INSTRUCTION MANUAL
MODEL 1120 THERMOCOUPLE SIMULATOR/CALIBRATOR

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1120 MANUAL
ERRATA

1. Page 2-2: in Paragraph 2.1.6, change the temperature coefficient to read as follows:

   ± 0.001% of setting/°C ± 0.2μV/°C ± 0.0008°C/°C. 5/14/90

2. Page 2-2: in Paragraph 2.2.5, change the temperature coefficient to read as follows:

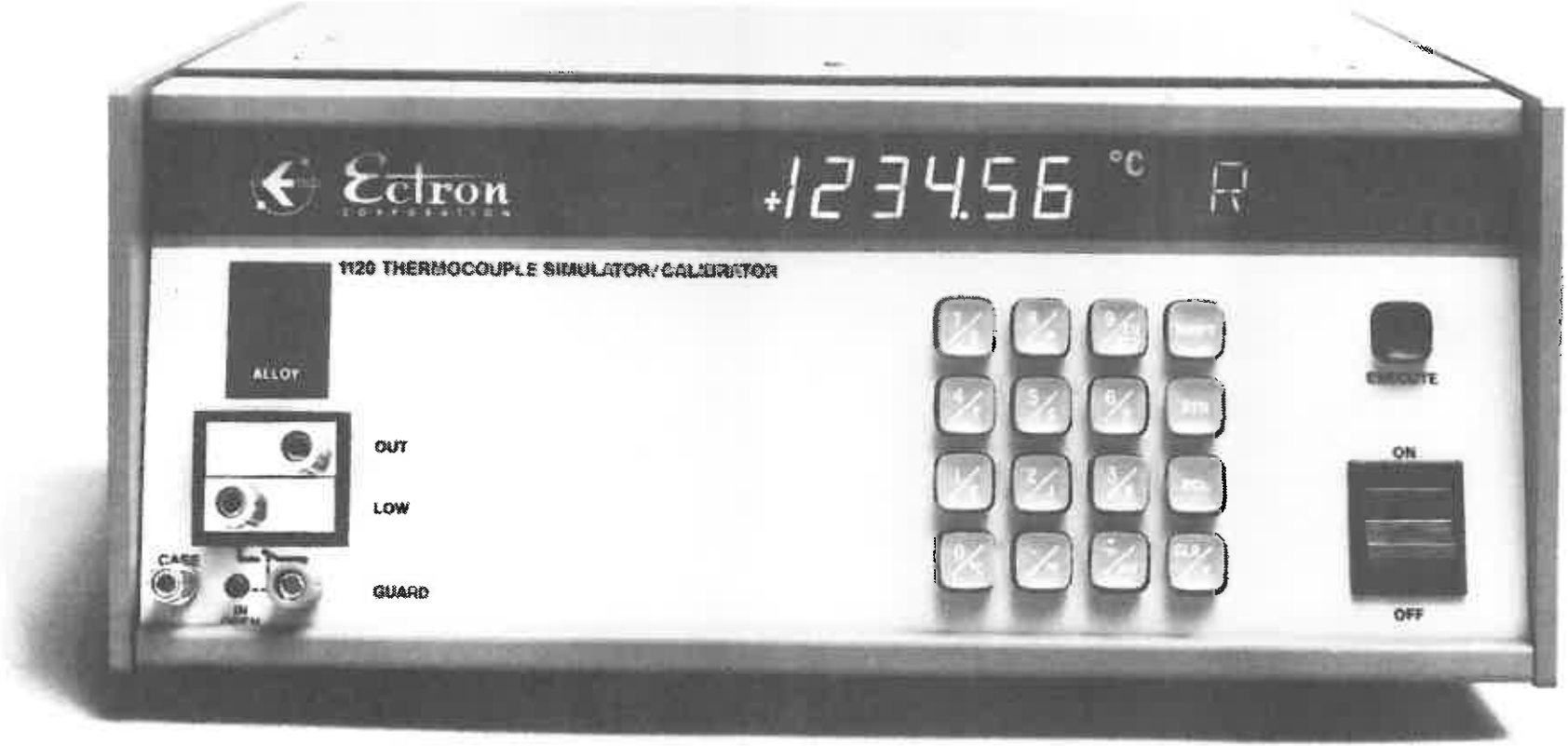
   ± 0.001% of setting/°C ± 0.2μV/°C. 5/14/90

3. Page 7-3: in Paragraph 7.1.3.2.36, change the divider setting from 000490 to 000409. 11/3/89

4. Page 7-4: in Paragraph 7.1.3.2.45, change the paragraph referenced from 7.1.3.13 to 7.1.4.13. 11/3/89

MODEL 1120

TYPICAL OPERATION



MODEL 1120

ALL DISPLAYS ILLUMINATED

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112-613	RS-232-C INTERFACE ASSEMBLY
112-615	POWER SUPPLY ASSEMBLY

MANUAL ABBREVIATIONS

μF	MICROFARAD
μV	MICROVOLT
Ω	OHMS
A	AMPERES
A-TO-D	ANALOG TO DIGITAL
A0-A15	ADDRESS BUS
AD0-AD9	MULTIPLEXED ADDRESS/DATA BUS
ADC	ANALOG TO DIGITAL CONVERTER
ALE	ADDRESS LATCH ENABLE
ALY	ALLOY
BIF	BIFURCATED
BLKTMP	BLOCK TEMPERATURE (FRONT PANEL TERMINALS)
BT	BATTERY
C	CAPACITOR
CE	CHIP ENABLE
CER	CERAMIC
CFLM	CARBON FILM
CLK	CLOCK TO U201, 216 AND REMOTE ASSEMBLY
CLR	CLEAR
CM	CENTIMETER
CMOS	COMPLEMENTARY METAL OXIDE SUBSTRATE
CMP	COMPOSITION
CR	CARRIAGE RETURN
CR	DIODE
CU	COPPER
DAC	DIGITAL TO ANALOG CONVERTER
DB	DECIBEL
DC	DIRECT CURRENT
DCE	DATA COMMUNICATIONS EQUIPMENT
DIA	DIAGNOSTIC
DIP	DUAL IN-LINE PACKAGE
DL0-DL3	DISPLAY LINES
DMM	DIGITAL MULTIMETER
DP	DECIMAL POINT
DS	DISPLAY
DTE	DATA TERMINAL EQUIPMENT
ELEC	ELECTROLYTIC
EMF	ELECTROMOTIVE FORCE (VOLTAGE)
EPROM	ERASABLE PROGRAMMABLE READ ONLY MEMORY
ERR	ERROR
Fe	IRON
FET	FIELD EFFECT TRANSISTOR
FS	FULL SCALE
GPIB	GENERAL PURPOSE INTERFACE BUS
HZ	HERTZ
IC	INTEGRATED CIRCUIT
IEEE	INSTITUE OF ELECTRICAL AND ELECTRONIC ENGINEERS
IO/M	INPUT/OUTPUT MEMORY
IO0-IO7	DECODED INPUT/OUTPUT LINES
J	CONNECTOR JACK
KG	KILOGRAM
LBS	POUNDS

MANUAL ABBREVIATIONS (Continued)

LED	LIGHT EMITTING DIODE
LOPRO	LOW PROFILE
LRC	LONGITUDINAL REDUNDANCY CHECK
LSB	LEAST SIGNIFICANT BIT
LSD	LEAST SIGNIFICANT DIGIT
MA	MILLIAMPERE
MFLM	METAL FILM
MHZ	MEGAHERTZ
MM	MILLIMETER
MMYL	METALLIZED MYLAR
MOS	METAL OXIDE SUBSTRATE
MPESTR	METALLIZED POLYESTER
MSB	MOST SIGNIFICANT BIT
MSD	MOST SIGNIFICANT DIGIT
MSD	MOST SIGNIFICANT DIGIT
MV	MILLIVOLTS
M°C	MILLIDEGREES CELSIUS
NA	NANOAMPERE
NBS	NATIONAL BUREAU OF STANDARDS
OA0-OA3	LINES TO DISPLAY CATHODES
OB0-OB3	SAME AS OA0-OA3
OPTCLK	CHOPPER DRIVE (1.2KHZ) TO ANALOG ASSEMBLY
OUOL	OUTPUTOVERLOAD
OUTOL	SAME AS OUOL
PE0-5	ROM ENABLE LINES
PIRQ	PRIORITY INTERRUPT REQUEST
POL	POLARITY
PPE	PARALLEL POLL ENABLE
PPEN	DECODED ADDRESS LINE FOR REMOTE
PPM	PARTS PER MILLION
PROM	PROGRAMMALBE READ ONLY MEMORY
PSAGND	POWER SUPPLY ANALOG GROUND
PSDGND	POWER SUPPLY DIGITAL GROUND
Pt	PLATINUM
Q	TRANSISTOR
R	RESISTOR
RAD	RADIAL
RAM	RANDOM ACCESS MEMORY
RCL	RECALL
RD	READ
Re	RHENIUM
REMGND	REMOTE GROUND
Rh	RHODIUM
RL0-RL3	KEYBOARD ROW LINES
ROM	READ ONLY MEMORY
RST5.5	RESTART INTERRUPT LINE
RST6.5	RESTART INTERRUPT LINE
RST7.5	RESTART INTERRUPT LINE
S	SWITCH
S0-2	ENCODED SCAN LINES
SB	SLOW BLOW
SC0-SC7	KEYBOARD AND DISPLAY SCAN LINES

MANUAL ABBREVIATIONS (Continued)

SG	SEGMENT
SID	SERIAL INPUT DATA LINE
SIP	SINGLE IN-LINE PACKAGE
SOD	SERIAL OUTPUT DATA LINE
STAB	STABILITY
STO	STORE
SWG	SWAGE
TANT	TANTALUM
TC	THERMOCOUPLE
TC0-TC7	THERMOCOUPLE SELECT LINES
TRAP	HIGHEST PRIORITY INTERRUPT
U	IC OR INTEGRATED CIRCUIT
UART	UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER
UFLM	ULTRA PRECISION METAL FILM
UR	UNREGULATED VOLTAGE
V	VOLTS
VA	VOLT-AMPS
VAC	ALTERNATING CURRENT VOLTS OR VOLTS AC
VDC	DIRECT CURRENT VOLTS OR VOLTS DC
W	TUNGSTEN OR WATTS
WR	WRITE
Y	CRYSTAL
°C	DEGREES CELSIUS
°F	DEGREES FAHRENHEIT

SECTION I

DESCRIPTION

1.1 GENERAL

The ECTRON Model 1120 Thermocouple Simulator Calibrator is a precision voltage source designed to perform calibration of thermocouple temperature measuring, indicating and recording instruments efficiently and without various auxiliary equipment.

In addition to providing thermocouple simulation, the Model 1120 is a precision dc voltage calibrator with a conventional linear output from -11 to +11Vdc in two ranges, millivolts and volts, with resolution to 0.01μV.

The efficiency of temperature calibration with the Model 1120 far exceeds that previously available with the traditional methods using an ice point reference, dc voltage standard, and the NBS Monograph 125 tables. With much less possibility for error, the Model 1120 allows easier and faster calibration of temperature instruments.

Featuring direct digital input via a keyboard, thermally compensated output terminals, a 5 1/2 digit display with floating decimal and up to eight (8) thermocouple types, the Model 1120 is unsurpassed as the calibration standard for thermocouple type instruments.

The Ectron Model 1120 Thermocouple Simulator Calibrator operates under microprocessor control to provide an output conforming to the emf output of any of eight thermocouple types when the thermocouple type and temperature is keyed directly in degrees Celsius (°C) or Fahrenheit (°F).

Precise conformity to the nonlinearity of ten thermocouple types (B, C, E, J, K, T, N, PL, R, S, and T) is controlled by optional plug-in thermocouple type modules, one for each of the nine thermocouple types offered. Each thermocouple type module includes a ROM containing the polynomial equation that corresponds to NBS Monograph 125. Using 32-bit floating point arithmetic, digital conformity errors are reduced to virtual insignificance.

Coupled with the ability to command a temperature directly, the Model 1120 provides accuracies traceable to NBS and superior to all but the most elaborate laboratory setups. With more than sufficient margin to calibrate even the best thermocouple measuring, indicating, and recording instruments the Model 1120 offers ACCURACY, not just resolution. As the leading manufacturer of Thermocouple Simulator Calibrators, Ectron has embodied in the Model 1120 the latest technology to simplify operation and to reduce all errors,

both hardware and operator, associated with the calibration of temperature instrumentation.

1.2 THERMOCOUPLE SIMULATOR

The Model 1120 operation is controlled by an 8085 microprocessor, which handles data entry, calculation, and DAC (digital-to-analog conversion) functions.

Entry to the Model 1120 is through a 17-key keyboard which allows the operator to specify temperature in degrees C or F, voltage in millivolts or volts, thermocouple type, and whether the output terminals perform as thermocouple alloy or copper. The user can also specify any reference junction temperature in either degrees C or F, over the range of the thermocouple type being used.

Above the keyboard is a LED display which indicates the simulation temperature or output voltage, unit of measure and the thermocouple type. Above the output terminals is an additional LED display which indicates the material to be connected to the terminals and output "NOT VALID" conditions.

Additional features include the storage of seven sets of operating conditions in nonvolatile memory, including simulation temperature or output voltage, thermocouple type, and the type of wire to be connected to the output. The user-entered reference junction temperature is also stored in this memory.

Within the Model 1120, the thermocouple emf's are calculated using polynomials, the coefficients for which are stored in the thermocouple type plug-in modules.

After the operator has entered the desired output conditions and presses the "EXECUTE" key, the instrument operates in one of the following four modes:

1. Thermocouple Simulator, Alloy Output
2. Thermocouple Simulator, Copper Output
3. Linear Voltage, Alloy Output
4. Linear Voltage, Copper Output

In Mode 1, the Model 1120 looks like a thermocouple of the specified type at the simulation temperature. Although the output connections are made to copper blocks, the temperature of that junction is measured and the generated emf is precisely compensated. Refer to Figures 1-1A and 1-1B of the Model 1120 output block diagrams. Figure 1-1A shows the Model 1120 in Mode 1 as it appears to the user.

Figure 1-1B shows the instrument in Mode 2. Here the Model 1120 looks to the user like the same thermocouple as in Mode 1 with a junction to copper at a temperature specified as the reference junction temperature.

As shown in Figure 1-1C, Mode 3 functions as a precision dc source with an output determined by the voltage specified. From the user point of view, the output is from terminals composed of the thermocouple alloys specified by the thermocouple type.

Mode 4, shown in Figure 1-1D, is the simplest of all, a precision dc voltage source feeding copper output terminals.

1.3 DC VOLTAGE CALIBRATOR

Simply by keying in millivolts or volts the Model 1120 becomes a precision dc voltage source. Outstanding accuracy, stability and resolution make the Model 1120 ideal as a working standard to calibrate virtually any dc measuring instrument, from digital voltmeters to recorders to data systems.

The selectable voltage ranges cover from -11 to +11Vdc with 5 1/2 digits of display and resolution to 0.01 microvolts.

Of special importance in low level calibration work is the low output impedance (0.05Ω) on all ranges. Most dc calibrators have high output impedance (1 to 20Ω) on low level ranges. When calibrating instruments with low or varying input impedance, it is difficult if not impossible to obtain accurate and consistent results. Instruments in this category include chopper amplifiers, A-to-D converters and low level multiplexers. The Model 1120 greatly simplifies this problem because the output impedance is extremely low (typically 0.01Ω) even for microvolt levels.

1.4 KEYBOARD

The front panel 16 key keyboard in a 4 X 4 array and a separate EXECUTE control are all that is necessary to operate the Model 1120. Coarse and fine variable controls are not used eliminating their inherent problems of instability, resolution, and repeatability. Through the use of the digital keyboard, all desired operating parameters can be selected, error free:

1. Thermocouple type
2. Output voltage or thermocouple temperature
3. Unit of measure in °C, °F, or linear millivolts or volts
4. Output terminals of copper or thermocouple alloy
5. Any reference junction temperature in °C or °F
6. Output polarity
7. Storage or recall of seven sets of operating conditions

1.5 DISPLAYS

The main display consists of a 5 1/2 digit (plus sign) seven-segment digital readout which indicates the numerical value of entered data. With a fully floating decimal, resolution of 0.00001 is obtainable. LED annunciators show the unit of measure, i.e. °C, °F, millivolts, or volts. Another indicator displays the thermocouple type selected. Additionally, should a reference junction other than 0°C be entered, another LED readout will so indicate. Three additional LED indicators complete the visual display. These are located above the output terminals and indicate the status of the terminals, ALLOY, COPPER, or NOT VALID. An "ALLOY" indication is displayed when the terminals are totally compensated and appear as thermocouple alloy material for the selected thermocouple type. A "COPPER" indication is displayed when the terminals appear as standard copper material. A "NOT VALID" indication is displayed when a change in output is pending or an excessive load is applied.

1.6 OUTPUT TERMINALS

A very important and unique part of the Model 1120 are its output terminal blocks. While there is only one set of output terminals for both the linear voltage and the eight thermocouple type outputs, the terminals and associated circuitry have the unique ability to appear electrically as copper or any of the thermocouple alloy materials.

The terminals are gold-plated solid copper blocks that are electrically isolated but thermally connected. Sensing elements are imbedded in each half to provide continuous information to the microprocessor for use in compensation calculations of the thermocouple polynomials. In this manner truly accurate outputs are obtained regardless of the thermal conditions and the thermocouple materials connected. No other thermocouple simulation instrument using standard terminals provides this unique and necessary contribution to overall accuracy. Guard and case ground terminals are also provided.

1.7 REFERENCE JUNCTION

Although in most instances a reference junction of 0°C (32°F) is desired, the operator can enter any reference junction temperature within the temperature range of the thermocouple module in use. No longer are laborious calculations required for those specific systems utilizing ambient or other reference junction temperatures. The Model 1120 automatically compensates and provides the precise output. The reference junction temperature entered can be recalled and displayed at any time. Memory 8 contains the reference junction temperature and may be changed.

1.8 MEMORY REGISTERS

A nonvolatile memory with eight memory registers permits storage or recall of seven sets of total operating conditions and one reference junction temperature. An internal replaceable lithium cell provides power to the memory in the absence of ac line power. Any memory register can be recalled for display without erasure.

The memory registers provide the user the ability to store frequently used conditions of operation for execution at the simple push of three keys.

1.9 SELF TEST DIAGNOSTICS

The Model 1120 incorporates a self test feature which checks several hardware and software functions for proper operation. The test is performed automatically when the instrument is turned on. The test can also be initiated at any time by depressing two keys or it can be initiated by remote command from the GPIB. The results of the test are indicated by the front panel displays. Section V explains the test in detail. The instrument reverts to operational status when the test is completed.

1.10 ALIGNMENT MODE

An alignment function is provided as an aid to making adjustments on the Analog Assembly and for troubleshooting. Provided is the capability to turn on individual DAC bits, change scale factor and sign, and to view the output terminal block temperature in °C.

1.11 ISOLATION

In order to preserve the microvolt accuracy of the Model 1120, the analog output is totally isolated from the case, power line, and remote control bus. Extensive shielding including a box shielded power transformer allows the Model 1120 to accept the ground system of the instrument being calibrated without introducing ground loop currents.

1.12 LINE POWER

The instrument can be adjusted to accept line voltages of 100, 120, 220, or 240Vac by positioning a small printed circuit board in one of four possible positions. The printed circuit board is located in the fuse/line filter module on the rear panel. The fuse is 3/4A SB for line voltages of 100-120, and 3/8A SB for 220-240. The fuse must be replaced only with one of specified rating when the line voltage is changed. The selected voltage is indicated on the printed circuit board. Domestic shipments are preset for 120VAc operation. No cooling is required as the ac

power consumption is less than 25VA.

1.13 OPTIONS

1.13.1 THERMOCOUPLE MODULES

The thermocouple EMF's are calculated using polynomials and the coefficients are stored in ROMs. Each module contains one ROM for a given thermocouple type, and the module is installed in a random manner in one of eight connectors on the mother board. The instrument will function only in millivolts or volts if a module is not installed.

TEMPERATURE RANGES

TYPE		°C	°F
B	(Pt 6% Rh/Pt 30% Rh)	0 TO 1820	32 TO 3308
C*	(W 5% Re/W 26% Re)	0 TO 2316	32 TO 4200.8
E	(CHROMEL/CONSTANTAN)	-270 TO 1000	-454 TO 1832
J	(Fe/CONSTANTAN)	-210 TO 1200	-346 TO 2192
K	(CHROMEL/ALUMEL)	-270 TO 1372	-454 TO 2501.6
N*	(NICROSIL/NICIL)	-270 TO 1300	-454 TO 2372
PL*	(PLATINEL II)	0 TO 1395	32 TO 2543
R	(Pt 13%Rh/Pt)	-50 TO 1767.6	-58 TO 3213.6
S	(Pt 10%Rh/Pt)	-50 TO 1767.6	-58 TO 3213.6
T	(Cu/CONSTANTAN)	-270 TO 400	-454 TO 752

*UNOFFICIAL DESIGNATIONS

** Thermocouple types B, E, J, K, R, S, and T have dedicated keys on the front panel keyboard for selection of each of these types. An eighth key is labelled * and is used to select either type C*, type N*, type PL*, or any future * type. Only one * type thermocouple module may be installed at any one time.

1.13.2 RACK MOUNT (Option 01)

Rack mount brackets are available which enable the Model 1120 to be installed in a standard 19 inch rack.

1.13.3 IEEE 488 INTERFACE (Option 02)

The optional IEEE 488 Interface provides complete control of all functions of the Model 1120 via the GPIB. The option is a plug-in assembly which may be added in the field without affecting calibration of the instrument. The Model 1120 functions both as a listener and a talker via the bus. Optical isolators provide complete isolation between the Model 1120 and bus grounds.

1.13.4 REAR TERMINALS (Option 03)

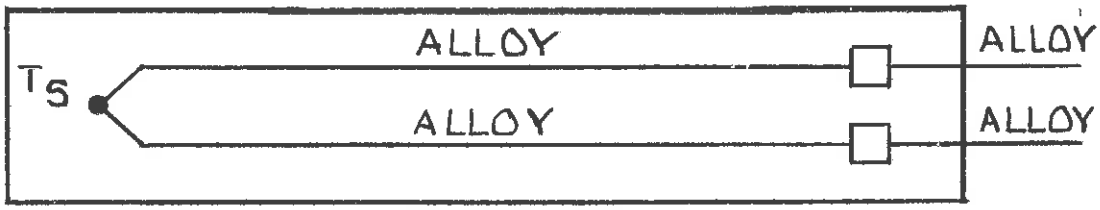
The optional rear terminals DELETE the front terminals (Output High, Output Low, Guard, and the Guard-to-Low switch) and provide these terminals on the rear panel of the instrument. This is not a field-installable option.

1.13.5 RS-232-C INTERFACE (Option 04)

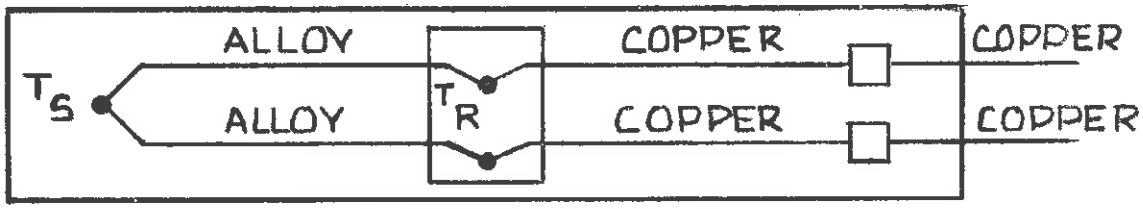
The Option 04, RS-232-C Interface allows the Model 1120 to be remotely controlled by data terminal equipment using a serial bit, serial character interface conforming to the E1A Standard RS-232-C. This subassembly is a plug-in card that plugs into any Model 1120. It may be factory installed when the Model 1120 is ordered or customer installed later without any modification to the Model 1120.

1.13.6 EXTENDER BOARD KIT

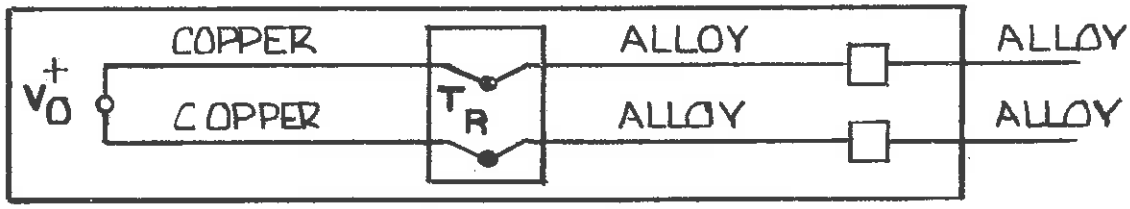
An extender board kit is available for all plug in assemblies under P/N 112-528-01. Details are in Section VIII (Parts List) under miscellaneous.



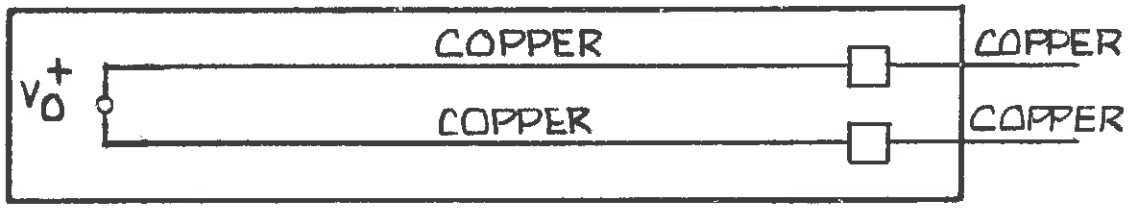
ALLOY °C OR °F
FIG 1-1A



COPPER °C OR °F
FIG 1-1B



ALLOY MV OR V
FIG 1-1C



COPPER MV OR V
FIG 1-1D

☐ IS THE FRONT PANEL TERMINALS

T_S IS THE SIMULATED THERMOCOUPLE TEMPERATURE

V_O IS THE SPECIFIED VOLTAGE OUTPUT

T_R IS THE SPECIFIED REFERENCE JUNCTION TEMPERATURE

FIG 1-1

SECTION II

SPECIFICATIONS

2.1 THERMOCOUPLE MODE

2.1.1 TEMPERATURE RANGES

TYPE		°C	°F
B	(Pt 6% Rh/Pt 30% Rh)	0 TO 1820	32 TO 3308
C*	(W 5% Re/W 26% Re)	0 TO 2316	32 TO 4200.8
E	(CHROMEL/CONSTANTAN)	-270 TO 1000	-454 TO 1832
J	(Fe/CONSTANTAN)	-210 TO 1200	-346 TO 2192
K	(CHROMEL/ALUMEL)	-270 TO 1372	-454 TO 2501.6
N*	(NICROSIL/NICIL)	-270 TO 1300	-454 TO 2372
PL*	(PLATINEL II)	0 TO 1395	32 TO 2543
R	(Pt 13%Rh/Pt)	-50 TO 1767.6	-58 TO 3213.6
S	(Pt 10% Rh/Pt)	-50 TO 1767.6	-58 TO 3213.6
T	(Cu/CONSTANTAN)	-270 TO 400	-454 TO 752

*UNOFFICIAL DESIGNATIONS

* C is an unofficial designation for Tungsten 5% Rhenium/Tungsten 26% Rhenium Thermocouple

* N is an unofficial designation for Nicrosil/Nicil.

* PL is an unofficial designation for Platinel II.

2.1.2 ACCURACY (30 DAYS)

0.01% of setting ±4μV

Includes 30 day stability, ambient of 23 ±5°C, all conformity errors, output terminal compensation and up to 70% relative humidity after 30 minute warm-up.

2.1.3 ACCURACY (6 MONTHS)

0.018% of setting ±8μV

Includes 6 month stability, ambient of 23C ±10°C, all conformity errors, output terminal compensation and up to 70% relative humidity after 30 minute warm-up.

2.1.4 CONFORMITY ERRORS

Total conformity errors compared to NBS monograph 125 are under 1μV. (Does not include type C which is not covered by monograph 125.)

2.1.5 RESOLUTION

0.0625μV on all thermocouple ranges.

Although a resolution of 0.01m°C or °F is possible to enter, the output emf will change in 0.0625μV increments.

2.1.6 TEMPERATURE COEFFICIENT

±0.001% of setting/°C ±0.2/°C ±0.008°/°C.

2.2 DC VOLTAGE CALIBRATOR

2.2.1 RANGE AND RESOLUTION (DISPLAY)

RANGE	RESOLUTION
0 to ±19.9999mV	0.1μV STEPS
0 to ±199.999mV	1μV STEPS
0 to ±1.99999V	10μV STEPS
0 to ±11.0000V	100μV STEPS

2.2.2 RESOLUTION (TERMINALS)

RANGE	RESOLUTION
0 to ±85.937mV	0.0625μV
±85.938mV to ±1.37500V	1μV
±1.37501V to ±11.0000V	8μV

2.2.3 ACCURACY (30 DAYS)

0.005% of setting ±3μV

Includes 30 day stability, temperature of 23°C ±5°C and up to 70% relative humidity after 30 minute warm up.

2.2.4 ACCURACY (6 MONTHS)

0.014% of setting ±7μV

Includes 6 month stability, temperature of 23°C ±5°C and up to 70% relative humidity after 30 minute warmup.

2.2.5 TEMPERATURE COEFFICIENT

±0.001% of setting/°C + 0.2/°C

2.3 SPECIFICATIONS THAT APPLY TO BOTH MODES

2.3.1 OUTPUT IMPEDANCE

0.05Ω shunted by 3.5μF. Typically under 0.01Ω.

2.3.2 OUTPUT CURRENT

Up to ±10mA, short circuit protected. Maximum current is <30mA.

2.3.3 SETTLING TIME

Within 15ppm of final output in <2 seconds.

2.3.4 REGULATION

Less than 0.0005% of setting ±2μV for a ±5% line voltage change.

2.3.5 OUTPUT NOISE (0.1 to 10Hz BANDWIDTH)

Thermocouple mode: 3μV peak

Millivolt/voltage mode: 3μV peak

2.4 ISOLATION

2.4.1 OUTPUT TERMINALS

The output terminals are isolated and guard shielded from case (power ground) and the remote control bus. A front panel switch enables the guard to be tied to output low to give maximum isolation. A front panel terminal provides connection to the guard.

2.4.2 POWER SAFETY GROUND

Power safety ground is connected to the case and is available at a front panel terminal.

2.4.3 COMMON MODE VOLTAGE

The output may be floated 100Vdc or peak ac from chassis.

2.4.4 LEAKAGE CURRENT

With guard tied to output low, leakage current will be less than 500nA dc to 500Hz.

2.4.5 CMR

Common mode rejection, output to case or Remote Input to case is 160db at dc and 140dB to 400 Hz (Guard connected to output low). Common mode rejection is defined as the ratio of the amplitude of the voltage applied between the specified points and the amplitude of any resulting effects at the output.

2.5 REMOTE CONTROL

Control of all functions except power and guard switches is available using the remote input connector. Optional IEEE 488 plug-in interface is available. Optical isolation assures freedom from interface noise.

2.6 MEMORY REGISTERS

Seven memory registers provide retention of seven sets of operating conditions including temperature or voltage setting; polarity; °C, °F, mV or V. An eighth memory retains the reference junction temperature. Battery backup is provided by a short circuit safe lithium primary cell. Battery life is at least two years.

2.7 POWER REQUIREMENTS

4 ranges, rear panel selectable:

100V, -10% + 5%, 48 to 440Hz
120V, -10% + 5%, 48 to 440Hz
220V, -10% + 5%, 48 to 63Hz
240V, -10% + 5%, 48 to 63Hz

Approximately 25VA without remote option.

The fuse is 3/4A SB for 100 and 120Vac and 3/8A SB for 220 and 240Vac.

2.8 DIMENSIONS

Width	325mm (12.8")
Depth	380mm (14")
Height	133mm (5.25")

2.9 WEIGHT

Net	8.6kg (19 lbs.) nominal
Shipping	11.8kg (26 lbs.) nominal

SECTION III

UNPACKING AND INSPECTION

3.1 GENERAL

This instrument was thoroughly tested and inspected prior to shipment; and unless damaged in transit, it should be ready for use when received.

The shipping carton should be examined for signs of damage before unpacking. If external damage is present, notify the carrier before proceeding.

Remove the contents of the carton and carefully examine all units for any evidence of damage due to excessive shock, vibration, water, etc. If there is evidence of physical damage, notify the carrier.

Account for all items on the packing list, including mating connectors and instruction manuals. If the inventory of equipment does not correspond with the packing slip, notify Ectron Corporation.

If all is satisfactory, proceed with Section IV, INITIAL CHECKOUT.

SECTION IV

INITIAL CHECKOUT

4.1 GENERAL

The simple tests described in this section are generally sufficient to check the instrument on receipt. The purpose of these tests is only to establish that the instrument is functional. This procedure should not be confused with the more elaborate specification validation in Section VII which the user may want to perform before placing the instrument in service.

4.2 POWER CONNECTIONS

The instrument is designed to operate at the following line voltages:

100Vac -10% +5%, 48 to 440Hz
120Vac -10% +5%, 48 to 440Hz
220Vac -10% +5%, 48 to 63Hz
240Vac -10% +5%, 48 to 63Hz

Domestic shipments are factory set to 120Vac, and overseas shipments are set as required.

Adjustments to accommodate various line voltages are easily made without opening the instrument. **DO NOT** apply power until it is verified that the instrument is set to the facility line voltage. This is readily accomplished by sliding the plastic cover on the fuse holder on the rear panel and noting the voltage indicated on the small printed circuit board. The board can be removed and reinstalled in one of four possible positions to accommodate a different line voltage. The fuse should be 3/4A SB for line voltages of 100 and 120, and 3/8A SB for line voltages of 220 and 240.

4.3 EQUIPMENT REQUIRED

Digital voltmeter, ±10Vdc, 1μV resolution.

4.4 PROCEDURE

Section V, Applications, contains several lists which show keyboard procedures to exercise each function of the instrument. Perform the sequences referred to in the List of Keyboard Procedures at the rear of Section V. If the instrument is operated without thermocouple modules, be sure to use the correct list.

This completes the Initial Checkout.

SECTION V

MODEL 1120 OPERATION INFORMATION

5.1 GENERAL

In this section an overview of the Model 1120 operating features is first presented, with detailed operation described later.

The keyboard consists of a 4 x 4 matrix of sixteen keys plus a seventeenth EXECUTE key. Thirteen of these keys are dual meaning keys in that they have a different meaning depending on the current Model 1120 operating state.

