Model 501J

±100mV to ±10V
Programmable
DC Voltage Calibrator

KROHN-HITE CORPORATION

Operating Manual

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PROGRAMMABLE
DC VOLTAGE CALIBRATOR
Model 501-J

Serial No._____

The following installed in S/N							
OPTIONS				**ACCESSORES**			
B		**J**		**AM-1**		**MR-1**	
C		**L**		**AM-2**		**IS-40**	
D				**KT-488**			

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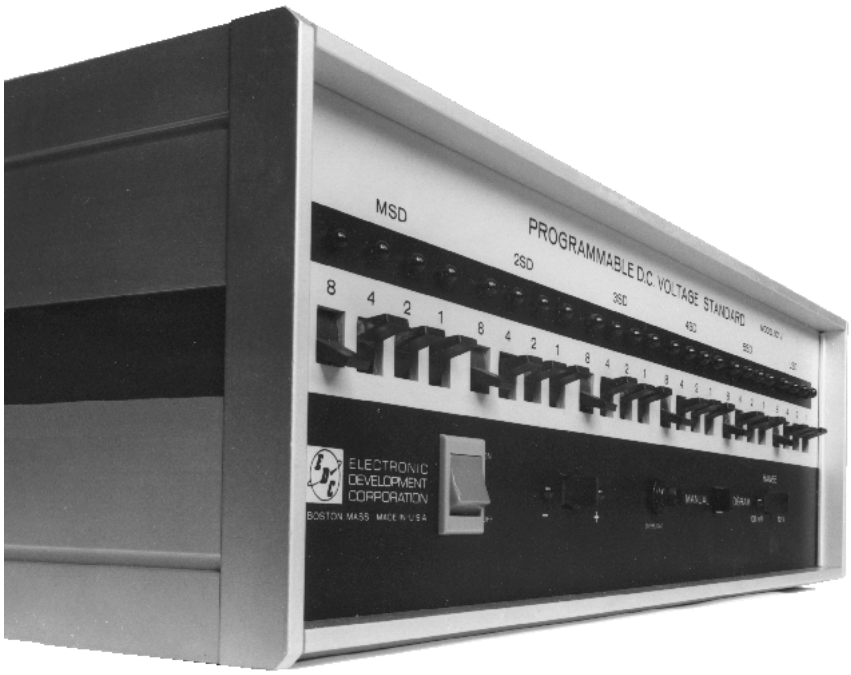
Model 501
OPERATORS
MANUAL



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NOTE: Errata and addendum (if any) will appear in the back of this manual.

SCHEMATICS AND LAYOUTS

DESCRIPTION	DRAWING #.
Option MR-1, Memory Register	CA-2761A
Option AK-1, Logic Inverter	CA-2935
Option D, 100 mV Range	CA-4747B
Option C, Standby/Ready Signal	A-3124
Control Logic	*A-3125
Range Logic	A-3552A
Power Supply (501)	*A-3196C
501 DAC Reference	*B-2750A
501 Voltage Amplifier	*B-2750B
Bipolar DAC	*B-2751
Option: IS-48	B-2995-F
Option: MR-488, Latches	B-3335H
Option: MR-488, Control Logic	B-3336I
Option: IS-40	B-4815
501 Adjustments and Test Points	*B-2791-C
Reference Drawing	930727A

* Basic 501 Model

LIMITED WARRANTY

The Krohn-Hite Corporation (K-H) warrants to the original purchaser each instrument manufactured by them to be free from defects in material and workmanship. This warranty is limited to servicing, repairing and/or replacing any instrument or part thereof returned to the K-H factory for that purpose in accordance with the instructions set forth below; and furthermore to repair or replace all materials, except tubes, fuses, transistors and other semiconductor devices which shall within ONE YEAR of shipment to the original purchaser be returned to the K-H factory and upon examination be deemed defective.

K-H instruments may not be returned to the factory under the terms of this warranty without the prior authorization of the K-H Service Department. All instruments returned to K-H for service hereunder should be carefully packed and shipped. All transportation charges shall be paid by the purchaser.

K-H reserves the right to discontinue instruments without notice and to make changes to any instrument at any time without incurring any obligation to so modify instruments previously sold.

This warranty is expressly in lieu of all other obligations or liabilities on the part of K-H. No other person or persons is authorized to assume in the behalf of K-H any liability in the connection with the sale of its instruments.

CAUTION: *The instrument you have purchased is a precision instrument manufactured under exacting standards. Any attempts to repair, modify or otherwise tamper with the instrument by anyone other than an K-H employee or authorized representative may result in this warranty becoming void.*

FACTORY SERVICE REQUEST
AND
AUTHORIZATION

WARRANTY SERVICE

Instruments may be returned only on prior authorization. Please obtain a RETURN AUTHORIZATION NUMBER either directly from the factory or from an authorized K-H Representative. (See General Information below.)

CHARGEABLE REPAIRS

If requested, an estimate of charges will be submitted prior to repairs. We suggest that you request a RETURN AUTHORIZATION NUMBER to facilitate handling.

GENERAL INFORMATION

A) Please provide the following information in order to expedite the repair:

1) Indicate MODEL

2) Serial Number

3) Complete description of the trouble:

Symptoms, measurements taken, equipment used, lash-up procedures, attempted repairs, suspected location of failure and any other pertinent information.

B) Freight Charges must be PREPAID.

C) The RETURN AUTHORIZATION NUMBER should be noted on your documentation.

D) See Packing Suggestions - next page.

PACKING SUGGESTION

Although your K-H instrument is built for laboratory, production environment and some field environment, it is NOT ruggedized.
Therefore . . . . . .

1. Be sure the carton is STRONG enough to carry the weight of the instrument, e.g. use double wall corrugation.

2. Be sure the carton is LARGE enough to allow for sufficient packing material, e.g., at least 2 inches all around the instrument. The packing material should be able to be compressed and then return to its approximate original volume.

3. For better handling, the shipment should always be by AIR FREIGHT (expect for short distances). You might use either UPS "blue label" or common air freight carrier, second day air.

   Please do not bounce it across the country in a truck. It may not hurt it, but it certainly is not going to do a laboratory instrument much good.

4. QUESTIONS? Just contact us. We will be pleased to help you.

SECTION I

1.0.0 GENERAL DESCRIPTION AND APPLICATIONS

1.0.1 The Model 501 Programmable DC Voltage Standard is a highly versatile reference source, designed to meet the needs of computer systems, production line testing, automated calibration and standards laboratories.

1.0.2 The instruments have a specified accuracy, and are traceable through a bank of saturated standard cells to the U. S. National Institute of Standards & Technology.

1.0.3 Depending on the model of the instrument, resolution of 1 ppm are attainable.

1.0.4 The instruments are highly accurate references which can be used for calibration of digital voltmeters, analog meters, semiconductor analyzing systems, analog references for computers, analog-to-digital converters, telemetry and data acquisition systems, and wherever a stable source is required.

1.0.5 There are no adjustments made during normal operation; the trims are made during calibration and are described under the calibration procedure.

1.0.6 The circuitry is completely solid state made of discrete, hybrid and/or integrated circuits packaged on etched glass circuit boards. These are proven circuits, using derated components to insure long life and maximum reliability.

1.0.7 The instrument is overload and short-circuit proof, and is fully operational in normal environmental conditions.

1.0.8 The Standard Source will drive a short circuit indefinitely without damage to the instrument, and will recover to rated specification in less than 10 ms.

1.1.0 Output Specifications

1.1.1 Output Voltages:

	BCD Units	BINARY Units
Basic Model	+9.9999 Vdc	10.24 Vdc Max F S
Option D	+99.999 mVdc	102.4 mVdc Max F S
Option J	Bipolar Operation	

1.1.2 Resolution:

Basic Model	10 V range	=10 ppm or 100 µV
Option D	100 mV range	=10 ppm or 1 µV
Option B	10 V range	=1 ppm or 10 µV
Options B & D	100 mV range	=1 ppm or 0.1 µV

1.1.3 Accuracy:

±(0.002% of programmed value + 0.0005% or range +3µV). The accuracy is based on the "Limit of Error" (or "Worst Case" Method. All other specifications noted hereafter, which effect accuracy, e.g., line, load, temperature, and drift are included in the accuracy statement. Thus, all other specifications listed are (*) NON-ADDITIVE.

1.1.4 Settling Time:

100 µs (50 µs nominal) to rated accuracy for voltage change. 10 ms (approx.) recovery from short-circuit.
100 µs (max) for polarity change.
60 ms (max) for range change.

1.1.5 Stability (non-additive specifications)
24 hrs: 0.001%; 90 days: ±0.0015%; 6 months: ±0.002%

1.1.6 Ripple and Noise:

Observe in a band pass of 0.1 Hz to 100 kHz with NO random spikes. (0.0005% of range +2 µV) rms.

1.1.7 Output Current:

10 V range: 50 mA
100 mV range: Not Applicable. (Output voltage is within stated accuracy if load impedance is greater than 60 kΩ.)

1.1.8 Output Impedance:

10 V range: 0.03Ω
100 mV range: 3.0Ω (constant)

1.1.9 Regulation: (*non-additive)
Line and Load = ±0.0005%

1.1.10 Temperature Coefficient: (*non-additive)
Ambient: ±0.0005%/° C
Operating limit: ±0.001%/° C

1.1.11 Monotonicity
Monotonicity is guaranteed for digital increments greater than 15 ppm of the programmed value.

1.1.12 A DAC (calibrator) is said to be monotonic if the output either increases or remains constant as the digital input increases, with the result that the output will always be a single-valued function of the input.

