+4.2V
LOW	<0.8V	<+3.3V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	LOW
GROUND	LOW	HIGH

Schematic General Information



SS10
Figure 8-48
Schematic
Diagram
8-826

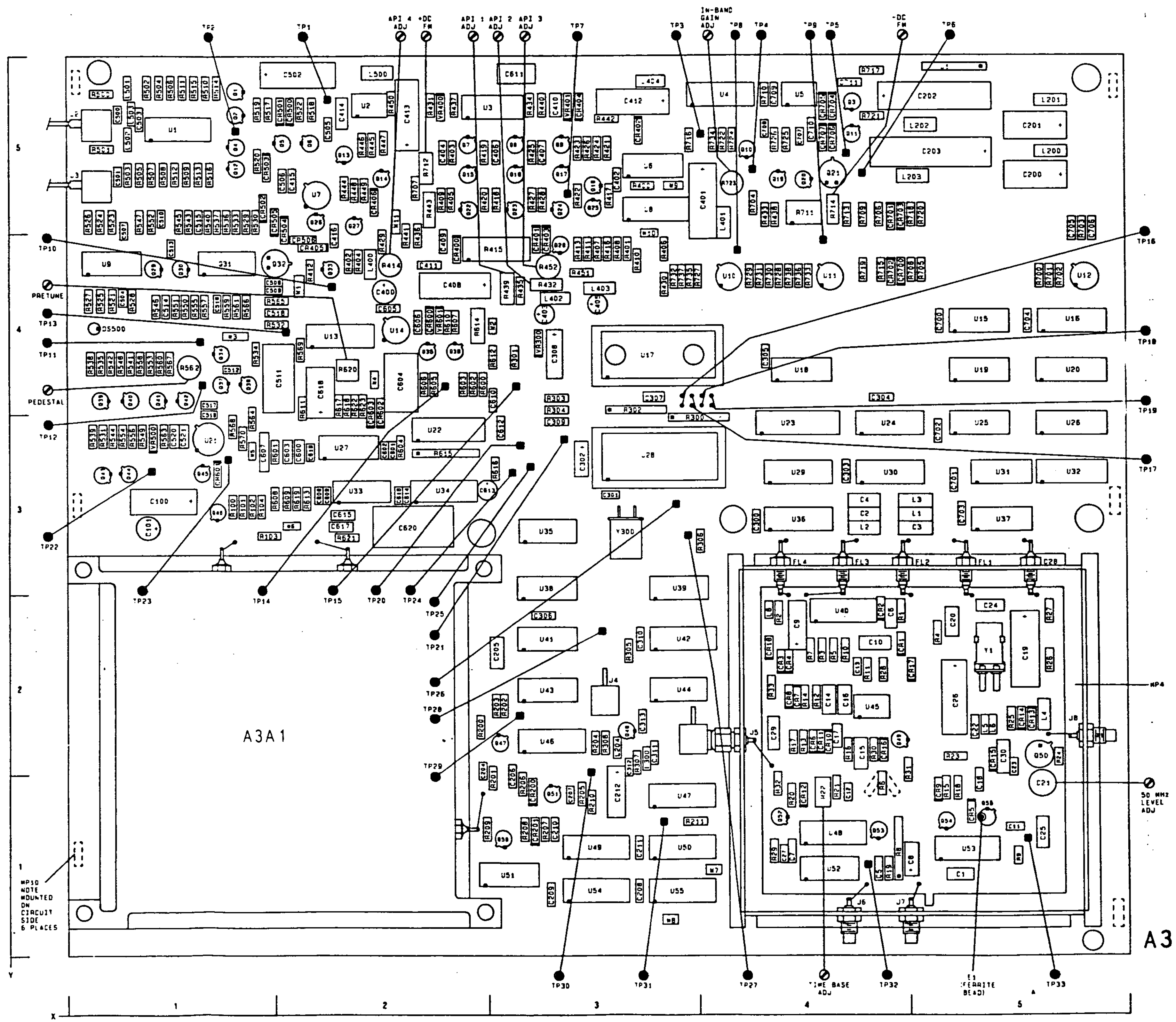
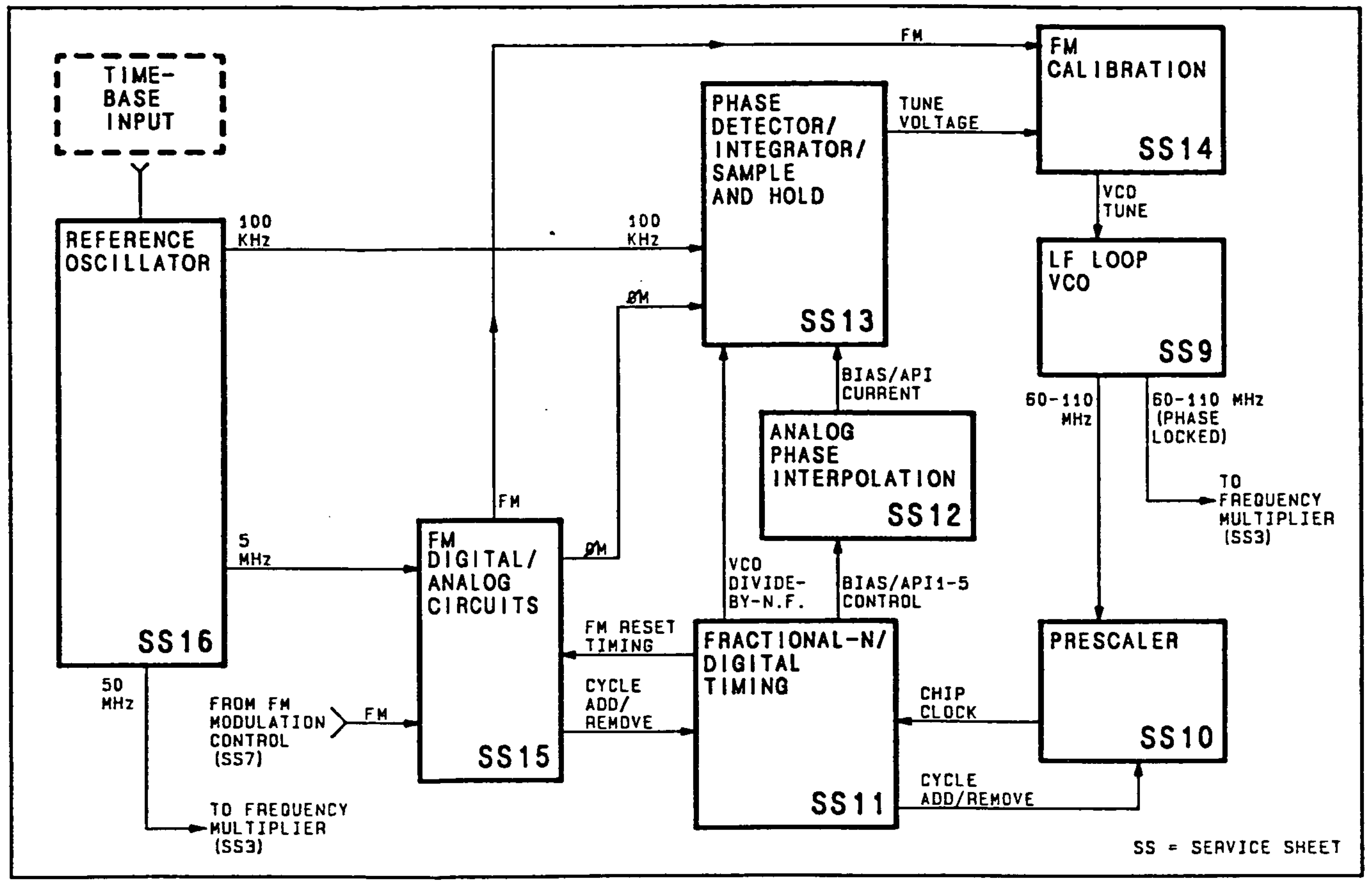


Figure 8-49. Service Sheet 11 Information

Component Locator



Reference Block Diagram

Component Coordinates

A3

COMP	X,Y
C300	4,3
C301	3,3
C302	3,3
C303	4,3
C304	4,4
C305	4,4
C306	3,2
C307	3,4
C308	3,4
C309	3,3
C310	3,2
C311	3,2
C312	3,2
C313	3,2
J1	5,5
J4	3,2
L300	3,2
Q48	3,2
R300	3,3
R301	3,4
R302	3,4
R303	3,4
R304	3,4
R305	3,2
R306	3,3
R307	3,2
R308	3,2

COMP	X,Y
TP15	3,4
TP16	3,4
TP17	3,4
TP18	3,4
TP19	4,4
TP20	3,3
TP21	3,3
TP24	3,3
TP25	3,3
TP26	3,3
TP27	3,3
TP28	3,2
U17	3,4
U18	4,4
U19	5,4
U23	4,3
U24	4,3
U28	3,3
U29	4,3
U30	4,3
U35	3,3
U36	4,3
U38	3,3
U39	3,3
U41	3,2
U42	3,2
U42	3,2
U43	3,2
U44	3,2
U47	3,1
VR300	3,4
Y300	3,3

P/O A3 LOW FREQUENCY LOOP DIVIDE-BY-2 AND PRESCALER SS10

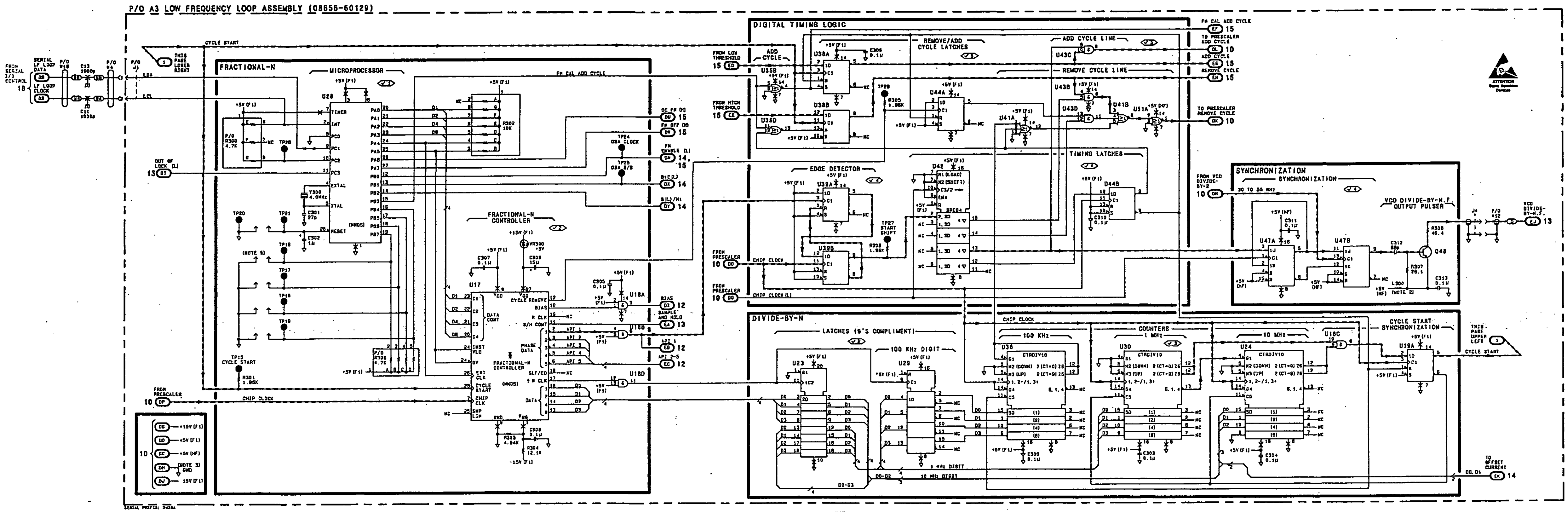
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Nominal value of RF choke is 2.5-6uH.
3. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
4. Reference designations on this service sheet C, CR, L, R and VR have numbers ranging from 300 to 399 only.
5. Jumper for TP17-19 is installed only for troubleshooting.

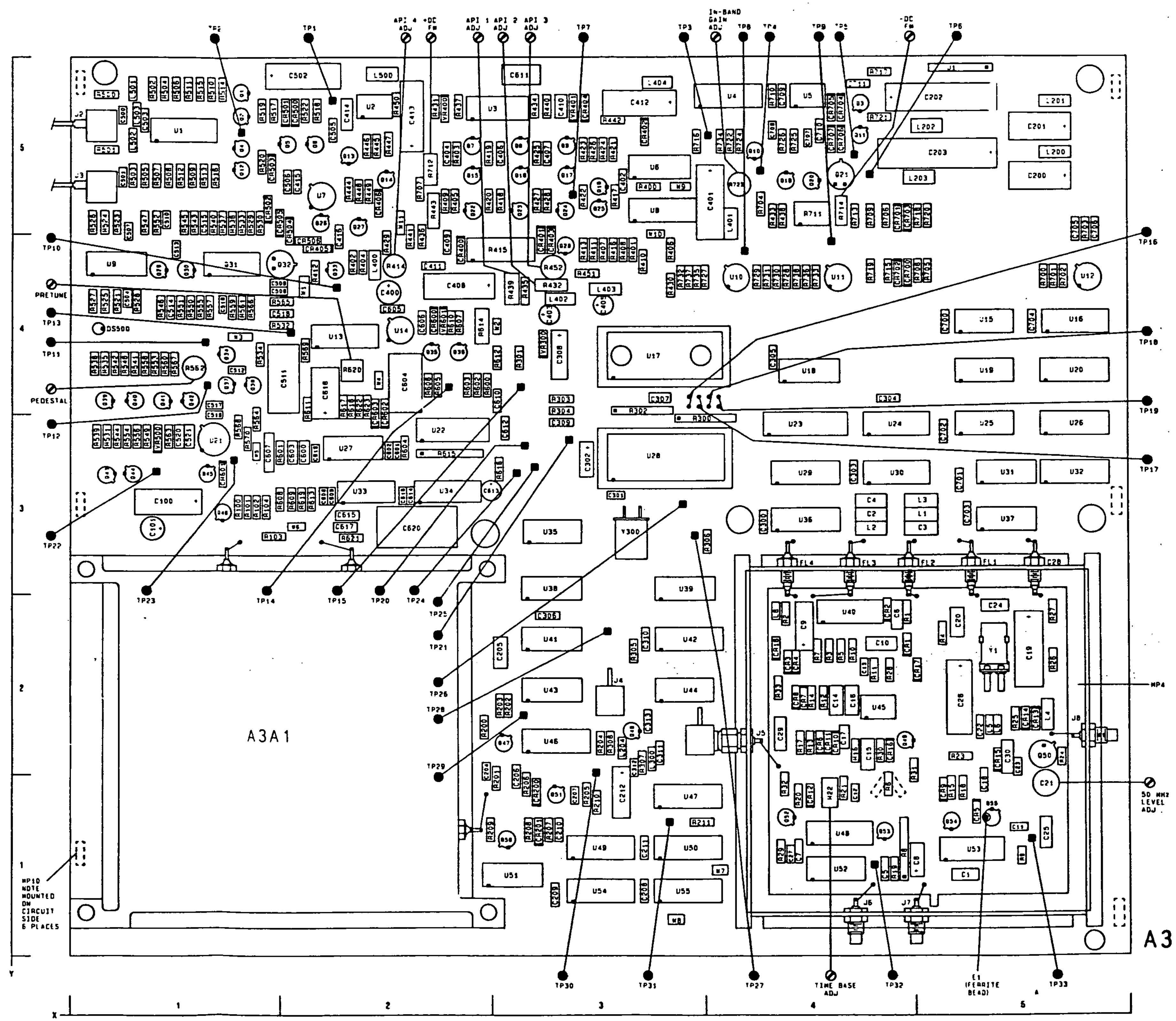
LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Schematic General Information

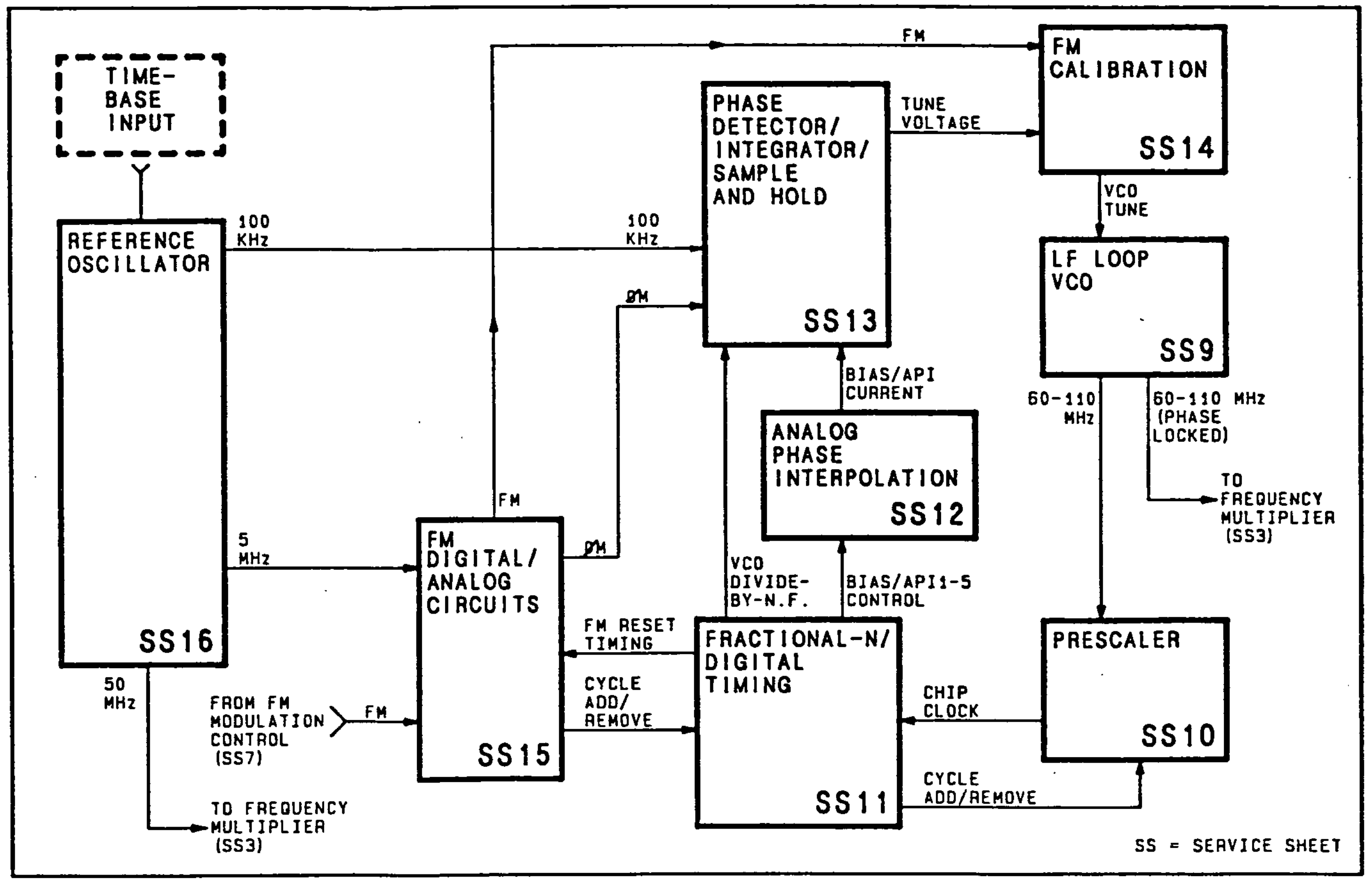


SS11
Figure 8-50
Schematic
Diagram
8-828



Component Locator

Figure 8-51. Service Sheet 12 Information



Reference Block Diagram

Component Coordinates

A3 COMP	X,Y
C400	2,4
C401	3,5
C402	3,5
C403	3,4
C404	2,5
C405	3,4
C406	2,5
C407	3,5
C408	2,4
C409	2,4
C410	3,5
C411	2,4
C412	3,5
C413	2,5
C414	2,5
C415	2,5
C416	2,4
CR400	2,4
CR401	3,4
CR402	3,5
CR403	3,4
CR404	3,5
CR405	2,4
CR406	2,5
L400	2,4
L401	4,5
L402	3,4
L403	3,4
L404	3,5
Q7	2,5
Q8	3,5

COMP	X,Y
Q9	3,5
Q13	2,5
Q14	2,5
Q15	2,5
Q16	3,5
Q17	3,5
Q18	3,5
Q19	4,5
Q22	2,5
Q23	3,5
Q24	3,5
Q25	3,5
Q26	2,5
Q27	2,5
Q28	3,4
Q33	2,4
R400	3,5
R401	3,4
R402	2,4
R403	2,5
R404	2,4
R405	2,5
R406	3,4
R407	3,4
R408	3,4
R409	2,5
R410	3,4
R411	3,4
R412	2,4
R413	3,4
R414	2,4
R415	2,4
R416	3,4
R417	3,5
R418	2,5

COMP	X,Y
R419	2,5
R420	2,5
R421	3,5
R422	3,5
R423	3,5
R424	3,5
R425	3,5
R426	3,5
R427	3,5
R428	3,5
R429	2,4
R430	3,4
R431	2,5
R432	3,4
R433	4,5
R434	3,5
R435	3,4
R436	2,4
R437	2,5
R438	4,5
R439	3,4
R440	3,5
R441	2,4
R442	3,5
R443	2,5
R444	2,5
R445	2,5
R446	2,5
R447	2,5
R448	2,5
R449	2,5
R450	2,5
R451	3,4
R452	3,4

COMP	X,Y
TP7	3,5
TP10	2,4
U2	2,5
U3	2,5
U6	3,5
U7	2,5
U8	3,5
VR400	2,5
VR401	3,5
W9	3,5
W10	3,4

P/O A3 LOW FREQUENCY LOOP FRACTIONAL-N, DIVIDE-BY-N AND DIGITAL TIMING LOGIC

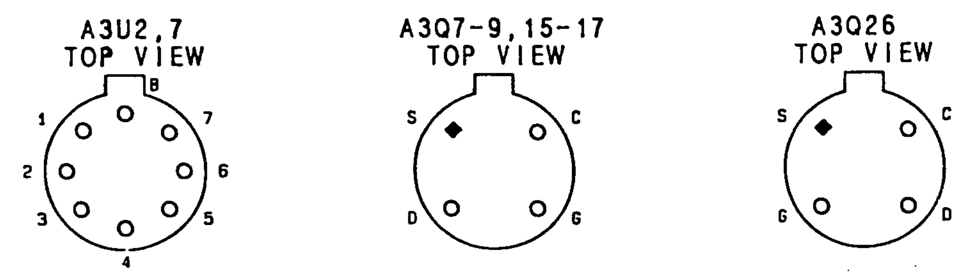
SS11

NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. Isolation (guard) trace.
4. Reference designations on this service sheet C, CR, L, R and VR have numbers ranging from 400 to 499 only.

LOGIC LEVELS

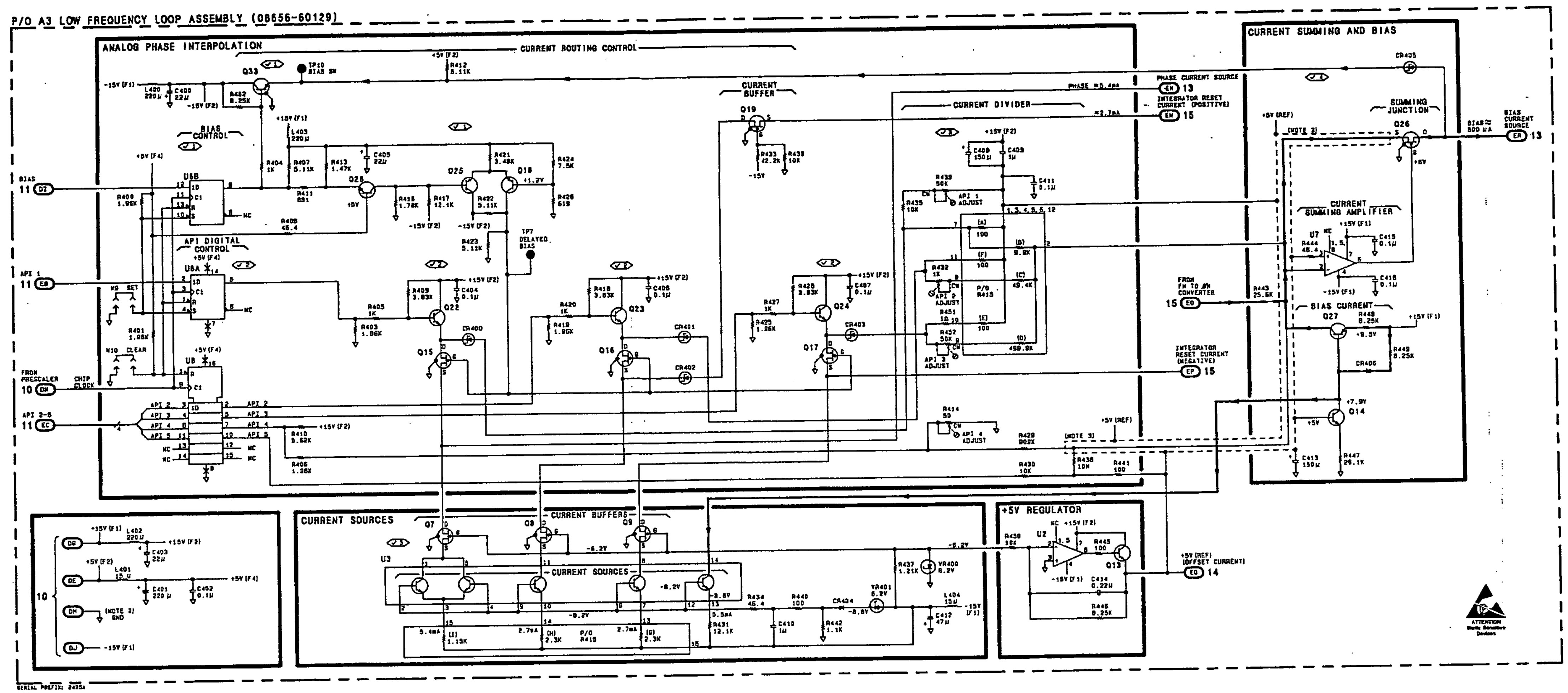
	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW



Schematic General Information

SERVICE SHEETS

	Assembly	Schematic Service Sheet Number	Block Diagram	Principles of Operation Page No.	Troubleshooting Page No.	Parts List Page No.
A1	Keyboard Assembly (08656-60134)	21	BD4	8-69, 245	8-71, 247	6-5
A2	Display Assembly (08656-60176) 2511A and above (08656-60126) 2425A to 2509A	21-24	BD4	8-69, 245, 253, 263, 271	8-71, 247, 255, 265, 275	6-7
A3	Low Frequency Loop Assembly (08656-60179) 2511A and above (08656-60129) 2425A to 2509A	10-16	BD3	8-53, 149, 157 171, 177, 193, 201, 213	8-63, 153, 165, 175, 187, 197, 207, 215	6-11
A3A1	Low Frequency Oscillator (08656-60137)	9	BD3	8-53, 145	8-63, 147	6-23
A4	High Frequency Loop Assembly (08656-60001)	1, 2	BD2	8-45, 73, 83	8-49, 77, 87	6-25
A5	High Frequency Oscillator Assembly (08656-60013)	1	BD2	8-46, 73	8-49, 77	6-31
A6	Output Assembly (08656-60180) 2511A and above (08656-60150) 2425A to 2509A	4, 5, 8	BD2	8-46, 99, 109, 135	8-50, 103, 111, 137	6-33
A7	RFI Assembly (08656-60063)	4, 5, 17	—	—	—	6-39
A8	Frequency Multiplier Assembly (08656-60004)	3	BD2	8-45, 93	8-51, 95	6-41
A9	Attenuator Replacement Kit (08656-60105)	8	BD2	8-46, 135	8-49, 137	6-45
A10	Audio/Power Supply Assembly (08656-60178) 2511A and above (08656-60128) 2425A to 2509A	6-8, 25	BD2	8-47, 117, 127, 135, 281	8-51, 121, 131, 137, 283	6-47
A11	Microprocessor/Memory/HP-IB (08656-60177) 2511A and above (08656-60127) 2425A to 2509A	17-20	BD4	8-69, 217, 227, 233, 241	8-71, 223, 229, 235, 243	6-53
A12	Voltage Regulator Assembly (08656-60016)	25	—	—	—	6-55
A13	HP-IB Connector Assembly (08656-60136)	20	BD4	—	—	6-57
A14	Filter Bank Assembly (08656-60135) 2425A to 2509A	6, 17, 25	—	—	—	6-59
A15	Line Power Module (0960-0443) 2425A to 2509A (0960-0679) 25114 and above	25	—	—	—	6-61
A16	10 MHz Reference Oscillator Assembly (0950-0441)	25	—	—	—	6-63
A17	Front Feedthru Assembly (08656-60081) 2425A to 2509A	6, 7, 21, 25	—	—	—	6-65
A18	Front (F) Feedthru Assembly (08656-60113) 2425A to 2509A	6, 21	—	—	—	6-67
A19	Rear Feedthru Assembly (08656-60122) 2425A to 2509A	5, 17, 25	—	—	—	6-69



SS12
Figure 8-52
Schematic
Diagram
8-830

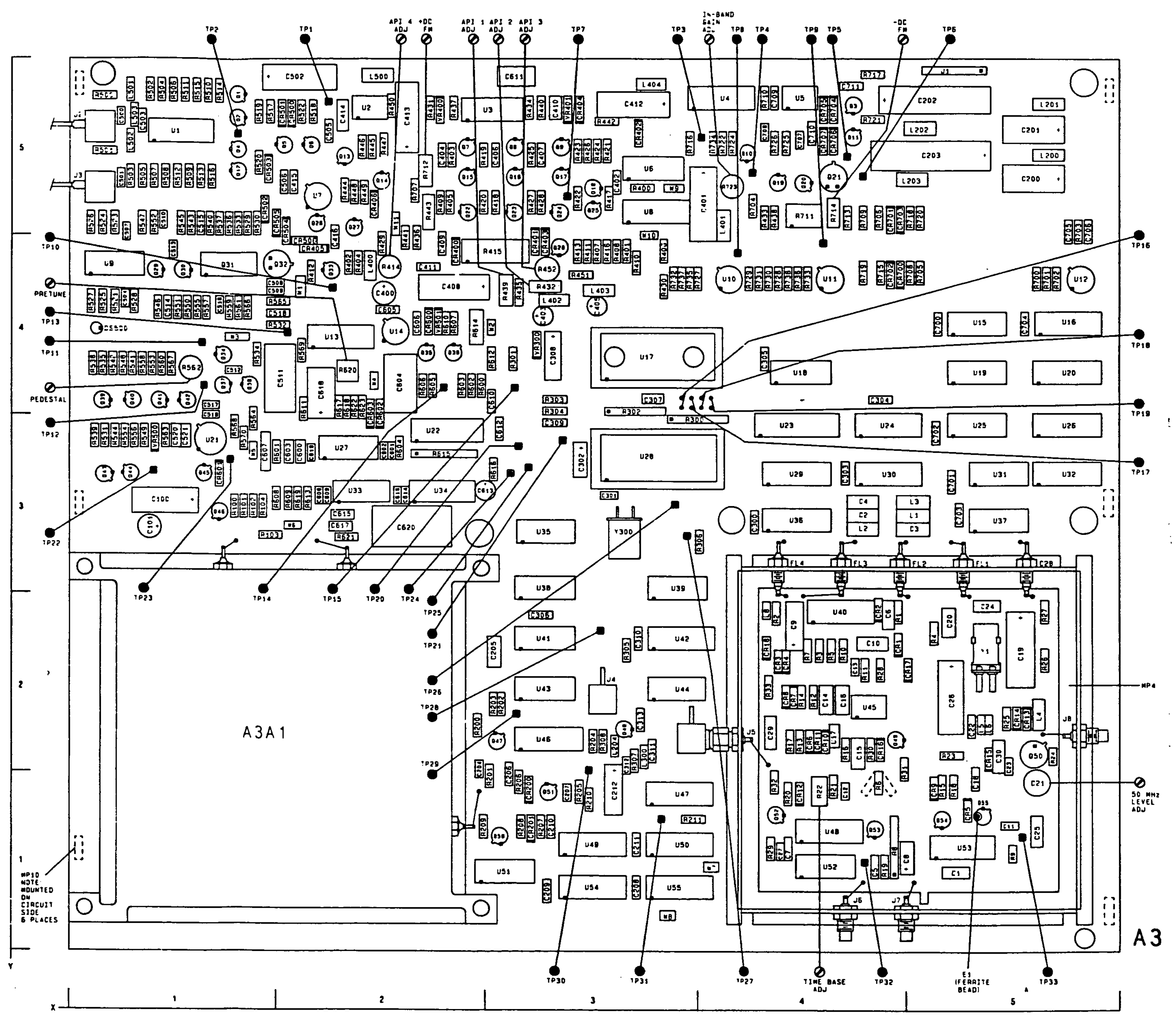
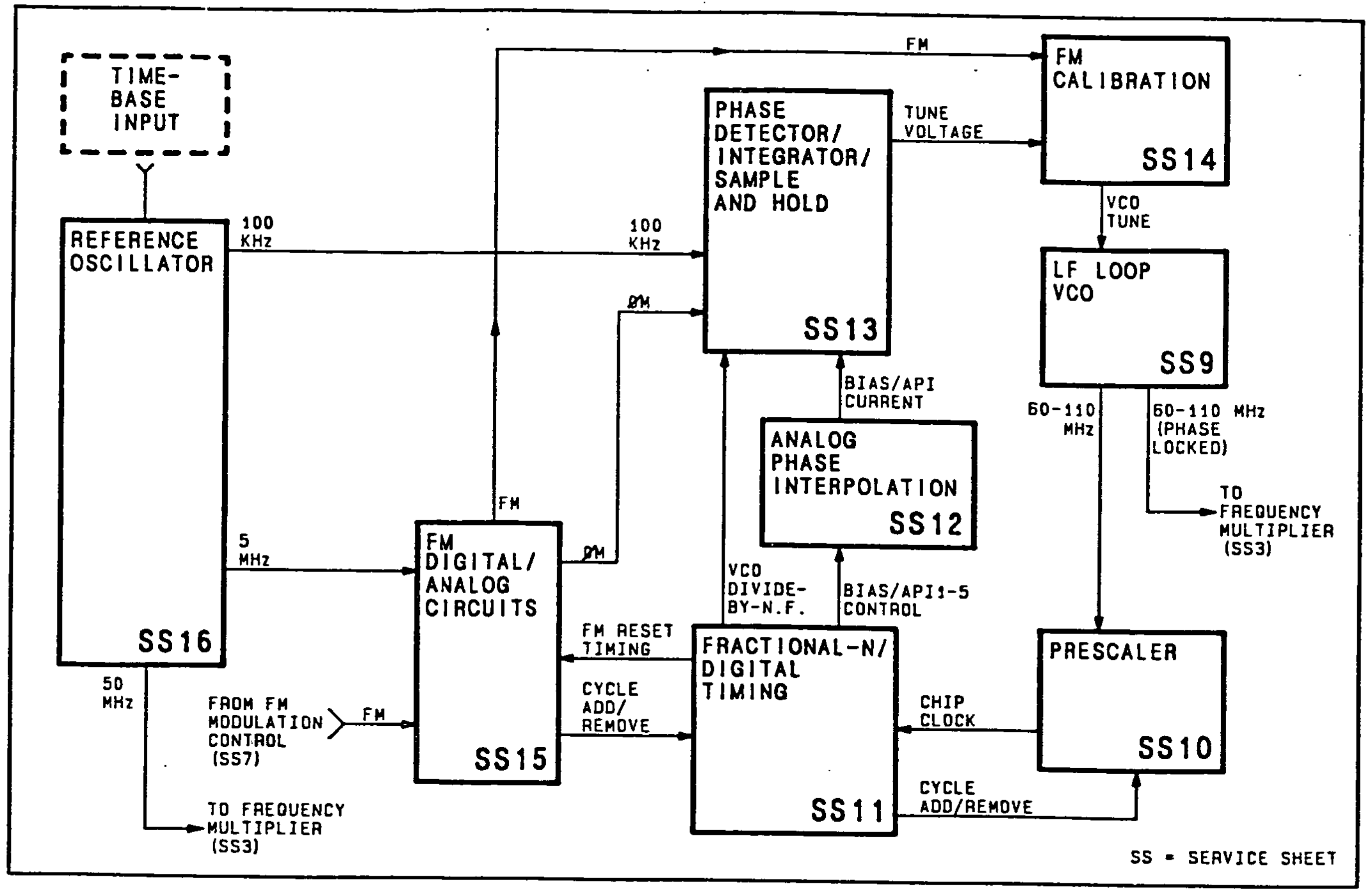


Figure 8-53. Service Sheet 13 Information

Component Locator



Reference Block Diagram

Component Coordinates

A3	
COMP	X,Y
C500	1.5
C501	1.5
C502	2.5
C503	1.5
C504	1.4
C505	2.5
C506	2.5
C507	1.5
C508	1.4
C509	1.4
C510	1.5
C511	1.4
C512	1.4
C513	1.4
C514	1.4
C515	1.5
C516	1.4
C517	1.4
C518	1.4
C519	1.3
C520	1.3
C521	1.3
CR500	2.5
CR501	1.5
CR502	1.5
CR503	1.5
CR504	2.5
CR505	1.5
CR506	2.4
DS500	1.4
J2	1.5
J3	1.5

COMP	X,Y
L500	2.5
L501	1.5
L502	1.5
L503	1.5
Q1	1.5
Q2	1.5
Q4	1.5
Q5	2.5
Q6	2.5
Q12	1.5
Q29	1.4
Q30	1.4
Q31	1.4
Q32	1.4
Q34	1.4
Q37	1.4
Q38	1.4
Q39	1.4
Q40	1.4
Q41	1.4
Q42	1.4
Q43	1.3
Q44	1.3
R500	1.5
R501	1.5
R502	1.5
R503	1.5
R504	1.5
R505	1.5
R506	1.5
R507	1.5
R508	1.5
R509	1.5
R510	1.5
R511	1.5

COMP	X,Y
R512	1.5
R513	1.5
R514	1.5
R515	1.5
R516	1.5
R517	1.5
R518	2.5
R519	1.5
R520	1.5
R521	1.4
R522	2.5
R523	1.5
R524	1.5
R525	1.4
R526	1.5
R527	1.4
R528	1.4
R529	1.5
R530	1.5
R531	1.3
R532	1.4
R533	1.5
R534	1.4
R535	1.4
R536	1.5
R537	1.5
R538	1.4
R539	1.3
R540	1.5
R541	1.4
R542	1.4
R543	1.5
R544	1.3
R545	1.5
R546	1.4
R547	1.5
R548	1.4

COMP	X,Y
R549	1.3
R550	1.4
R551	1.4
R552	1.5
R553	1.4
R554	1.3
R555	1.4
R556	1.3
R557	1.4
R558	1.4
R559	1.4
R560	1.4
R561	1.4
R562	1.4
R563	1.3
R564	1.3
R565	1.4
R566	1.4
R567	1.4
R568	1.3
R569	2.4
R570	1.3
TP1	2.5
TP2	1.5
TP11	1.4
TP12	1.4
TP13	2.4
TP22	1.3
TP23	1.3
U1	1.5
U9	1.4
U21	1.3

COMP	X,Y
VR500	1.3
W1	2.4
W3	1.4
W5	1.3

P/O A3 LOW FREQUENCY LOOP ANALOG PHASE INTERPOLATION (API), CURRENT SOURCES, CURRENT SUMMING AND BIAS

SS12

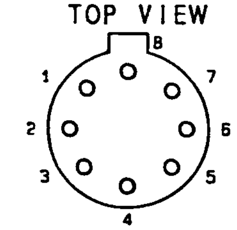
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Nominal value of RF choke is 2.5-6uH.
3. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
4. Isolation (guard) trace.
5. Reference designations on this service sheet C, CR, L, R and VR have numbers ranging from 500 to 599 only.
6. Inverting input of U21 is internally connected to the output pin 6.