The front panel display on the Model 1120 consists of two sections, output related displays and all other displays.

The output related displays consist of three annunciators located above the output terminals. These annunciators include the type of material which should be connected to the output terminals (ALLOY or COPPER), and a NOT VALID light which indicates that the voltage at the output is not valid due to excessive output current or a pending change.

Other displays include a 5 1/2 digit seven segment display for voltage and temperature readout, four annunciators for unit of measure and to indicate a reference junction of other than 0°C (32°F), and a 14 segment character to display the thermocouple type. The thermocouple type display is blank during operation involving COPPER output material and a millivolts or volts unit of measure, since thermocouple type is meaningless under these conditions.

The Model 1120 contains ten internal registers, each of which can store a complete set of operating conditions: magnitude, sign, unit of measure, output material and thermocouple type. Register zero always contains the conditions currently being output. This is a volatile register. Registers one through seven are nonvolatile general purpose registers used for storing frequently used sets of operating conditions.

Register eight is another nonvolatile register used to store the reference junction temperature that the Model 1120 uses in computing the output when using a temperature unit of measure with COPPER output material, or a voltage unit of measure with ALLOY output material.

Reference junction temperatures only have meaning if the unit of measure is one of temperature; in the case of the Model 1120, °C or °F. Therefore, if a set of conditions stored in Register eight has a mV or V unit of measure, it will automatically be changed to °C or °F, respectively when

stored in Register Eight.

The tenth register, although not accessed by number, is the display register. That is, the front panel displays always show what is in this register. Data transfers to or from any other register always go through the display register.

In typical operation, registers one through seven are used to store data used in test procedures so as to avoid unnecessary keying. As they are needed, each temperature is recalled from its register and then output.

Each time the Model 1120 is powered up, the display register is initialized to +00000. If a thermocouple module is installed in the Model 1120, the thermocouple type of the module closest to the front panel is entered as the thermocouple type for the display register. Otherwise, the thermocouple type for this working register is left blank. If a thermocouple module is installed in the connector closest to the front panel, the display register is set to ALLOY and °C. If no thermocouple module is installed in that connector, the display register is set to COPPER and mV.

A test is then performed on data contained in the nonvolatile registers to see if a failure in battery backup power has occurred. If so, registers one through eight (the nonvolatile registers) are initialized by copying data from the display register to these registers. Data from the display register is also copied to register zero, the output register, which causes that data to be used in calculating the output voltage.

5.2 FRONT PANEL OPERATION

This section will be divided into two parts for ease of presentation. The first part will be devoted to a functional description of each key on the keyboard followed by information which will describe sequences to enter or to change data. This section does not apply to the alignment operation. The latter part will describe the alignment operation the instrument.

When reference is made to the front panel displays or keys, CAPITAL letters will be used.

5.2.1 FRONT PANEL NORMAL OPERATION

This section describes the complete functions of all front panel keys when in the Normal Operating Mode. In the Alignment Mode, keys perform other functions as described in Section 5.2.2.

Most keys have two meanings. For example, the 2/J key can

be used to enter the number 2 or to select a type J thermocouple. The meaning of these keys depends on the current machine state (See Figure 5-6). Two main states exists: "Numeric" and "Function." The Numeric State uses the meaning shown in the upper left part of these dual meaning keys, while the Function State uses the meaning in the lower right part of the key.

5.2.1.1 NUMERIC STATE

The Numeric State on the Model 1120 is used for all number entry (including decimal point and sign) and for storing and recalling data from internal registers. Entered data may be corrected using the CLR key.

Numbers are always entered left justified and placed in the display at a position immediately to the right of the right most digit already displayed. If all digit positions on the display are filled, any additional number keys pressed are ignored. The decimal point can be inserted anywhere within the entered number and will be displayed where entered. If the decimal point is not entered, it is assumed to lie to the right of the right most digit already entered. The CLR key is used to correct incorrectly keyed digits. Each time the CLR key is pressed, the right most digit (or the decimal point, if it is to the right of the right most digit) is blanked. The next digit entered will be placed just to the right of the right most remaining digit. Successive CLR keystrokes will blank successive digits until the entire numeric display is blank except for the polarity sign. Additional depressions of the CLR key are ignored.

The +/- key is always active in the Numeric State and may be pressed at any time. This will result in the sign being toggled from plus to minus or from minus to plus.

The +/- display is also used for another function. When flashing, it indicates that the Model 1120 is in the Numeric State and that a previous set of keystrokes has not been terminated. Valid terminations are the EXECUTE key, or a successful Store or Recall operation.

The SHIFT key is used to transfer operation between the Numeric State and the Function State. When in the Numeric State, a single depression of the SHIFT key will cause subsequent keystrokes to be interpreted according to their meanings in the Function State.

Several other keys (STO, RCL, and EXECUTE) are valid while in the Numeric State and are described below.

5.2.1.2 FUNCTION STATE

Operation in the Function State is always accompanied by a

steady (not flashing) display of the polarity indicator and a flashing display of output material (COPPER or ALLOY), unit of measure (°C, °F, mV or V) and thermocouple type (when displayed). In this state the dual meaning keys take on the meaning described in the lower right part of the key. This state is used to select unit of measure, thermocouple type and output material. Each of these keys perform a complete function with one keystroke. Pressing the shift key from the Function State will cause the Model 1120 to revert to the Numeric State.

Other keys which are valid in the Function State include the STO, RCL and EXECUTE keys. Operation using these keys is described below.

5.2.1.3 STORE AND RECALL SEQUENCES

The STO and RCL keys are used for register data transfers as well as other functions. Data transfers always involve the display register and the register whose number is on the key pressed immediately after pressing the STO or RCL key. For example, to recall data from register five to the display register, press RCL and then the 5/S key. To store the contents of the display register in register three, press STO and then the 3/K key. When data transfers are made, data is copied and the original data remains unchanged. In the previous example the STO 3 command would leave the data in the display register unchanged. Store and recall sequences may be used in the above manner for registers zero through eight.

Register zero is the output register and storing data in this register will cause the Model 1120 to calculate a new output voltage based on the data being stored in register zero and the reference junction temperature stored in register eight. The STO 0 and the STO EXECUTE commands are both equivalent to pressing the EXECUTE key. It is important to note that even though the contents of register eight may be changed through the STO 8 command, the output voltage will not change until either a STO 0, STO EXECUTE, or EXECUTE command is entered.

A RCL 0 sequence will transfer data from the output register to the display register to enable the user to view what is being output. This is useful in order to restore the display to the output conditions after performing other functions such as loading registers, etc. A momentary version of this command is accessed by pressing the RCL key and then pressing and holding the EXECUTE key. As long as the execute key is held depressed, the display register will show the contents of the output register. When the EXECUTE key is released, the previous contents of the display register are again displayed. This is true even if data had only partially been entered into the display register. When the

EXECUTE key is released, conditions which previously existed in the display register will be restored.

Pressing the STO key followed by the 9/CU key will initiate self test diagnostics in a manner similar to turning the Model 1120 on, except that data in the display register and the output register (register zero) is not lost.

Successive depressions of the STO and RCL keys result in the Model 1120's recognizing only the last keystroke. Thus, in the event the STO key is pushed instead of RCL, or the RCL key instead of STO; merely pressing the correct key will result in the proper interpretation.

Whenever either the STO or RCL keys are pressed, the Model 1120 is automatically put in the Numeric State if it wasn't already. This is necessary because the next key to be interpreted will usually be a number key.

Pressing either the STO or RCL key followed by the CLR/V key will cancel the STO or RCL request and return operation to the Numeric State. This can be used if the STO or RCL key was pressed in error and some other key was desired.

Pressing the STO or RCL keys followed by the decimal point or +/- key is an invalid sequence and the second key stroke (the decimal point or +/- key) is ignored. At this point a valid key should be pressed to complete the store or recall sequence.

5.2.1.4 EXECUTE KEY

As mentioned above, pressing the EXECUTE key is equivalent to pressing either the STO key followed by the 0/°C key or the STO key followed by the EXECUTE key. The Model 1120 performs several operations when any of these key sequences are entered.

If a temperature unit of measure was selected, or if ALLOY output material was selected, the thermocouple type in the display register must be used. A check is made to see that a thermocouple module of that type is plugged into the Model 1120; and if not, Err 3 is displayed.

The temperature displayed is then checked to see that it is within the range of the thermocouple type selected. If not, Err 1 is displayed.

If a voltage unit of measure is selected, a check is made to see that the voltage entered is within the range of the unit (-11 volts to +11 volts). If not, Err 2 is displayed.

If a reference junction temperature is needed to calculate the output required (temperature unit of measure with COPPER

output material or voltage unit of measure with ALLOY output material), the reference junction temperature is verified to be within the range of the thermocouple type selected. If not, Err 4 is displayed. Pressing the CLR/V key once will cancel any error display and return operation to the Numeric State.

If no error conditions are detected, the output voltage is calculated based on the voltage or temperature specified in the display register, the unit of measure, the output material and the reference junction temperature.

5.2.2 ALIGNMENT MODE

An alignment function is provided as an aid to making adjustments on the Analog Assembly and for troubleshooting. Provided is the capability to turn on individual DAC bits, change scale factor and sign, and to view the output terminal (block) temperature in degrees celsius.

5.2.2.1 ACCESSING THE ALIGNMENT MODE

Alignment operation is switch selected according to the following procedure:

1. Turn off the Model 1120 power switch.

2. Remove the top cover by loosening the four captive screws.

3. Set the OPERATE/ALIGN switch on the Mother Board Assembly to the ALIGN position.

4. Turn the power switch on.

NOTE

Failure to turn off the power prior to changing the OPERATE/ALIGN setting switch may result in loss of data stored in nonvolatile registers.

5.2.2.2 OPERATING IN THE ALIGNMENT MODE

Figure 5-1 shows the display after power up in the Alignment Mode. The plus polarity sign indicates the status of the sign bit to the DAC. The two zeros indicate that no DAC data bits are on, and the 128 in the last three digits indicates the scale factor (1/128 at power up).

Any DAC data bit may be turned on by entering the two digit bit number from the keyboard. Bit numbers less than 10 must include a leading zero. For example, if it is desired to turn on bit 15, key in a 1 and then a 5. If bit 7 is desired, key a 0 and then a 7. Any bits previously on will

be turned off prior to the selected bit being turned on. Selecting bit 00 will turn all bits off.

The DAC on the Analog assembly is a 21 bit DAC excluding sign. Therefore, any bit number from 00 to 21 is valid and will be accepted. Entering a number greater than 21, except for some special ones which will be described later, will not be accepted and will result in no DAC bits being changed and a display of "Er." Pressing any number key will cancel the error display and will be interpreted as the first digit of the next bit number.

The +/- key controls the condition of the sign bit to the DAC. Pressing the +/- key will toggle the sign. It may be pressed at any time while in the DAC bit mode.

The scale factor (1/1, 1/8 or 1/128) is selected by pressing the STO, RCL or CLR buttons, respectively. This may be done with any bit selected (including 00), or in the middle of the bit entry sequence (between the first and second digits). The scale factor currently selected is indicated by the right three digits of the display.

The decimal point and EXECUTE key are not used in the Alignment Mode and are always ignored.

The SHIFT key is used to display the output terminal (block) temperature. When pressed, the display is changed to the format shown in Figure 5-2 and all bits to the DAC remain unchanged. The block temperature, as measured by the Model 1120, is displayed in degrees Celsius. This temperature is normally measured by the Model 1120 in order to calculate proper compensation voltages when using alloy output connections. The temperature is internally measured and stored as a 12 bit binary number. When converted to decimal form, however, this 12 bit number yields a resolution of about .015°C. With a display containing two decimal places, a change in the binary number of only one bit sometimes results in a change of more than one digit on the display. Thus, a smoothly changing block temperature will be seen to "skip" a digit from time to time.

While displaying the block temperature, the decimal point will be flashing to show A/D converter activity. A steady decimal point or no decimal point at all indicates a probable A/D converter failure.

While displaying the block temperature, all keys except the SHIFT key are ignored.

Pressing the SHIFT key again will change the operation back to the DAC bit mode. The display is returned to the conditions which were present when the SHIFT key was first pushed.

5.2.2.3 SPECIAL BIT SELECTIONS

Special bit numbers have been included which will turn on often used groups of bits (See Table 1). When selected, each special bit number will automatically set the correct scale factor for its corresponding output voltage, as shown in Table 1. Other voltages may be obtained by then setting the scale factor according to Table 2.

SPECIAL BIT NUMBER	OUTPUT VOLTAGE (VOLTS)	SCALE FACTOR
50	1.000	1/8
51	5.000	1/1
52	10.000	1/1
53	11.000	1/1

SPECIAL DAC BIT SELECTION
Table 5-1

ALIGNMENT MODE DAC BIT DISPLAY
Figure 5-1

ALIGNMENT MODE BLOCK TEMPERATURE DISPLAY
Figure 5-2

SPECIAL BIT NUMBER	OUTPUT VOLTAGE DIVIDED BY 1	DIVIDED BY 8	DIVIDED BY 128
50	8.000V	1.000V*	62.500mV
51	5.000V*	0.625V	39.0625mV
52	10.000V*	1.125V	78.125mV
53	11.000V*	1.375V	85.9375mV

* Indicates Initial Output Voltage.

SPECIAL DAC BIT SELECTIONS VS. SCALE FACTOR
Table 5-2

5.3 SPECIAL THERMOCOUPLE

One thermocouple type at a time not listed on the keyboard, can be installed in the instrument. The special thermocouple type is selected using the asterisk (*).

5.4 TERMINALS

The front panel terminals are used for both ALLOY and COPPER outputs. The terminals are mounted in two gold plated copper blocks in intimate thermal contact. Each block has a temperature sensor which applies output terminal compensation when in the ALLOY mode. The temperature sensors are not used when in the COPPER mode.

Reference junction compensation is applied when COPPER terminals are selected in the thermocouple simulator mode or when ALLOY terminals are selected in the dc voltage calibrator mode. The output terminal voltage is maintained until new data is entered and the EXECUTE key is depressed. The GUARD terminal is normally connected to the output LO by means of a front panel switch adjacent to the terminals. The switch allows this connection to be opened if required. Please refer to Figures 1-1A through 1-1D.

5.5 USE OF GUARD TERMINAL

The front panel GUARD terminal is usually connected to the output LOW terminal when there is no common voltage present between the device being calibrated and the Model 1120. The guard switch is pulled out for this condition.

If, however, a common mode voltage exists between the Model 1120 and the device being calibrated, the GUARD terminal should be driven by the common mode voltage and the switch pushed in to open the connection between the GUARD and the output LOW terminals.

Figure 5-5A shows the proper connections when no common mode voltage is present. Figure 5-5B shows the connections to be

used when a common mode voltage is present. The maximum permissible common mode voltage is 100 volts dc or peak ac to 500Hz.

5.6 INITIAL TURN ON

The Model 1120 can be ordered without thermocouple modules, and it will function only as a precision dc voltage calibrator. If it is ordered with one or more thermocouple modules, one module will be installed in J209. A type J thermocouple module has been installed in J209 on the instrument which was used to verify the subsequent procedures.

J209 to J216 are 15 pin double readout connectors and are located on the mother board behind the power switch and the keyboard. Thermocouple modules are installed in these connectors. J209 is located closest to the front panel. Thermocouple modules can be installed in a random manner in J209-J216.

If a thermocouple module is not present in J209 but may be present in J210-J216, the front panel will display COPPER + .00000mV at initial turn on. If a thermocouple module is present in J209 at initial turn on and after the diagnostic routine the front panel will display ALLOY + .00000°C and the thermocouple type in J209.

5.7 KEYBOARD PROCEDURES

The lists at the end of this section describe procedures to be used from initial turn on to attain a desired output. An example of most frequently used selections, error corrections, correction of errors not executed and memory storage will be included. The sequence should be followed as shown until the operator becomes familiar with shortcuts.

The lists show programming for instruments with and without thermocouple options. When a display shows a reading which is different than that expected at initial turn on, not all the steps listed will be required. When entering a numerical value consisting of less than five (5) digits, internal logic will supply the decimal and trailing zeros when the EXECUTE key is depressed. The output voltages shown for thermocouple functions do not include reference junction compensation.

5.8 USING THE MODEL 1120

The Model 1120 can be used as a laboratory standard millivolt/voltage source or with any device which accepts a thermocouple signal to 10mA. This would include calibration of

Digital voltmeters
Digital temperature indicators
Temperature indicators
Temperature recorders
Temperature controllers
Temperature transmitters
Data acquisition systems
Data loggers
Oven, furnace and boiler controls

Figure 5-3 is a block diagram which shows the apparent connections which the user would expect when connecting copper or alloy wires to the front panel terminals as well as the actual internal connections. Although the same terminals are used for each function, output terminal compensation is needed only in the ALLOY mode.

Figure 5-3A shows the connections to the instrument when used as a thermocouple source with alloy wires. The voltage V = f(TO) - f(TB) where

f is the temperature to voltage function for the thermocouple type used

TO is the temperature selected by the user

TB is the measured temperature of the front panel terminals

Figure 5-3B shows the connections to the instrument when used as a thermocouple source with copper wires. The output voltage V = f(TO) - f(TR) where TR is the stored reference junction temperature.

Figure 5-3C shows the connections to the instrument when used as a millivolt or voltage source with alloy wires. The output voltage V = VO + f(TR) - f(TB) where VO is the voltage selected by the user.

Figure 5-3D shows the connection to the instrument when used as a millivolt or voltage source with copper wires. The output voltage V = VO.

5.9 CONNECTIONS TO THE MODEL 1120

Caution must be observed when connecting a measuring device to the Model 1120 to ensure that no unwanted copper to alloy

junctions are formed which would degrade the accuracy of the measurement. Figure 5-4A is used when the measuring device has copper leads or terminals and it is desired to use the Model 1120 as a thermocouple source. A reference junction temperature must be stored in the Model 1120 corresponding to that specified for the unit being calibrated, and also the corresponding thermocouple type must be selected on the Model 1120. Figure 5-4B is used where the measuring device has alloy leads or terminals. When thermocouple extension wire is used, it must be appropriate for use with the leads or terminals on the measuring device, and the corresponding thermocouple type must be selected on the Model 1120.

Figure 5-4C is used when the measuring device has copper leads or terminals such as a digital multimeter. In this case copper wire is used for connections and COPPER terminals must be selected on the Model 1120.

5.10 STATE DRAWING

Figure 5-6 is a state drawing of the front panel keyboard and display functions. It shows all possible keystrokes to accomplish the state changes shown.

When the instrument is first turned on, the Self Test Diagnostics are performed. It then terminates in the numeric mode without any blinking displays. The state drawing also shows that the Self Test Diagnostics can be initiated manually by depressing STOre followed by the 9 key.

The five arrows leading from the numeric mode show that it is affected when the CLR, any number including decimal, polarity SHIFT or EXECUTE keys are depressed. The polarity sign blinks when any one of the first three keys are depressed, the function blinks when the SHIFT key is depressed and blinking ceases when the EXECUTE key is depressed. The arrows leading to the numeric mode show eleven conditions which affect it and cause a blinking polarity sign where indicated.

The function display blinks when a thermocouple type, units of measure, or output terminal is selected.

The drawing shows that the function and numeric displays will stop blinking when the EXECUTE key is depressed, and that the voltage is applied to the output terminals after the key is depressed. The temporary display output value is shown when the EXECUTE key is depressed and held down, when in the RECALL mode and the display reverts to the former reading when the key is released. The closed arrows on the STOre, recall and display error indicate no change when the keys shown are depressed.

5.11 SELF TEST DIAGNOSTICS

This test is initiated automatically when ac power is first applied or it may be initiated at any time by depressing STOre followed by the 9 key. Three separate tests are performed in the following order:

1. LED segment test
2. Checksum and LRC of all thermocouple ROMs
3. Checksum and LRC of main program ROMs

LRC is a longitudinal redundancy check.

When the test is initiated either automatically or manually, all LED segments and all sections of the front panel indicators are illuminated for two seconds. Any failures are readily observed.

The instrument advances to Dia 2 which is displayed for 2 seconds. If a failure should occur, Fail 2 will be displayed for 5 seconds.

The instrument then advances to Dia 3 which is displayed for 2 seconds. If a failure should occur, Fail 3 will be displayed for 5 seconds.

The instrument reverts to operational status at conclusion of the test sequence.

TYPICAL KEYBOARD OPERATIONS

CHANGE DESIRED	DO THE FOLLOWING	READOUT SHOWS	OUTPUT SIGNAL (after EXECUTE pressed)
Readout displays ALLOY + .00000°C	Occurs when a J type T/C module is in J209 at initial turn on		
To change thermocouple type	Press SHIFT, desired thermocouple type	Function blinks and shows new thermocouple type	Zero output on ALLOY terminals*
To change to mV and COPPER	Press SHIFT, mV, CU	COPPER terminals, numerical value of mV (blinking)	Zero output on COPPER terminals
To change to 10V	Press 1, 0, SHIFT, V	COPPER terminals, numerical value of V (blinking)	10Vdc output on COPPER terminals
To change to °F, J thermocouple, ALLOY terminals	Press SHIFT, °F, J ALLOY	°F, J, ALLOY +10.0000; function blinks	Desired output on ALLOY terminals*
To change to −300°F	Press ±, 3, 0, 0, SHIFT, °F	function blinks, −300°F ALLOY	−7.519mV for type J thermocouple*
Readout displays COPPER, +.00000mV at initial turn on	Occurs when no T/C module is in J209		
To change to Volts	Press SHIFT, V	V function blinks	V function on COPPER terminals
To enter +10Vdc	Press 1, 0	10 with blinking + polarity	+10Vdc on COPPER terminals
To reverse polarity	Press ±	−10 with blinking − polarity	−10Vdc on COPPER terminals

* Cannot be measured accurately with DVM compensated for ALLOY wires

EXCESS TEMPERATURE, display shows ALLOY +0.0000°C J

Enter 2000°C	Press 2, 0, 0, 0, EXECUTE	Err 1	No change from previous output
Clear error	Press CLR	Erroneous entry	
Enter valid reading	Press 7, 6, 0, EXECUTE	ALLOY, +760.00°C, J	+42.922mV*
Change output to 12Vdc copper terminals	Press 1, 2, SHIFT, V, CU, EXECUTE	Err 2	No change in output from previous condition
To clear error	Press CLR	Erroneous entry	
To correct to +11V	Press, 1, 1,	COPPER, +11.0000V	+11Vdc on COPPER terminals
To change to °C, type B, ALLOY (type B module not installed)	Press SHIFT, ALY, B, EXECUTE	Err 3	No change in output from previous condition
To clear error	Press CLR	ALLOY, +11.0000°C B	
To correct to type J	Press SHIFT, J,	ALLOY +11.0000°C J	+0.558mV*
Reference junction of 1200°C	Press 1, 2, 0, 0, STO, 8, RCL, 0, EXECUTE	ALLOY +11.0000°C J REF NOT 0°C	+0.558mV**

TYPICAL KEYBOARD OPERATIONS (Continued)

CHANGE DESIRED	DO THE FOLLOWING	READOUT SHOWS	OUTPUT SIGNAL (after EXECUTE pressed)
To change to copper terminals	Press SHIFT, CU, EXECUTE	Err 4	No change in output from previous condition
To clear error	Press CLR REF NOT 0C	COPPER +11.0000°C J	No change in output from previous condition
To correct error	Press 1 2 0, STO 8, 1 1	COPPER +11.0000°C J REF NOT 0°C	No change in output from previous condition

** Even though the reference junction is out of range for type J, it is not used when operating from ALLOY material and therefore an error condition is not shown.

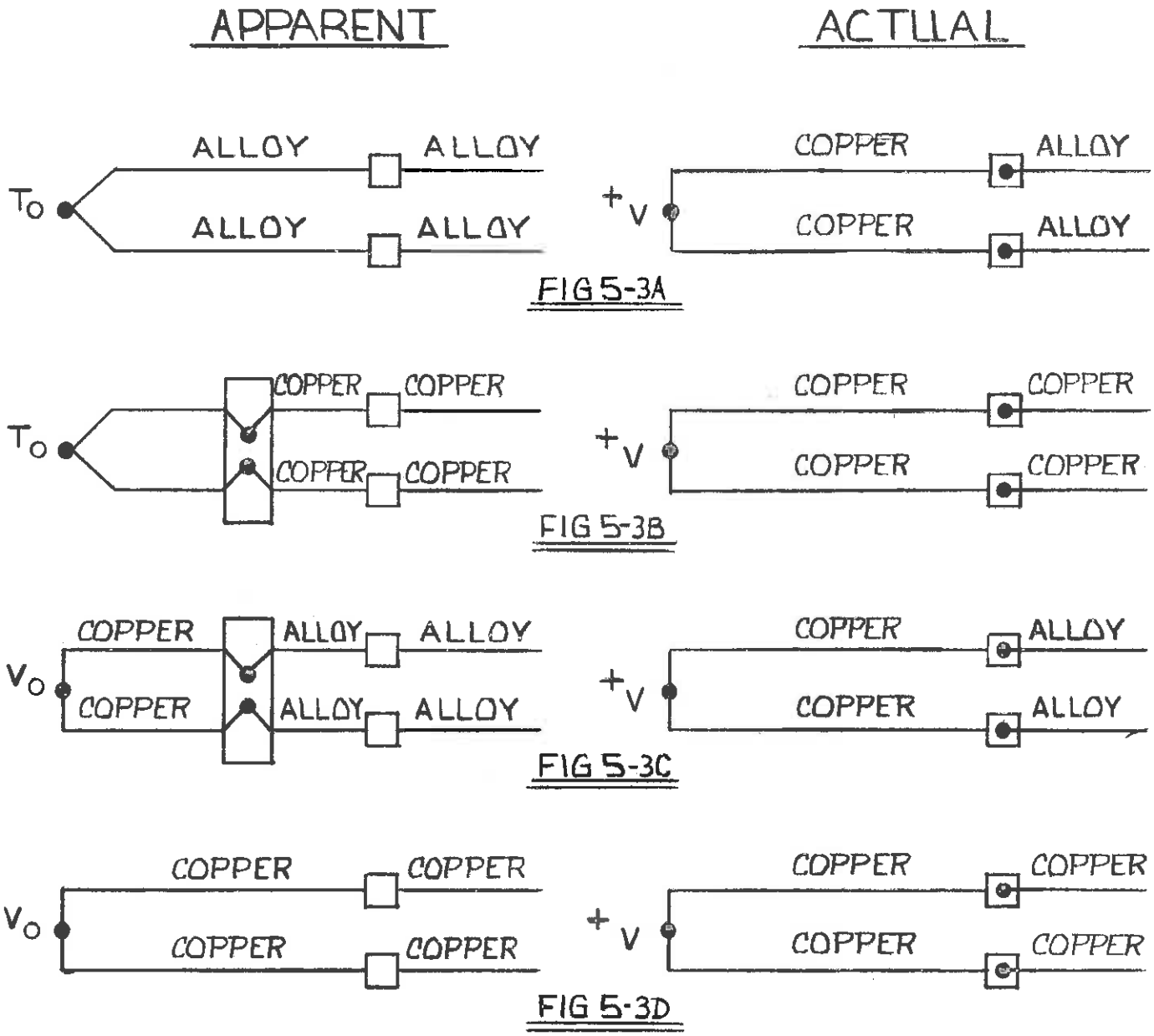
MEMORY REGISTERS

To store numerical and functional data in registers 1-7	Press STO, 1, STO, 2, etc. (blinks)	Same reading	As indicated on display
To recall memory and functional data in registers 1-7	Press RCL, 1, RCL 2, etc. (± blinks)	Data in selected memory register	As indicated on display
To recall reference junction temperature in register 8	Press RCL, 8 (± blinks)	Reference junction temperature	No change
To set reference junction temperature to 0°C (32°F)	Press 0 (± blinks), STO, 8 (already in °C)	+0.0000°C J. (REF NOT 0°C extinguished)	Zero, ALLOY terminals

MISCELLANEOUS

To examine previous data before new data is executed	Press RCL and hold down EXECUTE key	Previous data	Previous data
	Release EXECUTE key	New data, press EXECUTE	New data
To change from COPPER to ALLOY terminals	Press SHIFT, CU, ALY	Function blinks, press EXECUTE	Output on ALLOY terminals
SPECIAL THERMOCOUPLE			
To select special thermocouple	Press SHIFT, *	Function blinks, thermocouple type shown as asterisk (*)	
	Press EXECUTE	ALLOY, selected temperature, °C or °F, asterisk (*)	As selected on ALLOY terminals

Table 5-3 (continued)



