INSTRUCTION MANUAL

Digital Multimeter

Model 5900

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof which, within a year after shipment, proves defective upon examination. We will pay local domestic surface freight costs.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and shipping instructions.

REPAIRS AND CALIBRATION

Keithley Instruments maintains a complete repair and calibration service as well as a standards laboratory in Cleveland, Ohio. A service facility is also located in Los Angeles for our west coast customers.

A Keithley service facility at our Munich, Germany office is available for our customers throughout Europe. Service in the United Kingdom can be handled at our office in Reading. Additionally, Keithley representatives in most countries maintain service and calibration facilities.

To insure prompt repair or recalibration service, please contact your local field representative or Keithley headquarters directly before returning the instrument. Estimates for repairs, normal recalibrations and calibrations traceable to the National Bureau of Standards are available upon request.

KEITHLEY
The measurement engineers.

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FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltages hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC Mains through an autotransformer (such as a Variac or equivalent) ensure that the instrument common connector is connected to the ground (earth) connection of the power mains.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adapter.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument.

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation section.
2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.
3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

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PROPRIETARY NOTICE

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1.1 INTRODUCTION.

1.2 The Model 5900 Digital Multimeter is a five-decade instrument with a sixth digit providing 60% overrange. The basic instrument is equipped for dc and dc/dc ratio measurements on five ranges. With the addition of the optional AC Converter, a-c and ac/dc ratio measurements on four ranges are available. The Ohms Converter, also optional, adds ohms measurements on eight ranges. Complete measurement capability of a fully equipped instrument is tabulated in table 1.1.

Table 1.1 - Measurement Capability

Range	FUNCTION		
	DC & DC/DC RATIO (Basic 5900)	Ohms (Model 52 Ohms Converter)	AC & AC/DC RATIO (Model 32 or 33 AC Converter)
.1V	X		
1V	X		X
10V	X		X
100V	X		X
1000V	X		X
10Ω		X	
.1 KΩ		X	
1 KΩ		X	
10 KΩ		X	
100 KΩ		X	
1000 KΩ		X	
10 MΩ		X	
100 MΩ		X	

1.3 Range can be selected manually or automatically (autorange). In AUTO range, the proper range for a particular measurement is selected automatically (full scale is defined as "100000" on any range). The instrument "upranges" at 160% of full scale and "downranges" at 15% of full scale. Polarity selection is also automatic and is displayed on the readout.

1.4 Two operating modes are provided. In Hold mode (RATE control on EXT), a measurement is held (displayed) until a single reading is commanded by an external command. The new measurement is then held until the next external command. In Periodic mode (RATE control CW), measurements are made automatically at the rate of approximately four per second.

1.5 The basic Model 5900 includes an analog output voltage that is proportional to the parameter being measured (except ratio). The voltage, at 20 volts maximum, is available at a rear panel connector.

1.6 Also included as standard equipment is a solid-state isolated BCD output. TTL-compatible output levels of the reading, function, range, etc., plus a print command are provided. An additional line enables a new reading to be commanded externally. An optional isolated remote programming unit (Model 42) allows all operating commands to be made externally.

1.7 OPTIONS.

1.8 All optional accessories having model numbers are plug-in circuit boards that may be added at any time. A calibrated accessory board can be installed without affecting the d-c calibration of the basic instrument. An instrument shipped without PCB accessories will not be equipped with a Function Switching PCB assembly. This board must be added when accessory boards are installed. Analog accessories are identified in table 1.1.

1.9 Model 42 Remote Programming.

1.10 The Model 42 Remote Programming accessory allows the selection of function, range, filter, read command, etc., to be made externally. Auto range selection is also provided and appropriate timeouts are generated internally when ranging takes place. Remote Programming "overrides" all manual control settings to prevent erratic selections. Complete isolation of the programming unit is achieved by the use of photo-couplers and pulse transformers.

1.11 Rear Input Options (-1, -1B, -1S, -1SB).

1.12 Two rear input options are available for the Model 5900 DMM. The option designated -1 or -1B consists of connector J204 on the back panel with input lines ± INPUT, ± CURRENT, and GUARD wired in parallel with the front panel input terminals; the option designated -1S or -1SB is the same as the -1 or -1B except that the front or rear inputs are selectable by a switch on the front panel.

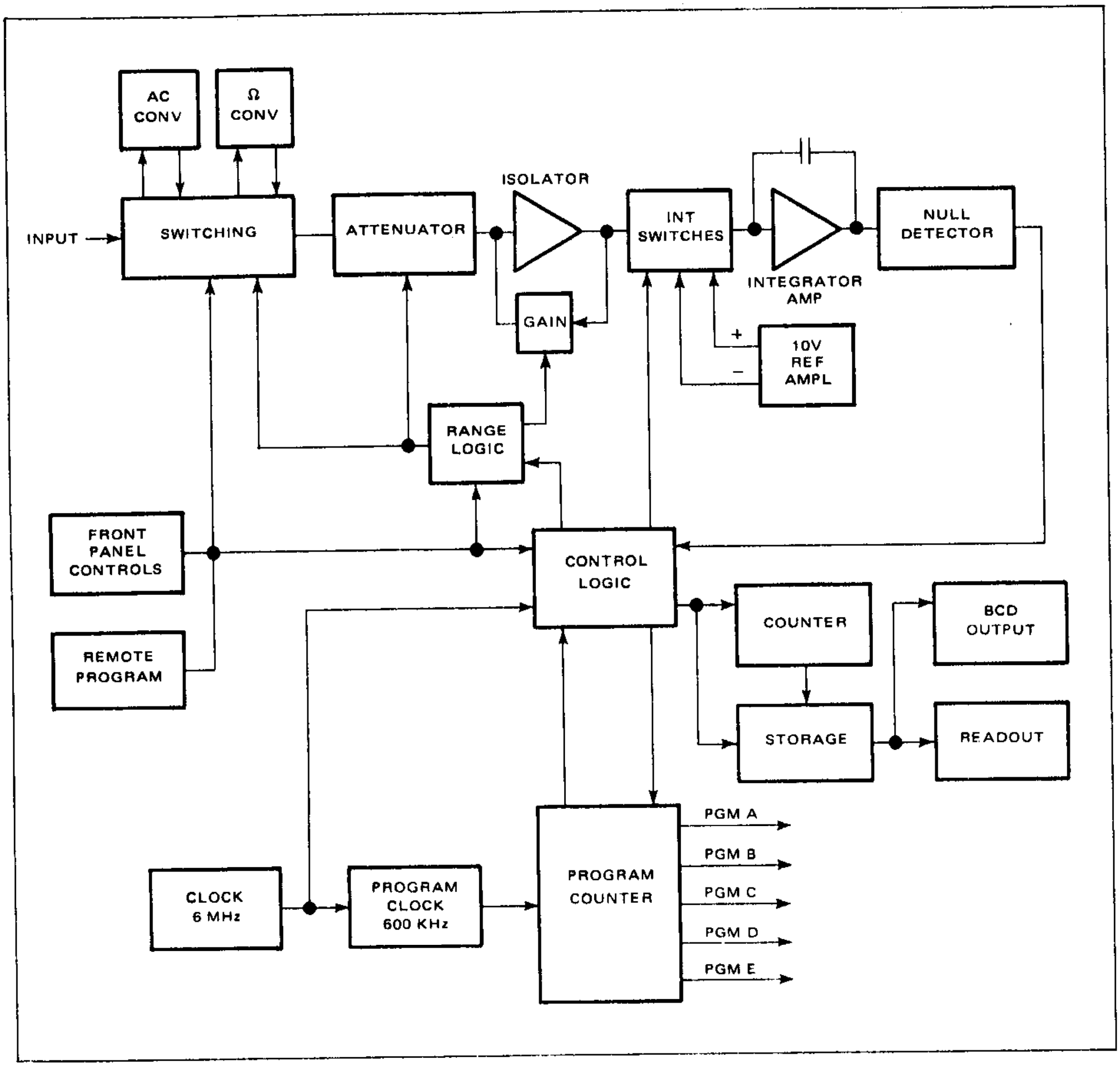


Figure 1.1 - Block Diagram - Model 5900

1.13 Rack-Mounting Flanges (403402).

1.14 Rack-Mounting Flanges are used where the instrument is to be installed in a relay-rack or cabinet.

1.15 High-Voltage Probe (641).

1.16 The High-Voltage Probe extends the voltage range of the instrument up to 10,000 volts (or 7500V rms). It is an insulated probe containing a 1000:1 voltage divider.

1.17 Current Shunt Set (651).

1.18 The Current Shunt Set consists of six precision shunt assemblies with values selected to produce a voltage drop that, measured in millivolts, has a numerical value equal to the current flow in milliamps or microamps.

1.19 ELECTRICAL DESCRIPTION.

1.20 The Model 5900 DMM is a dual slope integration instrument consisting of three main functional areas: signal conditioning, integrating, and control/display. A block diagram of the instrument is shown in figure 1.1.

1.21 The signal conditioning section includes the Switching p-c board, AC Converter, Ohms Converter, Attenuator, and Isolator. The function of these circuits is to convert the incoming signal to 10 VDC, full scale into the integrator.

1.22 The Integrating section consists of the Integrator amplifier, Null Detector and ± reference voltages. The function of these circuits is to convert the conditioned input signal to an equivalent time period and to transmit this time period to the display portion of the DMM.

1.23 Dual slope integration operates as follows in a sequence of program (PGM) states:

a. Signal Integration (PGM-A). The integrator capacitor charges to a voltage proportional to the input voltage during a 20 msec sampling period.

b. Reference Integrate (PGM-C). During this period, the integrator capacitor discharges at a constant current. The time that the integrator requires to discharge (full discharge detected by the Null Detector) is measured by the counter. The data in the counter at the end of PGM-C is proportional to the input voltage.

c. Strobe (PGM-D). At this time, data in the counter is strobed into the storage latches and displayed – the print pulse is inhibited, however if an uprange or downrange command is generated by the Autorange logic. If a range change is required, the counter is reset and the program returns to PGM-A.

d. Reset (PGM-E). At PGM-E, all internal logic is reset in preparation for the next reading.

1.24 An additional control state, PGM-B, occurs after PGM-A and is a delay to allow for propagation time of the counter.

1.25 The Control/Display section generates the control signals necessary to operate the signal conditioning and integrating circuits.

1.26 MECHANICAL DESCRIPTION.

1.27 The ohms measurement option consists of a single printed-circuit board. The AC options both consist of two boards. The accessory boards plus the Digitizer, Isolator, and Function Switching board all plug into the Main Logic board called the Logic and Interconnection assembly. This board also carries much of the instrument logic.

1.28 The Function Switching board is used only when either or both of the options (AC and Ohms) are installed. With no options installed, the Function Switching board is replaced with the Switching Bypass board. The Switching Bypass merely connects the + Input (from input connector) directly to the Isolator input and the – Input to ground.

1.29 At the rear edge of the Logic and Interconnection assembly is a PCB connector that extends to the rear panel and serves as the BCD output connector J201. If the optional Remote Program board is installed, it is mounted on stand-offs above the Logic and Interconnection board with the PROGRAM INPUT connector (J202) available at the rear panel above the BCD OUTPUT connector.

1.30 The POWER input connector J203, the power transformer, and power transistors for the power supply are mounted on the rear panel of the instrument. Other power supply components are mounted on the Logic and Interconnection assembly. Also mounted on the rear panel, in addition to J201 and J202, is the rear INPUT connector J204, the ANALOG OUTPUT connector and common, the EXTernal REFerence connector and common, and the line fuse F201.

1.31 A dimensional outline of the Model 5900 is shown in figure 1.2.

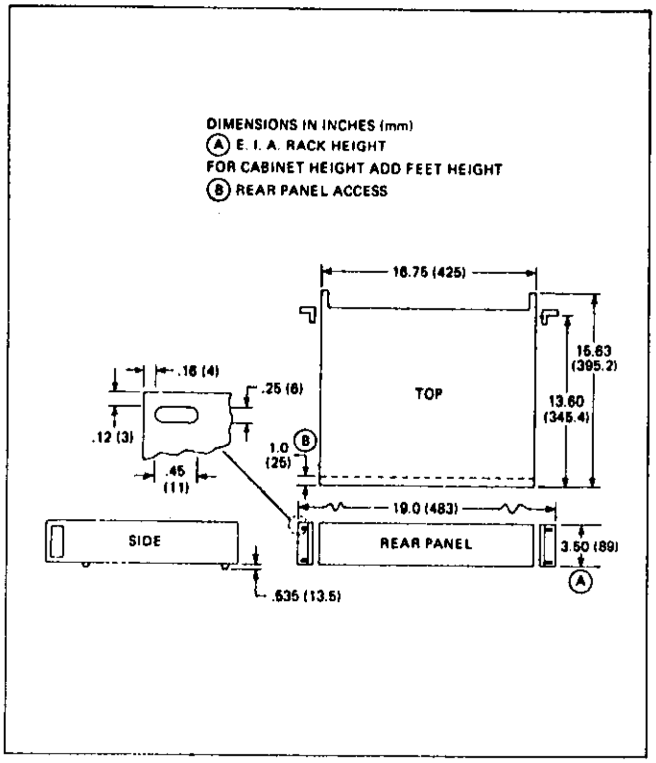


Figure 1.2 - Dimensions

1.32 SPECIFICATIONS.

1.33 Specifications are listed in table 1.2.

SPECIFICATIONS, MODEL 5900

AS A DC VOLTMETER (BASIC INSTRUMENT)

RANGE	MAXIMUM READING	ACCURACY* 24 HR (23°C ±1°C) ±(% of rdg + digits)	ACCURACY* 90 days (23°C ±5°C) ±(% of rdg + digits)	ACCURACY* 1 YR. (23°C ±5°C) ±(% of rdg + digits)	TEMP. COEF. 0°C - 50°C ±(% of rdg + digits) /°C
0.1V	.159999	0.002% + 5d	0.003% + 5d	0.005% + 5d	0.0004% + 0.5d
1V	1.59999	0.001% + 1d	0.002% + 1d	0.004% + 1d	0.0003% + 0.1d
10V	15.9999	0.000% + 1d	0.001% + 1d	0.003% + 1d	0.00015% + 0.05d
100V	159.999	0.001% + 1d	0.002% + 1d	0.004% + 1d	0.0003% + 0.1d
1000V	1000.00	0.001% + 1d	0.002% + 1d	0.004% + 1d	0.0003% + 1d

MAXIMUM INPUT VOLTAGE: 1100 VDC or 1500V peak AC on all ranges.
NON-LINEARITY (23°C±5°C, all ranges): Less than or equal to 0.5 digit
INPUT RESISTANCE: 0.1V to 10V: > 10,000MΩ. 100V and 1000V: 10MΩ.
INPUT BIAS CURRENT: At time of calibration: ≤ 10 pA
For 30 days at 23°C: ±100 pA
Temperature coefficient: ± 5 pA/PC
NORMAL MODE REJECTION:
UNFILTERED: 48 dB at every multiple of 60 Hz.†
FILTERED: 100 dB at 60 Hz.†

COMMON MODE REJECTION: (with 100Ω unbalance in either lead)
UNFILTERED: 140 dB at DC, 120 dB below 61 Hz. 54 dB at harmonics of 60 Hz.
FILTERED: 140 dB DC to 61 Hz. 126 dB 61 Hz to 100 kHz.
ANALOG SETTLING TIME (with 10 KΩ source):
UNFILTERED: Settles to within 0.01% in 5 ms, (except 10 ms on 100V range).
FILTERED: Settles to within 0.01% in 450 ms.
ZERO STABILITY: ±0.5 μV/°C, ±5 μV/week

WITH OHMS OPTION 52

RANGE	MAXIMUM READING	ACCURACY* 24 HR (23°C ±1°C) ±(% of rdg + digits)	ACCURACY* 90 DAYS (23°C ±5°C) ±(% of rdg + digits)	TEMP. COEF. 0°C - 50°C ±(% of rdg + digits)/°C	CURRENT THROUGH UNKNOWN	OPEN CIRCUIT VOLTAGE (MAXIMUM)
10 Ω	15.9999	0.003% + 5d	0.005% + 5d	0.0008% + 0.5d	10.101 mA	2.5V
0.1 kΩ	.159999	0.002% + 1d	0.003% + 1d	0.0007% + 0.1d	11.1111 mA	2.5V
1 kΩ	1.59999	0.002% + 1d	0.003% + 1d	0.0007% + 0.1d	1.11111 mA	2.5V
10 kΩ	15.9999	0.002% + 1d	0.003% + 1d	0.0006% + 0.1d	1 mA	22V
100 kΩ	159.999	0.002% + 1d	0.003% + 1d	0.0006% + 0.1d	100 μA	22V
1000 kΩ	1599.99	0.002% + 1d	0.003% + 1d	0.0006% + 0.1d	10 μA	22V
10 MΩ	15.9999	0.01% + 1d	0.03% + 1d	0.003% + 0.1d	1 μA	22V
100 MΩ	159.999	0.02% + 1d	0.03% + 1d	0.005% + 0.3d	100 nA	22V

MAXIMUM INPUT VOLTAGE: ± 500V peak on all ranges.
CONFIGURATION: 4-terminal
NORMAL MODE REJECTION:
UNFILTERED: 48 dB at every multiple of 60 Hz.†
FILTERED: 100 dB at 60 Hz†

COMMON MODE REJECTION: (with 100Ω unbalance in either lead)
UNFILTERED: 14k0 dB at DC, 120 dB up to 61 Hz, 54 dB at harmonics of 60 Hz.†
FILTERED: 140 dB DC to 61 Hz. 126 dB 61 Hz to 100 kHz.
ANALOG SETTLING TIME (to rated accuracy with filter out): 10Ω-10MΩ 30 ms
100M Ω 300 ms
OHMS GUARD: Use "Analog-Out" low on rear panel.

RATIO (dc/dc, mV/dc, ac/dc)

	3-Wire (Basic Instrument)	With 4-Wire Option 62
READOUT:	$\frac{(10V)}{(Ref\ V)} \times \frac{(Input)}{(Range)} \times 10$	$\frac{(10V)}{(Ref\ V)} \times \frac{(Input)}{(Range)} \times 10$
REFERENCE VOLTAGE RANGE:	+1V to +10.5 Volts DC	+1V to +10.5 Volts DC
ACCURACY:	24 hours, 23°C ±1°C DC, AC - same as respective 24 hour, 23°C ±1°C spec. times $\frac{(10V)}{(Ref\ V)}$	24 hours, 23°C ±1°C DC, AC - same as respective 24 hour, 23°C ±1°C spec. times $\frac{(10V)}{(Ref\ V)} \times 2$
REFERENCE INPUT RESISTANCE:	1000MΩ	+ to signal LO, 7 1000 MΩ — to signal LO, 10 MΩ
REFERENCE SETTLING TIME:	10 ms to 0.01 % of rated accuracy	50 ms to 0.01 % of rated accuracy
VOLTAGE BETWEEN REFERENCE INPUT (BOTH TERMINALS) AND SIGNAL COMMON:	—	15V max.

WITH TRUE RMS AC VOLTS OPTION 32

RANGES: 1.00000V, 10.0000V, 100.000V, 10000.00V RMS.
RESOLUTION: 0.001% of range. 10μV on 1V range.
OVERRANGE: 60% (within max input voltage limit).
MAXIMUM INPUT VOLTAGE: 1000V DC/RMS or 1500V peak, decreasing to 20 V RMS at 1 MHz. 2 x 10^7 V·Hz maximum on any range.
MAXIMUM CREST FACTOR: 7:1 at full range. $7 \times \sqrt{\frac{Range}{V\ input}}$ for other input voltages.

ACCURACY* AC MODE (90 days; 23°C ±5°C):

For inputs less than 500V:

FREQUENCY RANGE		FILTER IN ±(% of rdg + digits)
20 Hz to 30 Hz	Filter must be in	0.5% + 40d
30 Hz to 50 Hz	Filter must be in	0.2% + 40d
50 Hz to 200 Hz	Filter must be in	0.1% + 40d
200 Hz to 20 kHz		0.07% + 40d
20 kHz to 50 kHz		0.1% + 100d
50 kHz to 100 kHz		0.4% + 200d
100 kHz to 300 kHz (10, 100, 1000V)		3.0% + 500d
100 kHz to 300 kHz (1V)		5.0% + 1000d
Useable to 1 MHz		

AC + DC MODE: Add ±20 digits to AC specification

For inputs greater than 500V: add 0.1% of reading.

TEMPERATURE COEFFICIENT: (0°C to 50°C, to 20 kHz)
AC MODE: ±(.004% of rdg + 3 digits)/°C.
AC+DC MODE: ±(.004% of rdg + 5 digits)/°C.
INPUT IMPEDANCE: (AC MODE) 1 Megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common.
COMMON MODE REJECTION: (with 100 ohm unbalance in either lead, DC to 60 Hz)

RANGE	CMR
1V	12k0 dB
10V	100 dB
100V	80 dB
1000V	60 dB

SETTLING TIME (to within 0.1% of range)

INPUT:	FILTER OUT:	FILTER IN:
0 to full scale step	80 milliseconds	350 milliseconds
full scale to 10% FS step	100 milliseconds	400 milliseconds

WITH AVERAGING AC VOLTS OPTION 33

RANGES: 1.00000V, 10:0000V, 100.000V, 1000.00V RMS.
RESOLUTION: 0.001% of range. 10μV on 1V range.
OVERRANGE: 60% except 1000V range (1000V RMS maximum input).
MAXIMUM INPUT VOLTAGE: 1000V RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. 2 x 10^7 V·Hz maximum on any range.
ACCURACY* (24 hours, 23°C ±1°C):

For inputs less than 500 volts:

FREQUENCY RANGE		ACCURACY ±(% of rdg + digits)
20 Hz to 30 Hz	Filter in	0.2% + 2d
30 Hz to 60 Hz	Filter in	0.1% + 2d
60 Hz to 100 Hz	Filter in	0.05% + 2d
100 Hz to 300 kHz	Filter in	0.02% + 2d
100 Hz to 300 Hz (Filter out)		0.1% + 2d
300 Hz to 5 kHz		0.02% + 2d
5 kHz to 100 kHz		0.04% + 5d
100 kHz to 300 kHz		0.1% + 10d
Useable to 1 MHz		

For 90 days, 23°C ±5°C, add ±0.01% of rdg to 24 hour specs.
For 6 months, 23°C ±5°C, add ±0.02% of rdg to 24 hour specs.