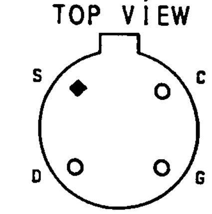
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

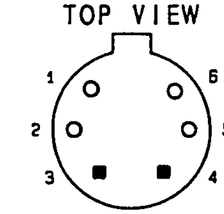
A3U21
TOP VIEW



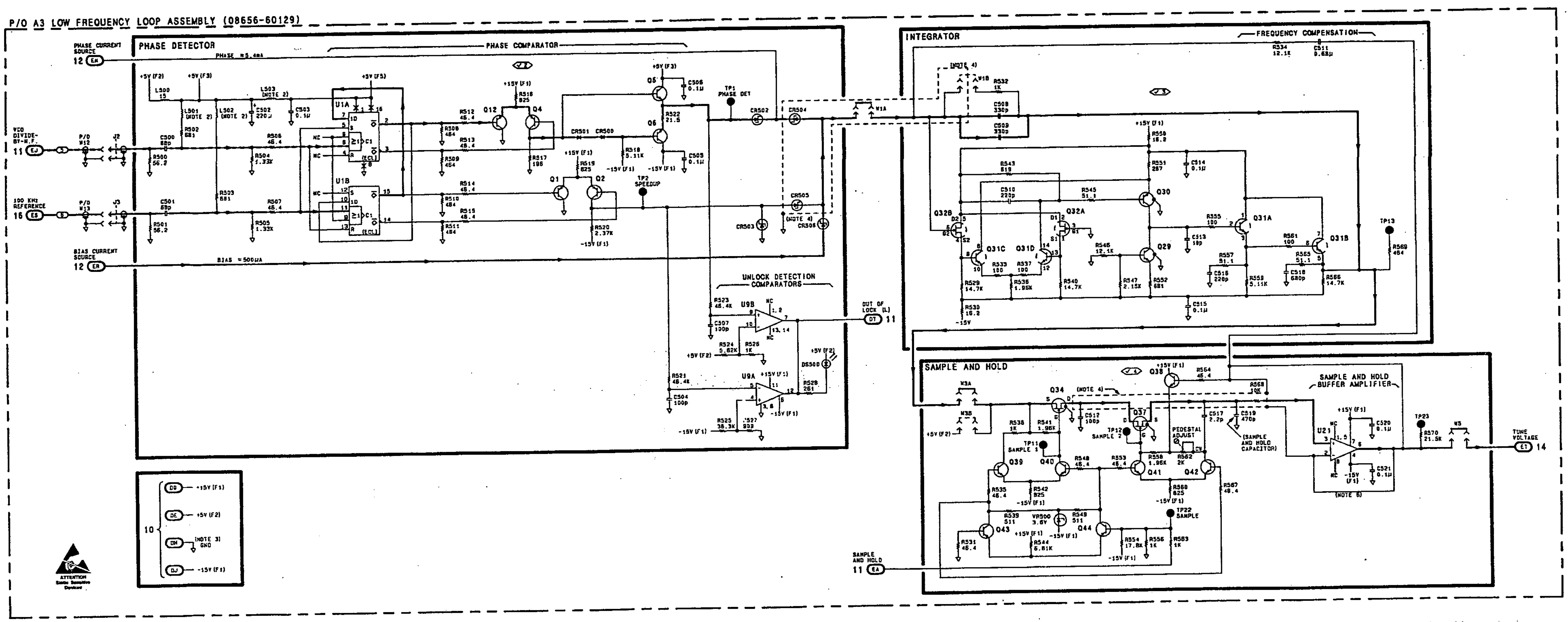
A3Q34,37
TOP VIEW



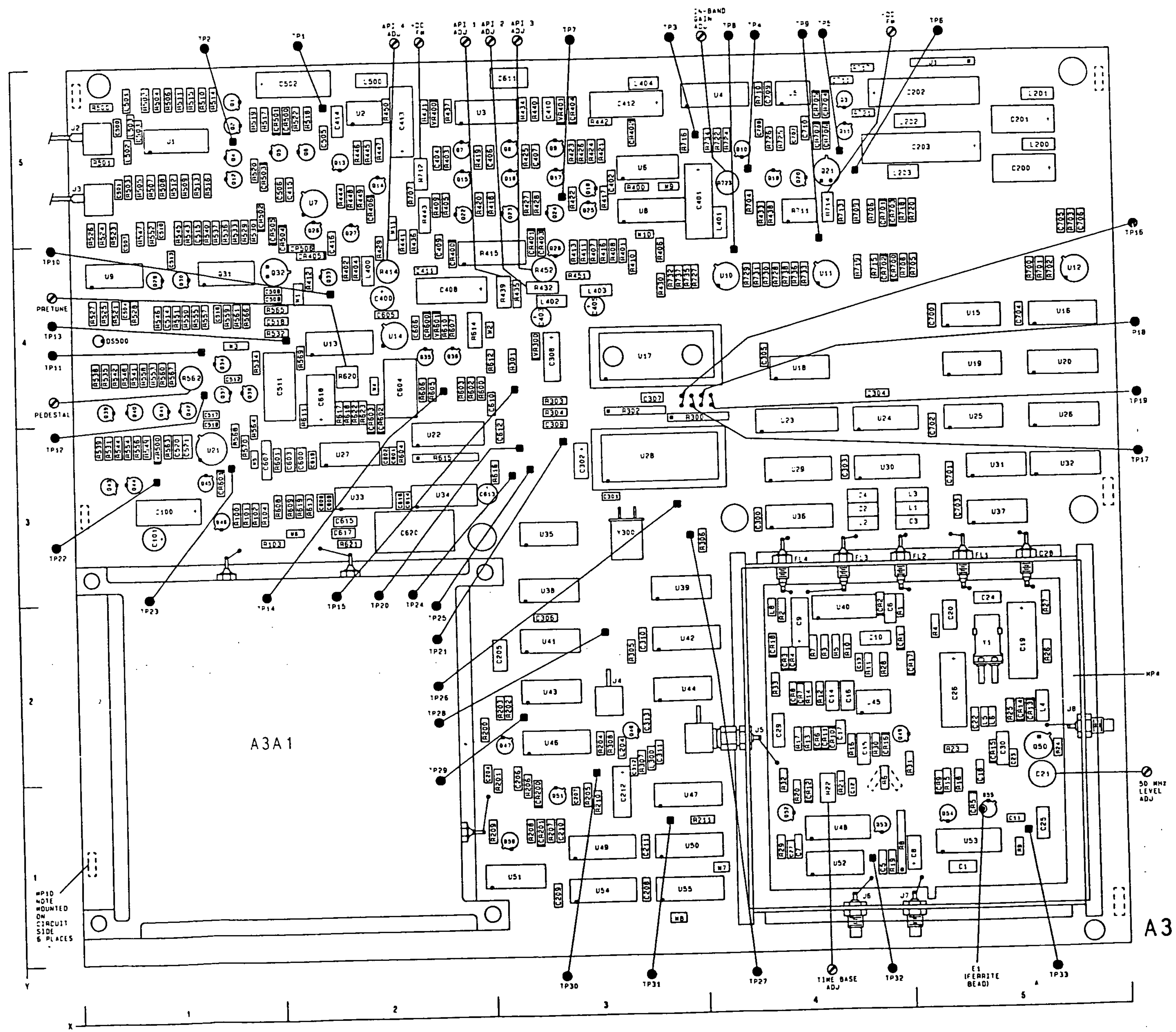
A3Q32
TOP VIEW



Schematic General Information

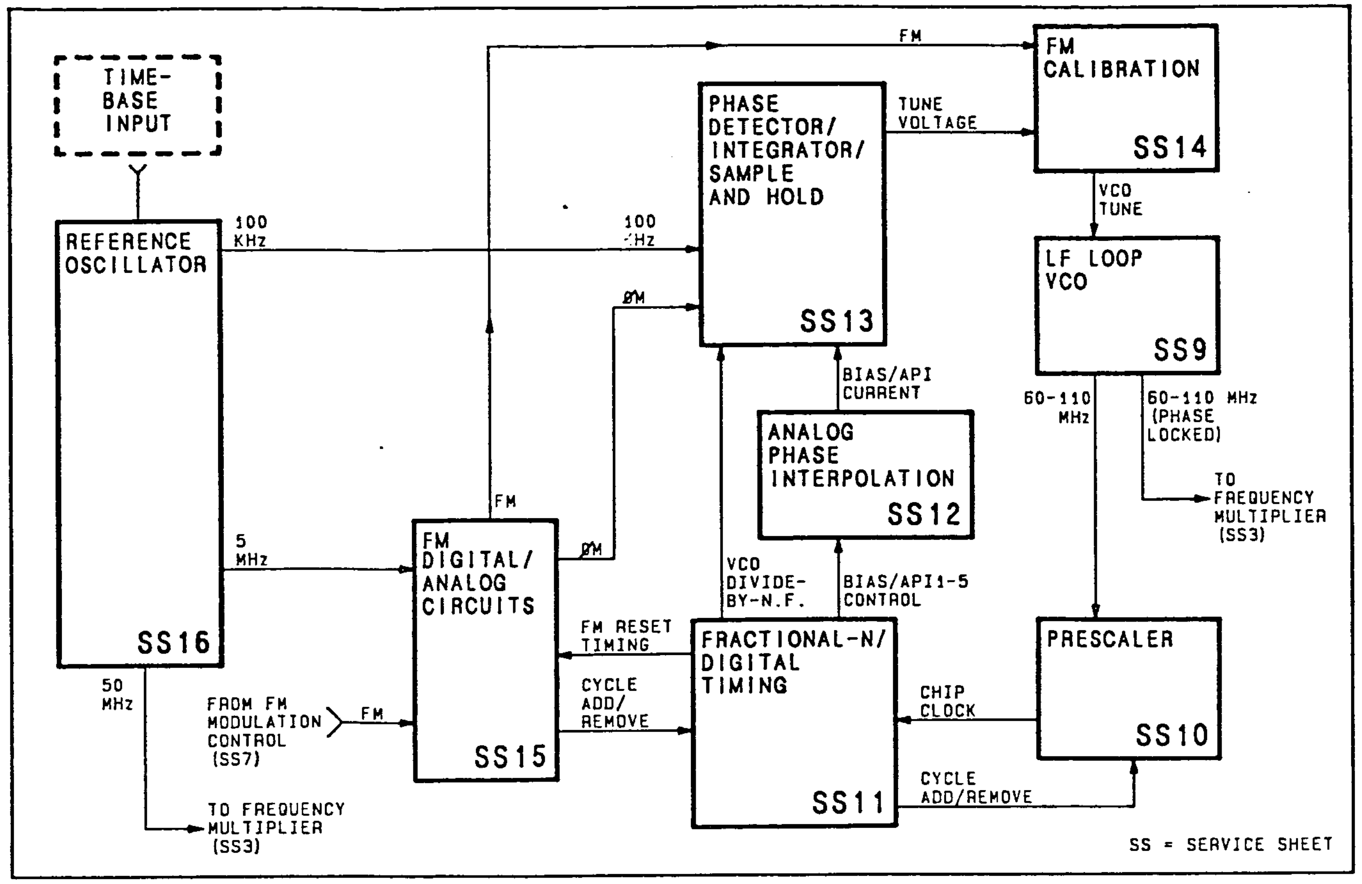


SS13
Figure 8-54
Schematic
Diagram
8-832



Component Locator

Figure 8-55. Service Sheet 14 Information



Reference Block Diagram

Component Coordinates

A3 COMP	X,Y
C600	2,3
C601	2,3
C602	2,3
C603	2,3
C604	2,4
C605	2,4
C606	2,4
C607	1,3
C608	2,3
C609	2,3
C610	2,4
C611	3,5
C612	3,3
C613	2,3
C614	2,3
C615	2,3
C616	2,3
C617	2,3
C618	2,4
C619	2,3
C620	2,3
CR600	2,4
CR601	1,3
CR602	2,4
CR603	2,4
Q35	2,4
Q36	2,4
Q45	1,3

COMP	X,Y
R600	2,4
R601	1,3
R602	2,4
R603	2,4
R604	2,3
R605	2,4
R606	2,4
R607	2,4
R608	1,3
R609	2,3
R610	2,4
R611	2,4
R612	2,4
R613	2,3
R614	2,4
R615	2,3
R616	2,3
R617	2,4
R618	2,4
R619	2,3
R620	2,4
R621	2,3
R622	2,4
R623	2,4
TP14	2,4
U13	2,4
U14	2,4
U22	2,3
U27	2,3
U33	2,3
U34	2,3
VR601	2,4

COMP	X,Y
W2	2,4
W4	2,4
W6	2,3
W11	2,5

P/O A3 LOW FREQUENCY LOOP PHASE DETECTOR, INTEGRATOR, AND SAMPLE AND HOLD

SS13

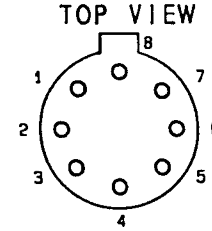
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
3. Isolation (guard) trace.
4. Reference designations on this service sheet C, CR, L, R and VR have numbers ranging from 600 to 699 only.

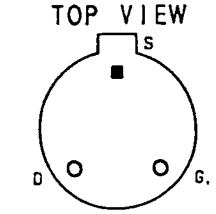
LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

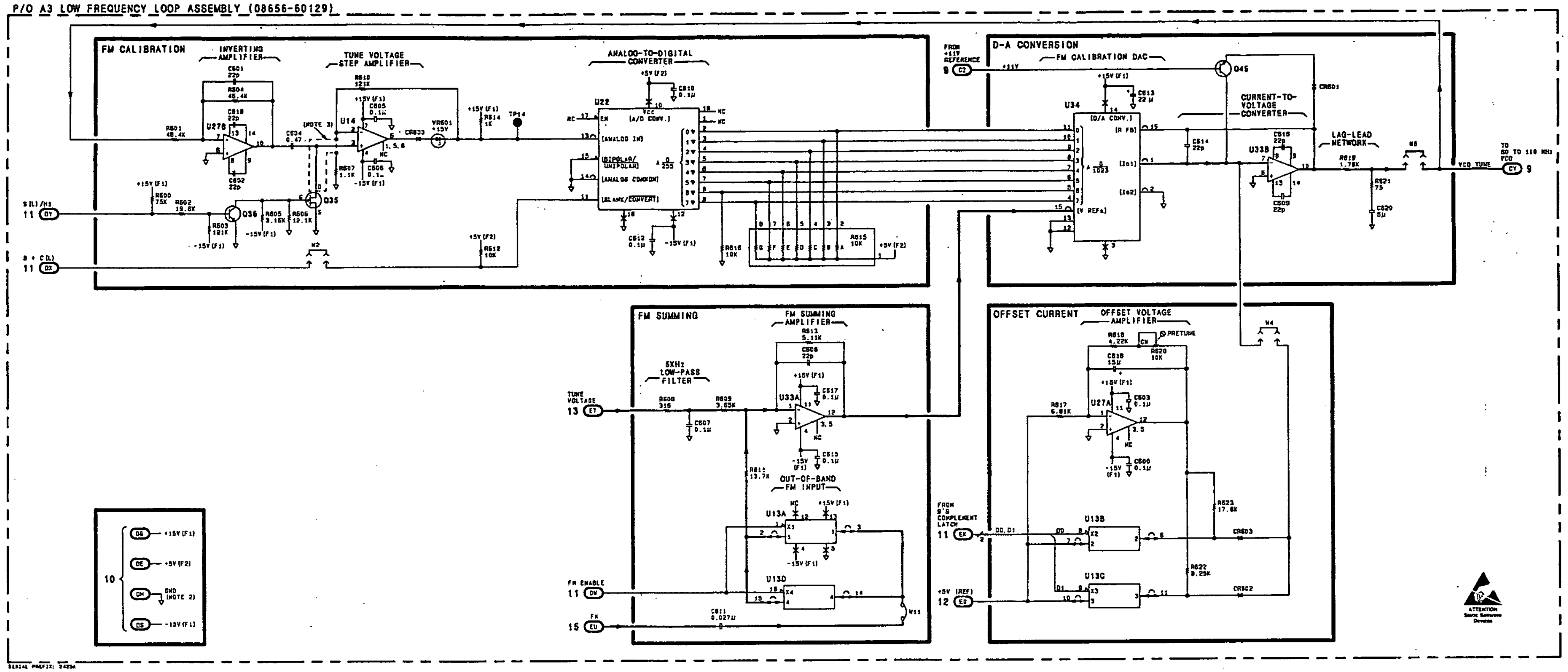
A3U14
TOP VIEW



A3Q35
TOP VIEW



Schematic General Information



SS14
Figure 8-56
Schematic
Diagram
8-834

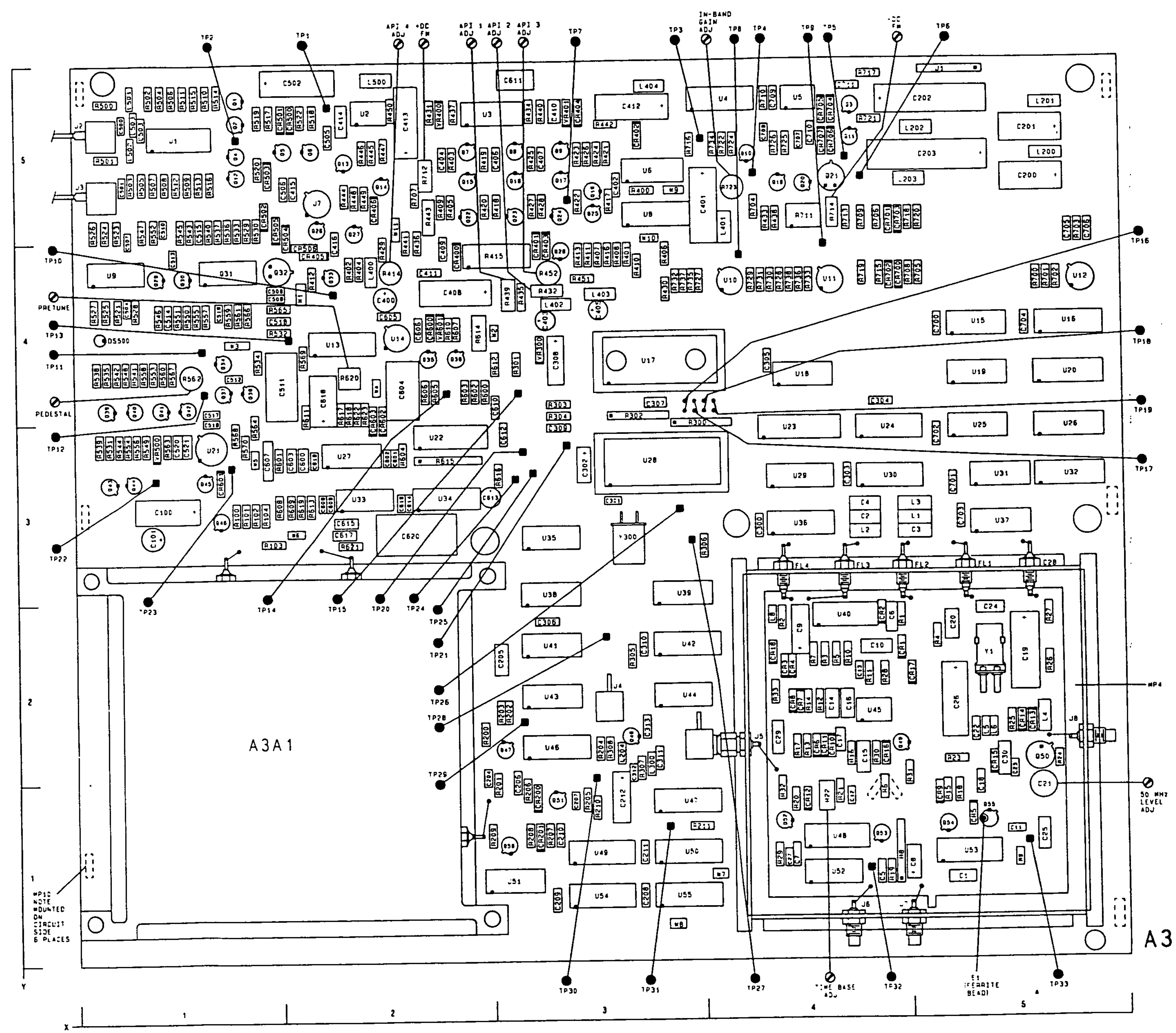
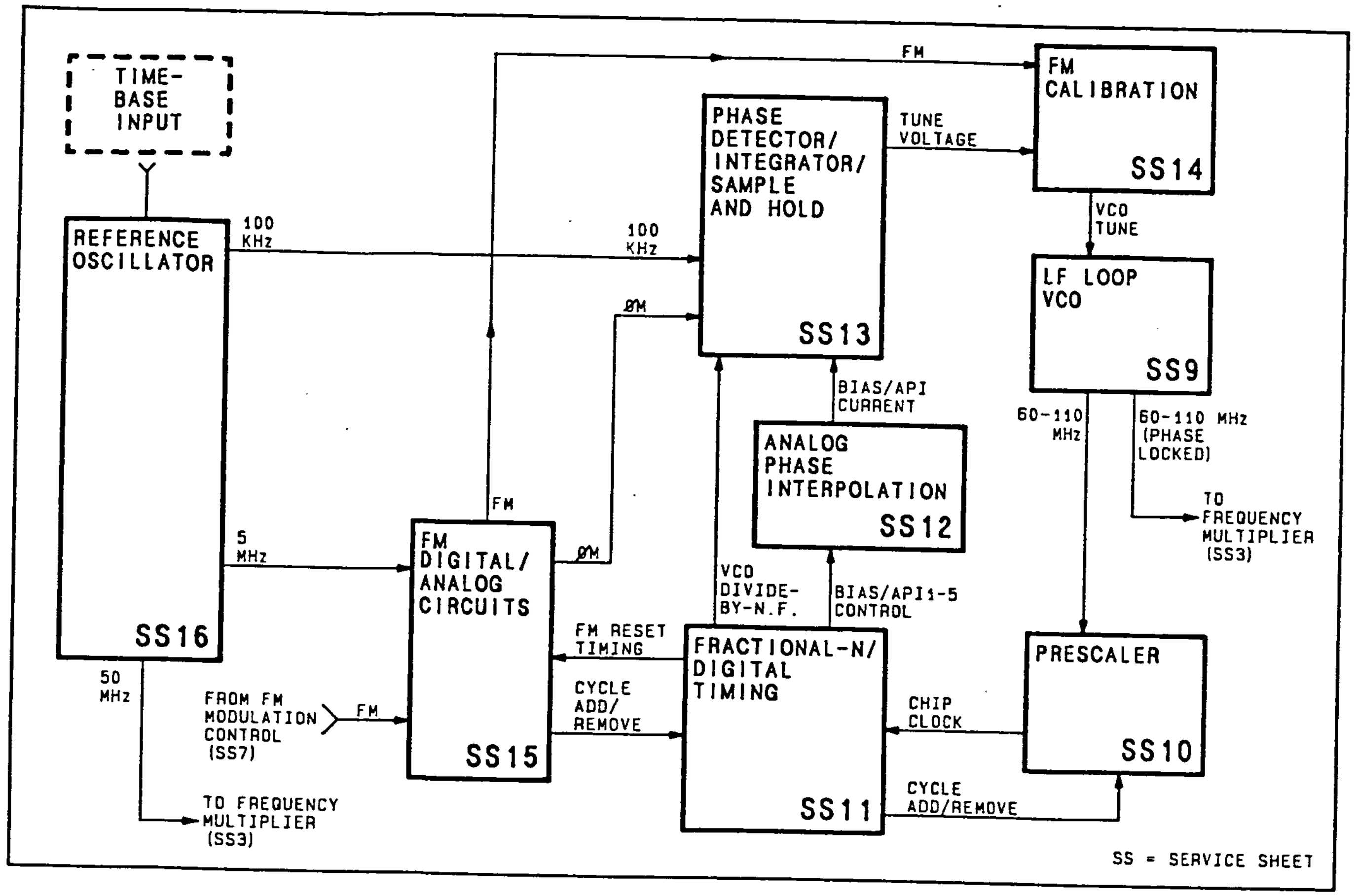


Figure 8-57. Service Sheet 15 Information

Component Locator



Reference Block Diagram

Component Coordinates

A3 COMP	X,Y	COMP	X,Y	COMP	X,Y
C700	5,4	R706	4,5	TP3	3,5
C701	5,3	R707	2,5	TP4	4,5
C702	5,3	R708	4,4	TP5	4,5
C703	5,3	R709	4,5	TP6	4,5
C704	5,4	R710	4,5	TP8	4,4
C705	5,5	R711	4,5	TP9	4,4
C706	5,5	R712	2,5		
C707	4,5	R713	4,5	U4	4,5
C708	4,5	R714	4,5	U5	4,5
C709	4,5	R715	4,4	U10	4,4
C710	4,5	R716	3,5	U11	4,4
C711	4,5	R717	4,5	U12	5,4
		R718	4,5	U15	5,4
CR700	4,4	R719	4,4	U16	5,4
CR701	4,5	R720	5,5	U19	5,4
CR702	4,4	R721	4,5	U20	5,4
CR703	4,5	R722	4,5	U25	5,3
CR704	4,5	R723	4,5	U26	5,3
CR705	4,5	R724	4,5	U31	5,3
CR706	4,5	R725	4,5	U32	5,3
CR707	4,5	R726	4,5	U37	5,3
		R727	3,4		
Q3	4,5	R728	4,4		
Q10	4,5	R729	4,4		
Q11	4,5	R730	4,4		
Q20	4,5	R731	4,4		
Q21	4,5	R732	3,4		
		R733	4,4		
R700	5,4	R734	4,5		
R701	5,4	R735	3,4		
R702	5,4	R736	4,4		
R703	5,5	R737	3,4		
R704	4,5	R738	4,4		
R705	5,4				

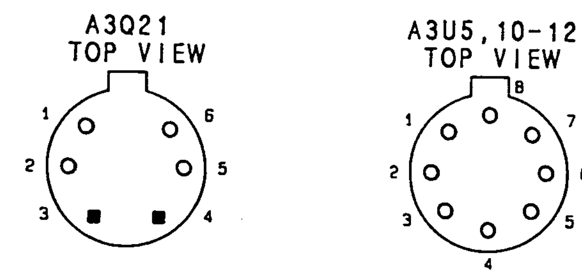
P/O A3 LOW FREQUENCY LOOP FREQUENCY MODUALTION CALIBRATION **SS14**

NOTES

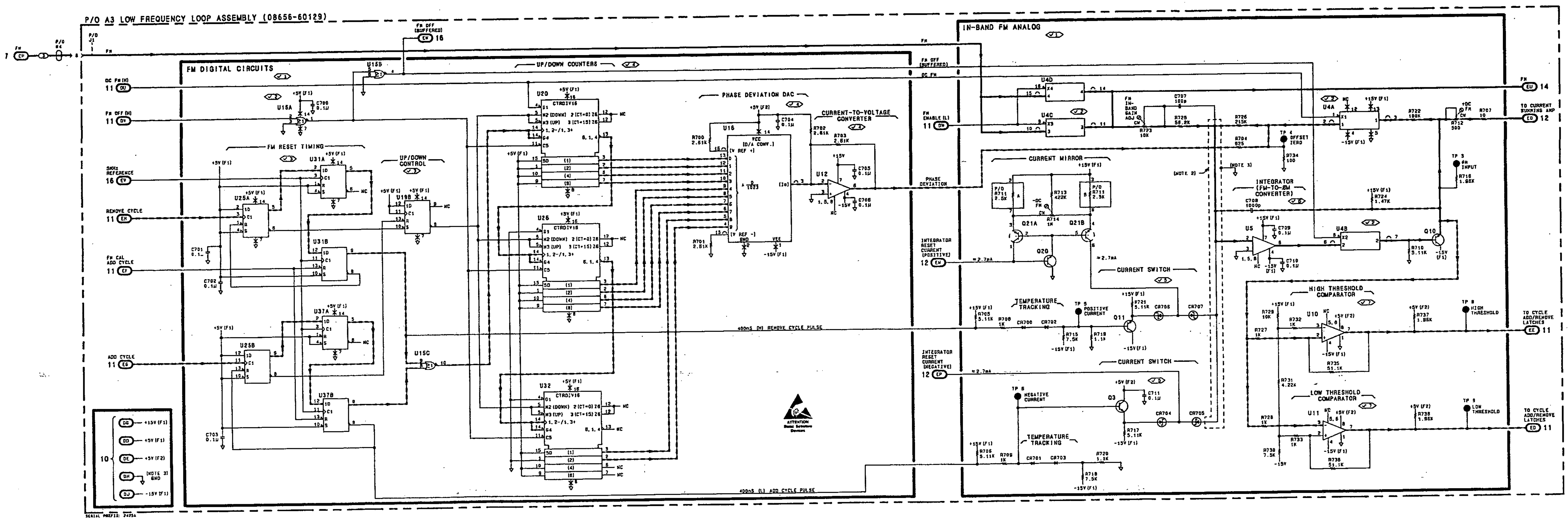
1. See Table 8-3 for schematic diagram notes.
2. Isolation (guard) trace.
3. Chassis ground is achieved by mechanical contact through nuts holding PC board to frame.
4. Reference designations on this service sheet C, CR, Q, R and U have numbers ranging from 700 to 799 only.
5. Wire jumper at TP16-21 is used only for test purposes.

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW



Schematic General Information



SS15
Figure 8-58
Schematic
Diagram
8-836

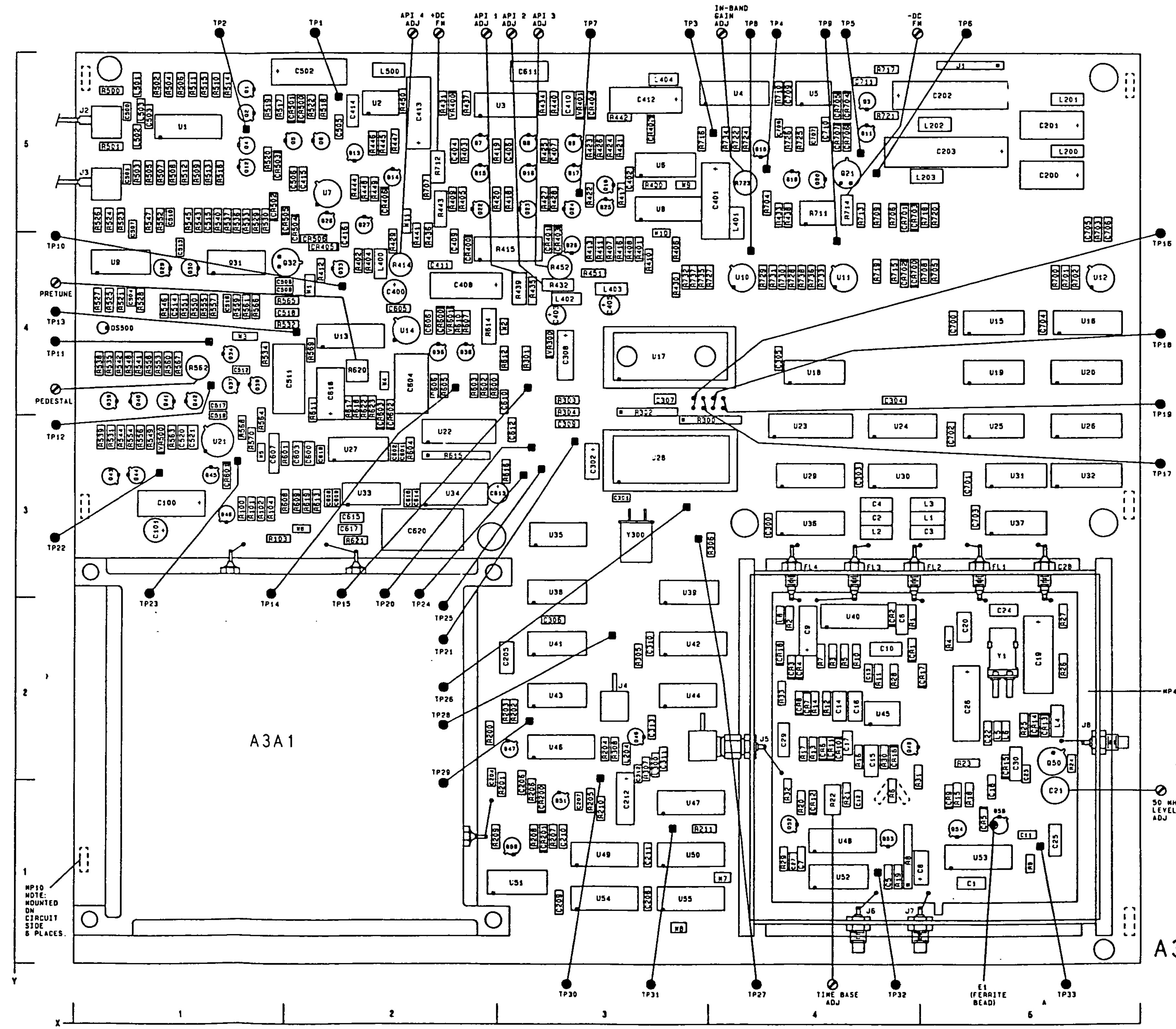
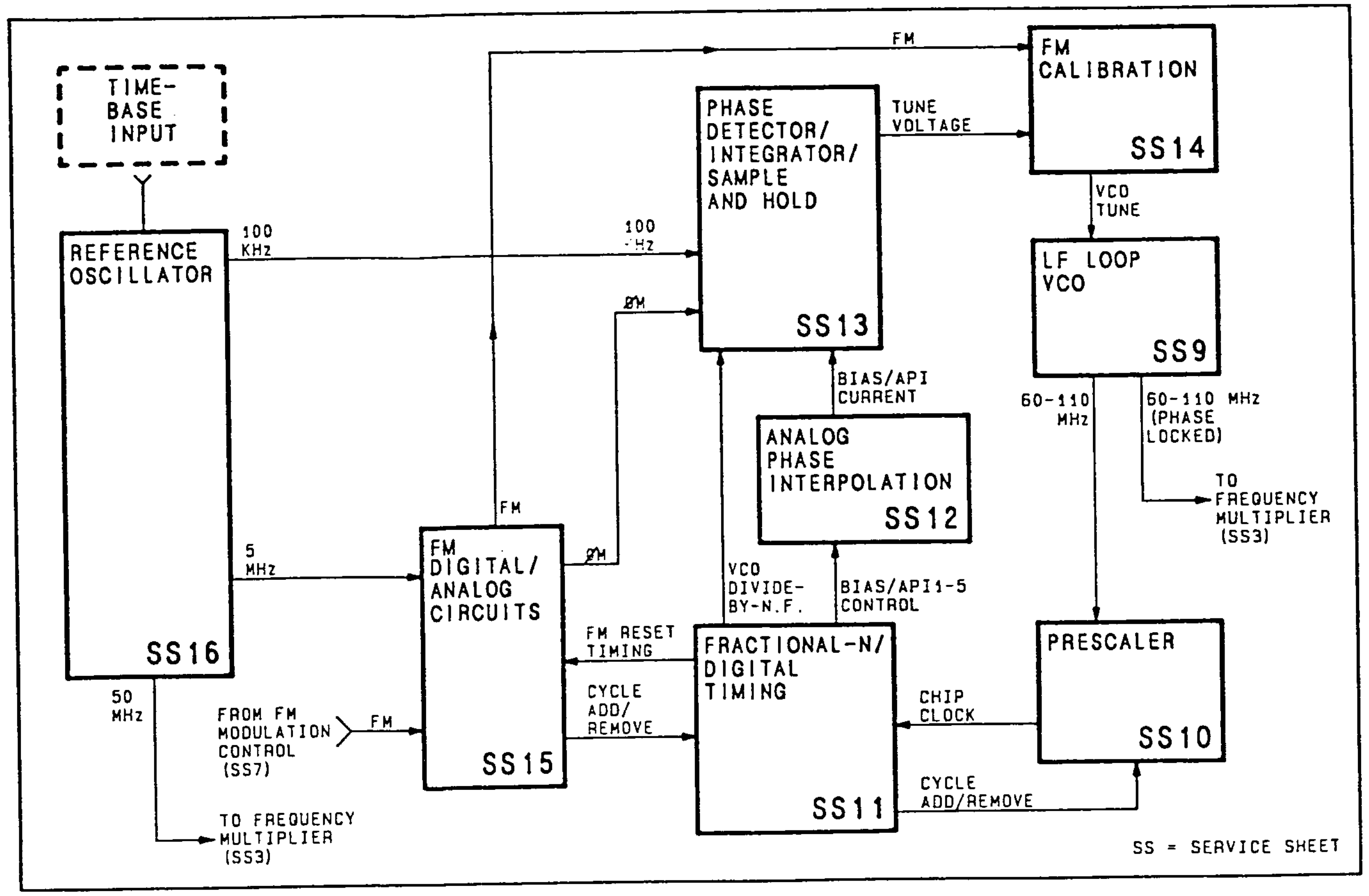