MODEL 1120 TERMINALS

APPARENT & ACTUAL

☐ FRONT PANEL TERMINAL

FIG 5-3

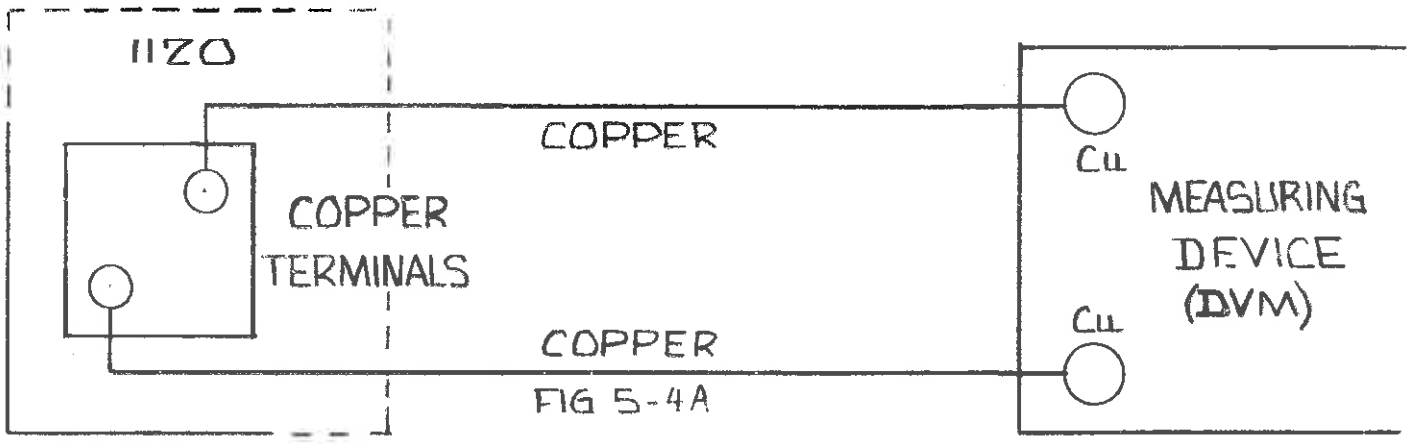


FIG 5-4A

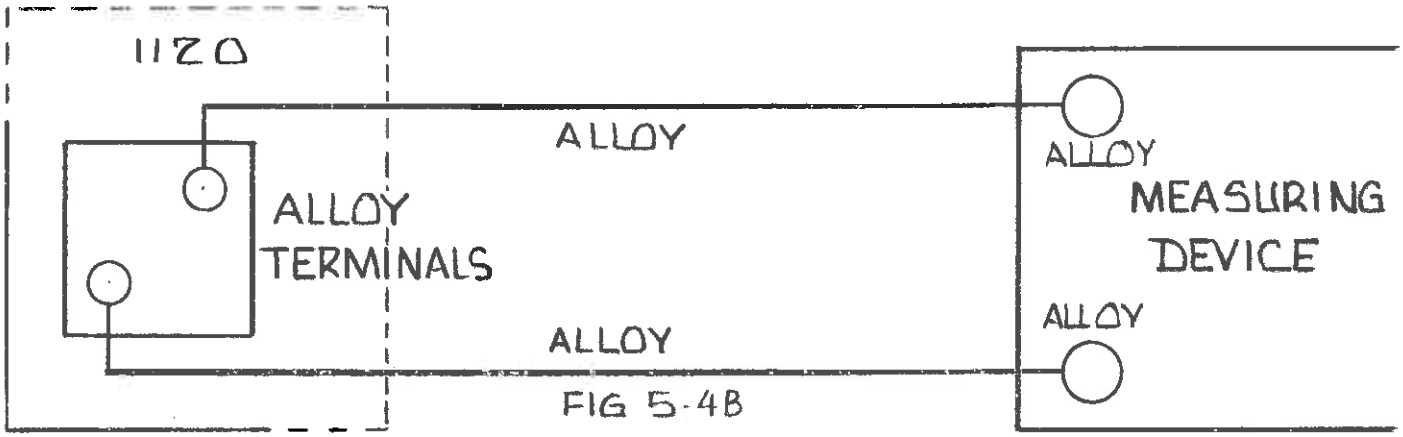


FIG 5-4B

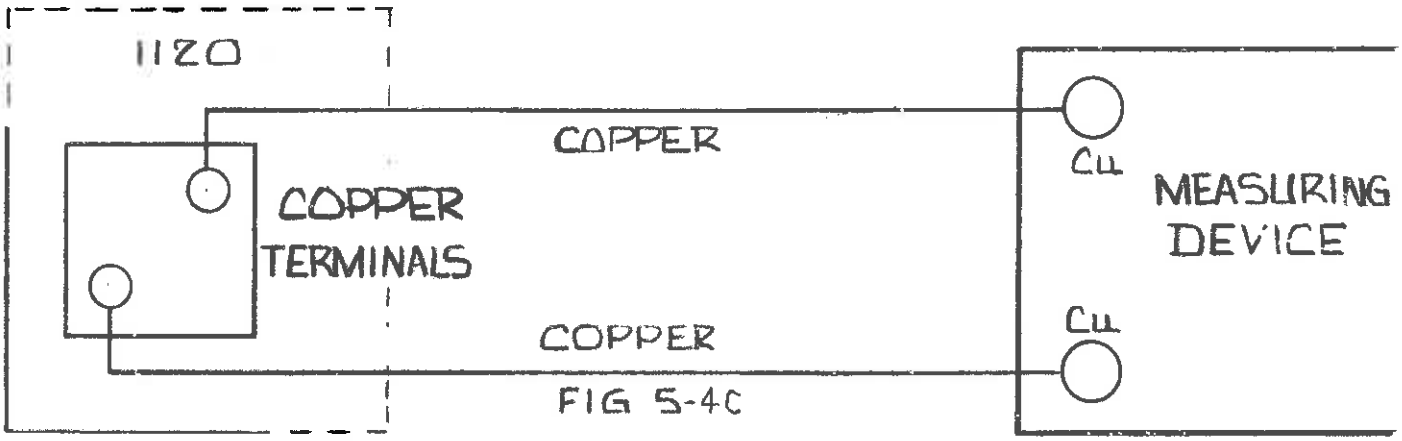


FIG 5-4C

MODEL 1120

CONNECTIONS FROM FRONT PANEL
TERMINALS TO MEASURING DEVICE

FIG 5-4

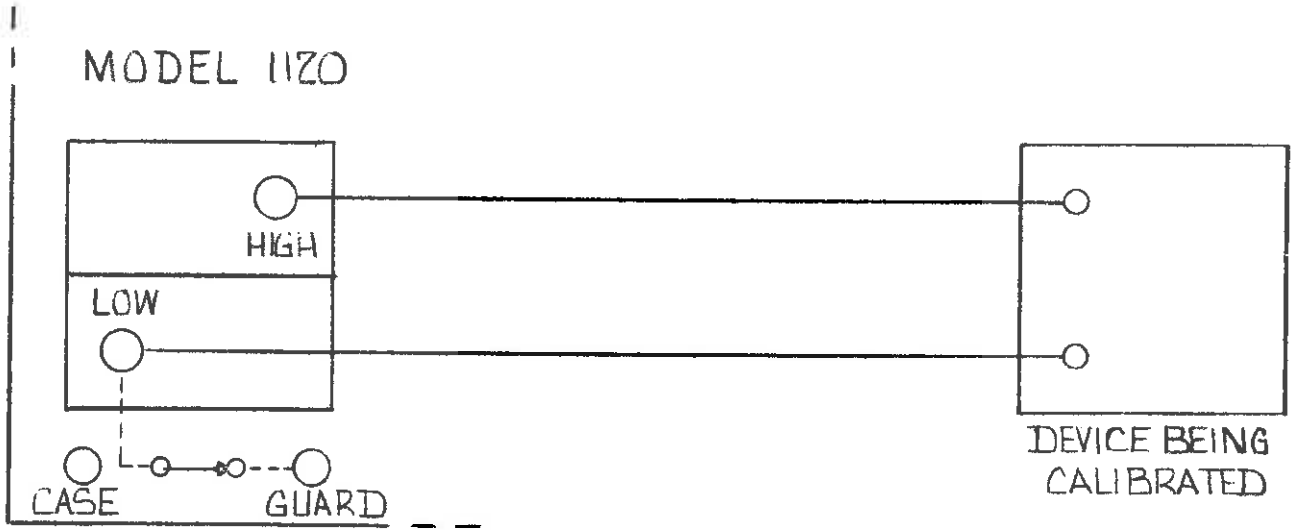


FIG 5-5A
NO COMMON MODE VOLTAGE

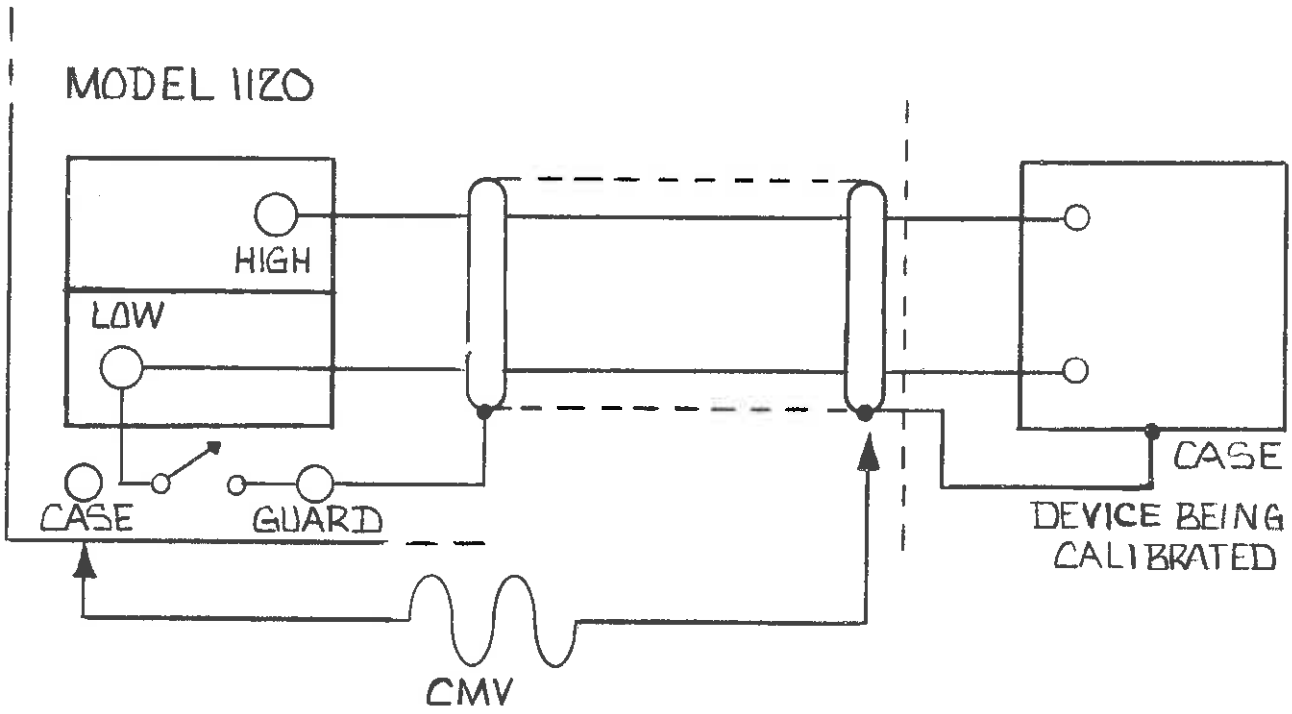
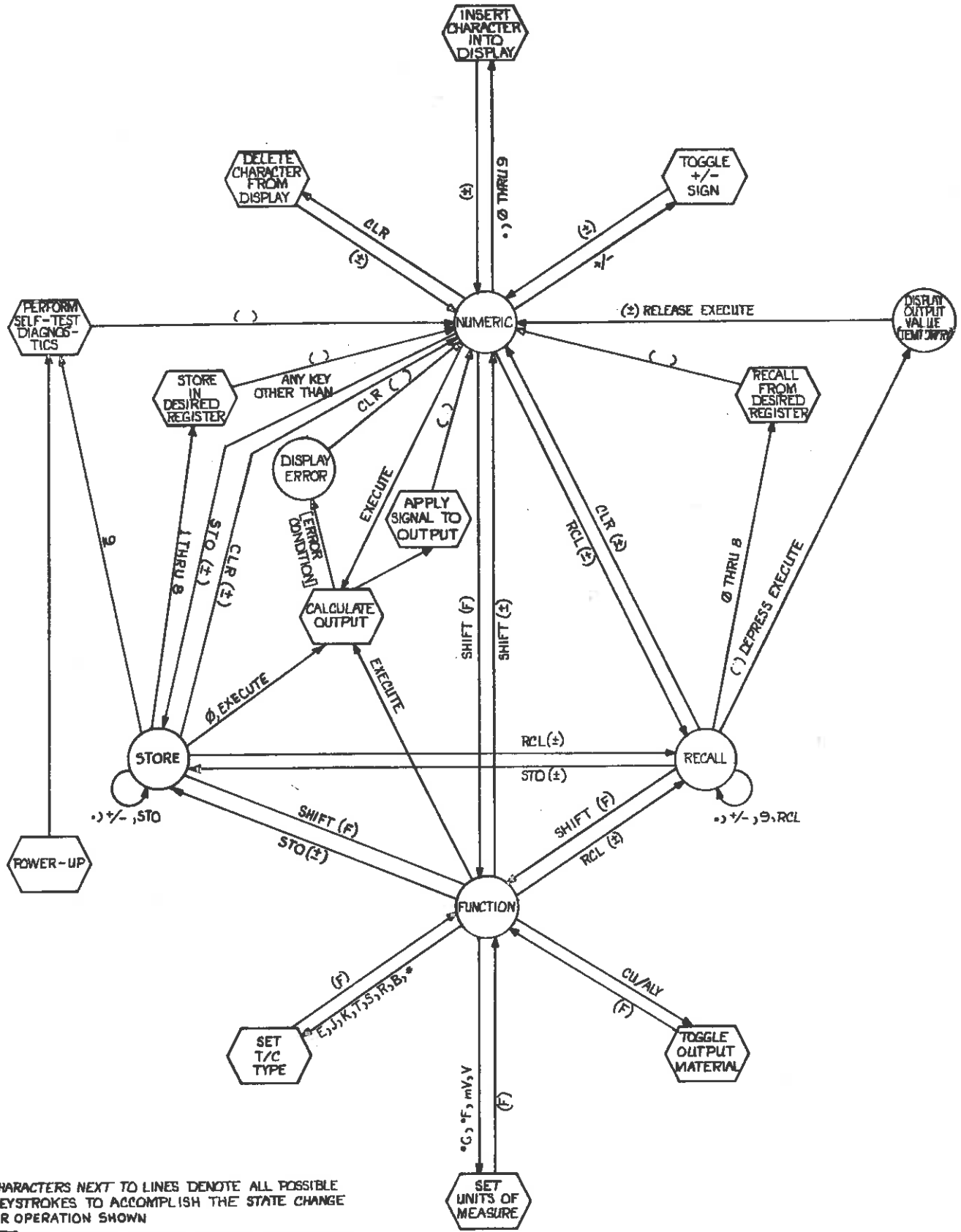


FIG 5-5B
COMMON MODE VOLTAGE PRESENT

MODEL 1120
CORRECT USE OF GUARD SWITCH

FIG 5-5



4 CHARACTERS NEXT TO LINES DENOTE ALL POSSIBLE KEYSTROKES TO ACCOMPLISH THE STATE CHANGE OR OPERATION SHOWN

3 ⬡ THIS SYMBOL DENOTES MACHINE OPERATIONS

2 ○ THIS SYMBOL DENOTES MACHINE STATES

1 ITEMS IN PARENTHESES DENOTE BLINKING INDICATORS:
- (±) INDICATES BLINKING POLARITY SIGN
- (F) INDICATES BLINKING FUNCTION DISPLAY
- ( ) INDICATES NO BLINKING DISPLAYS

NOTES: UNLESS OTHERWISE SPECIFIED

STATE DIAGRAM — 1120
FRONT PANEL OPERATION

FIG. 5-6

SECTION VI

THEORY OF OPERATION

This section will discuss in detail the various assemblies which constitute the Model 1120. It also presents, where required, simplified schematics to facilitate discussion.

6.1 ANALOG ASSEMBLY (DRAWING 120-607)

The analog assembly is installed in J205 on the mother board and the integral COPPER/ALLOY terminals project through an opening in the front panel. When rear terminals are installed (Option 03) these terminal blocks are removed from this assembly, and the necessary interconnections are made by cable to the rear terminals. The principal function of the assembly is to drive the output terminals.

Included on the analog assembly are

the output amplifier
two DAC's
a precision ±10Vdc reference
temperature sensing for the output terminals
output amplifier overload sensing
a ±8Vdc supply for CMOS

6.2 OUTPUT AMPLIFIER

Figure 6-1 is a simplified schematic of the output amplifier derived from drawing 120-607. The outputs from the two DAC's are summed ar U9-2. FET's Q29, 30 and 31 at the output of U9 provide a gain division of -1, -8, or -128. Q37, 38 U11-13 comprise a chopper amplifier and U13-6 drives the output terminal E6.

The internal reference voltages are ±10VDc. When the instrument is programmed for a low thermocouple temperature or as a low millivolt source, the output amplifier gain is changed for noise reduction. Table 6-1 shows the voltages at which the gain is changed.

OUTPUT VOLTAGE	AMPLIFIER GAIN
±1.375 TO ±11.0000	1
±0.085938 TO ±1.375	1/8
0 TO ±0.085937	1/128

Table 6-1

Gain changes are accomplished by FET switches Q29, 30 and 31. When Q29 conducts, the gain is 1 (R73 + R75 + R76/R72). When Q30 conducts, the gain is 1/8 (R75 + R76/R72 + R73) and when Q31 conducts, the gain is 1/128 (R76/R72 + R73 + R75).

The resistance of the calibration potentiometers R74 and R77 is not included in the above formulas.

FET's Q29, 30 and 31 are controlled by levels at SC0 and SC1. When the MOSFET Q34 conducts, Q31 is held off by a negative voltage on the gate. Q34 conducts when either Q32 or Q33 are conducting. Table 6-2 shows the output amplifier gain with level changes at SC0 and SC1.

	X1	X1/8	X1/128
SC0	0	+5	0
SC1	+5	0	0
Q34	ON	ON	OFF
Q31	OFF	OFF	ON
Q29	ON	OFF	OFF
Q30	OFF	ON	OFF

Table 6-2

The chopper amplifier consists of Q37, Q38, U10, 11, 12 and 13. U10A and U10B buffer and shape the incoming clock (pin 42 on the card edge connector) provide two levels which differ by 180 degrees. The chopping frequency is 1.2kHz and is derived from a 4.9152MHz crystal oscillator after division of 4096. MOSFET Q37 chops any dc level appearing on C14 which provides a square wave referenced to ground at the input vase of Q38. The square wave is amplified by Q38, U11 and demodulated by U12. The resulting dc level again referenced to ground is applied to U13-2.

6.3 DAC's

The output of the precision ±10Vdc reference supply is applied to two DAC's. One DAC consists of discrete components and contributes the major portion of the output voltage. The second DAC is a monolithic IC and contributes the minor portion of the output voltage.

Figure 6-2 is a simplified schematic derived from Drawing 112-607. It shows the DAC consisting of discrete components and the monolithic DAC U6. The MOSFET pairs Q7, 8 through Q27, 28 are shown as a form C switch, and in practice an invertor (U4, 5) is used to ensure when one MOSFET is conducting the other is not conducting. The MOSFET's pairs are selected for an on resistance of <4Ω at 100μA, and matched within 0.2Ω. The outputs of the DAC's are summed at U9-2, which is the input to the output amplifier.

U9-3 is at ground potential, and U9-2 is held at ground potential by the DAC current and the current of opposite polarity through R65. When the MSB is on as is shown in Figure 6-2, a current of 1mA flows through R22 to U9-2 which

is opposed by current flowing through R65. The voltage is 8.3886 at U9-6 for a current of 1mA.

Twenty-one bits are applied to the DAC's, eleven to the discrete DAC and 10 to the monolithic DAC. Table 6-3 shows the contribution of each DAC to the summing junction at U9-2:

BIT	DISCRETE	BIT	MONOLITHIC
1	8.388608V	12	0.004096V
2	4.194304	13	0.002048
3	2.097152	14	0.001024
4	1.048576	15	0.000512
5	0.524288	16	0.000256
6	0.262144	17	0.000128
7	0.131072	18	0.000064
8	0.065536	19	0.000032
9	0.032768	20	0.000016
10	0.016384	21	0.000008
11	0.008192		

Table 6-3

The output of the discrete DAC is connected directly to U9-2. The output of the monolithic DAC U6, however, is reduced by the gain of U8 (1/500) and the attenuator consisting of R59, R57, R65 and U9 (approximately 0.4). The reference voltage of 10Vdc is applied to U6-15. The MSB of the monolithic DAC is 512/1024 X 10 volts or 5 volts which is reduced to 1/500 and 0.4 and is approximately 4mV. In a similar manner, the LSB is 1/1024 X 10 volts X 0.4 and is 8μV. 8μV multiplied by 2^{20} is 8.388608 which is the MSB of the discrete DAC and also the value of R65 in thousands of ohms.

6.4 PRECISION ±10VDC REFERENCE (DRAWING 112-607)

The output of a stable zener is amplified, inverted and applied through JFET switches to the DAC inputs. Circuitry is included to ensure starting. CR1 is a 6.2Vdc zener selected for short and long term stability. The zener voltage is applied to the noninverting input U1-3 and amplified to provide +10Vdc. A divider network from U1-6 to common consisting of resistors R10, R16 and the calibration potentiometer R12 provides an output of +10Vdc at U1-6. U2 is an inverting amplifier with a gain of -1 which provides which provides a -10Vdc output at U2-6.

Transistors Q1 and Q2 insure that sufficient current is applied to CR1 when the instrument is first energized. Q2 does not conduct if no voltage is present at U1-6, and Q1 conducts which applies + 15Vdc to CR1 through R2.

The ±10VDc are applied to the JFET switches Q3 and Q4 respectively, which select the reference polarity. The source of Q3 and Q4 is connected to U3-3 which is a +1 amplifier used to drive the DAC's. The control for Q3 and Q4 is applied to pin 12 of the card edge connector. When pin 12 is low, Q5 does not conduct, -15Vdc is applied to Q4 and Q6 through R19, 21 and CR2. Q6 does not conduct allowing Q3 to conduct which applies a positive reference voltage to the DAC's. When pin 12 is high (+ 5Vdc), Q5 conducts applying a positive voltage to the junction of CR2 and R19. Q6 conducts and applies -15Vdc to Q3 turning it off. Q4 conducts which applies a negative reference voltage to the DAC's.

6.5 TEMPERATURE SENSING, OUTPUT TERMINALS (DRAWING 120-607)

U15 and U16 are selected LM234's. Although it is catalogued generically as a 3 terminal current source, the specifications for this device indicate that it has a very predictable and linear temperature coefficient. This is used to measure the temperature of the gold plated copper front panel terminals.

The terminals are thermally connected but electrically isolated. The plastic version of the LM234 is mounted inside each terminal to measure the temperature individually. The devices are powered by the ±10Vdc reference supply, and the outputs are paralleled and connected to pin 47 on the card edge connector. J205-47 on the mother board connects to pin 35 on the ADC U216. The outputs of U216 are applied to the microprocessor U208 which calculates the reference junction compensation.

6.6 OUTPUT AMPLIFIER OVERLOAD SENSING (Figure 6-3)

The front panel NOT VALID indicator is illuminated when either the output amplifier is overloaded or the microprocessor is computing. Two comparators sense these conditions and apply power to the indicator. Part of the circuit is on the Analog assembly and the remainder is on the mother board.

Figure 6-3 is a simplified schematic of the circuit. The voltage at pin 8 of the demodulator U12 is zero when no overload is present and also zero at pin 4 of the microprocessor U208 when it is not computing. U14 is a dual comparator and the outputs at U14-1 and -7 are 5VDc in the absence of an overload condition and the NOT VALID indicator is extinguished.

Two resistive dividers on U14-3 and U14-6 force the comparator outputs to +5 volts when no overload condition is present at U12-8. When the voltage at U12-8 exceeds approximately ±2Vdc, one comparator output is low, U202-6 is

high, U209-6 is high and U215-7 is low. When U215-7 is low, the NOT VALID front panel indicator is illuminated.

The Serial Output Data (SOD) at pin 4 is zero when the microprocessor U208 is not computing, and is +5 while computing. U208-4 is connected to the OR gate U209-4. U209-6 is high and the sequence continues as above.

6.7 MOTHER BOARD (DRAWING 112-605, Figure 6-4)

In addition to the microprocessor U208, the mother board contains the necessary logic to control the various integrated circuits and plug-in assemblies. Also included are two electronic switches which ensure memory retention when the instrument is turned off and that the microprocessor is clamped until the voltages are adequate when the instrument is turned on.

The following is a list of all connectors located on the mother board with description and use:

J201: 15 pin double readout, Main Program Memory assembly Drawing 112-609.

J202: 8 pin male, Secondaries 1 and 2 on transformer T701, Drawing 112-606.

J203: 20 pin male double readout, Front Panel, Drawing 112-602.

J204: 8 pin male, Power Supply test connector.

J205: 28 pin double readout, Analog Assembly.

J206: 18 pin double readout, Remote Program.

J207: 6 pin, Remote Program.

J208: 18 pin double readout, Power Supply Drawing 112-606.

J209-J216: 15 pin double readout, Thermocouple Modules Drawing 112-608.

J217: 8 male pins, secondaries 3 and 4 on Drawing 112-606.

The following list shows the integrated circuits used on the mother board, the manufacturers part number, and a brief description if their function.

U201: MC14020B Ripple-carry binary counter; divides 2.4576 MHz clock by 2^{11} (1/2048)

to provide a 1.2KHz pulse to operate the chopper on the Analog Assembly.

U202: 74LS05 Hex invertor; miscellaneous use.

U203: 74LS123 Dual multivibrator; used to reset the microprocessor U208 when the ac power is turned on.

U204: 78L05 5 volt regulator for + Vcc on U206 and U207.

U205: 74LS74 Dual D type positive edge triggered FF. Used for test purposes only, drives TP201, not normally installed.

U206, U207: 6514 CMOS RAM's: contain all non-vola tile memories.

U208: 8085A Microprocessor. Controls all logic in the instrument and generates a 2.4576 MHz clock from a 4.9152 MHz crystal Y206.

U209: 74LS32 Quad 2 input OR gate. Miscellaneous use, one gate not used.

U210: 74LS373 Octal transparent latch used for low order address latch.

U211: 74LS139 Dual 1 of 4 decoder. Used for line and address decoding.

U212: 74LS138 1 of 8 decoder/multiplexer. Used for address decoding to select thermocouple module.

U213: Same as U212. Used for address decoding for I/O (input/output) selection.

U214: P8255A Programmable peripheral interface used to feed front panel display.

U215: 75492 Hex LED driver. Two sections not used.

U216: 7109CPL A/D converter. Used to provide a digital output which is a function of the temperature of the front panel terminals.

U217: P8279-5 Keyboard and display encoder.

U218: 74LS08N Quad 2 input AND gate. One section used for RAM enable.

U222: 128K-byte EPROM containing all software for operation and alignment

Figure 6-4 is a simplified schematic derived from drawing 112-605. It shows the interface between the mother board logic, the plug-in assemblies, the displays and the keyboard. It does not show miscellaneous gates not electronic switches.

6.8 ELECTRONIC SWITCHES (DRAWING 112-605)

One switch is comprised of Q201-203 and U203. The unregulated voltage applied to U204 is approximately 9 volts. When the instrument is operating Q201 is conducting. The voltage at the base of Q202 is greater than that at the base of Q203 causing Q202 to conduct which drives the base of Q201. When the ac power is removed, Q201 opens when the voltage at the base of Q203 becomes less than 4.7Vdc. This asserts the trap input to the microprocessor to execute power down routines. U208-6. U202-4 is high when the instrument is operating. When the ac power is restored and the collector voltage at Q201 goes low, U203-5 goes high and then low after a delay resets the microprocessor at U208-36.

Q209 is not conducting when the instrument is operating, but when the ac line power is removed, the collector voltage of Q201 rises, causing Q209 to conduct after delay by C237 and R240. This clamps the RESET IN to ensure the microprocessor does not get reset prematurely by spikes occurring during power down and power up.

When the ac line power is turned off, the battery BT201 is connected through Q205 to the RAM's U206, 207 to retain the memory. When the ac line power is applied, Q204 begins conducting at approximately 4.2Vdc which applies base drive to Q206. The collector of Q206 goes low which opens Q205 and the battery BT201 is disconnected from the RAM's U206 and U207. Diode CR205 is reverse biased when 5Vdc is present, and it functions to maintain the connection from BT201 to the RAM's in case of slow start up.

When Q204 conducts, base drive is also applied to Q207. The collector of Q207 is connected to the CE (chip enable) inputs of U206, 207 pin 8. When these inputs are low the RAM's are enabled. This is accomplished when the emitter of Q207 is low by the output at U209-3. U209-3 is low when U211-6 is low (RAM enable) or the microprocessor selects RD or WR (read or write) after inversion by U213.

Note that the bridge rectifier CR207 and capacitors C233,

C234 which are part of the power supply are located on the mother board.

6.9 THERMOCOUPLE MODULE (DRAWING 112-608)

Each thermocouple module has a ROM which contains the function f(t) = V for a given thermocouple type and temperature. The calculations are performed in 32 bit floating point arithmetic with an accuracy of ± 1μV. The modules can be installed in a random manner in J209-216 on the mother board. Diode arrays CR401-CR403 and zener CR404 protect the MOS device U401 from static discharges.

6.10 POWER SUPPLY (DRAWING 112-615)

The Power Supply consists of a plug in assembly which mates with J208 on the mother board and a power transformer T701 which is mounted on the rear panel. The bridge rectifier CR207 and filter capacitors C233, 234 are installed on the mother board. The circuit is conventional except for Q501 which is a silicon controlled rectifier (SCR). It does not conduct under normal operation but if an overvoltage condition should exist it conducts and shorts the +5VDc supply. This protects the IC's on the mother board. When the voltage is normal, the 5Vdc zener CR507 does not conduct and Q501 is open. An overvoltage condition causes CR507 to conduct which applies a positive voltage to the gate of Q501. Q501 then conducts which shorts the +5Vdc supply to ground.

The fuseholder J701 which is located on the rear panel consists of the fuse, an ac line filter and a small removable printed circuit board. The fuse can not be removed with the line cord in position. When the line cord has been removed a plastic window can be positioned to the left to allow access to the fuse and a small printed circuit board. The printed circuit board is installed in one of four possible positions to select the proper taps on the power transformer T701. The selected line voltage is visible on the printed circuit board when it is installed. The power transformer primary taps are asymmetrical to accommodate the four available line voltages.

The fuse F701 should be 3/4A SB for line voltage settings of 100 and 120Vac and 3/8A SB for line voltage settings of 220 and 240Vac.

6.11 FRONT PANEL (DRAWING 112-602)

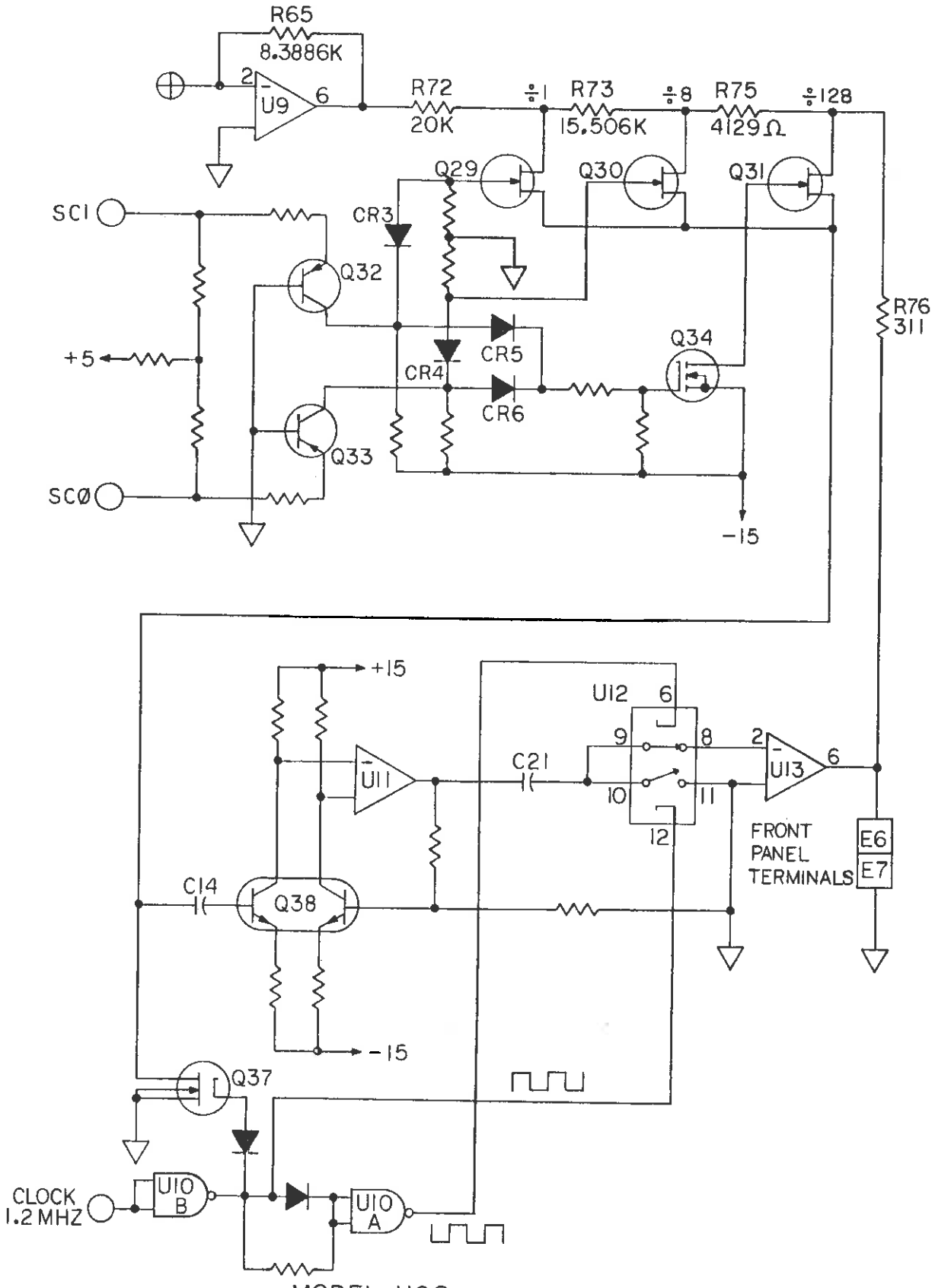
The Front Panel contains all displays except the three tier display at the left of the panel. Also included are the keyboard and the EXECUTE key. In addition, the front panel contains the line power switch S902 and the GUARD switch S901, but they are not a part of the front panel electrical-

ly. All components are installed on a printed circuit board.

The printed circuit board contains three IC's which provide the necessary inversion to operate the displays plus resistor arrays and transistor switches. Transistors Q601-606 supply anode voltage to the numeric displays, and the lines identified as SEG A - SEG G select the segment of the display. DP selects the decimal point. One half of the DS605 indicates the °F function and the other half the °C function. One half of DS606 indicates the Volts function and the other half indicates the millivolt function. The control lines are DL1, DL0, DL3 and DL2 respectively after inversion. DS607 is extinguished if the Reference Junction temperature is 0°C and illuminated if the Reference Junction temperature is not 0°C. The control line is DL6. The single alphanumeric display DS604 indicates the thermocouple type selected or it displays an asterisk (*) to indicate selection of a thermocouple type other than E, J, K, T, R, S or B. The control lines are OA0-OA3 and OB0-OB3 after inversion by U601 and part of U602. Q614 is not used. DS604 has two symmetrical parts, and selection of one part or both is accomplished by Q615 and Q616 controlled respectively by lines SC6 and SC7 after inversion.

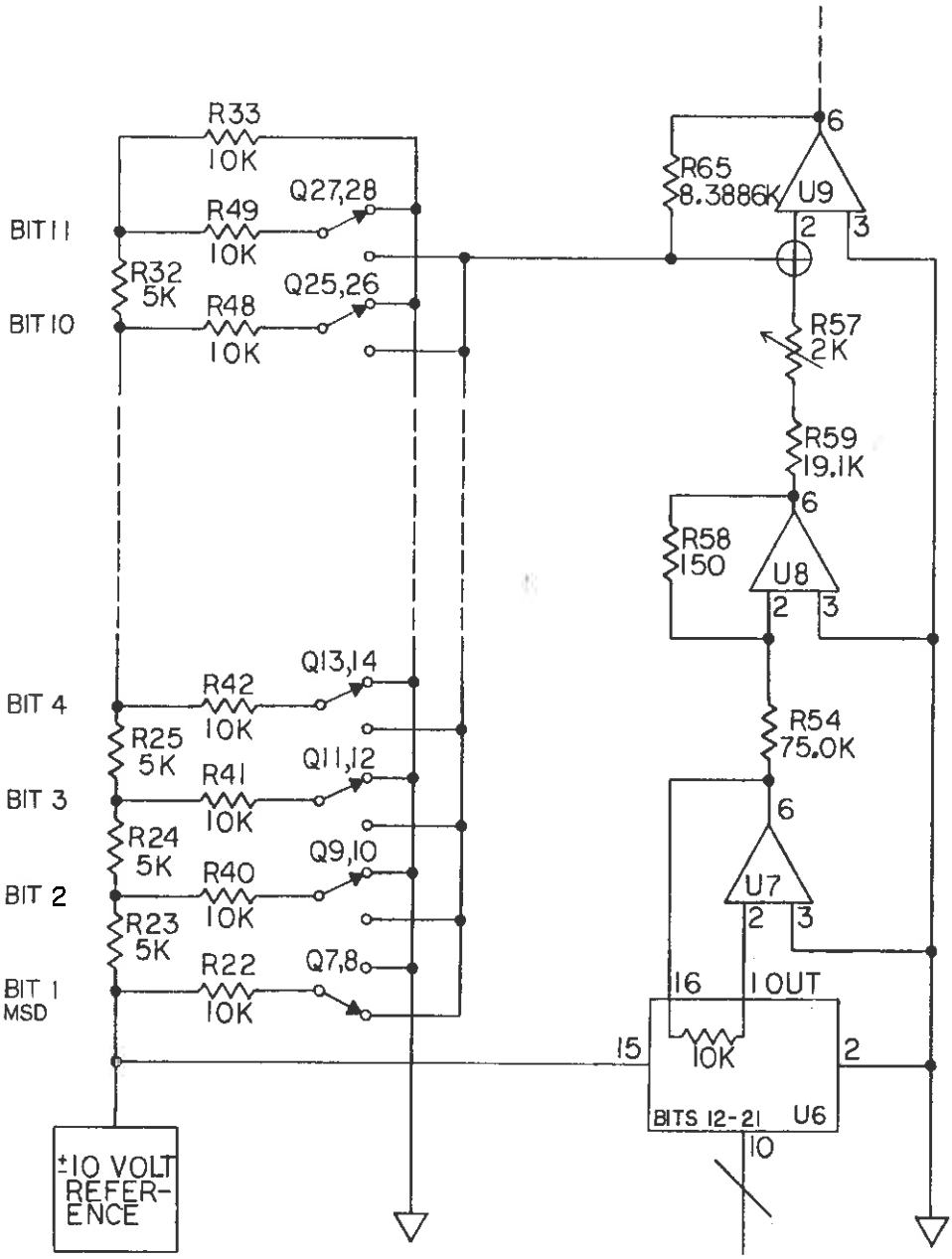
The keyboard consists of 16 form A switches which are connected to the mother board. Figure 6-4 shows the interface. The EXECUTE key is connected to the microprocessor. All connections to the mother board are made through J203.

Although the ac power switch S902 is mounted on the front panel, it is wired to the fuse holder J701 on the rear panel. S902 breaks both the high and low ac line as shown on drawing 112-610. The GUARD switch S901 is connected in a similar manner to E209 and E210 on the mother board.