1.2.0 Mechanical Specifications

1.2.1 Power Requirements

40 watts: 115 Vac or 220 Vac ±10% 50/60 Hz

1.2.2 Dimensions:

W 19 x H 5.25 x D 14 inches
W 485 x H 133 x D 362 mm

1.2.3 Weight:

12.5 lbs.; 5.7 kg
Shipping weight: 16.5 lbs.; 7.5 kg

1.2.4 Temperature:

Calibration Temperature:	23° ±1° C
Ambient Temperature:	20° C to 30° C
Operating Limit:	10° C to 50° C
Storage Limit:	-40° C to 85° C

SECTION II

2.0.0 INSTALLATION

2.1.0 Mounting.

2.1.1 The 501 is designed for mounting in a standard 19" relay rack. When installing in the rack it is recommended that nylon washers be placed under the mounting screws to prevent scratching the paint.

2.2.0 Input - Output Connectors.

2.2.1 All instruments are supplied with a mating AC power cord, output connector, and input connectors. These are:

	Nomenclature		Part no.	
(1)	AC Power Cord		P 2392	1 each
(2)	Output Connector		3106A-14S-6P	1 each
(3)	Program Connectors	*	MP-0156-25-SP-1	1 each

2.3.0 Grounding Consideration.

2.3.1 Special attention should be given to system grounds to avoid ground loop errors in units without optical isolation. In particular: DO NOT connect logic ground to arc ground at one point in the system and analog ground to arch ground at another point in the system. DO NOT connect output connector pin A to pins C, D or E if there is another earth ground in the system.

2.4.0 Line Voltage Setting.

2.4.1 A two position slide switch is mounted on the rear panel which is used to set the line voltage requirements to 115 Vac or 230 Vac. Make sure this switch is in the proper position for your line power prior to turning the instrument on for the first time.

* This connector is not supplied and is not required when the KT-488 bus option is installed.

SECTION III

3.0.0 OPERATION OF INSTRUMENT

3.1.0 Front Panel Controls

3.1.1 Power Switch: Rocker off-on, line power with associated indicator.

3.1.2 Program-Manual Mode Switch: This switch has two settings. In the "manual" position the instrument's output is controlled by the other front panel switches. In the "program" position the instrument is programmed by the data fed into the rear input connectors This switch in the "manual" mode, overrides all programmed input signals to the program connector.

3.1.3 Polarity Switch: (Option J) (Operational in the "manual" mode.) This switch has two settings. It determines the output polarity when the Program-Manual switch is in the manual position. "+" polarity denotes that output terminal B, (or red terminal is positive with respect to output terminal C (or black terminal) and vice versa.

3.1.4 Voltage Select Switches: (Option AM-1) (operational in the "manual" mode.) These are grouped in sets of 4. Each set of four controls 1 digit of the voltage. The most significant digit set is labeled "MSD", the least significant set is labeled "LSD". To manually set the output voltage, set the program-manual switch to manual and turn on (up) the appropriate voltage switches. Each digit is set using the 8-4-2-1 BCD Code. The value of a particular digit is equal to the sum of the numbers of the switches turned on in that digit set. Figure 3-1A summarizes the 8-4-2-1 code.

The following applies for Binary units.

3.1.4.1 Binary Voltage Select Switches: (Option AM-2) (Operational in the "manual" mode.) The value of each voltage select switch is equal to 2^{-n} times full scale of range (either 10.24 V or 102.4 mV). These values are tabulated in Figure 3.1.

501J WITH 20 BIT BINARY PROGRAMMING (FIG. 3.1)

N	$V(N) = \frac{10.24^*}{2^n}$	MAXIMUM ALLOWABLE DEVIATION IN μV = 20[V(N)] + 53
1	5.120000	155.4
2	2.560000	104.2
3	1.280000	78.6
4	.640000	65.8
5	.320000	59.4
6	.160000	56.2
7	.080000	54.6
8	.040000	53.8
9	.020000	53.4
10	.010000	53.2
11	.005000	53.1
12	.002500	53
13	.001250	53
14	.000625	53
15	.000313	53
16	.000156	53
17	.000078	53
18	.000039	53
19	.000020	53
20	.000010	53

* ROUNDED OFF TO NEAREST μV
AM2 Binary

3.1.4.2 Voltage Select Switches (continued) AM-1

	Value output	Switch 8 4 2 1	
	0	0 0 0 0	
	1	0 0 0 1	
	2	0 0 1 0	
	3	0 0 1 1	where: "1" = switch ON
	4	0 1 0 0	and "0" = switch OFF
	5	0 1 0 1	
	6	0 1 1 0	
	7	0 1 1 1	
	8	1 0 0 0	
	9	1 0 0 1	
"Illegal" Codes (1)	10	1 0 1 0	
	11	1 0 1 1	
	12	1 1 0 0	
	13	1 1 0 1	
	14	1 1 1 0	
	15	1 1 1 1	

BCD Truth Table
Fig. 3-1 A

(1) Notice: The use of "illegal" BCD codes may be employed. However, the operator should note that the analog output is inhibited to a maximum output of approximately 11 Volts.

3.1.5 Range Switch: (Option D.) (Operational in the "manual" mode.) This switch has

two settings. It determines the full scale voltage when the program-manual switch is in the manual mode the "V" position denote 10 volts full scale, (MSD = 1 volt per step). The "mV" position denotes 100 mV full scale, (MSD = 10 mV per step).

3.1.6 Remote Programming: - Parallel Entry.

Note: To remotely program the 501 turn the program-manual switch to "program" and connect appropriate TTL compatible inputs to the rear input connectors. The rear input connector pin connections are shown in Fig. 3-2. The pins for magnitude by parallel entry are B-1 through B-24. Logic ground is pin A-8. Polarity control (Option J) is pin A-24. Logic Zero (0) is plus (+) polarity and logic one (1) is negative (-) polarity. Range control, (Option D) is pin A-22, 1 is 10 V full scale, 0 is 100 mV full scale. The strobe input, pin A-21, when set to logic 0, will force the analog output to zero, regardless of the programmed data. The ready-flag (Option C) output is on pin A-25 and indicates either a normal or overloaded condition. 0 is normal, 1 is overload. Pin A-20 indicates program or manual mode, 1 is Program, 0, is Manual.

Pin A-20 is an isolated program/manual output flag when used with the opto-isolator IS-40 option.

A-4 p/m Non-opto isolated p/m output flag: indicates program/manual, 1 is Program, 0 is Manual.

3.1.6 Continued CONNECTOR A (FUNCTION)

Pin #	Designation	Description
A 1	MV/OR	+
A 2	AR-1	+
A 3	AR-2	+
*A 4	P/M	Non-isolated Output Flag: Indicates program/manual Mode
*A 5	STR(1)	Over-ride Strobe: Zero output in either Program or Manual Modes.
#A 6	IL +5	Isolated +5 Vdc output
A 7	IG	Isolated ground
*A 8	G	Logic Ground
A 9	Spare	
##A10	+5	Logic +5 V output
*A11	R2P	Range control bit
*A12	R8P	Range control bit
A13	Spare	
A14	Spare	
A15	AR-4	+
*A16	R4P	Range control bit
A17	AR8	+
A18	AP	+
A19	Spare	
A20	IS-40 P/M	IS40 isolated P/M Output Flag
*A21	STR(2)	Zero output (in program mode, only)
*A22	R1P	Range Control bit
*A23	MR	Follow/Latch (for accessory MR-1)
*A24	P	Polarity control (for option J)
*A25	RF	Stand-by/Ready Output Flag

* These bit lines are used for PARALLEL PROGRAMMING for function only. See Program Connector B for magnitude control.

+ These are output bits used to control the Auxiliary instruments.

150 mA max.

200 mA max. w/488, MR-2. 1000 mA max w/Dummy boards.

NOTE: IEEE-488 (GP-IB) and SERIAL PROGRAMMING are accomplished via connector "F".

3.1.6 Continued CONNECTOR B (MAGNITUDE)

BCD FORMAT			BINARY FORMAT		
PIN#	DESIGNATION	DESCRIPTION	PIN#	DESIGNATION	DESCRIPTION
B 1	61	1 LSD_2 (OPT. B)	B 1	spare	
B 2	62	2 LSD_2 (OPT. B)	B 2	spare	
B 3	64	4 LSD_2 (OPT. B)	B 3	spare	
B 4	68	8 LSD_2 (OPT. B)	B 4	spare	
B 5	51	1 LSD	B 5	2^{-20}	10 µV
B 6	52	2 LSD	B 6	2^{-19}	20 µV
B 7	54	3 LSD	B 7	2^{-18}	39 µV
B 8	58	8 LSD	B 8	2^{-17}	78 µV
B 9	41	1 4 SD	B 9	2^{-16}	156 µV
B10	42	2 4 SD	B10	2^{-15}	313 µV
B11	44	4 4 SD	B11	2^{-14}	625 µV
B12	48	8 4 SD	B12	2^{-13}	1250 µV
B13	31	1 3 SD	B13	2^{-12}	2500 µV
B14	32	2 3 SD	B14	2^{-11}	5 mV
B15	34	4 3 SD	B15	2^{-10}	10 mV
B16	38	8 3 SD	B16	2^{-9}	20 mV
B17	21	1 2 SD	B17	2^{-8}	40 mV
B18	22	2 2 SD	B18	2^{-7}	80 mV
B19	24	4 2 SD	B19	2^{-6}	160 mV
B20	28	8 2 SD	B20	2^{-5}	320 mV
B21	11	1 MSD	B21	2^{-4}	640 mV
B22	12	2 MSD	B22	2^{-3}	1.28 V
B23	14	4 MSD	B23	2^{-2}	2.56 V
B24	18	8 MSD	B24	2^{-1}	5.12 V
B25	G	Logic Gnd.	B25	G	Logic Gnd.