For inputs greater than 500 volts add ±0.1% of rdg (f < 5kHz).
For inputs greater than 500 volts add ±0.2% of rdg (f > 5kHz).

INPUT IMPEDANCE: 1MΩ ±0.1% in series with 0.22 μF shunted by less than 100pF to common.

COMMON MODE REJECTION: (with 100Ω unbalance in either lead)

RANGE	CMR
1V	120 dB
10V	100 dB
100V	80 dB
1000V	60 dB

TEMPERATURE COEFFICIENT: 0°C-50°C
50 Hz to 20 kHz (filtered) ± (0.003% of rdg + 0.5 digit)/°C
20 kHz to 100 kHz (both) ± (0.005% of rdg + 2 digits)/°C
100 kHz to 300 MHz (both) ± (0.01% of rdg + 10 digits)/°C

ANALOG SETTLING TIME:
FILTER OUT: Settles to within rated accuracy in 200 ms.
FILTER IN: Settles to within rated accuracy in 600 ms.
(Zero to full scale or full scale to 10% of full scale)

*When appropriately zeroed. †50 Hz with Option 04.

SPECIFICATIONS CONTINUED NEXT PAGE

GENERAL (Basic Instrument)

POLARITY SELECTION: Automatic.
RANGING: Automatic or manual. Upranges at 1600000, downranges at 015000.
SIGNAL INTEGRATION TIME: (60 Hz) 16⅔ ms. 1⅔ ms in Superfast
READING RATE: Greater than 20 per second on command, 120 per second at 10000 counts in Superfast. Zero to 3⅓ per second using internal trigger and front panel control
ACCURACY, SUPERFAST: Standard accuracy ±(0.03% rdg + 3 digits) 15999 counts maximum
COMMON MODE VOLTAGE: 1000V peak, guard to case, with logic common tied to case. 250V peak analog common to guard.
DISPLAY: 5-1/2 digits (LED .4 inches high) appropriate decimal position, function and polarity indication
OVERRANGE INDICATION: Reading of 160000 and "NO" annunicator illuminated
FILTER: 4-pole active
ANALOG SIGNAL OUTPUT: Signal input scaled and buffered 0 to ±16V. DC voltage is available for driving a recorder or as an accurate voltage source. 1 milliampere maximum current.
POWER: 105 to 125 or 210 to 250 Volts (switch selected) 60 Hz (50 Hz available). 40 watts at nominal line.
ENVIRONMENT:
Operating 0°C to 50°C
0% to 75% relative humidity up to 40°C
Storage -40°C to 70°C
DIMENSIONS, WEIGHT: 90 mm high x 425 mm wide x 355 mm deep (3½ in. x 16¾ in. x 14 in.) Net weight, 7, 3 kg (16 lbs.)

DATA OUTPUT (Basic Instrument)

ISOLATED DIGITAL OUTPUT: 6 BCD data digits, 4-bit range code, 5 function bits, polarity, overload, data flag, system flags and logic supplies.
Logic Levels: TTL
ISOLATED REMOTE CONTROLS: Superfast, Data Disable and System Direct
Logic Levels: TTL
ISOLATION: Data output common may be floated up to 200 volts from power line common.

WITH REMOTE PROGRAMMING OPTION 42

ISOLATED REMOTE CONTROLS: Function, Range, Filter, hold, Superfast, Program Storage, trigger, Time Out trigger, Data Inhibit.
Logic Levels: TTL
ISOLATION: See Data Output

WITH GENERAL PURPOSE INTERFACE BUS (GPIB) MODEL 55

OUTPUT INFORMATION: Numeric data, polarity, function, and special flags.
DATA OUTPUT FORMAT: DC, AC, Ratio: same as front panel display with no leading zero suppression. Ohms: readout expressed as kΩ.
INPUT INFORMATION: Functions, ranges and filter.
COMMAND MODES: Direct Command, Timeout Command, Superfast.
ELECTRICAL COMPATIBILITY: IEEE Std 488-1975
INFORMATION FORMAT: 7-bit ASCII code
POWER REQUIREMENT: 20 Watts Maximum
LINE VOLTAGE: 100/120/220/240V ±10%, 48-440 Hz
WEIGHT: 3.2 kg (7 lbs.)
DIMENSIONS: 45 mm x 355 mm x 425 mm 1¾ in. x 14 in. x 16¾ in.)

2.1 UNPACKING AND INSPECTION.

2.2 The Model 5900 DMM is packed in a molded plastic-foam form within a cardboard carton for shipment. The plastic form holds the DMM securely in the carton and absorbs any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 Included with the instrument in the packing container are the instruction manual, power cord, and rear input and BCD output mating connectors. With instruments equipped with remote programming, a mating connector for that accessory is included.

2.4 BENCH OPERATION.

2.5 Each Model 5900 is equipped with a tilt bail or "kickstand" to enable the front of the instrument to be elevated for convenient bench use. The tilt bail is attached to the two front supporting "feet" at the bottom of the instrument. For use, the bail is pulled down to its supporting position.

2.6 RACK MOUNTING.

2.7 The instrument can be mounted in a standard 19-inch rack with the optional rack-mounting flanges (403402, includes attaching hardware). To install the flanges, proceed as follows:

a. With instrument on its side, remove four Phillips-head screws holding bottom cover. Remove cover. Remove screws holding feet (and bail) in place. Replace bottom cover.

b. Place one of the supplied screws through each of the two holes in the mounting flange (figure 2.1). Thread a securing nut onto each screw just enough to attach it to the screw (approximately one turn).

c. Place the mounting flange onto the mounting slot in the instrument side panel so that the securing nuts fit entirely into the slot. Be sure the rack-mount slots on the flange are toward the front of the instrument.

d. Tighten screws. The securing nuts will rotate and hold the flange securely in place.

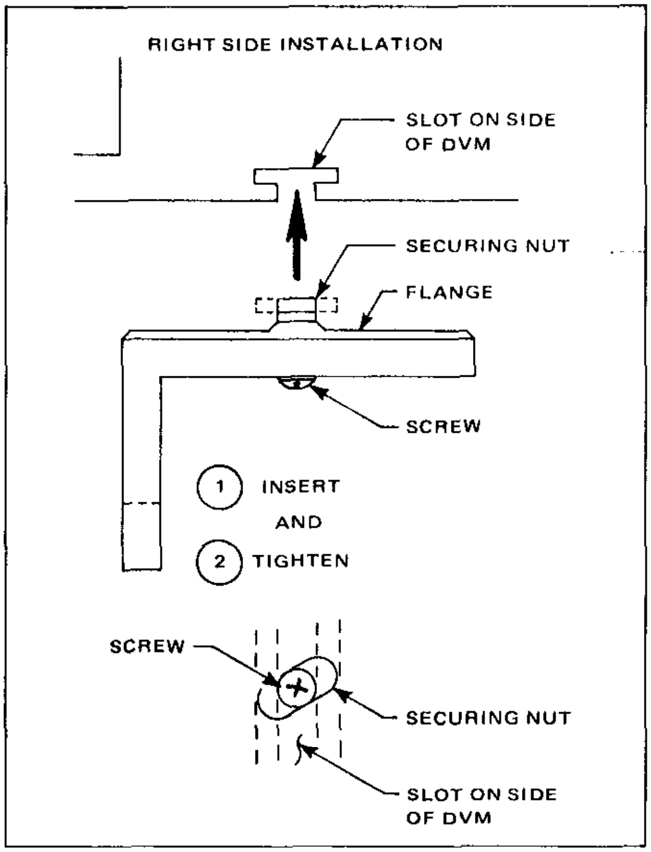


Figure 2.1 - Rack Mount Installation

2.8 POWER CONNECTIONS.

2.9 Standard units operate on either 115 volts or 230 volts, 50 to 60 Hz (400 Hz available). Power consumption is less than 40 watts. Operation on either of the two line voltages is selectable by a slide switch on the rear panel. Operation on 100/200 volts or 120/240 volts is possible by simple rewiring of the power transformer secondary wires:

WARNING

Disconnect the instrument from the AC Power source before attempting to change power connections. Potentially lethal voltages are exposed when covers are removed.

a. For operation on 100/200 volts, cut the brown wire 1" from the transformer and splice it to the red wire on the transformer; cut the blue wire 1" from the transformer and splice it to the violet wire.

b. For operation on 120/240 volts, cut the brown wire 1" from the transformer and splice it to the black wire; cut the blue wire and splice it to the yellow wire on the transformer.

2.10 A standard power cable having a three-pin plug is supplied with the instrument. It connects to POWER connector J203. The ground pin (round) is attached to the instrument case. It is important that this pin be connected to a good quality earth ground.

2.11 Fuse receptacle F201 on the rear panel is equipped with a .5 amp fuse in domestic units.

2.12 INPUT/OUTPUT CABLING.

2.13 Binding Posts.

2.14 Several connectors on the Model 5900 consist of a pair of binding posts spaced so as to accept standard "banana" plugs. The connectors are:

Front Panel	Rear Panel
± INPUT	± ANALOG OUTPUT
± OHMS CURRENT	± REFerence INput

2.15 Input cables to fit this type of connector can be ordered from Keithley (P/N 5900-402190). Figure 2.2 is a wiring diagram of this cable included for assistance to users desiring to construct their own cables.

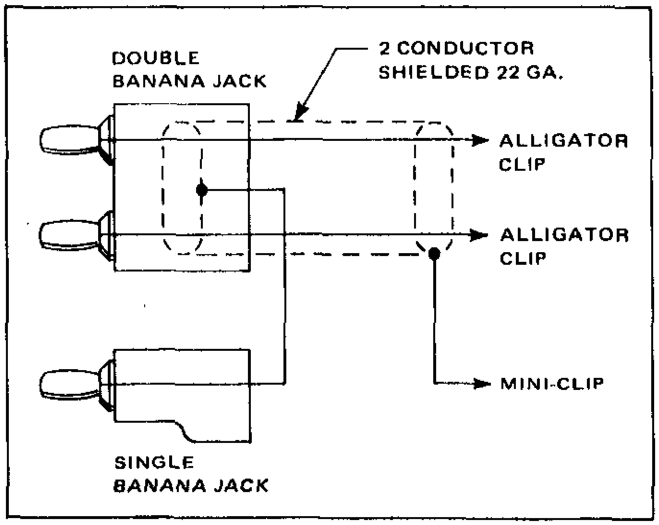


Figure 2.2 - Cabling Diagram, Binding Posts

2.16 Rear Input Connector.

2.17 Instruments equipped with the -1 or -1S rear input option are supplied with J204 7-pin input connector (Keithley P/N 5900-600673) and a mating connector (Keithley P/N 5900-600616). The instrument accepts inputs applied to this connector or inputs applied to the front-panel binding posts. The rear-panel input lines are wired in parallel with the front-panel input lines. It is recommended that the cable for the mating connector be constructed as shown in figure 2.3 using two two-conductor shielded cables. Other configurations may be desirable depending on the ohms measuring method to be used (see paragraph 2.28).

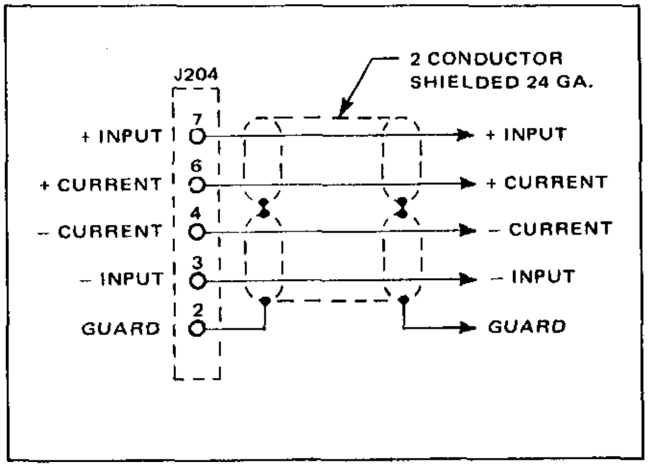


Figure 2.3 - Cabling Diagram, Rear Input

2.18 MANUAL OPERATION.

2.19 Controls.

2.20 All operating controls are located on the front panel of the instrument. They are shown in figure 2.5 and their operation described in table 2.1. Description of Systems operation begins in paragraph 2.44.

2.21 DISPLAY.

2.22 The display consists of 6 LED decimal readout devices with moving decimal point. The decimal point moves in conjunction with the range switch or automatically in auto range. Maximum usable readout with overrange is 159999. Overload is indicated by a NO and 160000 readout. A non-compatible range and function is indicated by a NO. However, mechanical interlocks are provided to prevent illegal combinations from the front panel. Figure 2.4 illustrates the readout, NO indicator, polarity sign and the annunciator.

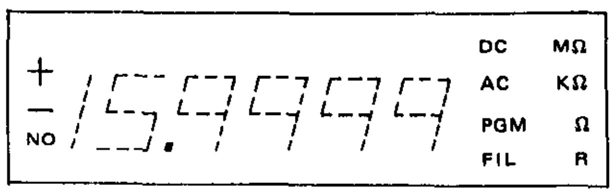


Figure 2.4 - Readout

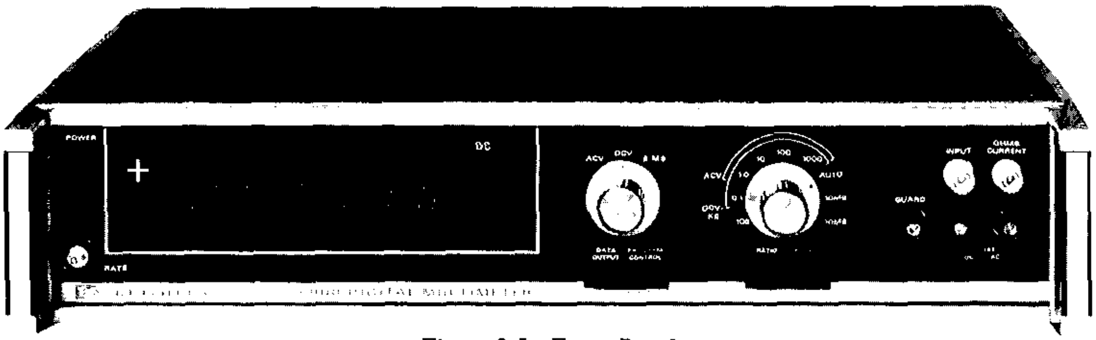


Figure 2.5 - Front Panel

Table 2.1 - Operating Controls

Control	Position	Function
Power (rocker switch)	ON (up)	Applies power to instrument
	OFF (down)	Removes power from instrument
Function Select (rotary switch)	AC†	Selects the measurement of AC voltages on the 1, 10, 100, and 1000 volt ranges (max. input, 1000V RMS)
	DC	Selects the measurement of DC voltages on the .1, 1, 10, 100, and 1000 volt ranges (max. input, 1100V)
	Ω-MΩ*	Selects the measurement of resistance on the 10 ohm range; on the .1, 1, 10, 100, and 1000 kilohms ranges; or on the 10 or 100 Megohm ranges
Range Select (rotary switch)	AUTO	Selects Auto Range in which the optimum range is selected automatically by internal circuits. Uprange occurs at 160% of full scale; downrange occurs at 15% of full scale
	Other Positions	Enables manual selection of fixed ranges. Ranges permissible for each function are inscribed on the panel
DATA OUTPUT (pushbutton)	Depressed	Enables the print pulse causing BCD data at P201 to be recorded by printer, or other output device. (Output data is present at P201 regardless of the position of this switch.)
PROGRAM CONTROL (pushbutton)	Depressed	Enables the selection of range, function, and mode to be made externally through the remote programming connector and disables all front panel controls (requires programming option)
RATIO (pushbutton)	Depressed	Selects a ratio measurement in which the readout represents the ratio of the input to an external d-c reference voltage (applied at terminals on the rear panel) multiplied by 10: $E_{in}/E_{Ref} \times 10$
FILTER (pushbutton)	Depressed	Adds an active four-pole filter across the input circuit
RATE (pot)	EXT (ccw)	Selects the Hold mode. A new reading is initiated through the remote program input
	CW	Increase periodic read rate to a maximum of four readings/second
FRONT/REAR (slide switch)	FRONT	Connects front panel data input terminals to instrument
	REAR	Connects rear panel data input terminals to instrument

*NOTE: Ohms input terminals are open in AC or DC function.

†NOTE: For inputs greater than 150V, Filter should be "IN".

2.23 MEASUREMENT CONNECTIONS.

NOTE

Before taking any measurements, refer to the list of maximum input voltages, table 2.2.

Table 2.2 - Maximum Input Voltage

CAUTION

Do not exceed the following maximum inputs:

DC	1100 VDC or 1000V RMS AC
AC	1000V RMS decreasing to 20V RMS at 1 MHz (see figure 2.7)
Ω	±500V peak between +I and –I (1000V RMS if in DC or AC function.)
RATIO	Input: same as function selected Reference: +10.5V, –0.5V
GUARD	Voltage between GUARD and – INPUT must not exceed 250 volts or damage to the instrument may result

2.24 Basic Voltage Measurement.

2.25 An ac or dc voltage measurement connection recommended to minimize the effects of noise requires a two-conductor shielded cable connected as shown in figure 2.6.

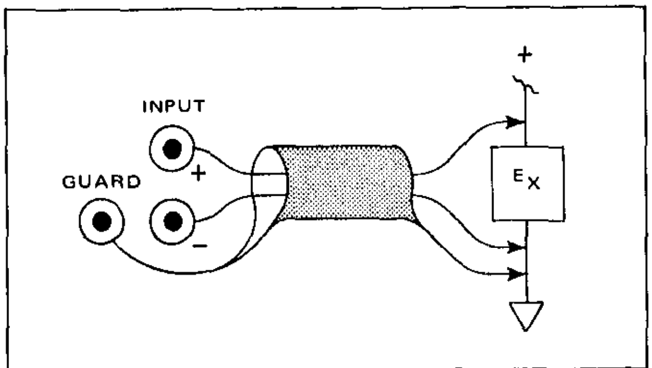


Figure 2.6 - Basic Voltage Measurement Connections

2.26 For all voltage measurements, the GUARD lead and the – INPUT lead are connected to the measurement point nearest ground potential. Somewhat less shielding is achieved by placing a shorting bar between – INPUT and GUARD and shorting the single banana plug (shield) to the – INPUT side of the double banana plug at the input connector. This arrangement is adequate for measuring all but low voltage (mV) levels and/or in high-noise environments.

2.27 When making "floating" voltage measurements (both measurement points above ground potential), do not connect GUARD to measurement ground without making sure that the voltage between GUARD and – INPUT does not exceed 250 volts.

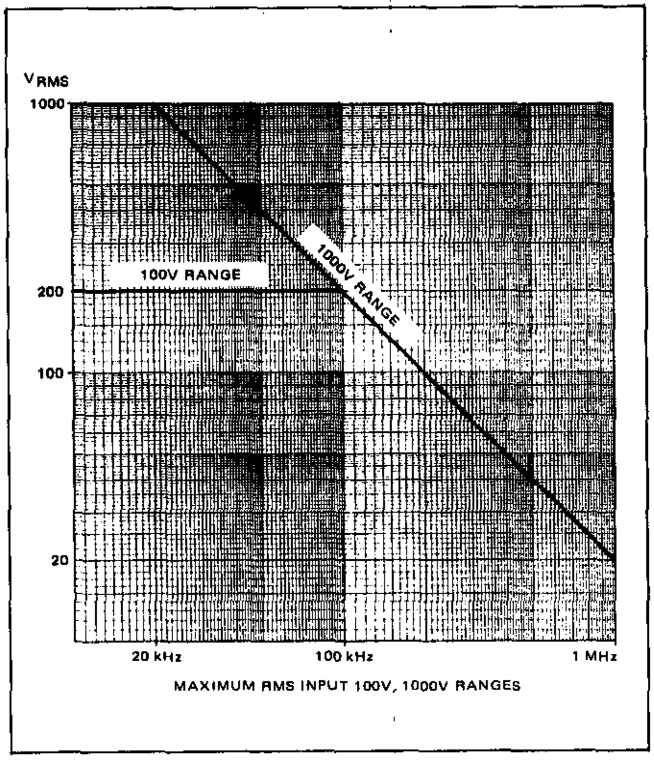


Figure 2.7 - Maximum RMS Input Voltage

2.28 Ohms Measurement.

2.29 Ohms measurement in the Model 5900 consists of the application of a known current through the unknown resistance (R_X) and measuring the ratio of the voltage drop across R_X to the drop across an internal "full-scale" resistor (E_{Rx}/E_{FS}). Current through R_X is applied through leads from the ± OHMS CURRENT terminals. The voltage drop is sensed by the ± INPUT terminals.