MODEL 1120
OUTPUT AMPLIFIER

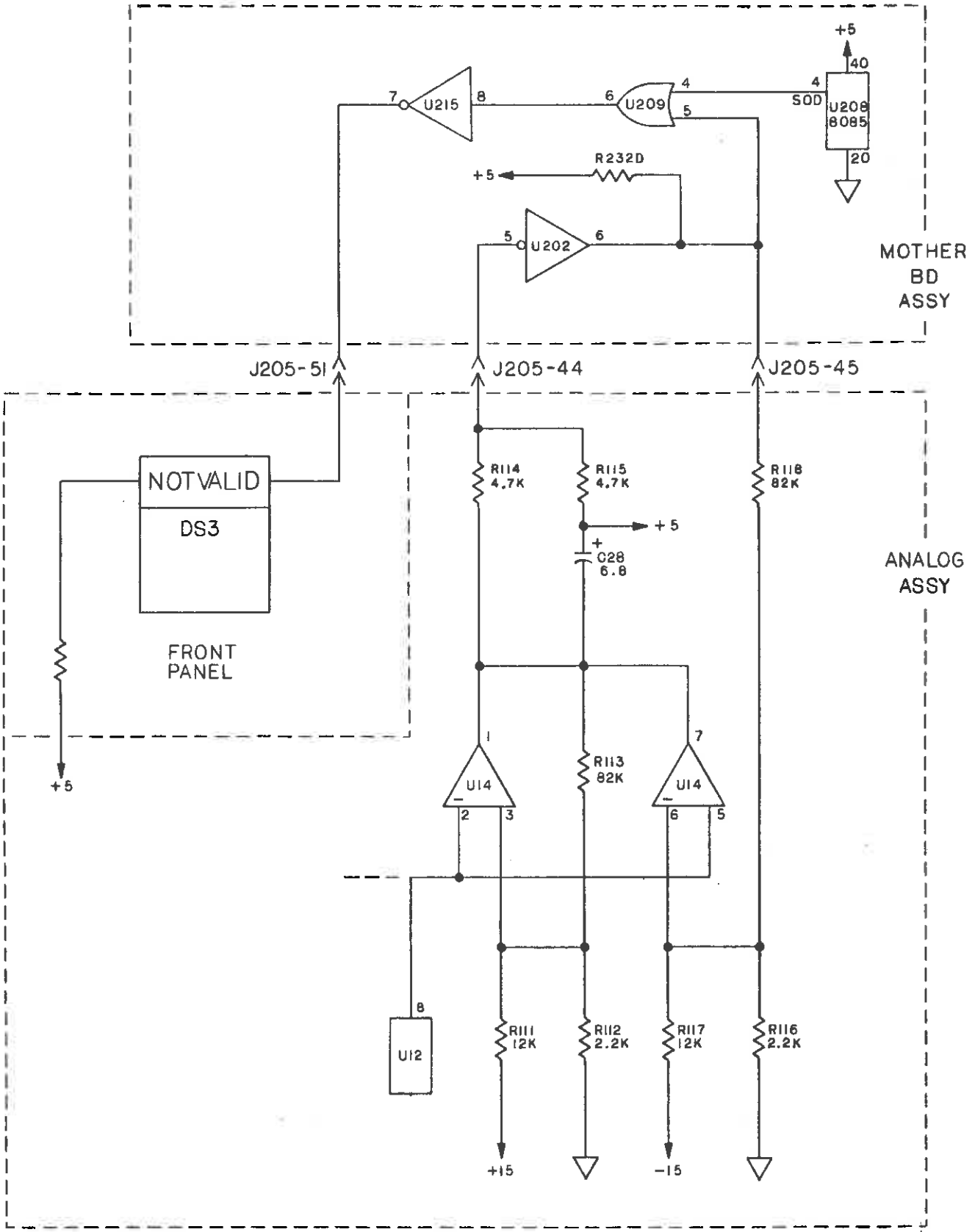
FIG 6-1



MODEL 1120

DAC

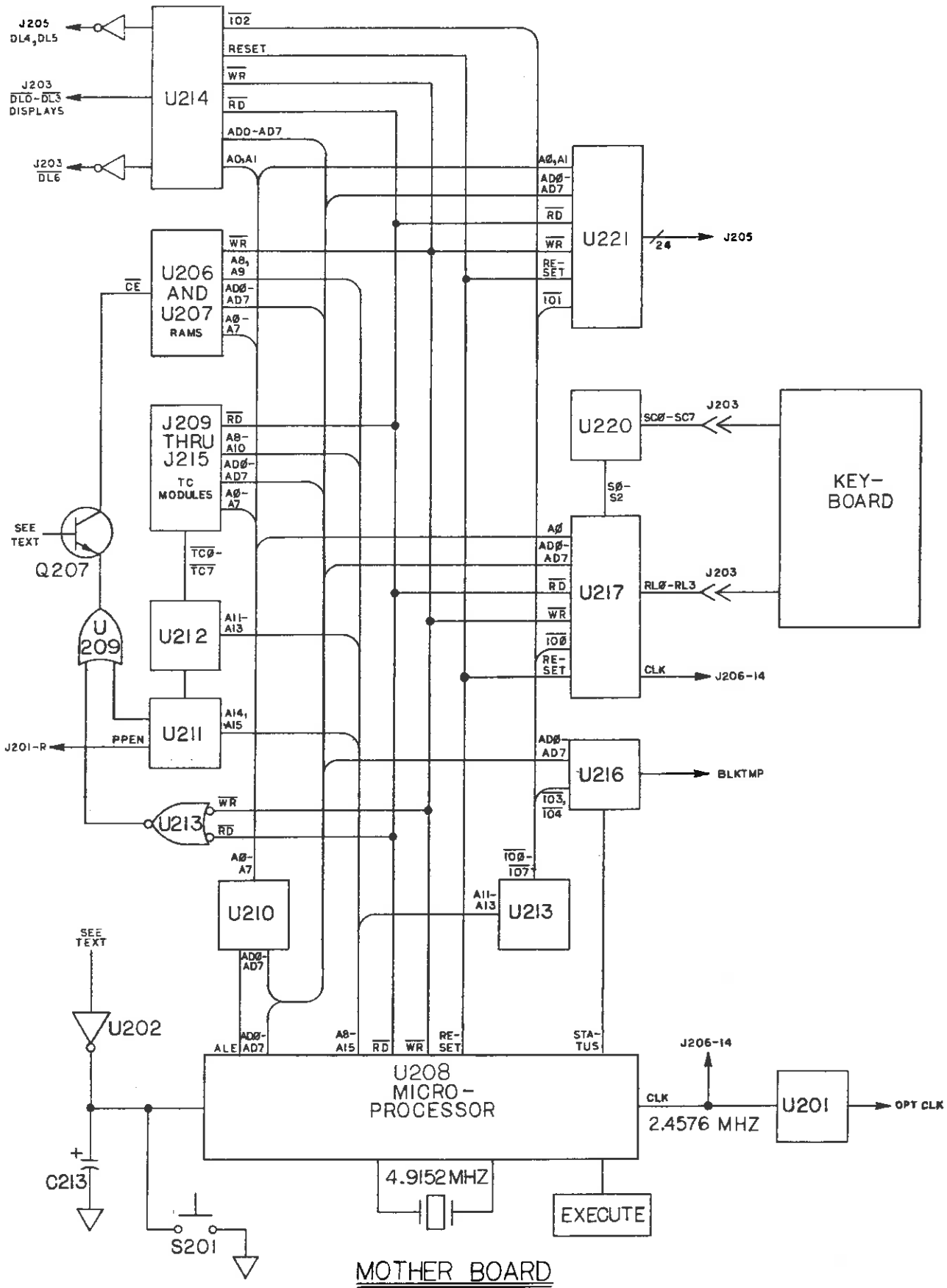
FIG 6-2



MODEL 1120

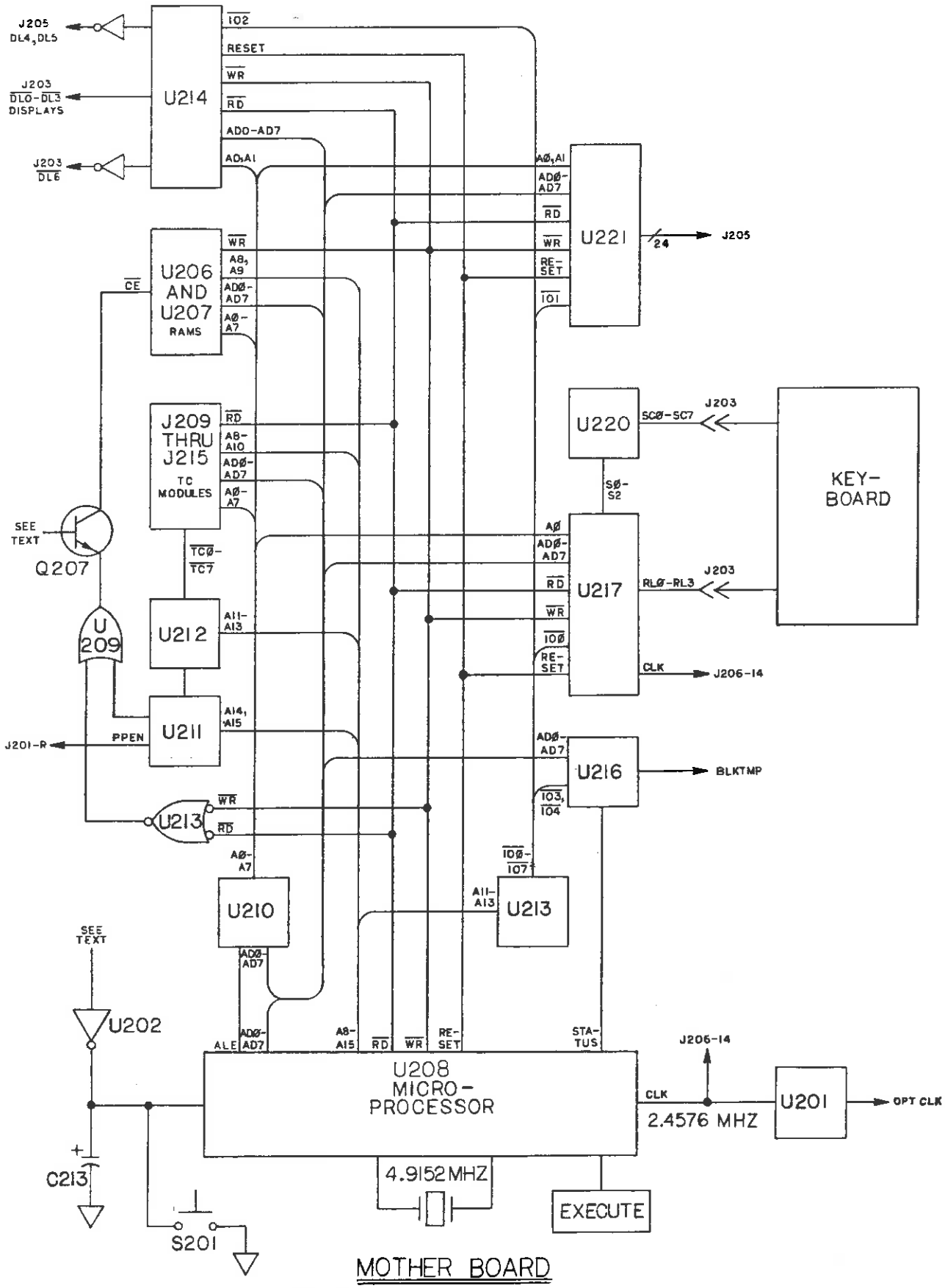
OVERLOAD INDICATOR

FIG 6-3



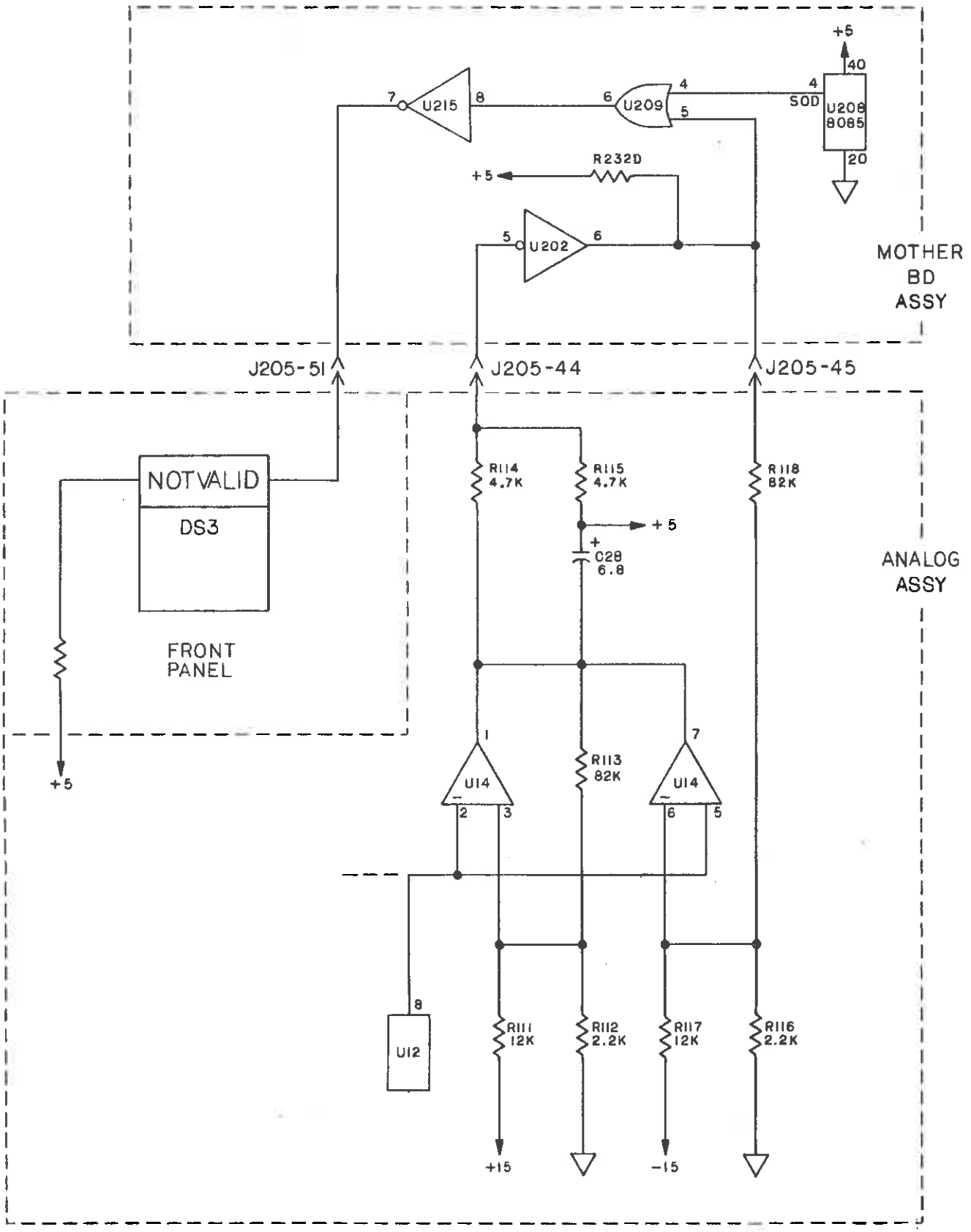
MOTHER BOARD
SIMPLIFIED SCHEMATIC

FIG 6-4



MOTHER BOARD
SIMPLIFIED SCHEMATIC

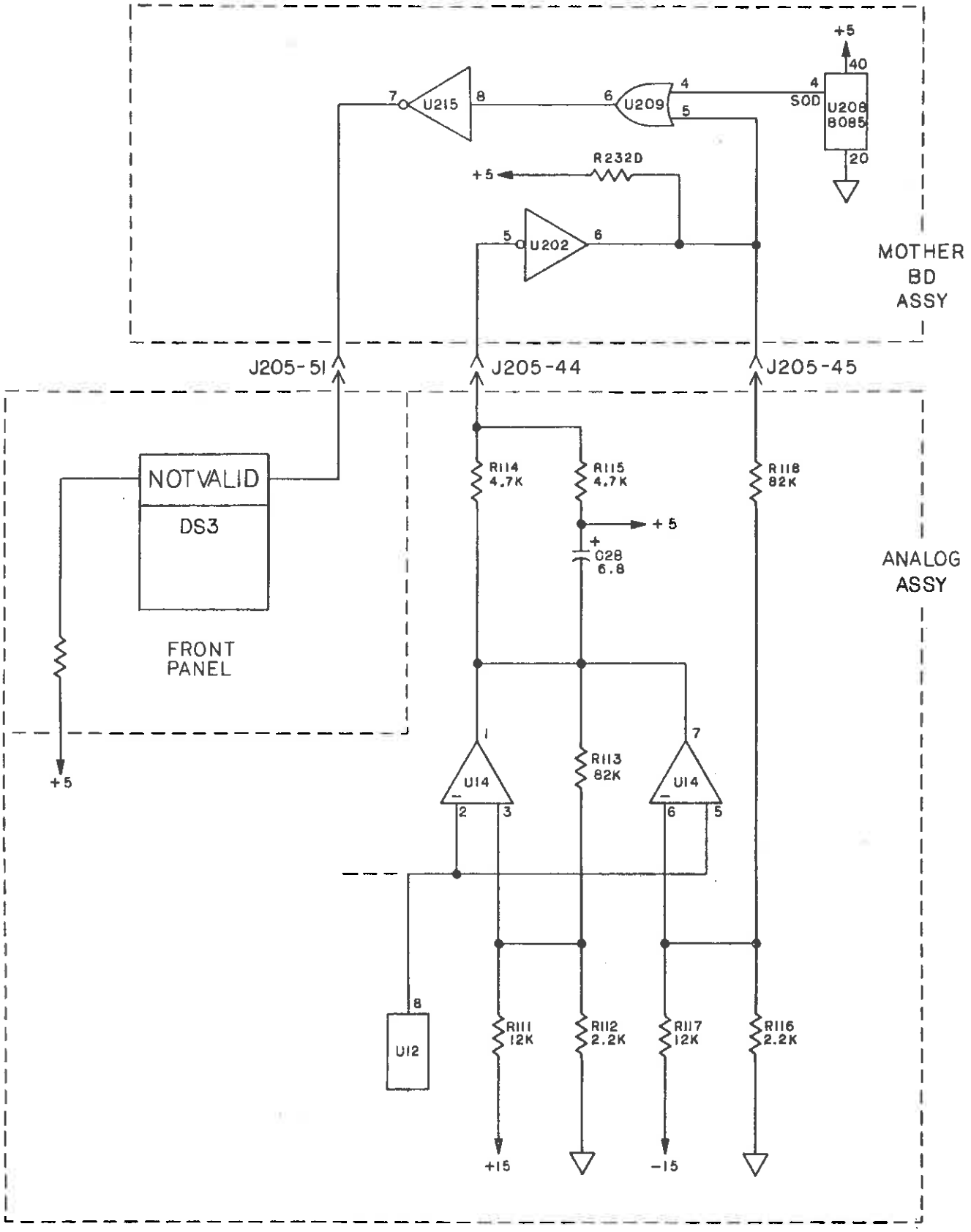
FIG 6-4



MODEL 1120

OVERLOAD INDICATOR

FIG 6-3



MODEL 1120

OVERLOAD INDICATOR

FIG 6-3

SECTION VII

CALIBRATION AND MAINTENANCE

7.1 CALIBRATION

7.1.1 General: In addition to maintenance that can be performed on the Model 1120, two alignment procedures are presented. If the unit under test has not had service and is only in need of calibration with minor or no adjustment, proceed to Paragraph 7.1.3. However, if repairs have been made or if a complete realignment is warranted proceed with Paragraph 7.1.4.

In many instances, the procedures contain the same steps, and in the abbreviated procedure, reference is made to the complete one for several steps. The list of required equipment in Paragraph 7.2 pertains to both procedures as does Figure 7-1.

7.1.2 Equipment Required

Galvanometer 1μV resolution. Keithley 155 or equivalent.

Dc voltage standard 10Vdc ±0.001% Fluke 731B or equivalent.

Voltage divider, 10kΩ input resistance, 5ppm linearity ESI RV622A or equivalent.

Oscilloscope, 50μV/cm vertical sensitivity, bandwidth to 1MHz with 10kHz filter. Tektronix 5110 main frame, 5B10N time base, 5A21N vertical amplifier or equivalent.

Digital multimeter, 100μV resolution, >100MΩ input resistance at 10Vdc.

Resistance substitution box, 1Ω steps, 10MΩ range.

Ice-point reference, 0 ± 0.02°C, Kaye Instruments K140-4 or equivalent.

Reference Thermocouple, see section 7.1.4.13.2.

7.1.3 Recalibration Procedure

NOTE

For a complete explanation on using the Alignment Mode in the Model 1120, refer to Section 5.2.2 on page 5-6.

7.1.3.1 Preliminary

7.1.3.1.1 Turn off the unit and remove the top cover. Switch the alignment switch to the ALIGN mode. Place the cover on top of the unit.

7.1.3.1.2 After each adjustment quickly close the top cover. Allow a few seconds before taking a reading.

7.1.3.1.3 Connect the unit to be aligned as in Figure 7-1.

7.1.3.2 Procedure

7.1.3.2.1 Turn off all DAC bits (+00128 on display).

7.1.3.2.2 Connect the test clip to E2 on the Analog board. (Fig 7-1)

7.1.3.2.3 Adjust R53 for 0 ± 1mV.

7.1.3.2.4 Connect the test clip to E3.

7.1.3.2.5 Adjust R64 for 0 ± 3μV.

7.1.3.2.6 Connect the test clip to E4.

7.1.3.2.7 Adjust R69 for 0 ± 5μV.

7.1.3.2.8 Complete the Output Stage Noise Adjustment in Paragraph 7.1.4.6.

7.1.3.2.9 Set the output to 0, divide by 128 (+00128 on display).

7.1.3.2.10 Connect the test clip to plus output binding post of the 1120.

7.1.3.2.11 Adjust R81 for 0 ± 1μV.

7.1.3.2.12 Set the output to 0, divide by 8 (+008 on display).

7.1.3.2.13 Adjust R137 for 0 ± 1μV.

7.1.3.2.14 Set the output to 0, divide by 1 (+001 on display).

7.1.3.2.15 Adjust R69 for 0 ± 3μV.

7.1.3.2.16 Repeat steps 12 through 15 as there is interaction between adjustments.

7.1.3.2.17 Leave the polarity switch in the plus position and adjust the divider to 838860.

7.1.3.2.18 Turn on bit 1 (+011) and adjust R12 to +8μV ± 40μV.

7.1.3.2.19 Adjust the divider to 419430.

7.1.3.2.20 Turn on bit 2 (+021) and adjust R34 to +4μV ± 20μV.

7.1.3.2.21 Adjust the divider to 209715.

7.1.3.2.22 Turn on bit 3 (+031) and adjust R35 to +2μV ± 10μV.

7.1.3.2.23 Adjust the divider to 104857.

7.1.3.2.24 Turn on bit 4 (+041) and adjust R36 to +6μV ± 5μV.

7.1.3.2.25 Adjust the divider to 052428.

7.1.3.2.26 Turn on bit 5 (+051) and adjust R37 to +8μV ± 3μV.

7.1.3.2.27 Adjust the divider to 026214.

7.1.3.2.28 Turn on bit 6 (+061) and adjust R38 to +4μV ± 1μV.

7.1.3.2.29 Adjust the divider to 013107.

7.1.3.2.30 Turn on bit 7 (+071) and adjust R39 to +2μV ± 1μV.

7.1.3.2.31 Repeat steps 17 through 30 until all of the bits (1-7) are approximately one half of the allowable tolerance. There is interaction between adjustments, so it may require a few passes.

7.1.3.2.32 Adjust the divider to 419430.

7.1.3.2.33 Turn on bit 2 (+021) and note the reading on the nullmeter.

7.1.3.2.34 Reverse the polarity switch to minus.

7.1.3.2.35 Reverse the polarity on bit 2 (-021) and adjust R8 for the same reading as step 33.

7.1.3.2.36 Reverse the polarity switch back to plus and adjust the divider to ~~000490.~~ 000409

7.1.3.2.37 Turn on bit 12 (+121) and adjust R57 to +6μV ± 1μV.

7.1.3.2.38 Set the output to 0, divide by 1 (+001 on display).

7.1.3.2.39 Adjust R69 for 0 ± 1μV.

7.1.3.2.40 Adjust the divider to 104857.

7.1.3.2.41 Turn on bit 1 divide by 8 (+018) and adjust R74 for +6μV ± 5μV.

7.1.3.2.42 Adjust the divider to 006553.

7.1.3.2.43 Turn on bit 1 divide by 128 (+01128) and adjust R77 for +6μV ± 1μV.

7.1.3.2.44 Repeat step 40 through 43 as there is interaction between adjustments.

7.1.3.2.45 Complete Block Temperature Measure Adjustment. See Section 7.1.3.13.

7.1.3.2.46 Turn off the input power and set the alignment switch to the OPERATE position. Turn the power back on.

7.1.3.2.47 Let the unit sit for 15 to 20 minutes with the top cover on.

7.1.3.2.48 Adjust the divider to 9999910.

7.1.3.2.49 Set the output to +10.0000V. Quickly lift the top cover, and adjust R12 to as close to zero as possible and then close the cover.

7.1.3.2.50 Reverse the polarity switch.

7.1.3.2.51 Set the output to -10.0000V. Quickly lift the top cover, and adjust R8 to as close to zero as possible and then close the cover.

7.1.3.2.52 Verify that +1.5000V and -1.5000V are in specification (± 78μV). If not, adjust R69 slightly to bring them in. (i.e. if +1.5V reads +30μV and -1.5V reads +90μV, adjust R69 for +40μV on -1.5V)

7.1.3.2.53 Next, verify +88.000mV and -88.000mV. The specification is ± 7μV. If adjustment is needed, adjust R137 in the same manner as in step 52.

7.1.3.2.54 If R137 is adjusted, then steps 52 and 53 may have to be repeated several times.

7.1.3.2.55 Tighten the four screws on the top cover.

7.1.4 Full Realignment Procedure: Before making any adjustments, make sure that all functions, line current and power supply voltages are correct. The ac line current is 250-300mA at 120Vac. Excessive line current may indicate an internal failure. The power supply voltages can easily be measured using the six-terminal connector J204 on the mother board. Pin 1 is located to the right, and the assignments are

PIN	FUNCTION
1	+15VDC ± 0.6V REFERENCED TO PIN 5
2	-15VDC ± 0.6V REFERENCED TO PIN 5
3	-5VDC ± 0.35V REFERENCED TO PIN 6
4	+5VDC ± 0.35V REFERENCED TO PIN 6
5	ANALOG GROUND
6	DIGITAL GROUND

The voltage between pins 5 and 6 should be 50mV ± 10mV with all zeroes in the display. Pin 6 is positive.

The +5Vdc should also be measured at the microprocessor U208 on the mother board. Pin 40 is nominally +5Vdc and pin 20 is digital ground. The voltage should measure 4.9Vdc ± 0.05 for units with plug-in main memory assemblies (112-502-02) and 4.95Vdc ±0.15 for units with the EPROM and CAL/OPERATE switch mounted directly to the master board. The adjustment is made by selecting R507 (Drawing 112-606) on the power supply assembly. The resistor should have a temperature coefficient of 50ppm (RN55C) and a nominal value of 249Ω.

CAUTION

Turn ac power off before removing any assemblies. Failure to do so may result in component damage.

NOTE

For a complete explanation on using the Alignment Mode in the Model 1120, refer to Section 5.2.2 on page 5-6.

7.1.4.1 Access Alignment Software

7.1.4.1.1 Turn off the front panel power switch.

7.1.4.1.2 Locate the Align/Operate switch on the mother board assembly. Set it to Align.

7.1.4.1.3 Locate the Analog Assembly. This is the vertical board closest to the left side of the instrument. Remove the component side shield from this board. It is retained by three snap type standoffs and one miniature banana plug.

7.1.4.1.4 Turn on the front panel power switch and allow the unit to stabilize for a thirty minutes.

7.1.4.2 Preliminary Setup

7.1.4.2.1 Connect the test equipment as shown in Figure 7-1. Due to the low level of signals to be measured, connections should be made using low thermal techniques. All wires and terminals should be copper, using low thermal solder in their connection. Spring steel "banana plugs" are not recommended, and any test clips used should be of copper.

7.1.4.3 U7 Zero

7.1.4.3.1 Set the divider to 000000.

7.1.4.3.2 Set all DAC bits off (+00128 on the display).

7.1.4.3.3 Connect the test clip to E2 on the Analog Assembly.

7.1.4.3.4 Adjust R53 (U7 zero) for 0 ± 1mV on the galvanometer (galvo).

7.1.4.4 U9 Zero

7.1.4.4.1 Set the divider to 000000.

7.1.4.4.2 Set all DAC bits off (+00128 on the display).

7.1.4.4.3 Connect the test clip to E3.

7.1.4.4.4 Adjust R64 for its electrical center by noting the voltage on the galvo when fully counterclockwise, then note the reading when fully clockwise, then adjust R64 to obtain a reading which is the average of those two voltages.

7.1.4.4.5 If the residual voltage is less than 1/4 the range of R64 (1/4 the difference between the counterclockwise and clockwise readings in 7.1.4.4.4), go to step 7.1.4.4.9.

7.1.4.4.6 If the residual voltage on the galvo is positive, connect the resistance substitution box at R60. If the residual voltage on the galvo is negative, connect the resistance substitution box at R63.

7.1.4.4.7 Adjust the value on the resistance substitution box for a reading on the galvo as close to zero as practical.

7.1.4.4.8 Note the value on the resistance substitution box and install the closest 1% resistor value in place of the substitution box.

7.1.4.4.9 Adjust R64 for 0 ± 3μV on the galvo.

7.1.4.5 E4 Zero

7.1.4.5.1 Set the divider to 000000.

7.1.4.5.2 Set all DAC bits off (+00128 on the display).

7.1.4.5.3 Connect the test clip to E4.

7.1.4.5.4 Adjust R69 for its electrical center by noting the voltage on the galvo when fully counterclockwise, then note the voltage when fully clockwise, then adjust R69 to obtain the average of the two voltages.

7.1.4.5.5 If the residual voltage is less than 1/4 of the range of R67 (the difference between the counterclockwise and clockwise voltages in 7.1.4.5.4) go to step 7.1.4.5.9.

7.1.4.5.6 If the residual voltage is positive, connect the resistance substitution box at R71. If the residual voltage is negative, connect the resistance substitution box at R67.

7.1.4.5.7 Adjust the value on the resistance substitution box for a reading on the galvo as close to zero as practical.

7.1.4.5.8 Note the value on the substitution box and install the closest 1% resistor value in place of the substitution box.

7.1.4.5.9 Adjust R69 for 0 ± 5μV on the galvo.

7.1.4.6 Output Stage Noise Adjustment

7.1.4.6.1 Connect the oscilloscope across the Model 1120 output terminals.

7.1.4.6.2 Adjust R108 for minimum signal of the main portion of the signal (excluding spikes). This should produce a straight line signal on the scope with the exception of spikes.

7.1.4.7 Output Stage Zero Adjustment

7.1.4.7.1 Set the divider to 000000.

7.1.4.7.2 Set all DAC bits off and the scale factor to 128 (+00128 on the display).

7.1.4.7.3 Connect the test clip to the output high binding post.

7.1.4.7.4 Adjust R81 for 0 ± 1μV on the galvo.

7.1.4.7.4.1 Set the scale factor to 8 (+00 8 on the display).

7.1.4.7.4.2 Adjust R137 for 0 ± 1μV on the galvo.

7.1.4.7.5 Set the scale factor to 1 (+00 1 on the display).

7.1.4.7.6 Adjust R69 for 0 ± 3μV on the galvo.

7.1.4.7.7 Repeat steps 7.1.4.7.2 through 7.1.4.7.6, as there is some slight interaction.

7.1.4.8 DAC Bit Adjustment: If only a minor readjustment is needed, proceed with step 7.1.4.8.24. Otherwise, perform 7.1.4.8 in its entirety.

7.1.4.8.1 See Table 7-1 for pertinent values referenced below.

7.1.4.8.2 Connect the test clip to the output high binding post.

7.1.4.8.3 Set the divider to the bit divider setting (see Table 7-1).

7.1.4.8.4 Set DAC bit 2 on and the scale factor to 1 (+02 1 on the display).

7.1.4.8.5 Adjust R34 to the electrical center of its range.

7.1.4.8.6 Repeat steps 7.1.4.8.3 through 7.1.4.8.5 for bits 3 through 7, adjusting R35 through R39 respectively, to their electrical centers.

7.1.4.8.7 Set the divider to the bit 2 setting.

7.1.4.8.8 Set DAC bit 2 on (+02 1 on the display).

7.1.4.8.9 Adjust R12 to its electrical center.

7.1.4.8.10 If the voltage on the galvo is less than ±5mV, go to step 7.1.4.8.14. If it is more than ±5mV, R11 and R13 need to be selected. Continue with step 7.1.4.8.11.

7.1.4.8.11 If the voltage on the galvo is positive, install the resistance substitution box for R13 and a jumper for R11. If the voltage is negative, install the substitution box for R11 and a jumper for R13.

7.1.4.8.12 Adjust the substitution box to bring the voltage on the galvo to 0 ± 3mV. Leave the substitution box connected as further adjustment may be required later in the procedure.

7.1.4.8.13 Adjust R12 to bring the voltage on the galvo to 0 ± 100μV. Record the voltage as bit 2 residual voltage.

7.1.4.8.14 Table 7-1 may be photocopied and the readings recorded on it. A space is provided for this.

7.1.4.8.15 Set the divider to the bit 3 setting.

7.1.4.8.16 Set DAC bit 3 on (+03 1 on the display).

7.1.4.8.17 Record the voltage on the galvo on the copy of Table 7-1.

7.1.4.8.18 Repeat steps 7.1.4.8.15 through 7.1.4.8.17 for bits 4 through 7.

7.1.4.8.19 Examine the error voltages recorded and compare them with the tabulated pot range values in Table 7-1. If none of the recorded values exceed about half of the pot range value, no further optimization is necessary. In this case proceed with step 7.1.4.8.24. If further optimization is necessary, continue with step 7.1.4.8.20.