PROGRAMMING CONNECTORS (Fig. 3-2)

3.1.6 Continued

RANGE CONTROL LOGIC

PIN#	DESIGNATION	100 mV (OPT. D)	10V	100 V (RA-3) 100 V (RA-4) 10 mA (PCS-1)	200 V (RA-3) 1000 V (RA-4) 100 mA (PCS-1)
A-22	R1P	0	1	0	1
A-11	R2P	0	0	0	1
A-16	R4P	0	0	0	0
A-12	R8P	0	0	0	0

FIG. 3-3

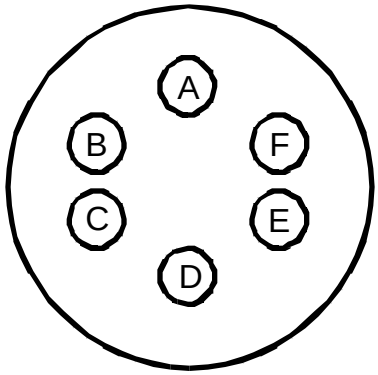
3.1.7 Indicator Lights:

The indicator lights indicate the state of a particular bit in both the program and manual modes. A voltage bit indicator light on indicates that voltage bit is on, i.e. that the appropriate switch in the DAC is on. This is a convenient method to verify the proper data entry from the programmer.

3.1.8 Output Connections:

The output connector points are:

*A -Chassis ground (and metal binding post)
B - + output (and red binding post)
F - + sense
C - - output (and black binding post)
E - - sense



*Special attention to grounds:

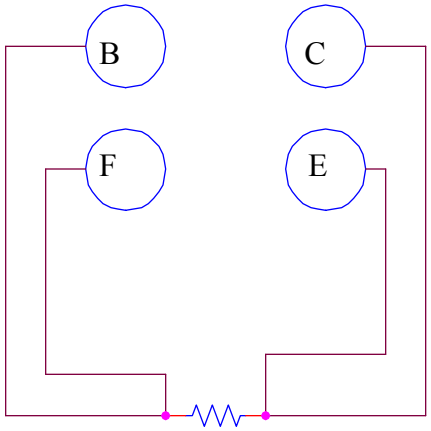
See paragraph 2.3.0
Grounding Consideration

3.1.8 Output Connections (continued)

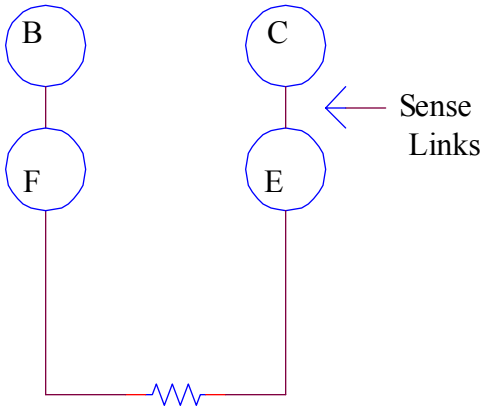
If a high impedance or low current load is connected, short pin B to pin F and short pin C to pin E. If an appreciable current is desired, the remote sense capability should be used. The 501 utilizes a unique 4 wire output, eliminating the effect of IR drops on the instrument's accuracy.

Please refer to Figure 3 on Reference Drawing 930727 in the rear of this manual.

NOTE: ***One of the Configurations Shown below must Be Used. Pins B Through F must All Be Used.***



CONFIGURATION A
(4 Wires Between 501 & Load) Correct for Large Loads.



CONFIGURATION B
(2 Wires Between 501 & Load) Incorrect for Large Loads, Acceptable for Small Loads

SECTION VI

6.0.0 OPTIONS, ACCESSORIES, AUXILIARY INSTRUMENTS AND SUPPLEMENTAL INSTRUCTIONS

This section contains information for all field Installable Accessories and Auxiliary Instruments.

NOTE: Your instrument may not contain all of the optional equipment listed herein. See Installation notations indicated on the cover page of this manual or on the back panel of the Model 501 main-frame instrument.

6.1.0 Memory Register - Accessory MR-1

6.1.1 The analog output will follow the digital input data as long as the memory control line (pin A-23) is at logical 1. When pin A-23 is dropped to logical 0, the data that was present at the input pins A-22, A-24 and B-1 through B-24, will be stored. (The pin numbers will depend on the options ordered.) Refer to FIG. 3-2.

6.1.2 The strobe input (pin A-21) when set to logical 0, will reduce the analog output to 0, regardless of the state of the other input data. However, strobing the 501 to C will not erase the information stored in the memory. After a 0 to 1 transition on pin A-21, the analog output will follow the previously stored digital data. Refer to schematic A276l.

6.1.3 MR-1 Installation Instructions. Remove jumper board (PC No. P2756/7) in mother board edge connector with components facing the front panel.

6.2.0 Model PCS-2, Auxiliary Instrument

Complete instructions and drawings for this model are contained in a separate manual designated:

Models PCS-2/3200

6.3.0 488 Interface (GP/IB) Accessory KT-488

6.3.1 The K-H model 501 is compatible with the IEEE Std. 488/1975 with the installation of the accessory kit KT-488.

The accessories are plug in configuration and installation may be easily accomplished in the field.

All interface information is in compliance with the publication and the user should be familiar with:

IEEE STANDARD DIGITAL INTERFACE FOR PROGRAMMABLE INSTRUMENTATION (IEEE STD 488/1975)

Publisher: The Institute of Electrical and
Electronics Engineers, Inc.
345 East 47th Street
New York, NY 10017

6.3.2 The interface kit is comprised of the following:
p/n MR-488 Serial to Parallel Converter (PC Board)
p/n IS-48 Opto-Isolator (PC Board)

6.3.3 Programming Procedures. Set the listen address on the "dip" switch assembly located on the MR-488 PC Board. Use switches 1 through 5. This is arranged in Binary Code 1 = 1, 2 = 2, 3 = 4, etc. On = True, Off = False. (For further description see 6.3.5.1)

6.3.4 Programming Sequence

CHAR.#	CODE	DESCRIPTION
	pon	Power-On Clear. Same status as IFC.
0	IFC	Interface Clear. This message may be sent at any time and sets the 501 output to: PLUS (+), ZERO (0) on the 100 mV range. It is not necessary to send IFC at the beginning of each word.
1	MLA	My Listen Address
2	POL	Polarity
3	DIGIT	MSD
4	DIGIT	2SD
5	DIGIT	3SD
6	DIGIT	4SD
7	DIGIT	5SD
8	DIGIT	LSD
9	RAN	RANGE b_1 $_b$2 b_3 $_b$4
		There are 4 range lines (4 bits) to control 16 range designations. The range control bits for all K-H Auxiliary Instruments (eg., PCS and RA type) are listed in the section of this manual that pertains to that instrument. The analog value will change from the old to the new value on the "Range" entry (Byte). Note: The 501 does remain on the "Listen" state.
10A	UNL	"Un-listen" the model 501 will disengage from the buss on this command. All previously programmed instructions will be retained. To poll the instrument(s): MLA (character #1) immediately followed by "UNL" (character #10A). All previously programmed instructions will be retained.
10B	SP	"space". The entry of this character keeps the 501 in the "listen" state to permit the entry of a new value without re-entering the attention and address command "MLA" (character #1, above). To enter a new value see characters 2 through 9 above.

6.3.5 MR-488 Programming Table

STEPS	ACCEPTABLE ASCII CHARACTERS	FUNC	BITS 1	2	3	4	5	6	7
1	*# (See A Below)	MLA	A	A	A	A	A	1	0
2	See B POLARITY	POL	B_1	B_2	B_3	B_4	1	1	0
3	0 THRU 9	1SD	C	C	C	C	1	1	0
4	0 THRU 9	2SD	C	C	C	C	1	1	0
5	0 THRU 9	3SD	C	C	C	C	1	1	0
6	0 THRU 9	4SD	C	C	C	C	1	1	0
7	0 THRU 9	5SD	C	C	C	C	1	1	0
8	0 THRU 9	6SD	C	C	C	C	1	1	0
9	0 THRU 9 :<;> = ?	RAN	D_1	D_2	D_3	D_4	1	1	0
10A	# ATN plus ?	UNL	1	1	1	1	1	1	0
10B	SPACE	SP	0	0	0	0	0	1	0

Bits: 1 = true; 0 = false

6.3.5.1 My Listen Address (MLA)

* A - MY LISTEN ADDRESS - the character entered here is dependent on the instrument's that has been entered on the DIP switch located on the MR-488 p.c. board.

To set the MLA, select a 5 bit BINARY number between 0 and 30 (See fig. 6.3) and set the dip switch on the MR-488 p.c. board using A-1 through A-5 only.

Since 501J is a "Listen Only" instrument, we have hard-wired bits A-6 and A-7.

Illustration of a bus address and command: See "Sample Program" para 6.3.9 Note bus command line 120.

See paragraph 6.3.3 of this manual and page 77 of IEEE Std. 488.

CAUTION: DO NOT set all DIP switches to: 11111.

#ATN must be true on the MLA and UNL only.
(ATN must be false on all data byte entries.)