Figure 8-59. Service Sheet 16 Information

Component Locator



Reference Block Diagram

Component Coordinates

A3							
COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	5,1	CR1	4,2	L1	5,3	R18	5,1
C2	4,3	CR2	4,2	L2	4,3	R19	4,1
C3	5,3	CR3	4,2	L3	5,3	R20	4,1
C4	4,3	CR4	4,2	L4	5,2	R21	4,1
C5	4,1	CR5	5,1	L5	5,2	R22	4,1
C6	4,2	CR6	4,2	L6	5,2	R23	5,2
C7	4,1	CR7	4,2	L8	4,2	R24	5,2
C8	4,1	CR8	4,2	Q49	4,2	R25	5,2
C9	4,2	CR9	5,1	Q50	5,2	R26	5,2
C10	4,2	CR10	4,2	Q52	4,1	R27	5,2
C11	5,1	CR11	4,2	Q53	4,1	R28	4,2
C12	4,1	CR12	4,1	Q54	5,1	R29	4,1
C13	4,2	CR13	5,2	Q55	5,1	R30	4,2
C14	4,2	CR14	5,2	R1	4,2	R31	4,2
C15	4,2	CR15	5,2	R2	4,2	R32	4,1
C16	4,2	CR16	4,2	R3	4,2	R33	4,2
C17	4,2	CR17	4,2	R4	5,2	TP32	4,1
C18	5,1	CR18	4,2	R5	4,2	TP33	5,1
C19	5,2	E1	5,1	R6	4,1	U40	4,2
C20	5,2	FL1	5,3	R7	4,2	U45	4,2
C21	5,1	FL2	4,3	R8	4,1	U48	4,1
C22	5,2	FL4	4,3	R9	5,1	U52	4,1
C23	5,2	J5	4,2	R10	4,2	U53	5,1
C24	5,2	J6	4,1	R11	4,2	Y1	5,2
C25	5,1	J7	4,1	R12	4,2		
C26	5,2	J8	4,2	R13	4,2		
C27	4,1			R14	4,2		
C28	4,2			R15	5,1		
C29	4,2			R16	4,2		
C30	5,2			R17	4,2		

P/O A3 LOW FREQUENCY LOOP IN-BAND FREQUENCY MODULATION **SS15**

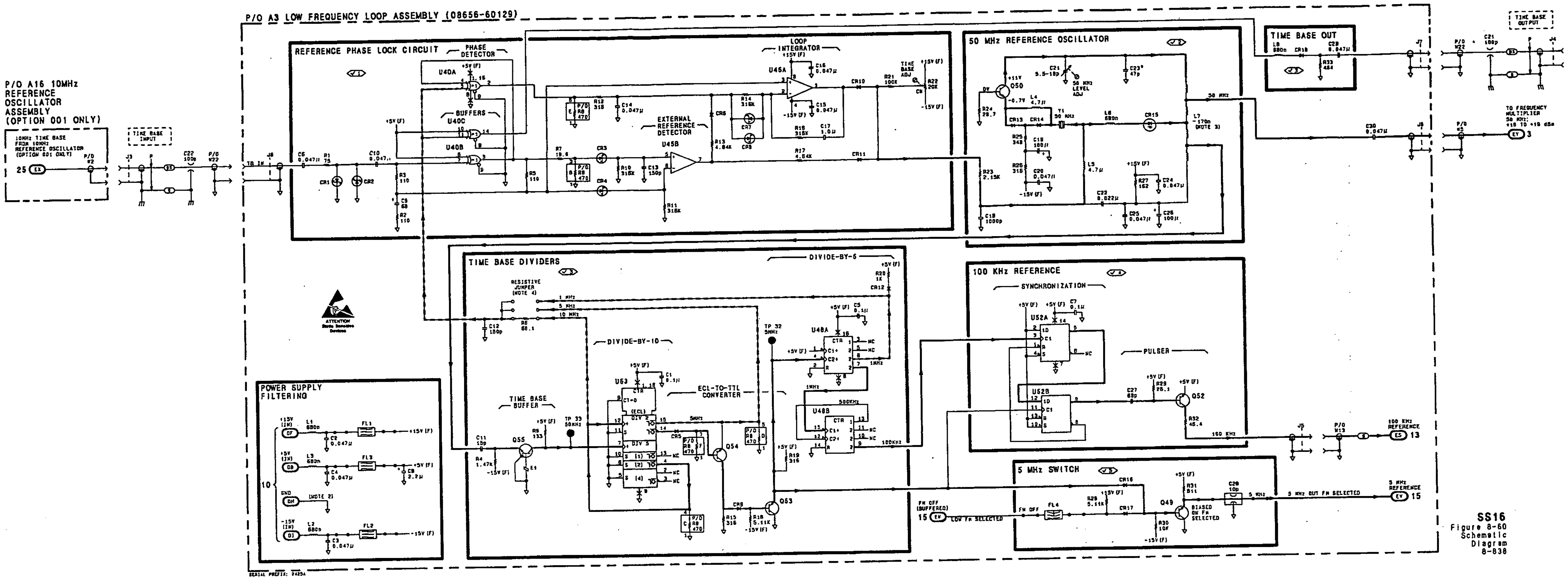
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by J3 and J4 connection and mechanical contact through nuts holding PC board to frame.
3. Printed circuit trace inductor.
4. PC board shipped with resistive jumper installed in the 10 MHz position.
5. Reference designations on this service sheet C, CR, FL, L and R have numbers ranging from 1 to 99 only.

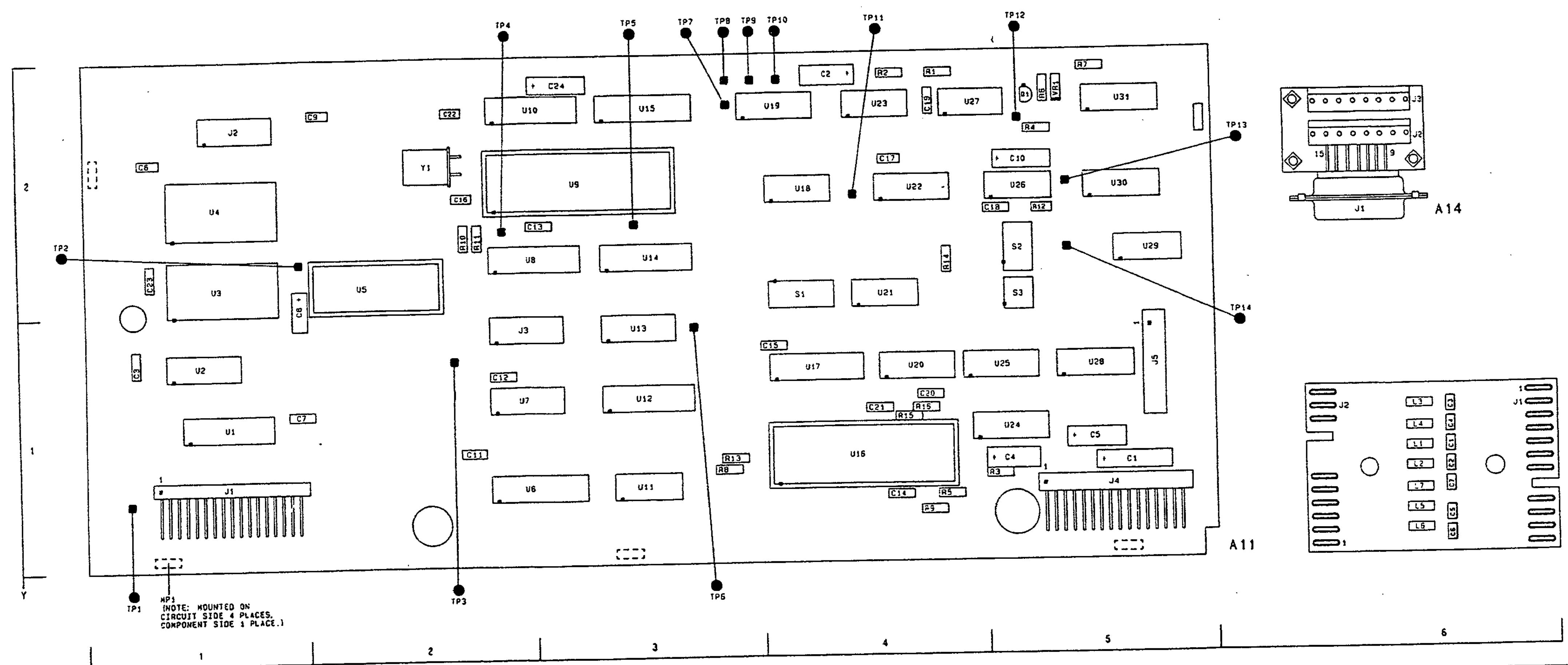
LOGIC LEVELS

	TTL	ECL
HIGH	>2V	>+4.2V
LOW	<0.8V	<+3.3V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	LOW
GROUND	LOW	HIGH

Schematic General Information

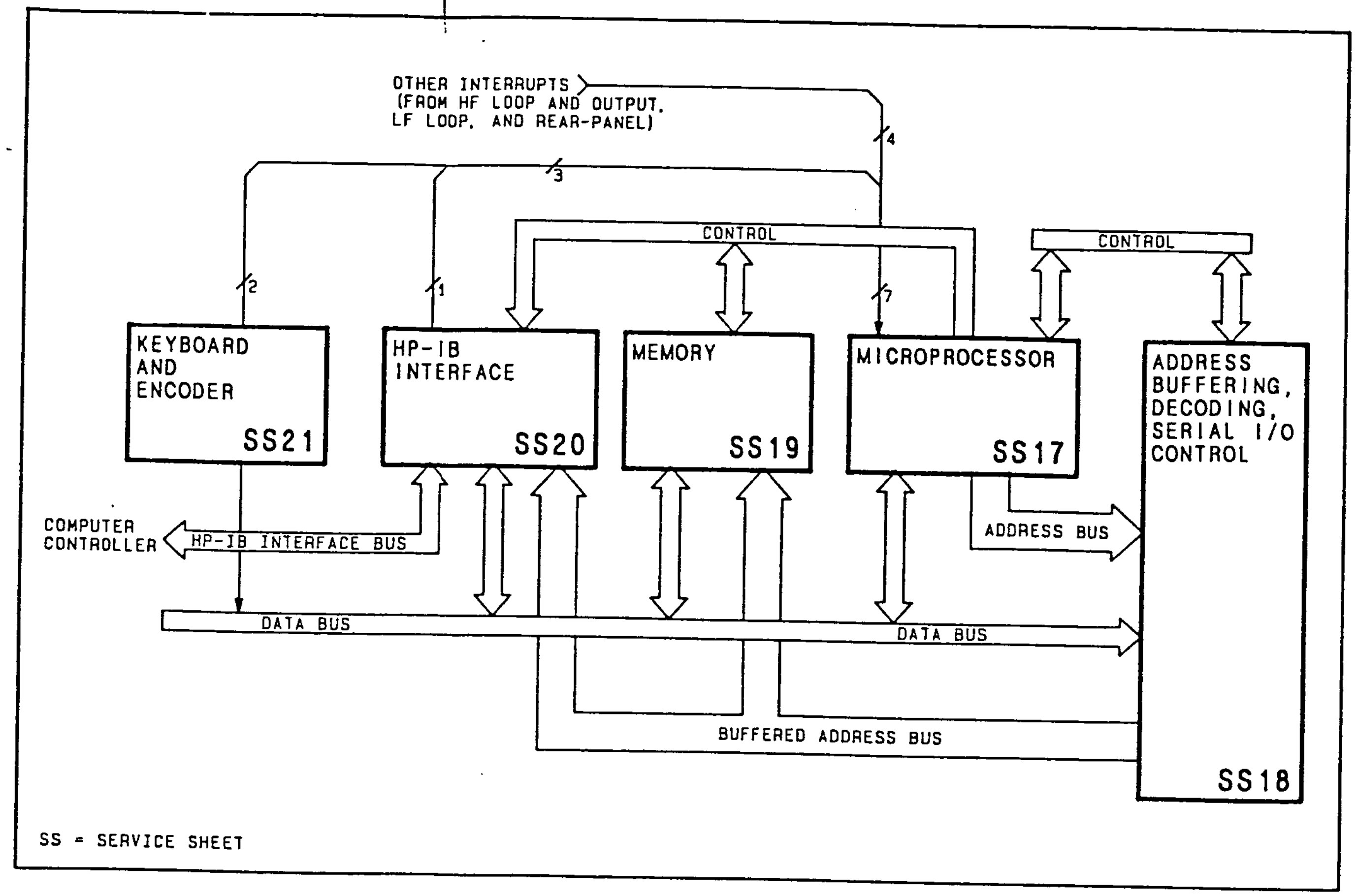


SS16
Figure 8-60
Schematic
Diagram
8-83B



Component Locator

Figure 8-61. Service Sheet 17 Information



Reference Block Diagram

Component Coordinates

A11

COMP	X,Y
C1	5,1
C2	4,2
C4	5,1
C9	2,2
C10	5,2
C11	2,1
C13	3,2
C16	2,2
C18	5,2
C19	4,2
C22	2,2
C24	3,2
J1	1,1
J2	1,2
J4	5,1
MP1	1,1
Q1	5,2
R1	4,2
R2	4,2
R3	5,1
R4	5,2
R5	4,1
R6	5,2
R7	5,2
R8	3,1
R10	2,2
R11	2,2
R12	5,2
R13	3,1
R14	4,2
S1	4,2
TP1	1,1
TP3	2,1
TP4	2,2
TP12	5,2
U1	1,1
U6	2,2
U9	3,2
U10	2,2
U11	3,1
U13	3,1
U15	3,2
U18	4,2
U23	4,2
U26	5,2
U27	4,2
U29	5,2
VR1	5,2
Y1	2,2

A7

COMP	X,Y
C7	6,1
J1	6,1
J2	6,1
L7	6,1

A14

COMP	X,Y
C8	6,2
J1	6,2
J3	6,2

P/O A3 LOW FREQUENCY LOOP 50 MHz REFERENCE OSCILLATOR AND PHASE LOCK LOOP

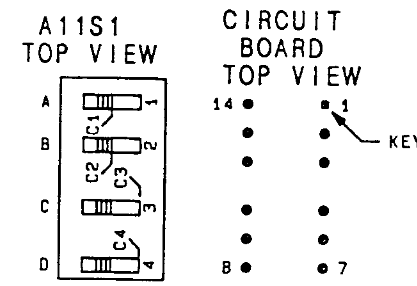
SS16

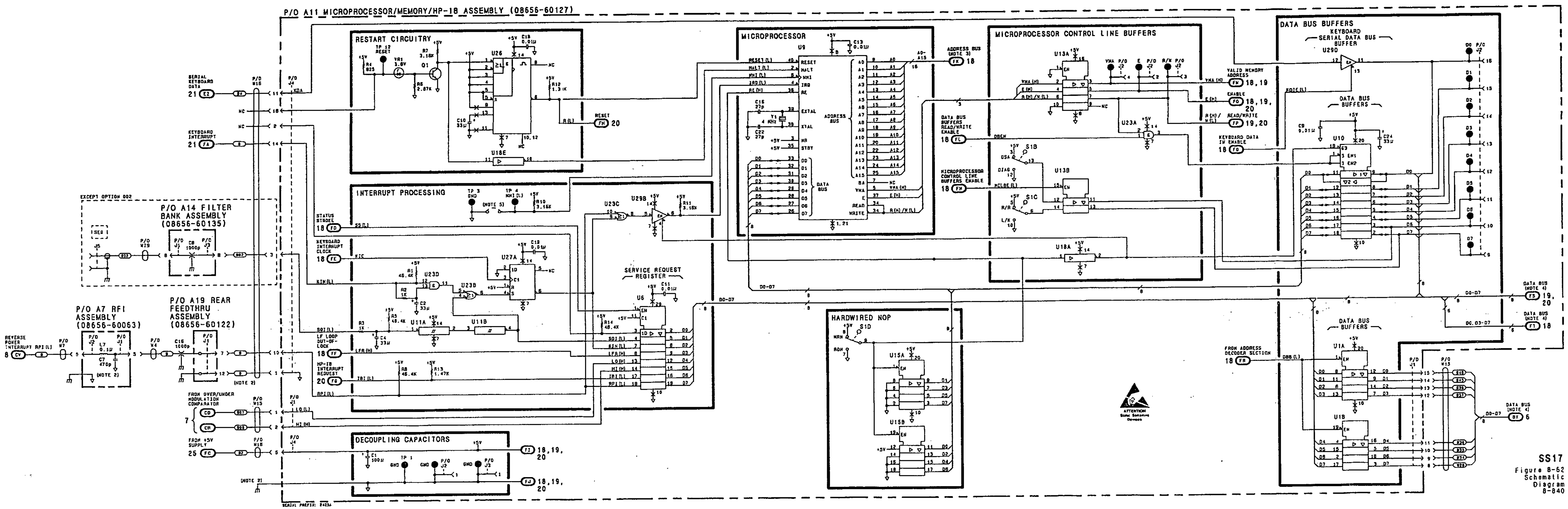
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A11J4-1 connection and mechanical contact through nuts holding PC board to frame.
3. Address data is transferred positive true from the microprocessor on the uni-directional address bus.
4. Data is transferred positive true to and from the microprocessor on the bi-directional data bus.
5. PC board shipped with jumper removed, in for service. Out for normal operation.

logic levels

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW





SS17
Figure 8-62
Schematic
Diagram
8-840

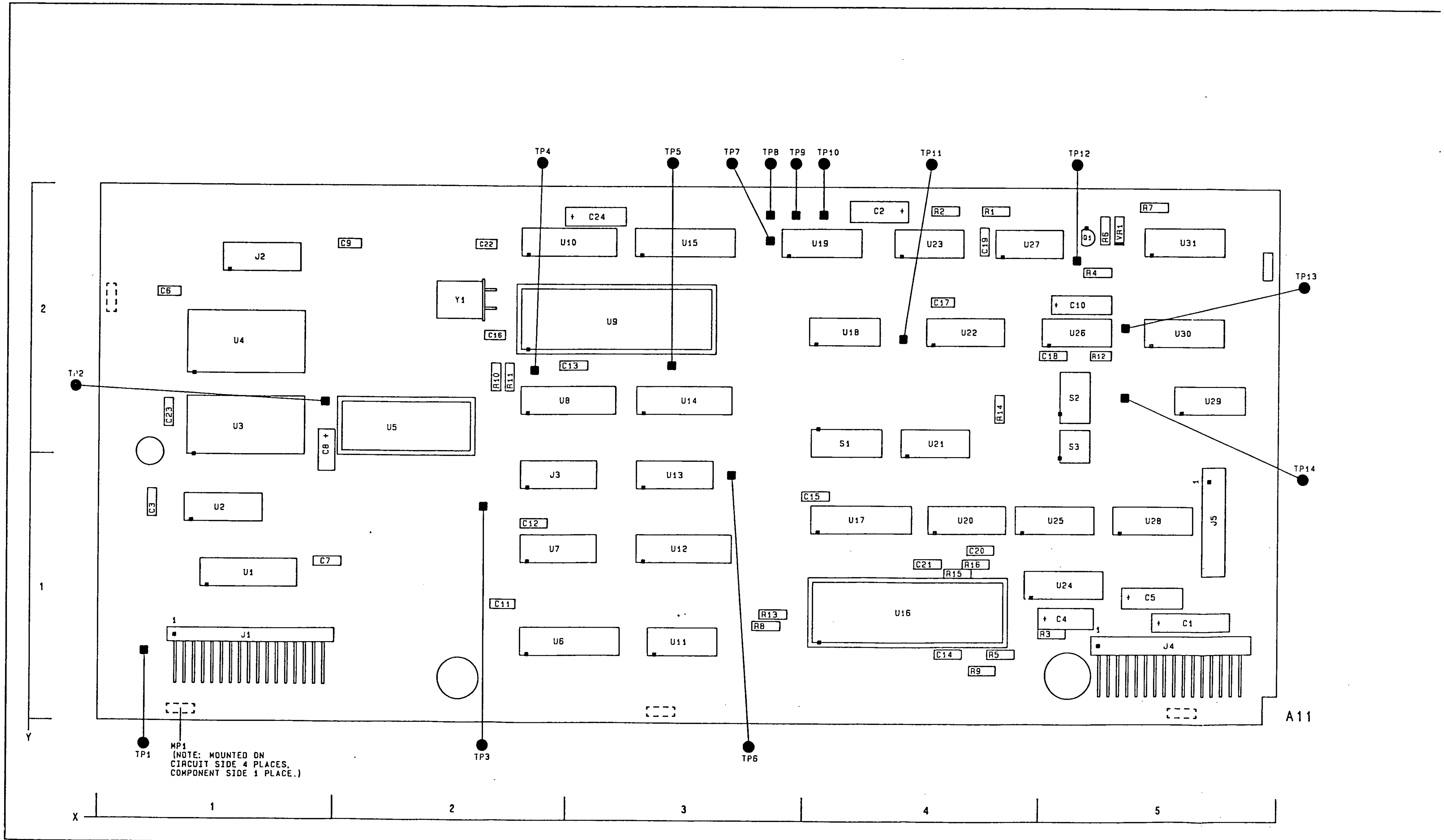
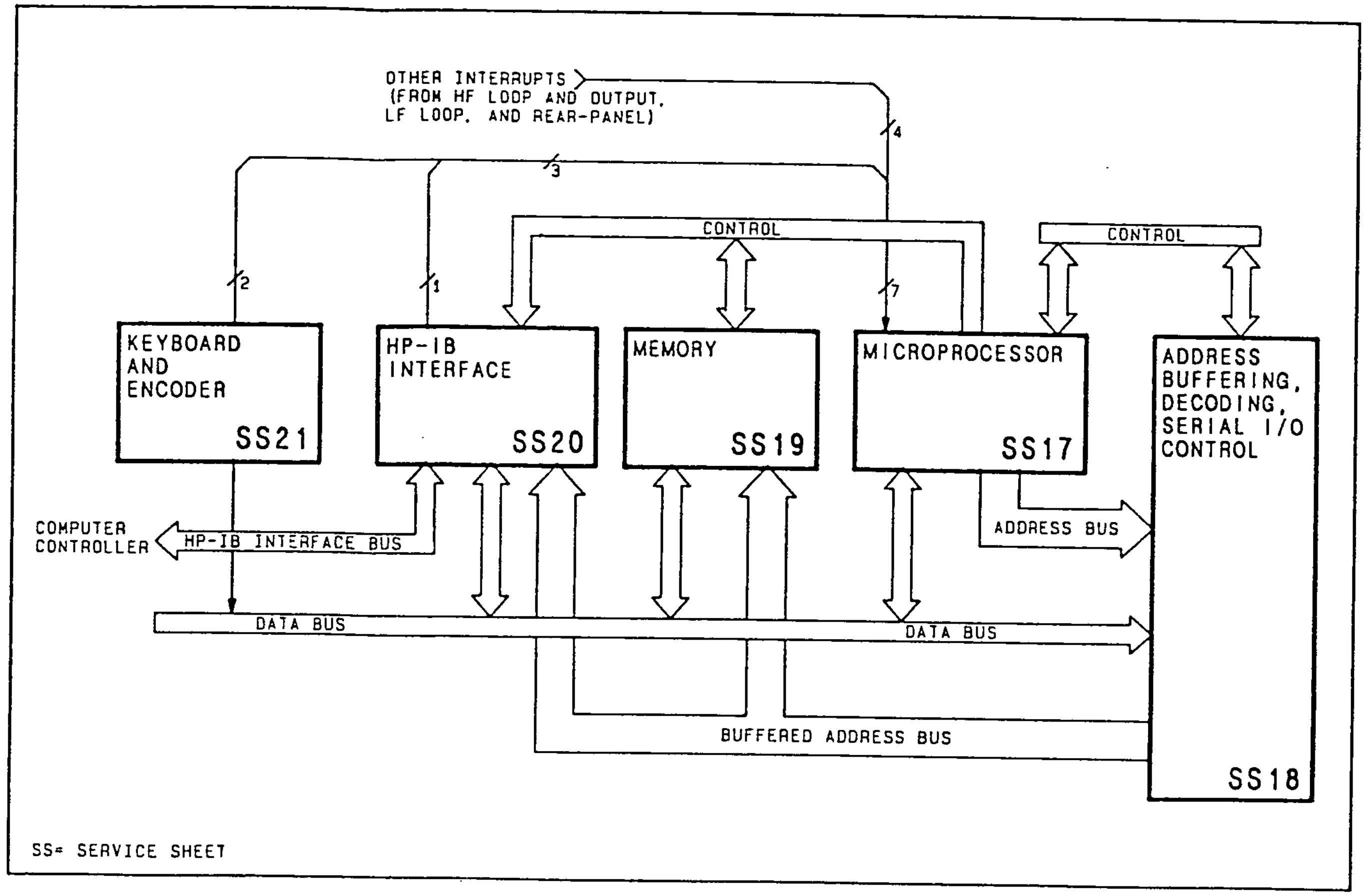


Figure 8-63. Service Sheet 18 Information

Component Locator



Reference Block Diagram

Component Coordinates

A11 COMP	X,Y	COMP	X,Y
C3	1,1	U19	4,2
C17	4,2	U21	4,2
J1	1,1	U22	4,2
J2	1,2	U27	4,2
J3	2,1	U29	5,2
J4	5,1	U30	5,2
MP1	1,1	U31	5,2
TP5	3,2		
TP7	3,2		
TP8	3,2		
TP9	3,2		
TP10	4,2		
TP13	5,2		
TP14	5,2		
U2	1,1		
U8	2,2		
U14	3,2		
U18	4,2		
U19	4,2		
U21	4,2		
U18	4,2		

P/O A11, P/O A14, P/O A7, P/O A19 MICROPROCESSOR, INTERRUPT PROCESSING AND RESTART SS17

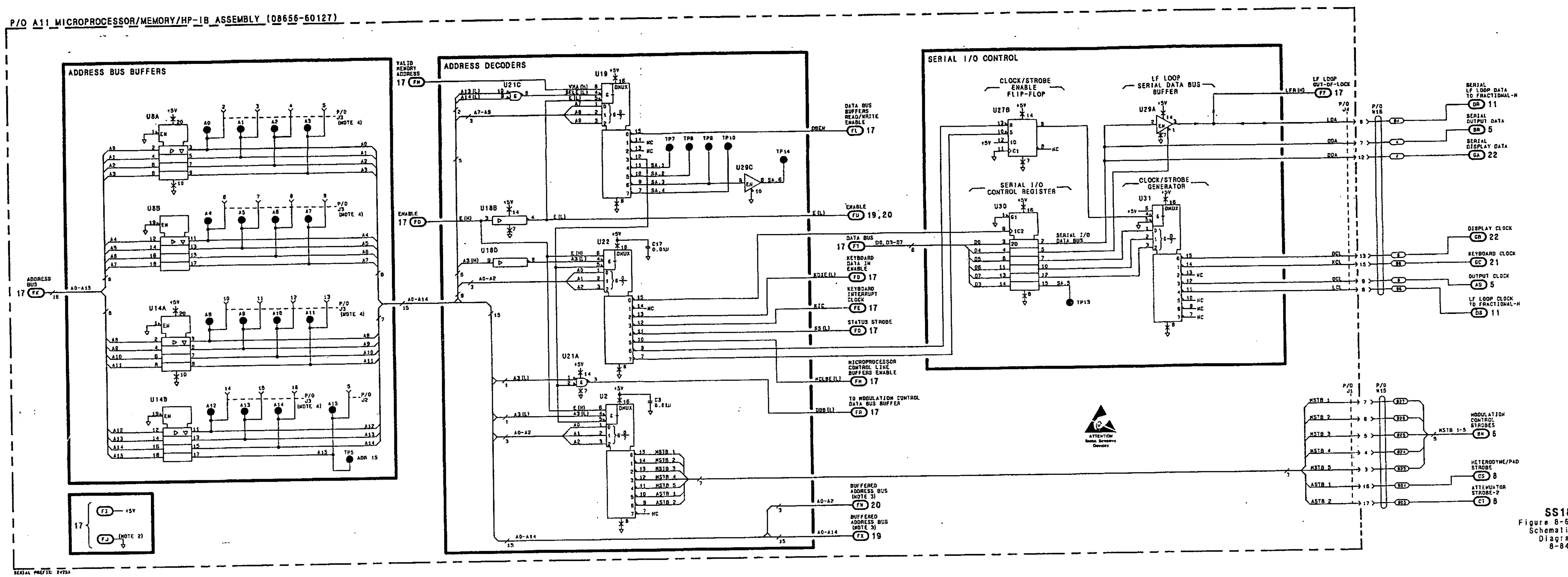
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A11J4-1 connection and mechanical contact through nuts holding PC board to frame.
3. Address data is transferred positive true from the microprocessor on the unidirectional buffered address bus.
4. Service test point. Pin of dual in-line test sockets J2 or J3.

logic levels

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

Schematic General Information



SS18
Figure 8-64
Schematic
Diagram
8-842

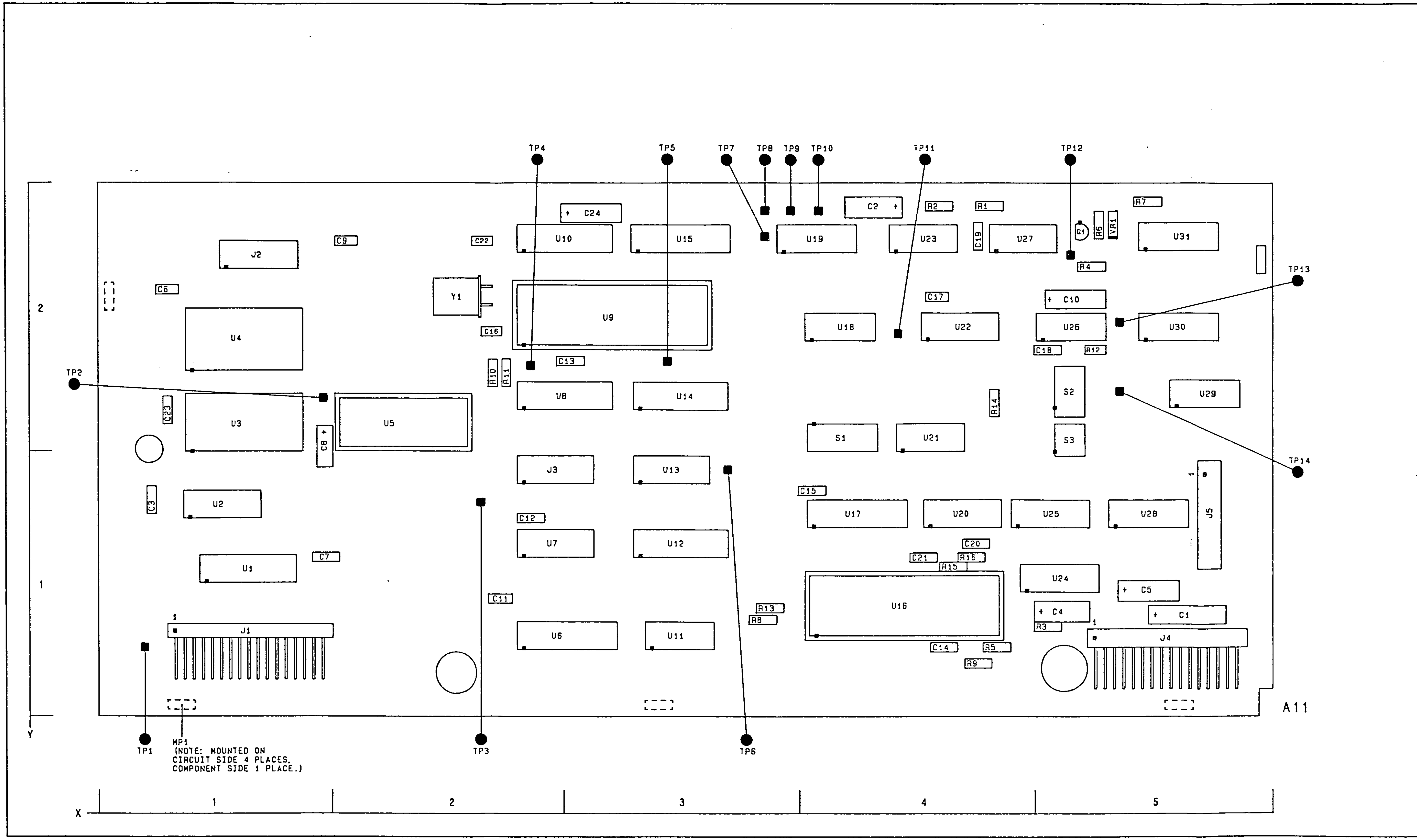
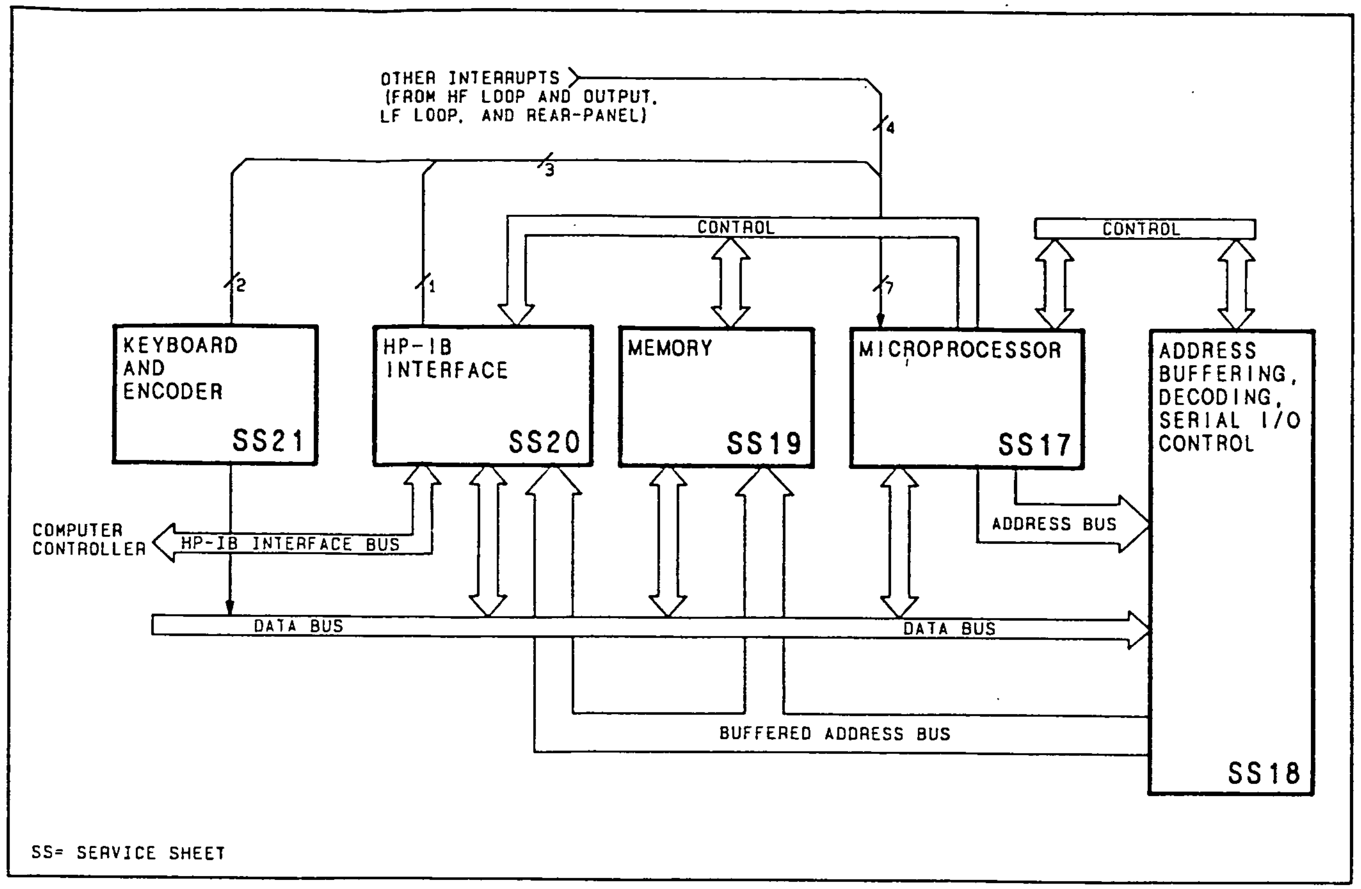


Figure 8-65. Service Sheet 19 Information

Component Locator



Reference Block Diagram

Component Coordinates

A11	
COMP	X,Y
C5	5,1
C6	1,2
C7	1,1
C8	1,2
C12	2,1
C23	2,1
MP1	1,1
R9	4,1
S1	4,2
TP2	1,2
TP6	3,1
TP11	4,2
U3	1,2
U4	1,2
U5	2,2
U7	2,1
U18	4,2
U21	4,2