7.1.4.8.20 Set the divider to the bit 2 setting.

7.1.4.8.21 Set bit 2 on (+02 1 on the display).

7.1.4.8.22 Adjust R12 (and if necessary, the resistance substitution box) to bring the residual voltages on bits 2 through 7 to within half

of each respective pot range. If R12 does not have enough range and the resistance substitution box is not connected, perform steps 7.1.4.8.11 and 7.1.4.8.12. Then perform this step. When R12 is adjusted, bit 2 will be affected most, and each successive bit will change half as much as the next lowest bit number. For instance, adjusting R12 for a 100μV change in bit 5 will change bit 2 by 800μV. Examine the recorded residual voltages carefully and estimate the effect of a contemplated adjustment on each bit.

7.1.4.8.23 Repeat steps 7.1.4.8.14 through 7.1.4.8.18 to make sure the adjustment has had the desired effect.

7.1.4.8.24 Set the divider to the DAC bit 2 setting.

7.1.4.8.25 Set bit 2 on (+02 1 on the display).

7.1.4.8.26 Adjust R34 for +4 (this value is the least significant digit in the Nominal Output Voltage column in Table 7-1). The allowable tolerance for this adjustment can be found in Table 7-1.

7.1.4.8.27 Repeat steps 7.1.4.8.24 through 7.1.4.8.26 for bits 3 through 7. Use Table 7-1 for values of divider settings, pot designators, voltage to adjust to and adjustment tolerance.

7.1.4.9 Adjust Ten Volt References

7.1.4.9.1 If the resistance substitution box was connected in step 7.1.4.8.11, repeat steps 7.1.4.8.7 through 7.1.4.8.9 and 7.1.4.8.11 and 7.1.4.8.12, then proceed with step 7.1.4.9.3.

7.1.4.9.2 If the resistance substitution box was not connected, repeat steps 7.1.4.8.7 through 7.1.4.8.9. If the voltage on the galvo is less than ±5mV, skip to step 7.1.44.9.4. If not, repeat steps7.1.44.8.11 and 7.1.4.8.12; then continue with step 7.1.4.9.3.

7.1.4.9.3 Obtain the closest value 1% resistor (50ppm/°C or less TC) and install in place of the resistor substitution box.

7.1.4.9.4 Be sure bit 2 is on (+02 1 on the display), then adjust R12 for +4 ± 20μV on the galvo.

7.1.4.9.5 Position the polarity switch on the divider input to "-."

7.1.4.9.6 Press the +/- key on the Model 1120 (-02 1 on the display).

7.1.4.9.7 Adjust R8 for -4 ± 20μV on the galvo.

7.1.4.10 Monolithic DAC Gain Adjustment

7.1.4.10.1 Repeat Section 7.1.4.7.

7.1.4.10.2 Set the divider to 000409.

7.1.4.10.3 Set DAC bit 12 on with positive polarity (+12 1 on the display).

7.1.4.10.4 Adjust R57 for +6 ± 1μV on the galvo.

7.1.4.10.5 Repeat Section 7.1.4.7 as there is some interaction.

7.1.4.11 Bit 1 Adjustment

7.1.4.11.1 Set the divider to the setting for bit 1.

7.1.4.11.2 Set on DAC bit (+01 1 on the display).

7.1.4.11.3 Connect the resistance substitution box across 2R133 (remove any resistors that may be installed at R133 first).

7.1.4.11.4 Adjust the resistance substitution box for +8 ± 40μV.

7.1.4.11.5 Obtain two 5% resistors such that their parallel combination results in the closest possible approximation to the value of the resistance substitution box. Install these resistors in parallel at R133.

7.1.4.11.6 Note the value on the galvo. If it is between -32μV and +48μV, skip to section 7.1.4.12. If not, proceed with step 7.1.4.11.7.

7.1.4.11.7 Adjust R12 for a voltage of +8 ± 40μV.

7.1.4.11.8 Repeat steps 7.1.4.8.23 through 7.1.4.8.27 until no further improvement can be made.

7.1.4.12 Scale Factor Adjustment

7.1.4.12.1 Set the divider to 104857.

7.1.4.12.2 Set on DAC bit 1 and scale factor 8 (+01 8 on the display).

7.1.4.12.3 Adjust R74 for +6 ± 5μV on the galvo.

7.1.4.12.4 Set the divider to 006553.

7.1.4.12.5 Set the DAC scale factor to 128 (+01128 on the display).

7.1.4.12.6 Adjust R77 for +6 ± 1μV on the galvo.

7.1.4.12.7 Repeat steps 7.1.4.11.1, 7.1.4.11.2 and 7.1.4.11.7, then repeat steps 7.1.4.12.1 through 7.1.4.12.6 as there is some interaction.

7.1.4.13 Block Temperature Measurement Adjustment

7.1.4.13.1 Return operation to the normal software.

7.1.4.13.1.1 Turn off the front panel power switch.

7.1.4.13.1.2 Set the Align/Operate switch to Operate.

7.1.4.13.1.3 Turn the front panel power switch on.

7.1.4.13.2 Connect the test equipment as shown in Figure 7-2. For the Reference Thermocouple, select a type which has the greatest Seebeck coefficient at the alignment room temperature from among the types of the thermocouple modules installed in the particular Model 1120 to be aligned.

For example, if the unit to be aligned has thermocouple modules installed for types E, J, K and S; use a calibrated type E thermocouple, since type E has the greatest Seebeck coefficient at the ambient temperature of the alignment environment. Table 7-2 is a compilation of Seebeck coefficients at 22°C. To construct the reference thermocouple, obtain a length of the needed alloys (paired wire is more convenient) and bond one end of each together to form a junction. The output of this thermocouple should then be tested with the measurement junction at the anticipated ambient temperature of the environment in which the Model

1120 is to be aligned and with the reference junction at 0°C. Record the deviation from "ideal" output at this temperature. This reference thermocouple should then terminate to copper wires for insertion into an ice point reference and the measurement junction broken for connection to the Model 1120. This completed assembly is loosely referred to as the Reference Thermocouple in this text.

7.1.4.13.3 Set the Model 1120 for 0°C, ALLOY output, and the thermocouple type selected in step 7.1.4.13.2.

7.1.4.13.4 Adjust R122 for a voltage on the galvo equal to the voltage recorded in step 7.1.4.13.2.

7.1.4.14 Re-install the component side shield which was removed in step 7.1.4.1.4. Be sure the three snap-type standoffs are fully seated. This completes the alignment procedure.

DAC BIT	NOMINAL OUTPUT VOLTAGE V**	ALLOWABLE ADJUSTMENT TOLERANCE µV	DIVIDER SETTING	POT DESIG	NOM POT RANGE µV	RESIDUAL VOLTAGES µV
1	8.388608	40	838860	*	*	
2	4.194304	20	419430	R34	±1550	
3	2.097152	10	209715	R35	±720	
4	1.048576	5	104857	R36	±350	
5	.524288	3	052428	R37	±280	
6	.262144	1	026214	R38	±90	
7	.131072	1	013107	R39	±90	

*Adjustment is made by fixed resistor.

**Use the least significant digit in these numbers as the desired set in microvolts when making final adjustments on each DAC bit.

DAC BIT ADJUSTMENT REFERENCE VALUES
Table 7-1

T/C TYPE	SEEBECK COEFFICIENT AT 22°C µV/°C
B	0.011
C	13.912
E	60.655
J	51.593
K	40.388
N	26.669
PL	31.308
R	5.868
S	5.919
T	40.420

SEEBECK COEFFICIENTS AT 22°C
Table 7-2

7.2 MAINTENANCE

7.2.1 Replacement of Lithium Battery BT201

7.2.1.1 General: The expected life of the lithium battery is greater than 2 years. The open circuit of a fresh battery is approximately 3.9Vdc, and the battery should be replaced when the voltage reaches 3Vdc. Replacement batteries are supplied with a plastic insulator which should remain in place as the battery case is the positive output.7.1.4.2

7.2.1.2 Measuring the Voltage: The easiest method to measure the voltage is to remove the line cord and the analog assembly. The voltage can be measured from the top of the mother board. The rear terminal is negative and the two front terminals are positive.

WARNING

Extreme care should be taken to prevent shorting the battery terminals together as serious damage could occur, and a prolonged short may result in the explosion of the battery.

7.2.1.3 Replacing the Lithium Battery: The lithium battery is soldered into three swaged terminals. As the terminals are not spaced evenly, the battery can only

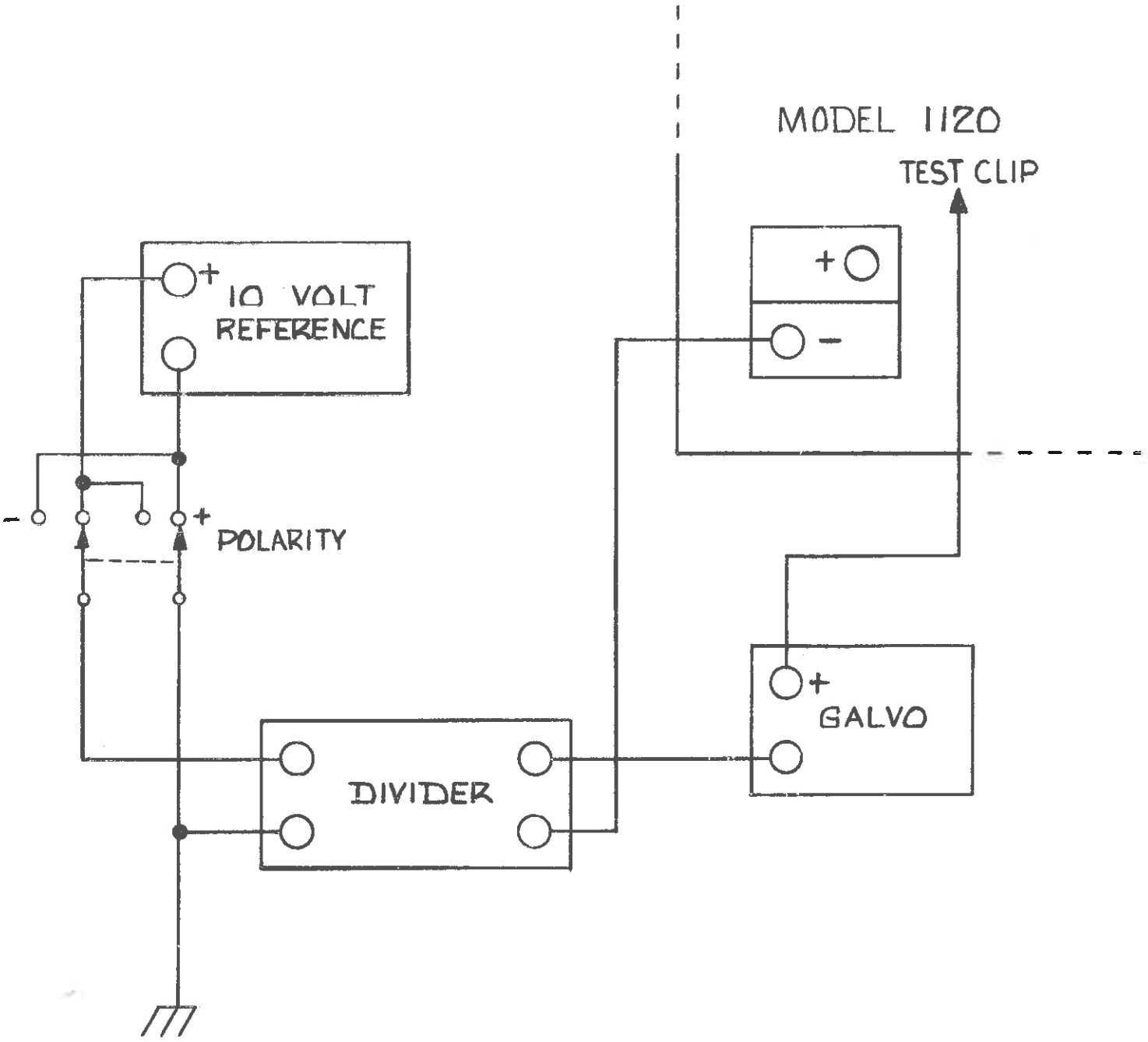
be installed in the correct position. Remove the top and bottom covers and the analog assembly. Using one hand, excerpt a steady upward pull on the battery while heating the swaged terminals on the underside of the mother board until the battery is free. The new battery is installed reversing the above.

7.2.2 Replacement of Displays

7.2.2.1 General: Both the lettered and numerical front panel displays are installed in the DIP sockets and must be pulled forward for replacement. The overlay prevents this, so the front panel must be opened to allow the displays to be removed from the sockets.

7.2.2.2 Opening the Front Panel: Remove the two top 6-32 x 1/2 oval head machine screws which secure the front panel to the side panels and tip the panel forward using the bottom screws as a hinge. Then remove the seven 6-32 x 5/16 machine screws which secure the printed circuit board to the front panel. The displays can then be removed.

7.2.2.3 Replacing the Displays: The not valid, alloy or copper, function and reference not 0°C displays are installed in a 16 pin DIP socket. The displays are wired symmetrically so they can be installed without concern for polarization. The MSD with polarity indicator installs in the obvious manner; however, the two right hand pins on the MSD mate with the socket for DS602, and three unused socket contacts on DS601 should be visible to the left after installation. The other two numerical displays install in one position only, but no damage should occur if they are installed incorrectly. The thermocouple type display is installed with the decimal points down.



MODEL 1120
CALIBRATION
CONNECTIONS

FIG 7-1

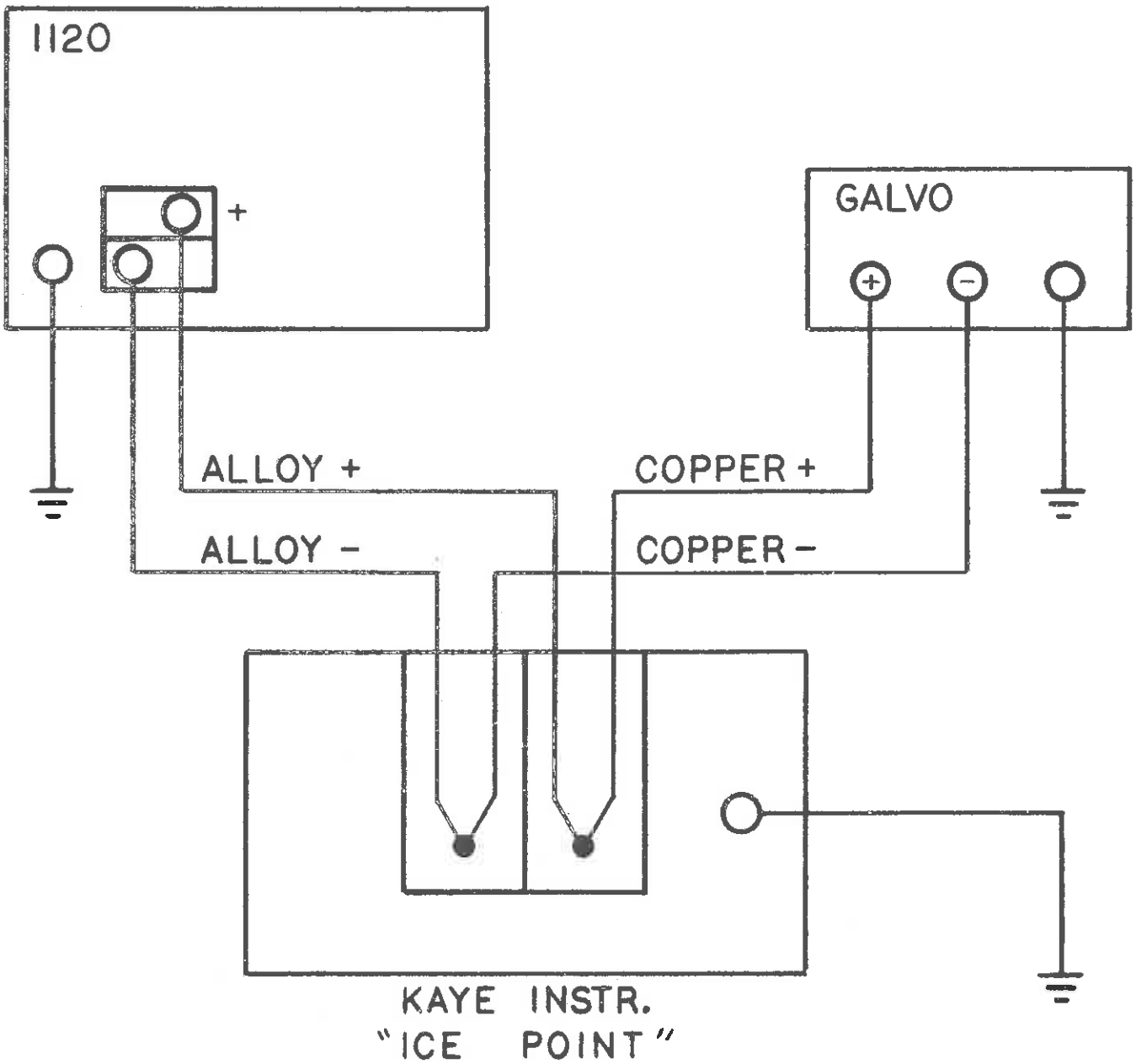


FIG. 7-2

SECTION VIII

OPTION 02, IEEE-488 INTERFACE

8.1 GENERAL DESCRIPTION

There are ten interface functions specified by the IEEE-488 Standard. Not all devices need to have all functions, and some may only have partial subsets. The interface functions supported by the ECTRON GPIB interface are SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, and DT1. These functions allow the Model 1120 to be addressed and to send data as a Talker, to be addressed and to receive data as a Listener, to perform a Service Request, to be in Remote or Local state, to respond to a Parallel Poll, to be Cleared into an initialized state, and to be Triggered for concurrent execution. The ECTRON Talker and Listener address is selected by a five-station DIP switch on the interface board.

The ECTRON GPIB interface allows full remote programming of the instrument, with support of all interface functions needed for convenient and flexible operation.

8.2 REMOTE PROGRAMMING

GPIB Remote Programming of the ECTRON Model 1120 is accomplished by sending the Model 1120 a command string which represents keystrokes as would be entered through the front panel.

Table 8-1 shows the relationship between the keyboard key codes and the character used for the corresponding function in the remote mode. The +/- key on the keyboard causes the sign of the numeric value in the display to toggle. In remote programming, the sign is sent along with the numeric information. The numeric sign remains in the previous state unless programmed different with the new command. Similarly, for CU/ALY, instead of a toggle function, a U or A is sent to denote CU or ALY. The CU/ALY state remains in the previous state unless programmed differently with the new command. The front panel operation of depressing RCL and EXECUTE to display the output setting is not supported in the remote mode.

For example,

To change the output to 4.5810 millivolts copper,

(a) Unlisten Command
(b) Address ECTRON Model 1120 as a Listener
(c) Send, 4.581 MUZ

To store the output state into register five,

(a) Unlisten Command
(b) Address ECTRON Model 1120 as a Listener
(c) Send, Y0X5

8.2.1 SERIAL POLL

When an error condition exists in the Model 1120, a Service Request will be generated and the Model 1120 will respond with a Request Service Message during a subsequent serial poll if enabled. Along with the Request Service Message the Model 1120 sends a status byte on the low order three data lines during a serial poll. The controller can thus determine the error state of the Model 1120 by conducting the serial poll. The Request Service Message and error Status Byte are cleared after a serial poll. The Model 1120 will not be removed from the error state until a Clear Command, A "W," is sent over the interface. The Request Service Message and Error Status Byte are also cleared by a Clear Command in case a Parallel Poll is used.

8.2.2 PARALLEL POLL

The Model 1120 will respond to a Parallel Poll to request service if Configured and Enabled for a Parallel Poll by the System Controller. The Parallel Poll Enable (PPE) Message tells the Model 1120 which data line to respond with during the Parallel Poll. The S bit in the PPE Message must be a "1" in order for the Model 1120 to respond to a Parallel Poll. During an error condition (Parallel Poll Flag is a "1") the Model 1120 will pull the GPIB data line low indicated by the PPE Message provided the S bit is a "1." The Model 1120 will respond with an error condition during a Parallel Poll until the Clear Command, a "W," is sent to the Model 1120 over the interface, clearing the Parallel Poll Flag.

8.2.3 TALKER

When addressed as a Talker, the Model 1120 will respond with the current error condition. If no error condition is present the Model 1120 will send an "E0" over the interface. If an error condition does exist, the Model 1120 will send either E1, E2, E3, or E4, depending on the error condition. The conditions for these messages are listed in Table 8-2. The error response will be cleared to an "E0" when Clear Command, "W," is sent to the Model 1120 over the interface. A Line Feed character with the EOI line pulled low terminates each talker response.

8.2.4 REMOTE/LOCAL

The Model 1120 enters the Remote State when the REN line is pulled low and the Model 1120 is addressed as a listener. In the Remote State the Model 1120 keyboard is locked out. Raising the REN line or sending the Go To Local addressed command when addressed as a Listener causes the Model 1120 to enter the Local State. (Unless the Model 1120 is in an error condition where a Clear Command, "W," must be sent first.) In the Local State the front panel keyboard is functional and the GPIB interface will receive messages from the bus but will not respond to them.

8.2.5 DEVICE CLEAR

A power-on initialization sequence is performed when the Model 1120 receives the Device Clear universal GPIB command or the Selected device Clear addressed GPIB command when addressed as a Listener.

8.2.6 DEVICE TRIGGER

An execute command is performed when the Model 1120 receives the Group Execute Trigger addressed command when addressed as a Listener.

KEYBOARD KEY CODE	REMOTE PROGRAMMING CHARACTER	KEYBOARD KEY CODE	REMOTE PROGRAMMING CHARACTER
0	0	mV	M
1	1	V	V
2	2	CU	U
3	3	ALY	A
4	4	STO	X
5	5	RCL	Y
6	6	CLR	W
7	7	EXECUT	Z
8	8	E	E
9	9	J	J
.	.	K	K
+	+	T	T
-	-	S	S
C	C	R	R
F	F	B	B
		*	*

*Allocated for an additional thermocouple type. May be any type for which a full polynomial equation or emf vs temperature data is available. Currently available T/C types include

"C" Tungsten 5% Rhenium/Tungsten 26% Rhenium
"N" Nicrosil/Nicil
"PL" Platinel II

Table 8-1

ERROR CODE	CONDITION
E0	NO ERROR
E1	ERROR 1 if temperature selected is beyond the specification for the selected thermocouple type.
E2	ERROR 2 if the selected voltage is beyond the specified voltage range (± 11 volts).
E3	ERROR 3 if a thermocouple type has been selected and that thermocouple module is not present in the instrument.
E4	ERROR 4 if the reference junction temperature is beyond the range of the selected thermocouple type.

Table 8-2

8.2.7 BASIC LANGUAGE PROGRAM

Included is Figure 8-1,a Basic language program written for the HP-85A with IEEE-488 Interface that will test the Model 1120 with Option 02. Using this program, all operating and error functions of the Model 1120 can be tested. It is given here as a check-out aid when setting up the Model 1120 for remote control. Although written for the HP computer, with appropriate changes it can be adapted to other languages and computers.

CAUTION

The interface input connector is in exact accordance with the IEEE-488 standard, meaning that the mating threads are METRIC.

NOTE

In accordance with the IEEE-488 standard, a removable jumper, W801, is provided on the interface board, terminals E801 to E802, to remove case ground from the interface connector pin 12.

8.3 THEORY OF OPERATION

Drawing 112-612 is the schematic of the IEEE-488 Interface assembly.

U801 and U802 are used as buffers for direct interface to the bus lines. The operational instructions and data come from U803, and 8291A Talker/Listener. This device generates all necessary handshake and control signals required to interface on the bus.

Interface of U803 to the Model 1120 Microprocessor System is accomplished through optical isolators U814-U819. U814, U815, U820 and U816 are used to latch and couple address signals to U803.

Data transfer from the bus to the Model 1120 and vice versa is accomplished through U804, U818, U819 and U823. U804 and U823 are UARTS which transfer data in serial form through U818 and U819. Data transfer through the UARTS to the bus is initiated by the microprocessor at the time the data is presented to the UART U823. Data transfer from the bus occurs on a continuous basis as transmission of data from U804 to U823 is initiated by the microprocessor by a signal sent through U817. This signal is received and the data transmission protocol executed by a state machine composed of U809A, U805, U806B, U806C, U812A-D, U808A-C. A multiphase clock for use by this state machine is generated by U807 and U811. From the oscillator composed of Y801 and U810C, U810E and U810F another state machine composed of

U806A, other sections of U805 and other gates previously mentioned, is used to supervise data transfer through the UARTS from the Model 1120 to the bus.
Bus address selection as determined by the setting of DIP switch S801 is read by the microprocessor through U825.

U824 is a ROM which contains instructions for the Model 1120 microprocessor concerning bus operations and data interpretation.

Other minor logic functions are performed by U826B (Clock Frequency Division), U813 (Power-Up Reset), U826A (Read Command Toggling), and U821A, U821B, U821F, U813B, U813E signal buffering through the optical isolators.

```
 10  REM ** ECTRON 1120 GPIB **
 20  REM **   TEST PROGRAM   **
 30  DIM S$[50]
 40  CLEAR
 50  DISP "0 - NEW INPUT"
 60  DISP "1 - ERROR 1"
 70  DISP "2 - ERROR 2"
 80  DISP "3 - ERROR 3"
 90  DISP "4 - ERROR 4"
100  DISP "5 - PARALLEL POLL"
110  DISP "6 - SERIAL POLL"
120  DISP "7 - TALKER"
130  DISP "8 - CLEAR ERROR"
140  DISP "9 - REMOTE"
150  DISP "10 - LOCAL"
160  DISP "11 - DEVICE TRIGGER"
170  DISP "12 - DEVICE CLEAR"
175  DISP "13 - EXIT"
180  DISP "ENTER DESIRED FUNCTION"
190  INPUT F
200  F=F+1
210  ON F GOSUB 230,270,310,350,390,430,
      600,780,750,890,930,960,990,1020
220  GOTO 30
230  DISP "ENTER COMMAND STRING"
240  INPUT S$
250  GOSUB 860
260  RETURN
270  REM ** CAUSE ERROR 1 **
280  OUTPUT 708 ;"+5000.CUJZ"
290  REM ** 5000 VOLTS TYPE J **
300  RETURN
310  REM ** CAUSE ERROR 2 **
320  OUTPUT 708 ;"+50.VUZ"
330  REM ** 50 VOLTS **
340  RETURN
350  REM ** CAUSE ERROR 3 **
360  OUTPUT 708 ;"+0.0CX8200.CAEZ"
370  REM ** TYPE E **
380  RETURN
390  REM ** CAUSE ERROR 4 **
400  OUTPUT 708 ; "+2000.CX8200.JUZ"
410  REM ** 2000 C REFERENCE **
420  RETURN
430  REM ** PARALLEL POLL **
440  DISP "ENTER DESIRED PPR MESSAGE 1-8"
450  INPUT P1
460  P1=P1+103
470  IF P1<104 OR P1>111 THEN GOTO 1050
480  SEND 7 ; UNL LISTEN 8 MTA CMD 5,P1
490  X1=PPOLL(7)
500  SEND 7 ; CMD 5,112
510  IF X1=2^(P1-104) THEN GOSUB 570 ELSE
      PRINT "NO ERROR PARALLEL POLL
      RESPONSE"
520  PRINT
530  PRINT
540  PRINT
550  PRINT
560  RETURN
570  PRINT "DECIMAL PPR RESPONSE",X1
580  PRINT "PARALLEL POLL RESPONSE"
590  RETURN
600  REM ** SERIAL POLL **
610  Y1=SPOLL(708)
620  IF Y1<64 THEN PRINT "NO ERROR SERIAL
      POLL RESPONSE" ELSO GOTO 680
630  PRINT
640  PRINT
650  PRINT
660  PRINT
670  RETURN
680  Y1=Y1-64
690  PRINT "ECTRON ERROR NUMBER",Y1,
      "SERIAL POLL RESPONSE"
700  PRINT
710  PRINT
720  PRINT
730  PRINT
740  RETURN
750  REM ** CLEAR ERROR **
760  OUTPUT 708 ;"W"
770  RETURN
780  REM ** TALKER **
790  ENTER 708 ; Z$
800  PRINT "ECTRON ERROR",Z$,"TALKER RESPONSE
810  PRINT
820  PRINT
830  PRINT
840  PRINT
850  RETURN
860  REM ** STORE SUBROUTINE **
870  OUTPUT 708 ;S$
880  RETURN
890  REM ** REMOTE **
900  REMOTE 7
910  OUTPUT 708
920  RETURN
930  REM ** LOCAL **
940  LOCAL 7
950  RETURN
960  REM ** TRIGGER **
970  TRIGGER 708
980  RETURN
990  REM ** CLEAR **
1000 CLEAR 708
1010 RETURN
1020 REM ** EXIT **
1030 DISP "ECTRON TEST HALTED"
1040 END
1050 DISP "INVALID PPR MESSAGE RESPONSE"
1060 DISP "TRY AGAIN?"
1070 GOTO 430
```

ACCEPTANCE TEST PROCEDURE PROGRAM

Figure 8 - 1

```
10  REM ** ECTRON 1120 GPIB **
20  REM **   TEST PROGRAM   **
30  DIM S$[50]
40  CLEAR
50  DISP "0 - NEW INPUT"
60  DISP "1 - ERROR 1"
70  DISP "2 - ERROR 2"
80  DISP "3 - ERROR 3"
90  DISP "4 - ERROR 4"
100 DISP "5 - PARALLEL POLL"
110 DISP "6 - SERIAL POLL"
120 DISP "7 - TALKER"
130 DISP "8 - CLEAR ERROR"
140 DISP "9 - REMOTE"
150 DISP "10 - LOCAL"
160 DISP "11 - DEVICE TRIGGER"
170 DISP "12 - DEVICE CLEAR"
175 DISP "13 - EXIT"
180 DISP "ENTER DESIRED FUNCTION"
190 INPUT F
200 F=F+1
210 ON F GOSUB 230,270,310,350,390,430,
     600,780,750,890,930,960,990,1020
220 GOTO 30
230 DISP "ENTER COMMAND STRING"
240 INPUT S$
250 GOSUB 860
260 RETURN
270 REM ** CAUSE ERROR 1 **
280 OUTPUT 708 ;"+5000.CUJZ"
290 REM ** 5000 VOLTS TYPE J **
300 RETURN
310 REM ** CAUSE ERROR 2 **
320 OUTPUT 708 ;"+50.VUZ"
330 REM ** 50 VOLTS **
340 RETURN
350 REM ** CAUSE ERROR 3 **
360 OUTPUT 708 ;"+0.0CX8200.CAEZ"
370 REM ** TYPE E **
380 RETURN
390 REM ** CAUSE ERROR 4 **
400 OUTPUT 708 ; "+2000.CX8200.JUZ"
410 REM ** 2000 C REFERENCE **
420 RETURN
430 REM ** PARALLEL POLL **
440 DISP "ENTER DESIRED PPR MESSAGE 1-8"
450 INPUT P1
460 P1=P1+103
470 IF P1<104 OR P1>111 THEN GOTO 1050
480 SEND 7 ; UNL LISTEN 8 MTA CMD 5,P1
490 X1=PPOLL(7)
500 SEND 7 ; CMD 5,112
510 IF X1=2^(P1-104) THEN GOSUB 570 ELSE
     PRINT "NO ERROR PARALLEL POLL
     RESPONSE"
520 PRINT
530 PRINT
540 PRINT
550 PRINT
560 RETURN
570 PRINT "DECIMAL PPR RESPONSE",X1
580 PRINT "PARALLEL POLL RESPONSE"
590 RETURN
600 REM ** SERIAL POLL **
610 Y1=SPOLL(708)
620 IF Y1<64 THEN PRINT "NO ERROR SERIAL
     POLL RESPONSE" ELSO GOTO 680
630 PRINT
640 PRINT
650 PRINT
660 PRINT
670 RETURN
680 Y1=Y1-64
690 PRINT "ECTRON ERROR NUMBER",Y1,
     "SERIAL POLL RESPONSE"
700 PRINT
710 PRINT
720 PRINT
730 PRINT
740 RETURN
750 REM ** CLEAR ERROR **
760 OUTPUT 708 ;"W"
770 RETURN
780 REM ** TALKER **
790 ENTER 708 ; Z$
800 PRINT "ECTRON ERROR",Z$,"TALKER RESPONSE
810 PRINT
820 PRINT
830 PRINT
840 PRINT
850 RETURN
860 REM ** STORE SUBROUTINE **
870 OUTPUT 708 ;S$
880 RETURN
890 REM ** REMOTE **
900 REMOTE 7
910 OUTPUT 708
920 RETURN
930 REM ** LOCAL **
940 LOCAL 7
950 RETURN
960 REM ** TRIGGER **
970 TRIGGER 708
980 RETURN
990 REM ** CLEAR **
1000 CLEAR 708
1010 RETURN
1020 REM ** EXIT **
1030 DISP "ECTRON TEST HALTED"
1040 END
1050 DISP "INVALID PPR MESSAGE RESPONSE"
1060 DISP "TRY AGAIN?"
1070 GOTO 430
```

ACCEPTANCE TEST PROCEDURE PROGRAM

Figure 8 - 1

SECTION IX

OPTION 04, RS-232-C INTERFACE

9.1 GENERAL DESCRIPTION

The Option 04, RS-232-C Interface allows the Model 1120 to be remotely controlled by data terminal equipment using a serial bit, serial character interface conforming to the EIA Standard RS-232-C. This subassembly is a plug-in card that plugs into any Model 1120. It may be factory installed when the Model 1120 is ordered or customer installed later without any modification to the Model 1120.

Because the Model 1120 provides microvolt level precision dc signals, extensive shielding and isolation has been incorporated into the design of its interfaces. Separate power supplies operate the interface circuitry connected to the RS-232 link with optical isolators used to interconnect to the rest of the Model 1120.

9.2 REMOTE PROGRAMMING

The Option 04, RS-232-C Interface allows full remote programming of the Model 1120, with support of all interface functions needed for convenient and flexible operation.

Remote programming by an RS-232-C link is accomplished by setting appropriate configuration options on the Option 04 interface, cabling the interface to the controlling instrument and sending appropriate command strings.

Unfortunately, within the scope of RS-232-C there is enough latitude to permit minor incompatibilities from one device to another, which can result in start-up problems. Section 9.4 includes suggestions when difficulty is encountered in establishing proper RS-232 communications.

9.2.1 COMMANDS

Table 9-1 lists the remote commands in ASCII and in HEX code to provide the given keyboard action along with a description of the function.

At power up, REMOTE operation is disabled. Therefore, an ENABLE REMOTE OPERATION command, ">," must be sent to start remote operation. Sending a command string which represents keystrokes as would be entered through the front panel will now operate the Model 1120.