ASCII Code Character		Address switch	
Listen A7 A6 0 1	Talk A7 A6 1 0	(Binary) A5 A4 A3 A2 A1	Decimal
Space	@	0 0 0 0 0	00
!	A	0 0 0 0 1	01
“	B	0 0 0 1 0	02
#	C	0 0 0 1 1	03
$	D	0 0 1 0 0	04
%	E	0 0 1 0 1	05
&	F	0 0 1 1 0	06
‘	G	0 0 1 1 1	07
(	H	0 1 0 0 0	08
)	I	0 1 0 0 1	09
*	J	0 1 0 1 0	10
+	K	0 1 0 1 1	11
,	L	0 1 1 0 0	12
-	M	0 1 1 0 1	13
.	N	0 1 1 1 0	14
/	O	0 1 1 1 1	15
0	P	1 0 0 0 0	16
1	Q	1 0 0 0 1	17
2	R	1 0 0 1 0	18
3	S	1 0 0 1 1	19
4	T	1 0 1 0 0	20
5	U	1 0 1 0 1	21
6	V	1 0 1 1 0	22
7	W	1 0 1 1 1	23
8	X	1 1 0 0 0	24
9	Y	1 1 0 0 1	25
:	Z	1 1 0 1 0	26
;	[	1 1 0 1 1	27
<	\	1 1 1 0 0	28
=	]	1 1 1 0 1	29
>	^	1 1 1 1 0	30

Fig 6.3 Address selection

The 501/J is a LISTEN ONLY instrument. Therefore, switch A-7 is hard wired “lo” (0) and switch A-6 is hard wired “hi” (1).

B - POLARITY where: B_3 = 0 = + (Pos Polarity)
B_3 = 1 = - (Neg Polarity)

ASCII CHARACTERS: for + (Positive) Enter: +
fpr - (Negative) Enter: -

If Option J, Bipolar Operation, is <u>not</u> installed in your 501, the ASCII Character + (plus) must be entered in Step 2.

C - MAGNITUDE Enter appropriate ASCII Character.

If Option B, Additional Resolution (LSD_2), is not installed in your 501, the ASCII Character 0 (zero) must be entered in Step 8.

D - RANGE

b_1	b_2	b_3	b_4	501 RANGE	ASCII CHAR.	PCS-2	PCS-1	RA-3	RA-4
0	0	0	0	100 mV	0	Standby			
1	0	0	0	10 V	1	Standby			
0	1	0	0		2	Standby	10 mA	100 V	100 V
1	1	0	0		3	Standby	100 mA	200 V	1000 V
0	0	1	0		4	Standby			
1	0	1	0		5	Standby			
0	1	1	0		6	Standby			
1	1	1	0		7	Standby			
0	0	0	1		8	Standby			
1	0	0	1		9	1 mA			
0	1	0	1		:	10 mA			
1	1	0	1		;	100 mA			
0	0	1	1		<	1 A			
1	0	1	1		=	10 A			
0	1	1	1		>	Standby			
1	1	1	1		?	Standby			

6.3.6 Manual-Program control switch.

NOTE: These paragraphs apply only to the 501 instruments that have the Front Panel Control & Display Accessory AM-1 or AM-2 installed.

The front panel control is normally set to the "program" position. However, to use in "manual" the program lines do not have to be disconnected. The 501 will continue to receive and store any programmed instructions.

When set in the "manual" mode, the analog output will not respond to the programmed data. It will respond to the manually entered information.

6.3.7 Field Installation of KT-488.

1) Remove jumper boards P2756/7 from connectors J-1 and J-2.
Refer to drawing B-2791.

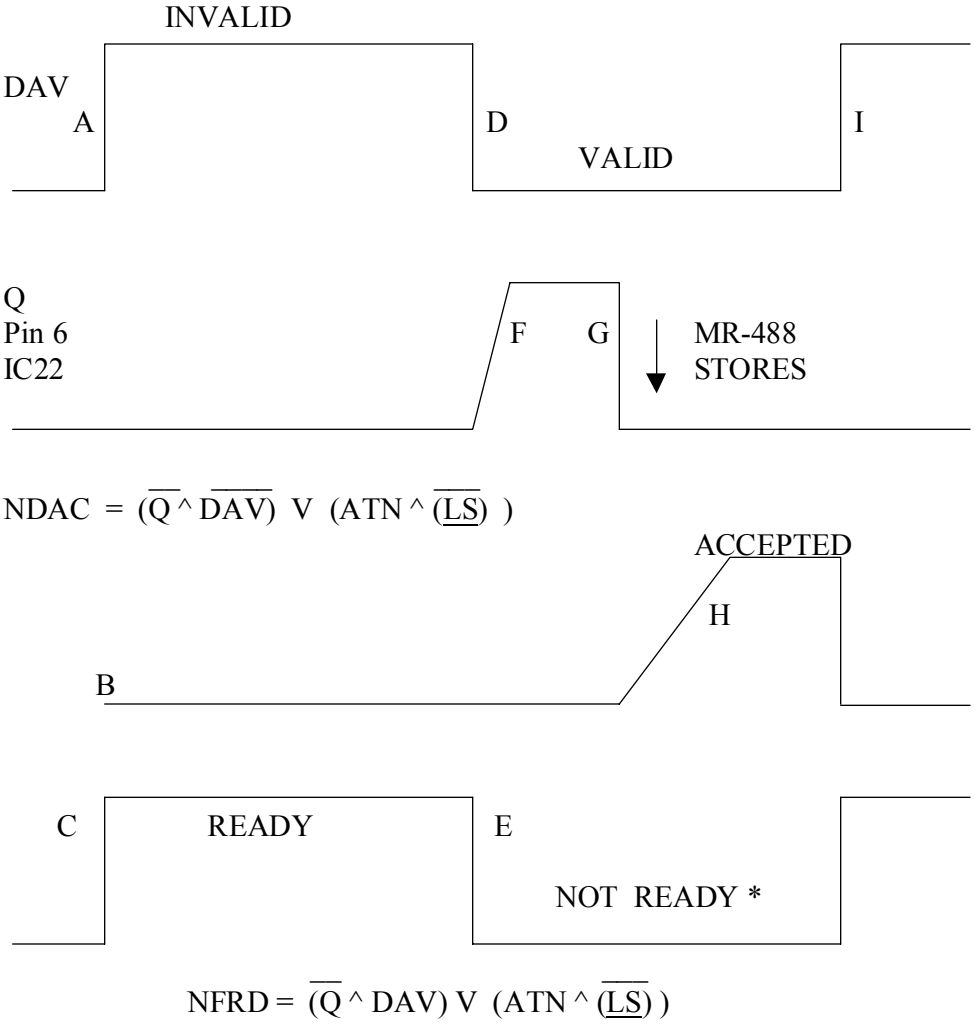
2) Install IS-48 (opto-isolator) in connector J-1 with component side facing front panel.

3) Install MR-488 in connector J-2 with component side facing the front panel.

4) Install board retainer bar.

6.3.8 Handshake Process Timing Sequence. See Appendix B of IEEE STD 488-1975 for a detailed discussion of the process. The timing sequence for the MR-488 is shown below.

6.3.8.1 MR-488 Handshake Process Timing Sequence.



* *NOTE:* The Auxiliary instruments, PCS and RA type, require more switching and settling time then when the 501 (main frame) is used alone. Thus, the NFRD (not ready for data) flag will remain in the "not ready" state for a longer period than when the 501 is used without the Auxiliary instruments

6.3.9 Sample Programs

The following programs are included as a guide.

Interface: IEEE 488/1978 (GP-IB)

Address: The set address for the K-H Model 501/J for all the following examples is 5.

1	2	3	4	5	6	7
ON	OFF	ON	OFF	OFF	OFF	OFF

6.3.9.1 *Listed Below Is a Short Sample Program For The 501. This Program Is in Quick Basic Using a National 488 Driver Card.*

```
REM $INCLUDE: 'qbdecl.bas'
A5 = 5: REM 501 ADDRESS
3 CALL SendIFC(0)
CLS
CR$ = CHR$(13)
GOTO 10000
1700 REM 501 INPUT SUB
CALL Send(0, (A5), DM$, NLend)
RETURN
10000 CLS : GA$ = ""
LOCATE 6, 23: PRINT ""; TIME$; " 501 ADDR = "; A5
LOCATE 9, 20: PRINT "     PRESS (1) FOR TEST"
LOCATE 11, 20: PRINT "     PRESS (2) TO EXIT PROGRAM "
LOCATE 13, 20: PRINT "     PRESS (3) TO CHANGE ADDRESS "
LOCATE 6, 23
PRINT ""; TIME$
10270 LOCATE 6, 23: PRINT ""; TIME$: GG = VAL(INKEY$): IF GG = 0 OR GG > 3
THEN 10270
IF GG = 2 THEN 50200
IF GG = 3 THEN GOTO 14500
11100 CLS
LOCATE 9, 20: PRINT " USE THE LETTER J FOR 10"
LOCATE 11, 20: INPUT " ENTER POLARITY + OF - "; POL$
11500 LOCATE 11,20:INPUT "ENTER MAGNITUDE IN SIX CHARACTERS "; MAG$
 IF LEN(MAG$) <> 6 THEN MAG$ = "": GOTO 11500
LOCATE 11, 20: INPUT " ENTER RANGE 0 FOR MILLIVOLTS OR 1 FOR       10
VOLTS"; RG$
 DM$ = POL$ + MAG$ + RG$
 GOSUB 1700: REM SEND TO 501
GOTO 10000
14500 REM ADDR CHANGE
CLS : LOCATE 6, 23: PRINT "501 ADDR = "; A5
INPUT "ENTER 501 ADDRESS"; A5
GOTO 3
50200 CALL SendIFC(0)
END
```

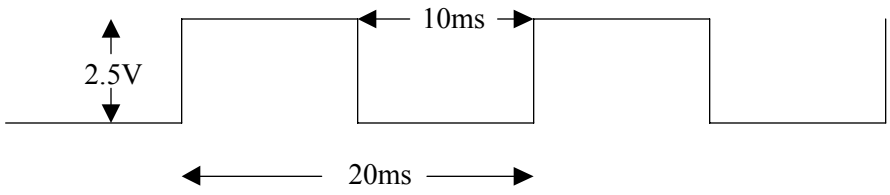
6.3.9.2 Sample program using FLUKE MODEL 1720A controller to operate K-H model 501/J

Language: Basic

```
10 INIT PORT 0
20 REMOTE @5
30 Print_@5, _"+2500001_"
40 Print_@5, _"+0000001_"
50 GOTO _30
RUN    (RET)
```

NOTE: _ Designates space

The program listed above will program the Model 501/J to have an analog output characteristic as shown in the figure below.