2.30 TWO-WIRE MEASUREMENTS.

2.31 Connections for a simple two-wire shielded ohms measurement are shown in figure 2.8a. It consists simply of a single-conductor shielded cable with the conductor serving as both the + CURRENT and + INPUT leads and the shield

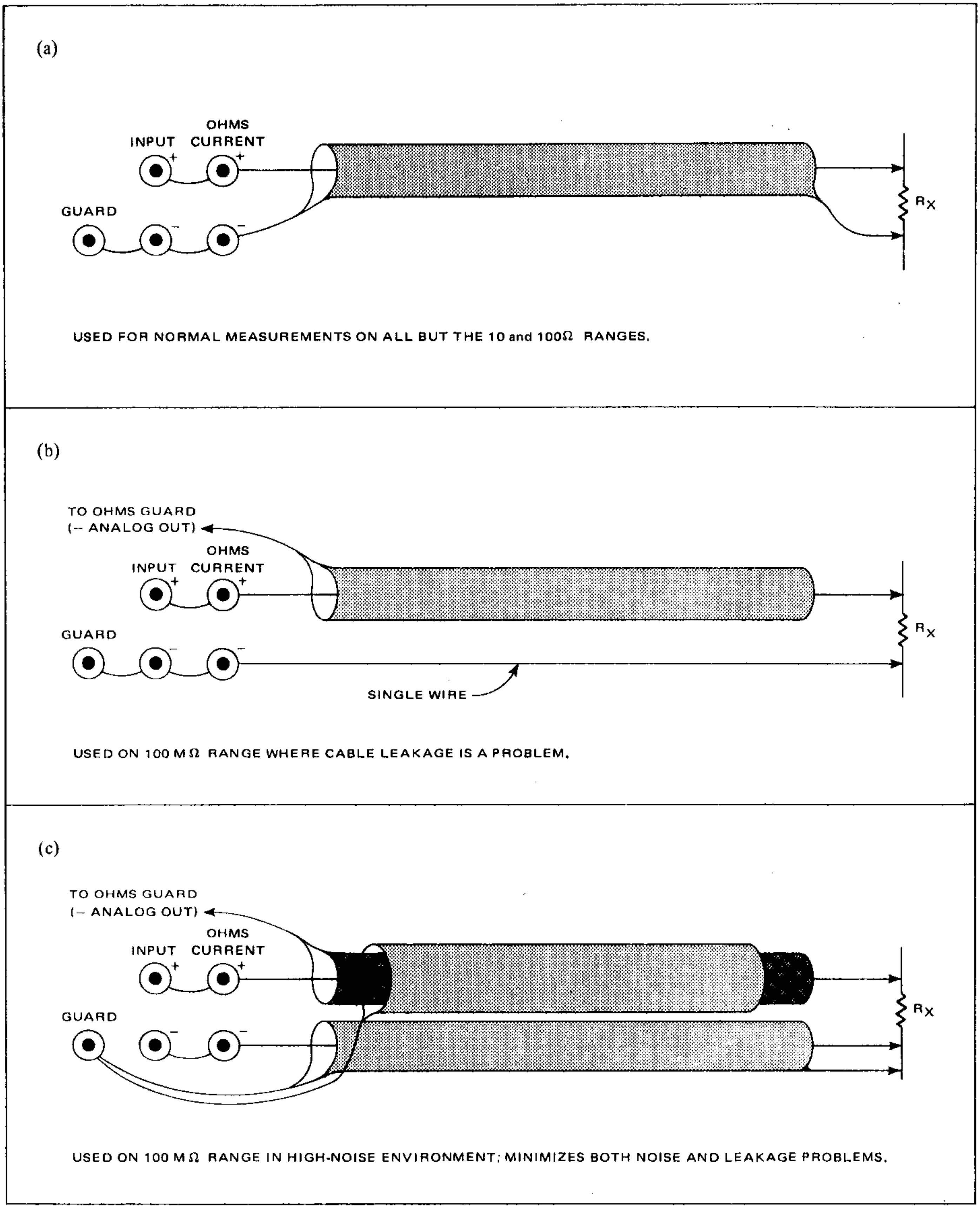


Figure 2.8 - Two Wire Ohms Measurements

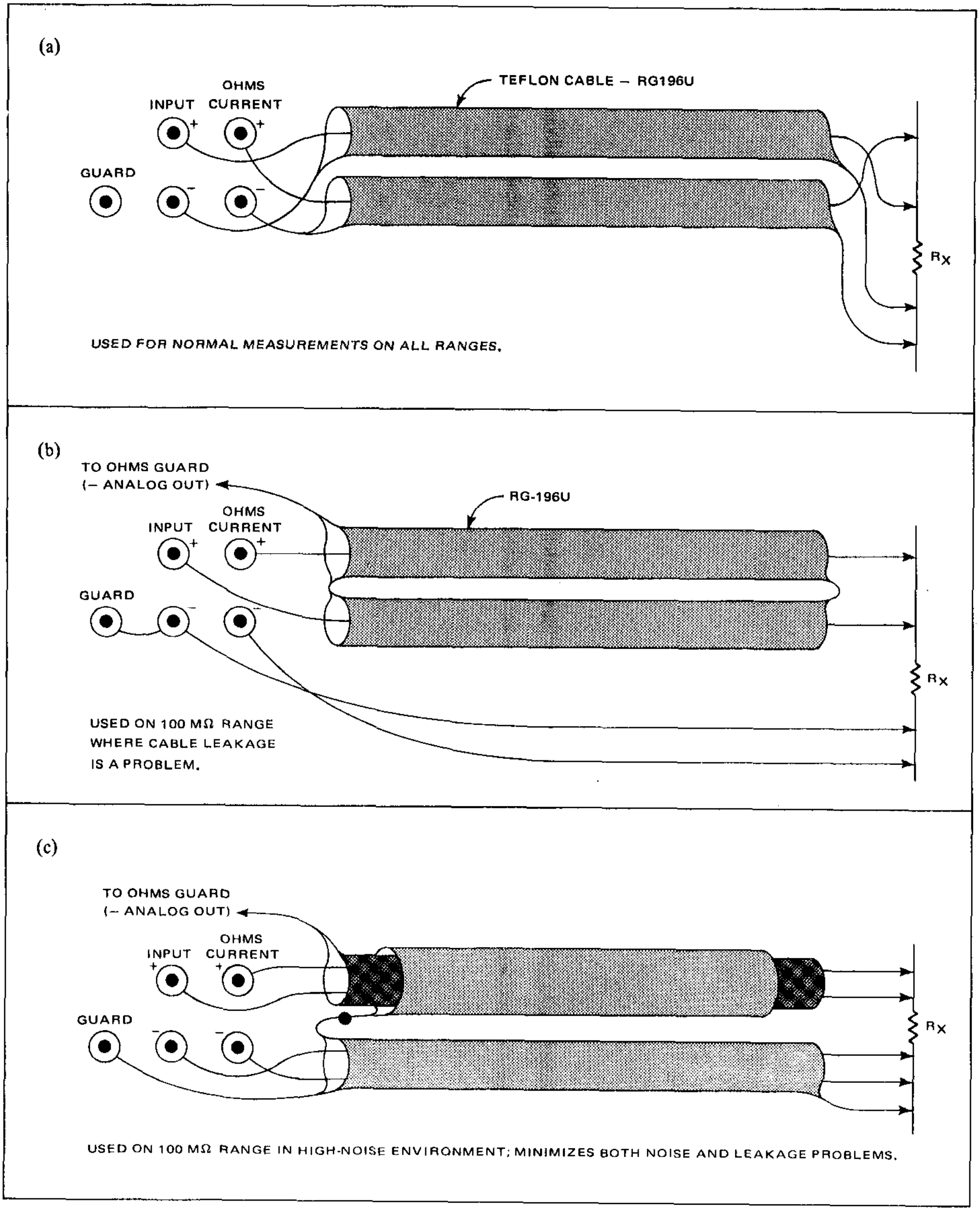


Figure 2.9 - Four Wire Ohms Measurement

carrying – CURRENT and – INPUT. While reasonably accurate measurements can be made with this method, shunt leakage problems result from the parallel combinations of R_X and the cable impedance. This causes loss of accuracy, especially at high resistance (100 MΩ range). Also, lead resistance becomes a factor in the 10 and 100 ohms ranges; the four wire measurement system is recommended for these ranges.

2.32 A more accurate two-wire measurement connection is shown in figure 2.8b. The + INPUT and + CURRENT, – INPUT and – CURRENT terminals are again tied together. But now, the positive side is a single-conductor, shielded cable with the shield tied to Ohms Guard. Ohms Guard is the low ANALOG OUTPUT terminal on the rear panel of the Model 5900 when ohms is selected. The negative side is a single wire connected as shown. Guard current is present in the low side, but the leakage problems of the first configuration are eliminated.

2.33 In high noise-level environments, the configuration shown in figure 2.8c is recommended. This method also eliminates error due to shunt leakage, but provides more complete shielding. The positive terminals are tied together and carried in a single-conductor, double-shielded cable with the inner shield tied to Ohms Guard (– ANALOG OUTPUT). The outer shield is tied to GUARD. The negative terminals are tied together and carried in a single-conductor shielded cable with the shield tied to GUARD. This configuration eliminates guard current sensitivity, thereby increasing guarding characteristics.

2.34 FOUR-WIRE MEASUREMENTS.

2.35 In most system applications, the device to be measured is located at a remote location requiring interconnection by cables of lengths from several to possibly hundreds of feet. When measuring low resistance values over long cables, most lead resistance problems can be solved by the use of a four-wire measurement system.

2.36 For high resistance measurements over long cables, other problems are encountered: noise pick-up, leakage resistance, and capacitive loading of the system. These problems can be minimized by proper shielding and the use of ohms guard.

2.37 Figure 2.9a shows a basic shielded four-wire ohms measurement configuration. This method uses two single-conductor shielded teflon cables. The conductors carry the positive sides of the INPUT and CURRENT lines while each shield carries the low side.

2.38 This configuration, although shielded, places the shield capacitance and cable leakage in parallel with R_X. This results in loss of accuracy and slow measurements. In addition, it is very responsive to the triboelectric effect at high resistance measurements.

2.39 Better guarding is achieved by the use of the configuration shown in figure 2.9b. Here again, RG196U teflon dielectric cable (either single-conductor shielded or two-conductor shielded) is used on the positive terminals. The shield(s) are connected to Ohms Guard (low ANALOG OUTPUT terminal). The negative leads are single wires with the – INPUT terminal tied to GUARD.

2.40 This eliminates much of the shunt leakage problem of the previous configuration since guard current now flows through the low side of the measurement circuit. Measurement is much faster since the shield capacity is driven by the guard current.

2.41 A high-noise environment calls for the "super" configuration shown in figure 2.9c. Here, a two-conductor, double-shielded cable is used as the positive leads. The inner shield is tied to Ohms Guard. A two-conductor shielded cable is used as the negative leads. Its shield is tied to GUARD and to the outer shield of the positive cable. The shield is also tied to – CURRENT at the measurement point. This configuration maintains high guarding characteristics while eliminating guard current sensitivity.

2.42 Ratio Measurements.

2.43 Ratio measurements are made by applying a positive d-c voltage to the reference input terminals on the rear panel and an input signal of any function at the front input terminals. For DC/DC or AC/DC ratios, the reference voltage must be within the range of +1V to +10.5V. Input signal limitations (numerator) are the same as those given for conventional measurement of the particular function (table 2.2). The readout is the ratio multiplied by ten: $E_{input}/E_{reference} \times 10$. In the standard instrument the – INPUT terminal is internally connected to the – REF input terminal; in instruments equipped with the option 62 4-wire ratio, both reference inputs are floating (10 MΩ between – REF and – SIGNAL).

2.44 SYSTEM CAPABILITIES.

2.45 The 5900 has two system interface connectors designated as J201 (PRINTER OUTPUT) and J202 (PROGRAM INPUT) mounted on the rear panel of the instrument (figure 2.10). The following is a brief description of the capabilities of each connector.

2.46 Printer Output - J201.

2.47 Through this connector the 5900 supplies BCD representations of the decimal display; various flags or indicators of the mode of operation, function and range; and a print command. Provision has also been made for 60 Hz instruments to accept a fast (20 readings per second maximum) or a superfast (101 readings per second minimum) read command. In 50 Hz units, the fast command obtains 17 readings per second, minimum, and the superfast command 93 readings per second.

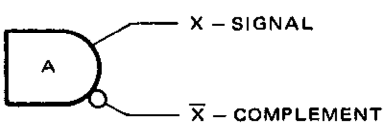
2.48 Program Input.

2.49 Through this connector the 5900 receives externally generated signals that select the function, range, mode of operation, and initiate the read commands.

2.50 LOGIC LEVELS AND ELECTRONIC INTERFACE.

2.51 TTL-compatible positive-true logic levels are used in the 5900. In some instances, however, complementary signals are used. These terms are more specifically defined below:

Signals and Their Complements –



WHERE:

X	$\overline{X}$
1	0
0	1

2.52 If the non-inverting output of gate A is defined as signal X, then it follows that the inverting output is $\overline{X}$; in other words, the complement of X is $\overline{X}$. The truth table shows that the two signals X and $\overline{X}$, are by definition, in opposite logic states (see table 2.3).

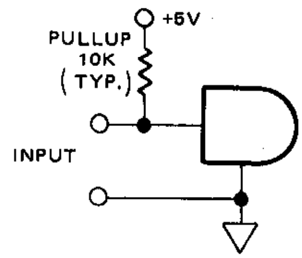
Table 2.3 - Positive True Logic Relationships

Signal	Logic State	Voltage Level of Output Line "X"	Voltage Level of Output Line "$\overline{X}$"
"X"	True or "1"	2.4 - 5.0 Volts	0.0 - 0.4
	False or "0"	0.0 - 0.4 Volts	2.4 - 5.0

2.53 As seen above, if gate A has a true or "1" level on output X, its voltage level is the most positive of the two ranges present, and output $\overline{X}$ must be in a false or "0" state with the lowest or most negative voltage range present. The reverse would be true for a false or "0" level on output X.

2.54 Driving the Inputs.

2.55 All inputs are TTL compatible and most are the equivalent of one 7400 series TTL input with a pull-up resistor for contact closure operation.



2.56 TTL Loading Conditions.

2.57 To input a "1" level the pull-up resistor will supply the necessary source current (40 μA) to maintain the minimum 2.4 volts. In fact, the pull-up resistor will maintain a

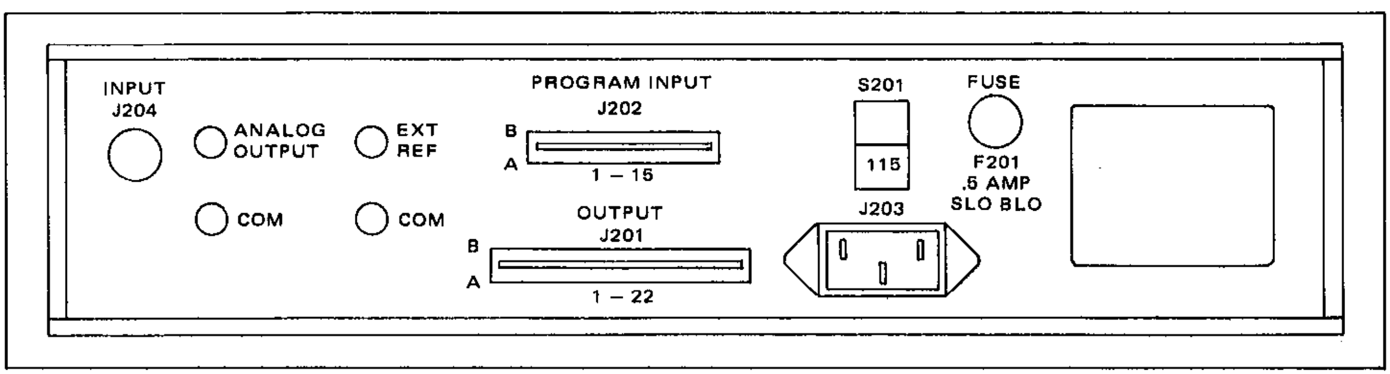


Figure 2.10 - Rear Panel

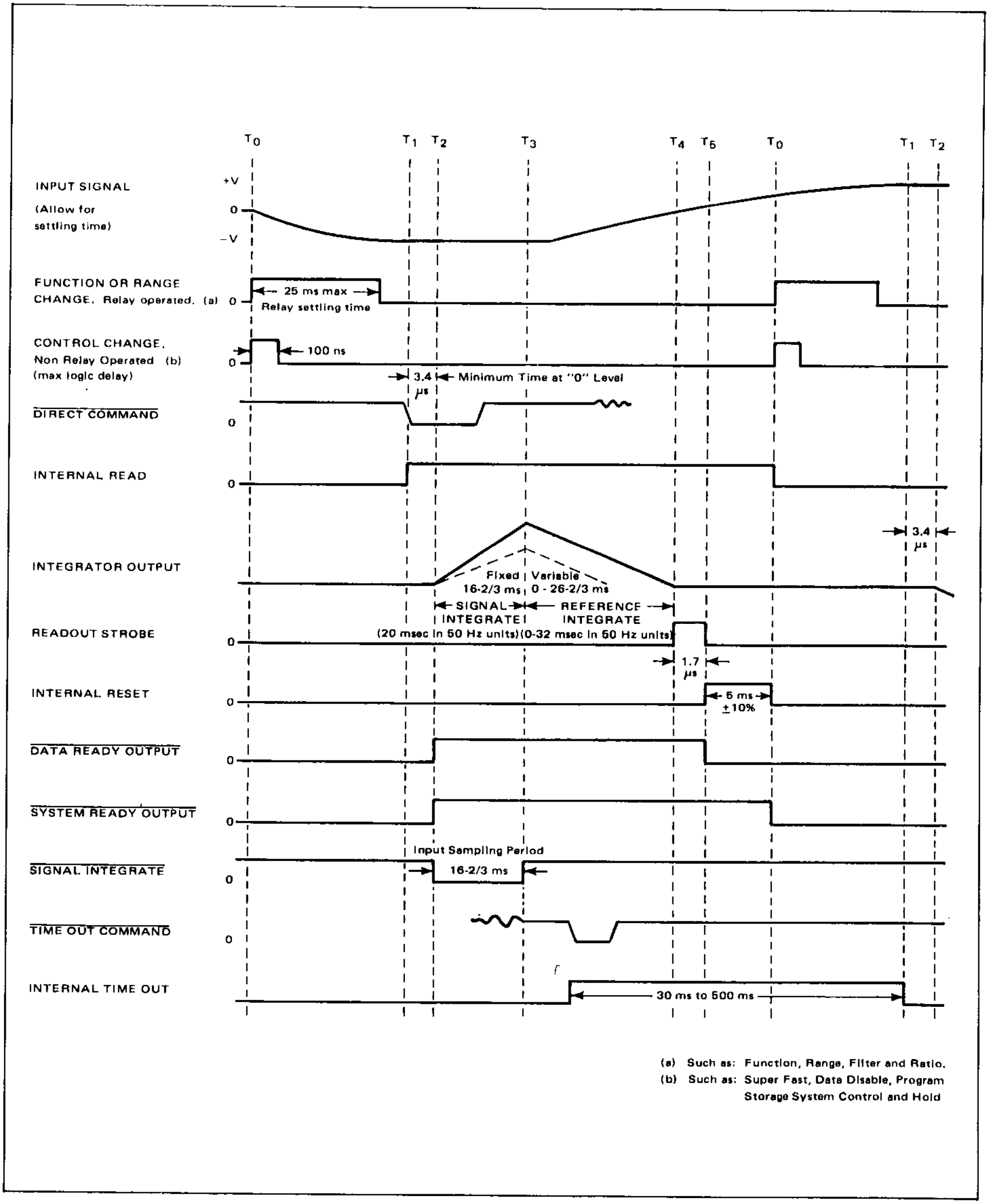
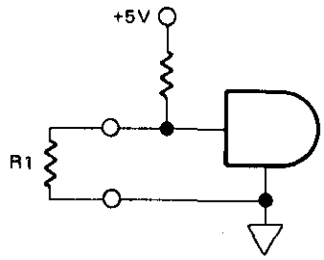


Figure 2.11 - Measurement Sequence

one level as long as the input source resistance (R1) to ground is greater than 15K ohms.



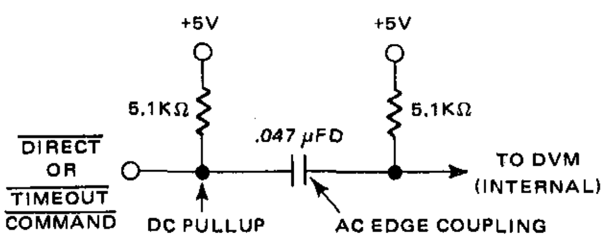
2.58 To input a "0" level, at least 2.0 ma of current must be sinked maintaining the input voltage below 0.4 volts. This requires a resistance to ground of 200 ohms or less.

2.59 Exceptions to Input Loading Conditions.

a. Program Storage Input (J202, pin B-15) is the equivalent of 3 TTL inputs and requires a minimum 5.8 ma sinking current, or 68 ohms or less to common.

b. Maximum input voltage level, referenced to common, must not exceed 5.5 volts peak. Otherwise, gate destruction will occur.

c. The Direct and Time Out Commands are AC coupled with pull-up resistors to +5 volts. These inputs are compatible with TTL outputs or contact closures to ground. The AC coupling does require that rise and fall times be less than 100 μseconds. This input circuit is illustrated below:



d. Digital output common can be floated as high as 200 VDC above power line ground.