REMOTE COMMAND (ASCII)		EQUIVALENT KEYBOARD ACTION	FUNCTION
CHAR	HEX		
0	30	0	
1	31	1	
2	32	2	
3	33	3	
4	34	4	
5	35	5	
6	36	6	
7	37	7	
8	38	8	
9	39	9	
.	2E	.	
+	2B	+/-	POLARITY NOW +
-	2D	+/-	POLARITY NOW -
C	43	C	UNIT OF MEASURE NOW °C
F	46	F	UNIT OF MEASURE NOW °F
M	4D	mV	UNIT OF MEASURE NOW mV
V	56	V	UNIT OF MEASURE NOW V
U	55	CU	OUTPUT MATERIAL NOW COPPER
A	41	ALY	OUTPUT MATERIAL NOW ALLOY
X	58	STO	STORE
Y	59	RCL	RECALL
W	57	CLR	CLEAR
Z	5A	EXECUTE	
E	45	E	THERMOCOUPLE TYPE NOW E
J	4A	J	THERMOCOUPLE TYPE NOW J
K	4B	K	THERMOCOUPLE TYPE NOW K
T	54	T	THERMOCOUPLE TYPE NOW T
S	53	S	THERMOCOUPLE TYPE NOW S
R	52	R	THERMOCOUPLE TYPE NOW R
B	42	B	THERMOCOUPLE TYPE NOW B
*	2A	*	THERMOCOUPLE TYPE NOW *
DEL	7F	CLR	CLEAR

The following commands are not implemented on the Model 1120 keyboard and can only be performed by receipt of the command over the RS-232 line. See text for explanation.

>	3E	--	ENABLE REMOTE OPERATION
<	3C	--	DISABLE REMOTE OPERATION

MODEL 1120 RS-232-C COMMANDS
Table 9-1

For example:

To change the output to +4.5810 millivolts copper, send +4.581MUZ.

To store the output state into register 5, send Y0X5.

To change the output to -265.1°F for type J thermocouple using alloy terminals, send -265.1FAJZ.

The +/- key on the keyboard causes the sign of the numeric value in the display to toggle. In remote programming, the sign is sent along with the numeric information. The numeric sign remains in the previous state unless programmed different with the new command. Similarly, for CU/ALY, instead of a toggle function, a U or A is sent to denote CU or ALY. The CU/ALY state remains in the previous state unless programmed different with the new command. The front panel operation of depressing RCL-EXECUTE to display the output setting is not supported in the remote mode. However, the front panel display operates the same for remote operation as for local and can serve as a monitor for remote operation.

Lower case letters have the same function as their upper case equivalents. Any characters received over the RS-232 bus by the Model 1120 and not appearing in Table 9-1 will be ignored. Remote commands do not require the shift key so the shift function is not used in remote operation.

Any remote EXECUTE command which results in an erroneous condition (Error 1 through 4) will cause the Model 1120 to send a CR followed by the error message listed below followed by another CR. If in MODE 2, as described in Section 9.2.2, the BEL character (07 Hex) shall be inserted just after the first CR.

9.2.2 OPERATING MODES

When using the RS-232-C Interface, two modes of operation are available as selected by a DIP switch on the Interface subassembly:

Mode 1: In this mode, the Model 1120 display and output respond to inputs sent over the RS-232 bus. In addition, keystrokes made by the operator to the Model 1120 front panel keyboard will result in the appropriate command character being sent over the RS-232 bus. For shifted functions, the shift keystroke is not sent but all other keystrokes result in a command being sent. In this way the remote controller can allow local opera-

tion by echoing the information back to the Model 1120, thus locking out the keyboard.

Mode 2: In this mode the Model 1120 echoes commands received, provided they appear in Table 9-1. Any CR or LF characters received are also echoed. Other invalid characters received result in the "#" character (23 Hex) being echoed to alert the operator that an invalid character was received. This mode would normally be used with a full duplex terminal.

Section J of S801 selects the mode of operation. When open (up position), mode 2 is selected, when closed (down position), mode 1 is selected.

9.2.3 CONFIGURATION OPTIONS

The RS-232-C Interface allows the selection of several configuration choices including baud rate, parity enable, odd or even parity, seven or eight bit characters, one or two stop bits and four modes of handshaking. The function selected by the DIP switch positions are programmed only during Model 1120 initialization (turn-on) or during reset (switch located within the Model 1120) when the self test diagnostics are run. Therefore, if these switches are changed, power to the Model 1120 must be switched off and on or the reset switch actuated to enable a new function.

9.2.3.1 BAUD RATE

Section A,B and C of the DIP switch S801 are used to select one of the 8 different receive/transmit baud rates.

S801-C	S801-B	S801-A	SELECTED BAUD RATE
0	0	0	110
0	0	1	300
0	1	0	1200
0	1	1	1800
1	0	0	2400
1	0	1	3600
1	1	0	4800
1	1	1	9600*

A "0" means the switch is in the closed (down) position; a "1" means it is in the open (up) position.

*At 9600 baud, characters cannot be received in bursts. A one msec delay between characters is required to allow processing time.

For example:

To change the output to +4.5810 millivolts copper, send +4.581MUZ.

To store the output state into register 5, send Y0X5.

To change the output to -265.1°F for type J thermocouple using alloy terminals, send -265.1FAJZ.

The +/- key on the keyboard causes the sign of the numeric value in the display to toggle. In remote programming, the sign is sent along with the numeric information. The numeric sign remains in the previous state unless programmed different with the new command. Similarly, for CU/ALY, instead of a toggle function, a U or A is sent to denote CU or ALY. The CU/ALY state remains in the previous state unless programmed different with the new command. The front panel operation of depressing RCL-EXECUTE to display the output setting is not supported in the remote mode. However, the front panel display operates the same for remote operation as for local and can serve as a monitor for remote operation.

Lower case letters have the same function as their upper case equivalents. Any characters received over the RS-232 bus by the Model 1120 and not appearing in Table 9-1 will be ignored. Remote commands do not require the shift key so the shift function is not used in remote operation.

Any remote EXECUTE command which results in an erroneous condition (Error 1 through 4) will cause the Model 1120 to send a CR followed by the error message listed below followed by another CR. If in MODE 2, as described in Section 9.2.2, the BEL character (07 Hex) shall be inserted just after the first CR.

9.2.2 OPERATING MODES

When using the RS-232-C Interface, two modes of operation are available as selected by a DIP switch on the Interface subassembly:

Mode 1: In this mode, the Model 1120 display and output respond to inputs sent over the RS-232 bus. In addition, keystrokes made by the operator to the Model 1120 front panel keyboard will result in the appropriate command character being sent over the RS-232 bus. For shifted functions, the shift keystroke is not sent but all other keystrokes result in a command being sent. In this way the remote controller can allow local opera-

tion by echoing the information back to the Model 1120, thus locking out the keyboard.

Mode 2: In this mode the Model 1120 echoes commands received, provided they appear in Table 9-1. Any CR or LF characters received are also echoed. Other invalid characters received result in the "#" character (23 Hex) being echoed to alert the operator that an invalid character was received. This mode would normally be used with a full duplex terminal.

Section J of S801 selects the mode of operation. When open (up position), mode 2 is selected, when closed (down position), mode 1 is selected.

9.2.3 CONFIGURATION OPTIONS

The RS-232-C Interface allows the selection of several configuration choices including baud rate, parity enable, odd or even parity, seven or eight bit characters, one or two stop bits and four modes of handshaking. The function selected by the DIP switch positions are programmed only during Model 1120 initialization (turn-on) or during reset (switch located within the Model 1120) when the self test diagnostics are run. Therefore, if these switches are changed, power to the Model 1120 must be switched off and on or the reset switch actuated to enable a new function.

9.2.3.1 BAUD RATE

Section A,B and C of the DIP switch S801 are used to select one of the 8 different receive/transmit baud rates.

S801-C	S801-B	S801-A	SELECTED BAUD RATE
0	0	0	110
0	0	1	300
0	1	0	1200
0	1	1	1800
1	0	0	2400
1	0	1	3600
1	1	0	4800
1	1	1	9600*

A "0" means the switch is in the closed (down) position; a "1" means it is in the open (up) position.

*At 9600 baud, characters cannot be received in bursts. A one msec delay between characters is required to allow processing time.

9.2.3.2 PARITY

Switch section D of S801 enables transmission of and checking for a parity bit when in the open (up) position. Parity transmission is disabled when in the closed (down) position.

Switch section E of S801 selects even or odd parity. In the open or up position, parity will be even and in the closed or down position, parity will be odd.

9.2.3.3 7-BIT OR 8-BIT CHARACTERS

Switch section G of S801 selects 7 or 8 bit characters to be received or transmitted. The closed or down position selects 7-bit characters while the open or up position selects 8-bit characters.

9.2.3.4 STOP BITS

Switch section F of S801 selects 1 or 2 stop bits in the transmitted word. In the closed or down position, one stop bit will be transmitted while in the open or up position, two stop bits will be transmitted. The Model 1120 Interface receive UART requires only one stop bit although it will accept two.

9.2.3.5 HANDSHAKE MODES

Sections H and I of S801 select one of the four different handshake modes available. Handshaking is necessary to prevent received data from being lost during processing of certain characters. The handshake is a command to the remote terminal to stop transmission of input characters. Handshaking and its implications are discussed in Section 9.4.

S801-I	S801-H	HANDSHAKING MODE
Ø	Ø	NO HANDSHAKING
Ø	1	SOFTWARE ONLY (XON AND XOFF)
1	Ø	HARDWARE ONLY (/DTR)
1	1	HARDWARE AND SOFTWARE

A "Ø" means the switch is in the closed (down) position, a "1" means it is in the open (up) position.

9.3 CABLING

The Option 04, RS-232-C Interface includes the 25-pin connector on the rear panel that is currently the established standard. (The EIA specification does not call out the connector.) This female connector is AMP P/N 745783-2, which mates with Cannon P/N DB-25P. Table 9-2 gives the pin

assignments, symbol, signal type, direction of signal flow and description for all signals supported by the ECTRON interface.

9.4 SETTING UP THE RS-232 LINK

The following guidelines are provided for assistance when difficulty is encountered in establishing communications on the RS-232 bus.

First, the user must fully understand the characteristics of the controlling terminal or computer.

9.4.1 DTE/DCE

Although the EIA RS-232-C specification assumes the peripheral device is a DTE (Data Terminal Equipment) and the controller is a DCE (DATA Communications Equipment), frequently both are DTE. When two DTE devices are interconnected (no modem) then a "null modem" or "modem eliminator" must be used. This simply means that what is data out at one device is data in at the other device and so the wires in the cables are cross connected to provide proper communications. For example, TD (Transmit Data), pin 2 of the connector, is the data output of the DTE but RD (Received Data) at the
DTE is assigned to pin 3. Therefore, when connecting DTE to DTE, these signal lines must be cross connected in the cable. (Some devices provide switches for this purpose.)

9.4.2 PARITY, STOP BITS AND CHARACTER LENGTH

When trying to establish communication with the Model 1120 RS-232-C Interface particular attention must be paid to the RS-232 character definition.

Character length refers to the number of data bits the receiving UART is expecting per character.

The parity bit is an additional bit of information that is transmitted after the data and before the stop bit(s) in each character. Besides even and odd parity there is sometimes reference made to MARKING AND SPACING parity. MARKING parity can be supported but one must not think of it as parity but as an extra stop bit. For example if a remote terminal required that MARKING parity, 7-bit characters, and one stop be supported, configure the Model 1120 RS-232 Interface for 7-bit characters, no parity, and two stop bits. To the remote terminal UART, what is actually the first of two stop bits will be interpreted as the MARKING PARITY bit.

MODEL 1120 RS-232-C INTERFACE PIN OUT CHART

PIN #	SYMBOL	SIGNAL	DIRECTION *	DESCRIPTION
1	PG	Protective Ground	--	Case (chassis) ground. Connected to pin 7 (signal ground) through removable jumper
2	TD	Transmitted Data	S	Serial data signal transmitted from interface (1120).
3	RD	Received Data	R	Serial data signal received by interface (1120).
4	RTS	Request to Send	S	Transmission request from interface. Always high when 1120 is powered up.
5	CTS	Clear to Send	R	Reply signal to RTS. Must be high for RS-232 transmission.
6	DSR	Data Set Ready	R	Signal to notify interface that transmitter is ready for transmission. Must be high for interface to receive data. Once detected LOW, the interface will read and ignore before it will accept additional data.
7	SG	Signal Ground	--	RS-232 signal ground. Isolated from all other 1120 grounds by optical isolators.
20	DTR	Data Terminal	S	Hardware hand shake signal. A high on this output indicates the 1120 interface is able to receive data.
8-19 and 21-25		not used		

* S = Sent by interface. R = Received by interface

Table 9-2

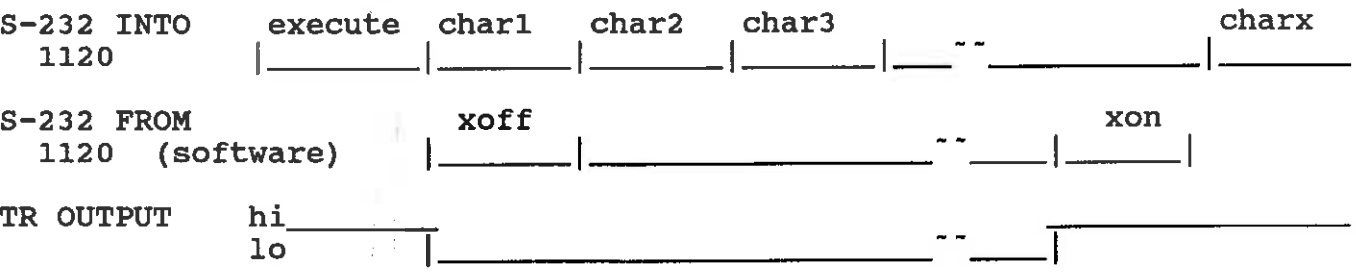
The Model 1120 RS-232 Interface only processes or transmits 7-bit ASCII code. When specifying 8-bit characters the eighth bit position will always be a zero, which is like 7-bit characters with SPACING parity.

9.4.3 HANDSHAKING

The use for active handshaking in this application is to prevent the loss of incoming characters during long processing times. In general, running at 4800 baud, characters may be transmitted in a continuous stream without overrun. The execute command requires special attention though. Following an execute command, the next character input should not occur for approximately 600ms unless handshaking is used.

On receipt of an execute command, if the DIP switches are appropriately set, a handshake takes place. It is a request to the remote terminal to please stop sending input characters as I am going to be busy for a while. Before actually becoming unable to receive any further input characters, some buffering will take place to allow response time of the remote terminal to the XOFF handshake. Buffering will be for three characters or 300ms, which ever comes first. During this time, any characters received will be saved for processing after the execute has been processed. Only after the buffering is completed will the execute be processed followed by processing the buffered characters, if any. Upon completion of processing of the buffered characters, the remote terminal will see the "XON" handshake.

9.4.3.1 HANDSHAKE TIMING DIAGRAM



9.5 1120 RS-232 HP85 ACCEPTANCE TEST PROCEDURE

This test verifies the Model 1120 RS-232 hardware is functioning. Using an HP85 computer with a STANDARD RS-232 plug-in module and cable, this code will allow the user to exercise the RS-232 Interface Card in its various modes.

To interface the Model 1120 and the HP85, it is necessary to have a one-to-one female-to-female (25 pin DB connectors) cable.

The RS-232 card should have DIP switch settings for

4800 BAUD
ENABLE PARITY
7-BIT CHARACTERS
1 STOP BIT
BOTH HARDWARE AND SOFTWARE HANDSHAKING
MODE 1 OR MODE 2

This acceptance test procedure uses the Basic program listed in Figure 9-1. Written for the HP 85 computer, this program may not function properly if operated with another computer because of timing differences.

When the test is first started, a menu will appear from which the user will enter numeric selections in order to test the various functions of the 1120 RS-232 card. The selections are described below.

SELECTION "0": This selection allows the user to input character strings to the Model 1120 via the RS-232 interface.

SELECTION "1": Causes the unit to display "ERR 1."

SELECTION "2": Causes the unit to display "ERR 2."

SELECTION "3": Causes the unit to display "ERR 3."

SELECTION "4": Causes the unit to display "ERR 4."

SELECTION "5": Transmits a "W" to the Model 1120. Used to clear the error conditions.

SELECTION "6": This selection tests the software handshake to be active. A 26-character string is attempted to be input to the Model 1120. There is an execute in that string. The HP85 is configured to respond to the "XOFF" and "XON" codes. The HP85 will stop transmitting when it recognizes the XOFF and wait for receipt of the XON before continuing. The test passes when the Model 1120 display shows "-54321VBA" when the menu reappears. Before making this selection, one should have just cleared an error from the Model 1120 display.

SELECTION "7": This selection tests the hardware handshaking (DTR). The test feeds the Model 1120 an execute string that causes an error. The HP85 is programmed to respond to the DTR input changing state. If a change of state is detected, the error on the display will be cleared. There are three error messages that may appear on the HP85 terminal; HARDWARE HANDSHAKE ERROR 1, 2, OR 3. Message #1 means that the initial state of the handshake signals is wrong ie. that DTR or RTS are in the wrong

state. Message #2 means that after the execute command there was no hardware XOFF handshake detected. Message #3 says that xoff was detected but that the DTR signal never returned to the XON state. The test passes when the Model 1120 display shows "+50.VU" and no error condition. Before making this selection one should have just cleared an error from the Model 1120 display.

SELECTION "8": This tests the Model 1120's rejection of data when the DSR signal is held at a low level. Data is fed to the Model 1120 with the DSR signal both high and low. When low, the Model 1120 should ignore the data received. The test passes if the Model 1120 display shows "98765." If one looks closely, you can observe a delay between the "98" and "765" appearing on the display. During this delay time, the DSR line is low and characters are being transmitted to the Model 1120 but should be ignored. Before making this selection, one should have just cleared an error from the Model 1120 display.

SELECTION "9": This selection transmits the ">" character to the Model 1120. This is the remote enable code. Prior to receipt of this character, the Model 1120 should not respond to RS-232 input commands.

SELECTION "10": This selection transmits the "<" character to the Model 1120 and exits the test program. This is the remote disable code to the Model 1120.

A minimum test would consist of selecting each of the options. The order of selections is important only in that the machine state after an error is cleared is necessary for the correct use of selections 6, 7 and 8. For example, this could be a valid test:

1. POWER UP BOTH THE MODEL 1120 AND HP85 WITH PROPER DIP SWITCH SETTINGS. START THE TEST PROGRAM.

2. MAKE SELECTION 1. SEE THAT THE MODEL 1120 DOESN'T RESPOND AS IT IS NOT UNDER REMOTE CONTROL YET.

3. MAKE SELECTION 9. THERE SHOULD BE NO VISIBLE RESPONSE BUT THE UNIT IS NOW UNDER REMOTE CONTROL. TRY THE MODEL 1120 KEYPAD. NOTHING SHOULD HAPPEN.

4. MAKE SELECTION 1. SEE THAT "ERR 1" IS ON THE DISPLAY.

5. CLEAR THE ERROR WITH SELECTION 5.

6. MAKE SELECTION 2. SEE THAT "ERR 2" IS DISPLAYED.

7. CLEAR THE ERROR WITH SELECTION 5.

8. MAKE SELECTION 3. SEE THAT "ERR 3" IS DISPLAYED.

9. CLEAR THE ERROR WITH SELECTION 5.

10. MAKE SELECTION 4. SEE THAT "ERR 4" IS DISPLAYED.

11. CLEAR THE ERROR WITH SELECTION 5.

12. MAKE SELECTION 6. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

13. CAUSE AN ERROR WITH SELECTION 1. CLEAR THE ERROR WITH SELECTION 5.

14. MAKE SELECTION 7. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

15. CAUSE AN ERROR WITH SELECTION 1. CLEAR THE ERROR WITH SELECTION 5.

16. MAKE SELECTION 8. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

17. TO COMPLETE THE TEST, MAKE SELECTION 10 AND SEE THAT THE UNIT IS BACK UNDER LOCAL CONTROL.

8. MAKE SELECTION 3. SEE THAT "ERR 3" IS DISPLAYED.

9. CLEAR THE ERROR WITH SELECTION 5.

10. MAKE SELECTION 4. SEE THAT "ERR 4" IS DISPLAYED.

11. CLEAR THE ERROR WITH SELECTION 5.

12. MAKE SELECTION 6. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

13. CAUSE AN ERROR WITH SELECTION 1. CLEAR THE ERROR WITH SELECTION 5.

14. MAKE SELECTION 7. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

15. CAUSE AN ERROR WITH SELECTION 1. CLEAR THE ERROR WITH SELECTION 5.

16. MAKE SELECTION 8. ASSURE THAT IT BEHAVES AS DESCRIBED ABOVE.

17. TO COMPLETE THE TEST, MAKE SELECTION 10 AND SEE THAT THE UNIT IS BACK UNDER LOCAL CONTROL.

```
10  REM ** ECTRON RS232 **
20  REM ** TEST PROGRAM **
30  REM ** PROG. RS232 PARAM. **
40  REM ** 7-BIT,ODD PARITY **
50  CONTROL 10,4 ; 10
60  REM ** DISAB. INTERRUPTS **
70  CONTROL 10,1 ; 0
80  REM ** PROG. DSR CTS **
90  CONTROL 10,2 ; 5
100 REM ** PROG. BAUD RATE **
110 REM ** 4800 BAUD **
120 CONTROL 10,3 ; 13
130 REM ** DISABLE DROPOUTS **
140 CONTROL 10,5 ; 0
150 CLEAR
160 DISP "0 - NEW INPUT"
170 DISP "1 - ERROR 1"
180 DISP "2 - ERROR 2"
190 DISP "3 - ERROR 3"
200 DISP "4 - ERROR 4"
210 DISP "5 - CLEAR ERROR"
220 DISP "6 - XOFF/XON HANDSHAKE"
230 DISP "7 - DTR HARDWARE HANDSHAKE"
240 DISP "8 - DSR XMIT INHIBIT CHECK"
250 DISP "9 - REMOTE OPERATION"
260 DISP "10 - LOCAL OPER"
270 DISP "11 - EXIT PROGRAM"
280 DISP "ENTER DESIRED FUNCTION"
290 INPUT F
300 F=F+1
310 ON F GOSUB 330,370,400,430,460,490,
    580,720,650,520,550,930
320 GOTO 150
330 DISP "ENTER COMMAND STRING"
340 INPUT S$
350 OUTPUT 10 ;S$
360 RETURN
370 REM ** CAUSE ERROR 1 **
380 OUTPUT 10 ;"+5000.CU*Z"
390 RETURN
400 REM ** CAUSE ERROR 2 **
410 OUTPUT 10 ;"+50.VUZ"
420 RETURN
430 REM ** CAUSE ERROR 3 **
440 OUTPUT 10 ;"+0.0CX8200.CAJZ"
450 RETURN
460 REM ** CAUSE ERROR 4 **
470 OUTPUT 10 ; "+2000.CEAX8200.EUZ"
480 RETURN
490 REM ** CLEAR ERROR **
500 OUTPUT 10 ;"W"
510 RETURN
520 REM ** REMOTE **
530 OUTPUT 10 ;">"
540 RETURN
550 REM ** LOCAL **
560 OUTPUT 10 ;"<"
570 RETURN
580 CONTROL 10,11 ; 192
590 CONTROL 10,14 ; 19
600 CONTROL 10,15 ; 17
610 OUTPUT 10 ;"+0.0CX835.75+CU*Z
    54321-VBA"
620 CONTROL 10,11 ; 0
630 RETURN
640 REM ** DSR TEST ROUTINE **
650 OUTPUT 10 ;"+.98"
660 CONTROL 10,2 ; 1
670 OUTPUT 10 ;"-999Z"
680 CONTROL 10,2 ; 5
690 OUTPUT 10 ;"765"
700 RETURN
710 REM ** DTR HANDSHAKE TEST **
720 STATUS 10,3 ; S3
730 IF S3=13 THEN 780
740 CLEAR
750 DISP "HARDWARE HANDSHAKE ERROR 1"
760 WAIT 7000
770 GOTO 890
780 CONTROL 10,1 ; 1
790 ON INTR 10 GOTO 850
800 OUTPUT 10 ;"+50.VUZ"
810 CLEAR
820 DISP "HARDWARE HANDSHKE ERROR 2"
830 WAIT 7000
840 GOTO 890
850 STATUS 10,3 ; S3
860 IF S3=13 THEN 910
870 DISP "HARDWARE HANDSHAKE ERROR 3"
880 WAIT 7000
890 CONTROL 10,1 ; 0
900 RETURN
910 OUTPUT 10 ;"W"
920 GOTO 890
930 END
```

ACCEPTANCE TEST PROCEDURE PROGRAM

Figure 9 - 1

```
10  REM ** ECTRON RS232 **
20  REM ** TEST PROGRAM **
30  REM ** PROG. RS232 PARAM. **
40  REM ** 7-BIT,ODD PARITY **
50  CONTROL 10,4 ; 10
60  REM ** DISAB. INTERRUPTS **
70  CONTROL 10,1 ; 0
80  REM ** PROG. DSR CTS **
90  CONTROL 10,2 ; 5
100 REM ** PROG. BAUD RATE **
110 REM ** 4800 BAUD **
120 CONTROL 10,3 ; 13
130 REM ** DISABLE DROPOUTS **
140 CONTROL 10,5 ; 0
150 CLEAR
160 DISP "0 - NEW INPUT"
170 DISP "1 - ERROR 1"
180 DISP "2 - ERROR 2"
190 DISP "3 - ERROR 3"
200 DISP "4 - ERROR 4"
210 DISP "5 - CLEAR ERROR"
220 DISP "6 - XOFF/XON HANDSHAKE"
230 DISP "7 - DTR HARDWARE HANDSHAKE"
240 DISP "8 - DSR XMIT INHIBIT CHECK"
250 DISP "9 - REMOTE OPERATION"
260 DISP "10 - LOCAL OPER"
270 DISP "11 - EXIT PROGRAM"
280 DISP "ENTER DESIRED FUNCTION"
290 INPUT F
300 F=F+1
310 ON F GOSUB 330,370,400,430,460,490,
    580,720,650,520,550,930
320 GOTO 150
330 DISP "ENTER COMMAND STRING"
340 INPUT S$
350 OUTPUT 10 ;S$
360 RETURN
370 REM ** CAUSE ERROR 1 **
380 OUTPUT 10 ;"+5000.CU*Z"
390 RETURN
400 REM ** CAUSE ERROR 2 **
410 OUTPUT 10 ;"+50.VUZ"
420 RETURN
430 REM ** CAUSE ERROR 3 **
440 OUTPUT 10 ;"+0.0CX8200.CAJZ"
450 RETURN
460 REM ** CAUSE ERROR 4 **
470 OUTPUT 10 ; "+2000.CEAX8200.EUZ"
480 RETURN
490 REM ** CLEAR ERROR **
500 OUTPUT 10 ;"W"
510 RETURN
520 REM ** REMOTE **
530 OUTPUT 10 ;">"
540 RETURN
550 REM ** LOCAL **
560 OUTPUT 10 ;"<"
570 RETURN
580 CONTROL 10,11 ; 192
590 CONTROL 10,14 ; 19
600 CONTROL 10,15 ; 17
610 OUTPUT 10 ;"+0.0CX835.75+CU*Z
    54321-VBA"
620 CONTROL 10,11 ; 0
630 RETURN
640 REM ** DSR TEST ROUTINE **
650 OUTPUT 10 ;"+.98"
660 CONTROL 10,2 ; 1
670 OUTPUT 10 ;"-999Z"
680 CONTROL 10,2 ; 5
690 OUTPUT 10 ;"765"
700 RETURN
710 REM ** DTR HANDSHAKE TEST **
720 STATUS 10,3 ; S3
730 IF S3=13 THEN 780
740 CLEAR
750 DISP "HARDWARE HANDSHAKE ERROR 1"
760 WAIT 7000
770 GOTO 890
780 CONTROL 10,1 ; 1
790 ON INTR 10 GOTO 850
800 OUTPUT 10 ;"+50.VUZ"
810 CLEAR
820 DISP "HARDWARE HANDSHKE ERROR 2"
830 WAIT 7000
840 GOTO 890
850 STATUS 10,3 ; S3
860 IF S3=13 THEN 910
870 DISP "HARDWARE HANDSHAKE ERROR 3"
880 WAIT 7000
890 CONTROL 10,1 ; 0
900 RETURN
910 OUTPUT 10 ;"W"
920 GOTO 890
930 END
```

ACCEPTANCE TEST PROCEDURE PROGRAM

Figure 9 - 1

SECTION X

PARTS LISTS

10.1 NAMES OF MANUFACTURERS

Following is the list of manufacturers of the components used by Ectron in the products discussed in this manual. They are listed numerically for easy cross reference to the parts lists.

00014	ADVANCED MICRO DEVICES
00027	ALLEN-BRADLEY CO.
00043	AMP INC.
00048	ANALOG DEVICES
00057	ARCO ELECTRONICS
00060	ARIES ELECTRONICS
00072	ATLEE OF DELAWARE INC.
00108	BOURNS, INC., TRIMPOT DIV.
00128	C&K COMPONENTS INC.
00137	CAMBION, DIV., MIDLAND-ROSS
00149	CENTRALAB INC
00163	CHICAGO SWITCH INC.
00166	CIRCUIT ASSEMBLY CORP.
00188	CORCOM INC.
00189	CORNELL-DUBILIER ELECTRONICS
00236	DIMCO-GRAY
00272	EDAC INC.
00277	ELECTROCHEM INDUSTRIES
00305	ELLIOTT INDUSTRIES
00321	ERIE TECHNICAL PRODUCTS
00336	FAIRCHILD
00338	FASTEX
00369	GENERAL INST DESCRETE SEMI
00383	GRAYHILL INC.
00397	HARRIS SEMICONDUCTOR
00403	HEWLETT-PACKARD CO.
00416	H.R. RESISTOR CORP.
00443	INTEL CORP.
00454	INTERSIL
00463	ITT SCHADOW INC.
00484	JORDAN DIVISION, GRO-CON
00493	KEMET, UNION CARBIDE CORP
00503	KOA SPEER ELECTRONICS
00532	LITTELFUSE INC.
00541	M-TRON INDUSTRIES
00548	MALLORY CAPACITOR CO.
00558	MATSUO ELECTRONICS
00564	MEPCO/ELECTRA, INC.
00608	MOLEX
00616	MOTOROLA SEMICONDUCTOR
00628	NATIONAL SEMICONDUCTOR CORP.
00670	PANASONIC INDL. ELECTRN. COMPS
00712	PRECISION MONOLITHICS

10.1 NAMES OF MANUFACTURERS (Continued)

00726	ROHM
00737	RCA SOLID STATE DIVISION
00805	SIGNETICS
00808	SILICONIX INC.
00828	SPECTRA-STRIP
00834	SPRAGUE ELECTRIC CO.
00858	SULLINS ELECTRONICS CORP.
00862	SUPERTEX INC.
00897	TEXAS INSTRUMENTS INC.
00924	TRW RESISTIVE PRODUCTS DIV.
00949	USECO
01144	SGS SEMICONDUCTOR
01146	STANDARD MICROSYSTEMS
01152	TRW-CINCH
01166	KULKA SMITH
01173	FLEXLINE
01175	POMONA
01176	BELDEN
01177	KEYSTONE
01189	IEE HERCULES
01196	DATANETICS
01230	ECTRON CORPORATION

MODEL 1120 THERMOCOUPLE SIMULATOR CALIBRATOR

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
	ANALOG ASSEMBLY	01230		112-501-01
	BOTTOM COVER ASSEMBLY	01230		112-511-02
	POWER SWITCH CABLE	01230		112-022-01
	FRONT PANEL CABLE	01230		112-019-01
	FRONT PANEL ASSEMBLY	01230		112-508-01
	HANDLE	01173	7835-315-314*BLK Y-12561	3-820010-0
	MOTHER BOARD ASSEMBLY	01230		112-500-01
	POWER CORD	01176	17250B	3-840026-0
	POWER SUPPLY ASSEMBLY	01230		112-544-01
	T/C HOLD DOWN PLATE	01230		112-525-01
	TOP COVER & BROW ASSEMBLY	01230		112-511-01
C701,702	CAPACITOR,.01UF DISC 1KV	00834	5GAS10	1-421004-1
F701,100-120VAC	FUSE,3/4A 3AG SLO-BLO	00532	313.750	2-160750-1
F701,220-240VAC	FUSE,3/8A 3AG SLO-BLO	00532	313.375	2-160375-1
J701	RECEPTACLE,AC POWER/FUSEHOLDER	00188	6J4	3-840032-0
T701	TRANSFORMER,POWER	01230		112-516-01

ANALOG ASSEMBLY

	TERMINAL BLOCK ASSEMBLY	01230		112-507-01
	POST,MINI-BANANA W-THRD STUD	01175	4513	3-830039-0
	SET,3-PIECE LED BAR DISPLAY	01230		112-009-01
CR1	ZENER, 6.2V 7.5MA .001% STAB	01230		030-002-01
CR10,11	ZENER, 8.2V 20MA 500MW	00336	1N756A	1-190756-2
CR2-9,12,13	DIODE,SIGNAL	00336	1N4148	1-194148-0
C1,14	CAPACITOR,1UF MPESTR RAD 100V	00564	712A1GL105PK101SL	1-441006-0
C11,44	CAPACITOR,.01UF CER DIP 10%	00149	CW20A103K	1-421009-1
C12,25	CAPACITOR,.1UF CER DIP 100V	00620	RPE121Z5U104M100V	1-431009-0
C13	CAPACITOR,.0022UF MMYL AXL	00834	192P2229R8	1-412209-0
C15	CAPACITOR,100PF MICA 300V 5%	00057	DM5FC101J	1-401003-0
C16	CAPACITOR,220PF MICA 50V 5%	00057	DM5FY221J	1-402203-0
C19	CAPACITOR,5PF MICA 300V .5PF+-	00057	DM5-050D	1-400053-0
C2-10,17,18,22,26-27,29,34-36	CAPACITOR,.1UF MMYL RAD 10%	00564	712A1BB104PK101LA	1-431009-1
C20,30,31	CAPACITOR,4.7UF TANT DIP 35V	00834	199D475X9035CA2	1-444700-1
C21	CAPACITOR,.022UF CER RAD 100V	00321	RPE121X7R223K/100V	1-422204-0
C23	CAPACITOR,2.2UF MTLPOL RAD 63V	00564	712A1RL225PK101SN	1-442209-0
C28	CAPACITOR,TANT DIP 6.8/35V-10%	00834	196D685X9035KA1	1-446800-1
C32,33,38,39	CAPACITOR,47UF ELEC RAD 25V	00670	ECE-A1EV470S	1-454700-1
C37	CAPACITOR,TANT 68MF 6V	00834	196D686X9006KA1	1-456800-0
C40,41	CAPACITOR,15/20V TANT DIP 20%	00493	T354F156K020AS	1-451500-2
C42	CAPACITOR,1UF TANT DIP 50V	00558	221L5002105M3(20%)	1-441000-2
C43	CAPACITOR,.001UF CER DIP 10%	00149	CW15A102K	1-411009-3
E1-4	TERMINAL,SWG TURRET 1/16 BOARD	00949	1282B-1	3-830001-0
E6,7	TERMINAL,SWG BIF .3H 1/16BD	00949	1310B-1	3-830034-0
E8-11	TERMINAL,SWG BIF .16H 1/16BD	00949	2000B-1	3-830033-0
Q1,3,4,29,30	FET,N CHANNEL J	00628	J112	1-240112-0
Q2,6,36	TRANSISTOR,NPN	00336	2N3904	1-203904-0
Q31	FET,N CHANNEL J	00808	J113	1-240113-0
Q34	FET	00862	VNO106N3	1-240106-0
Q37	MOSFET,DUAL	00737	3N138	1-240138-0