EDC 501/J analog (Voltage) output per the Sample program in paragraph 6.5.7.3

6.4.0 OPTO-ISOLATOR

Accessory: p/n IS-40

6.4.1 Accessory, p/n IS-40 consists of a plug in P.C. card, P2805/6, that contains a maximum of up to 39 opto-isolator units. The number of actual opto-isolators depends upon which other options and accessories are installed.

6.4.2 Program line inputs. Current level requirements per line:

Logical zero - 10 mA sink current
Logical one - open circuit

6.4.3 Connect the programmer logic common to isolated ground, Pin A7. The sink currents are drawn from the appropriate bit lines back to the isolated ground.

6.4.4 Two signals from the 501J are opto-isolated and develop a TTL compatible level with respect to the isolated ground.

1) PM, Mode Indicator: manual/program - Pin A20
2) RF, Analog Standby/Ready Flag - Pin A25 (Option C)

6.4.5 The latter is provided when the option is provided.

6.4.6 Thee 501J may be restored to non-opto-isolated operation by removing the opto-isolator card, and inserting jumper card, P2756/7. However, now computer ground must be connected to logic ground, Pin A8, as described previously in the manual. (See paragraph 3.1.6.)

6.4.7 The opto-isolator board is installed in the rear edge connector with the components facing the rear.

NOTICE: Paragraph 6.4.7 applied to the IS-40 board only.
(Do not confuse with the IS-48.)

6.5.0 Serial to Parallel Programming

(When not using the IEEE-488 Convention)

6.5.1 If it is desired not to use the IEEE STD. 488/1975 hermaphroditic cables, use a Cinch 57-30240 connector. The pinout is shown below:

Contact	Signal Line	Contact	Signal Line
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DIO7
4	DIO4	16	DIO8
6	DAV	18	Gnd. (6)
7	NRFD	19	Gnd. (7)
8	NDAC	20	Gnd. (8)
9	IFC	21	Gnd. (9)
		22	Gnd. (10)
11	ATN	23	Gnd. (11)
12	SHIELD	24	Gnd. LOGIC

NOTE: Gnd.(n) refers to the signal ground return of the referenced contact.

6.5.2 The interface may be driven with an 8 bit system, with a separate DAV (Data Valid), line. Use bit 8 for the ATN function. The flags NRFD and NDAC may be ignored, if at least 100 µs is allowed between characters and words.

6.5.3 The IEEE-488 specifies NEGATIVE TRUE LOGIC.

Where: TRUE = < +0.8 Vdc
FALSE = > +2 V dc

In the IS-48 (Opto-Isolator P. C. Card) the IC_1 and IC_2 are the type 7406 I.C., which provides for the 488 specified NEGATIVE TRUE LOGIC in B_1 through b_7. However, if POSITIVE true logic is desired, then, IC_1 and IC_2 may be changed to a type 7407.

6.6.0 Negative Programming Logic - Option AK-1

6.6.1 Option AK-1 consists of 30 logic inverters contained in a plug in P. C. card, P2936/7.

6.6.2 The following data inputs from the data input connectors are inverted:

1) Code 18 through 61 (24 BCD magnitude bits) for BCD units
2) Code B1 through B20 (20 Binary magnitude bits) for binary units

(A TTL logical zero will now turn on these bit lines)

3)	POL 1 - Pos. Polarity	0 - Neg. Polarity (Option J)
4)	RAN 1 - 100 mV Range	0 - 10 V Range (Option D)
5)	STR 0 - Unit on	1 - zero analog output
6)	MR1 1 - Memorize	0 - Follow (Option MR-1)
7)	PMM Mode Indicator 1 - M	0 - P
8)	RF 0 - Overload	1 - Normal

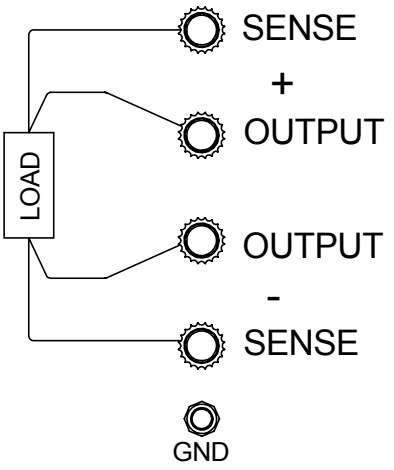
6.6.3 Notes: 7) and 8) above are signals from the 501 to the rear data connectors. The strobe line must be grounded to obtain a non-zero analog output.

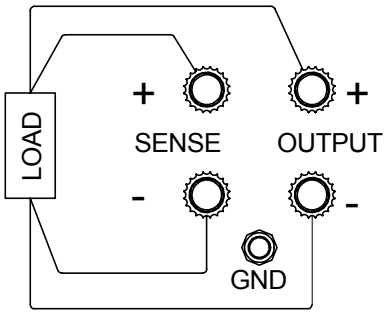
6.6.4 The 501 may be restored to positive logic operation by removing the P.C. card P 2936/7 and inserting the jumper card P2756/7.

Refer to schematic drawing A-2935.

SENSE CONNECTIONS

HIGH CURRENT LOAD

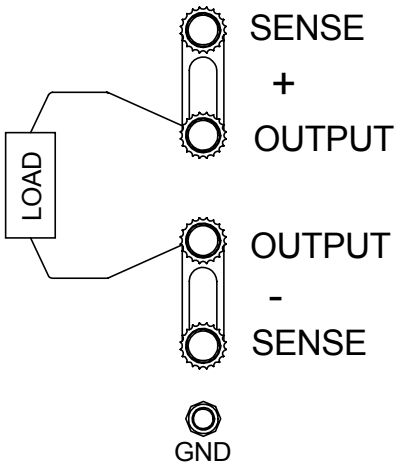


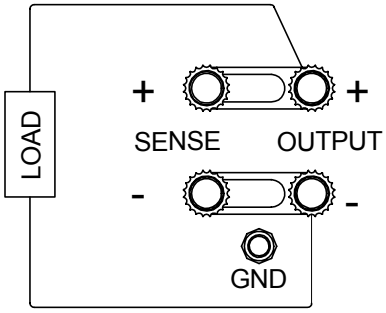


[Sense Links Removed]

FIG 1

LIGHT LOAD

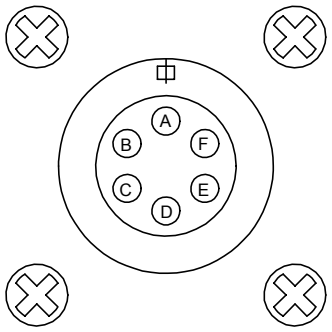




[Sense Links Installed]