2.60 TTL Output Capabilities.

2.61 The 5900 electrical outputs are specified to drive two TTL inputs such as described in the TTL loading section. Summary:

False: 0 to +0.4V
True: +2.4 to +5.0V
Fan out: 2 minimum
Maximum Capacitance Load: 500 pF

2.62 Timing Sequence.

2.63 The standard remote mode of operation of the 5900 is to initiate a reading sequence with each Direct Command *received through the programmer, providing that sufficient* time has been allowed between commands for the reading to be completed. This reading sequence is illustrated in figure 2.11.

$T_1 - T_0$ During this period the input signal must finish settling to within the desired accuracy. Any control changes involving the 25 msec relay settling time (a) can be completed; other logic control inputs (b) can also be changed.

$T_2 - T_1$ The Direct Command signal, which is AC coupled, must meet the following conditions:

a. Rise and fall times less than 100 μsec.

b. *Signal must stay in the logical "0"* state for at least 3.4 μsec. If these conditions are met, the internal read command is sustained at T_2 and the signal integrate period is started.

$T_3 - T_2$ The period of signal integration lasts for 16-2/3 msec (60 Hz line frequency; 20 msec in 50 Hz units). During this time the integrator charges to a voltage proportional to the input voltage. This is the input sampling period.

$T_4 - T_3$ During this period, the integrator is isolated from the input signal, and is discharged at a precise current. The time the integrator requires to discharge to a level equal to its voltage at T_2 is proportional to the input voltage. This time is measured by an internal counter and stored.

$T_5 - T_4$ This 1.7 μsec period is required to strobe the new reading from the internal counter into the readout latches.

$T_0 - T_5$ This 5 mseconds (±10%) is required to reset the internal logic for the next reading.

$T_1 - T_0$ If the next read command is a Direct Command, this period must be made long enough to allow for the condition covered in the first cycle; however, if the next command is a Timeout Command, this period can approach zero since the necessary timeout to *satisfy these conditions are automatically* programmed.

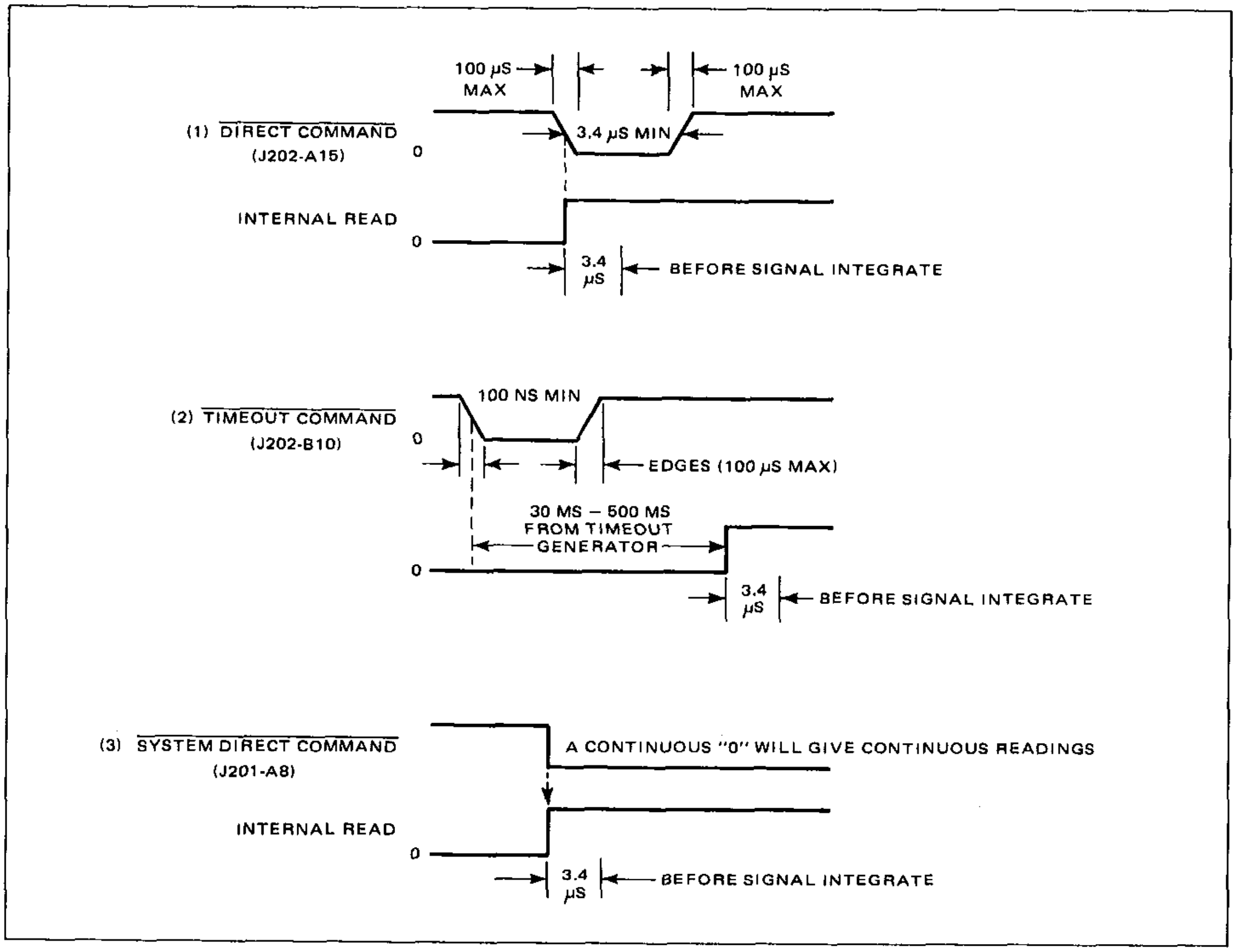


Figure 2.12 - Command Timing

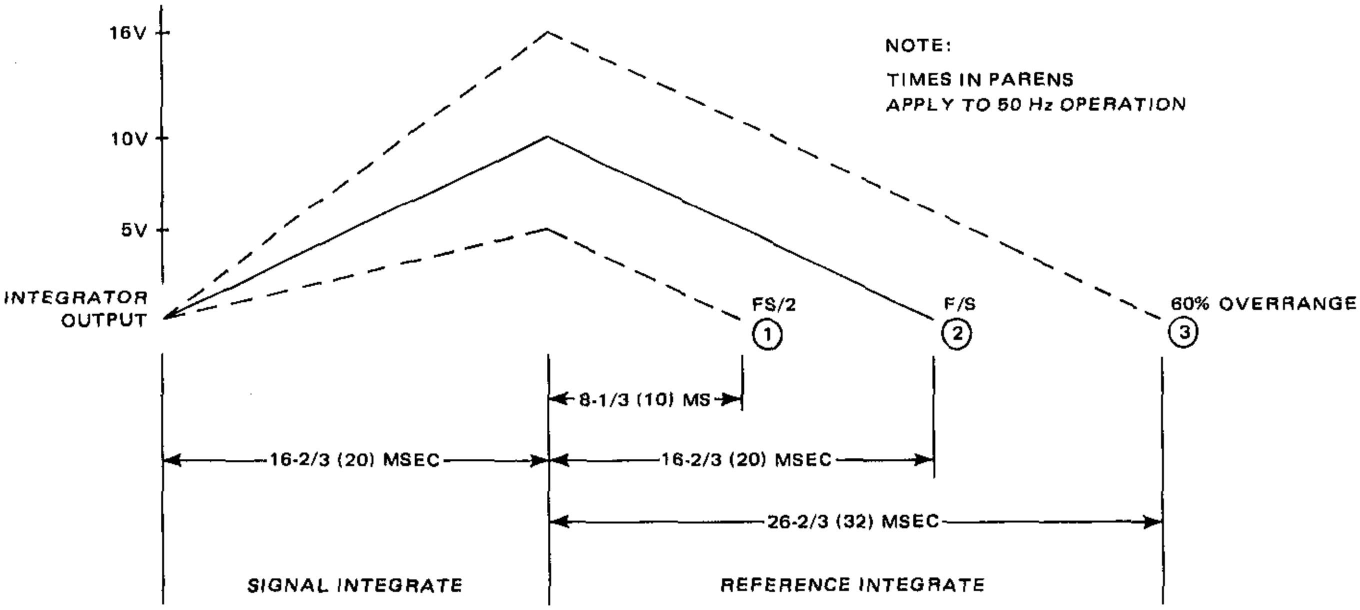
2.64 Other Read Command Options.

2.65 In addition to the Direct Command, there are two other programmable read commands, as illustrated in figure 2.12.

a. Time Out Command: Again, this is an AC coupled input which must have rise and fall times of less than 100 μseconds but must remain in a "0" state for at least 0.1 μsecond. The timeouts given in table 2.7 for various combinations of ranges and functions ranging from 30 mseconds to 500 mseconds will be automatically inserted before the internal read command is generated. If this command is wired to the Data Ready Output on J201 - pin A11, fully automatic reading with timeouts is achieved.

> **NOTE**
>
> The 5 msec internal delay is not adequate for settling time on the 100 VDC, 1000 KΩ, 10 MΩ, 100 MΩ ranges, or any AC range. Therefore, the timeout command, providing timeout delays listed in table 2.7, must be used to initiate accurate readings on these ranges unless a fixed range and function have been programmed and the input has been present longer than the timeout period.

b. System Direct Command: While the other two read commands were AC coupled and programmed through the Program Input Connector (J202), this command is DC coupled and programmed through



MINIMUM READ RATES CORRESPONDING TO INTEGRATION PERIODS (ABOVE).

① V_{IN} = 5 VOLTS (HALF SCALE ON 10V RANGE)

50 Hz: $$\frac{1000}{20\text{ MS} + 10\text{ MS} + 5.5\text{ MSEC}} = 28.2\text{ READINGS/SEC}$$

60 Hz: $$\frac{1000}{16\text{-}2/3\text{ MS} + 8\text{-}1/3\text{ MS} + 5.5\text{ MS}} = 32.8\text{ READINGS/SEC}$$

② V_{IN} = 10V (FULL SCALE ON 10V RANGE)

50 Hz: $$\frac{1000}{20\text{ MS} + 20\text{ MS} + 5.5\text{ MS}} = 22.0\text{ READINGS/SEC}$$

60 Hz: $$\frac{1000}{16\text{-}2/3\text{ MS} + 16\text{-}2/3\text{ MS} + 5.5\text{ MS}} = 25.7\text{ READINGS/SEC}$$

③ V_{IN} = 16V (FULL SCALE & MAX. OVERRANGE) ON 10V RANGE:

50 Hz: $$\frac{1000}{20\text{ MS} + 32\text{ MS} + 5.5\text{ MS}} = 17.4\text{ READINGS/SEC}$$

60 Hz: $$\frac{1000}{16\text{-}2/3\text{ MS} + 26\text{-}2/3\text{ MS} + 5.5\text{ MS}} = 20.5\text{ READINGS/SEC}$$

Figure 2.13 - Minimum Read Rate vs. Input

the Printer Output Connector (J201). The System Direct Command must remain in the "0" state for at least 3.4 μseconds to generate the internal read command. This delay, as in the Direct Command, is to prevent noise from triggering the readings. If this command is tied to ground, the 5900 will recycle at its maximum reading rate with no timeouts.

2.66 Reading Rates.

2.67 In figure 2.13, integrator operation with three different input signal levels is illustrated: half scale, full scale, and 160% of full scale (full scale is defined as 100000 on any range). The figure shows that the maximum reading rate is a function of the input signal. The signal integrate period and internal reset remain fixed while the reference integrate period can vary from 0 to 32 mseconds. Therefore the maximum read rate could vary from 17.4 to 45 reading per second.

2.68 Superfast.

2.69 The Superfast reading mode (programmed through either the PRINTER OUT or PROGRAM INPUT connector)

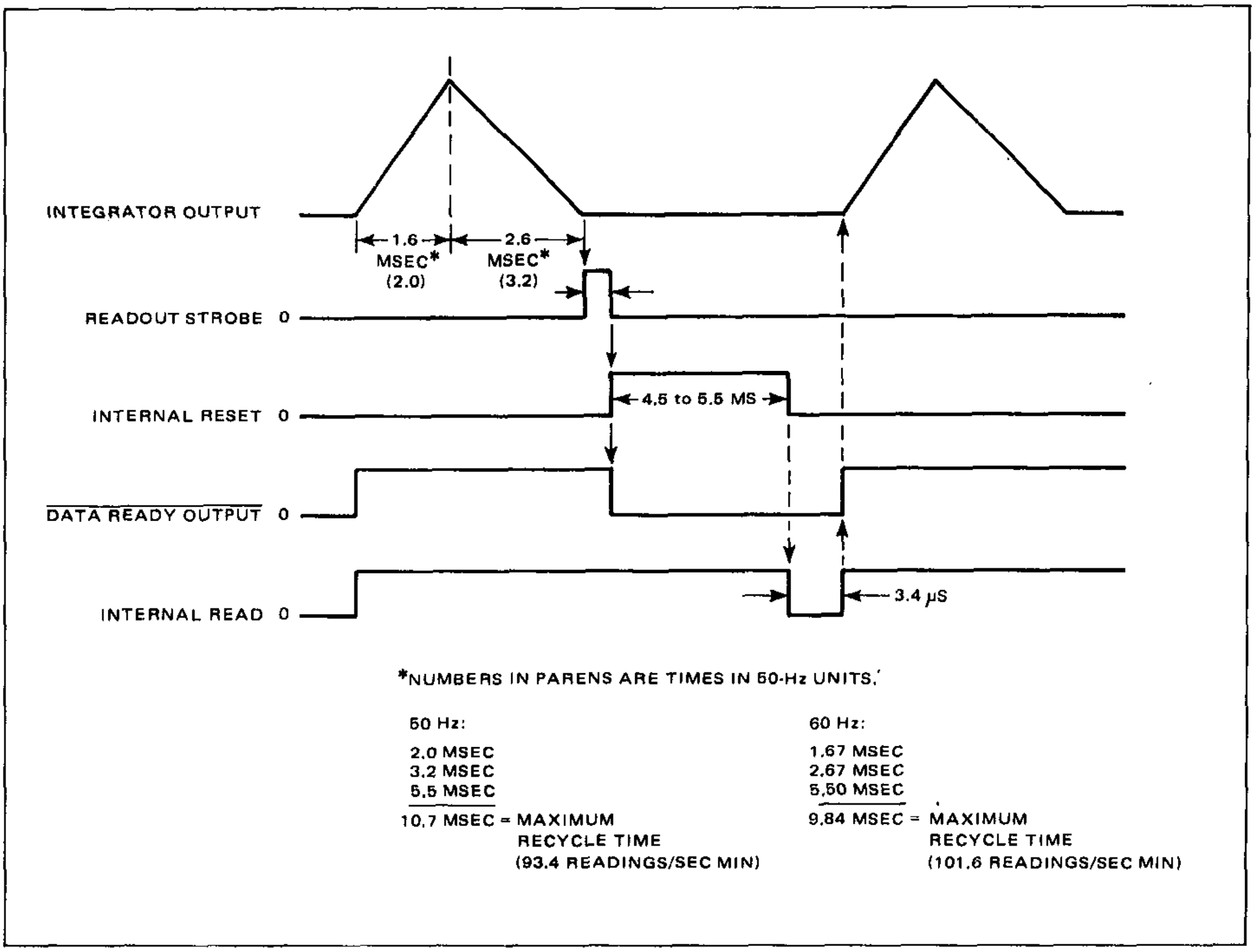


Figure 2.14 - Superfast Read Rate (Worst Case)

increases the minimum reading rate from 20.5 to 102 readings per second (50 Hz: 17.4 to 93 r/s). This is done at the expense of losing the least-significant digit which is reset to zero (blanked out on readout). The signal integration period is reduced from 16-2/3 msec to 1-2/3 msec (50 Hz: 20 msec to 2 msec). This and the resulting reference integrate period reduce the maximum recycle time from 48.8 msec to 9.8 msec (50 Hz: 57.5 msec to 10.7 msec), thereby yielding the 107 reading per second figure (93 r/s with 50 Hz). Timing changes are shown in figure 2.14.

2.70 PRINTER OUTPUT.

2.71 The printer output connector is a double-edged PCB connector (extension of Interconnection and Logic board) with pins A1 through A22 on the bottom edge and pins B1 through B22 on the top edge. Pin assignments are shown in figure 2.15. All outputs are referenced to digital ground pin B1.

2.72 Numerical Data

2.73 Numerical data appears as positive true, four-line BCD code, as shown in figure 2.15. The designator of each line identifies the digit and weight. For example: Pins A18, 19, 20, and 21 are designated 1_2, 1_8, 1_4, and 1, consecutively. The 1 indicates these lines correspond to the units or least significant display; the 2, 8, 4, and 1 subscripts indicate the binary weight of each line.

CAUTION

True output lines are not short-circuit proof. Accidental grounding may damage the output circuitry.

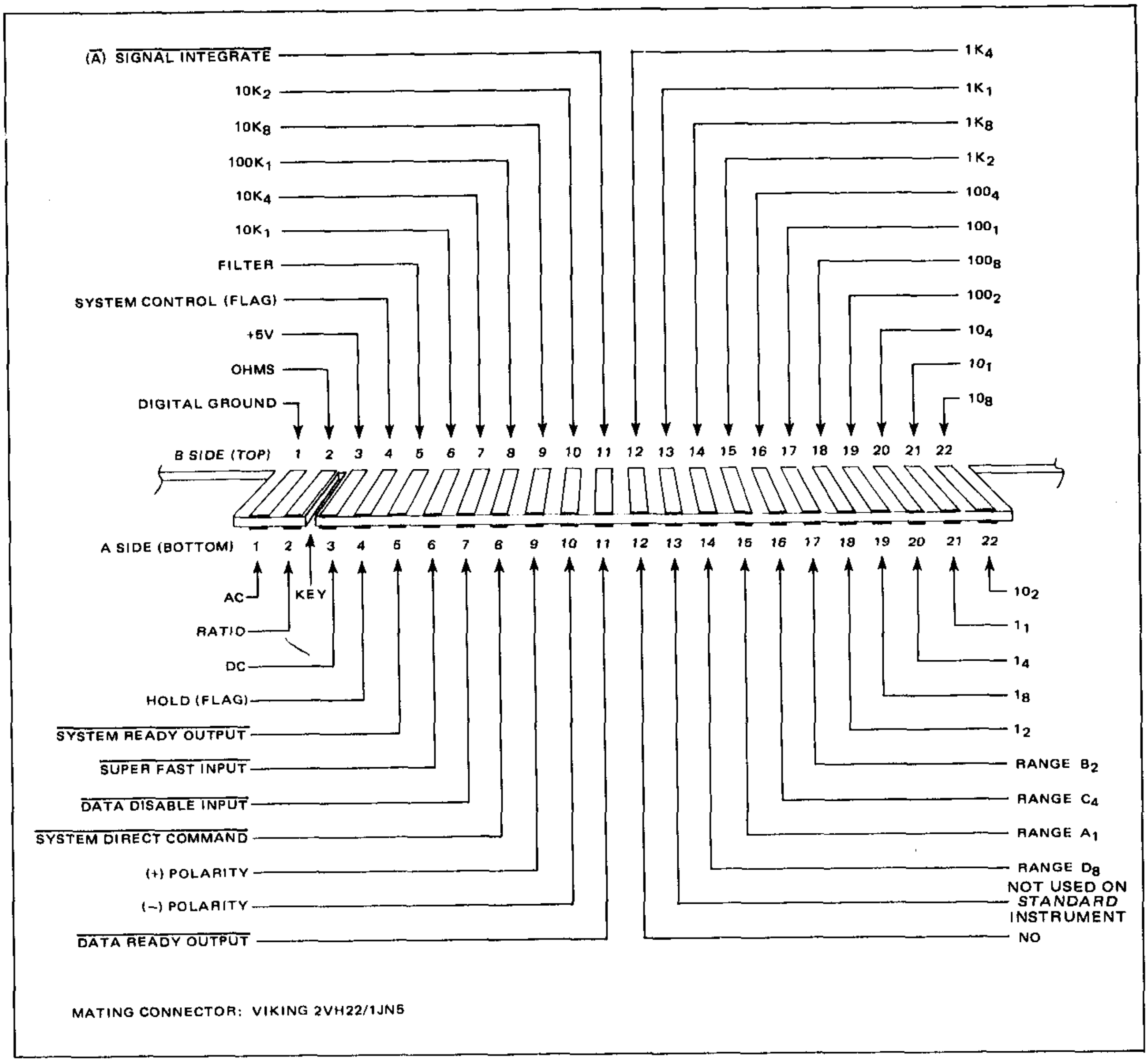


Figure 2.15 - Pin Assignments J201 PRINTER OUT

2.74 Polarity is indicated in positive true format on pin A9 (positive) and pin A10 (negative). The positive polarity line is true when the function output is AC or .1K through 1K OHMS ranges. Negative polarity is true with Ohms on the 10K through 100M ranges. If the instrument overranges, the polarity bit is not updated since no axis-crossing has occurred.

2.75 Function Data.

2.76 Function outputs appear on pins A1, 2, 3 and B2 in their true format. For example: with AC function selected, AC is true and is indicated by a true level on the corresponding line.

2.77 Range Data.

2.78 Range data appears in four-line BCD code on pins A14 through A17. Range codes are described in table 2.4.

2.79 "NO" Indication.