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y

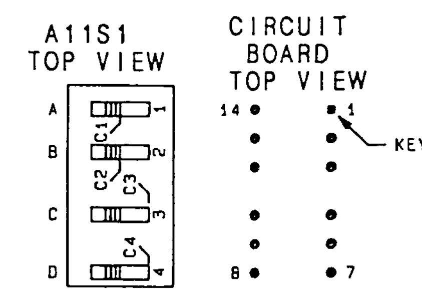
P/O A11 ADDRESS BUFFERING AND DECODING, SERIAL I/O AND CONTROL **SS18**

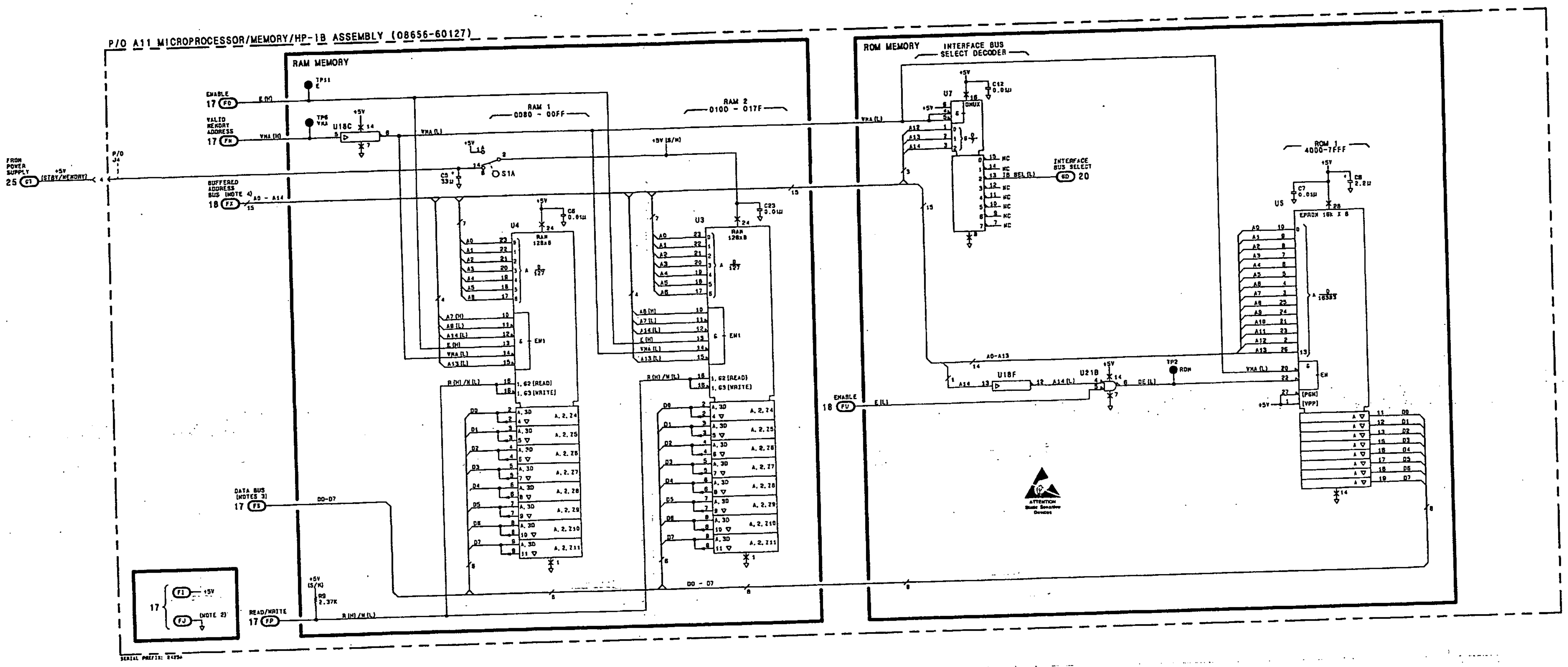
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A11J4-1 connection and mechanical contact through nuts holding PC board to frame.
3. Data is transferred positive true from ROM or RAM memory to the microprocessor on the data bus (D0-D7).
4. Address data is transferred positive true from the microprocessor on the buffered address bus (A0-A14).

logic levels

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW





SS19
Figure 8-66
Schematic
Diagram
8-844

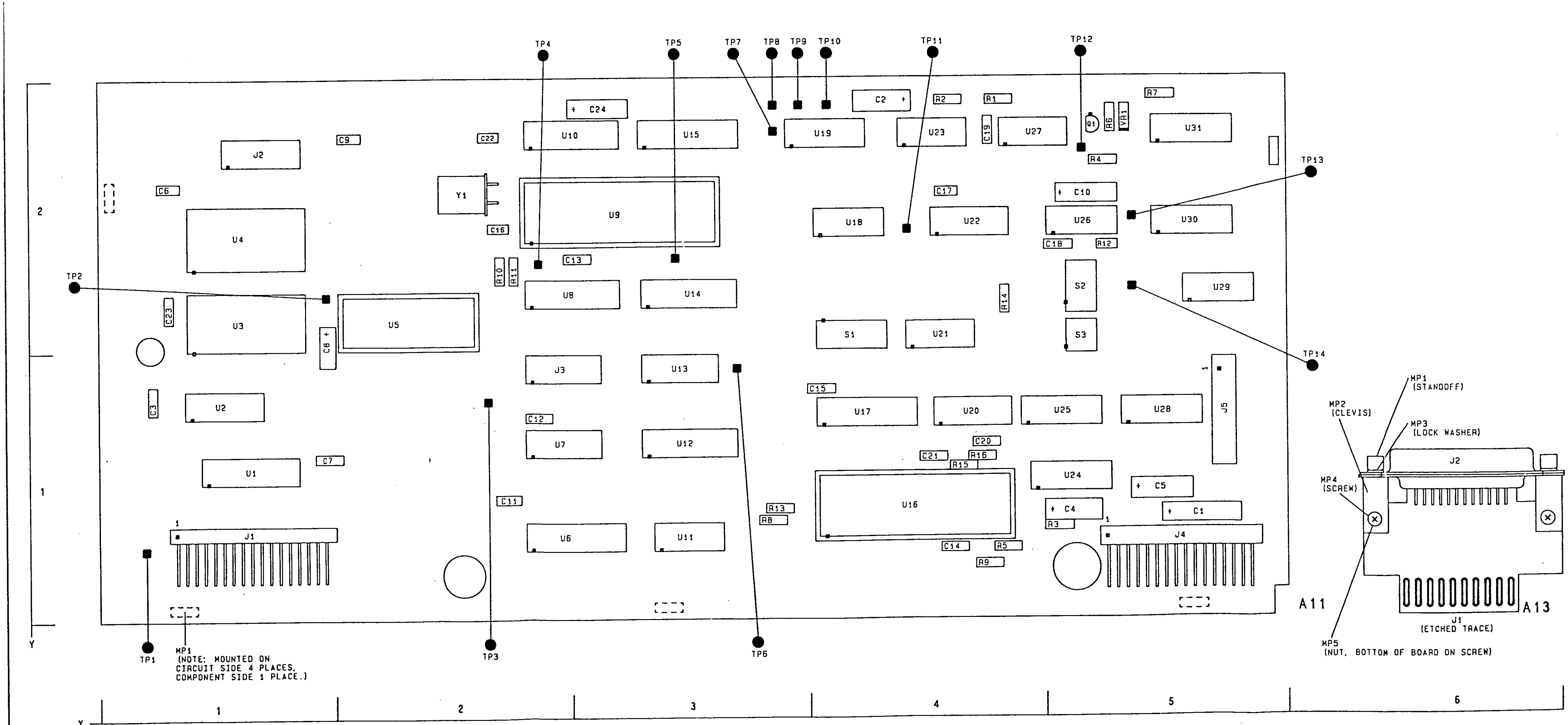
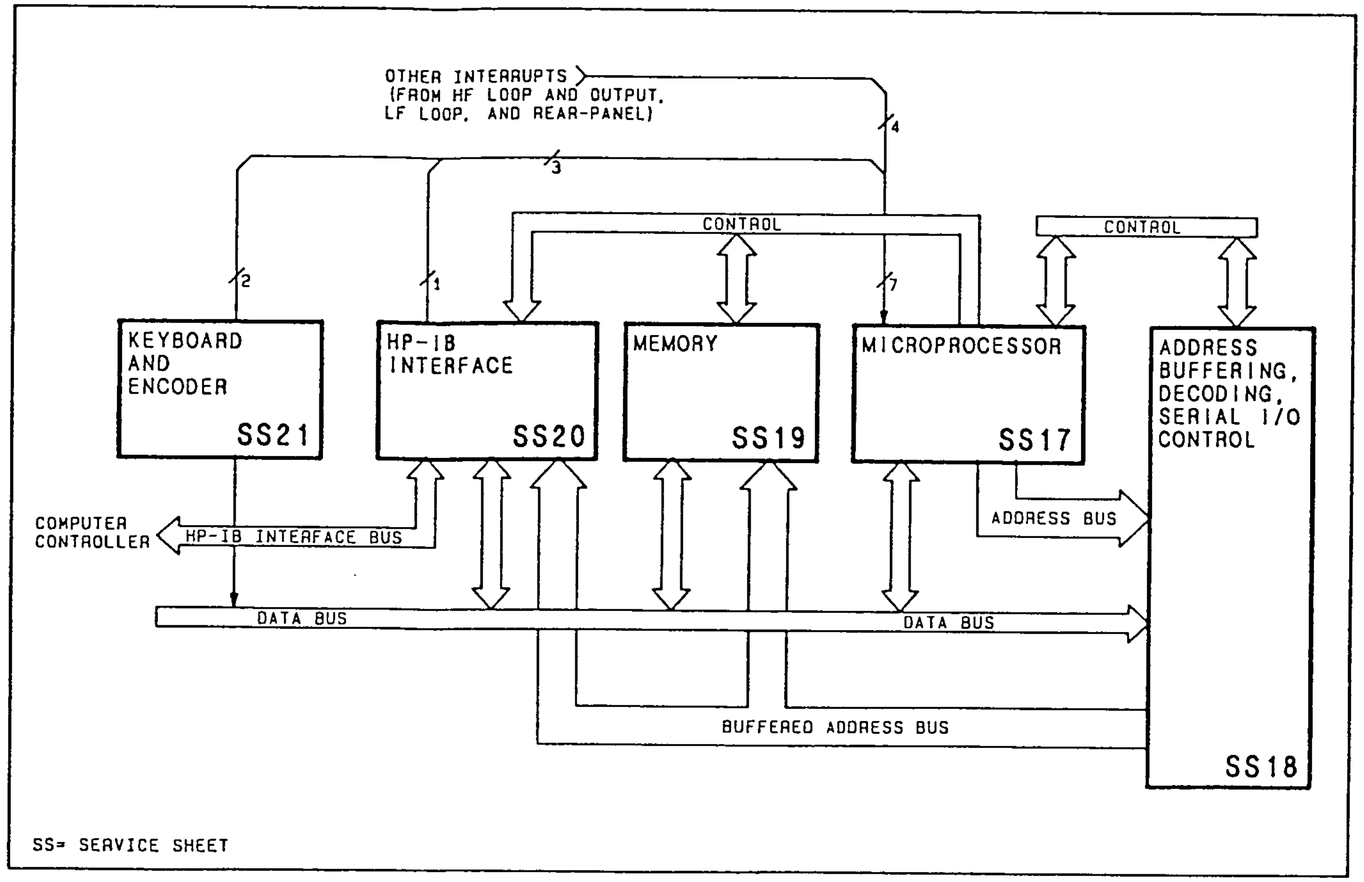


Figure 8-67. Service Sheet 20 Information

Component Locator



Reference Block Diagram

Component Coordinates

A11 COMP	A11 X,Y	A13 COMP	A13 X,Y
C14	4,1	J1	6,1
C15	4,1	J2	6,1
C20	4,1	MP1	6,1
C21	4,1	MP2	6,1
J5	5,1	MP3	6,1
MP1	1,1	MP4	6,1
R15	4,1		
R16	4,1		
S2	5,2		
S3	5,2		
U12	3,1		
U16	4,1		
U17	4,1		
U20	4,1		
U21	4,2		
U24	5,1		
U25	5,1		
U28	5,1		

P/O A11 MEMORY SS19

NOTES

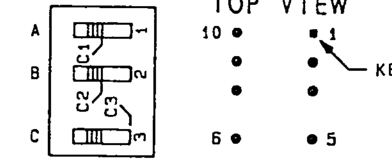
1. See Table 8-3 for schematic diagram notes.
2. A11 chassis ground is achieved by A11J4-1 connection and mechanical contact through nuts holding PC board to frame.
3. A13 chassis ground is achieved by A13J2-12 connection and mechanical contact through nuts holding PC board to frame.
4. Data transferred on the data bus (D0-D7) is positive true.
5. Data transferred on the data input/output bus (DIO1-DIO8) is negative true.
6. HP-IB addresses greater than 30 are invalid.

LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

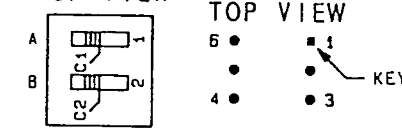
A11S2 TOP VIEW

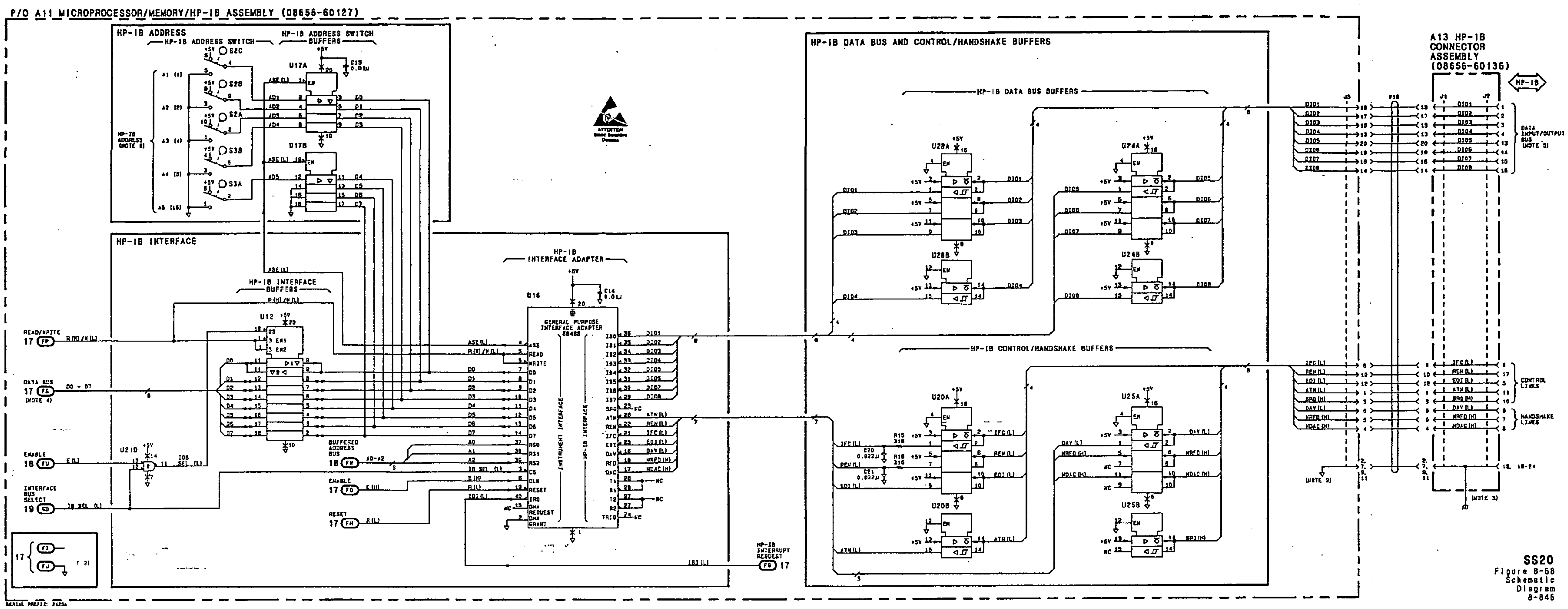
CIRCUIT BOARD TOP VIEW



A11S3 TOP VIEW

CIRCUIT BOARD TOP VIEW





SS20
Figure 8-58
Schematic
Diagram
8-846

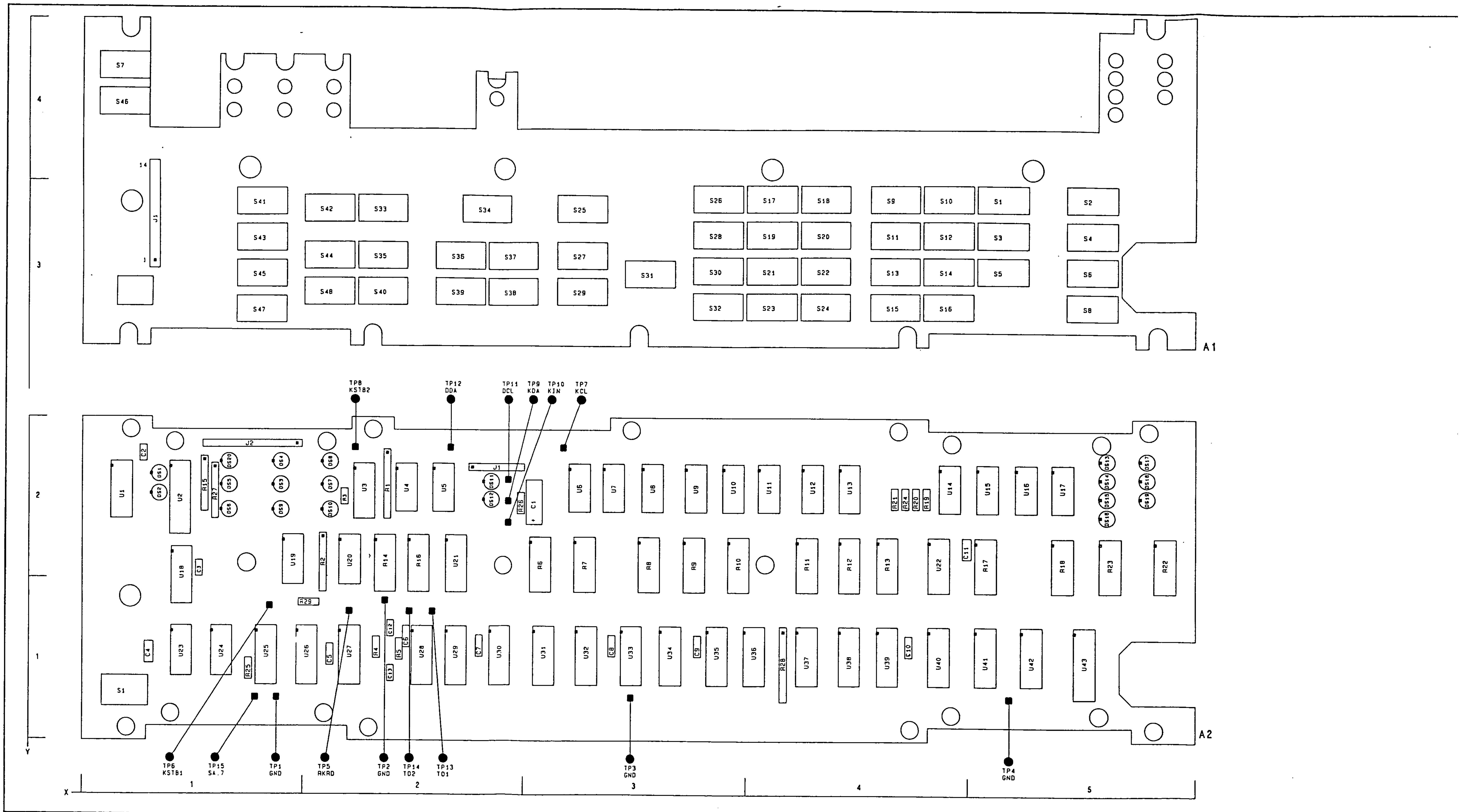
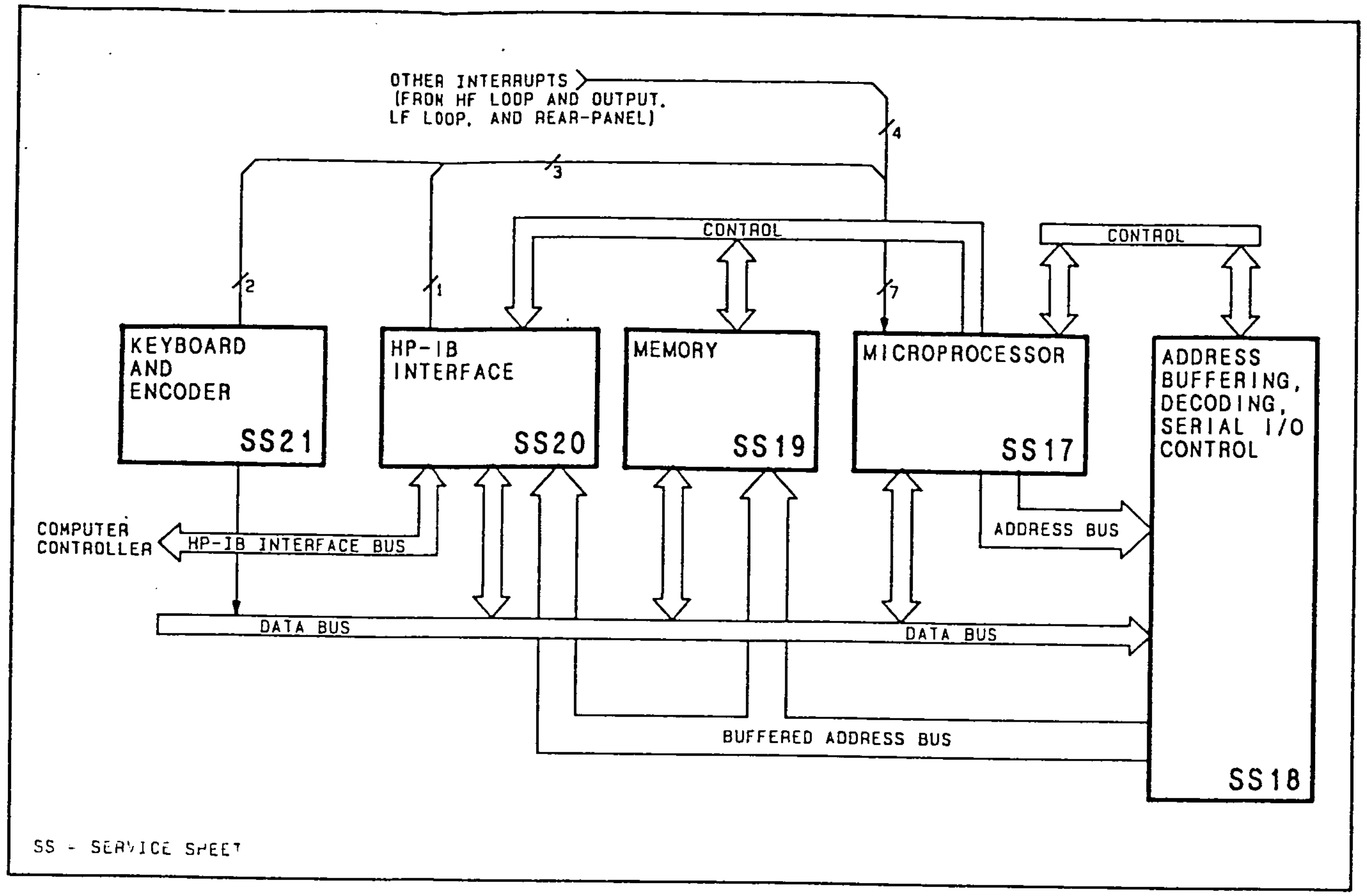


Figure 8-69. Service Sheet 21 Information

Component Locator



Reference Block Diagram

Component Coordinates

A1

COMP	X,Y
J1	1, 3
S1	5, 3
S2	5, 3
S3	5, 3
S4	5, 3
S5	5, 3
S6	5, 3
S7	1, 4
S8	5, 3
S9	4, 3
S10	4, 3
S11	4, 3
S12	4, 3
S13	4, 3
S14	4, 3
S15	4, 3
S16	4, 3
S17	4, 3
S18	4, 3
S19	4, 3
S20	4, 3
S21	4, 3
S22	4, 3
S23	4, 3
S24	4, 3
S25	3, 3
S26	3, 3
S27	3, 3
S28	3, 3
S29	3, 3
S30	3, 3
S31	3, 3
S32	3, 3
S33	2, 3
S34	2, 3
S35	2, 3
S36	2, 3
S37	2, 3
S38	2, 3
S39	2, 3
S40	2, 3
S41	1, 3
S42	2, 3
S43	1, 3
S44	2, 3
S45	1, 3
S46	1, 4
S47	1, 3
S48	2, 3

A2

COMP	X,Y
C1	3, 2
C2	1, 2
C3	1, 2
C4	1, 1
C5	2, 1
C5	2, 1
C7	2, 1
C8	3, 1
C9	3, 1
C10	4, 1
R1	2, 2
R2	2, 2
R3	2, 2
R26	2, 2
R29	2, 1
S1	1, 1
TP2	2, 1
TP3	3, 1
TP4	5, 1
TP5	2, 1
TP6	1, 1
TP7	3, 2
TP8	2, 2
TP9	2, 2
TP10	2, 2
U3	2, 2
U18	1, 2
U19	1, 2
U20	2, 2
U22	4, 2

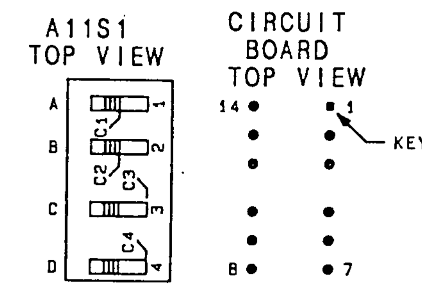
P/O A11, A13 HP-IB INTERFACE SS20

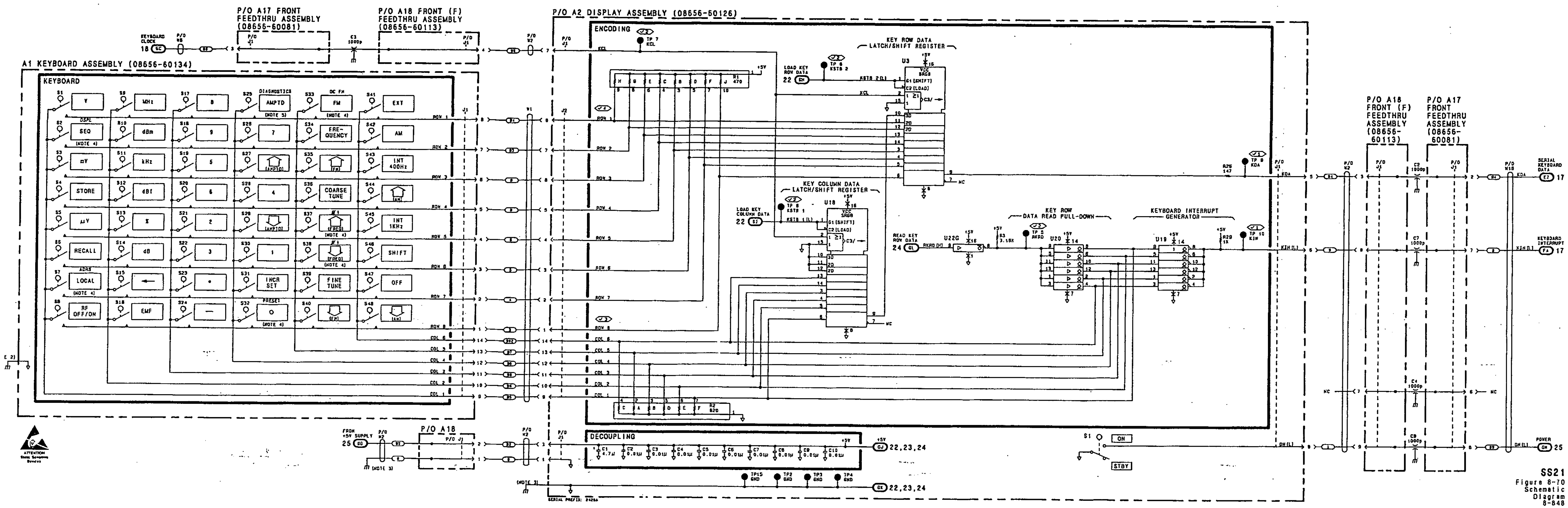
NOTES

1. See Table 8-3 for schematic diagram notes.
2. A1 chassis ground is achieved by A1J1-16 connection and mechanical contact through nuts holding PC board to frame.
3. A2 chassis ground is achieved by A2J1-1 connection and mechanical contact through nuts holding PC board to frame.

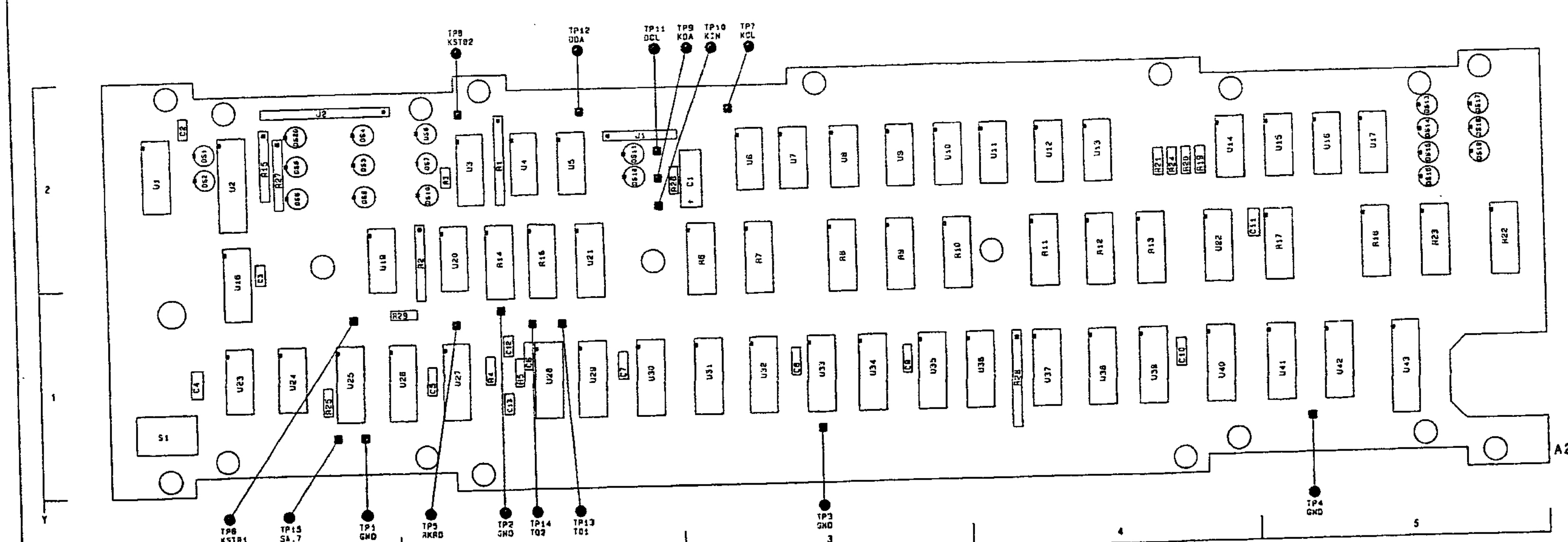
LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW



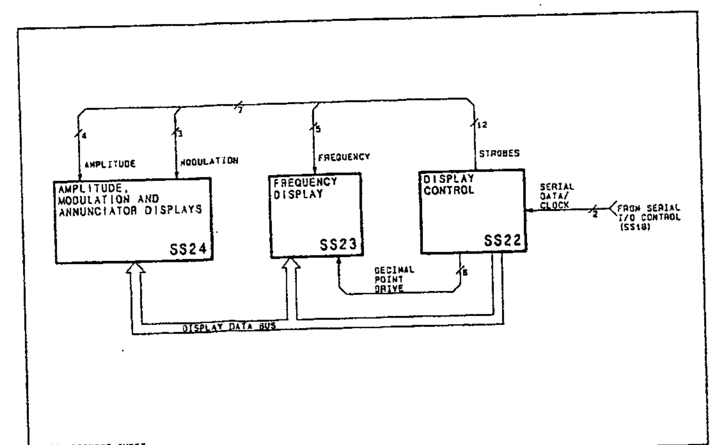


SS21
Figure 8-70
Schematic
Diagram
8-848



Component Locator

Figure 8-71. Service Sheet 22 Information



Reference Block Diagram

Component Coordinates

A2																	
COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C11	4,2	U21	2,2														
C12	2,1	U23	1,1														
C13	2,1	U24	1,1														
J1	2,2	U25	1,1														
R4	2,1	U26	2,1														
R5	2,1	U28	2,1														
R6	3,2	U30	2,1														
R7	3,2																
R8	3,2																
R9	3,2																
R10	3,2																
R11	4,2																
R25	1,1																
R28	4,1																
TP1	1,1																
TP11	2,2																
TP12	2,2																
TP13	2,1																
TP14	2,1																

P/O A2, A1, KEYBOARD AND ENCODER
P/O A17,
P/O A18

SS21

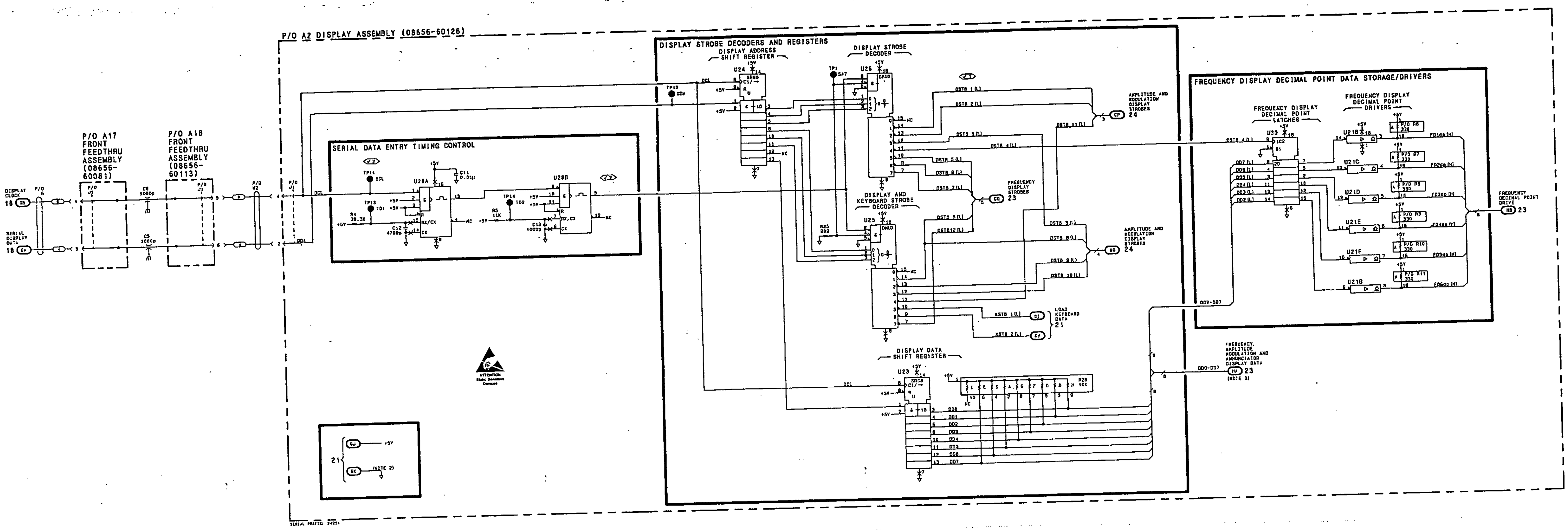
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A2J1-1 connection and mechanical contact through nuts holding PC board to frame.
3. Display data bus (DD0-DD7) is positive true for numeric data. Display data bus (DD0-DD7) is negative true for decimal point, sign and annunciator data.

LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

Schematic General Information



SS22
Figure 8-72
Schematic
Diagram
8-850

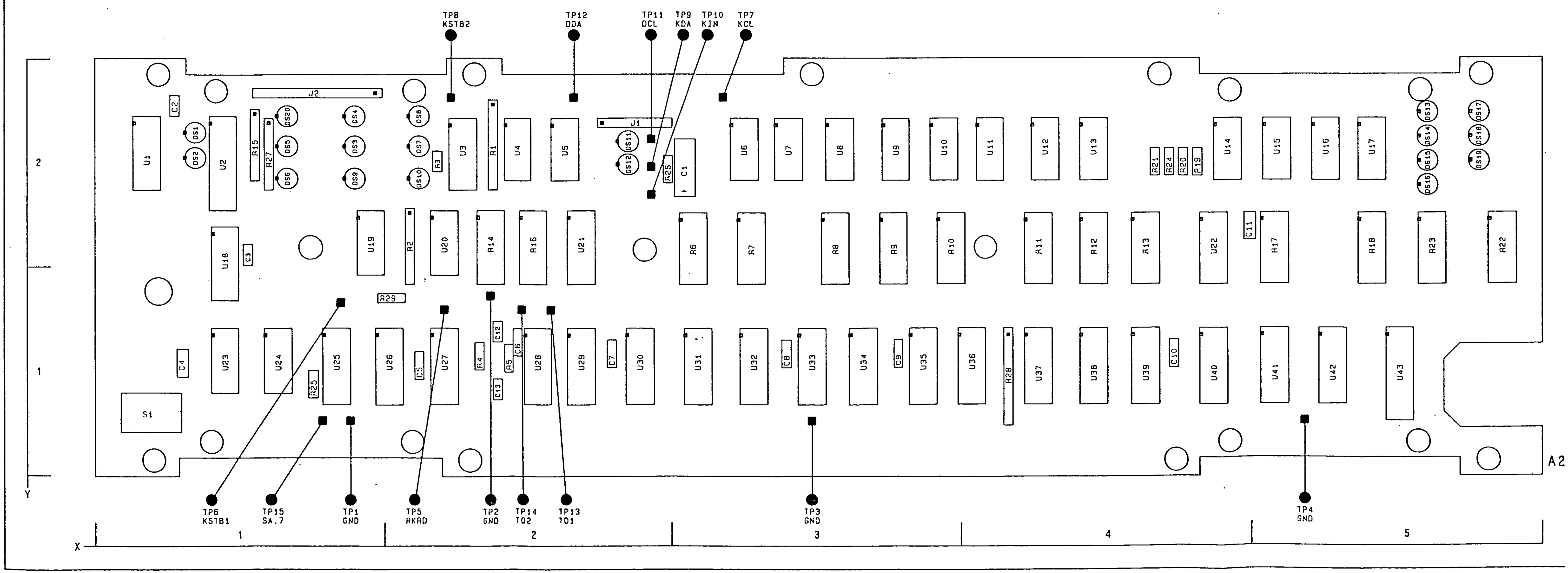
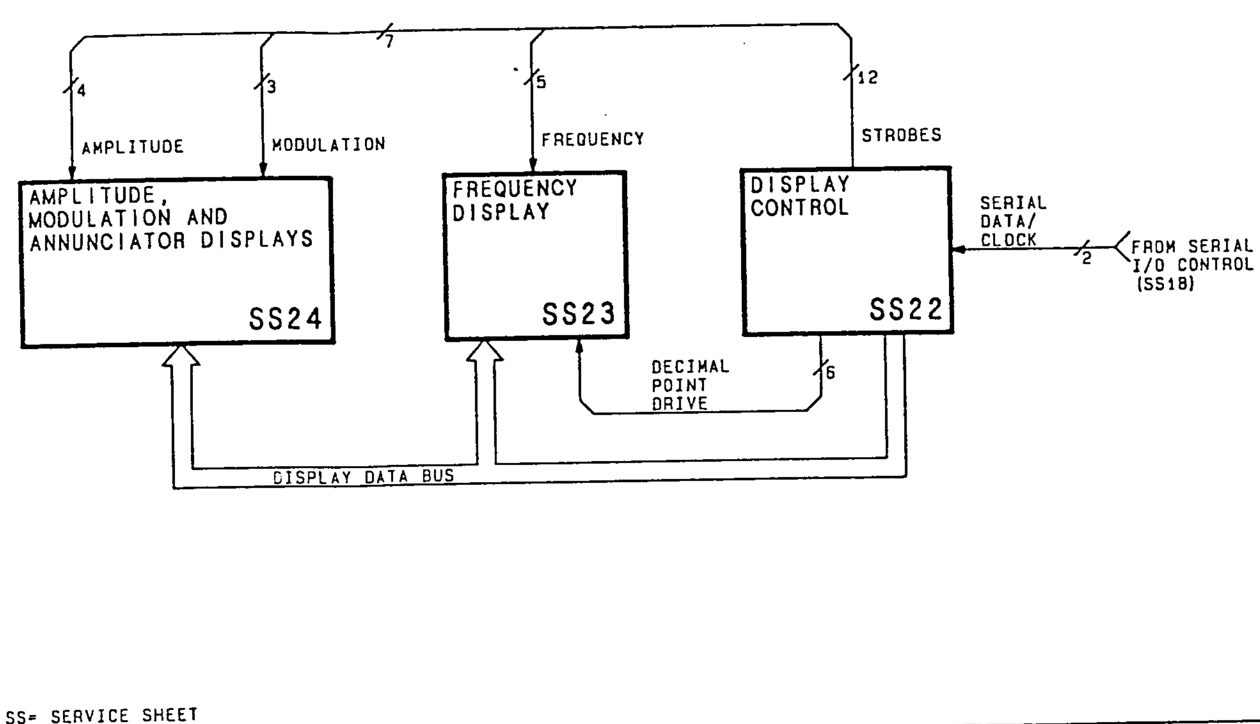


Figure 8-73. Service Sheet 23 Information Component Locator



Reference Block Diagram

Component Coordinates

A2	
COMP	X,Y
J1	2,2
J2	1,2
R6	3,2
R7	3,2
R8	3,2
R9	3,2
R10	3,2
R11	4,2
R12	4,2
R13	4,2
U6	3,2
U7	3,2
U8	3,2
U9	3,2
U10	3,2
U11	4,2
U12	4,2
U13	4,2
U31	3,1
U32	3,1
U33	3,1
U34	3,1
U35	3,1
U36	4,1
U37	4,1
U38	4,1

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y

P/O A2,
P/O A17,
P/O A18

DISPLAY CONTROL

SS22

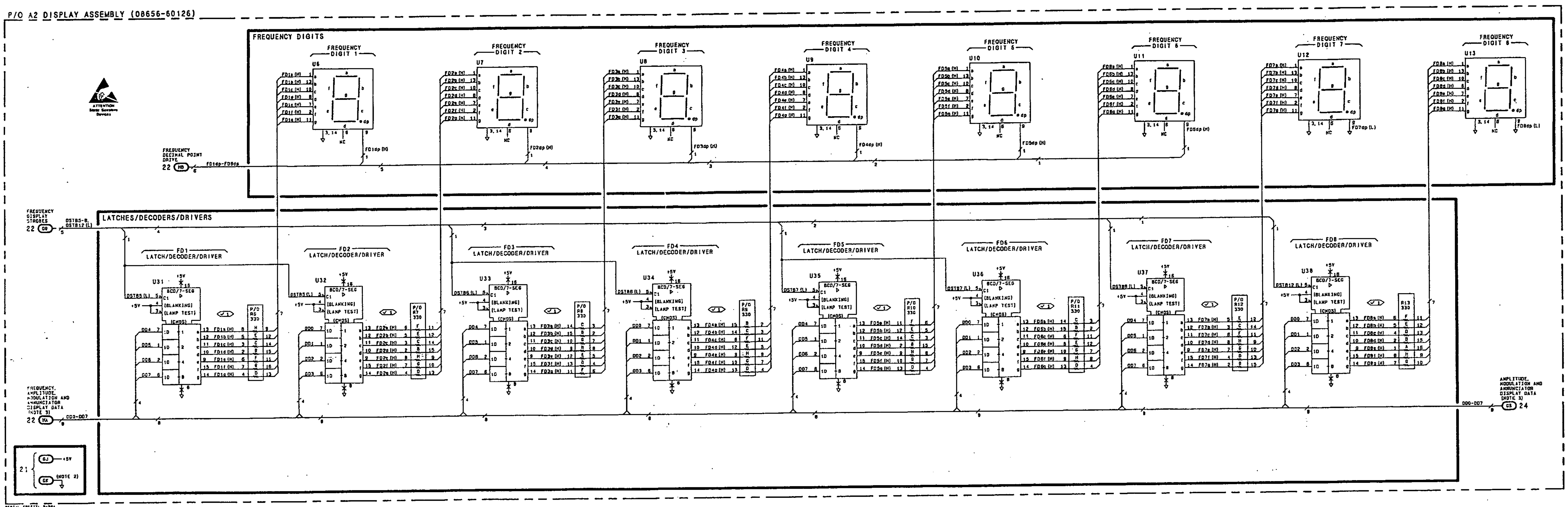
NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A2J1-1 connection and mechanical contact through nuts holding PC board to frame.
3. Display data bus (DD0-DD7) is positive true for numeric data. Display data bus (DD0-DD7) is negative true for decimal point, sign and annunciator data.

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Schematic General Information



SS23
Figure 8-74
Schematic Diagram
8-852

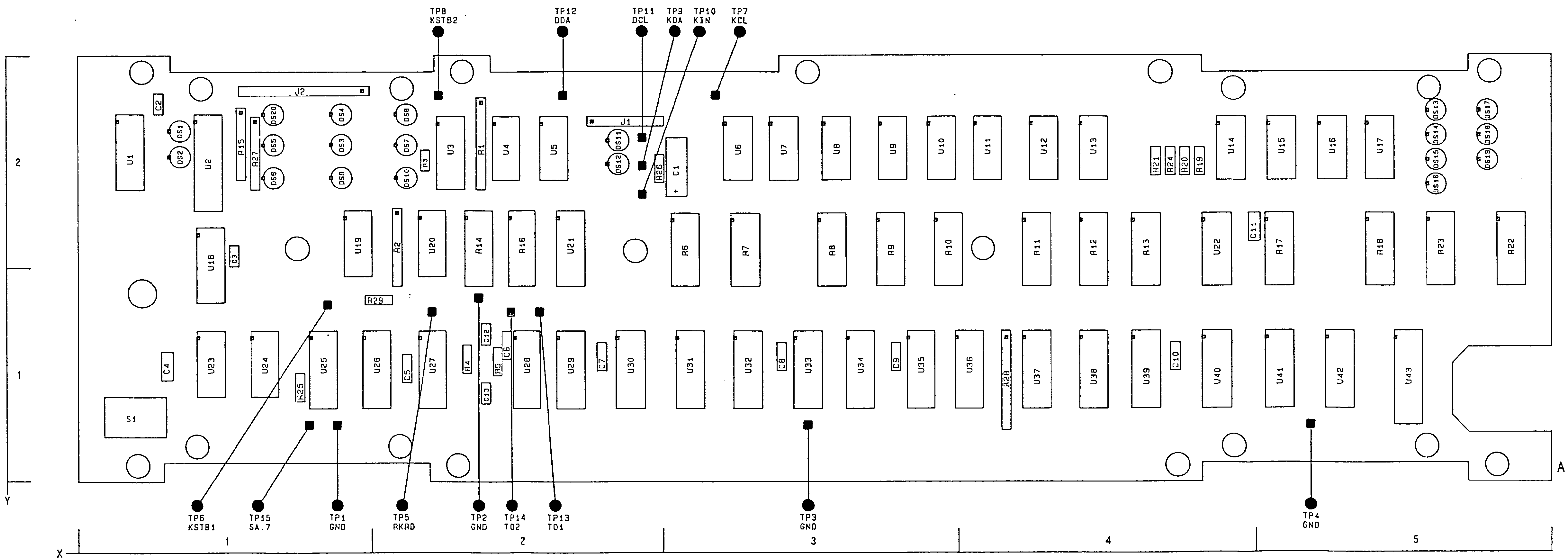
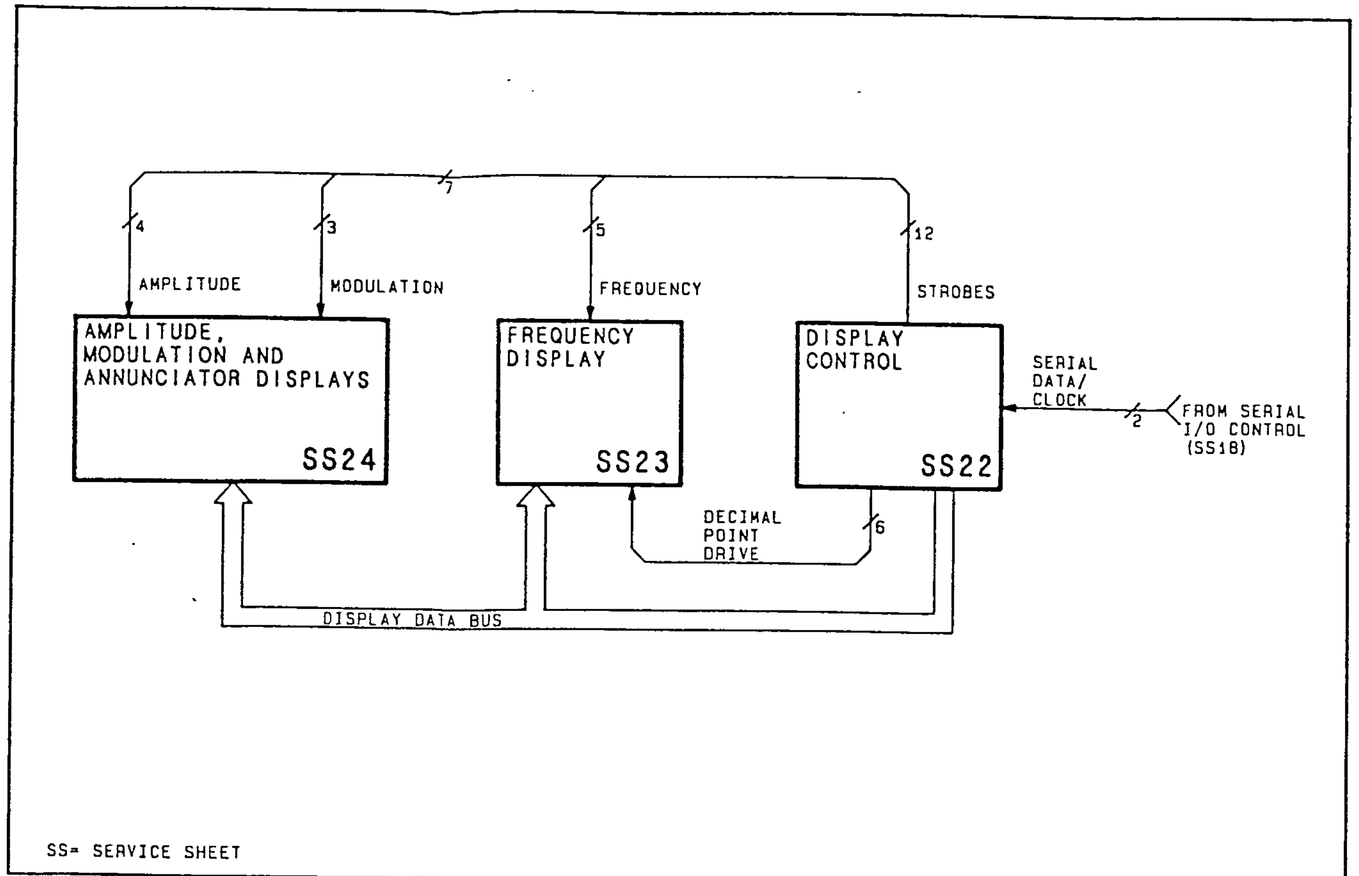


Figure 8-75. Service Sheet 24 Information

Component Locator



Reference Block Diagram

Component Coordinates

A2			
COMP	X,Y	COMP	X,Y
DS1	1,2	R22	5,2
DS2	1,2	R23	5,2
DS3	1,2	R24	4,2
DS4	1,2	R27	1,2
DS5	1,2	U1	1,2
DS6	1,2	U2	1,2
DS7	2,2	U4	2,2
DS8	2,2	U5	2,2
DS9	1,2	U14	4,2
DS10	2,2	U15	5,2
DS11	2,2	U16	5,2
DS12	2,2	U17	5,2
DS13	5,2	U21	2,2
DS14	5,2	U22	4,2
DS15	5,2	U27	2,1
DS16	5,2	U29	2,1
DS17	5,2	U39	4,1
DS18	5,2	U40	4,1
DS19	5,2	U41	5,1
DS20	1,2	U42	5,1
		U43	5,1
R12	4,2		
R14	2,2		
R15	1,2		
R16	2,2		
R17	5,2		
R18	5,2		
R19	4,2		
R20	4,2		
R21	4,2		

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y

P/O A2 FREQUENCY DISPLAYS **SS23**

NOTES

1. See Table 8-3 for schematic diagram notes.
2. Chassis ground is achieved by A2J1-1 connection and mechanical contact through nuts holding PC board to frame.
3. Display data bus (DD0-DD7) is positive true for numeric data. Display data bus (DD0-DD7) is negative true for decimal point, sign and annunciator data.
4. Numeric segment anodes are indicated by subscript "a" and cathodes by subscript "c" as follows:

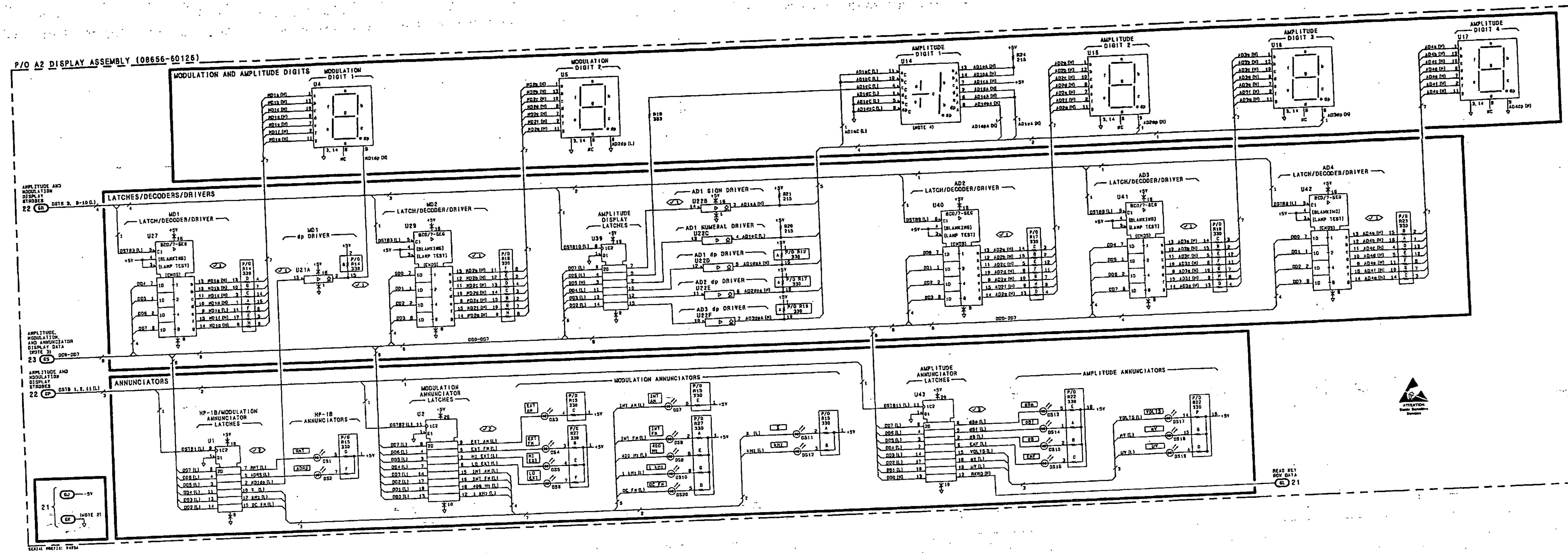
a

a_c —◄— a_a

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Schematic General Information



SS24
Figure 8-76
Schematic Diagram
8-854

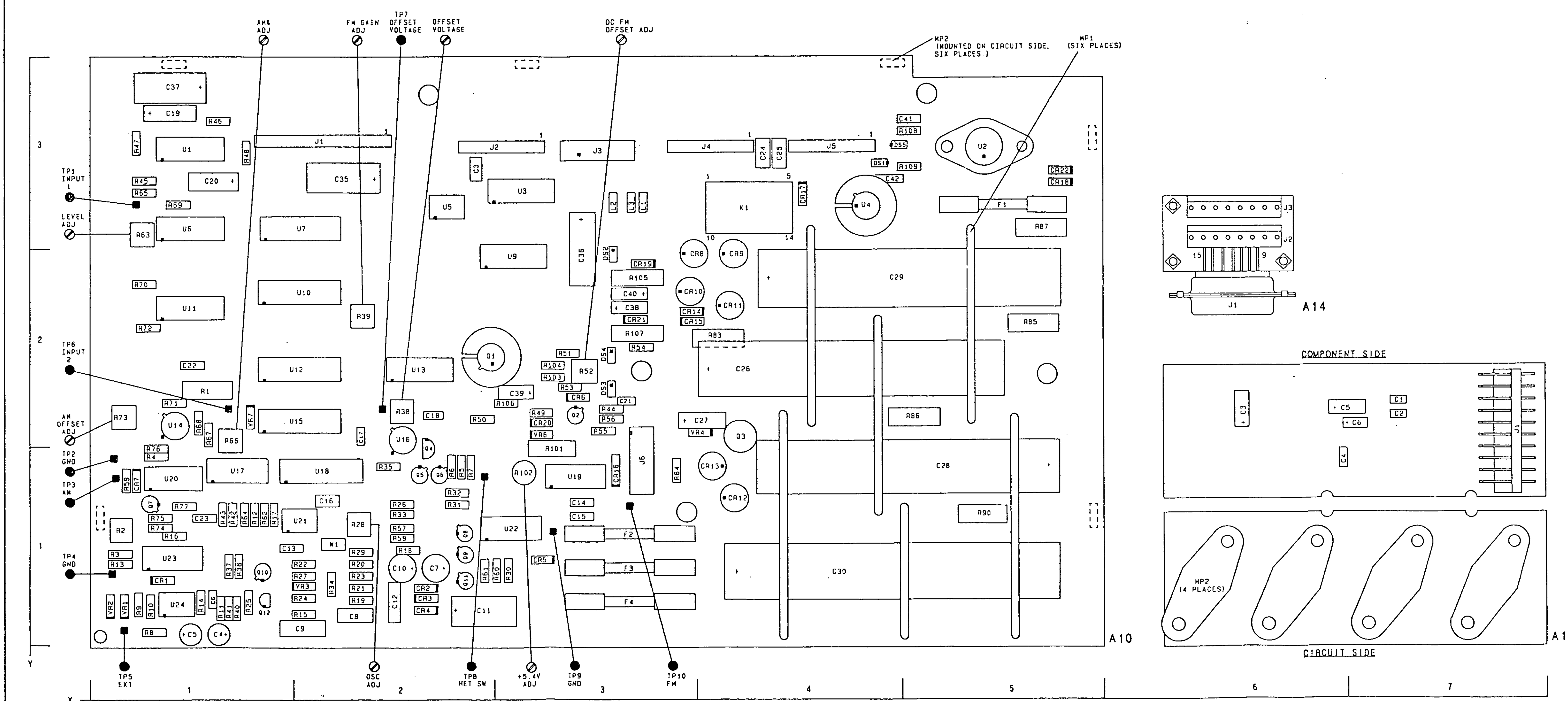


Figure 8-77. Service Sheet 25 Information

Component Locator

Component Coordinates

A10					
COMP	X,Y	COMP	X,Y	COMP	X,Y
C3	2,3	DS1	4,3	Q1	2,2
C24	4,3	DS2	3,2	Q3	4,2
C25	4,3	DS3	3,2	R83	4,2
C26	4,2	DS4	3,2	R84	3,1
C27	4,2	DS5	4,3	R85	5,2
C28	5,1	F1	5,3	R86	5,2
C29	4,2	F2	3,1	R87	5,3
C30	4,1	F3	3,1	R90	5,1
C41	4,3	F4	3,1	R101	3,1
C42	4,3	J2	2,3	R102	3,1
CR8	3,2	J4	4,3	R103	3,2
CR9	4,2	J5	4,3	R104	3,2
CR10	3,2	J6	3,1	R105	3,2
CR11	4,2	K1	4,3	R106	3,2
CR12	4,1	L1	3,3	R107	3,2
CR13	4,1	L2	3,3	R108	4,3
CR14	3,2	L3	3,3	R109	4,3
CR15	3,2	MP1	5,2	U2	5,3
CR16	3,1	MP2	1,3	U4	4,3
CR17	4,3			VR4	3,2
CR18	5,3			VR6	3,2
CR19	3,2				
CR20	3,2				
CR21	3,2				
CR22	5,3				

A12	
COMP	X,Y
C1	7,2
C2	7,2
C3	6,2
C4	6,1
C5	6,2
C6	7,2
J1	7,2
MP2	6,1

A14	
COMP	X,Y
J1	6,2
J2	6,3
J3	6,3

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y

P/O A2 AMPLITUDE, MODULATION AND ANNUNCIATOR DISPLAYS **SS24**

WARNING

This instrument does not have a primary power switch. The following voltages are always present whenever the instrument is connected to an AC outlet:

A. Line voltage
B. Primary and secondary AC voltages.
C. Unregulated DC voltages (+24V, +15V, +5V and -15V).
D. Regulated DC voltages (+5V (STBY/MEMORY)).

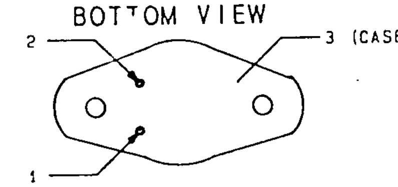
CAUTION

Do not connect or disconnect the Audio/Power Supply board (A10) or Voltage Regulator board (A12) with the AC power cord connected, otherwise damage to the instrument may result.

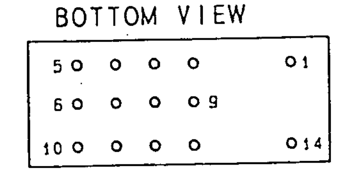
NOTES

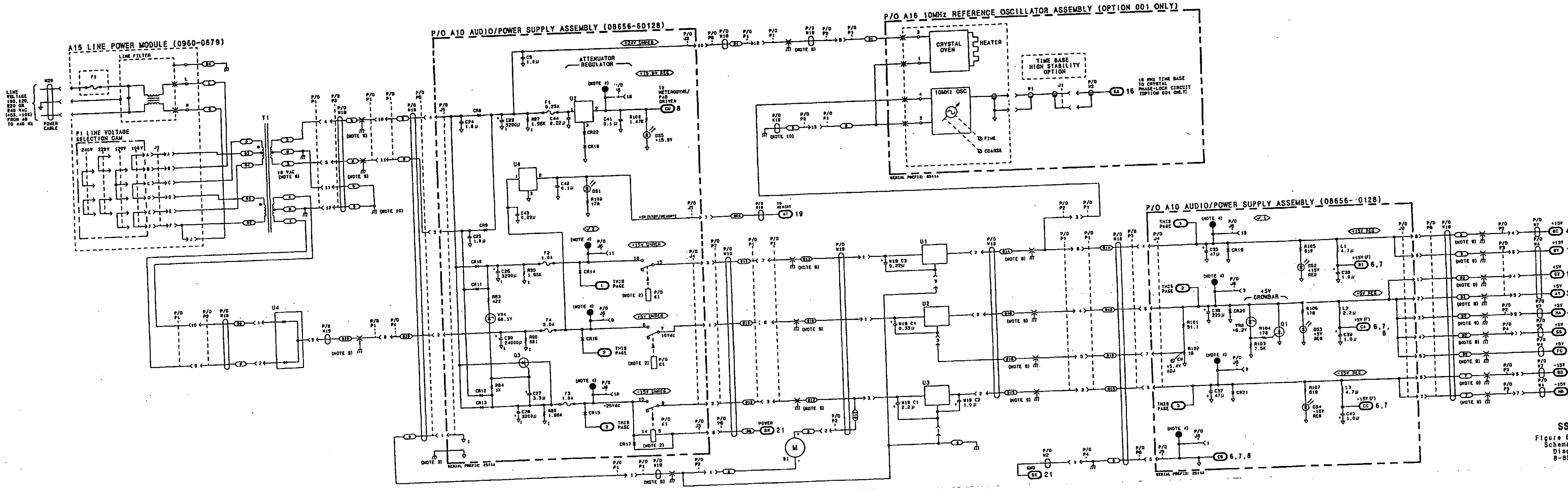
1. See Table 8-3 for schematic diagram notes.
2. Energized by the "Power" switch put to "ON".
3. A10 chassis ground is achieved by A10J5-1 and 5 connections and mechanical contact through nuts holding PC board to frame.
4. Service test point. Pin of dual in-line test socket J6.
5. A12 chassis ground is achieved by mechanical contact through nuts holding U1 to frame.
6. Cases of U2, U3 and U4 are insulated from chassis ground.
7. A14 chassis ground is achieved by mechanical contact through nuts holding assembly to frame.
8. This AC voltage measurement is to chassis ground.

U1-4
BOTTOM VIEW

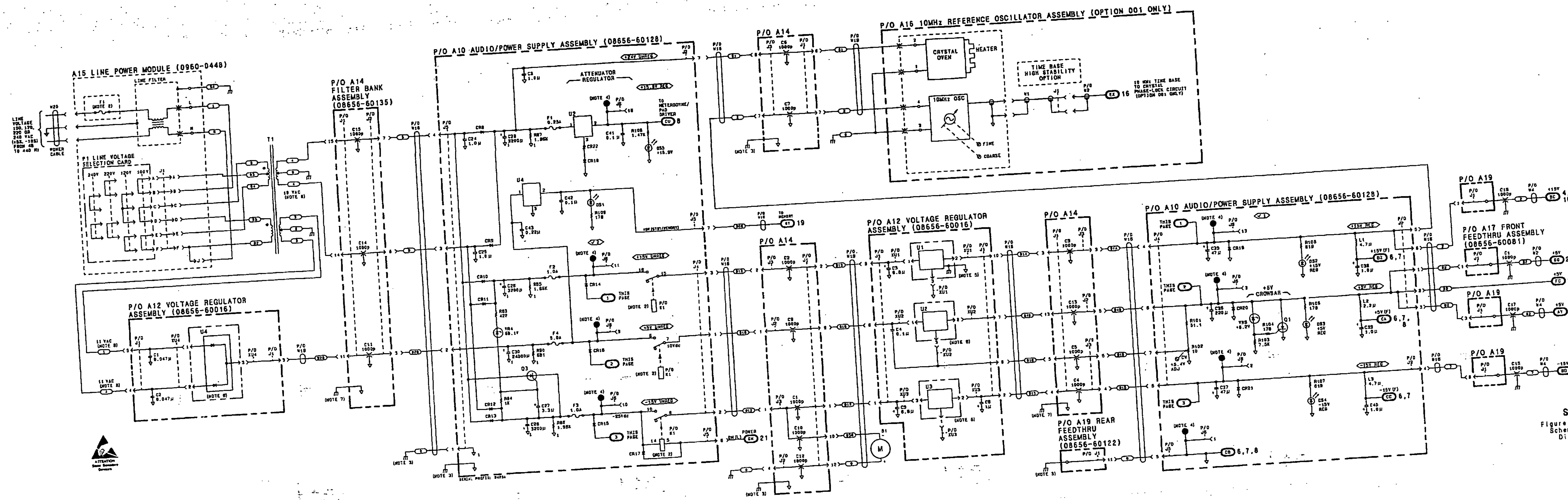


A10K1
BOTTOM VIEW





SS25
Figure 8-78
Schematic
Diagram
8-855.3



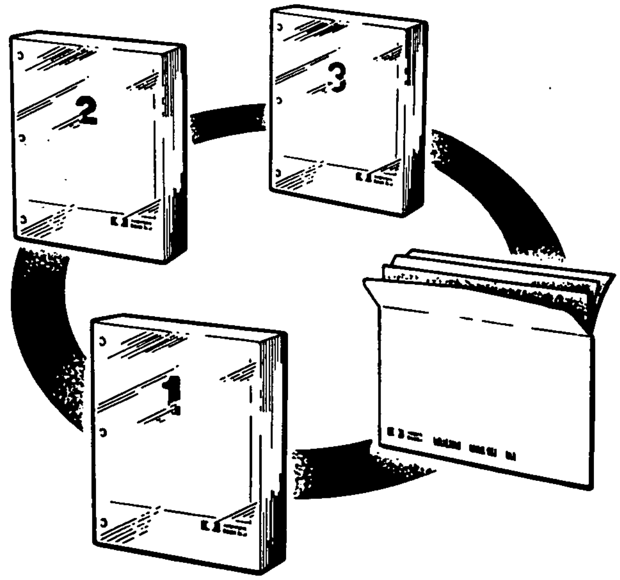
SS25

Figure 8-78 Schematic Diagram

HEWLETT PACKARD

MANUAL UPDATES

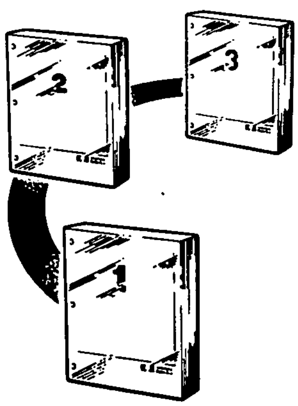
What are Manual Updates?



You might have received some combination of the packets shown above. If not, you will be receiving packets like this if you join the Manual Update Service. (Refer to the next page for information about this service.) If you have not received any packets and you do not want to join the Manual Update Service, you probably don't need this information. These packets contain pages for you to insert into your manual so your manual can be as up-to-date as possible.

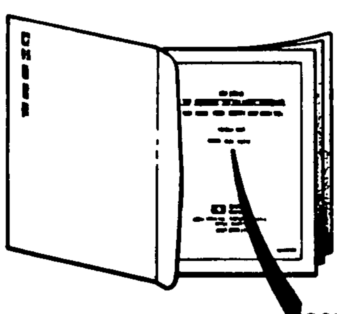
The Documentation Update Packets document all instrument changes over a specified time period. The packet of Manual Update Pages documents the most recent changes and will eventually be included in a numbered packet.

Each packet contains "update" pages that add new information. (In case you have never seen a change packet before, open it up to see what kind of changes are presented.) These pages replace pages currently in your manual and add new or changed information.



Documentation Update Packets

These packets completely document all changes that have occurred within the range of instrument serial prefixes listed on the new title page (usually in the Manual Update Packet.)



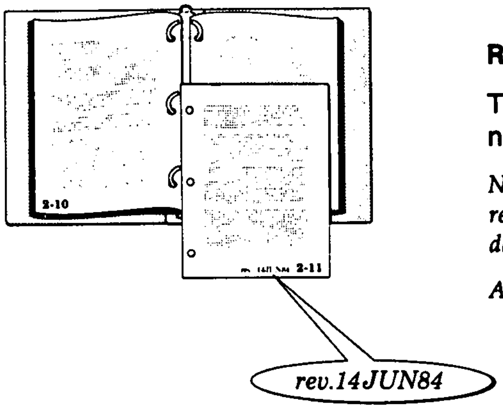
serial-number prefix range

Manual Update Pages

This packet contans all *major* change information for instruments with serial prefixes beyond the range shown on the title page. (The *minor* changes, not included, will be covered in subsequent updates. You can receive the subsequent updates by joining the **Documentation Update Service.)**

How to Update Your Manual

When you get ready to replace each page, pay close attention to the page numbers and the revision dates on each side of the sheet.The page numbers will tell you whether a page from this packet is a Replacement page or an Addition page. The revision date will tell you how recently the change occurred. Note that each update page is either a "replacement page" or an "addition page".

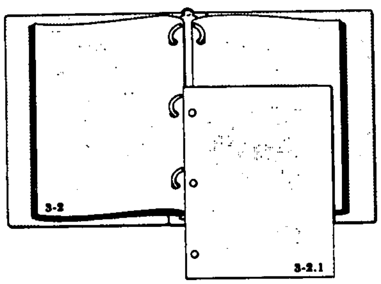


Replacing a Page

The replacement page number will always be the same as the number on the page it is meant to replace.

NOTE: There may be a revision date on the existing page in the manual, replace only after making sure that the replacement page has a later revision date. (The later revision date could be on either side of the sheet.)

Always use the page with the latest revision date.



Adding a Page

An addition page will have a page number with a decimal number. Simply add this page into your manual in the appropriate place. (For example, the addition page 3-2.1 in this packet would be added immediately following page 3-2 in your manual.)

Receiving Further Updates

Hewlett-Packard offers a **Documentation Update Service** to keep your manual updated. This service is free of charge and provides you with updates as soon as they become available.

If you operate or service instruments of different serial prefixes, we recommend that you join this service immediately to ensure that your manual is kept current. For more information, refer to the **Documentation Update Service** reply card in your manual or contact:

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Spokane, WA 99220
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NOTE: Use the ***Documentation Update Service*** *reply card to promptly notify us of any changes or corrections to your mailing information. To avoid receiving duplicate packets, be sure to mark the* "Name/Address Correction Only" *box on the reply card, if applicable.*

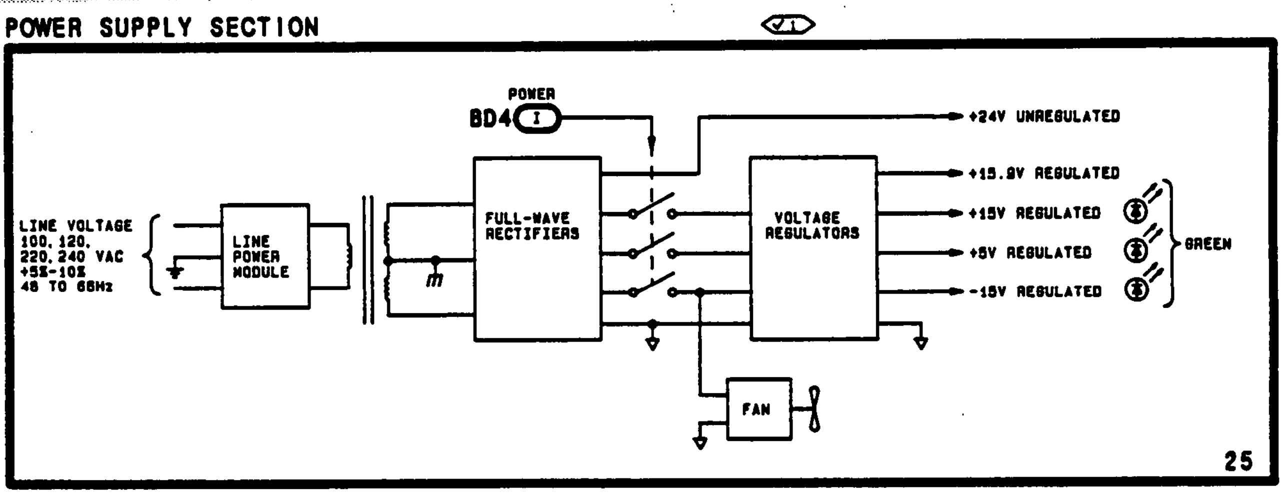
If you subscribe to the **Documentation Update Service**, you may find the first **Manual Update** packet you receive contains pages that have already been incorporated into your manual. These pages have been included in your first updating packet to ensure your receipt of all applicable change information. Any duplicate pages may be discarded.

CHANGES

All Serial Prefixes

POWER SUPPLY SECTION – Replace the Power Supply Section of BD1 with the following diagram:

POWER SUPPLY SECTION



CHANGES

All Serial Prefixes	A3TP23 - Change the location of TP23 to the output of the Sample and Hold Amplifier in Service Sheet 13.