FIG 2

OUTPUT CONNECTOR PIN FUNCTIONS

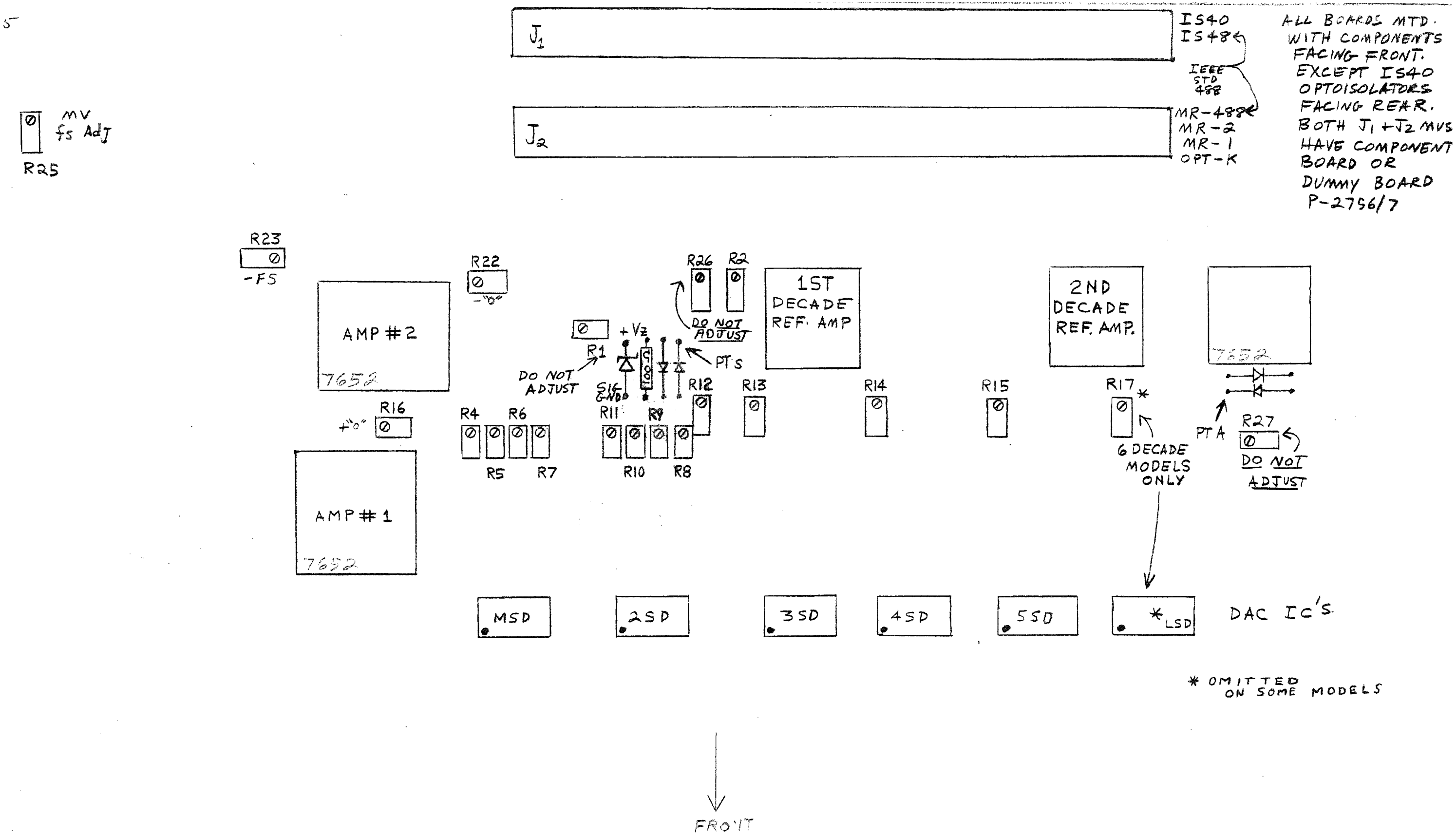


PIN A Chassis Ground
PIN B + Output
PIN C - Output
Pin D Not Used
Pin E - Sense
Pin F + Sense

FIG 3

Reference Drawing #930727-A

15



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BOARD EDGE CONNECTOR

P1

1	1		
2	2		
3	3	JMP1	
4	4		+5V
5	5	R8 IN	
6	6	R4 IN	
7	7	R2 IN	
8	8		
9	9		
10	10		
11	11		
12	12		+5IL
13	13		
14	14	PM OUT	
15	15	STR IN	
16	16	R1 IN	
17	17	MR1 IN	
18	18	POL IN	
19	19	RF OUT	
20	20	61 IN	
21	21	62 IN	
22	22	64 IN	
23	23	68 IN	
24	24	51 IN	
25	25	52 IN	
26	26	54 IN	
27	27	58 IN	
28	28	41 IN	
29	29	42 IN	
30	30	44 IN	
31	31	48 IN	
32	32	31 IN	
33	33	32 IN	
34	34	34 IN	
35	35	38 IN	
36	36	21 IN	
37	37	22 IN	
38	38	24 IN	
39	39	28 IN	
40	40	11 IN	
41	41	12 IN	
42	42	14 IN	
43	43	18 IN	
1B	44	PM IN	
2B	45		
3B	46	JMP1	
4B	47		+5V
5B	48	R8 OUT	
6B	49	R4 OUT	
7B	50	R2 OUT	
8B	51		
9B	52		
10B	53		
11B	54		
12B	55		
13B	56		
14B	57	PM IN	
15B	58	STR OUT	
16B	59	R1 OUT	
17B	60	MR1 OUT	
18B	61	POL OUT	
19B	62	RF IN	
20B	63	61 OUT	
21B	64	62 OUT	
22B	65	64 OUT	
23B	66	68 OUT	
24B	67	51 OUT	
25B	68	52 OUT	
26B	69	54 OUT	
27B	70	58 OUT	
28B	71	41 OUT	
29B	72	42 OUT	
30B	73	44 OUT	
31B	74	48 OUT	
32B	75	31 OUT	
33B	76	32 OUT	
34B	77	34 OUT	
35B	78	38 OUT	
36B	79	21 OUT	
37B	80	22 OUT	
38B	81	24 OUT	
39B	82	28 OUT	
40B	83	11 OUT	
41B	84	12 OUT	
42B	85	14 OUT	
43B	86	18 OUT	

B NUMBERS ARE SOLDER SIDE

U1 R1 330 R2 22K R4 22K R6 22K R8 22K R10 22K R12 22K R18 22K
U2 R3 330
U3 R5 330
U4 R7 330
U5 R9 330
U6 R11 330
U9 R17 330

+5IL
STR IN
R2 IN
R4 IN
R8 IN
R1 IN
MR1 IN
POL IN
STR OUT
R2 OUT
R4 OUT
R8 OUT
R1 OUT
MR1 OUT
POL OUT

U12 R23 330 R24 22K
U13 R25 330 R26 22K
U14 R27 330 R28 22K
U15 R29 330 R30 22K
U20 R39 330 R40 22K
U21 R41 330 R42 22K
U10 R19 330 R20 22K
U11 R21 330 R22 22K

68 IN
64 IN
62 IN
61 IN
58 IN
54 IN
52 IN
51 IN
68 OUT
64 OUT
62 OUT
61 OUT
58 OUT
54 OUT
52 OUT
51 OUT

U16 R31 330 R32 22K
U17 R33 330 R34 22K
U18 R35 330 R36 22K
U19 R37 330 R38 22K
U24 R47 330 R48 22K
U25 R49 330 R50 22K
U26 R51 330 R52 22K
U27 R53 330 R54 22K

48 IN
44 IN
42 IN
41 IN
38 IN
34 IN
32 IN
31 IN
48 OUT
44 OUT
42 OUT
41 OUT
38 OUT
34 OUT
32 OUT
31 OUT

U32 R63 330 R64 22K
U33 R65 330 R66 22K
U22 R43 330 R44 22K
U23 R45 330 R46 22K
U28 R55 330 R56 22K
U29 R57 330 R58 22K
U30 R59 330 R60 22K
U31 R61 330 R62 22K

28 IN
24 IN
22 IN
21 IN
18 IN
14 IN
12 IN
11 IN
28 OUT
24 OUT
22 OUT
21 OUT
18 OUT
14 OUT
12 OUT
11 OUT

REVERSED ISOLATED LINES

U7 R14 22K PM OUT R13 330 PM IN
U8 R16 22K RF OUT R15 330 RF IN

+5V
+5IL

NOTE:
U1 - U33 ARE 4N26

BYPASS CAPS

C4 .1
C3 6.8/35
C2 .1
C1 6.8/35

LOGIC GND
ILCOM

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Date: Friday, April 05, 2002 Sheet 1 of 1

All resistors 1/2W 5%, all capacitors in μf.
All diodes 1N914B unless otherwise specified

b1-b7 H ≡ TRUE

Z26 B5 B4 B3 B2 B1 EN A5 A4 A3 A2 A1 A=B

SW-1

LIST ADD SEL
ON ≡ TRUE

5 x 6.8K
(SIP)

Z20 A13 A12 A11 A14 A9 A16

Z23
9x6.8K
DAV
ATN
A23

LS ≡ LACS ∧ LADS

Z27 PRE CLR D CLK Q

TO Z25-13

Z27 CLR D,PRE CLK Q

STR

PON

IFC

10K

10/16

Z21

Z28

Z17

Z18

MLA

UNL

ATN

Z29 10-14 1-5

Z24

Z25

Z31

NDAC (A20)

NRFD (A19)

Z22 CD C RC

.022

10K

DAV
A17

Z15 PRESET SI CLK A B C D E

Z16 PRESET SI CLK A B C D

2,3,4,6,7

8,16

Z32

2000PF

3.6K

TO
FINAL
LATCH
CLOCK

5088

4.7K

MAST STR

TO INT LATCH
CLOCKS

Z28-11

TO
Z15

TO
Z16

SEE B3335H

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Z28-11 | 14 | 13 | 11 | 10 TO Z15 | 15 | 14 | 13 ← TO Z16 | Q_1-C

$\overline{b_1}$ $\overline{b_2}$ $\overline{b_3}$ $\overline{b_4}$

Z14 POL: D, CLK, $\overline{Q}$ — pin 12, 11, 8

+5 — pin 2

13,4,10

Z14 POL: D, CLK, ½ Q — pin 2, 3, 5

ICLR 1

P

Z8 MSD: CLKS, Q — pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z1 MSD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 11, 12, 14, 18

Z9 2SD: pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z2 2SD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 21, 22, 24, 28

Z10 3SD: pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z3 3SD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 31, 32, 34, 38

Z11 4SD: pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z4 4SD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 41, 42, 44, 48

Z12 5SD: pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z5 5SD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 51, 52, 54, 58

Z13 6SD: pins 2 3 6 7 / 13 / 4 / 16 15 10 9

Z6 6SD: pins 2 3 6 7 / 13 / 4 / 1 14 11 8 — 61, 62, 64, 68

Z7 RAN: pins 1 14 11 8 / 13 / 4 / 13 12 4 5

Z30 RAN: CLR, CLK — pins 1, 9 / 15 10 2 7 — R_1, R_2, R_4, R_8

Z27-1

All resistors 1/2W 5%, all capacitors in µf.
All diodes 1N914B unless otherwise specified