ANALOG ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
Q38	TRANSISTOR,1UV/C DUAL NPN	01230		031-002-01
Q5,32,33,35	TRANSISTOR,PNP	00616	2N3906	1-213906-0
Q7-28	FET SET, MATCHED	01230		112-001-01
R1	RESISTOR,511 1% MFLM	00726	CRB14FY511	6-100511-0
R10	RESISTOR,5.295K WW .1%	00416	AP-150,5.295K .1%	6-223057-0
R100,101	RESISTOR,287K 1% MFLM	00726	CRB14FY287K	6-103287-0
R102	RESISTOR,2.00K 1% MFLM	00726	CRB14FY2.00K	6-101200-0
R104	RESISTOR,4.7M 1/4W 5% MFLM/CMP	00564	5043EM4M700JB	6-174470-0
R107,112,116	RESISTOR,2.2K 1/4W 5% CFLM	00503	CF1/4W 2.2K OHM 5%	6-171220-0
R108,137	POT,100K CM PC 3/4L 1/2LD LOPR	00108	3006P-1-104	6-453100-0
R109	RESISTOR,22M 1/4W 5% CCMP	00027	RC07GF226J-	6-175220-0
R111,117	RESISTOR,12K 1/4W 5% CFLM	00503	CF1/4W 12K OHM 5%	6-172120-0
R113,118	RESISTOR,82K 1/4W 5% CFLM	00564	5043CX82K00J	6-172820-0
R119,120	RESISTOR,127 WW .1% LO-THERMAL	00484	S307 127 OHM .1% LT	6-223061-0
R121	RESISTOR,10K WW .1%	00305	TYPE 27 10K 1%	6-223003-0
R122	POT,500 CM PC 3/4L 1/2LD LOPRO	00108	3006P-1-501	6-450500-0
R123-125	ARRAY,9X150 SIP RESISTOR	00108	4310R-101-151	6-310013-0
R126,127	RESISTOR,330 1/2W 5% CFLM	00564	5053CX330E0J	6-180330-0
R16	RESISTOR,8.80K WW .1%	00484	J110	6-223058-0
R17,19,R106	RESISTOR,100K 1/4W 5% CFLM/CMP	00503	CF1/4W 100K OHM 5%	6-173100-0
R2,18,52,114,115,135	RESISTOR,4.7K 1/4W 5% CFLM	00564	5043CX4K700J	6-171470-0
R20,83-85	RESISTOR,1MEG 1/4W 5% MFLM/CMP	00564	5043EM1M000JB	6-174100-0
R21,131,132	RESISTOR,33K 1/4W 5% CFLM	00564	5043CX33K00J	6-172330-0
R22-27,40-44,65	RESISTOR SET,12-PC DAC	01230		112-002-01
R28-32	RESISTOR,5K 10PPM .025% UFLM	00564	UPR5023ZB5K000Z	6-290015-0
R3,5,93,94,103	RESISTOR,39K 1/4W 5% CFLM	00726	R25J-S39K OHM	6-172390-0
R33,48,49	RESISTOR,10K 25PPM .1% UFLM	00564	UPR5023ZE10K00B	6-290012-0
R34-38,74	POT,10 CM PC 3/4L 1/2LD LOPROF	00108	3006P-1-100	6-450010-0
R4,15,56,82,88,110	RESISTOR,10K 1/4W 5% CFLM	00503	CF1/4W 10K OHM 5%	6-172100-0
R45	RESISTOR,9987 10PPM .05% UFLM	00564	UPR5023ZB9K987A	6-290013-0
R46,47	RESISTOR,9997 25PPM .025% UFLM	00564	UPR5023ZE9K997Z	6-290014-0
R51,50	ARRAY,7X4.7K SIP RESISTOR	00108	4308R-101-472 OR	6-310010-0
R53	POT,10K CM PC 3/4L 1/2LD LOPRO	00108	3006P-1-103	6-452100-0
R54	RESISTOR,75.0K 1% MFLM	00726	CRB14FY75.0K	6-102750-0
R55	RESISTOR,150 1/4W 5% CFLM	00503	CF1/4W 150 OHM 5%	6-170150-0
R57,64	POT,2K CM PC 3/4L 1/2LD LOPROF	00108	3006P-1-202	6-451200-2
R58	RESISTOR,150 1% MFLM	00726	CRB14FY150	6-100150-0
R59	RESISTOR,19.1K 1% MFLM	00726	CRB14FY19.1K	6-102191-0
R6,14,96,128	RESISTOR,10 1/4W 5% CFLM	00503	CF1/4W5% 10 OHM	6-170010-0
R61,62	RESISTOR,10.0K 1% MFLM	00726	CRB14FY10.0K	6-102100-0
R66,138	RESISTOR,15M 1/4W 5% CCMP	00027	CB1565	6-175150-0
R68,70	RESISTOR,24.9K 25PPM 1% UFLM	00564	UPR5023ZE24K90F	6-290016-0
R69	POT,5K CM PC 3/4L 1/2LD LOPROF	00108	3006P-1-502	6-451500-1
R7,9	RESISTOR,20K WW .05%	00484	J110	6-224019-0
R72,73,75,76	SET,4 PIECE OUTPUT SCALING RES	01230		112-003-01
R77	POT,50K CM PC 3/4L 1/2LD LOPRO	00108	3006P-1-503	6-452500-0
R78	RESISTOR,49.9K 1% MFLM	00726	CRB14FY49.9K	6-102499-0
R79,80,105,129,130	RESISTOR,1.0K 1/4W 5% CFLM	00726	R25J-S1K OHM	6-171100-0
R8,12,39	POT,20 CM PC 3/4L 1/2LD LOPROF	00108	3006P-1-200	6-450020-0
R81	POT,20K CM PC 3/4L 1/2LD LOPRO	00108	3006P-1-203	6-452200-2
R89,90	RESISTOR,68K 1/4W 5% CFLM	00564	5043CX68K00J	6-172680-0

ANALOG ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
R91	RESISTOR,47K 1/4W 5% CFLM	00564	5043CX47K00J	6-172470-0
R92,136	RESISTOR,220K 1/4W 5% MFLM/CMP	00503	CF1/4W 220K OHM 5%	6-173220-0
R95	RESISTOR,6.8K 1/4W 5% CFLM	00564	5043CX6K800J	6-171680-0
R97	RESISTOR,27K 1/4W 5% CFLM	00503	CF1/4W 27K OHM 5%	6-172270-0
R98,99	RESISTOR,100K 1% MFLM	00726	CRB14FY100K	6-103100-0
U1-3,9	OPAMP	00712	OP-05CP	1-100005-0
U10	IC,QUAD 2-INP NAND GATE PLA	00336	4011BPC	1-114011-0
U11	OPAMP	00397	HA7-2605-5	1-102605-6
U12	IC,QUAD BILATERAL SWITCH PLAST	00737	CD4016BE	1-114016-0
U13	OPAMP	00712	OP-27GZ	1-100027-0
U14	COMPARATOR,DUAL VOLTAGE	00628	LM393N	1-140001-0
U4,5	IC,CMOS HEX INVERTER PLASTIC	00336	4069UBPC	1-114069-1
U6	IC,CMOS,D/A CONV 10 BIT PLA	00048	AD7533LN	1-147533-0
U7,8	OP AMP	00897	UA741CP	1-100741-2
XDS1-S3	SOCKET,16P VERT RT ANGLE DIP	00060	16-810-90	1-290036-0
XU1,2,3,7,8,9,11,13,14	SOCKET,IC 8 PIN DIP TIN	00043	640463-3	1-290008-0
XU10,12	SOCKET,IC 14 PIN	00137	703-1314-01-04-10	1-290011-0
XU6	SOCKET,IC 16 PIN	00137	703-5316-01-04-12	1-290012-0

FRONT PANEL ASSEMBLY

	GROMMET,#6/8 SCREW HOLDING	00338	242-160502-70	3-801605-0
	KEY CAP,MOLDED BLACK	01196	02-2143-0003 BLACK	7-190020-0
	STUD,3/16DIA CLENCH	00236	1-S-125-125	3-905060-0
C601,602,604	CAPACITOR,.1UF MMYL RAD 10%	00564	712A1BB104PK101LA	1-431009-1
C603	CAPACITOR,47UF ELEC RAD 25V	00670	ECE-A1EV470S	1-454700-1
CASE GROUND POST	BINDING POST,METAL 8-32	01166	137	3-830060-0
DS601-603	DISPLAY SET,3-PC	01230		112-008-01
DS604	DISPLAY,2DIGIT ALPHAMERIC LED	01189	LR3785R	4-120026-0
DS605,606	LIGHT BAR,DUAL .35SQ RED LED	00403	HLMP2670-S02	4-120025-0
DS607	LIGHT BAR,SNGL .35X.75 RED LED	00403	HLMP2685-S02	4-120024-0
E901	BINDING POST,BLUE STD BANANA	01175	3750-6	3-830038-0
J601	HEADER,2X20 PIN DOUBLE ROW	00828	842-800-2X20	1-300024-0
POWER SWITCH	SWITCH,ROCKER DPST	00163	171-099-109	7-180003-0
Q601-606	TRANSISTOR,PNP	00628	2N6710	1-236710-0
Q607-613	TRANSISTOR,PNP	00616	2N3906	1-213906-0
Q615,616	TRANSISTOR,NPN	00628	2N6707	1-226707-0
R601,602,612	ARRAY,9X4.7K SIP RESISTOR	00108	4310R-101-472 OR	6-310011-0
R603-610	RESISTOR,27 1/4W 5% CFLM	00503	CF1/4W 27 OHM 5%	6-170027-0
R611	ARRAY 7X470 DIP RESISTOR	00108	4116R-001-471	6-310012-0
R613-618	RESISTOR,330 1/4W 5% CFLM	00564	5043CX330R0J	6-170330-0
R619-620	RESISTOR,120 1/2W 5% CFLM	00564	5053CX120E0J	6-180120-0
R621-627	RESISTOR,15 1/4W 5% CFLM	00503	CF1/4W 15 OHM 5%	6-170015-0
R629-631	ARRAY,9X150 SIP RESISTOR	00108	4310R-101-151 OR	6-310013-0
S601-617	SWITCH,KEYBOARD PUSHBUTTON	00463	3204401	7-150000-0
S901	SWITCH,PULL-TO-MAKE	00383	30-32	7-120004-0
U601,602	IC,MOS-LED HEX DIGIT DRIVER	00628	DS75492N	1-117549-2
U603	IC,QUAD 2 INPUT + NAND BUFFER	00897	SN7438J	1-117438-0
XDS601-604A,601B-604B	SOCKET,11P SIP 2-WIRE-WRAP	00166	CA-11STL-102WW	1-290031-0
XDS605-607	SOCKET,IC 16 PIN TIN LEADS	00060	16-501-20	1-290012-1

FRONT PANEL ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
XU601-603	SOCKET,IC 14 PIN	00137	703-1314-01-04-10	1-290011-0

MOTHER BOARD ASSEMBLY

	CABLE,GUARD CONNECTION	01230		112-020-01
	STUD,HEX 3/16AF 6-32	00236	1-H-6-080-312	3-905070-0
ON TOP OF LONG STANDOFFS	BATTERY,3V LITHIUM W/COVER	00277	BCX72/3B50 WITHBCX72/3B67	1-340000-0
BT201	ZENER,4.7V 20MA 500MW	00336	1N750A	1-190750-0
CR201	DIODE,SIGNAL	00336	1N4148	1-194148-0
CR202,204,210	ZENER,2.4V 20MA 500MW	00616	1N5221A	1-195221-0
CR203	DIODE,SIGNAL	00336	1N457	1-190457-0
CR205	DIODE,BRIDGE	00369	KBPC602	1-190602-0
CR207	DIODE,POWER	00336	1N4002	1-194002-0
CR208,209				
C201,202,205-208,210-212, 216-224,227-230,235,236, 238,239	CAPACITOR,.1UF MMYL RAD 10%	00564	712A1BB104PK101LA	1-431009-1
C203,204	CAPACITOR,4.7UF TANT DIP 10V	00834	196D475X0010HA1	1-444700-0
C209,213	CAPACITOR,15/20V TANT DIP 20%	00493	T354F156K020AS	1-451500-2
C214,215	CAPACITOR,20PF MICA 300V 5%	00057	DM5CC200J	1-400203-0
C225,237	CAPACITOR,.22UF MMYL RAD 10%	00564	712A1BF224PK101LA	1-432206-0
C226	CAPACITOR,1UF MPESTR RAD 100V	00564	712A1GL105PK101SL	1-441006-0
C231	CAPACITOR,68PF MICA 500V 5%	00057	DM10ED680J	1-400683-1
C233	CAPACITOR,21KUF ELEC CMPTR 25V	00564	3110EA213U025AM	1-482100-0
C234	CAPACITOR,125UF ELEC AXL 50V	00189	NLW125-50	1-461250-0
E203,207-210	TERMINAL,SWG BIF .12H 3/32BD	00949	2000C-1	3-830032-0
E204-206	TERMINAL,SWG POST W/HOLE 3/32B	00137	2027-3-01	3-830005-1
F201	FUSE,.125/125V SUBMIN AX-LD	00532	275.125	2-160125-0
J202,204,217	HEADER,8-P	00608	09-67-1082	1-312008-0
J203	HEADER,2X20 PIN DOUBLE ROW	00828	842-800-2X20	1-300024-0
J205	CONNECTOR,2X28P CARD-EDGE	00858	EZM28DRXH	1-314128-0
J206,208	CONNECTOR,2X18P CARD-EDGE	01152	50-36B-10/252-18-30-160	1-314218-0
J207	CONNECTOR,6P CARD-EDGE	01152	50-6B-10/252-06-30-240	1-314206-0
J209-216	CONNECTOR,2X15P CARD-EDGE	00272	341-030-521-202	1-314315-0
J209-216	KEY,CONNECTOR POLARIZING	00272	341-240-318	1-319208-0
Q201,206,207	TRANSISTOR,NPN	00336	2N3904	1-203904-0
Q202-204	TRANSISTOR,PNP	00616	2N3906	1-213906-0
Q205	FET,N CHANNEL J	00628	J201	1-240201-0
Q209	FET	00862	VN0106N3	1-240106-0
R201,202	RESISTOR,150K 1/4W 5% MFLM/CMP	00564	5043EM150K0JB	6-173150-0
R203,235	RESISTOR,1.2K 1/4W 5% CFLM	00503	CF1/4W 1.2 OHM 5%	6-171120-0
R204,214,229	RESISTOR,4.7K 1/4W 5% CFLM	00564	5043CX4K700J	6-171470-0
R205,209	RESISTOR,270 1/4W 5% CFLM	00503	CF1/4W 270 OHM 5%	6-170270-0
R206,211	RESISTOR,47K 1/4W 5% CFLM	00564	5043CX47K00J	6-172470-0
R207,208,215-217	RESISTOR,10K 1/4W 5% CFLM	00503	CF1/4W 10K OHM 5%	6-172100-0
R210,212	RESISTOR,2.49K 1% MFLM	00726	CRB14FY2.49K	6-101249-0
R213	RESISTOR,100 1/4W 5% CFLM	00564	5043CX100R0J	6-170100-0
R218,219,223	RESISTOR,100K 1/4W 5% CFLM/CMP	00503	CF1/4W 100K OHM 5%	6-173100-0
R220	RESISTOR,10M 1/4W 5% MFLM/CMP	00564	5043EM10M00JB	6-175100-0
R221	RESISTOR,1.0K 1/4W 5% CFLM	00726	R25J-S1K OHM	6-171100-0
R222	RESISTOR,249K 1% MFLM	00726	CRB14FY249K	6-103249-0

MOTHER BOARD ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
R224	RESISTOR,1.25K WW .1%	00484	J110 1.25K 0.1%	6-223062-0
R225	RESISTOR,10K WW .1%	00305	TYPE 27 10K 1%	6-223003-0
R226	RESISTOR,22K 1/4W 5% CFLM	00564	5043CX22K00J	6-172220-0
R230-232,240-242	ARRAY,9X4.7K SIP RESISTOR	00108	4310R-101-472 OR	6-310011-0
R233,234	RESISTOR,1.5K 1/4W 5% CFLM	00503	CF1/4W 1.5K OHM 5%	6-171150-0
R236,237	RESISTOR,470 1/4W 5% CFLM	00503	CF1/4W 470 OHM 5%	6-170470-0
R239	RESISTOR,150 1/4W 5% CFLM	00503	CF1/4W 150 OHM 5%	6-170150-0
R240	RESISTOR,1MEG 1/4W 5% MFLM/CMP	00564	5043EM1M000JB	6-174100-0
S201	SWITCH,KEYBOARD PUSHBUTTON	00463	3204401	7-150000-0
S202	SWITCH,TOGGLE	00128	7101SDV30BE	7-110041-0
U201	IC,CMOS 14 STG BI/RIP CTR PLA	00336	F4020BPC	1-114020-0
U202	IC,HEX INVERTER	00628	DM74LS055N	1-157405-2
U203,219	IC,DUAL MLTVBRTR W/CLR 74LS123	00628	DM74LS123N	1-157412-3
U204	REGULATOR,5V 100MA	00616	MC78L05CP	1-137805-1
U206,207	IC,1024X4 CMOS RAM	00397	HM1-6514-9(CERAMIC)	1-146514-9
U208	IC,8BIT N-CH MICROPROCESSOR	00443	MICROPROCESSOR, P8085A-2	1-148085-2
U209	IC,QUAD 2INPUT +OR GATE	00628	DM74LS32N	1-157432-2
U210	IC,OCTAL D-LATCH	00897	SN74LS373N	1-157437-3
U211	IC,DUAL 2TO4 LINE DCDR/MUX	00897	SN74LS139AN	1-157413-9
U212,213,220	IC,3TO8 LINE DCDR/MUX	00897	SN74LS138N	1-157413-8
U214,221	IC,PROGRAMMABLE I/O INTERFACE	00443	P8255A-5	1-148255-5
U215	IC,MOS-LED HEX DIGIT DRIVER	00628	DS75492N	1-117549-2
U216	IC,12BIT A-TO-D CONVERTER	00454	ICL7109CPL	1-147109-0
U217	IC,PROGRAMMABLE KYBD&DISPL I/O	00443	P8279-5	1-148279-5
U218	IC,QUAD 2-IN +AND GATE	00628	DM74LS08N	1-157408-2
U222	EPROM	01230		112-545-01
XU201,203,211-213,219-20	SOCKET,IC 16 PIN	00137	703-5316-01-04-12	1-290012-0
XU202,205,209,215,218	SOCKET,IC 14 PIN	00137	703-1314-01-04-10	1-290011-0
XU206,207	SOCKET,18PIN DIP-SOLDER	00043	640359-3	1-290032-0
XU208,214,216,217,221	SOCKET,40PIN DIP-SOLDER	00137	703-4240-01-04-10	1-290034-0
XU210	SOCKET,20PIN DIP-SOLDER	00043	640464-3	1-290033-0
XU222	SOCKET,IC 28PIN DIP LOPROFILE	00043	640362-3	1-290037-0
XY201	CLIP,CRYSTAL HC-18/U SIZE	00072	100-206-10	1-307001-0
Y201	CRYSTAL,4.9152MHZ QUARTZ	00541	MP-1 4.9152MHZ HC-18/U	1-307000-0

POWER SUPPLY ASSEMBLY

CR502-504	DIODE,BRIDGE 1.5A 200V	00369	WO2M	1-190075-0
CR505,508,512-519	DIODE,POWER	00336	1N4002	1-194002-0
CR507	ZENER, 5.1V 20MA 500MW	00336	1N751A	1-190751-2
CR509,510	DIODE,POWER	00616	MR751	1-19M751-0
C503,522	CAPACITOR,100PF MICA 300V 5%	00057	DM5FC101J	1-401003-0
C504	CAPACITOR,TANT DIP 6.8/35V-10%	00834	196D685X9035KA1	1-446800-1
C505,510,513,521	CAPACITOR,.1UF MMYL RAD 10%	00564	712A1BB104PK101LA	1-431009-1
C506	CAPACITOR,15/20V TANT DIP 20%	00493	T354F156K020AS	1-451500-2
C507,508,511,514,516,518,520	CAPACITOR,1UF TANT DIP 50V	00558	221L5002105M3(20%)	1-441000-2
C509,512,517,519	CAPACITOR,1000UF ELEC AX 35V	00564	3074LH102T040JPB	1-471000-0
C515	CAPACITOR,5000UF ELEC AX 15V	00548	TC1550	1-475000-0
Q501	SCR	00737	S2800A	1-284086-7
R501,503	RESISTOR,.1 2W 5% WIREWOUND	00924	BWH .1 OHM 5%	6-217505-0

POWER SUPPLY ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
R502	RESISTOR,261 1% MFLM	00726	CRB14FY261	6-100261-0
R504	RESISTOR,47 1/4W 5% CFLM	00503	CF1/4W 47 OHM 5%	6-170047-0
R505	RESISTOR,1.0K 1/4W 5% CFLM	00726	R25J-S1K OHM	6-171100-0
R506,508	RESISTOR,806 1% MFLM	00726	CRB14FY806	6-100806-0
R509	RESISTOR,560 1/4W 5% CFLM	00503	CF1/4W 560 OHM 5%	6-170560-0
R510	RESISTOR,330K 1/4W 5% MFLM/CMP	00564	5043EM330K0JB	6-173330-0
U501-503	REGULATOR,3 TERM ADJ	00628	LM317-T	1-130317-0
U504	OP AMP,	00628	LF356N	1-100356-1
U505	REGULATOR,-5 TO-92V	00628	LM320LZ-5.0	1-130320-2
U506	REGULATOR,15V .5A	00336	UA78M15UC	1-137815-0
U507	REGULATOR,-15V	00616	MC7915CT	1-137915-0
U508	REGULATOR,5V 1A	00336	UA7805UC	1-137805-0
U509	REGULATOR,12V .5A	00336	78M12UC	1-137812-0
U510	REGULATOR,-12V 1A	00628	LM7912CT	1-137912-0
XU504	SOCKET,IC 8 PIN DIP TIN	00043	640463-3	1-290008-

THERMOCOUPLE MODULES, OTHER OPTIONS, AND MISCELLANEOUS

	THERMOCOUPLE TYPE B	01230		112-503-07
	THERMOCOUPLE TYPE C	01230		112-503-08
	THERMOCOUPLE TYPE E	01230		112-503-01
	THERMOCOUPLE TYPE J	01230		112-503-02
	THERMOCOUPLE TYPE K	01230		112-503-03
	THERMOCOUPLE TYPE N	01230		112-503-09
	THERMOCOUPLE TYPE PL	01230		112-503-10
	THERMOCOUPLE TYPE R	01230		112-503-06
	THERMOCOUPLE TYPE S	01230		112-503-05
	THERMOCOUPLE TYPE T	01230		112-503-04
	RACK MOUNT ASSEMBLY	01230		112-519-01
OPTION 01	IEEE INTERFACE	01230		112-506-01
OPTION 02	REAR PANEL TERMINALS	01230	NOT FIELD INSTALLABLE	
OPTION 03	RS-232-C INTERFACE	01230		112-541-01
OPTION 04	EXTENDER BOARD ASSEMBLY	01230		112-528-01

THERMOCOUPLE MODULE ASSEMBLY

	EPROM,T/C TYPE B	01230		112-523-07
	EPROM,T/C TYPE C	01230		112-523-08
	EPROM,T/C TYPE E	01230		112-523-01
	EPROM,T/C TYPE J	01230		112-523-02
	EPROM,T/C TYPE K	01230		112-523-03
	EPROM,T/C TYPE N	01230		112-523-09
	EPROM,T/C TYPE PL	01230		112-523-10
	EPROM,T/C TYPE R	01230		112-523-06
	EPROM,T/C TYPE S	01230		112-523-05
	EPROM,T/C TYPE T	01230		112-523-04
CR401-CR403	ARRAY,16 DIODES 14 PINS	00336	FSA2501P	1-180000-0
CR404	ZENER,12V 10.5MA 500MW	00336	1N963B	1-190963-2
C401	CAPACITOR,68UF ELEC AXL 16V	00564	3073DA680T016JPB	1-456800-1

THERMOCOUPLE MODULE ASSEMBLY (Continued)

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
C402	CAPACITOR,.1UF CER DIP 100V	00620	RPE121Z5U104M100V	1-431009-0

IEEE-488 INTERFACE ASSEMBLY

	HARDWARE SET,6-PIECE	00043	552633-3	1-319024-0
C801,C805	CAPACITOR,47UF ELEC RAD 25V	00670	ECE-A1EV470S	1-454700-1
C802	CAPACITOR,TANT-DIP 10MF 25V	00834	199D106X0025CA2	1-451000-0
C803	CAPACITOR,20PF MICA 300V 5%	00057	DM5CC200J	1-400203-0
C804,C806	CAPACITOR,.01UF CER DIP 10%	00149	CW20A103K	1-421009-1
C807-C823	CAPACITOR,.1UF CER DIP 100V	00620	RPE121Z5U104M100V	1-431009-0
E801,E802	TERMINAL,SWG BIF .16H 1/16BD	00949	2000B-1	3-830033-0
J702	CONNECTOR,24-S	00043	552791-2	1-310224-0
RN801-RN803	ARRAY,9X10K SIP RESISTOR	00108	4310R-101-103 OR	6-310014-0
R801-R805,R816	RESISTOR,22K 1/4W 5% CFLM	00564	5043CX22K00J	6-172220-0
R806,R807	RESISTOR,680 1/4W 5% CFLM	00503	CF1/4W 680 OHM 5%	6-170680-0
R808,R809,R817	RESISTOR,10K 1/4W 5% CFLM	00503	CF1/4W 10K OHM 5%	6-172100-0
R810-R815	RESISTOR,390 1/4W 5% CFLM	00503	CF1/4W 390 OHM 5%	6-170390-0
S801	SWITCH,DIP 5-STATION PIANO	00383	76PSB05S	7-190022-0
U801,U802	IC,GPIB TRANSCEIVER	00443	D8293	1-148293-0
U803	IC,GPIB TALKER-LISTENER	00443	P8291A	1-148291-0
U804,U823	IC,UART UNIV ASYNC REC-TRANS	00454	IM6402-1IPL	1-146402-0
U805,U820	IC,LS HEX QUAD D FLIP-FLOP	00805	74LS175N	1-157417-5
U806	IC,LS TRIPLE 3INPUT AND GATE	00805	74LS11N	1-157411-0
U807,U809,U811,U826	IC,DUAL-D FLIPFLOP W/CLR&PRSET	00897	SN74LS74AN	1-157474-2
U808	IC,LS QUAD 2INPUT NOR GATE	00805	74LS02N	1-157402-0
U810	IC,LS HEX INVERTER	00805	74LS04N	1-157404-0
U812,U822	IC,QUAD 2-INP POS-NAND GATE PL	01144	T74LS00B1	1-117400-1
U813,U821	IC,LS INV HEX SCHMITT TRIGGER	00805	74LS14N	1-157414-0
U814-U819	OPTOCOUPLER	00403	HCPL-2503	1-280011-0
U824	EPROM	01230		112-533-01
U825	IC,LS TRI-STATE HEX INV BUFFER	00805	74LS366AN	1-157436-6
U827	IC,QUAD 2-INP POS-OR GATE PLA	00336	7432PC	1-117432-0
XU801,XU802	SOCKET,IC 28PIN DIP LOPROFILE	00043	640362-3	1-290037-0
XU803,XU804,XU823	SOCKET,40PIN DIP-SOLDER	00137	703-4240-01-04-10	1-290034-0
XU814-XU819	SOCKET,IC 8 PIN DIP TIN	00043	640463-3	1-290008-0
XU824	SOCKET,IC 24 PIN GOLD ROM	00137	703-5324-01-04-12	1-290009-0
XY801	CLIP,CRYSTAL	00072	100-206-10	1-307001-0
Y801	CRYSTAL,4.9152MHZ QUARTZ	00541	MP-1 4.9152MHZ HC-18/U	1-307000-0

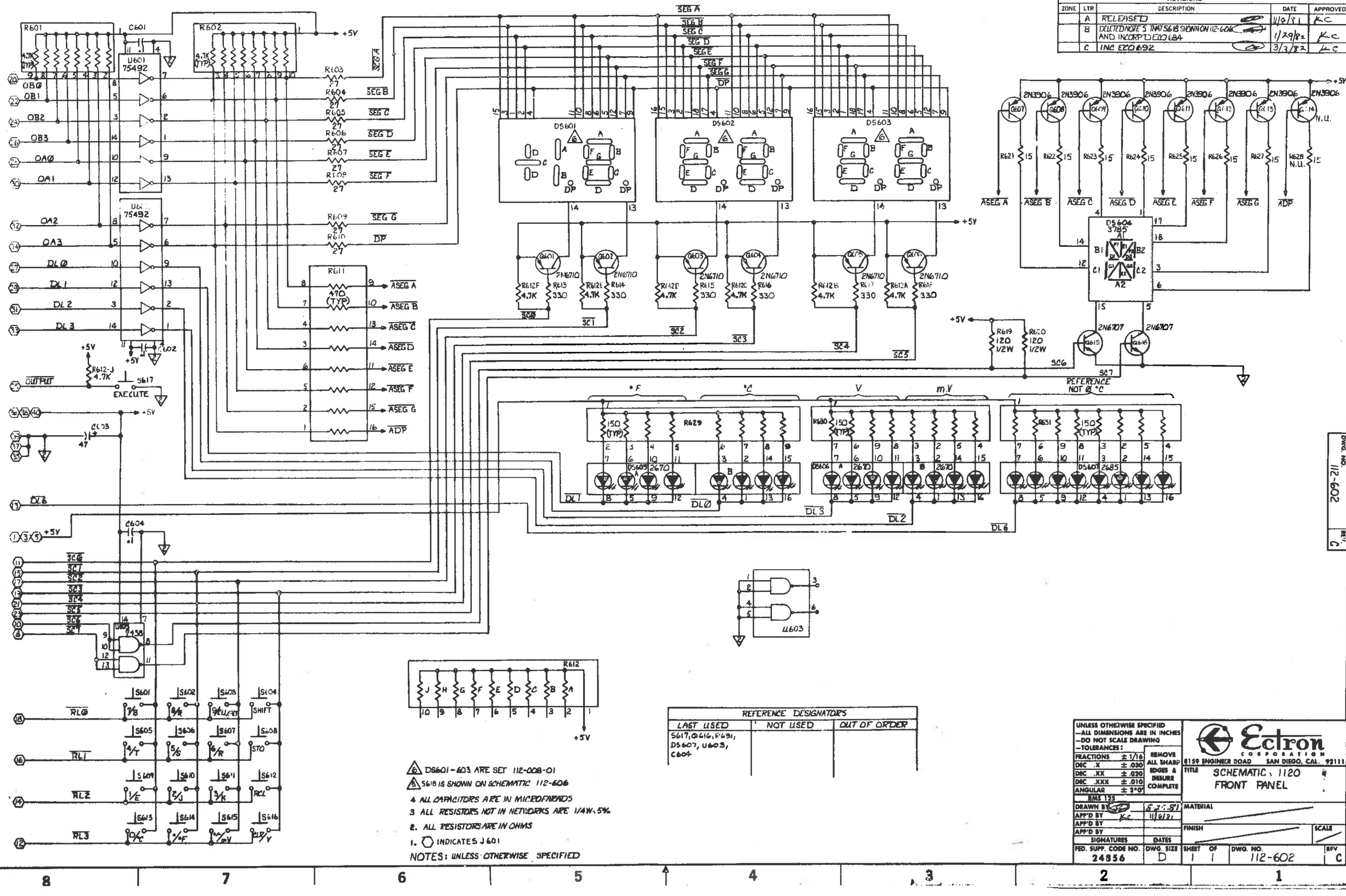
REAR PANEL TERMINAL

	REAR TERMINAL BLOCK ASSEMBLY	01230		112-537-01
	CAPTIVE LATCH KIT	01230		050-506-01
CASE GROUND POST	BINDING POST,METAL 8-32	01166	137	3-830060-0