2.80 The NO line (pin A12) is the same as the NO indicator on the readout. The line is true if a function

Table 2.4 - Range Codes (Printer Output)

Range	A (Pin A15)	B (Pin A17)	C (Pin A16)	D (Pin A14)	Dec Value
10Ω	0	1	0	0	2
0.1V 0.1 KΩ	1	1	0	0	3
1V 1 KΩ	0	0	1	0	4
10V 10 KΩ	1	0	1	0	5
100V 100 KΩ	0	1	1	0	6
1000V 1000 KΩ	1	1	1	0	7
10 MegΩ	0	0	0	1	8
100 MegΩ	1	0	0	1	9

or range is selected for which the particular instrument is not equipped. Overrange is indicated by a true NO line plus a numerical data output of 160000.

2.81 Status Output Lines.

2.82 The following outputs indicate the status of the conversion process within the instrument.

a. DATA READY. This line (pin A11) remains true during the signal and reference integration periods plus any overrange time, if required. The line drops to the false level to indicate to the printer that the measurement is complete and output data can be printed (Printer Command). With front-panel operation, DATA READY is enabled only when the DATA OUTPUT switch (on front panel) is depressed. Minimum false level time is 4.5 mseconds.

b. HOLD FLAG. A true level on this line (pin A4) indicates that the instrument is in the Hold mode. A reading can be initiated by one of the following commands:

1. SYSTEM DIRECT COMMAND (J201-A8)

2. DIRECT COMMAND (J202-A15)

3. TIMEOUT COMMAND (J202-B10)

4. RATE Control (front panel)

c. SYSTEM READY. This line (pin A5) drops to a false level to indicate that the instrument can now initiate a new reading at the first available read command.

d. SIGNAL INTEGRATE. This line (pin B11) becomes true at the end of the signal integration period. After this time, the input signals may be changed in preparation for the next reading. The input signal need remain constant only while the instrument is in Signal Integrate, indicated by this line in the false state. For example, the 1-2/3 msec sample time in Superfast could be used in slow sample and hold applications.

2.83 Input Control Lines.

a. DATA DISABLE. A contact closure to ground or a false logic level applied to this line (pin A7) inhibits the DATA READY output (Print) pulse.

b. SYSTEM CONTROL. A contact closure to ground or a false logic level on this line (pin B6) disables all front panel operating controls. Operation of the instrument is then under control of the Remote Program input. This command duplicates operation of the PROGRAM CONTROL switch on the front panel. It is necessary that one of these commands be initiated during Autorange to inhibit extra DATA READY pulses.

c. SUPERFAST. A contact closure to ground or a false logic level applied to this line (J201-A6 or J202-A7) decreases the conversion time of the instrument while sacrificing the least-significant digit. This mode is described in paragraph 2.68. Because of the superfast read rate, do not use this mode with Autorange.

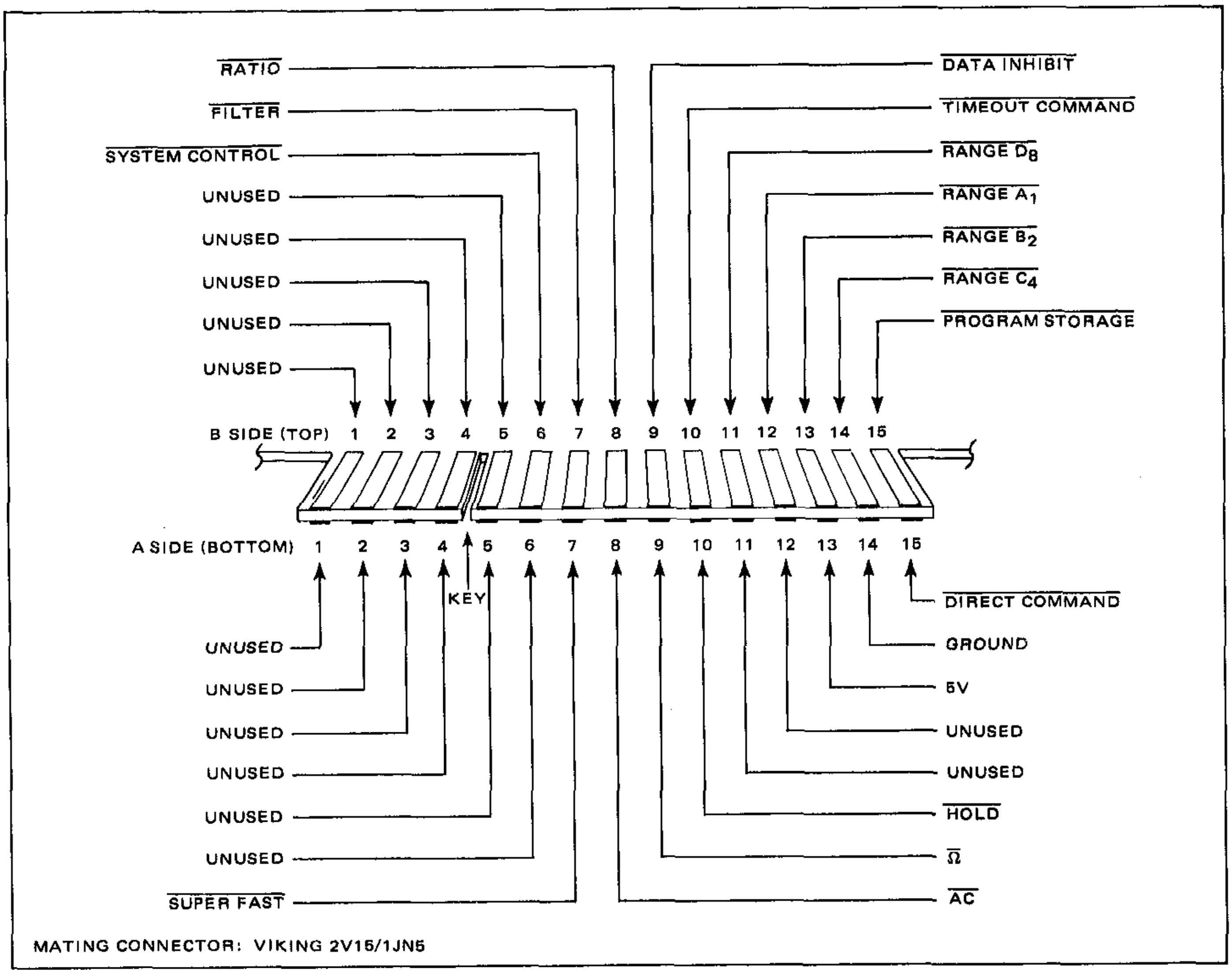


Figure 2.16 - Pin Assignments J202 PROGRAM INPUT

2.84 SYSTEM DIRECT COMMAND.

2.85 To externally initiate a measurement with this command, the instrument must be in the Hold mode. Then, a contact closure to ground or a false logic level to this line (pin A8) generates a read command. Minimum false level time is 3.4 μsec. Continuous readings at the maximum read rate are obtained by tying this line to ground. Read commands delayed by 5 msec ± 10% (for settling time) are then generated automatically.

2.86 REMOTE PROGRAMMING.

2.87 The instrument accepts commands made through PROGRAM INPUT connector J202 on the rear panel. Pin assignments of J202 are shown in figure 2.16. Commands are made by a switch closure from the appropriate pin to ground or by standard TTL logic levels as described earlier.

2.88 SYSTEM CONTROL.

2.89 A contact closure to ground or a false logic level applied to pin B6 disables all front panel operating controls. Operation of the instrument is then under control of the remote program input. This line duplicates the PROGRAM CONTROL switch on the front panel.

2.90 Function Programming.

2.91 The desired function is selected by applying a ground or false logic level to the appropriate pin (table 2.5).

Table 2.5 - Function Programming

$\overline{\text{DC}}$	NC
$\overline{\text{AC}}$	pin A8
$\overline{\text{OHMS}}$	pin A9
$\overline{\text{RATIO}}$	pin B8
$\overline{\text{FILTER}}$	pin B7

2.92 The 5 msecond internal delay is not adequate for settling time on the 100 VDC, 1000 Kilohm, 10 Megohm, 100 Megohm, and all AC ranges. Therefore, the timeout command, providing timeout delays listed in table 2.7, must be used to initiate readings on these ranges unless the input is fixed with range and function predetermined.

2.93 Range Programming.

2.94 Range programming is selected by applying false logic levels in BCD code to the four range lines described in table 2.6 below. With no lines programmed, Autorange is automatically selected.

2.95 + Five Volts.

2.96 This voltage, +5 volts ± 5%, from the logic power supply is available at pin A13 for external use. Current output is .1A, maximum.

2.97 Hold.

2.98 The Hold line parallels the operation of the ccw position of the front panel RATE potentiometer and is selected by a contact closure or a false logic level on pin A10. Hold is required when using either of the two read commands.

2.99 Read Commands.

2.100 Either of two read command lines can be selected by a contact closure to ground or by a negative logic level applied to the appropriate pin. Pin A15, $\overline{\text{DIRECT COMMAND}}$, commands a new measurement if applied after a five millisecond reset delay, and if the command is present for 3.4 μseconds. Pin B10, $\overline{\text{TIMEOUT COMMAND}}$, starts a new measurement after five milliseconds plus a timeout delay to allow for internal settling time of the measured signal. $\overline{\text{TIMEOUT COMMAND}}$ may be commanded before the previous 5 msec delay since the timeout generator stores the reading.

2.101 Timeouts.

2.102 Timeout periods for each function are listed in table 2.7. In Autorange, the indicated delays are taken following each range change.

2.103 Data Inhibit.

2.104 A contact closure or false logic level on pin B9 inhibits $\overline{\text{DATA READY OUTPUT}}$ (Print pulse) from being generated.

2.105 Program Storage.

2.106 A false level (equivalent to three TTL inputs) on pin B15 will store all the programmed inputs except the Direct and Timeout commands as they existed on the negative edge of this command (see diagram below).

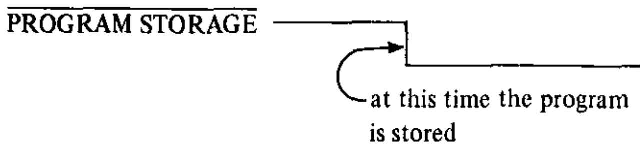


Table 2.6 - Range Codes (Programmer)

Range	$\overline{\text{A}}$ (Pin B12)	$\overline{\text{B}}$ (Pin B13)	$\overline{\text{C}}$ (Pin B14)	$\overline{\text{D}}$ (Pin B11)	Dec Value
AUTO	1	1	1	1	0
10Ω	1	0	1	1	2
0.1V 0.1 KΩ	0	0	1	1	3
1V 1 KΩ	1	1	0	1	4
10V 10 KΩ	0	1	0	1	5
100V 100 KΩ	1	0	0	1	6
1000V 1000 KΩ	0	0	0	1	7
10 MegΩ	1	1	1	0	8
100 MegΩ	0	1	1	0	9

2.107 SUPERFAST.

2.108 A contact closure to ground or a false logic level applied to pin A7 decreases the signal integrate and the reference integrate times (see paragraph 2.68). This provides the maximum reading rate in the Direct COMMAND mode of operation. Because of the high reading rate, Superfast must be programmed with a fixed range rather than AUTORANGE.

Table 2.7 - Timeouts

DC	30 msec
1 Ohm to 1 Megohm	30 msec
10 Meg*	30 msec
100 Megohm	300 msec
Filter	470 msec (plus function timeout)
AC(fixed range, no filter)	180 msec
AC+Filter(&Autorange)	650 msec
*Use filter for <.01% error	

Table 2.8 - Maximum Input Voltage

CAUTION Do not exceed the following maximum inputs.	
DC	1000 VDC or RMS AC All ranges
AC	1000 RMS to 20 kHz decreasing 20 dB/ decade to 20V RMS at 1 MHz
RATIO	Input: same as function selected Reference: +10.5V, −0.5V
OHMS	±500V DC or Peak AC
GUARD	Voltage between GUARD AND − INPUT must not exceed 250 volts or damage to the instrument may result

2.109 ADDING/REMOVING ACCESSORIES.

2.110 The AC and Ohms options may be added or removed at any time in the field without modification to the basic instrument. Note that the switching board (403625) is required whenever the plug-in options are used. Access to the mounting connectors is by removal of the top cover, held down by captive screws in each of the four corners, and by removal of the shield, mounted by four flat head screws.

2.111 When an option is added or removed from the instrument, a jumper corresponding to the option is removed or added to allow proper operation of the NO circuitry. The two jumpers (W1 Ohms and W2 AC) are located on the display board, shown partially in figure 2.17. When an option is added, the corresponding jumper is added; conversely, when an accessory is removed, the jumper is removed.

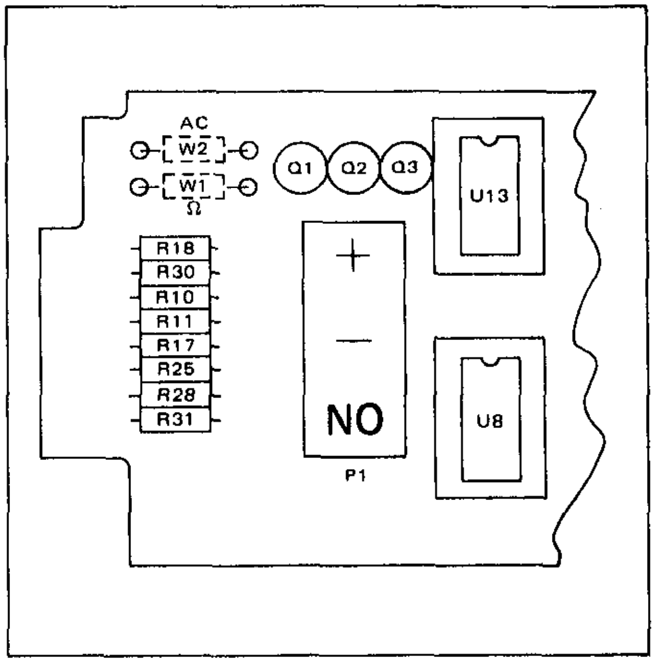


Figure 2.17 - Jumper Location

3.1 GENERAL.

3.2 This section contains procedures that compare the operation of the instrument against the published specifications found at the front of this manual. It is intended to be used for incoming inspection and as a periodic check to determine if recalibration of the instrument is warranted.

3.3 The procedures provide sufficient checks to verify proper operation and that the instrument is within the 90 day accuracy limits. Covers of the instrument are not removed for any of the tests. The required ambient temperature of the environment is $23^{o} \pm 5^{o}C$.

3.4 REQUIRED EQUIPMENT.

3.5 In Table 3.1 is a list of equipment necessary for checking the instrument. The equipment in this table, with the exception of those in the OTHER category, is the same as required for recalibration and is explained in detail in Section 5.

3.6 PROCEDURE.

3.7 Allow one hour for warmup. Convert the instrument and the test equipment as shown in the figure supplied with each accuracy check. Select the controls and inputs as called out in the tables and monitor the instrument readout for the indicated values. If the instrument is equipped with the rear panel selectable input option, set the FRONT/REAR switch to the FRONT position for all procedures presented in this section.

Table 3.1 - Required Equipment

Function	Qty	Item	Minimum Use Specifications	Suggested Equipment
DC	(1)	Saturated Standard Cell Bank (6 cells)	1 ppm, certified	EPPLEY 106
	(2)	DC Voltages Sources	0.1 ppm resolution	FLUKE 332B
	(2)	Voltage Dividers, Adjustable	0.1 ppm linearity	FLUKE 720A
	(2)	Null Detector/μ Voltmeters	1 μV sensitivity	FLUKE 845AR
AC	(1)	Thermal Transfer Standard	50 ppm	HOLT 6A, With corrections
	(1)	AC Voltage Source	1 ppm resolution	HP745A/746A
Ω	(8)	Resistance Standards		
		10Ω	10 ppm	ESI SR1 with corrections
		100Ω	5 ppm	ESI SR1 with corrections
		1 KΩ	5 ppm	ESI SR1 with corrections
		10 KΩ	5 ppm	ESI SR1 with corrections
		100 KΩ	5 ppm	ESI SR1 with corrections
		1 MΩ	5 ppm	Fabricated
		10 MΩ	20 ppm	ESI SR1 with corrections
		100 MΩ	80 ppm	Fabricated
OTHER	(1)	Momentary Switch, SPST	–	–
	(2)	1.5 volt cells w/screwtype binding posts	–	–
	(1)	Insulated Adjustment tool	–	JFD5284
	(1)	100Ω, 10, 100 Kilohm, 1 Megohm 1/4 Watt 5% Carbon Resistors	5%	–
	(1)	1 μFD non polar capacitor	–	–

Table 3.2 - DC Range Check (Low Ranges)

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD	DIVIDER SETTING			
DC	.1V	10.00000	.01000	.100000	.099992 – .100008	23°C ± 5°C (After zeroing)
	1V	10.00000	.10000	1.00000	0.99997 – 1.00003	

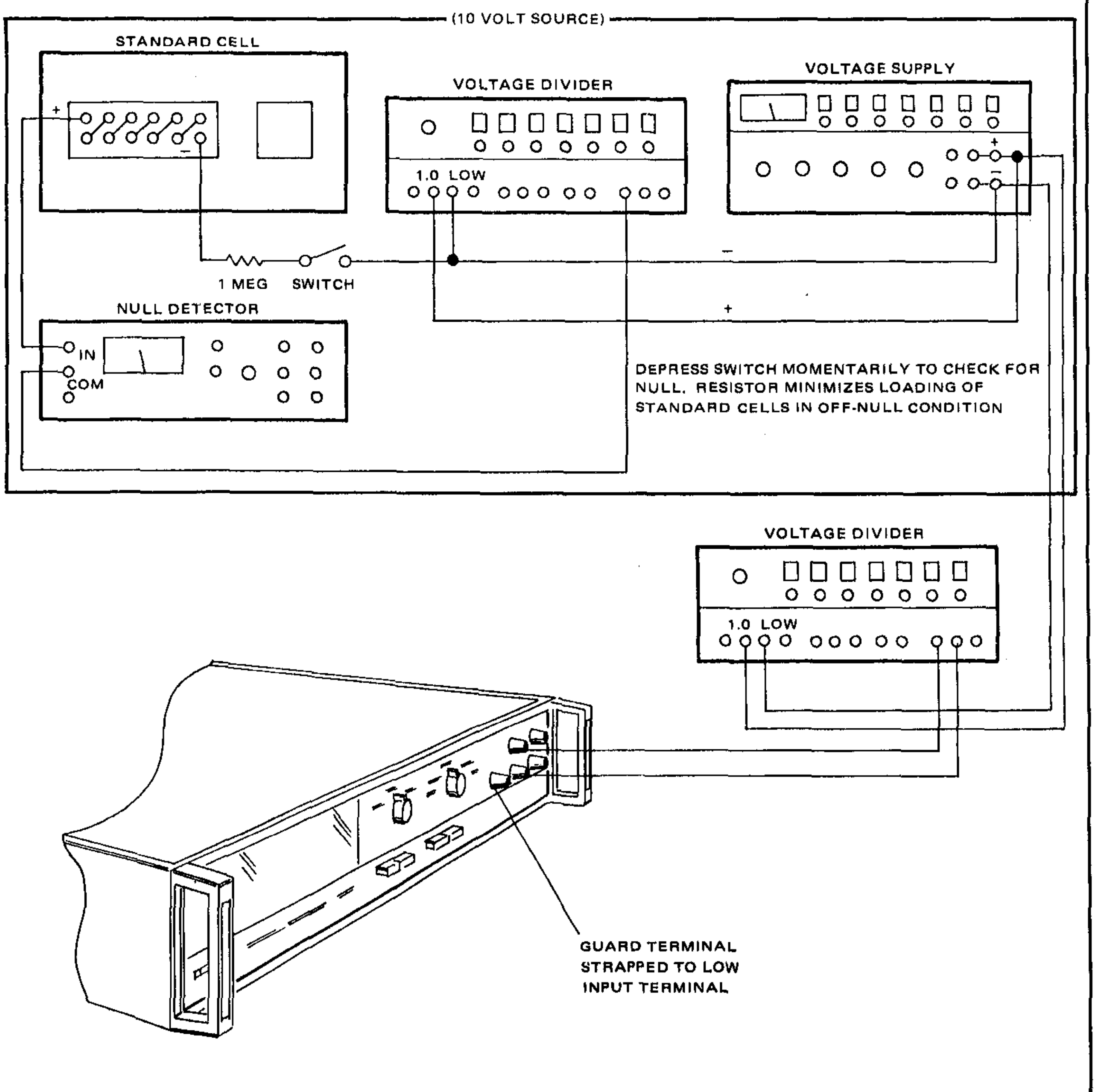


Table 3.3 - DC Range Check (High Ranges)

DVM		INPUT SIGNAL				
FUNCTION	RANGE	DC VOLTAGE STANDARD		NOMINAL READING	TOLERANCE	NOTE
DC	10	10.0000V		10.0000	9.9998 – 10.0002	$23^oC \pm 5^oC$ (After zeroing)
	100	100.000V		100.000	99.997 – 100.003	
	1000	1000.00V		1000.00	999.97 – 1000.03	