SW-1 CONTROL SWITCH SL1007

Z#	Z TYPE	GND PIN	+5 PIN
1,13	7475	12	5
15,16	7496	12	5
17,18	74LS30	7	14
20	7404	7	14
22	9602	8	16
23	SPR916C682 X2 PE	NONE	16
24,25 21,28	7400	7	14
26	9324	8	16
27	7474	7	14
29	7413	7	14
30	74175	8	16

□- INPUTS
○- OUTPUTS

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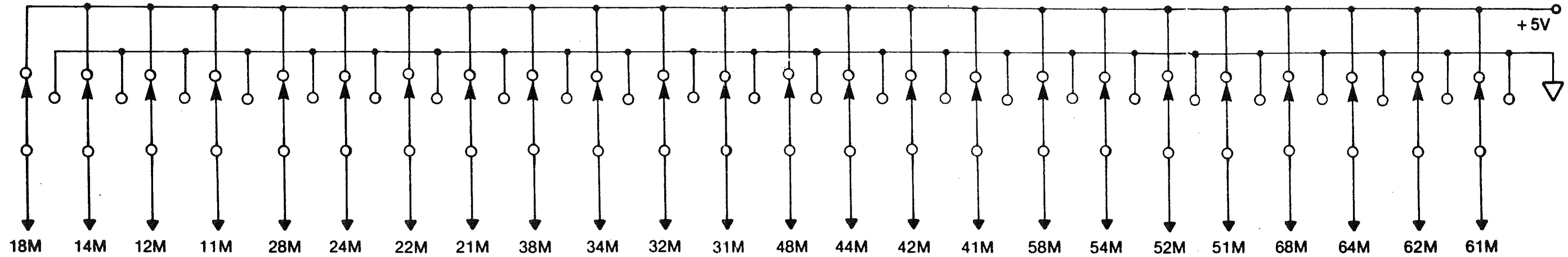

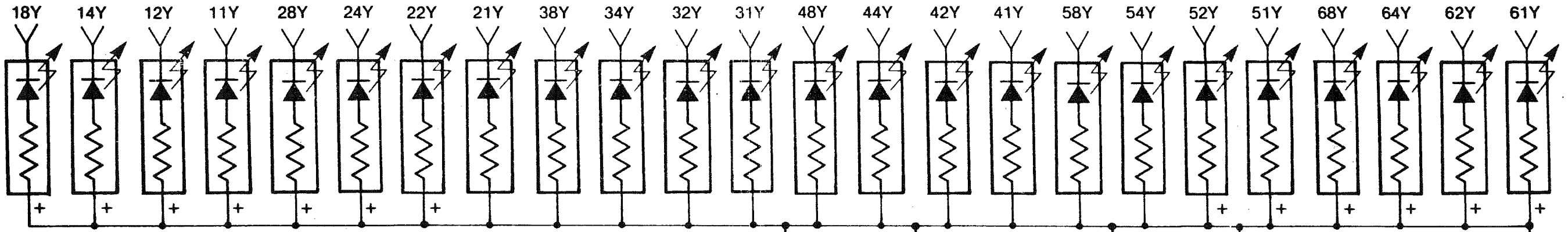

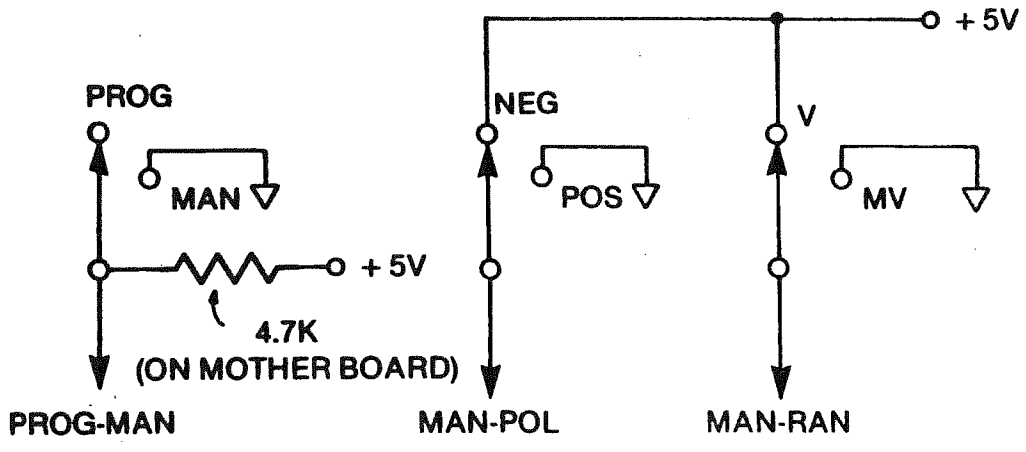

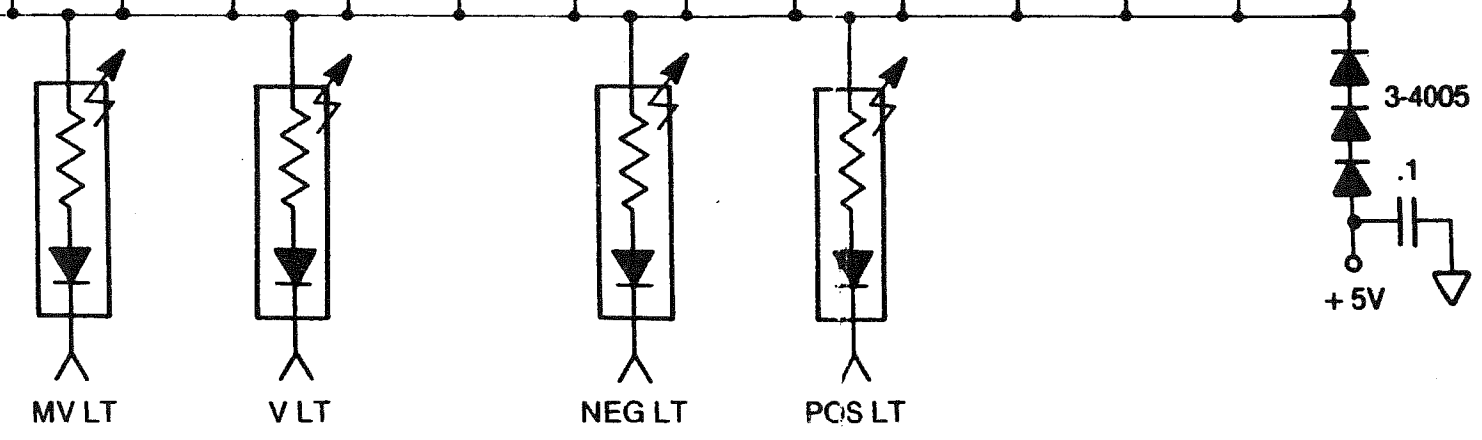

All resistors 1/2W 5%, all capacitors in μf.
All diodes 1N914B unless otherwise specified.

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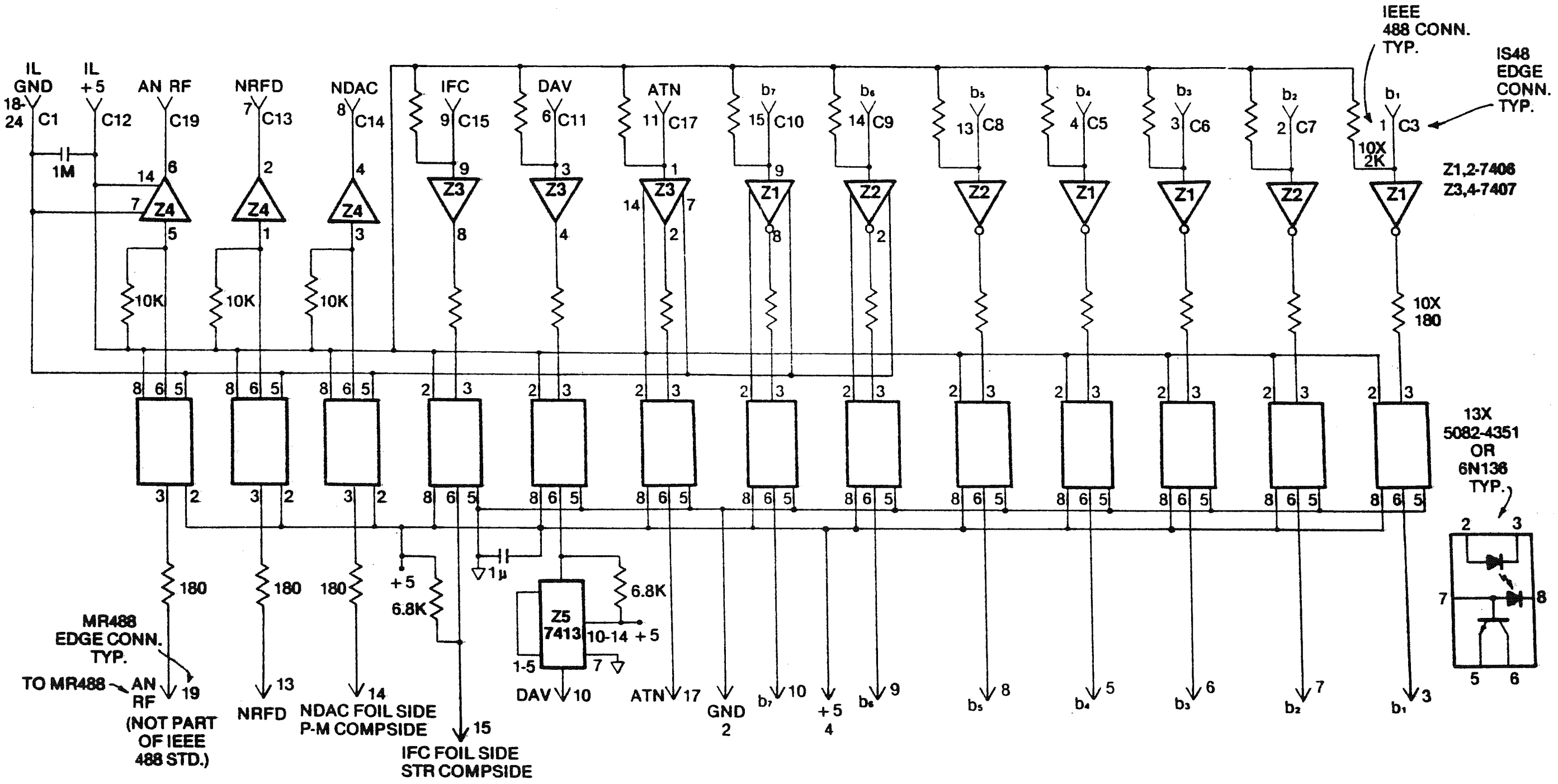

All resistors 1/2W 5%, all capacitors in µF.
All diodes 1N914B unless otherwise specified.