CHANGES

2514A and above	On the schematic: • A4R35 - Change the value of R35 in the DC NOTCH FILTER to 511 ohms.
2542A and above	On the schematic: • A4C86 - Change the value of C86 in the 300 MHz NOTCH FILTER to 8.2pf.

CHANGES

2635A and above	On the schematic: • <u>A4R52</u> - In the Gain Compensation and Sideband Logic section, change the value of R52 to 10k.

CHANGES

All Serial Prefixes

On the component locator:

- A8Q1-Q3 - Reverse the "B" and "C" markings for Q1-Q3.

On the schematic:

- On the left side of SS3 locate bullet 25 (AY) and change the colorcode of P/O W4 from 92 to 2 on the left side of C10 only.

CHANGES

All Serial Prefixes	On the schematic: • A6R33, A6R35 - In the **DETECTOR BIAS** section, change A6R33 to 1.62K and change A6R35 to 500. • A6L31, A6L33, A6L35 - In the **HIGH-BAND OUTPUT AMPLIFIER** section, change L31, L33, and L35 to NH values. • A6Q3 - Change the base bias voltage of Q3 to +1.9V. • A6R6 - In the **DIVIDE-BY-TWO** section, change R6 to 316 ohms. • J2 - Replace part of SS4 with the partial schematics found on pages 8-814.5 and 8-814.7. • U2 - Delete the line connecting pin 9 to R5. Connect pin 9 to ground. Delete the ground from U2 pin 12. Connect pin 12 to the anode of CR6.
2447A and above	On the schematic: • A6C40 - In the **HIGH-BAND OUTPUT AMPLIFIER** section, delete C40.
2506A and above	On the schematic: • A6R9 - In the **DIVIDE-BY-TWO** section change R9 to 511 ohms.
2509A and above	On the schematic: • A6C63, A6C64 - In the **ALC AMPLIFIER** at U6, change the value of C63 and C64 to 0.047μ.
2511A and above	On the schematic: • W7 - Replace part of SS4 with the partial schematic found on page 8-814.3. On the partial schematic for W7, change pin 3 to pin 5, pin 9 to pin 8, and pin 5 to pin 9. • A6 - Change the part number of the A6 Output Assembly to 08656-60180.
2532A and above	On the schematic: • A6C70 - In the **HIGH-BAND OUTPUT AMPLIFIER** section, change the value of C70 to 2.2p, found on pages 8-814.1 and 8-815.

CHANGES

2620A and above

On the Component Coordinates:

- A6C72 - Add C72 under C70 and 2,2 in the X,Y column.

On the Component Locator:

- A6C72 - Add C72 between R3 and C17.

On the schematic:

- A6C72 - In the **P/O A6 OUTPUT ASSEMBLY** under DIVIDE-BY-TWO, add C72 10PF to ground off of the connection of C14.

2630A and above

On the schematic:

- L27 - In the **VOLTAGE-TUNED FILTERS**, under 123.5 TO 247 MHz VOLTAGE-TUNED FILTER, change the value of L27 to 100NH.

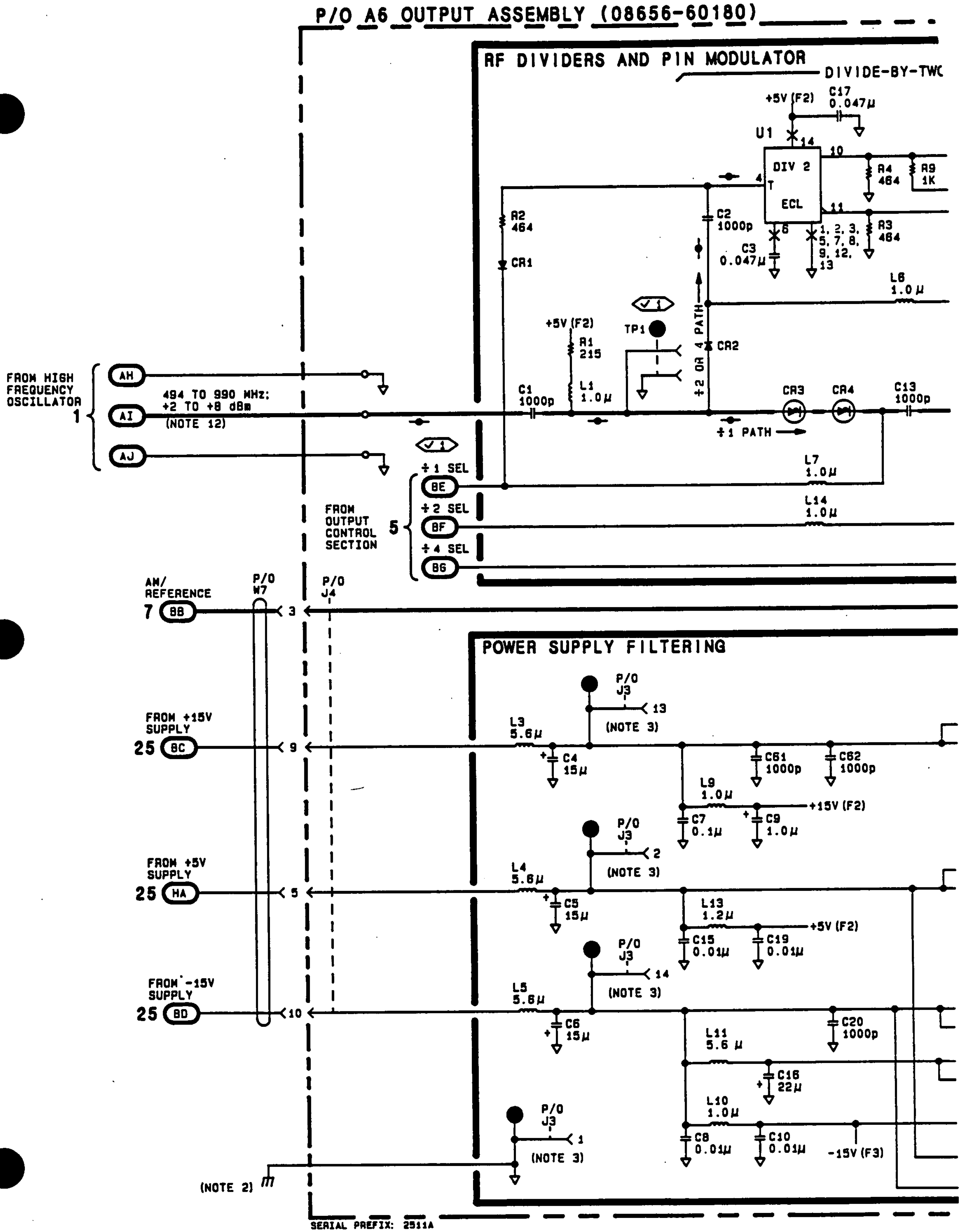
2639A and above

On the component locator:

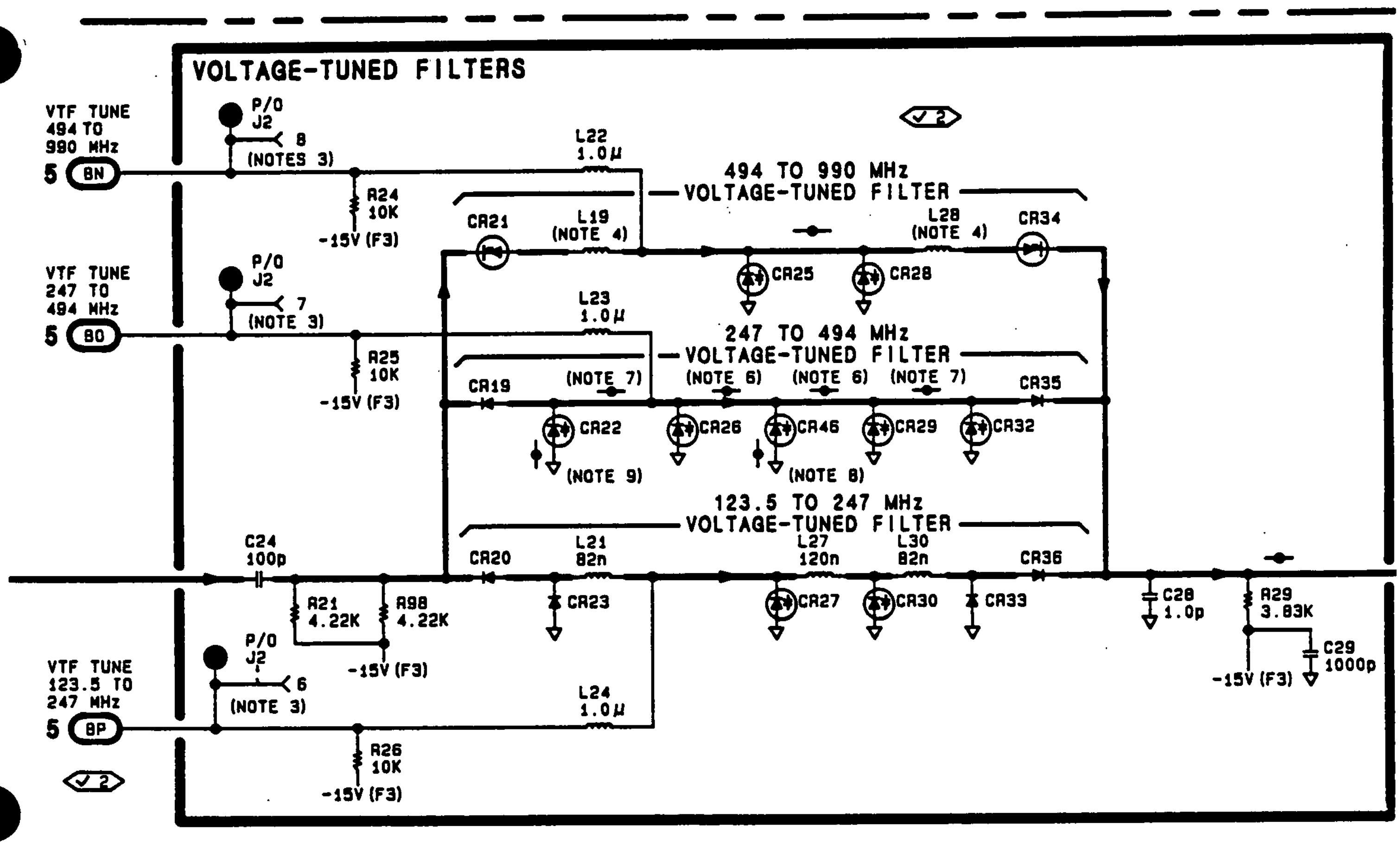
- A6R106, R107 - In grid coordinate block 5,2, add R106 to the right of R46 (where C40 used to be), and add R107 to the right of R47.
- Add R106 and R107 to the component coordinates table in grid locations 5,2 (X,Y).

On the schematic:

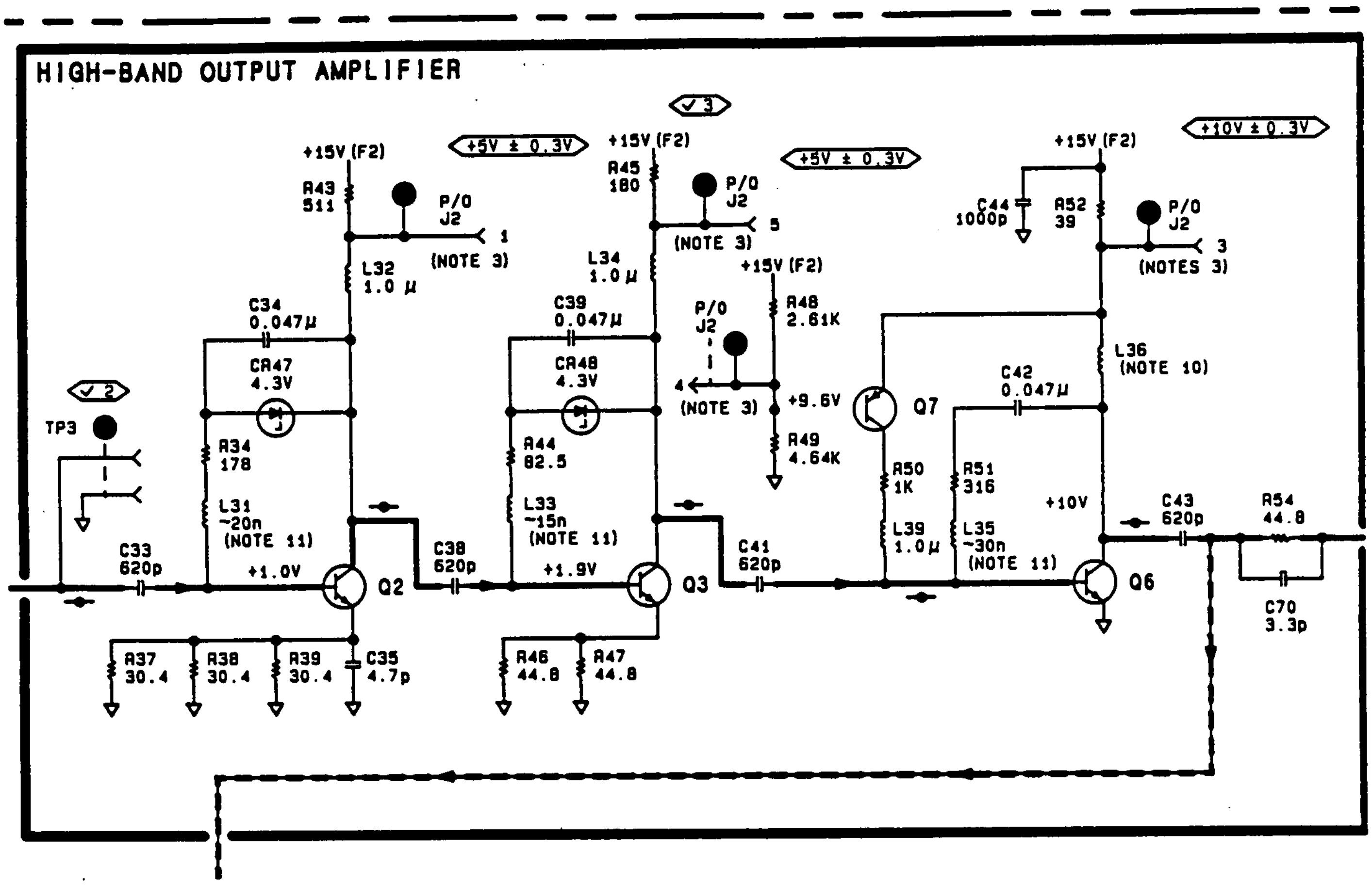
- A6R46, R47 - In the **HIGH-BAND OUTPUT AMPLIFIER** section, change the value of R46 and R47 to 68.1 ohms.
- A6R106, R107 - In the **HIGH-BAND OUTPUT AMPLIFIER** section, add R106 and R107 (both 68.1 ohms) in parallel with R46 and R47.



P/O Figure 8-36 (2511A and above)



P/O Figure 8-36 (All Serial Prefixes)


HIGH-BAND OUTPUT AMPLIFIER
+15V (F2)
+5V ± 0.3V
R43 511
P/O J2
L32 1.0 µ
(NOTE 3)
C34 0.047µ
CR47 4.3V
R34 178
L31 ~20n (NOTE 11)
TP3
C33 620p
+1.0V
Q2
R37 30.4
R38 30.4
R39 30.4
C35 4.7p
R45 180
L34 1.0 µ
C39 0.047µ
CR48 4.3V
R44 82.5
L33 ~15n (NOTE 11)
C38 620p
+1.9V
Q3
R46 44.8
R47 44.8
R48 2.61K
+9.6V
R49 4.64K
C41 620p
Q7
R50 1K
L39 1.0µ
R51 316
L35 ~30n (NOTE 11)
C42 0.047µ
L36 (NOTE 10)
C44 1000p
R52 39
(NOTES 3)
+10V ± 0.3V
+10V
Q6
C43 620p
R54 44.8
C70 3.3p

CHANGES

All Serial Prefixes

On the schematic:

- A6C46, A6C48 - In the HETERODYNE SECTION'S 800 MHZ BANDPASS FILTER, change C46 and C48 to adjustable 1-3p capacitors.
- (NOTE 7) - Delete the references to "(NOTE 7)" at A6C46 and A6C48.
- J2 - Replace part of SS5 with the partial schemaic found on page 8-816.5.

2506A and above

On the schematic:

- A6C31 - In the HETERODYNE SECTION'S LOW-BAND-OUTPUT AMPLIFIER change the value of C31 to 10p.

2511A and above

On the schematic:

- W7 - Replace part of SS5 with the partial schematic found on page 8-816.3. On the partial schematic for W7, change pin 2 to pin 3, and change pin 6 to pin 2.
- A6 - Change the part number of the A6 Output Assembly to 08656-60180.

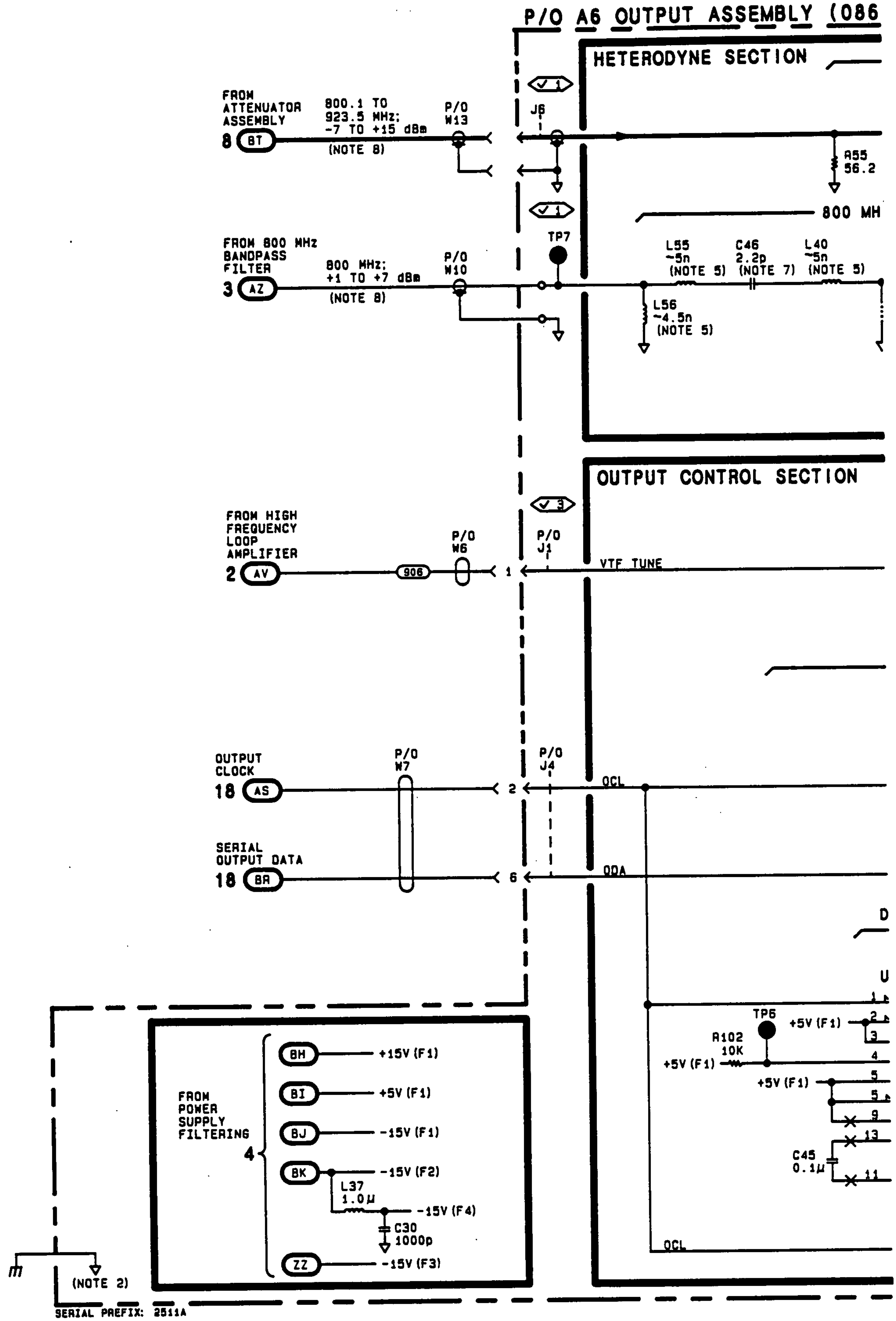
2523A and above

On the schematic:

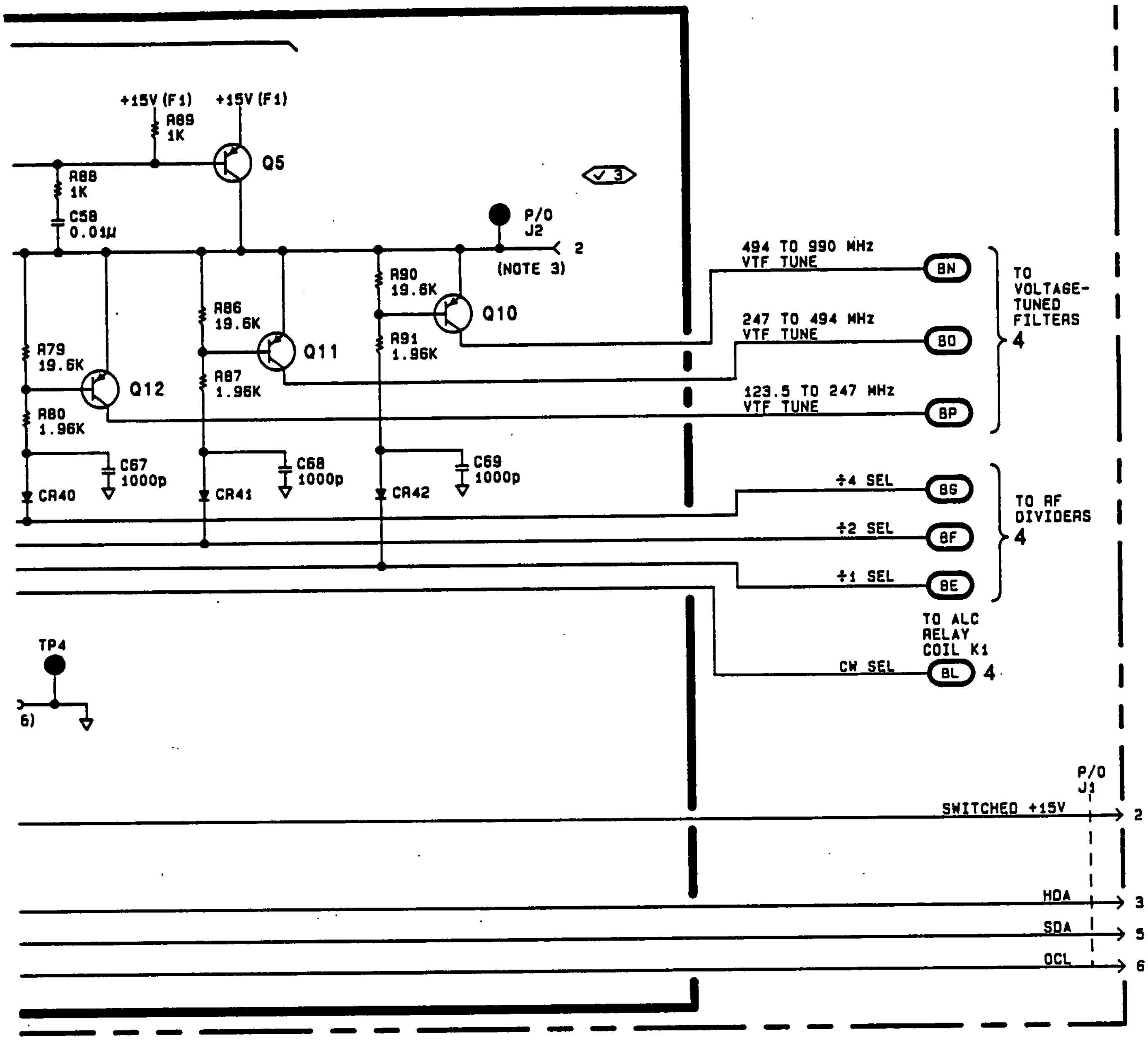
- A6C71 - In the HETERODYNE SECTION'S LOW-BAND OUTPUT AMPLIFIER, add C71 10p. It is located between L54 and J7, with one end connected to ground.

On the component locator:

- A6C71 - In the Component Coordinates table, add A6C71 at 4,1. In the Component Locator, add C71; it is located between L54 and J7.



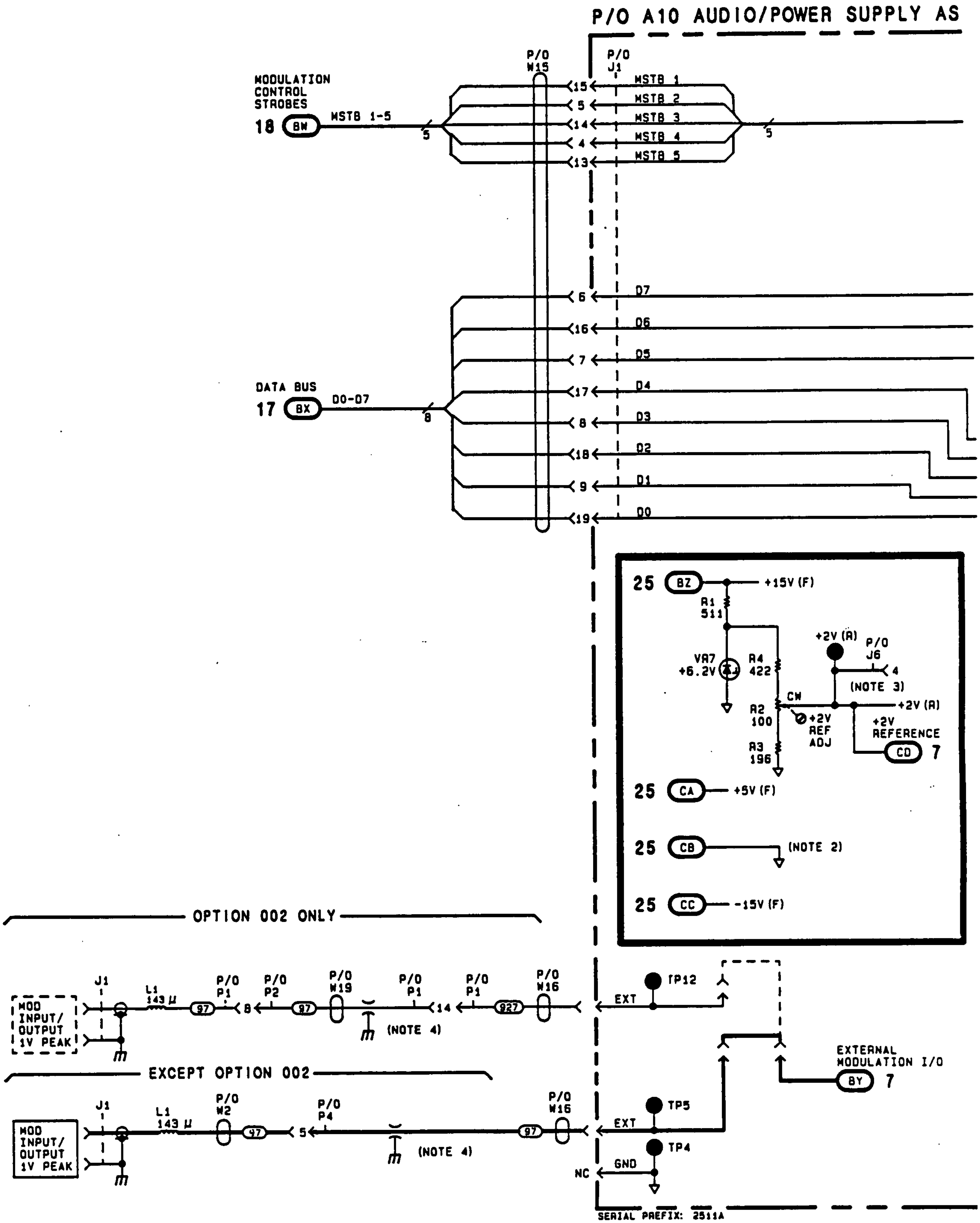
P/O Figure 8-38 (2511A and above)



P/O Figure 8-38 (All Serial Prefixes)

CHANGES

Serial Prefix	Change
All Serial Prefixes	On the Component Locator: • A10Q4, and A10R5-7 - Delete Q4 and R5-7 located at the component coordinates 2,1. Delete Q4 and R5-7 out of the Component Coordinates table. On the schematic: • A10Q4, and A10R5-7 - Delete Q4 and R5-7 from the Heterodyne Switch section. • A10U5 - Indicate that U15 pin 16 is not connected (NC).
2511A and above	In Schematic General Information: • NOTES - Add the following note: 4. FEEDTHRU CAPACITOR IS PART OF W16P1 OR W16P4 AND IS NOT SEPARATELY REPLACEABLE. On the schematic: • W2, W15, W16, and W19 - Replace part of SS6 with the partial schematic found on page 8-818.3. On the partial schematic for W15, change pin 15 to pin 10, pin 5 to pin 9, pin 14 to pin 8, pin 4 to pin 7, pin 13 to pin 6, pin 6 to pin 11, pin 16 to pin 12, pin 7 to pin 13, pin 17 to pin 14, pin 8 to pin 15, pin 18 to pin 16, pin 9 to pin 17, and pin 19 to pin 18. • A10 - Change the part number of the A10 Power Supply Assembly to 08656-60178.



P/O Figure 8-40 (2511A and above)

CHANGES

2425A to 2509A

On the schematic:

- W16 - Replace part of SS7 with the partial schematic found on page 8-820.5.

2511A and above

In Schematic General Information:

- NOTES - Add the following notes:

  4. FEEDTHRU CAPACITOR IS PART OF W16P2 OR W16P3 AND IS NOT SEPARATELY REPLACEABLE.
  5. CHASSIS GROUND IS ACHIEVED THROUGH MECHANICAL CONTACT WITH W16P2.

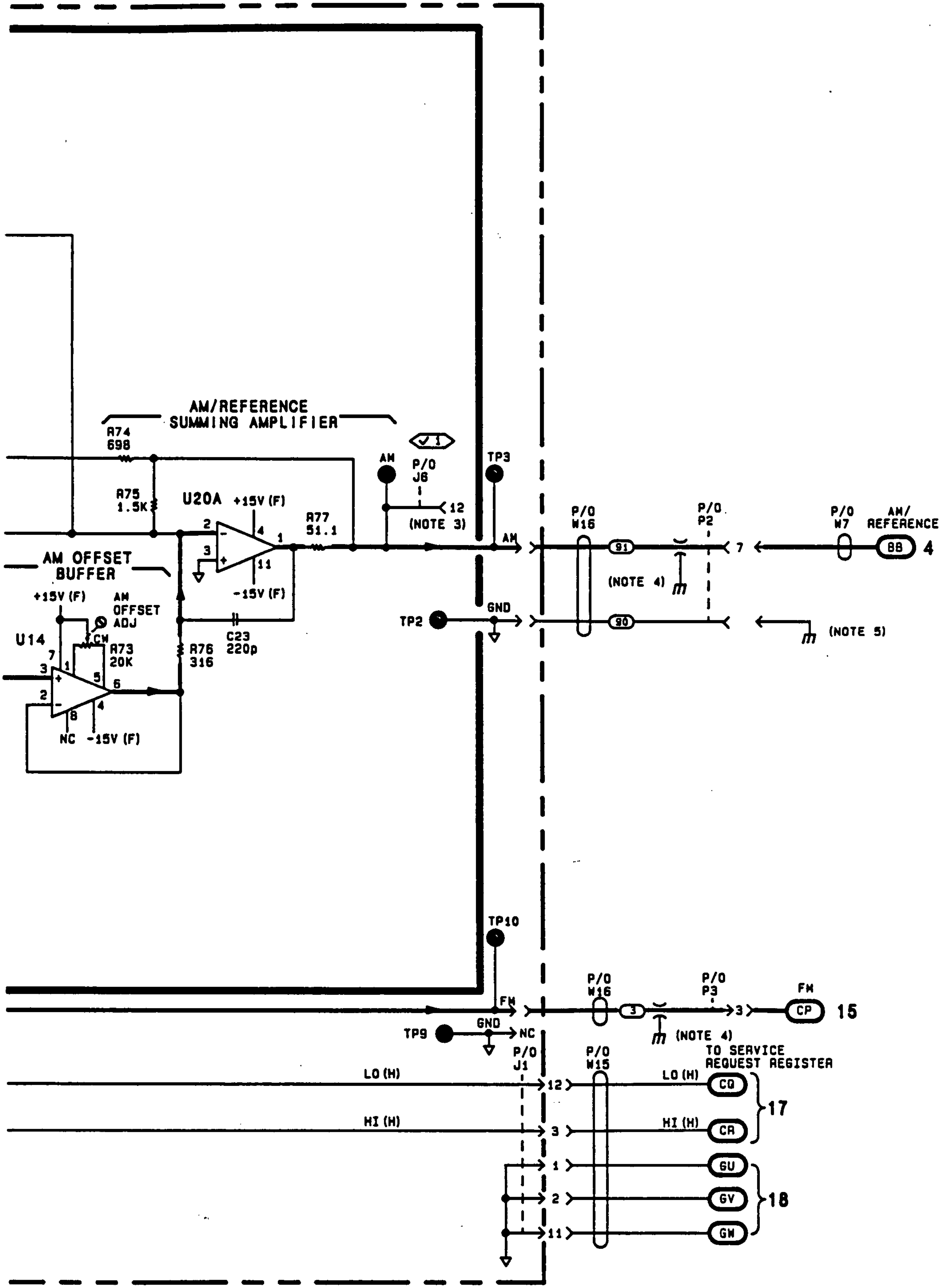
On the schematic:

- W7, W15, and W16 - Replace part of SS7 with the partial schematic found on page 8-820.3. On the partial schematic for W15, change pin 12 to pin 4, pin 3 to pin 5, pin 2 to pin 3, and pin 11 to pin 2.
- A10 - Change the part number of the A10 Power Supply Assembly to 08656-60178.

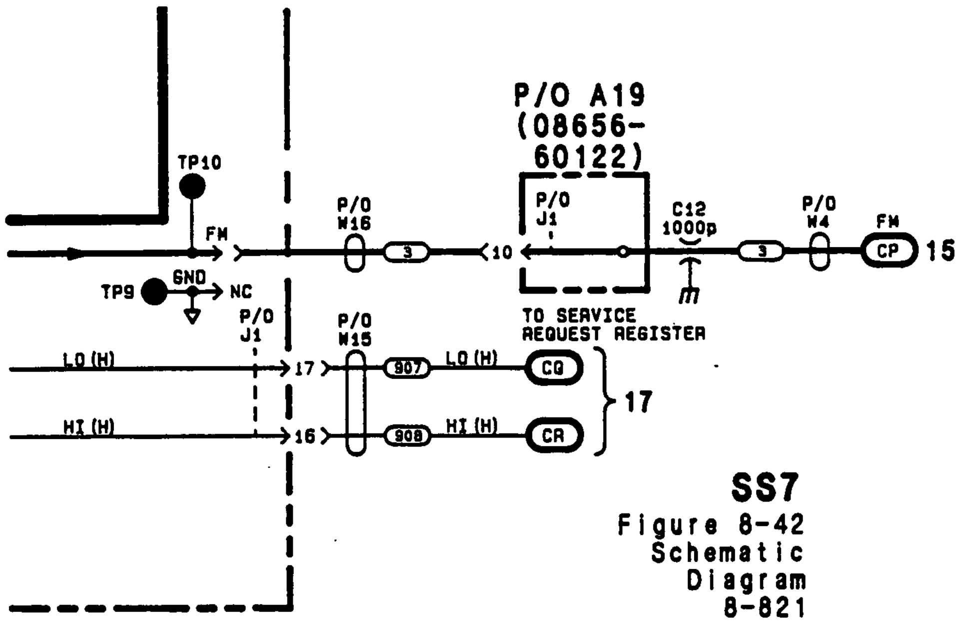
2637A and above

On the schematic:

- A10R56 - In the FM MODULATION CONTROL circuitry, change the value of R56 to 100 ohms. (R56 is part of the FM Deviation Amplifier.)