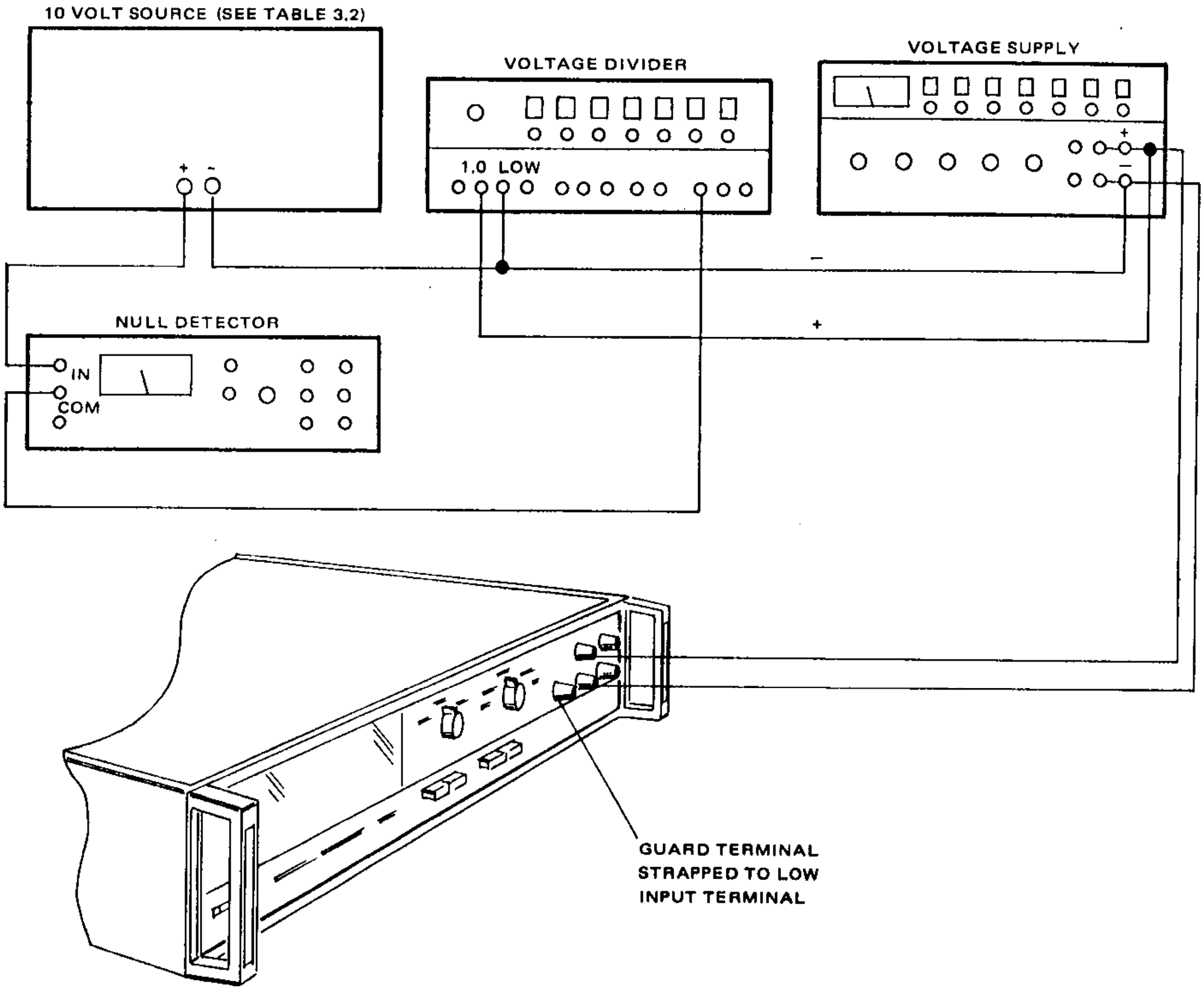


Table 3.4 - 3-Wire Ratio Check

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC RATIO	10	+ 2.00000V		10.0000	9.9990 – 10.0010	23°C ± 5°C (After zeroing)
		+10.00000V		10.0000	9.9998 – 10.0002	

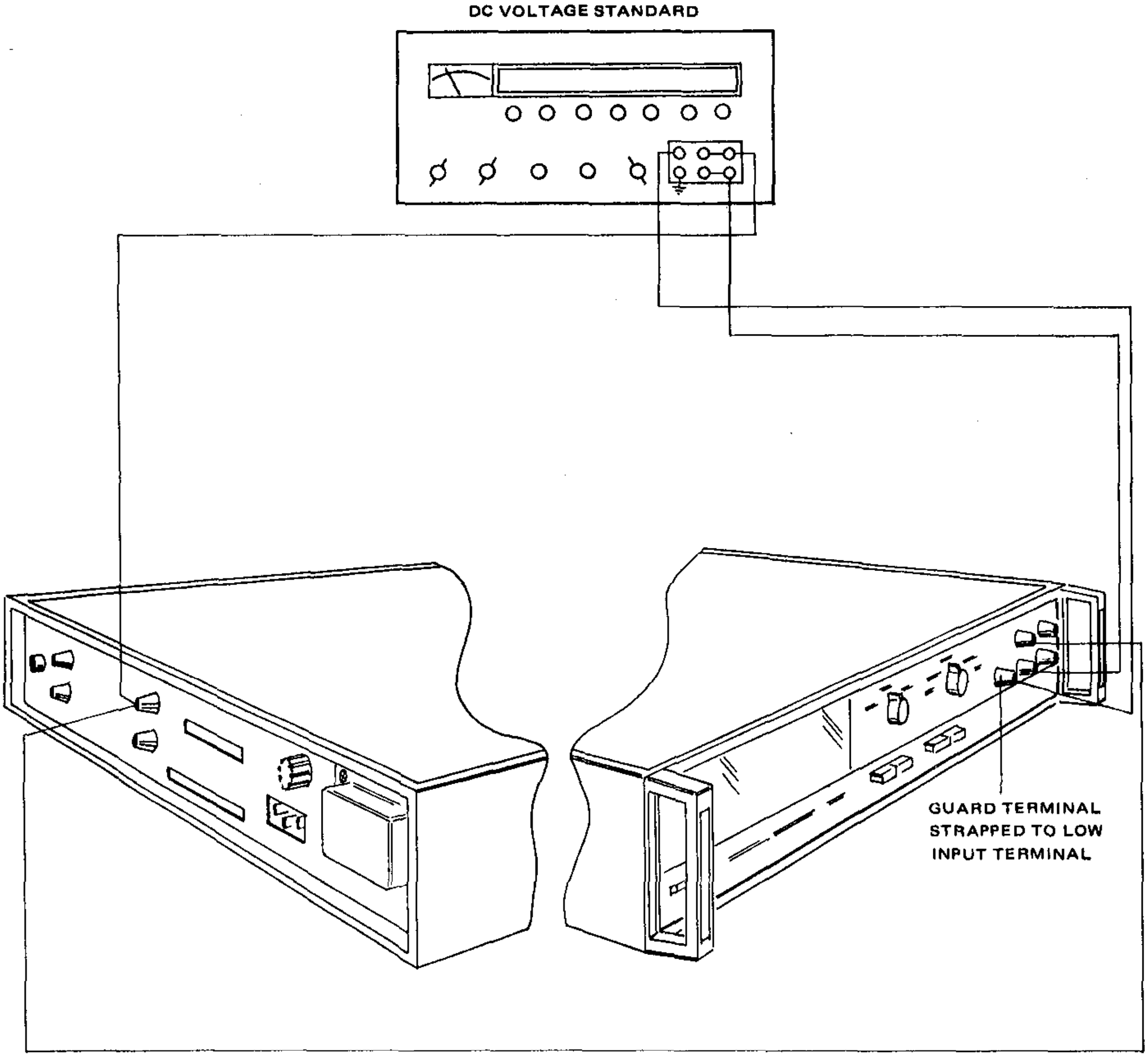


Table 3.5 - 4-Wire Ratio Check

DVM		INPUT SIGNAL				
FUNCTION	RANGE	DC VOLTAGE STANDARD		NOMINAL READING	TOLERANCE	NOTE
DC RATIO	10	+ 2.00000V		+10.0000	9.9980 – 10.0020	23°C ± 5°C (After zeroing)
	10	+10.00000V		+10.0000	9.9996 – 10.0004	
		–10.00000V		+10.0000	9.9996 – 10.0004	

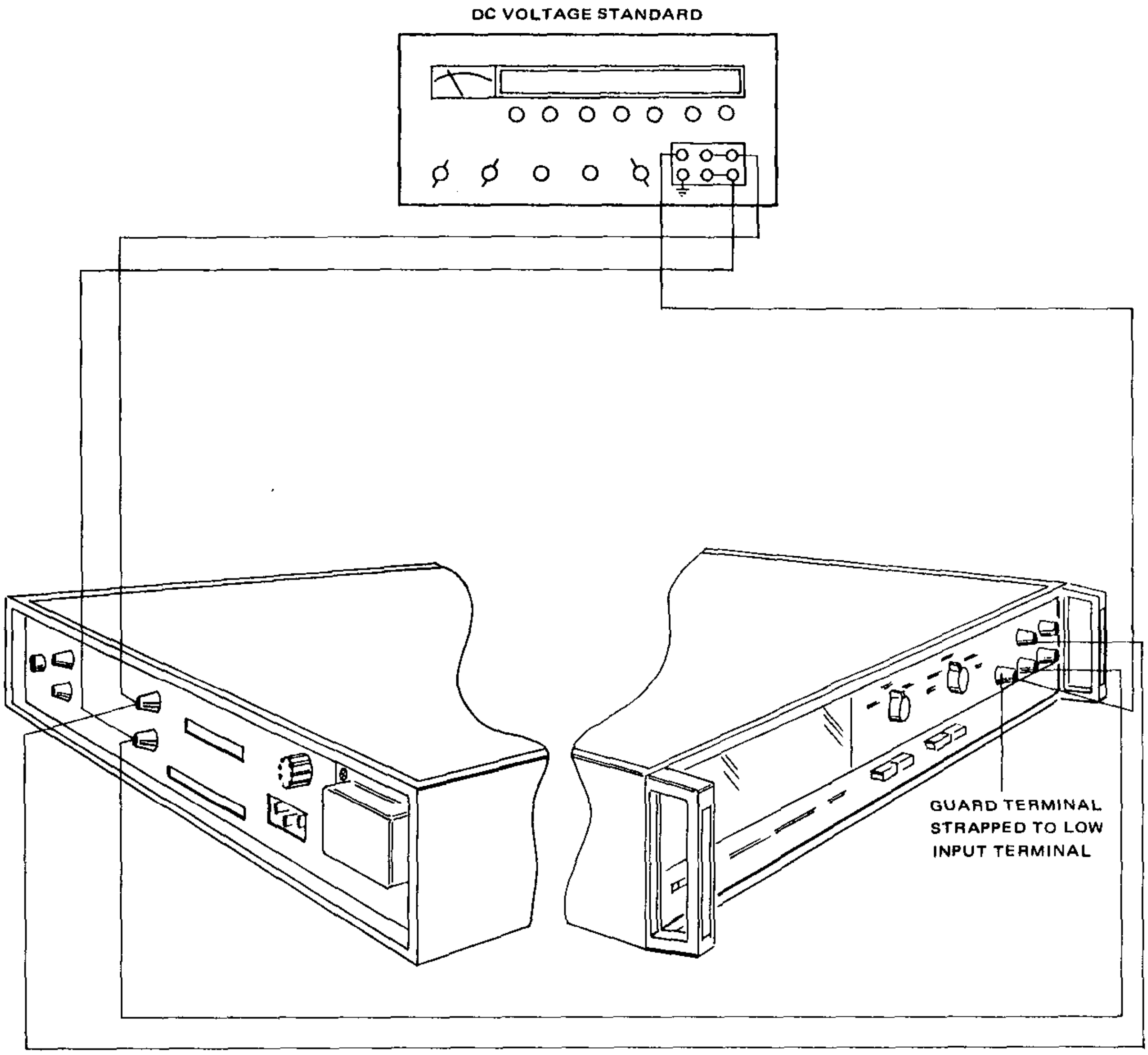


Table 3.6 - DC Input Resistance

DVM		INPUT SIGNAL		DVM DISPLAY	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTS*	S1			
DC	0.1	.100000	Closed	.100000		Rs
			Open		.099989 – .100001	1 Meg
	1	1.000000	Closed	1.00000		
			Open		0.99989 – 1.00001	1 Meg
	10	10.00000	Closed	10.0000		
			Open		9.9989 – 10.0001	1 Meg
	100	100.0000	Closed	100.000		
			Open		99.989 – 100.001	1 K
	1000	1000.000	Closed	1000.00		
			Open		999.89 – 1000.01	1 K
						*Adjust the DC Voltage Standard to produce the DVM DISPLAY reading.

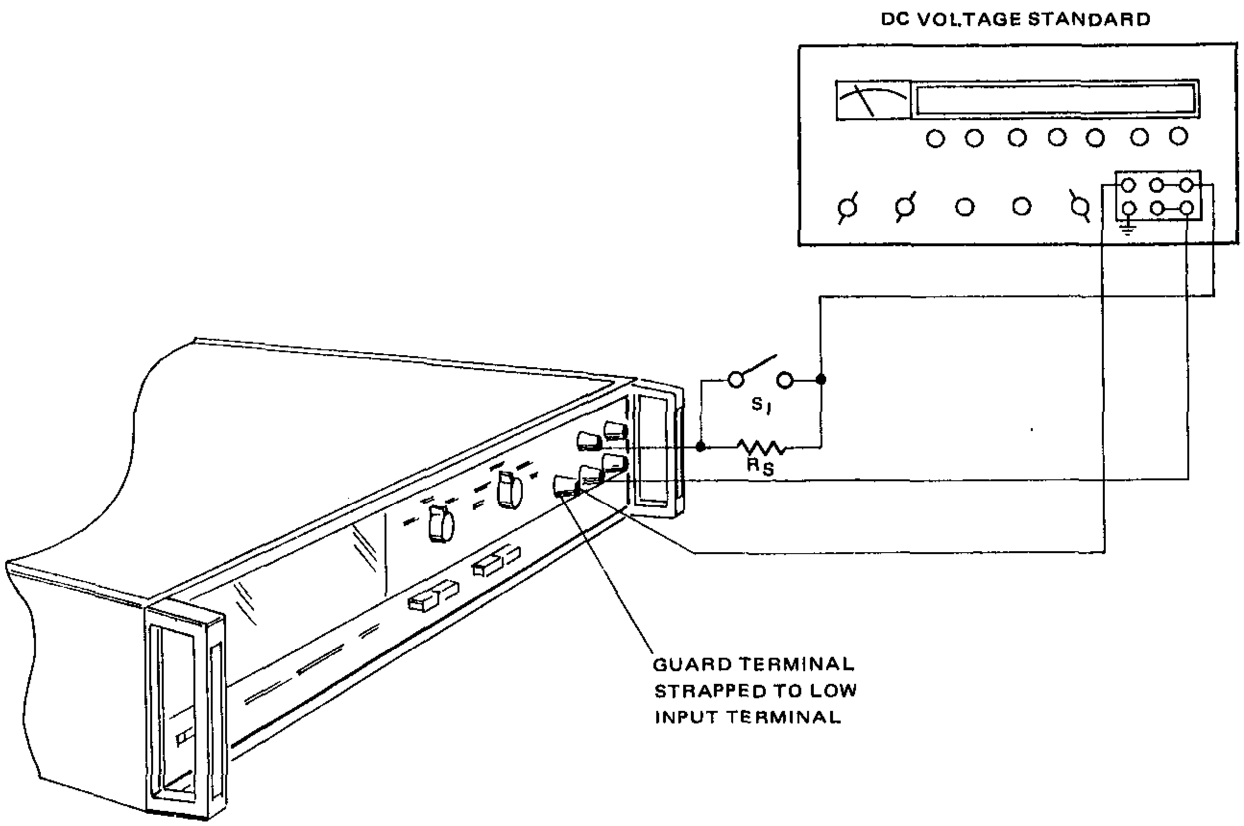


Table 3.7 - Model 33 AC Converter Range Check

DVM		INPUT SIGNAL				
FUNCTION	RANGE	DC VOLTAGE STANDARD	AC	NOMINAL READING	TOLERANCE	NOTE
AC	1	1.000000	1V @ 400 Hz	1.00000	0.99968 – 1.00032	Refer to figure 5.3 for additional information on use of AC source equipment
		1.000000	1V @ 50 kHz	1.00000	0.99945 – 1.00055	
	10	10.00000	10V @ 400 Hz	10.0000	9.9968 – 10.0032	
		10.00000	10V @ 50 kHz	10.0000	9.9945 – 10.0055	
	100	100.0000	100V @ 400 Hz	100.000	99.968 – 100.032	
		100.0000	100V @ 50 kHz	100.000	99.945 – 100.055	
	1000	1000.000	1000V @ 400 Hz	1000.00	999.48 – 1000.52	
		500.00	500V @ 50 kHz	500.00	499.70 – 500.30	

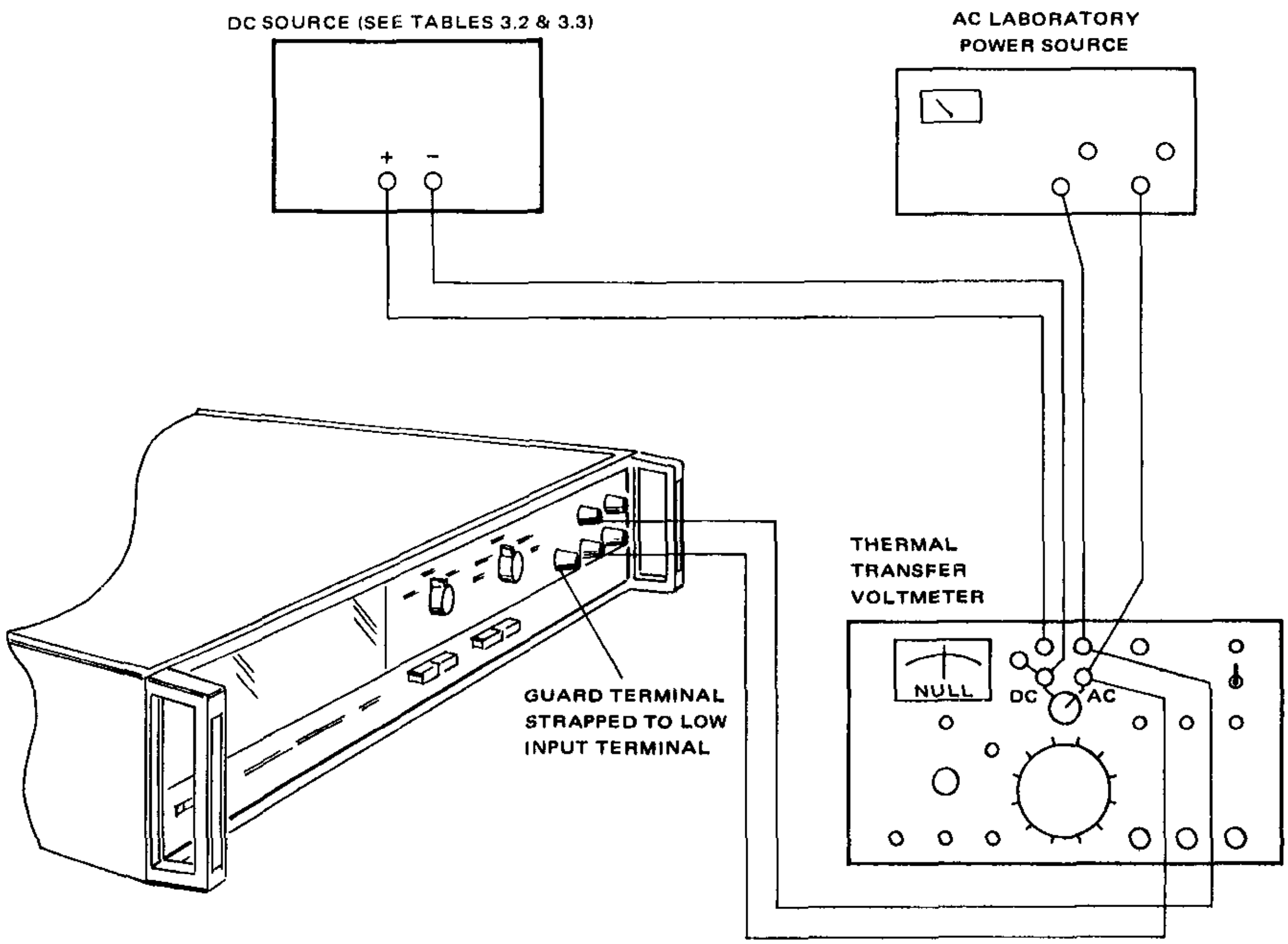


Table 3.8 - Model 32 AC Converter Range Check

DVM		INPUT SIGNAL				
FUNCTION	RANGE	DC VOLTAGE STANDARD	AC	NOMINAL READING	TOLERANCE	NOTE
AC	1	1.000000	1V @ 400 Hz	1.00000	0.99910 – 1.00090	Same as table 3.7
		1.000000	1V @ 50 kHz	1.00000	.99800 – 1.00200	
	10	10.00000	10V @ 400 Hz	10.0000	9.9910 – 10.0090	
		10.00000	10V @ 50 kHz	10.0000	9.9800 – 10.0200	
	100	100.0000	100V @ 400 Hz	100.000	99.910 – 100.090	
		100.0000	100V @ 50 kHz	100.000	99.800 – 100.200	
	1000	1000.000	1000V @ 400 Hz	1000.00	998.80 – 1001.20	
		500.000	500V @ 50 kHz	500.00	498.50 – 501.50	