RS-232-C INTERFACE ASSEMBLY

REFERENCE DESIGNATOR	DESCRIPTION	MFR	MANUFACTURER'S P/N	ECTRON P/N
C801,C808	CAPACITOR,47UF ELEC RAD 25V	00670	ECE-A1EV470S	1-454700-1
C802-C803	CAPACITOR,470PF MICA 500V 5%	00057	DM15FD471J	1-404703-2
C805,6,10-22,25,27,29-31,33	CAPACITOR,.1UF CER DIP 100V	00620	RPE121Z5U104M100V	1-431009-0
C807,C809	CAPACITOR,TANT-DIP 10MF 25V	00834	199D106X0025CA2	1-451000-0
FOR J701	SCREWLOCK ASSEMBLY	01152	D20418-2	1-319903-0
FOR W802	TERMINAL,SWG BIF .16H 1/16BD	00949	2000B-1	3-830033-0
J701	CONNECTOR, 25PIN	00043	745783-2	1-310125-0
RN801	ARRAY,9X4.7K SIP RESISTOR	00108	4310R-101-472 OR	6-310011-0
R801-R806,R810-R812	RESISTOR,4.7K 1/4W 5% CFLM	00564	5043CX4K700J	6-171470-0
R807,R808,R814-R816	RESISTOR,390 1/4W 5% CFLM	00503	CF1/4W 390 OHM 5%	6-170390-0
R817	RESISTOR,15K 1/4W 5% CFLM	00564	5043CX15K00J	6-172150-0
S801	SWITCH,DIP 10-STATION PIANO	00383	76PSB10S	7-190023-0
U801-U803,U805,U806	IC,3-STATE OCTAL BUFFER	00336	74LS244PC	1-157424-4
U804	IC,3-STATE OCTAL TRANSCEIVER	00336	74LS245PC	1-157424-5
U807	IC,QUAD 2INPUT +OR GATE	00628	DM74LS32N	1-157432-2
U808	IC,LS HEX INVERTER	00805	74LS04N	1-157404-0
U809,U814	IC,QUAD 2-IN +AND GATE	00628	DM74LS08N	1-157408-2
U810	IC,GENERATOR DUAL BD RATE PROG	01146	COM8116	1-148116-0
U811	IC,ENHANCED USART	00014	P8251A	1-148251-0
U812	EPROM	01230		112-540-01
U813	EPROM	01230		112-540-02
U815,U816,U818-U820	OPTOCOUPLER	00403	HCPL-2503	1-280011-0
U821	IC,QUAD LINE DRIVER	00336	UA1488PC	1-141488-0
U822	IC,QUAD LINE RECEIVER	00336	UA1489APC	1-141489-0
XU810	SOCKET,18PIN DIP-SOLDER	00043	640359-3	1-290032-0
XU811	SOCKET,IC 28PIN DIP LOPROFILE	00043	640362-3	1-290037-0
XU812,XU813	SOCKET,IC 24 PIN GOLD ROM	00137	703-5324-01-04-12	1-290009-0
XU815,XU816,XU818-XU820	SOCKET,IC 8 PIN DIP TIN	00043	640463-3	1-290008-0
XU821,XU822	SOCKET,IC 14 PIN	00137	703-1314-01-04-10	1-290011-0
XY801	CLIP,CRYSTAL	00072	100-206-10	1-307001-0
Y801	CRYSTAL,5.0688MHZ QUARTZ	00541	MP-1 5.0688MHZ-HC-18/U	1-307002-0

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	1/6/81	KC
	B	DELETED NOTE 5 THAT 5618 SHOWN ON 112-606 AND INCORP'D E20684	1/29/82	KC
	C	INC E20692	3/3/82	KC



REFERENCE DESIGNATORS		
LAST USED	NOT USED	OUT OF ORDER
S617, Q616, R631, DS607, U603, C604		

6. DS601-603 ARE SET 112-008-01
5. S618 IS SHOWN ON SCHEMATIC 112-606
4. ALL CAPACITORS ARE IN MICROFARADS
3. ALL RESISTORS NOT IN NETWORKS ARE 1/4W, 5%
2. ALL RESISTORS ARE IN OHMS
1. ⬡ INDICATES J601

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED
—ALL DIMENSIONS ARE IN INCHES
—DO NOT SCALE DRAWING
—TOLERANCES:

FRACTIONS	± 1/16
DEC .X	± .030
DEC .XX	± .020
DEC .XXX	± .010
ANGULAR	± 2°0'
RMS 125	

REMOVE ALL SHARP EDGES & BURRS COMPLETE

SIGNATURES	DATES
DRAWN BY	5-27-81
APP'D BY KC	11/6/81
APP'D BY	
APP'D BY	

FED. SUPP. CODE NO. 24856 | DWG. SIZE D

Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

TITLE SCHEMATIC, 1120 FRONT PANEL

MATERIAL | FINISH | SCALE

SHEET 1 OF 1 | DWG. NO. 112-602 | REV C

LTR	DESCRIPTION	BY	DATE	APPD
A	RELEASED			
B	CHANGED CKT 032-002-01 TO 030-002-01			
C	IMPLEMENTED PMR CA078 & ECO 834			
D	INC ECO 880			
E	INC ECO 920			
F	INC ECO 307 5-8-84			
G	INC ECO 919			
H	INC ECO 984			

LAST USED	NOT USED	OUT OF SEQUENCE
R138, C44, CR13, Q38, U16, E11, D33	R86, R87, C26	R129-R138, C43

NOTES: UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE 1/4W 5%
2. CAPACITORS ARE IN MICROFARADS
3. INDUCTORS ARE IN MICROHENRYS
4. DIODES ARE 1N4148
5. 'R22 - R27, R40 - R44 ARE PART OF SET 112-008-01
6. ⬡ INDICATES LINES GOING OFF THE 3D AND ALL DAC LINES GO OFF THE 3D
7. Q21 THRU Q28 ARE 112-001 MATCHED PAIRS

UNLESS OTHERWISE SPECIFIED		
—ALL DIMENSIONS ARE IN INCHES		
—DO NOT SCALE DRAWING		
—TOLERANCES:		
FRACTIONS	± 1/16	REMOVE
DEC .X	± .030	ALL BURRS
DEC .XX	± .010	BREAK &
DEC .XXX	± .010	DEBURR
ANGULAR	± 1°-0'	COMPLETE
MATERIAL 173		
DRAWN BY W.W.W	1-28-81	
APP'D BY R.C.	1/31/81	
APP'D BY		
APP'D BY		
SIGNATURES	DATE	
FED. SUPP. CODE NO. 24856	SIZE R	DWG. NO. 112-607 REV. H

Ectron CORPORATION
6185 Cornerstone Court, San Diego, CA 92121

TITLE: SCHEMATIC ANALOG ASSY 1120

SHEET 1 OF 1

DWG. NO. 112-607 REV. H

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	11/9/81	KC
	B	INC ECO 684	1/29/82	KC
	C	INC ECO 700	3/3/82	KC
	D	INC ECO 921 JW 8-15-84	8/28/84	KC

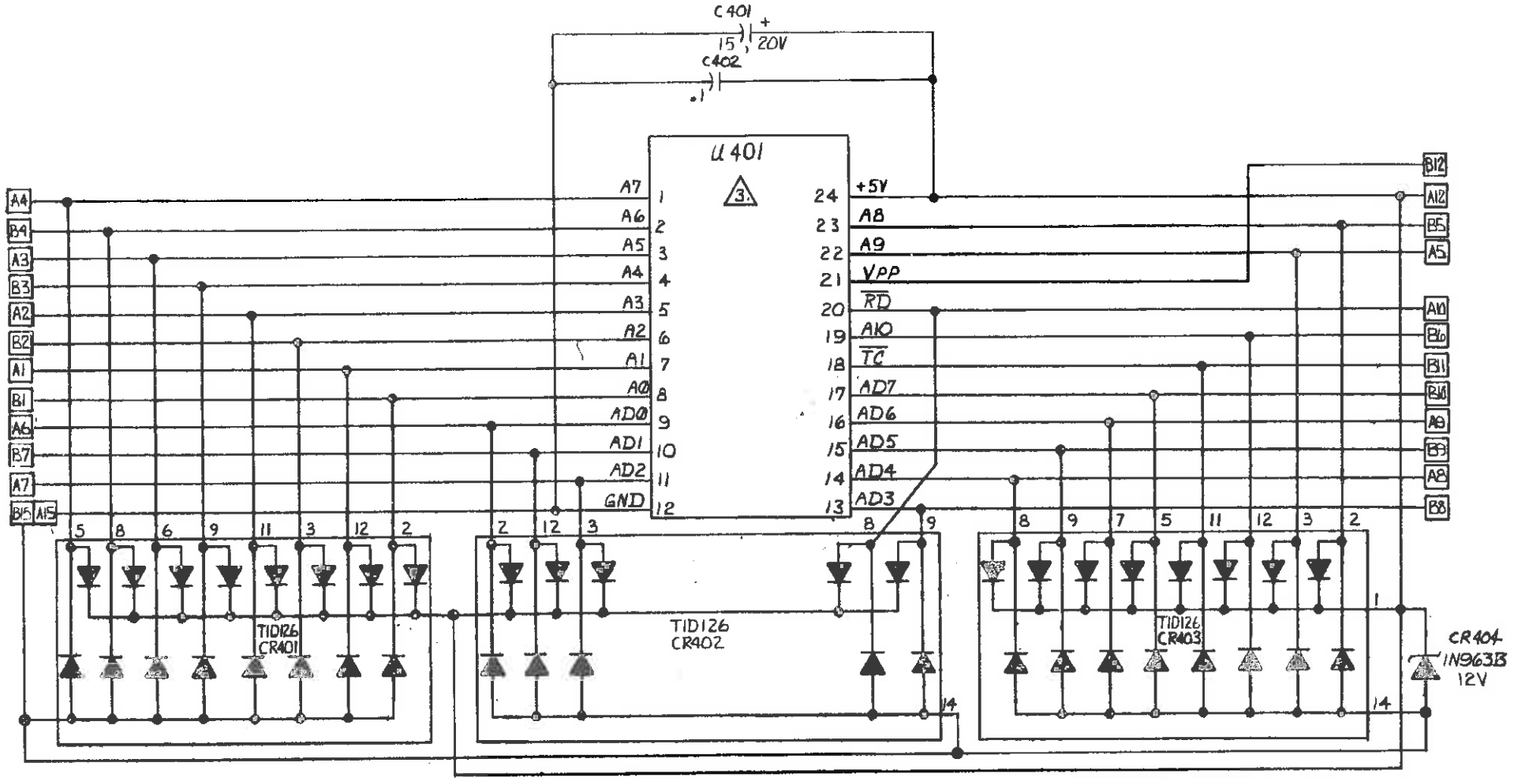


TABLE 1		
T/C TYP	U401 P/N	TC MODULE ASSY NO.
E	112-523-01	112-503-01
J	02	02
K	03	03
T	04	04
S	05	05
R	06	06
B	112-523-07	112-503-07
C	112-523-08	112-503-08

DWG. NO. 112-608 REV. D

3. REF TO TABLE 1 FOR U401 P/NS
2. CAPACITORS ARE IN MICROFARADS
1. ☐ INDICATES PINS OF P401 WHICH MATES WITH J209 THRU J216 ON MOTHER BOARD.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED
—ALL DIMENSIONS ARE IN INCHES
—DO NOT SCALE DRAWING
—TOLERANCES:

FRACTIONS	± 1/16
DEC .X	± .030
DEC .XX	± .020
DEC .XXX	± .010
ANGULAR	± 2°0'
RMS 125	

REMOVE ALL SHARP EDGES & DEBURR COMPLETE

SIGNATURES	DATES
DRAWN BY	2-11-81
APP'D BY KC	2/13/81
APP'D BY	
APP'D BY	
FED. SUPP. CODE NO. 24856	DWG. SIZE C

Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

TITLE SCHEMATIC, 1120 TC MODULE

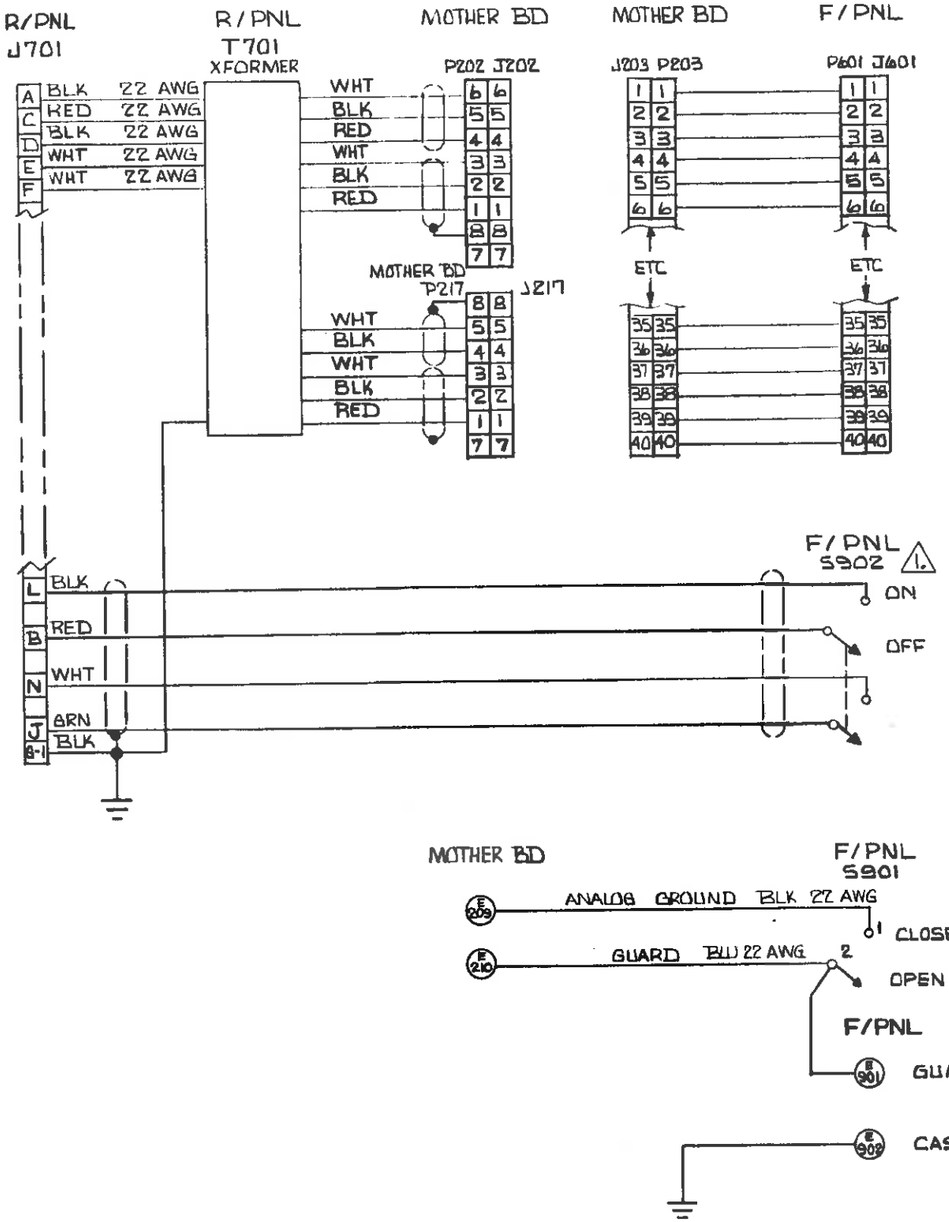
MATERIAL

FINISH SCALE

SHEET 1 OF 1 DWG. NO. 112-608 REV. D

Optico 279-8161 REORDER NO. 150C

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	12-30-81	K.C.



1. S902 IS SHOWN ON SCHEMATIC 112-6006 FOR CLARITY OF POWER SUPPLY.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED --ALL DIMENSIONS ARE IN INCHES --DO NOT SCALE DRAWING --TOLERANCES:	
FRACTIONS ± 1/16	REMOVE ALL SHARP EDGES & DEBURR COMPLETE
DEC .X ± .030	
DEC .XX ± .020	
DEC .XXX ± .010	
ANGULAR ± 2°0'	
RMS 125	
DRAWN BY L. NELSON	11/19/81
APP'D BY K C	12/30/81
APP'D BY	
APP'D BY	
SIGNATURES	DATES
FED. SUPP. CODE NO. 24856	DWG. SIZE C

Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

TITLE: SCHEMATIC, 1120 INTERCONNECTION

MATERIAL

FINISH

SCALE: NONE

SHEET 1 OF 1

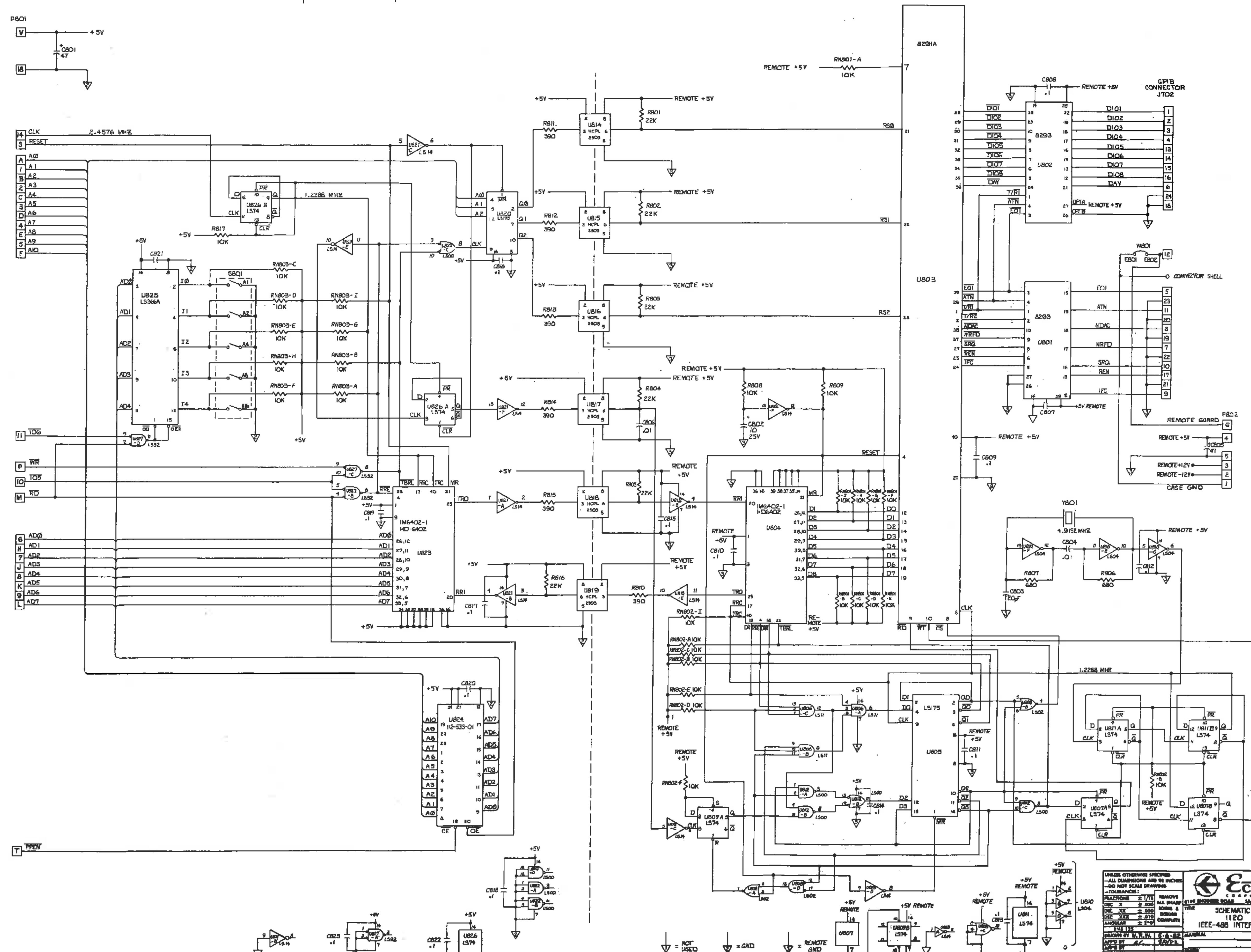
DWG. NO. 112-610 REV. A

DWG. NO. 112-610 REV. A

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

REF DESIGNATORS	
LAST USED	NOT USED
U827, R817, C823, RN803, Y801, W801, E802, S801	

REVISION				
	DESCRIPTION	BY	DATE	APPD
A	RELEASED			
B	UPDATED PER BREAD BD CHECK			
C	INPUT U829 WAS CONNECTED TO U822-C			
D	UPDATED PER LAYOUT			
E	INC ECO 774			



UNLESS OTHERWISE SPECIFIED
—ALL DIMENSIONS ARE IN INCHES
—DO NOT SCALE DRAWING
—TOLERANCES:

FRACTIONS	± 1/16
DEC .X	± .030
DEC .XX	± .020
DEC .XXX	± .010
ANGULAR	± 2°0'

REMOVE ALL SHARP EDGES & DEBURR COMPLETE

Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

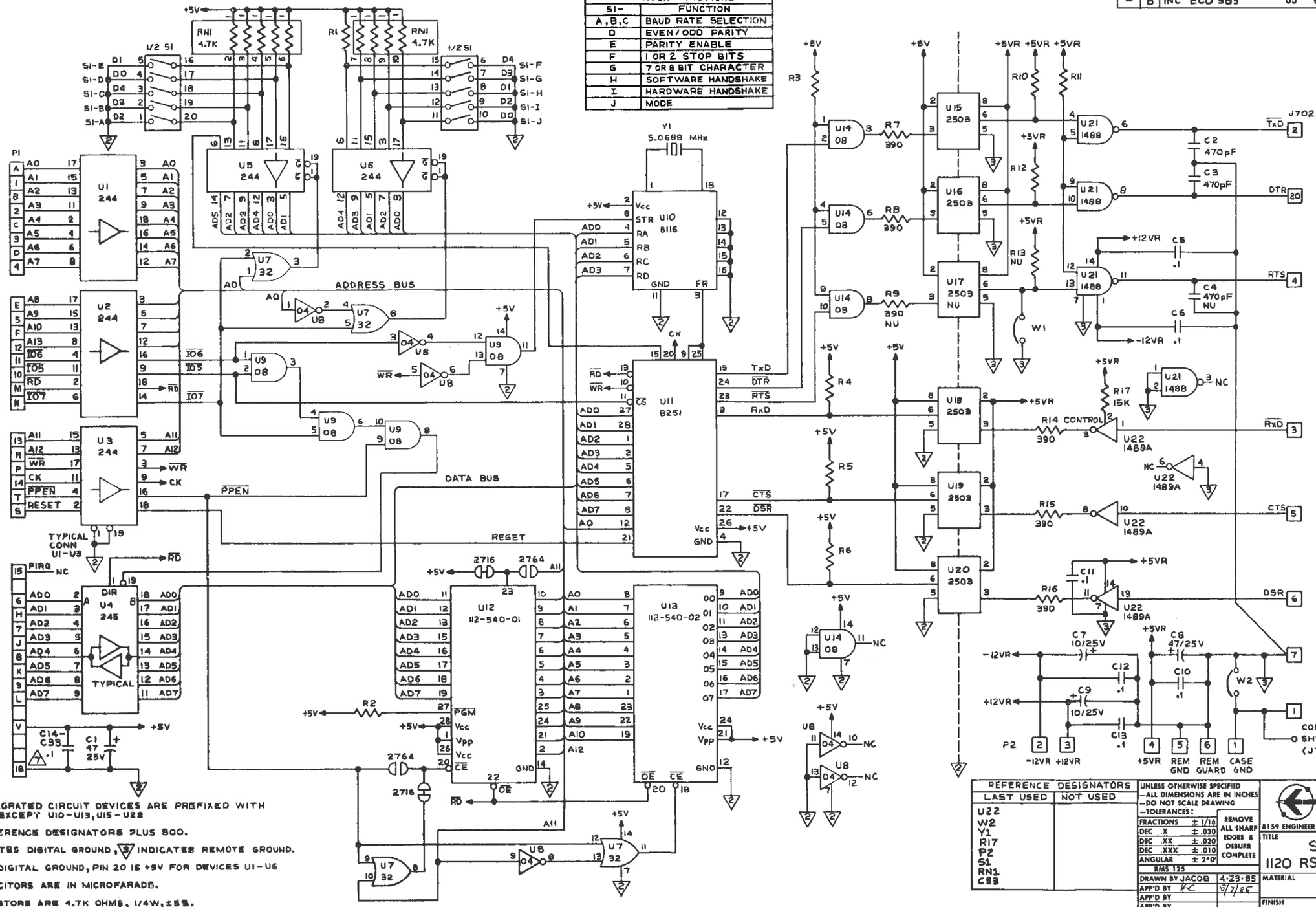
TITLE: SCHEMATIC, 1120 IEEE-488 INTERFACE

DRAWN BY D.T.W. 5-6-82
APP'D BY 8/9/82
MATERIAL
FINISH
SCALE NONE

MFR. SUPP. CODE NO.	DWG. SIZE	SHEET	OF	DWG. NO.	REV.
24856	E	1	1	162-612	E

REVISIONS					
ZONE	LTR	DESCRIPTION		DATE	APPROVED
–	A	RELEASED	JJ 4-23-85	5/7/85	KC
–	B	INC ECO 983	JJ 8-2-85	8/2/85	KC

SWITCH FUNCTIONS	
SI-	FUNCTION
A,B,C	BAUD RATE SELECTION
D	EVEN/ODD PARITY
E	PARITY ENABLE
F	1 OR 2 STOP BITS
G	7 OR 8 BIT CHARACTER
H	SOFTWARE HANDSHAKE
I	HARDWARE HANDSHAKE
J	MODE



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 4.7K OHMS, 1/4W, ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. PIN 10 IS DIGITAL GROUND, PIN 20 IS +5V FOR DEVICES U1-U6
4. (2) INDICATES DIGITAL GROUND, (3) INDICATES REMOTE GROUND.
5. ALL REFERENCE DESIGNATORS PLUS 800.
6. ALL INTEGRATED CIRCUIT DEVICES ARE PREFIXED WITH SN74LS EXCEPT U10-U13, U15-U22

(7) C23, C24, C26, C28, AND C32 ARE NOT INSTALLED.

REFERENCE DESIGNATORS	
LAST USED	NOT USED
U22	
W2	
Y1	
R17	
P2	
S1	
RN1	
C33	

UNLESS OTHERWISE SPECIFIED
–ALL DIMENSIONS ARE IN INCHES
–DO NOT SCALE DRAWING
–TOLERANCES:

FRACTIONS	± 1/16
DEC .X	± .030
DEC .XX	± .020
DEC .XXX	± .010
ANGULAR	± 2° 0'
RMS 125	

REMOVE ALL SHARP EDGES & DEBURR COMPLETE

DRAWN BY JACOB	4-23-85	
APP'D BY KC	5/7/85	
APP'D BY		
APP'D BY		
SIGNATURES	DATES	
FED. SUPP. CODE NO. 24856	DWG. SIZE D	

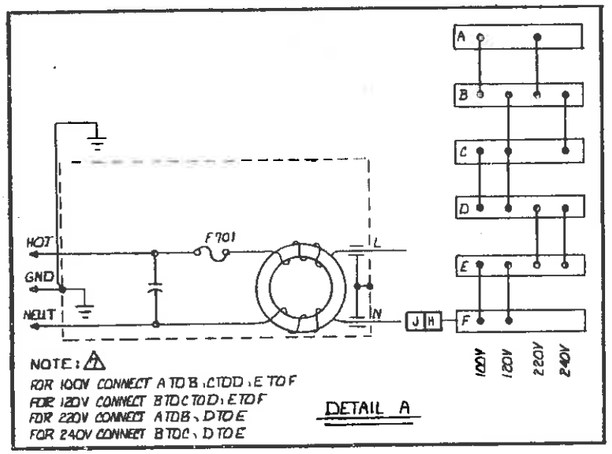
Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

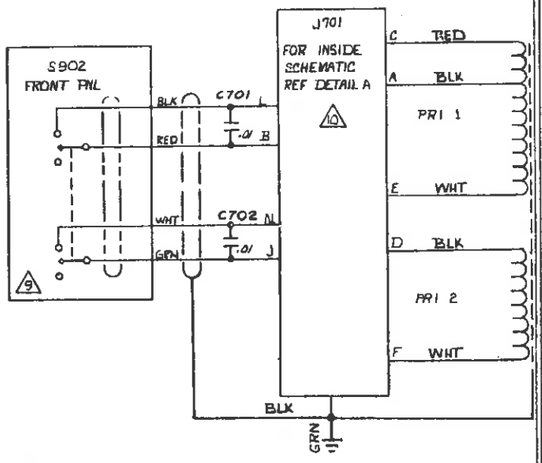
TITLE
SCHEMATIC
1120 RS-232C INTERFACE

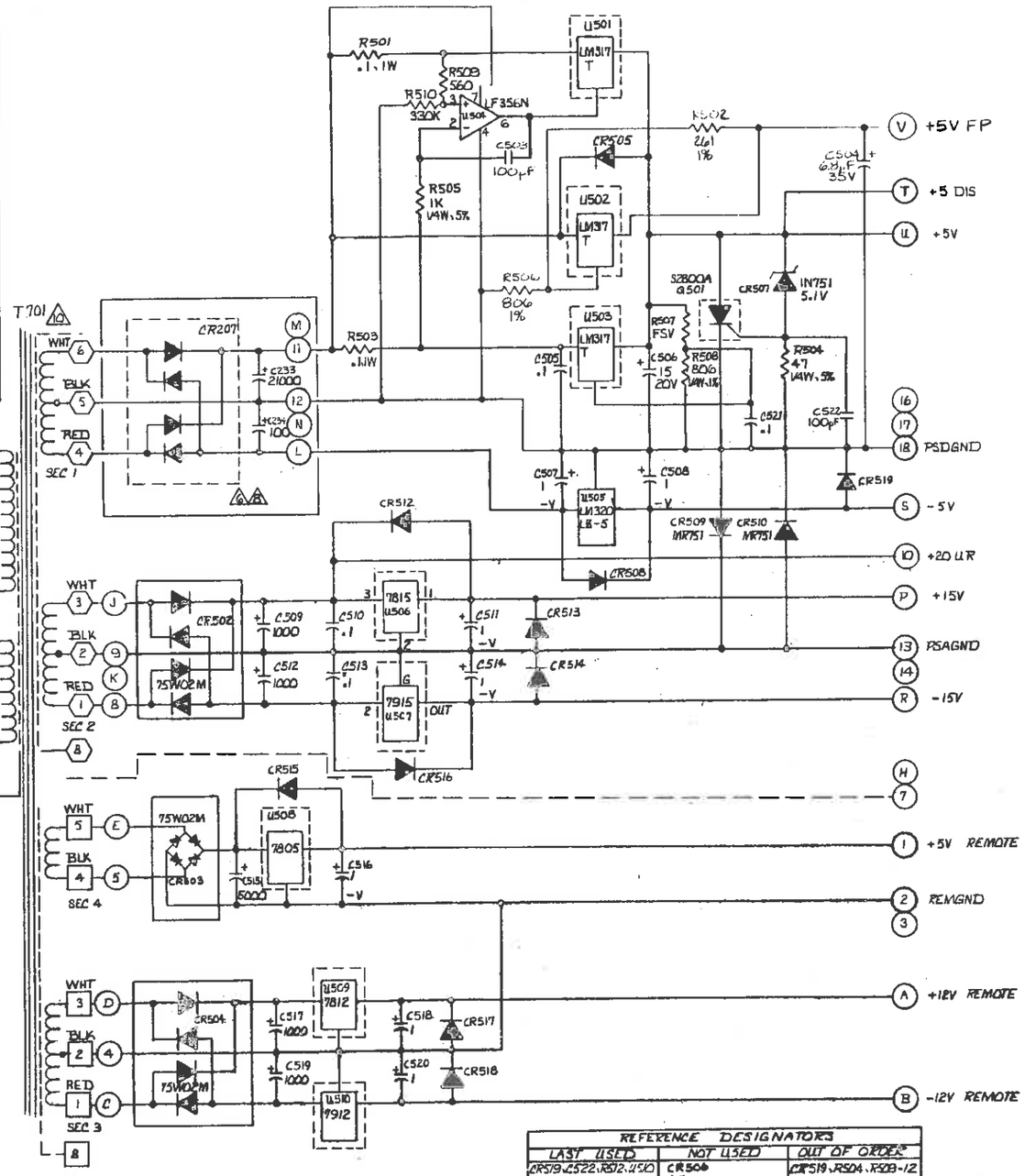
MATERIAL —
FINISH —
SCALE NONE
SHEET 1 OF 1
DWG. NO. 112-613
REV. B

DWG. NO. 112-613 REV. B

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED JJ	8/20/87	MC







12. U501, 502, 503, 506, 507, AND CR7 HEATSINK IS ATTACHED TO PSDGND
11. U508, 509, AND 510 HEATSINK IS ATTACHED TO PIN 7 & H OF J501
⚠10 J701 AND T701 ARE MOUNTED ON REAR PANEL
⚠9 REF. DESIGNATOR S902 IS ASSOCIATED WITH INTERCONNECTION SCHEMATIC 112-610
⚠8 REF. DESIGNATORS CR207, C233, AND C234 ARE ASSOCIATED WITH SCHEMATIC 112-605
⚠7 TO ACCOMPLISH POWER VARIATION USE THE INSERT CARD SUPPLIED WITH THE POWER RECEPTICAL INFORMATION IS PRINTED ON THE INSERT CARD AS TO WHICH SIDE SHOULD BE UP, AND WHICH EDGE IS INSERTED TO GAIN THE POWER DESIRED. CHECK INSERT CARD FOR POSITION, AND THE FUSE BEFORE APPLYING POWER
⚠6 CR207, C233, AND C234 ARE MOUNTED ON MOTHER BD
5. COMPONENTS WITH DASHED LINE AROUND THEM ARE HEATSINKED
4. ALL RECTIFIERS ARE IN4002
3. ○ INDICATES P561 WHICH MATES TO J208 ON MTHR BD, ⬡ INDICATES X-FORMER CONNECTION ☐ INDICATES X-FORMER CONNECTIONS TO J217 ON MTHR BD
2. CAPACITORS ARE IN MICROFARADS
1. RESISTORS ARE 2W, 5% (BWH STYLE)
NOTES: UNLESS OTHERWISE SPECIFIED

REFERENCE DESIGNATORS		
LAST USED	NOT USED	OUT OF ORDER
CR519, C522, R512, U510, Q501	CR520, R511, R512	CR519, R504, R508-12

UNLESS OTHERWISE SPECIFIED
—ALL DIMENSIONS ARE IN INCHES
—DO NOT SCALE DRAWING
—TOLERANCES:
FRACTIONS ± 1/16
DEC .X ± .030
DEC .XX ± .020
DEC .XXX ± .010
ANGULAR ± 2°0'
REMOVE ALL SHARP EDGES & DEBURR COMPLETE
MMS 125

DRAWN BY J. JACOB	8/20/87	
APP'D BY M.C.	8/20/87	
APP'D BY		
APP'D BY		
SIGNATURES	DATES	

FED. SUPP. CODE NO. 24856 | DWG. SIZE D

Ectron CORPORATION
8159 ENGINEER ROAD SAN DIEGO, CAL. 92111

TITLE SCHEMATIC 1120 POWER SUPPLY
MATERIAL
FINISH
SCALE
SHEET 1 OF 1 | DWG. NO. 112-615 | REV. A

DWG NO. 112-615 REV. A