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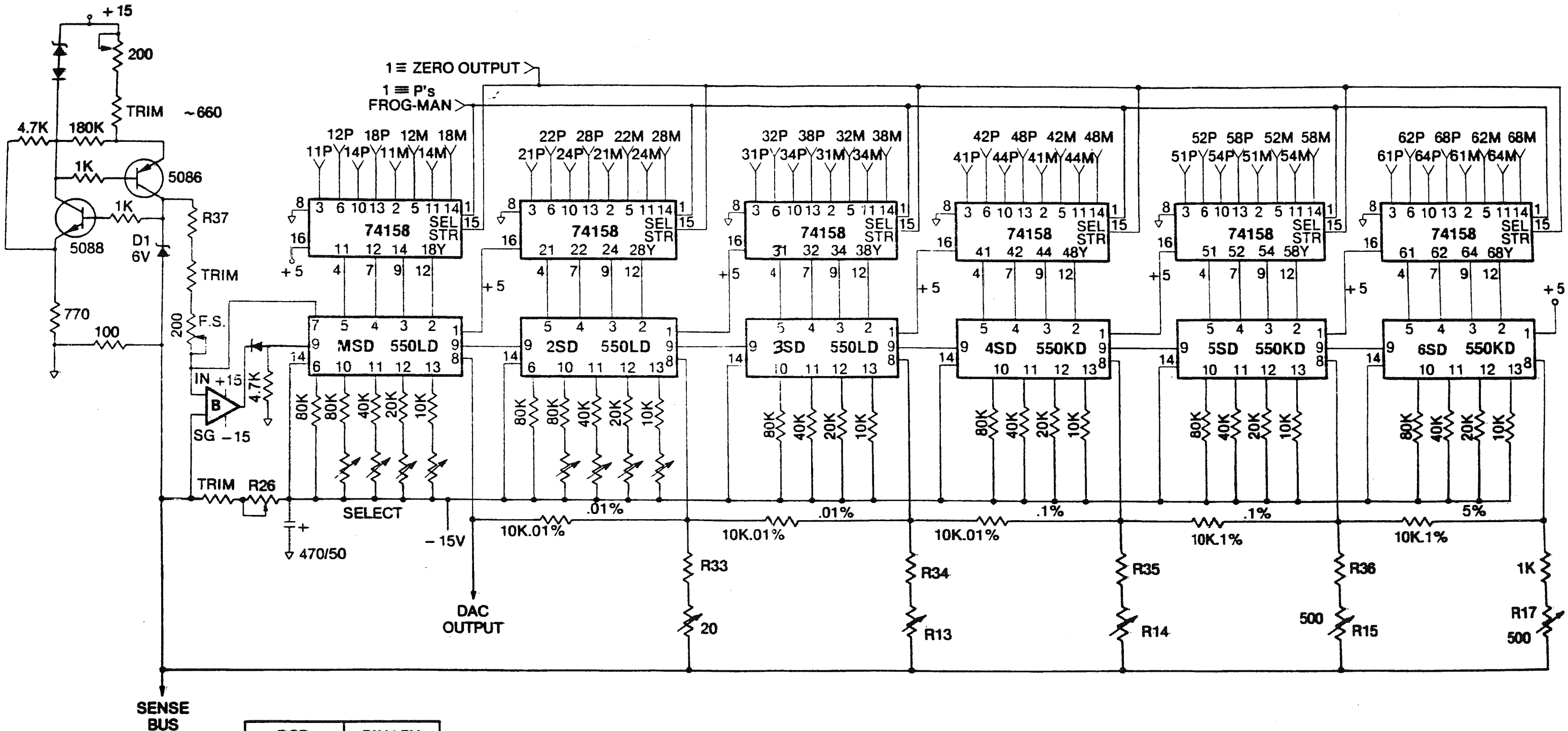
Size	Document Number: B-2995	Rev: F
Date: Wednesday, April 03, 2002	Sheet 1 of 1	



BCD	BINARY
R33-1.22K	700
R34-1.22K	546
R35-1.22K	546
R36-1K	470
R37-49.3K	76.8K
R13-20	200
R14-20	200

All resistors 1/2W 5%, all capacitors in μf.
All diodes 1N914B unless otherwise specified.

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Title		
501 DAC REFERENCE		
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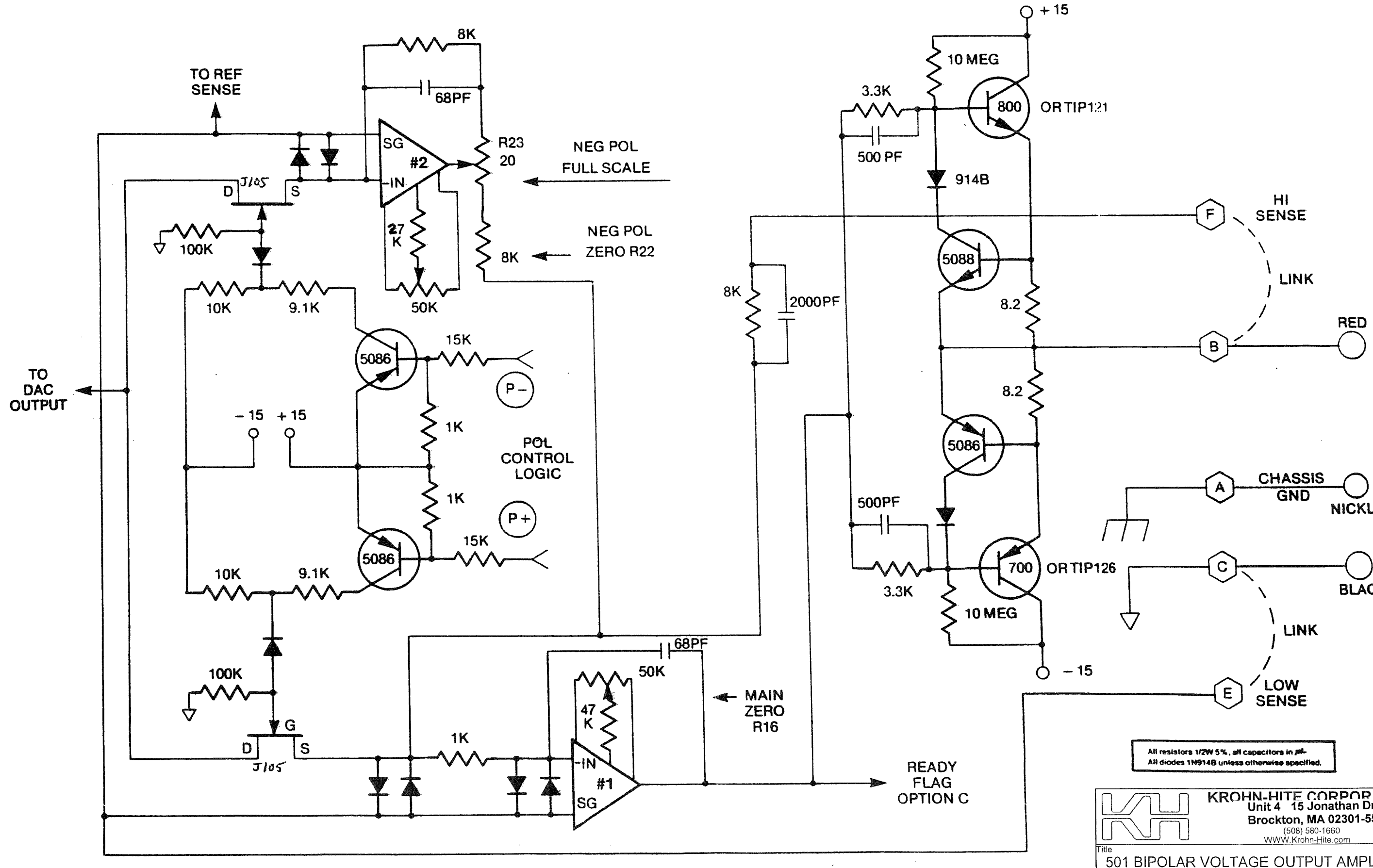

All resistors 1/2W 5%, all capacitors in pF.
All diodes 1N914B unless otherwise specified.

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