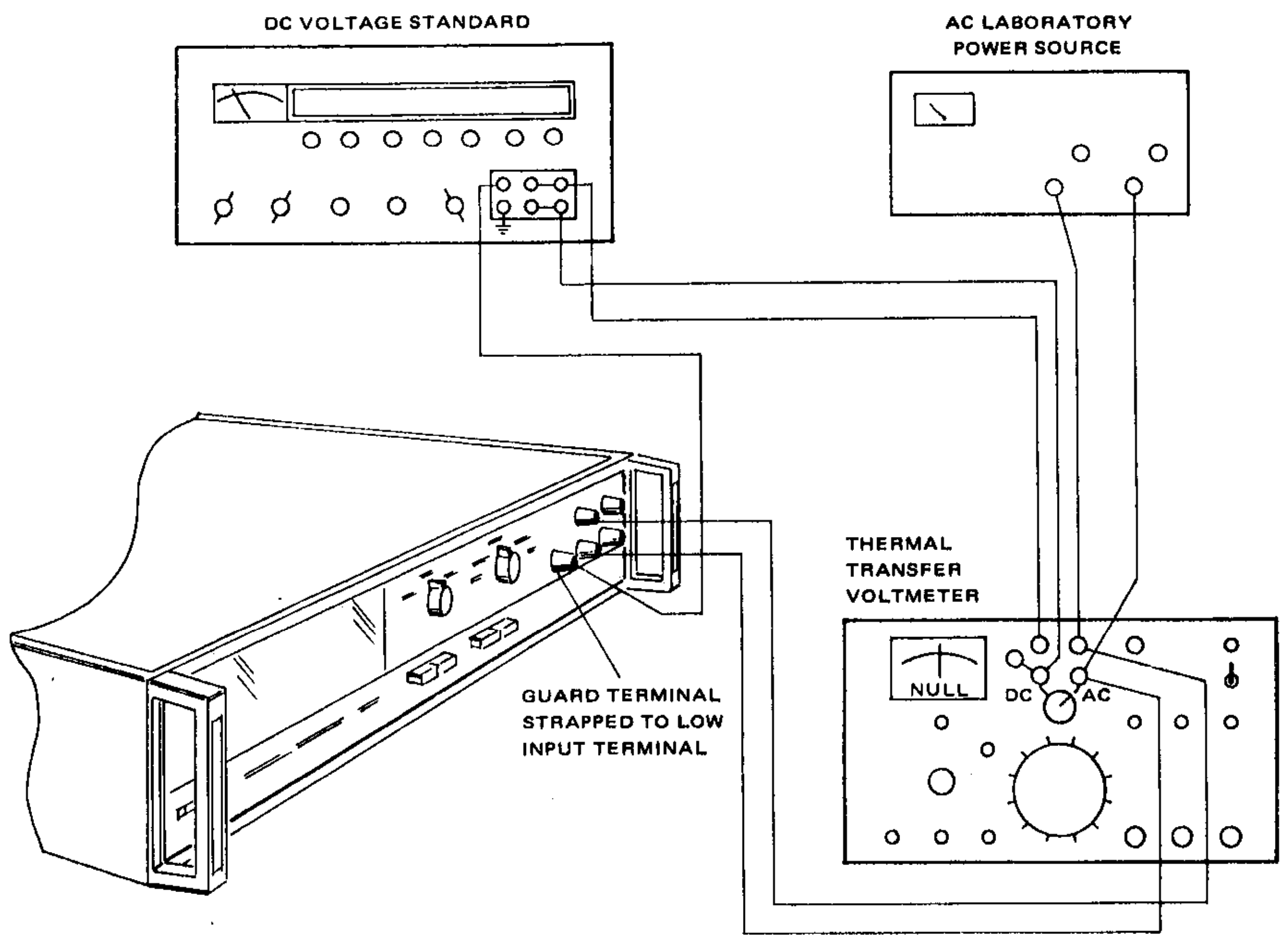


Table 3.9 - Ohms-Megohms Range Check

DVM		INPUT SIGNAL		NOMINAL READING (Same as Standard)	TOLERANCE
FUNCTION	RANGE	NOMINAL STANDARD VALUE	TOLERANCE		
Ω - MΩ	10Ω	10Ω	.001%		±10 digits
	100Ω	100Ω	.0005%		±4 digits
	1 kΩ	1 kΩ	.0005%		±4 digits
	10 kΩ	10 kΩ	.0005%		±4 digits
	100 kΩ	100 kΩ	.0005%		±4 digits
	1 MΩ	1 MΩ	.0005%		±4 digits
	10 MΩ	10 MΩ	.002%		±31 digits
	100 MΩ	100 MΩ	.01%		±51 digits

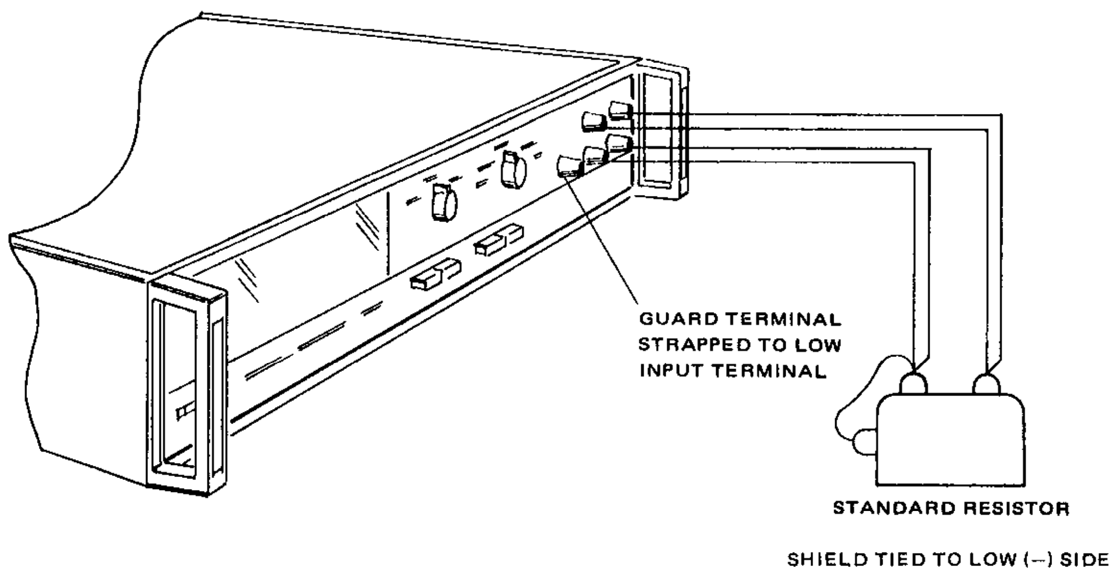


Table 3.10 - Common Mode Rejection (In DC Volts Function)

DVM		INPUT SIGNAL		NOMINAL READING See Note 1	TOLERANCE	NOTE
FUNCTION	RANGE	S1				
DCV FILT. OUT	0.1	Off			±1 digit from nominal	1) With switch S-1 in the off position, record the reading displayed on the DMM's readout in the "nominal reading" boxes of the table.
		DC			±5 digits from nominal	
		AC			±25 digits from nominal	
DCV FILT. IN	0.1	DC			±50 digits from nominal	
		AC			±25 digits from nominal	

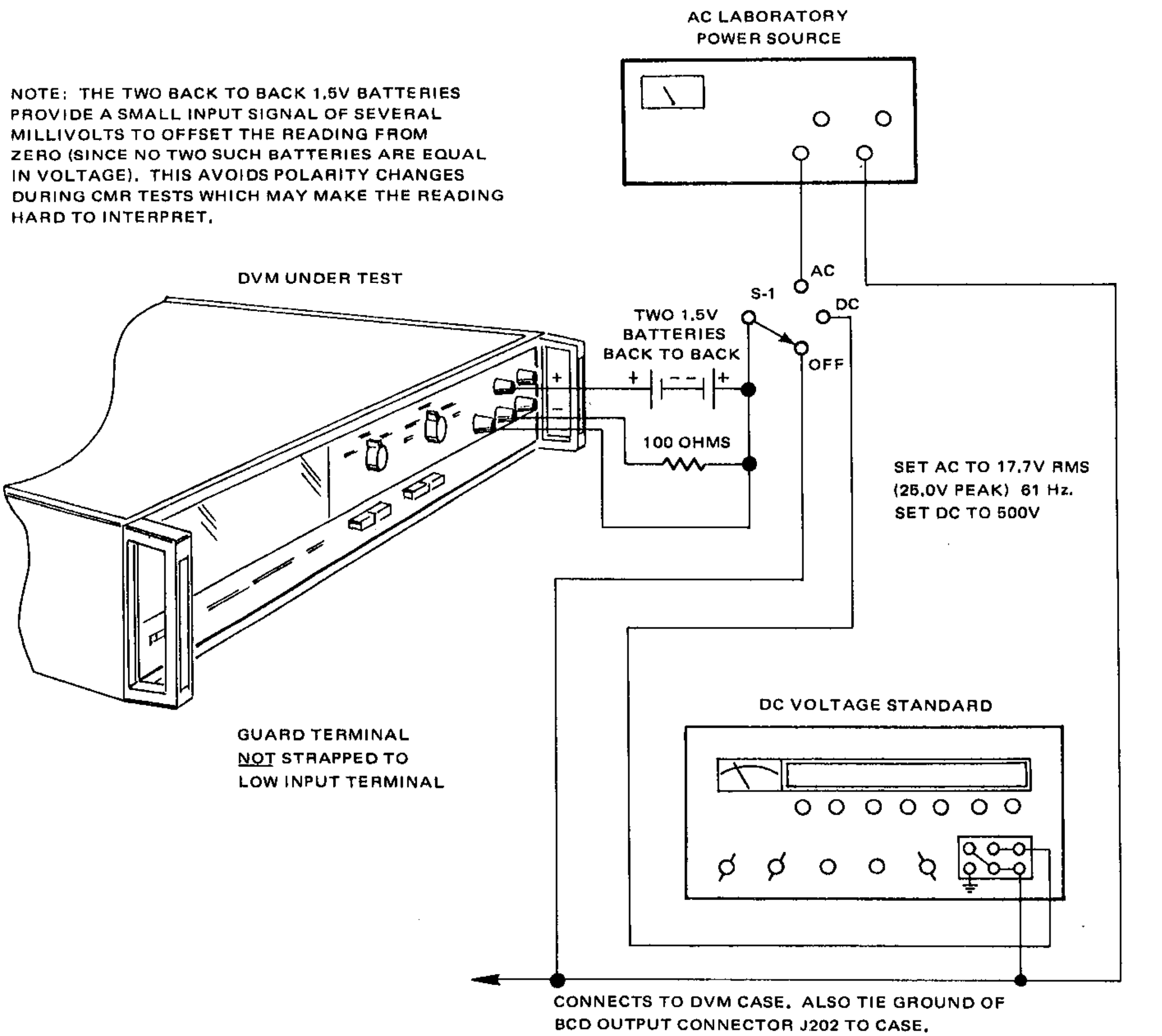


Table 3.11 - Normal Mode Noise Rejection (In DC Volts Function)

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC	AC			
DC FILT. OUT	10	0.5V	10V*, 60 Hz†	00.5000	±400 digits	
FILT. IN	1V	0.5V	2V*, 60 Hz†	0.50000	± 2 digits	

*peak
†50 Hz (Option 04)

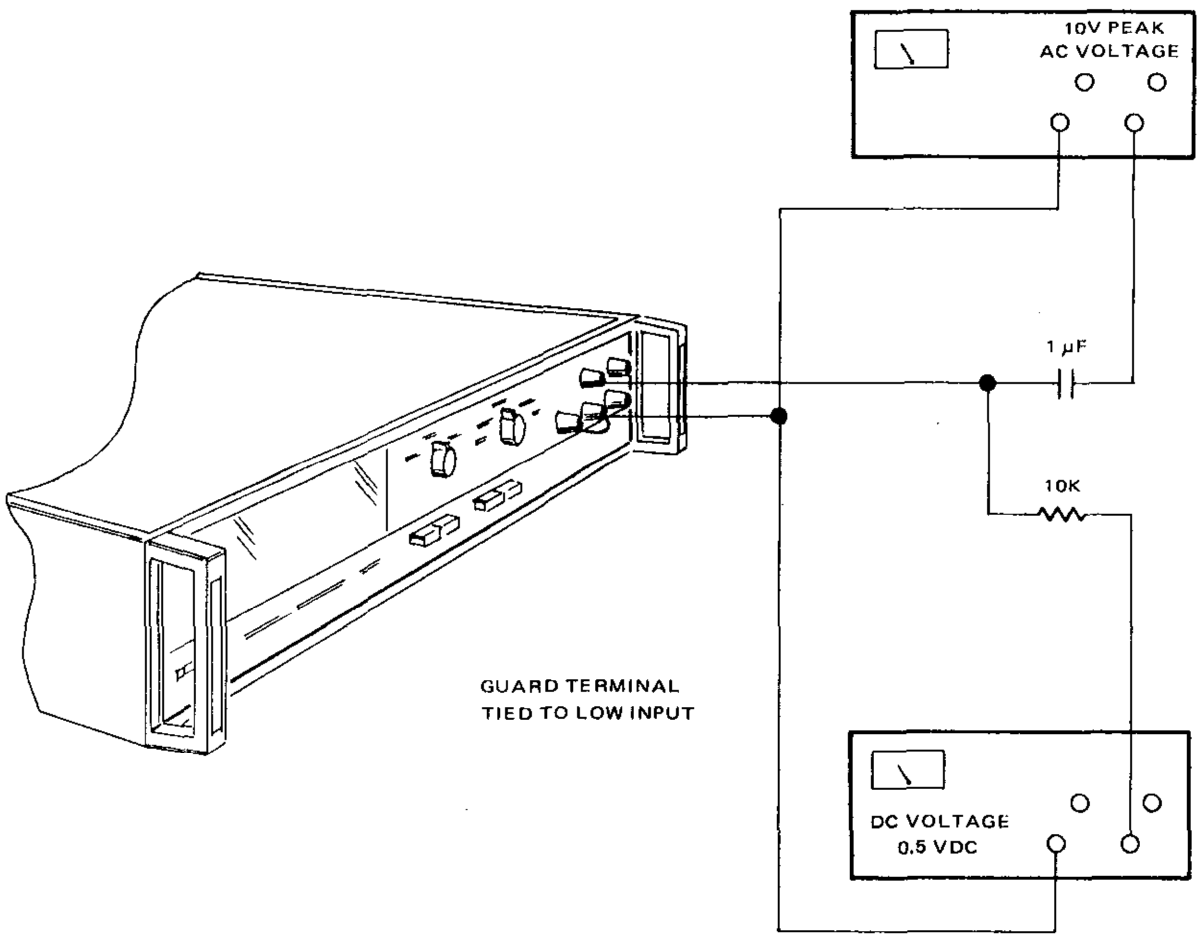
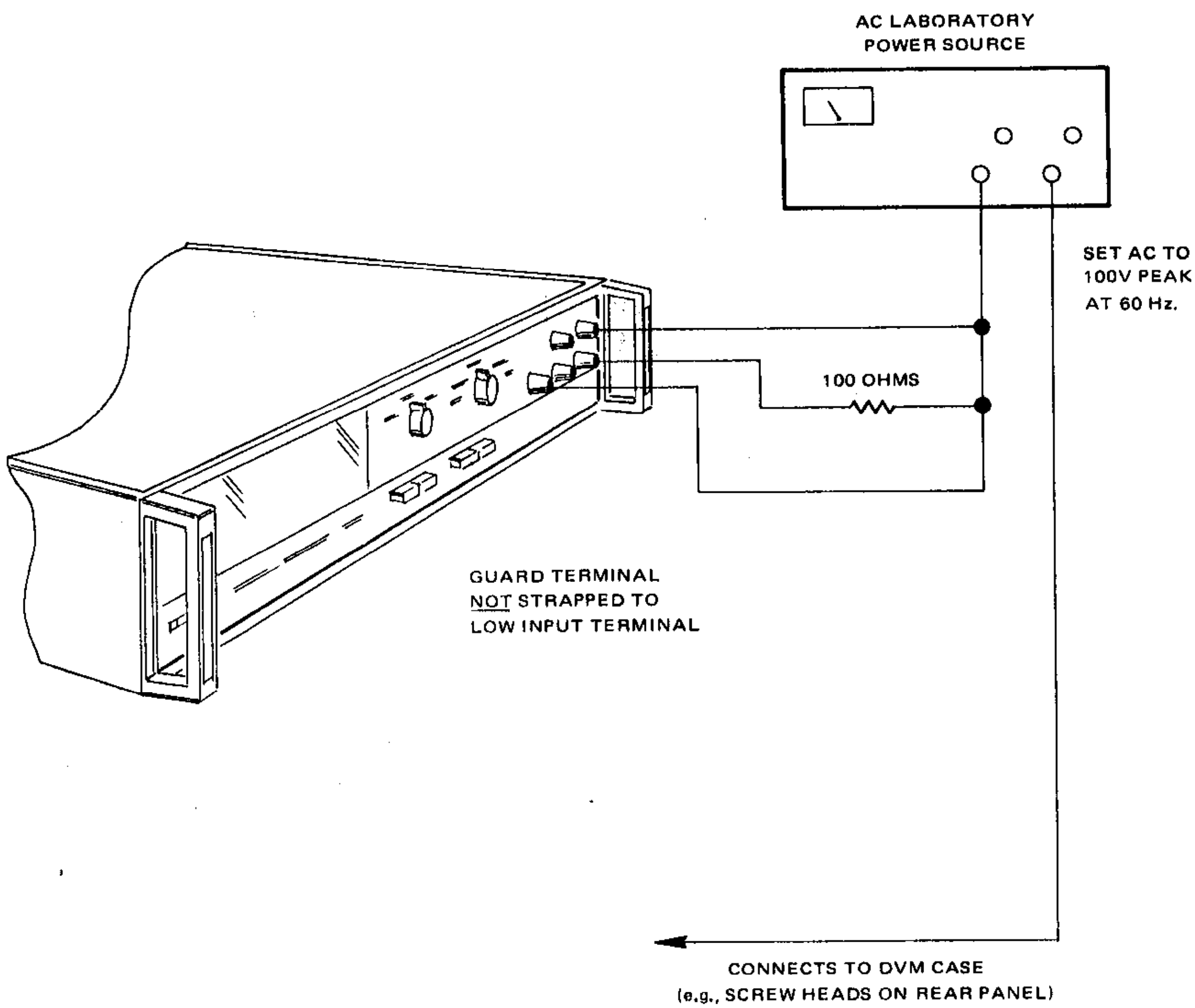


Table 3.12 - Common Mode Rejection (In AC Volts Function)

DVM		COMMON MODE INPUT SIGNAL		NOMINAL READING (see note)	TOLERANCE	NOTE
FUNCTION	RANGE	VOLTAGE	FREQ.			
AC	1	100V Peak	60 Hz		±10 digits	Enter reading with shorted input in nominal column before beginning
	10	100V Peak	60 Hz		±1 digit	
	100	100V Peak	60 Hz		±1 digit	
	1000	100V Peak	60 Hz		±1 digit	



4.1 GENERAL.

4.2 This section describes the operation of the main circuitry of the Model 5900 DVM, briefly covering the mechanical organization and then the electrical operation of the instrument. The simplified drawings provided in this section are for the purpose of illustration, and supplement the complete schematics of Section 6.

4.3 MECHANICAL DESCRIPTION.

4.4 The Model 5900, shown in figure 4.1, consists of a large, single, printed circuit Logic and Interconnection board (Main Logic) with as many as 12 separate PC boards plugging directly or indirectly (by means of cables) into the Main Logic board. The electronics are housed in a sturdy die cast and stamped aluminum package with the readout, input terminals, and all manual controls located on the front panel. On the back panel is located the power cable input, all data output, optional remote input, analog output, external reference, and optional rear inputs.

4.5 ELECTRICAL DESCRIPTION.

4.6 The instrument is divided into three functional groups. These are the Signal Conditioning section, the Analog-to-Digital Conversion section, and the Display/Control Logic section.

4.7 SIGNAL CONDITIONING SECTION.

4.8 The Signal Conditioning section for a fully equipped instrument consists of: the Switching Board, the Ohms Converter, the Averaging AC Converter or the RMS AC Converter, the Attenuator, and the Isolator. The basic instrument consists of the Switching Bypass Board, the Attenuator, and the Isolator.

4.9 The Signal Conditioning section routes, scales, filters and, when required, converts the input signal into a stable 10 volt full scale dc level for use by the measurement portion of the DVM.

4.10 Switching Board.

4.11 The Switching board is a single printed circuit board and occupies connectors J5 and J6 on the Main Logic board. The Switching board is used with instruments equipped with either the Ohms Converter or either of the available ac converters and is necessary for the generation and isolation of range data and for signal routing required by the options. The interconnection of the Switching board with the options and the other components of the Signal Conditioning section is shown in block diagram form in figure 4.2.

4.12 The control of signal flow through the Switching board, shown in simplified form in figure 4.3, is by means of two relays K1 and K2. The three possible signal routes provided by the board are illustrated in figure 4.4. Referring to this figure, with the dc function selected, neither of the relays is energized and the signal flow is as shown in (a); with the ac function selected, relay K1 is energized and the signal flow is as shown in (b); with ohms function selected, relay K2 is energized and the signal flow is as shown in (c).