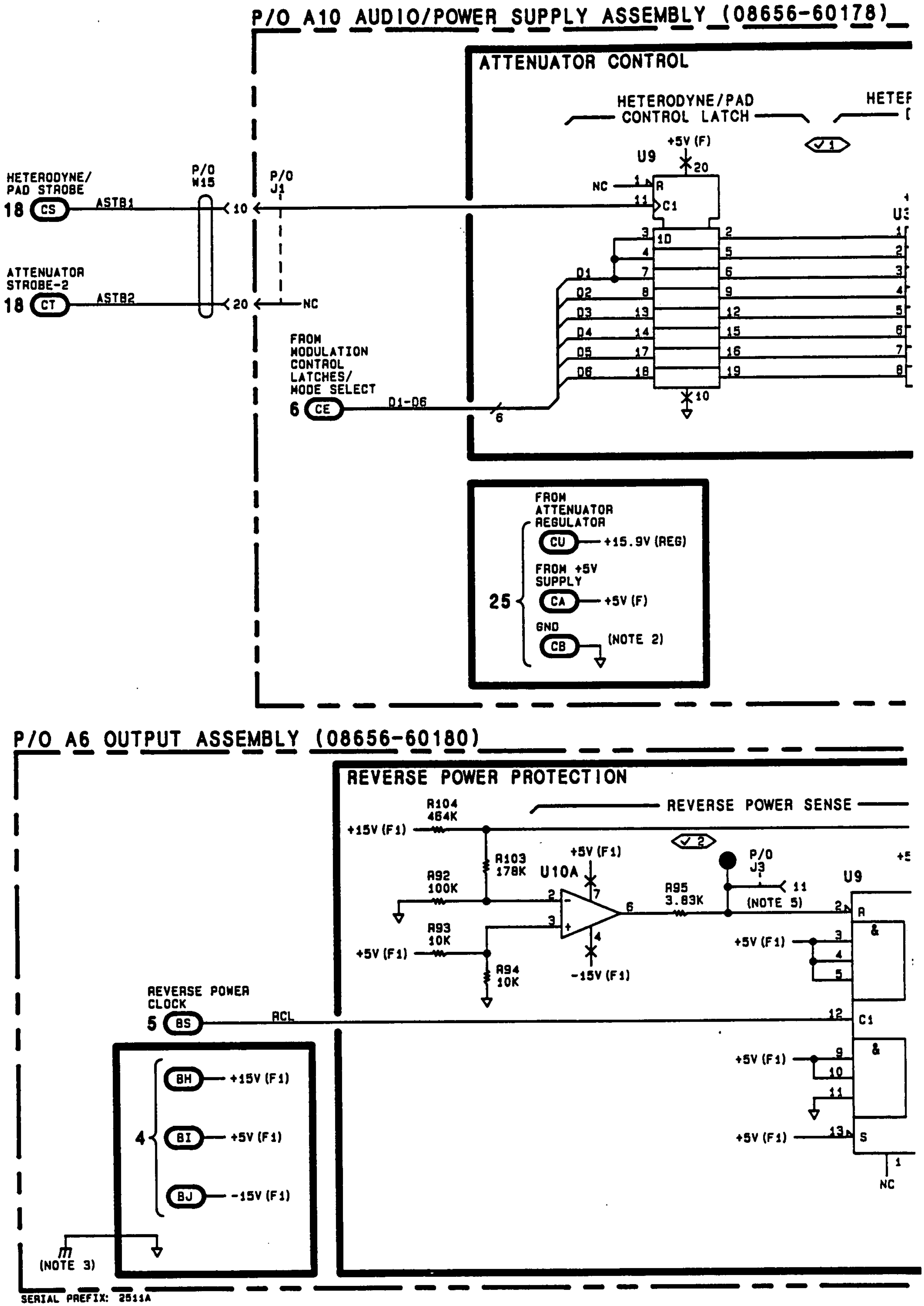
P/O Figure 8-42 (2511A and above)



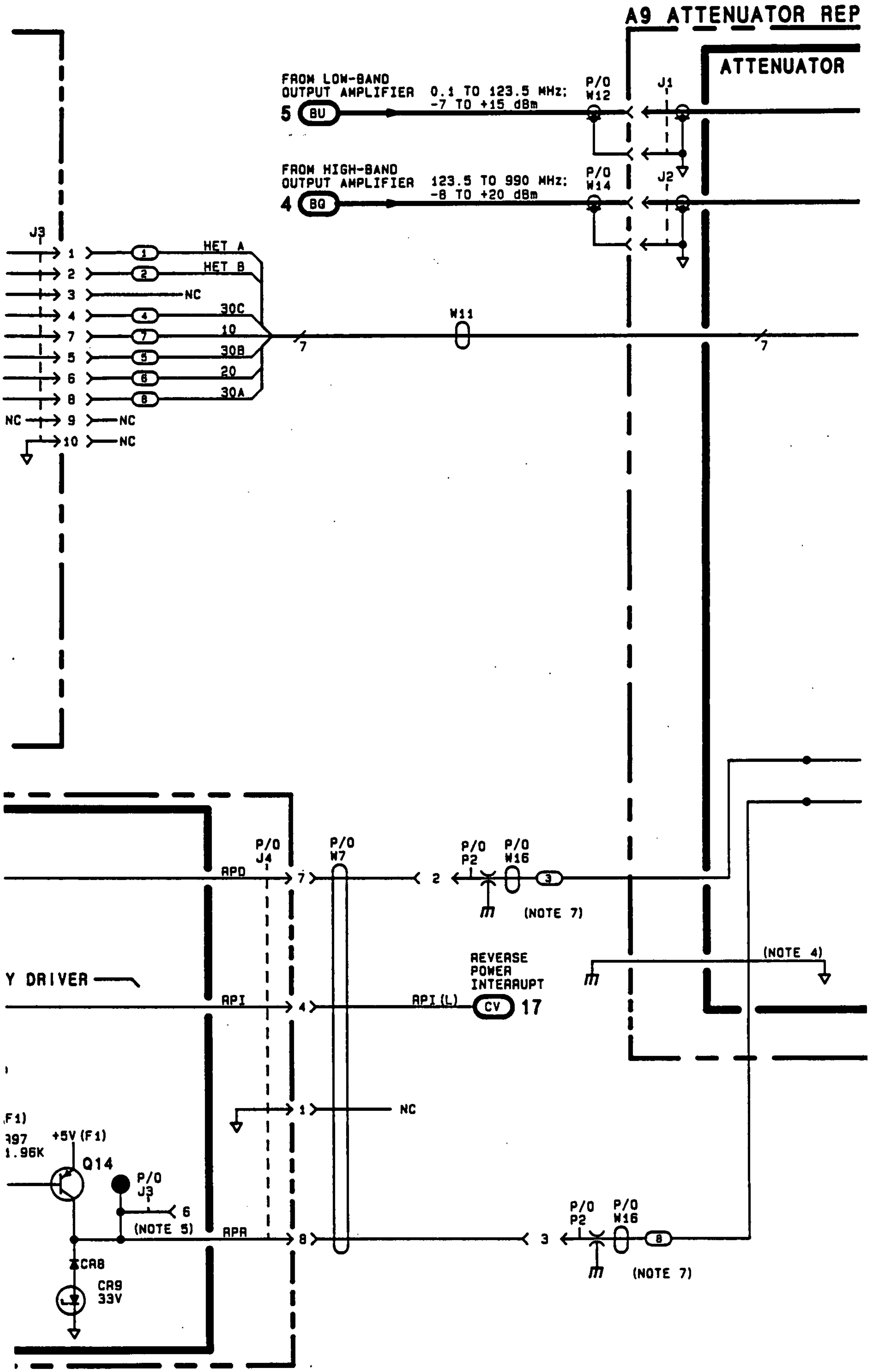
P/O Figure 8-42 (2425A to 2509A)

CHANGES

All Serial Prefixes	On the schematic: • <u>A6U10A</u> - Change A6U10A to A6U10. Pins 1, 5, and 8 are not connected.
2511A and above	In Schematic General Information: • <u>NOTES</u> - Add the following notes: 7. FEEDTHRU CAPACITOR IS PART OF W16P2 AND IS NOT SEPARATELY REPLACEABLE. 8. REFER TO THE ATTENUATOR REMOVAL PROCEDURE FOUND IN SECTION VIII PARAGRAPH 8-31. On the schematic: • <u>W7, W15, and W16</u> - Replace parts of SS8 with the partial schematics found on pages 8-822.3 and 8-822.5. On the partial schematic for W7, change pin 7 to pin 4, pin 4 to pin 7, and pin 8 to pin 6. On the partial schematic for W15, change pin 10 to pin 19. • <u>NOTE 8</u> - Add NOTE 8 next to the word ATTENUATOR. • <u>A10</u> - Change the part number of the A10 Power Supply Assembly to 08656-60178. • <u>A6</u> - Change the part number of the A6 Output Assembly to 08656-60180.



P/O Figure 8-44 (2511A and above)



P/O Figure 8-44 (2511A and above)

CHANGES

All Serial Prefixes	On the schematic: • In the upper left corner of the schematic, change the bullet description "DG" from -15V(F1) to +15V(F1). • A3A1E1 - In the LIMITER AMPLIFIER, delete E1 from te base of O2.
2511A and above	On the schematic: • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179.

CHANGES

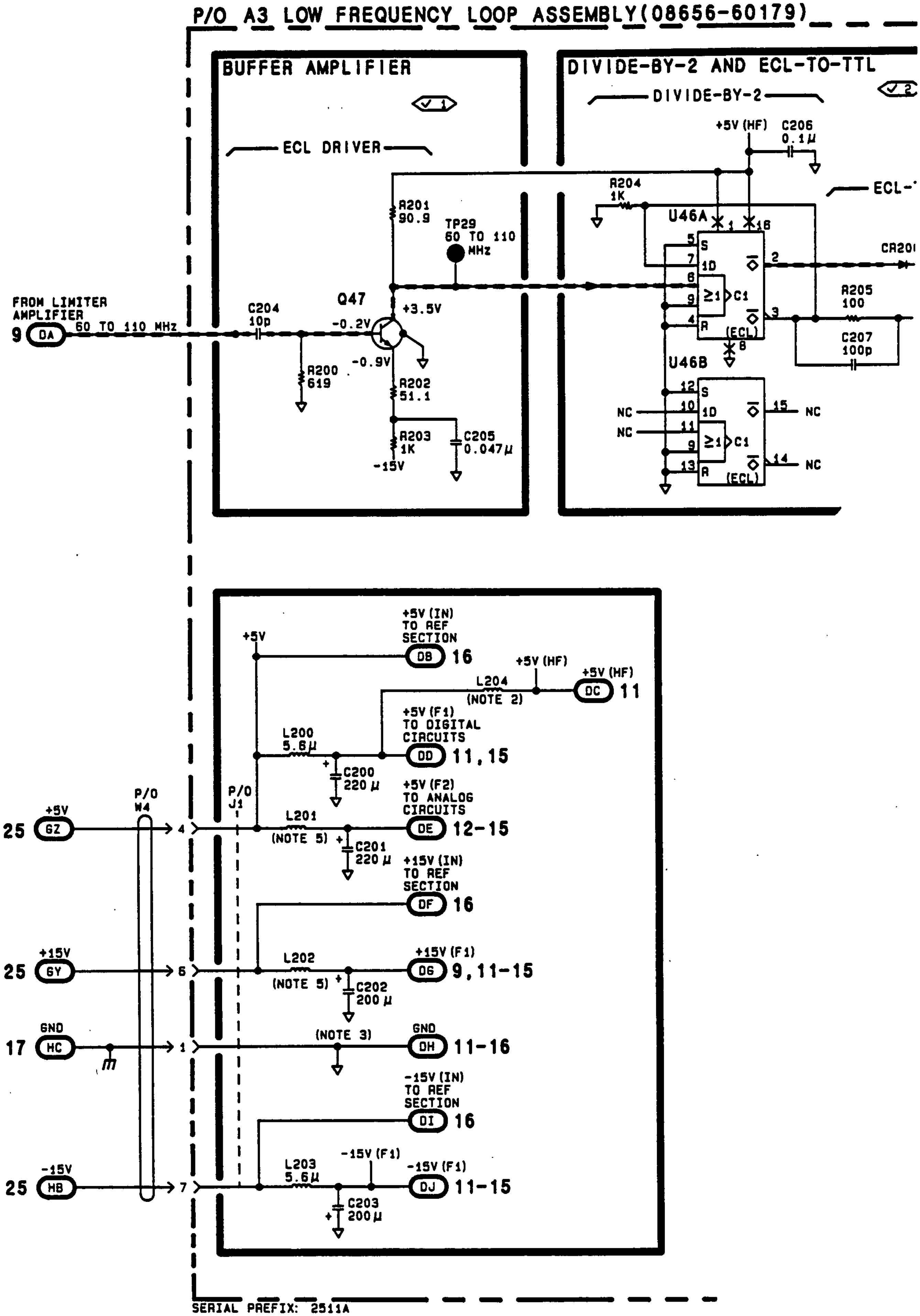
2511A and above

On the component locator:

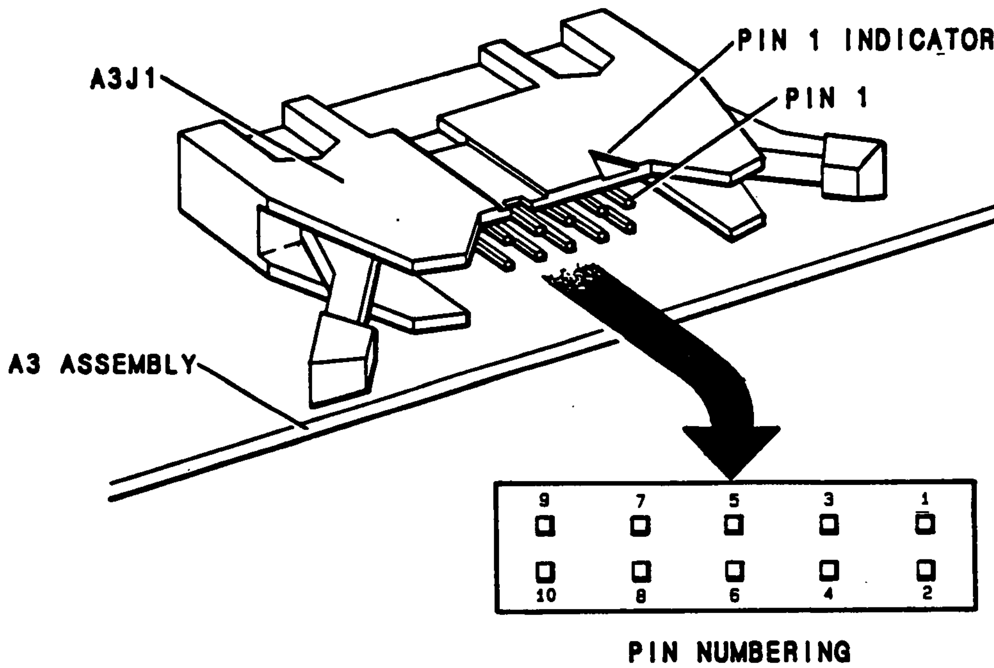
- A3C202 - Change the location of C202 found at coordinates 5,5 to below C200 and between R720 and C705.

On the schematic:

- W4 - Replace part of SS10 with the partial schematic found on page 8-825.3. On the partial schematic for W4, change pin 4 to pin 7, pin 6 to pin 2, and pin 7 to pin 4.
- A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179.
- P/O W4 - Change pin 4 to pin 7, pin 6 to pin 2 and pin 7 to pin 4.



P/O Figure 8-48 (2511A and above)

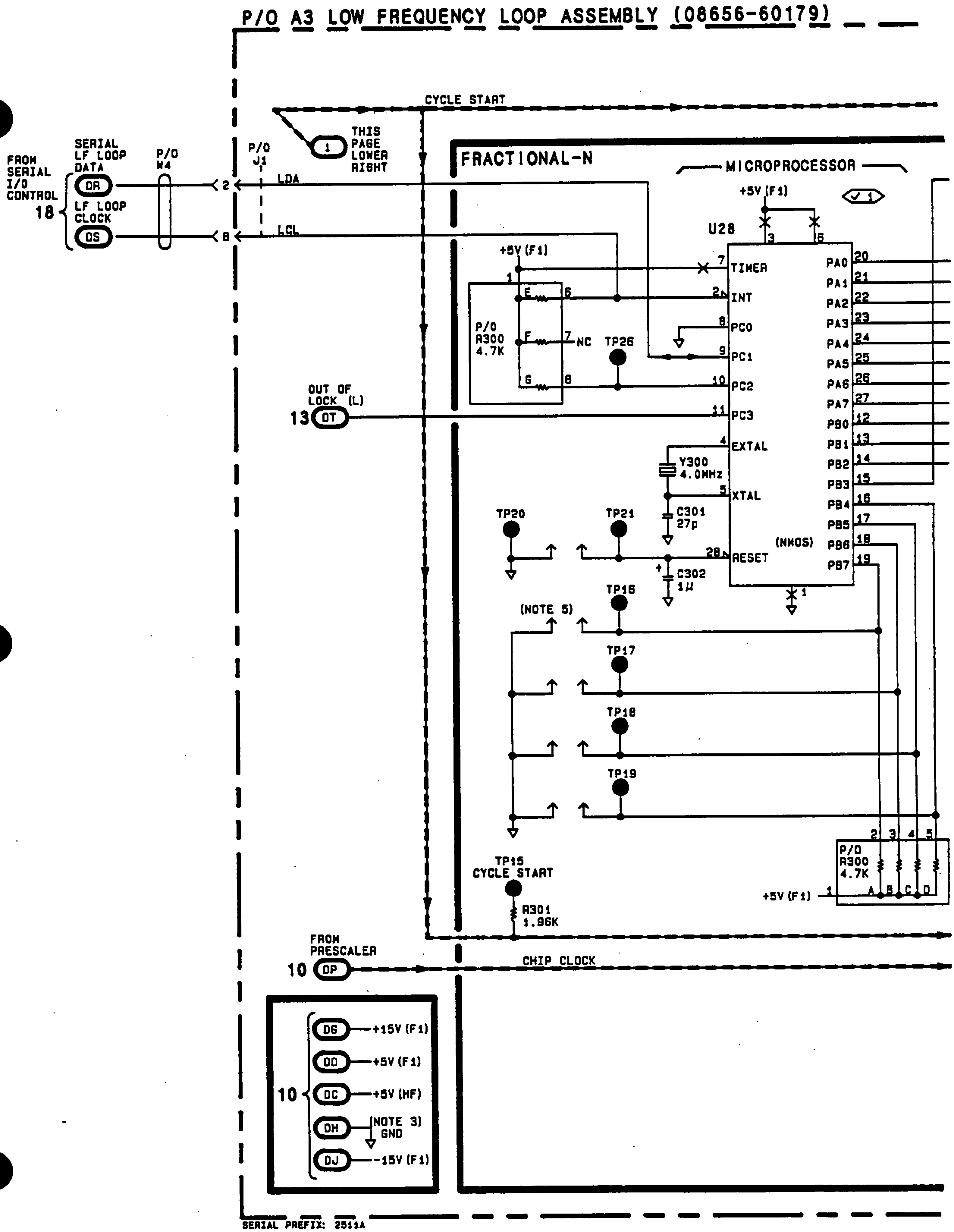


A3J1 (2511A and above).

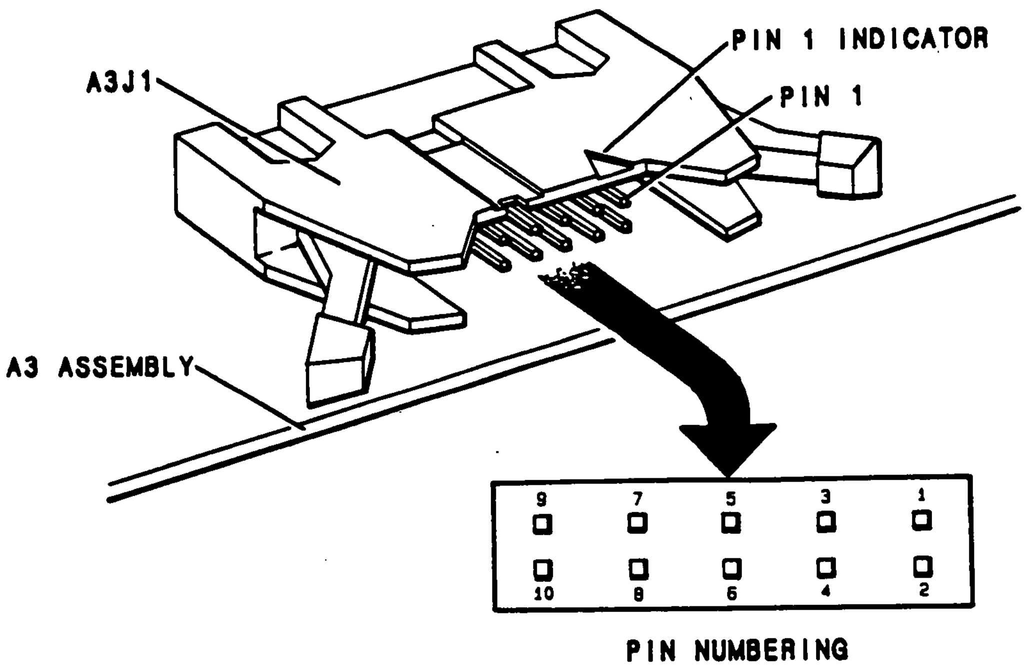
SS10

CHANGES

All Serial Prefixes	On the schematic: • A3U28 - Put pin 6 to ground. • A3U28 - Change the pin number locations and pin descriptions for pins 4 and 5 by switching pins 4 and 5. • W4 and W16 - Change the color code descriptions for P/O W4 and P/O W16. The LDA line color code should be 94, and the LCL line color code should be 96. • A3R303 - At the bottom of FRACTIONAL N-CONTROLLER, change R303 to R303* (star value).
2511A and above	On the schematic: • W4 - Replace part of SS11 with the partial schematic found on page 8-827.3. On the partial schematic for W4, change pin 2 to pin 3, and pin 8 to pin 6. • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179. • P/O W4 - Change pin 2 to pin 3 and pin 8 to pin 2.
2620A and above	On the schematic: • R303 - In the **FRACTIONAL-N**, at the bottom of the **Fractional-N Controller**, change the value of R303 to 3.16K.



P/O Figure 8-50 (2511A and above)



A3J1 (2511A and above).

SS11

CHANGES

2511A and above	On the schematic: • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179.

CHANGES

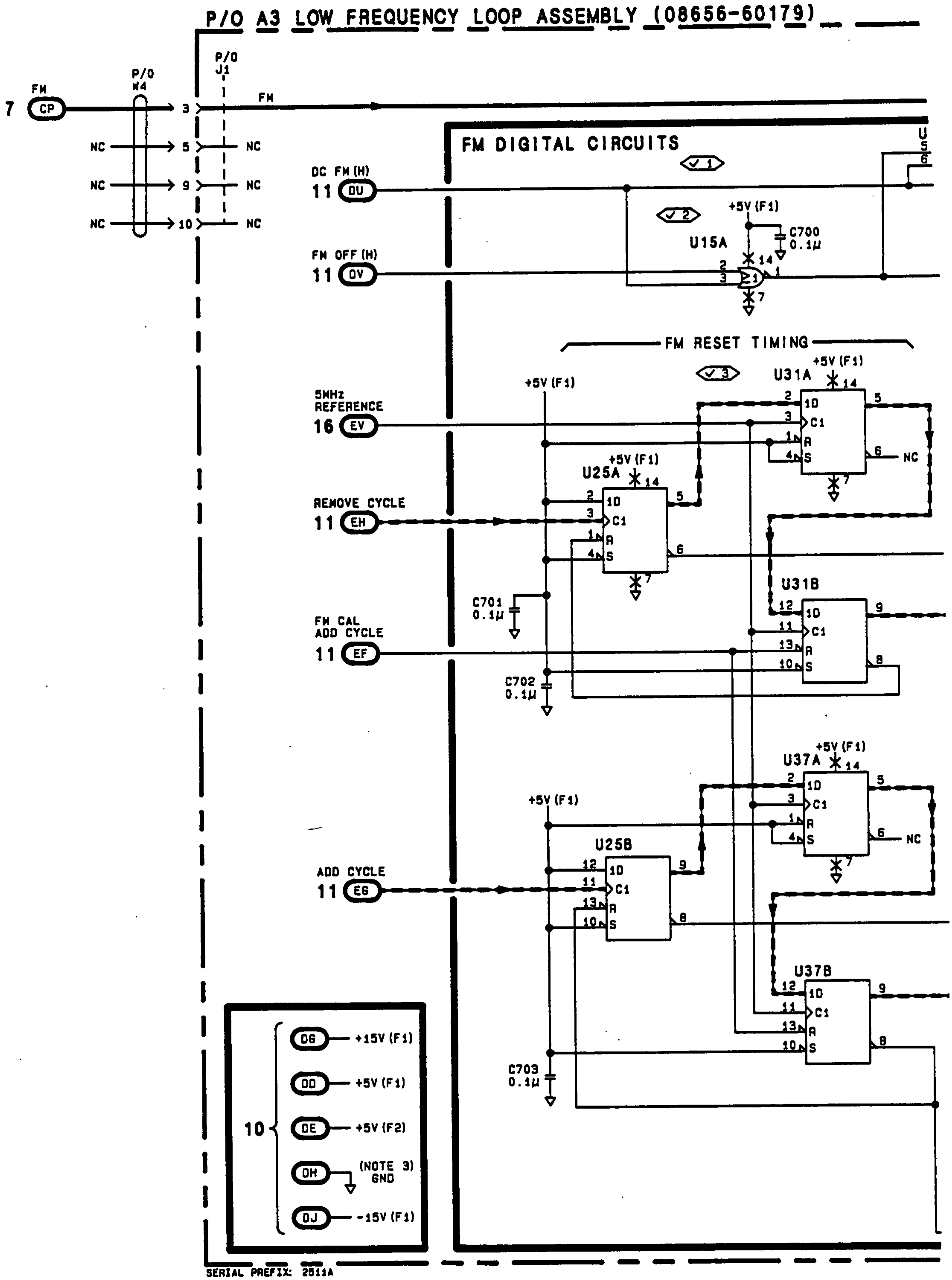
2511A and above	On the schematic: • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179.

CHANGES

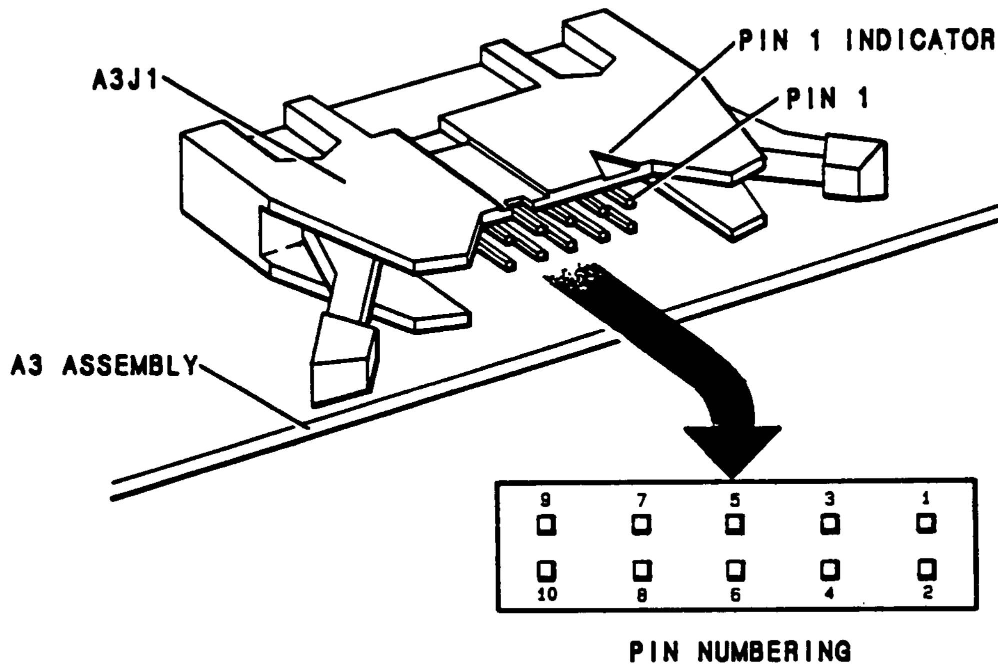
All Serial Prefixes	On the schematic: • Check 1 - Add hexagon troubleshooting check-mark 1 to the FM SUMMING section. • Check 2 - Add hexagon troubleshooting check-mark 2 to the D-A CONVERSION section. • Check 3 - Add hexagon troubleshooting check-mark 3 to the FM CALIBRATION section. • Check 4 - Add hexagon troubleshooting check-mark 4 to the OFFSET CURRENT section. • A3C618 - Change the "+" symbol to the other side of C618, the "+" side of C618 is connected to U27A pin 1.
2511A and above	On the schematic: • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179.

CHANGES

All Serial Prefixes	On the schematic: • A3U15A and A3U15B - In the FM DIGITAL CIRCUITS, change the connection of U15A pin 3 and U15B pin 6 to go to the DC FM (H) line. They are not connected to ground. • Check 7 - In the HIGH and the LOW THRESHOLD COMPARATOR, change the check-mark numbers from 7 to 6. • A3U5 - In the IN-BAND FM ANALOG's INTEGRATOR (FM TO ΦM CONVERTOR), add the "-" symbol to U5 pin 2 and add the "+" symbol to U5 pin 3.
2511A and above	On the schematic: • W4 - Replace part of SS15 with the partial schematic found on page 8-835.3. On the partial schematic for W4, change pin 3 to pin 5, pin 5 to pin 9, and pin 9 to pin 8. • A3R730 - On page 8-836, in the IN-BAND FM ANALOG block, under LOW THRESHOLD COMPARATOR: delete R730. Indicate that the junction of R731 and R733 goes to ground. • A3R731 - Change the value of R731 to 1.47k ohms. • A3 - Change the part number of the A3 Low Frequency Loop Assembly to 08656-60179. • P/O W4 - Change pin 3 to pin 5, pin 5 to pin 9 and pin 9 to pin 8.
2626A and above	On the schematic: • A3R723, A3R725 - In the upper left portion of the IN-BAND FM ANALOG, change the values of R723 to 20k and R725 to 46.4k.



P/O Figure 8-58 (2511A and above)

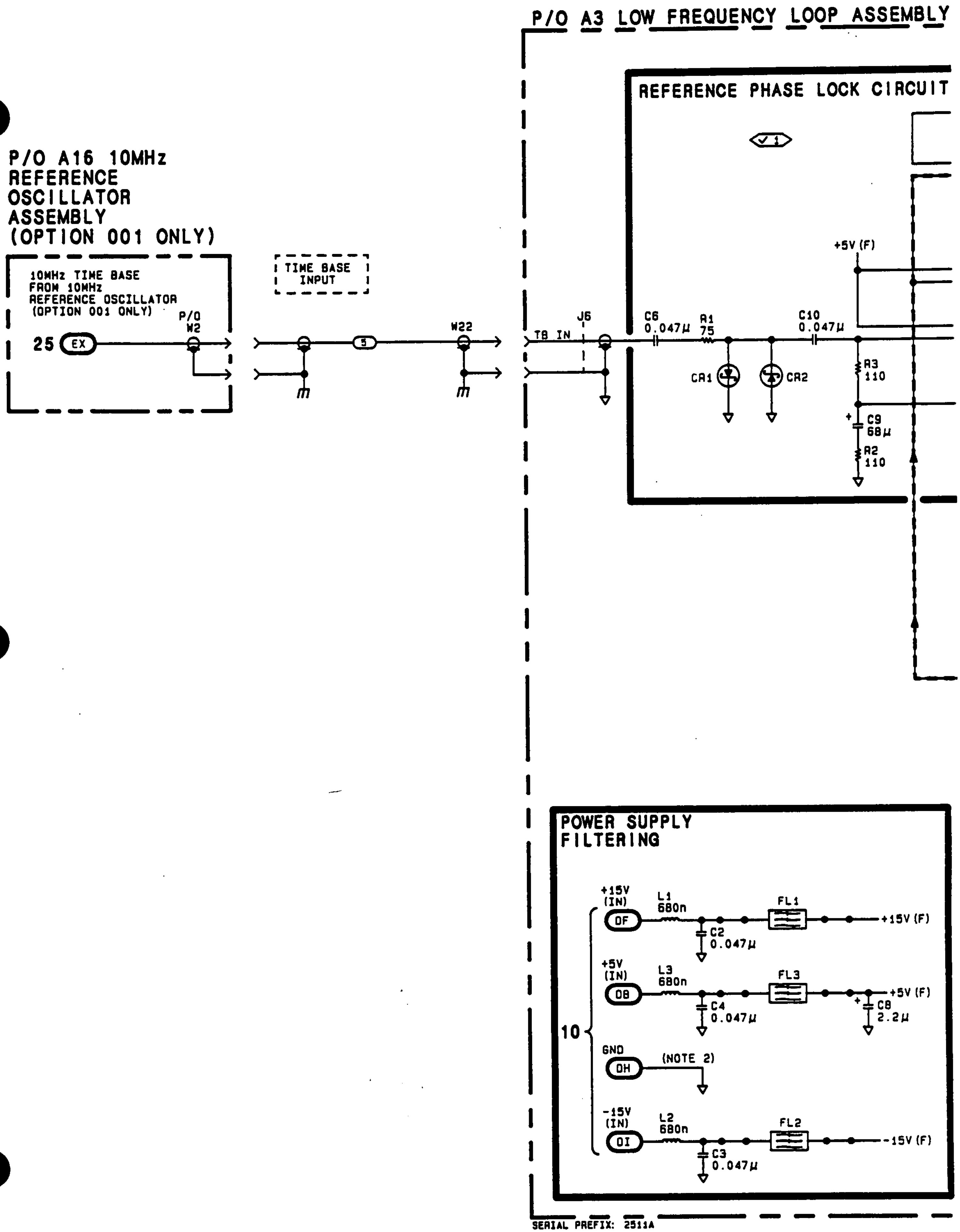


A3J1 (2511A and above).

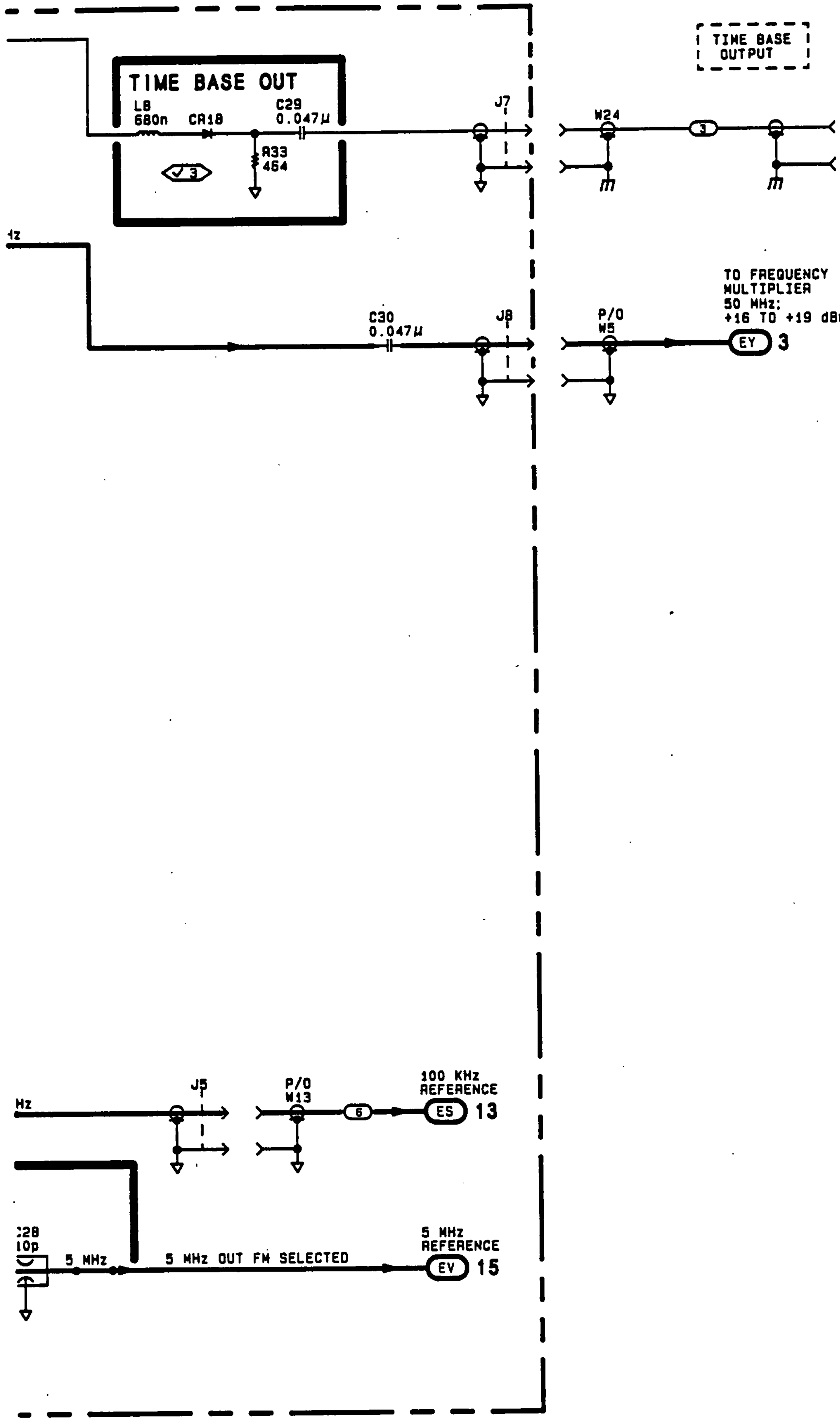
SS15

CHANGES

Serial Prefix	Change
All Serial Prefixes	On the schematic: • L6 - In the **50 MHz REFERENCE OSCILLATOR**, change the value of L6 to 470 NH.
2511A and above	On the schematic: • W22, and W24 - Replace parts of SS16 with the partial schematics found on pages 8-837.3 and 8-837.5. • A3 - Change the part number of the A3 Low Frequency Assembly to 08656-60179.
2549A and above	On the component locator: • A3CR13, A3CR14, and A3L4 - Delete CR13, CR14, and L4 located at coordinates 5,2. On all 08656-60179 assemblies, the components are replaced with wire jumpers. On the schematic: • A3CR13, A3CR14, and A3L4 - In the **50 MHz REFERENCE OSCILLATOR**, delete CR13, CR14, and L4. They are replaced on the 08656-60179 assembly with wire jumpers. Indicate on the schematic that R25 is now connected to the junction of Y1 and the emitter of Q50. • A3Q50 - In the **50 MHz REFERENCE OSCILLATOR**, change the collector bias voltage to +13V, and change the emitter bias voltage to -0.1V. • A3R26 - In the **50 MHz REFERENCE OSCILLATOR**, change the value of R26 to 1K ohms.



P/O Figure 8-60 (2511A and above)



P/O Figure 8-60 (2511A and above)

CHANGES

2511A and above

On the component locator:

- A11C1 - Change the location of C1 found at coordinates 5,1 by pivoting the "+" side of C1 to the right of J5.

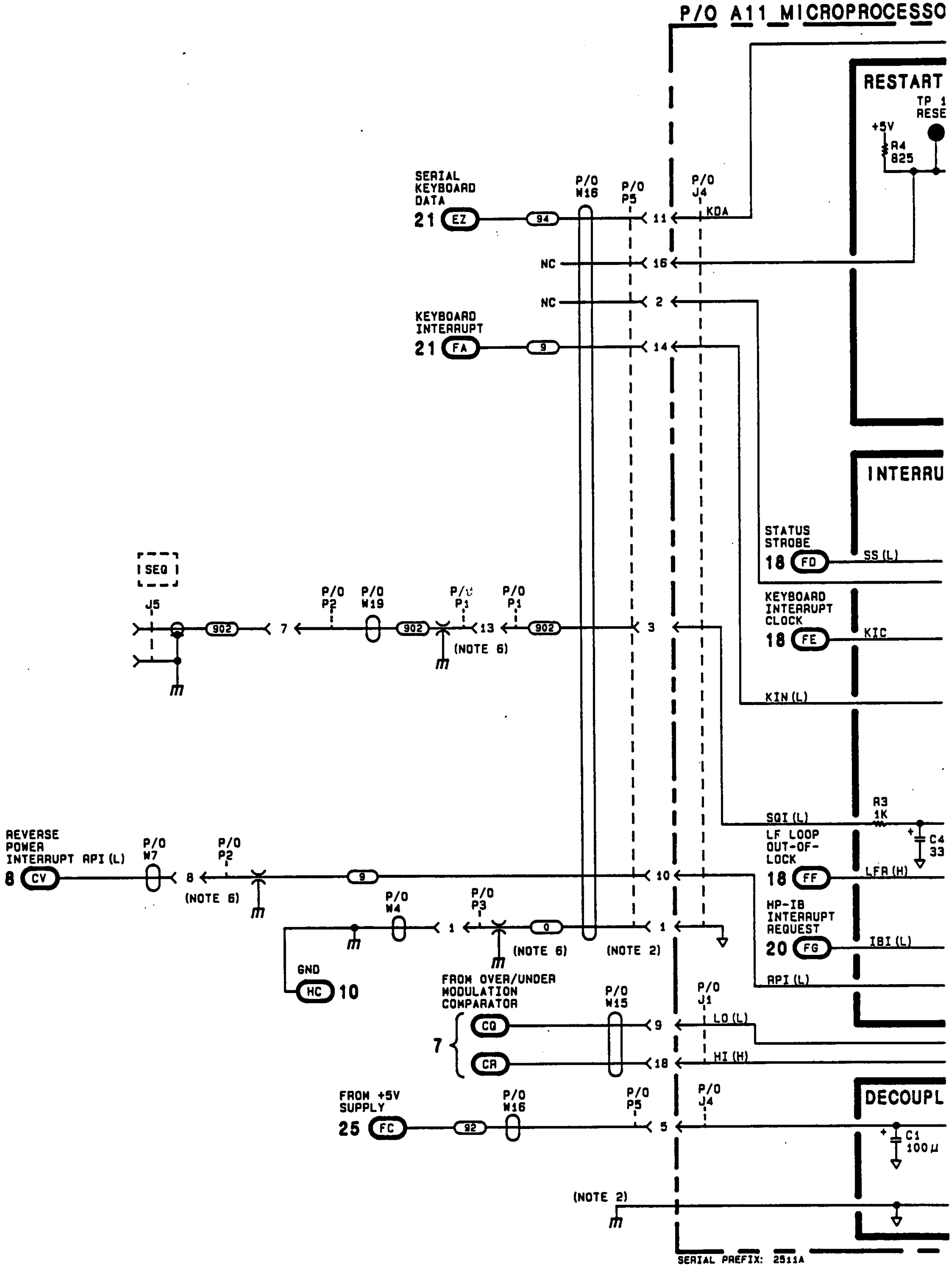
In Schematic General Information:

- NOTES - Add the following note:

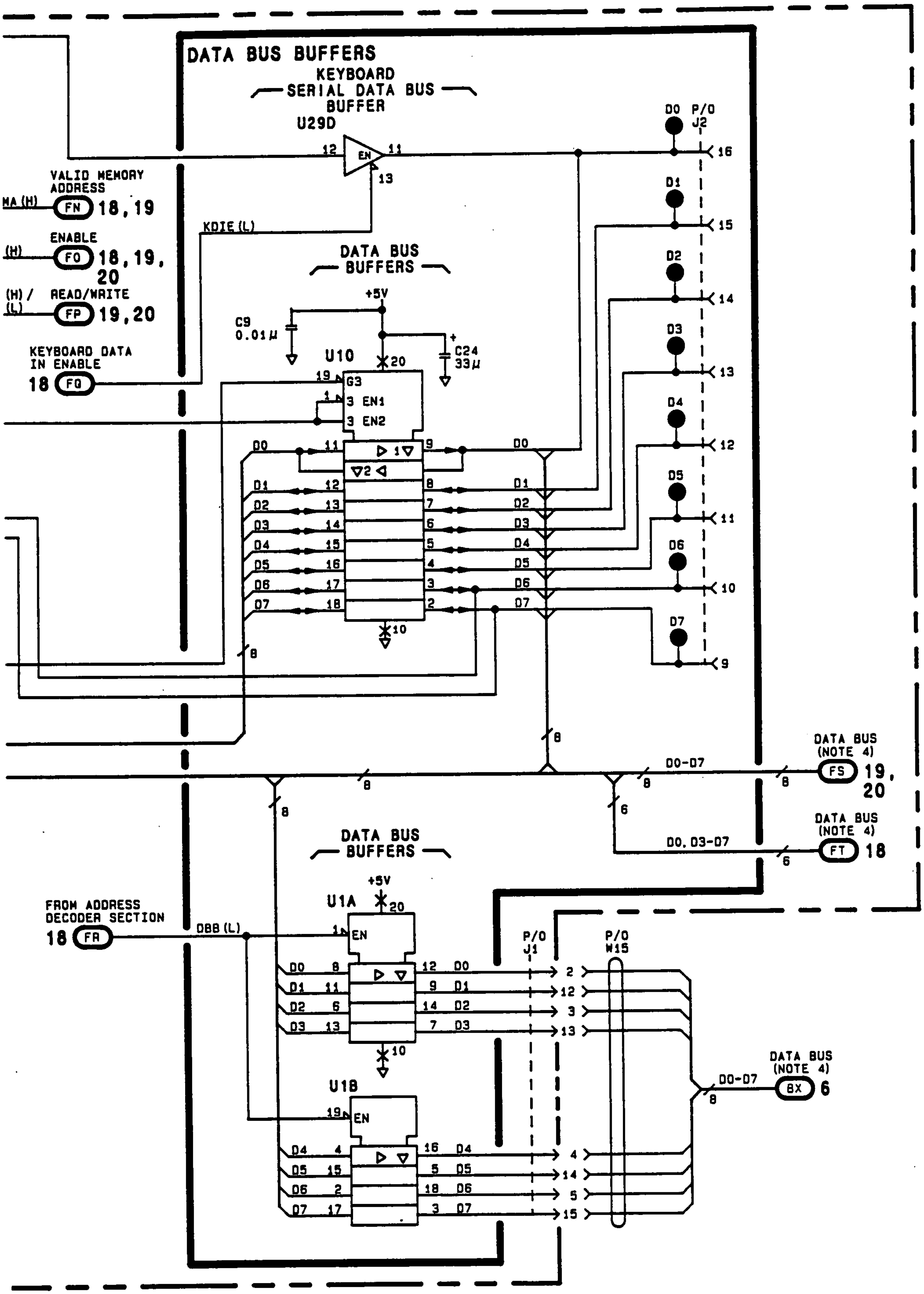
  6. FEEDTHRU CAPACITOR IS PART OF W16P2, W16P3 OR W19P1 AND IS NOT SEPARATELY REPLACEABLE.

On the schematic:

- W4, W7, W15, W16, and W19 - Replace parts of SS17 with the partial schematics found on pages 8-839.3 and 8-839.5. On the partial schematics for W15, change pin 9 to pin 17, pin 18 to pin 16, pin 2 to pin 3, pin 12 to pin 4, pin 3 to pin 5, pin 13 to pin 6, pin 4 to pin 7, pin 14 to pin 8, pin 5 to pin 9, and pin 15 to pin 10.
- A11 - Change the part number of the A11 Microprocessor/Memory/HP-IB Assembly to 08656-60177.



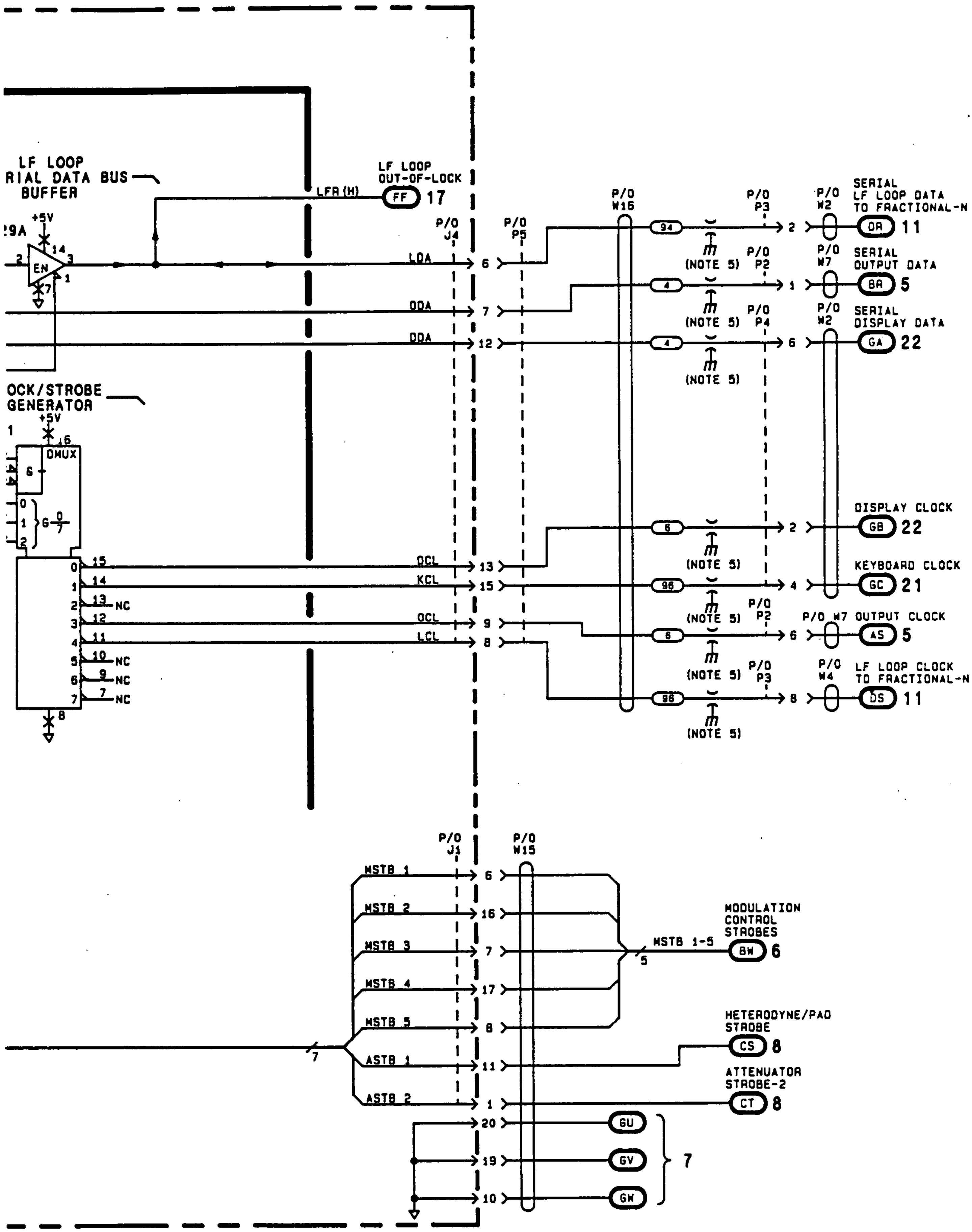
P/O Figure 8-62 (2511A and above)



P/O Figure 8-62 (2511A and above)

CHANGES

2511A and above	In Schematic General Information: • NOTES - Add the following note: 5. FEEDTHRU CAPACITOR IS PART OF W16P2, W16P3 OR W16P4 AND IS NOT SEPARATELY REPLACEABLE. On the schematic: • W2, W4, W7, W15, and W16 - Replace part of SS18 with the partial schematic found on page 8-841.3. On the partial schematic for W15, change pin 6 to pin 11, pin 16 to pin 12, pin 7 to pin 13, pin 17 to pin 14, pin 8 to pin 15, pin 11 to pin 2, pin 19 to pin 18, and pin 10 to pin 19. • A11 - Change the part number of the A11 Microprocessor/Memory/HP-IB Assembly to 08656-60177.



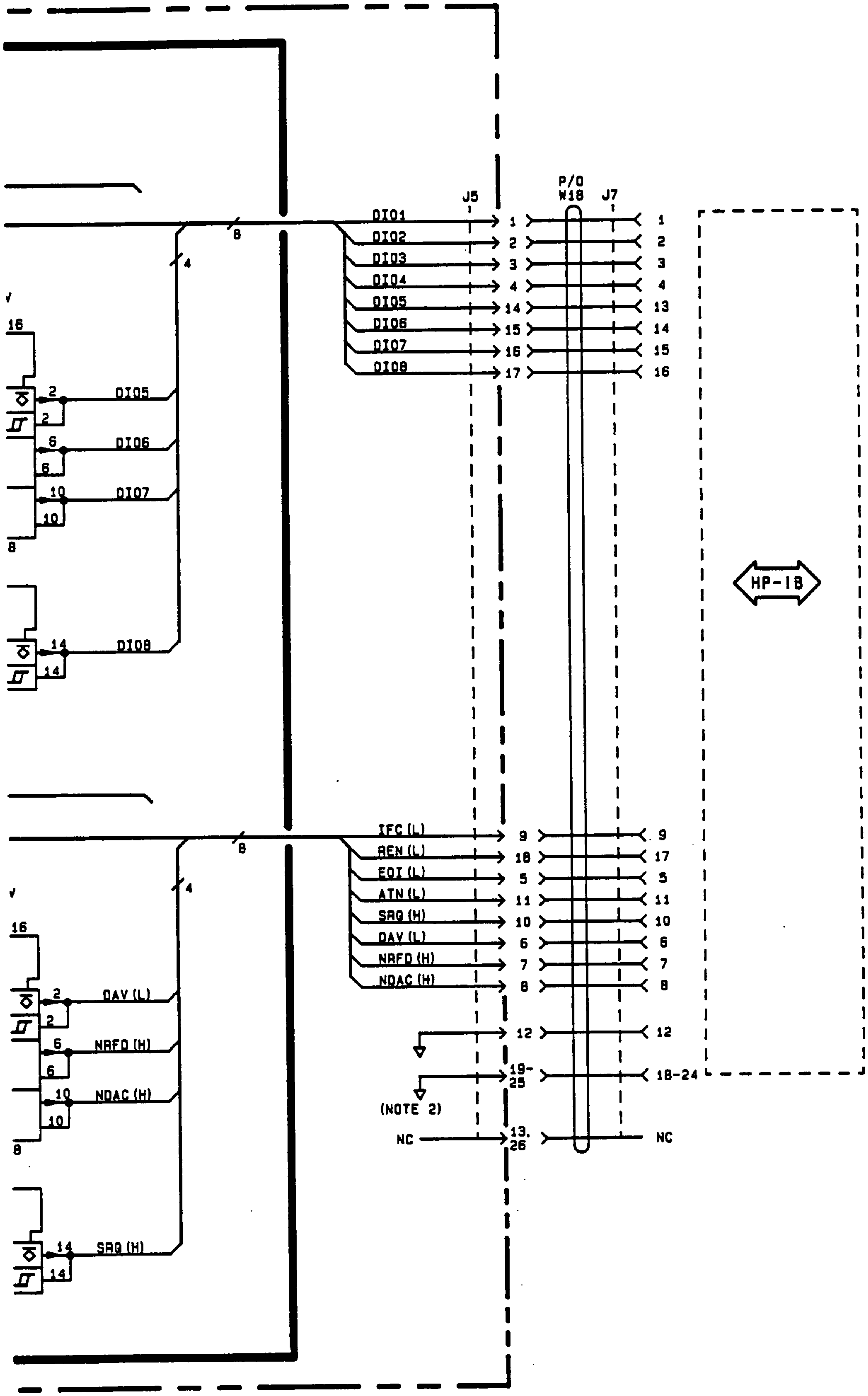
P/O Figure 8-64 (2511A and above)

CHANGES

2511A and above	On the schematic: • <u>A11</u> - Change the part number of the A11 Microprocessor/ Memory/HP-IB Assembly to 08656-60177.

CHANGES

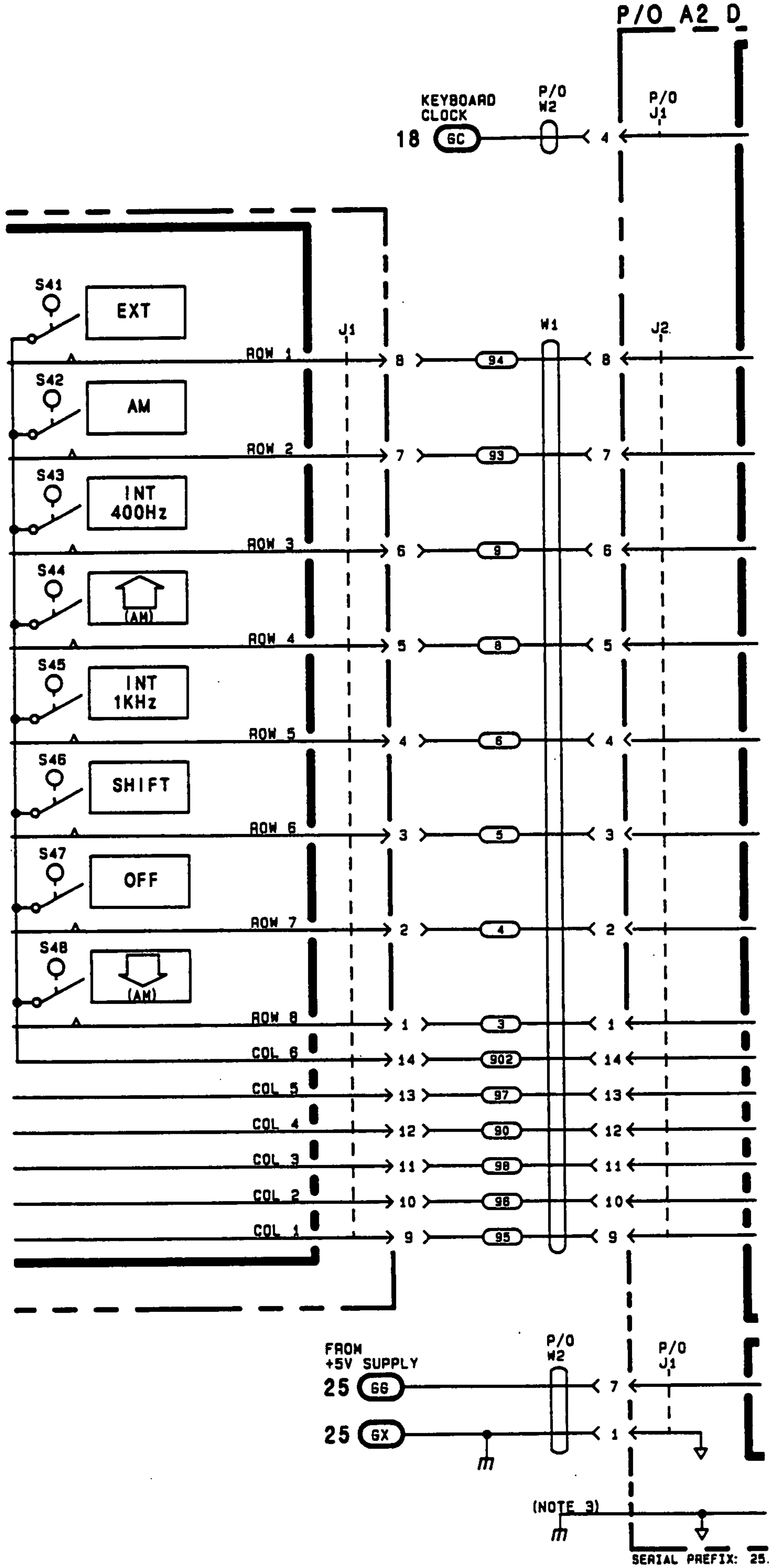
Serial Prefixes	Changes
All Serial Prefixes	On the schematic: • In the lower left corner of the schematic, add +5V after the "FI" bullet. • <u>U20A&B, U24A&B, U25A&B, U28A&B</u> - At pins 4 and 12 add the active low indicator symbol.
2511A and above	On the schematic: • <u>W18</u> - Replace part of SS20 with the partial schematic found of page 8-845.3. On the partial schematic for W18 (on connector J5), change pin 2 to pin 3, pin 3 to pin 5, pin 4 to pin 7, pin 14 to pin 2, pin 15 to pin 4, pin 16 to pin 6, pin 17 to pin 8, pin 9 to pin 17, pin 18 to 10, pin 5 to pin 9, pin 11 to pin 21, pin 10 to pin 19, pin 6 to pin 11, pin 7 to pin 13, pin 8 to pin 15, pin 12 to pin 23, pins 19-25 to pins 12, 14, 16, 18, 20, 22, 24, and pins 13, 26 to pins 25, 26. • <u>A11</u> - Change the part number of the A11 Microprocessor/Memory/HP-IB Assembly to 08656-60177.



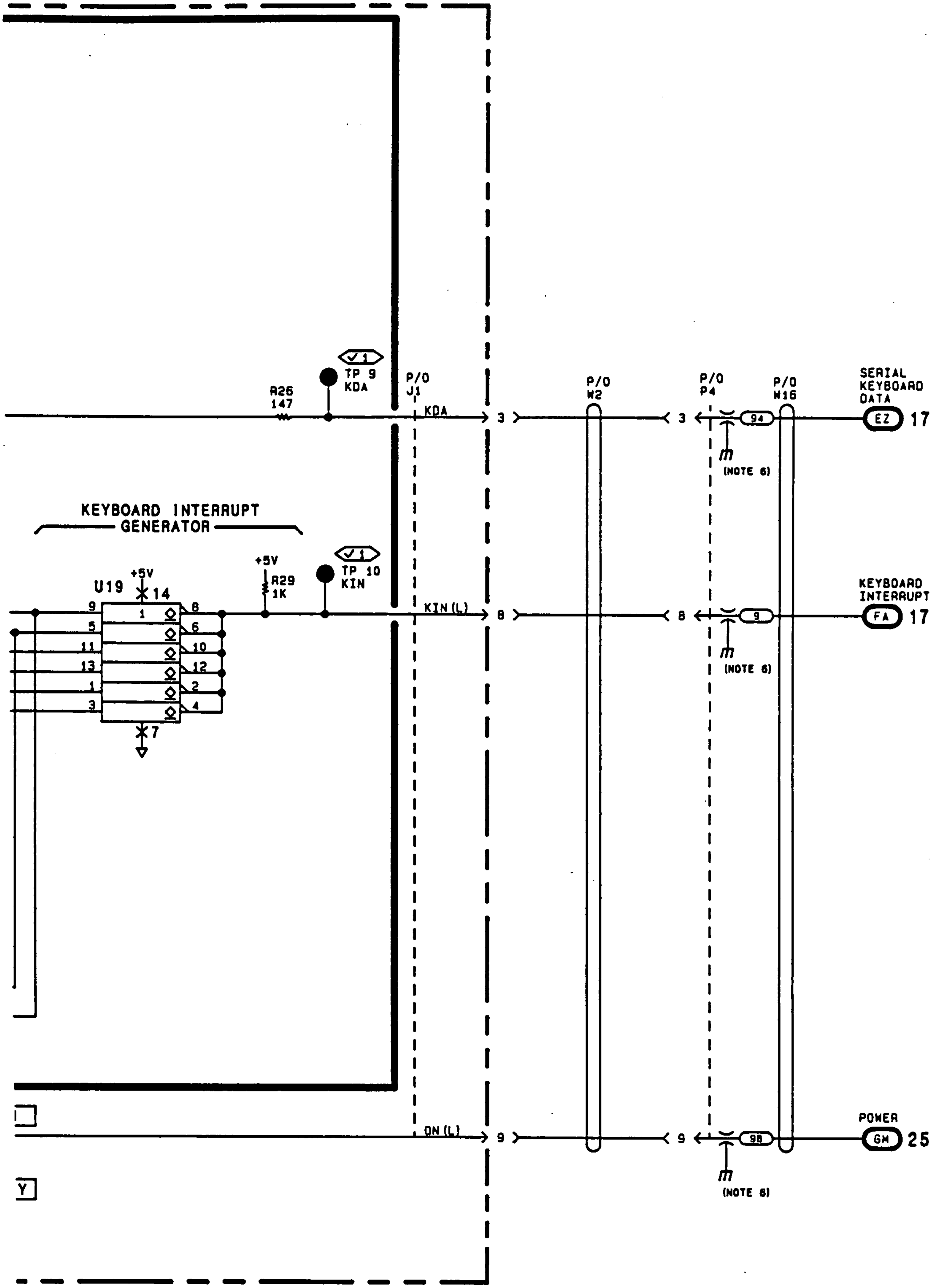
P/O Figure 8-68 (2511A and above)

CHANGES

All Serial Prefixes	In Schematic General Information: • <u>NOTES</u> - Add the following notes: 4) ALL FUNCTIONS ARE ACTIVATED BY FIRST PRESSING THE BLUE "SHIFT" KEY. 5) PRESSING "SHIFT" AND THEN "INCR SET" ACTIVATES THE KEYBOARD INVOKED TESTS. THESE TESTS ARE REFERRED TO IN TROUBLESHOOTING PROCEDURES. On the schematic: • <u>A1</u> - On the Keyboard Assembly, change "DIAGNOSTICS" to read "AMPLITUDE OFFSET" and change "(NOTE 5)" to read "(NOTE 4)" on the "AMPTD" key. Add "(NOTE 5)" under the "INCR SET" key.
2511A and above	In Schematic General Information: • <u>NOTES</u> - Add the following note: 6. FEEDTHRU CAPACITOR IS PART OF W19P1 OR W16P4 AND IS NOT SEPARATELY REPLACEABLE. On the schematic: • <u>W2, and W16</u> - Replace parts of SS21 with the partial schematics found on pages 8-847.3 and 8-847.5. On the partial schematics for W2, change pin 4 to pin 7, pin 7 to pin 4, pin 3 to pin 5, pin 8 to pin 6, and pin 9 to pin 8. • <u>A2</u> - Change the part number of the A2 Display Assembly to 08656-60176.



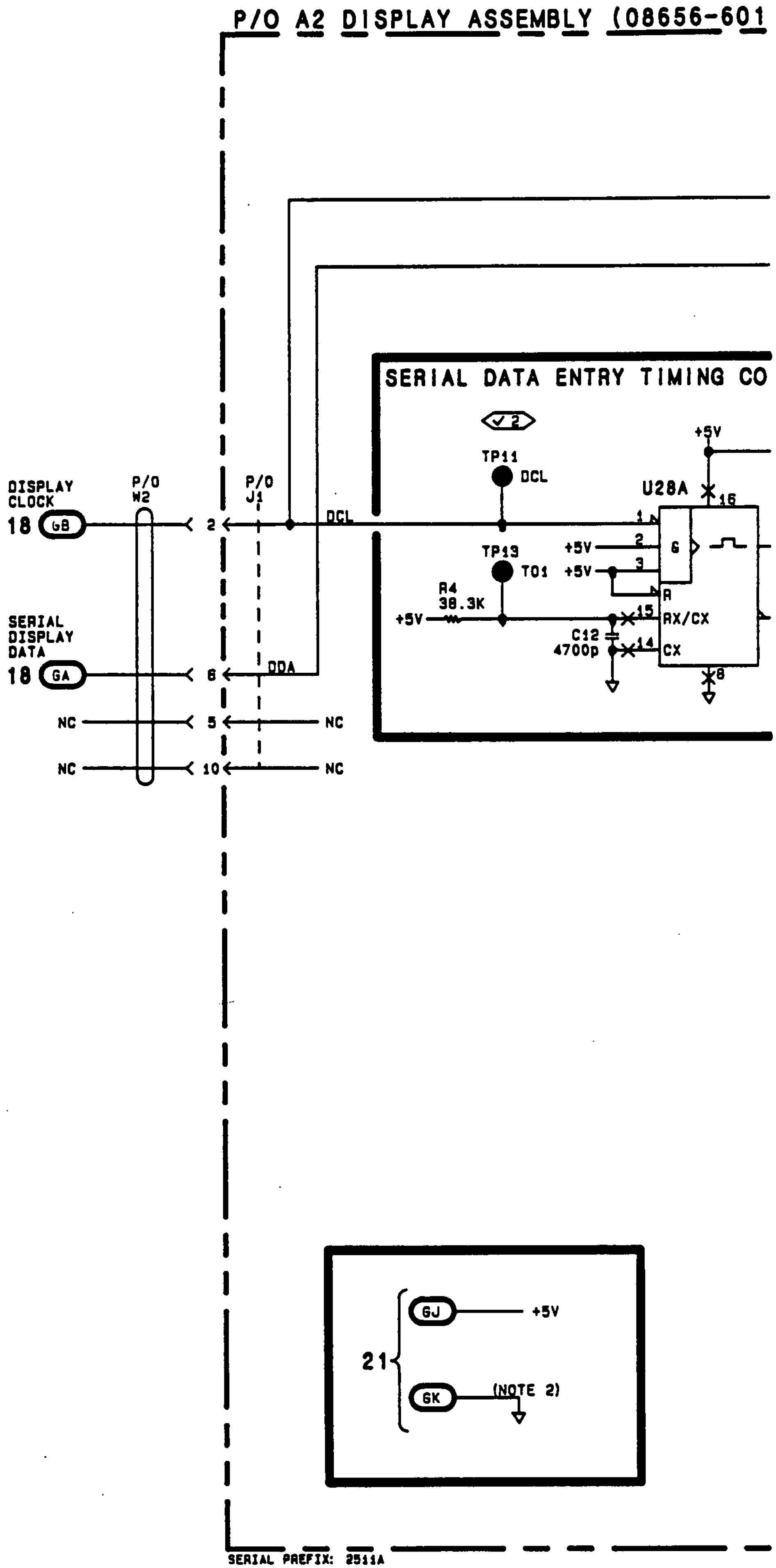
P/O Figure 8-70 (2511A and above)



P/O Figure 8-70 (2511A and above)

CHANGES

2511A and above	On the schematic: • W2 - Replace part of SS22 with the partial schematic found on page 8-849.3. On the partial schematic for W2, change pin 2 to pin 3, pin 6 to pin 2, and pin 5 to pin 9. • A2 - Change the part number of the A2 Display Assembly to 08656-60176.



P/O Figure 8-72 (2511A and above)

CHANGES

2511A and above	On the schematic: • A2 - Change the part number of the A2 Display Assembly to 08656-60176.

CHANGES

All Serial Prefixes

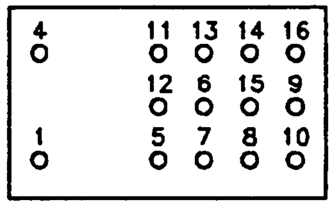
On the component locator:

- A10C43 - Add A10C43 directly below A10U4.
- A10C43 - Add C43 to the A10 Component Coordinates table at 4,3.

In Schematic General Information:

- A10K1 - Change the drawing of the Bottom View of A10K1 to:

BOTTOM VIEW A10K1



On the schematic:

- Under A15 Line Power Module, locate P/O W19. Change color code of the wire connected to pin 2 of U4 from 6 to 8.

2425A to 2509A

On the component locator:

- A12U1-U4 - On A12 (CIRCUIT SIDE) from left to right, add the reference designators U1, U2, U3 and U4.
- A12U1 - On A12U1, delete "MP2 (4 PLACES)".
- A12U2 - On A12U2, add "MP125 (3 PLACES; U2, U3 AND U4)"
- A12MP2 - In the Component Coordinates table for A12, change MP2 to MP125.
- A12U1-U4 - Add the following to the Component Coordinates table for A12:

U1	6,1
U2	6,1
U3	7,1
U4	7,1

CHANGES

2511A and above

On the component locator:

- A12, and A14 - Delete both A12 and A14 assemblies.

In Schematic General Information:

- NOTES - Add the following notes:

  9. FEEDTHRU CAPACITOR IS PART OF W16P2 OR W19P1 AND IS NOT SEPARATELY REPLACEABLE.
  10. GROUND IS ACHIEVED BY MECHANICAL CONTACT THROUGH SCREW (MP11) AND GROUND LUG (W19MP1) FASTENED TO THE CHASSIS.
  11. GROUND IS ACHIEVED BY MECHANICAL CONTACT THROUGH SCREW MP131 AND CONNECTOR W19P1.
  12. GROUND IS ACHEIVED BY MECHANICAL CONTACT THROUGH SCREW MP131 AND CONNECTOR W19P2.

On the schematic:

- Figure 8-78 - Replace all of SS25 with the schematic found on page 8-855.3. In SS25 on page 8-855.3 change the part number of the A10 assembly from 08656-60128 to 08656-60178. On page 8-855.5, change the color coding of the wire that goes to U4 pin 2; the color of this wire on W19 should be grey (8) not blue (6).

- Figure 8-78 - In SS25 on page 8-855.3, move F1 in the A15 Line Power Module to the right of the Line Filter (keeping F1 on the L line).

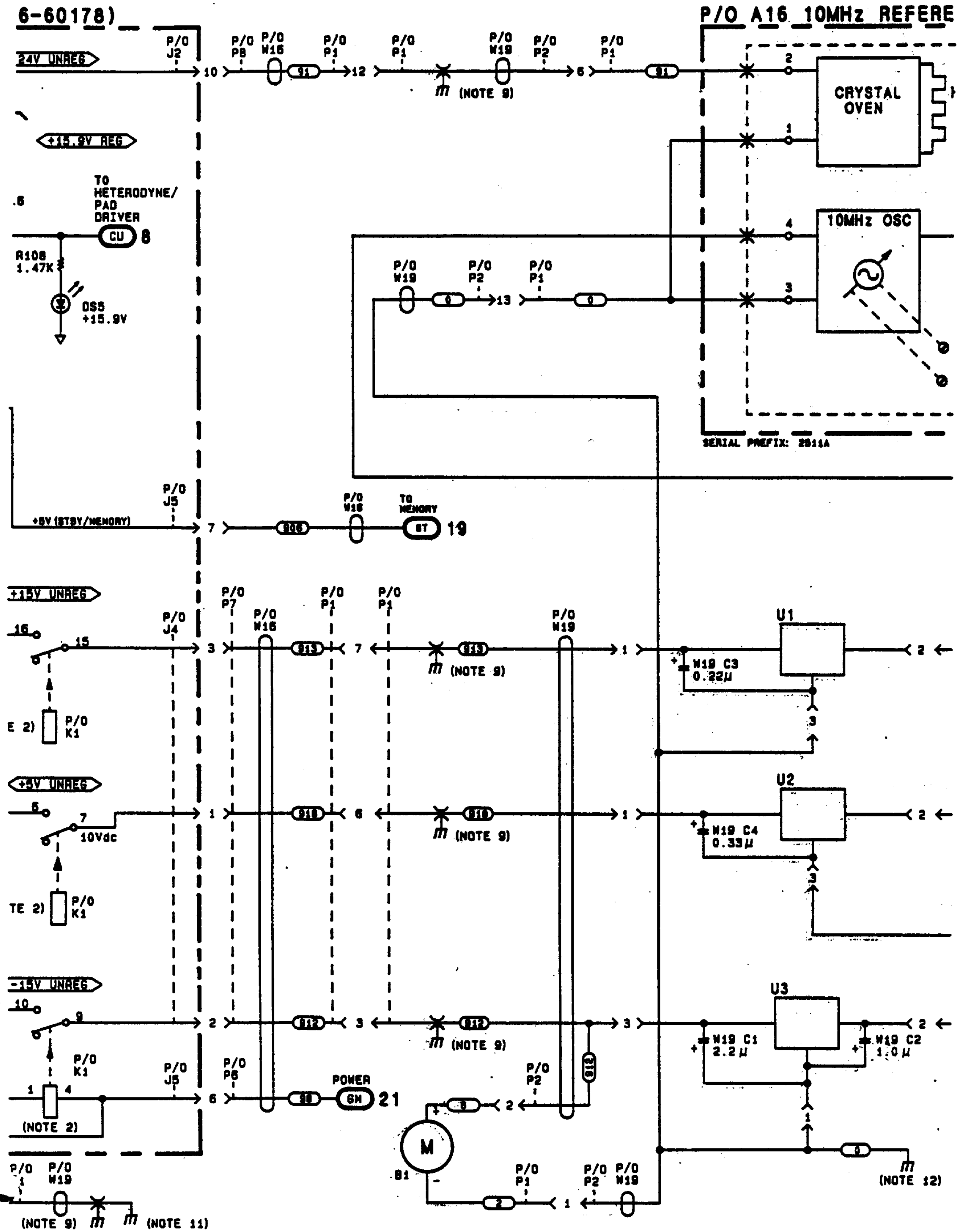
- T1 - Delete the earth ground symbols at the center-tapped secondary side of the transformer T1. On the lower secondary side of T1, add "8 VAC (NOTE 8)".

- Figure 8-78 - Replace part of SS25 on page 8-855.3 with the partial schematic found on page 8-855.5.

2612A and above

On the schematic:

- W19C4 - Change the value of W19C4 to 1 UF, delete the connection from W19C4 to U2 pin 3 and add connection to chassis ground. Add W19C5, value 10 UF, from U2 pin 2 to chassis ground.


6-60178)
P/O A16 10MHz REFERE
24V UNREG
+15.9V REG
TO HETERODYNE/ PAD DRIVER
R108 1.47K
DS5 +15.9V
CRYSTAL OVEN
10MHz OSC
SERIAL PREFIX: 2511A
+5V (STBY/MEMORY)
TO MEMORY
+15V UNREG
+5V UNREG
-15V UNREG
10Vdc
U1
U2
U3
W19 C3 0.22μ
W19 C4 0.33μ
W19 C1 2.2μ
W19 C2 1.0μ
(NOTE 9)
(NOTE 2)
(NOTE 11)
(NOTE 12)
POWER
B1