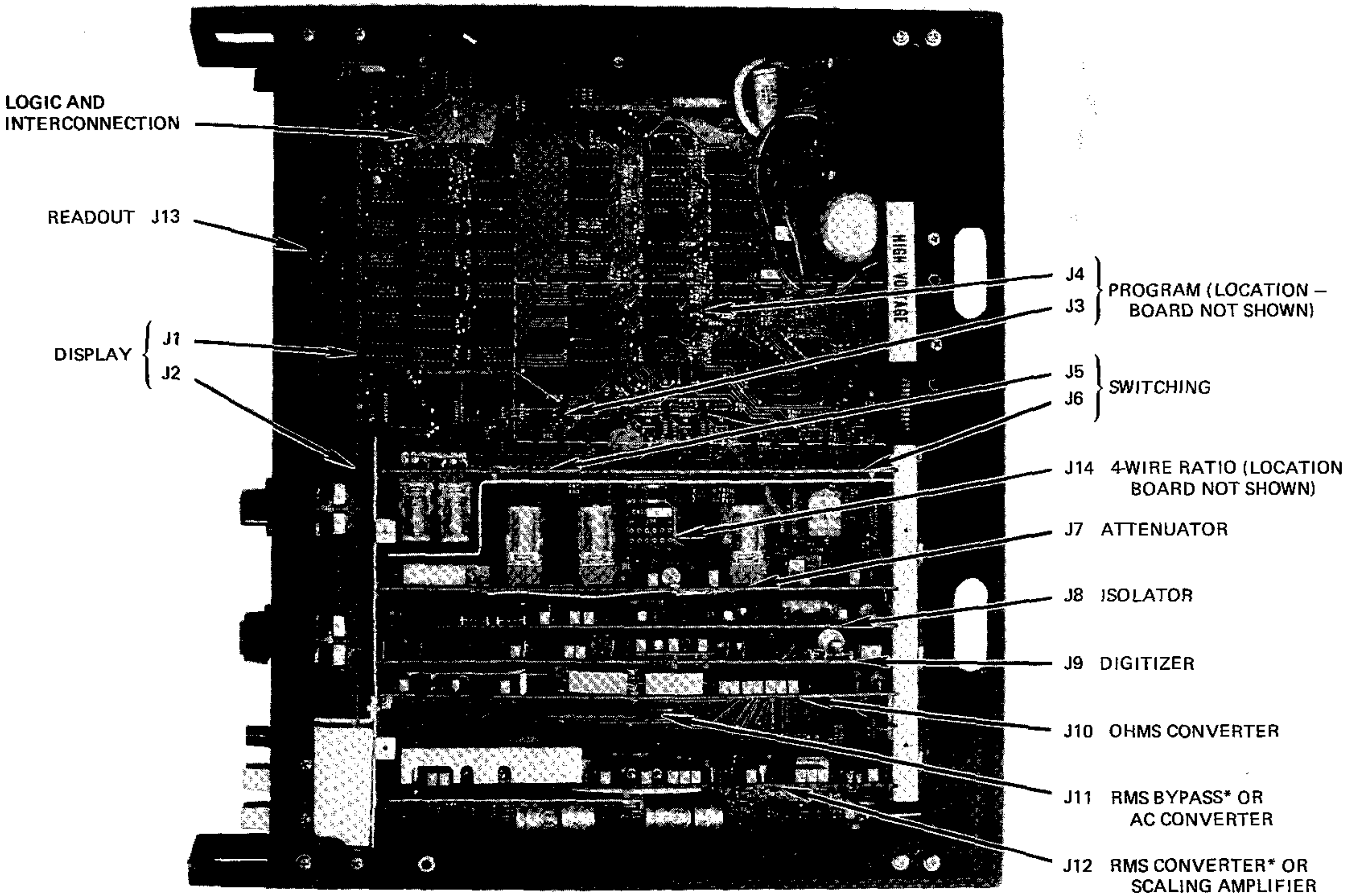
4.13 The range control of the option boards uses analog supply voltages and require isolation from the digital supplies and decoding. This is provided on the Switching board by three Optically Coupled Isolators (OCI) and a BCD to TEN line driver. The decoding of the range logic is given in table 4.1.

Table 4.1 - Switching Board Range Decode

INPUT CODE			WEIGHT	OUTPUT CODE							
RANGE				U2 PIN NO.							RANGE
A_1	B_2	C_4		8	9	13	14	11	10	16	
L	H	L	2	L	H	H	H	H	H	H	.01
H	H	L	3	H	L	H	H	H	H	H	.1
L	L	H	4	H	H	L	H	H	H	H	1
H	L	H	5	H	H	H	L	H	H	H	10
L	H	H	6	H	H	H	H	L	H	H	100
H	H	H	7	H	H	H	H	H	L	H	1000
L	L	L	0	H	H	H	H	H	H	L	10,000

4.14 Ohms Converter.

4.15 The Ohms Converter circuitry is mounted on a single printed circuit board and occupies connector J10 on the Main Logic board. The circuitry, shown simplified in figure 4.5, consists of a high gain amplifier and a relay operated positive current source that is capable of producing any one of eight precise current levels depending on the range selected.



*INSTRUMENT SHOWN IS EQUIPPED WITH RMS CONVERTER.

Figure 4.1 - Mechanical Assembly

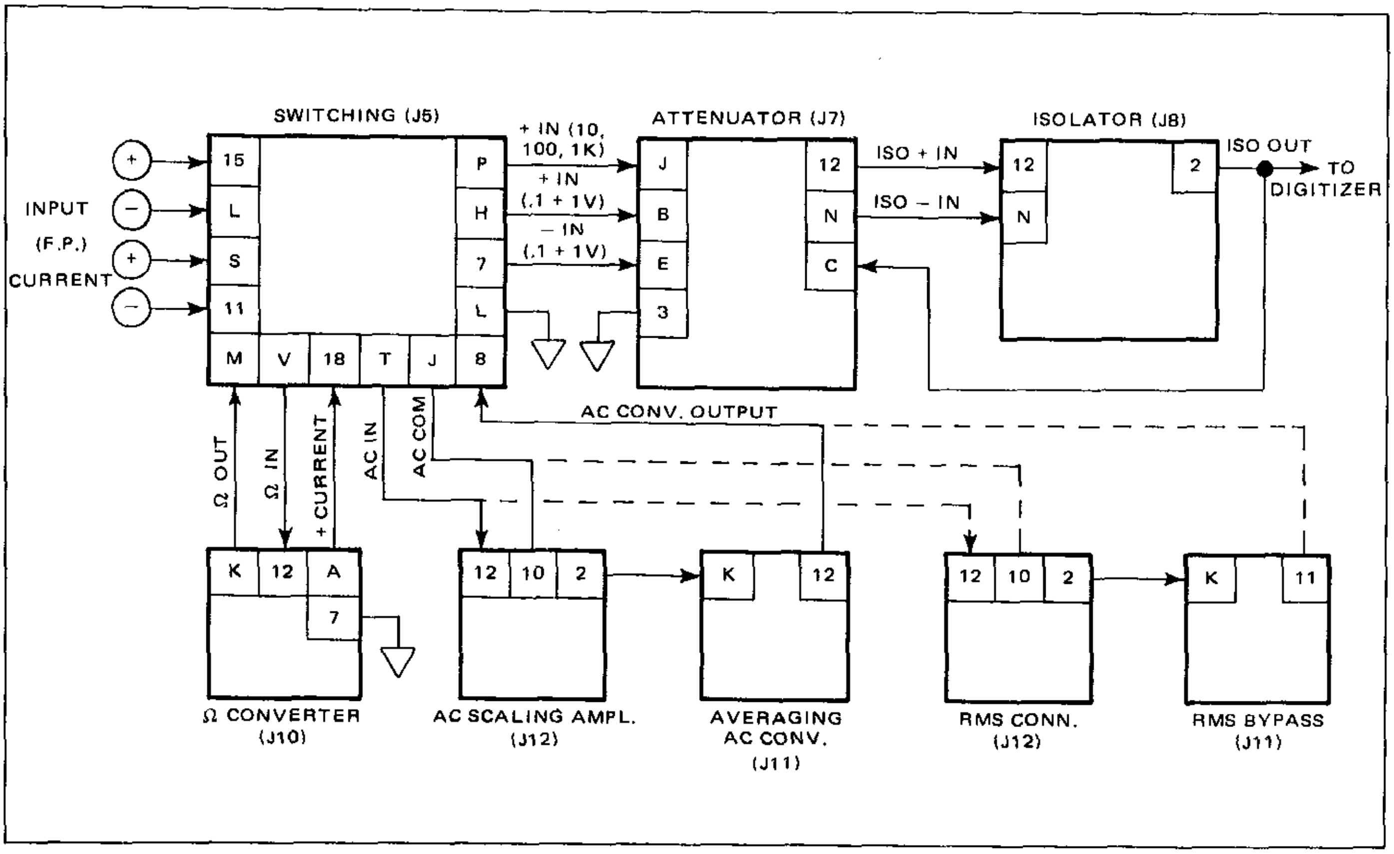


Figure 4.2 - Signal Flow, Loaded DVM

4.16 The Ohms Converter, in conjunction with the Switching board, the Attenuator, and the Isolator, converts the resistance to be measured into a proportional dc voltage that can be measured by the DVM. The current produced for each range, when applied to a resistance equal to the range selected, generates a voltage at the output of the resistance measurement network of 10 volts.

4.17 The resistance measurement network assumes two forms, depending on the range being measured, as shown in figure 4.6. The basic technique used consists of effectively connecting the resistance to be measured (Rx) as a negative feedback path of an operational amplifier, with the amplifier provided by the Ohms Converter and the input to the operational amplifier formed by the current generator. In this hookup, the current through Rx equals the current generated by the current source. Referring to configuration (a), used for the ranges 10 kilohm through 100 megohm, the voltage developed across Rx is monitored through the – IN front panel connector and buffered by the isolator in a gain-of-one mode. The full scale output for these ranges, as shown in the table, is –10 volts. Referring to figure (b), the isolator is connected in a potentiometric configuration but with the input at an effective ground potential and the reference end of the feedback network tied to the voltage developed across Rx. The low impedance provided by the isolator feedback network is offset by the current compensation circuit (c.c.). This circuit monitors the output potential of the isolator and produces a current drain precisely equal to the current produced by the feedback network. The result is that the feedback network appears to have an extremely high input impedance. The configuration used in (b) reduces normal the gain of the isolator by 1, thereby producing gains of 99 and 9 as shown in the table.

4.18 Scaling Amplifier.

4.19 The Scaling Amplifier, shown simplified in figure 4.7, is used in conjunction with the Averaging AC Converter and occupies position J12. It provides isolation between the signal being measured and the signal converting circuitry and it scales the input signal to a level suitable for the converter (1V RMS output for a full scale input).

4.20 The Scaling Amplifier consists of an AC coupled operational amplifier with four possible gain settings (X1, X.1, X.01, and X.001). The gain control network is controlled by three relays and these are operated from decoded data from the range logic. A change in the roll off of the amplifier is provided when the 1 volt range is selected.

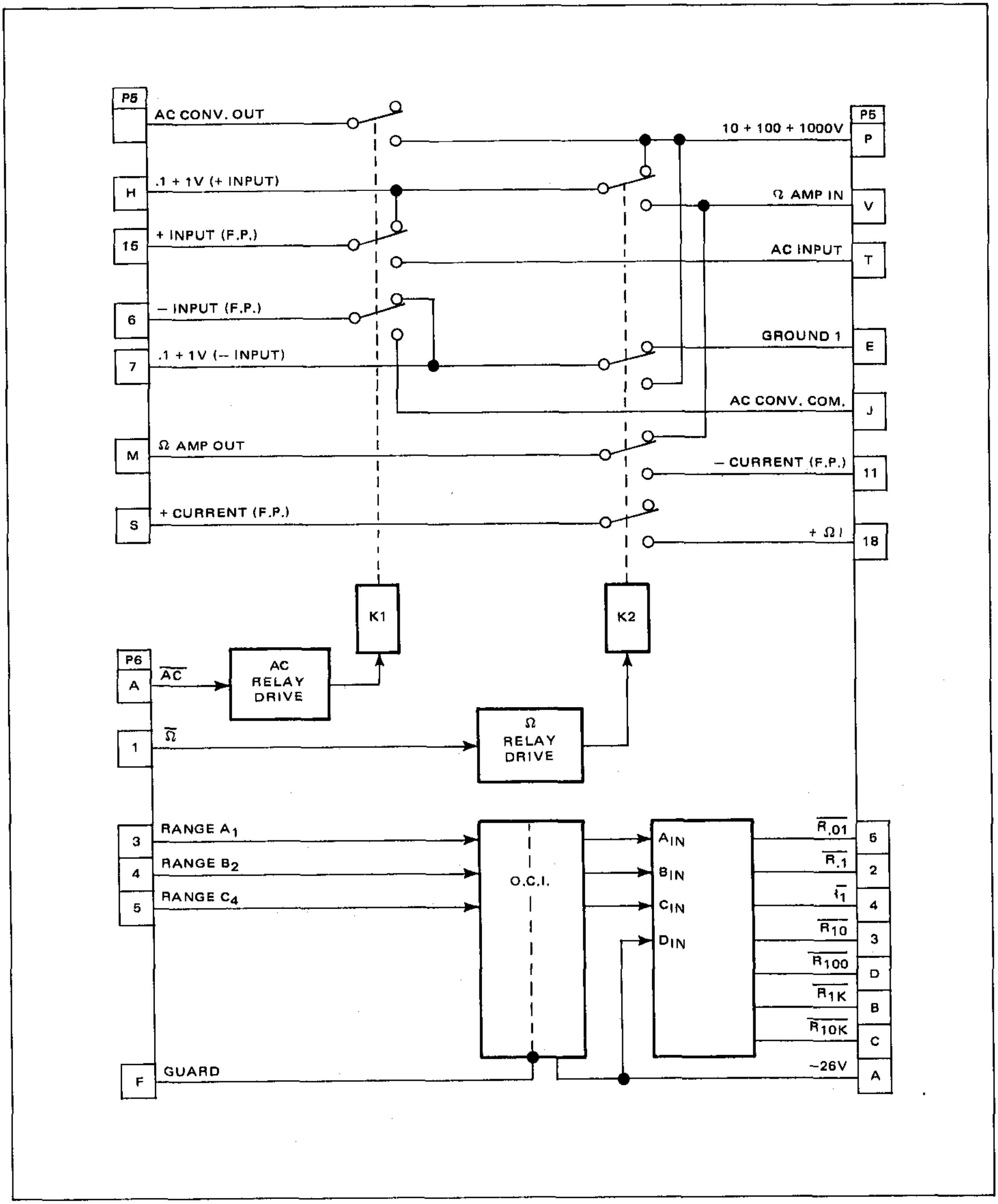
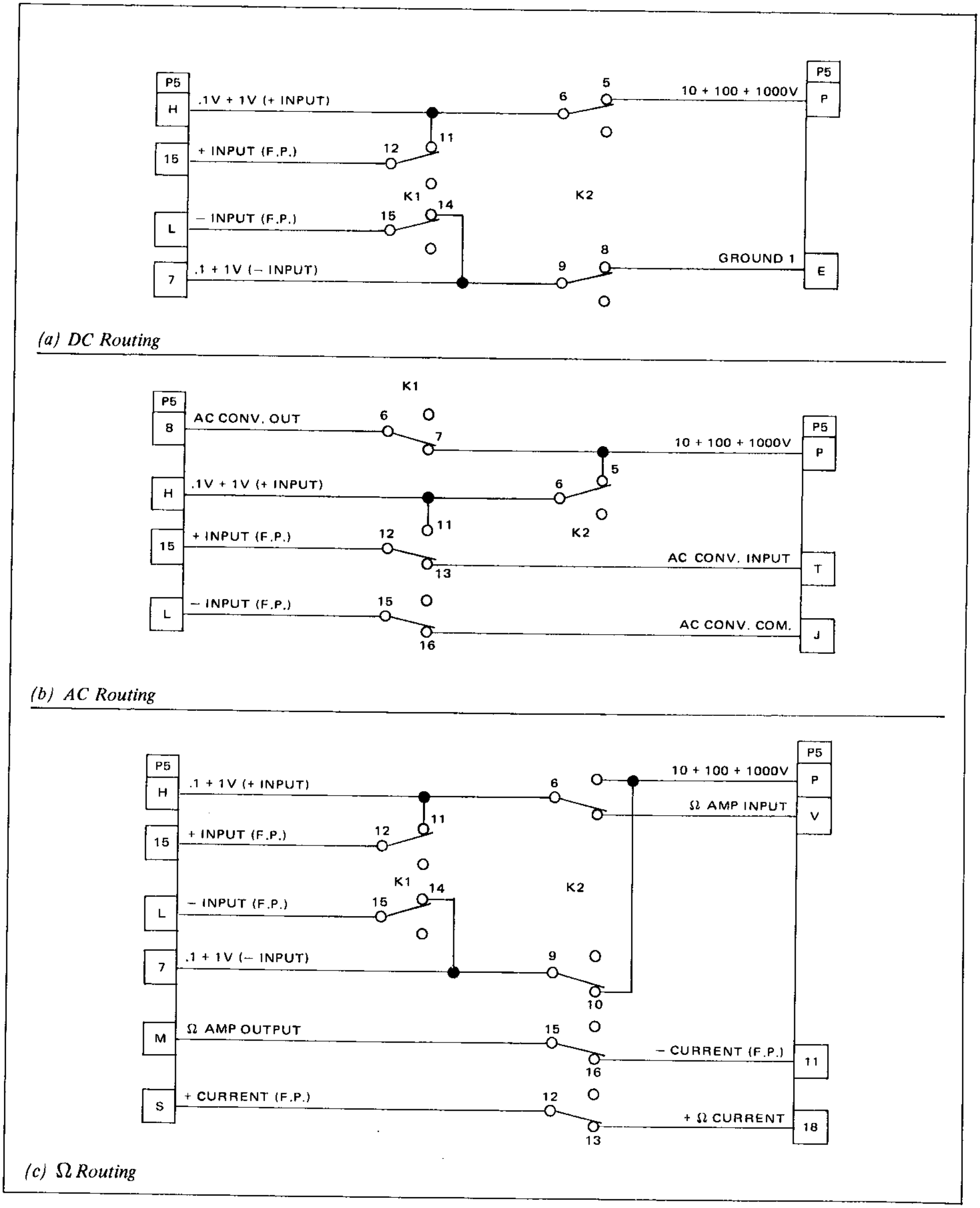


Figure 4.3 - Switching Board

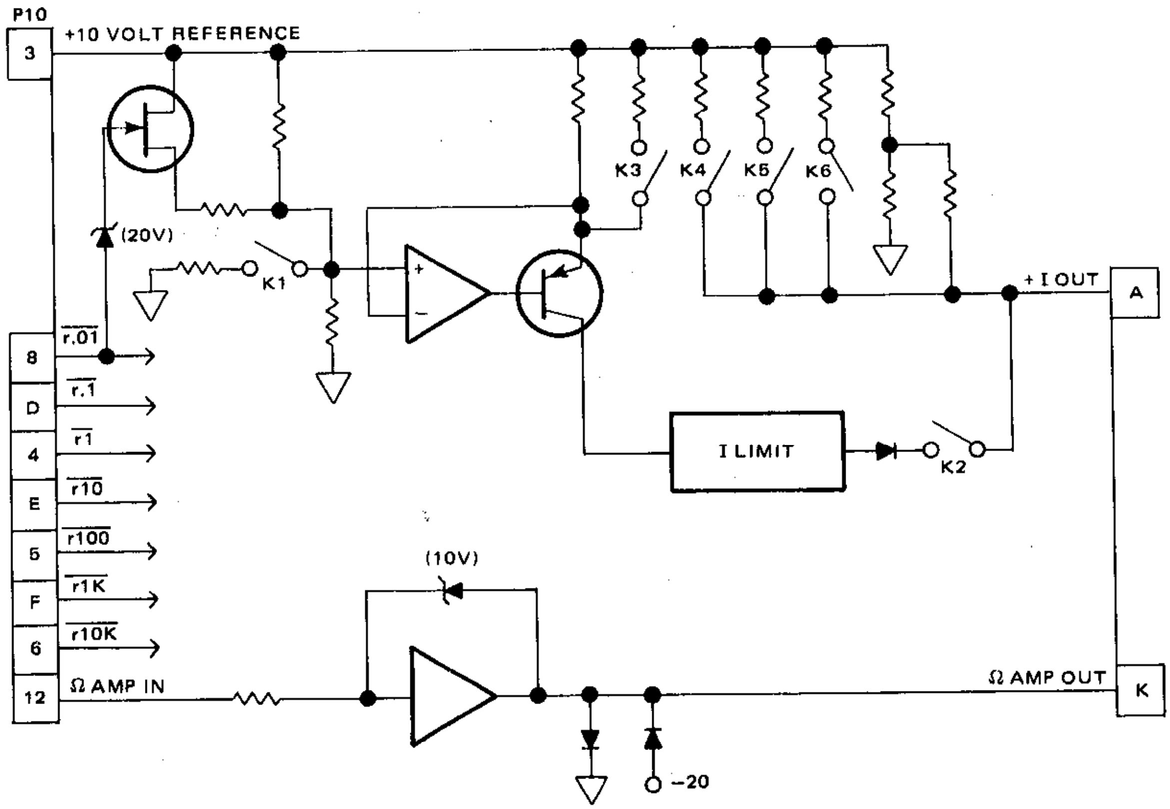


(a) DC Routing

(b) AC Routing

(c) Ω Routing

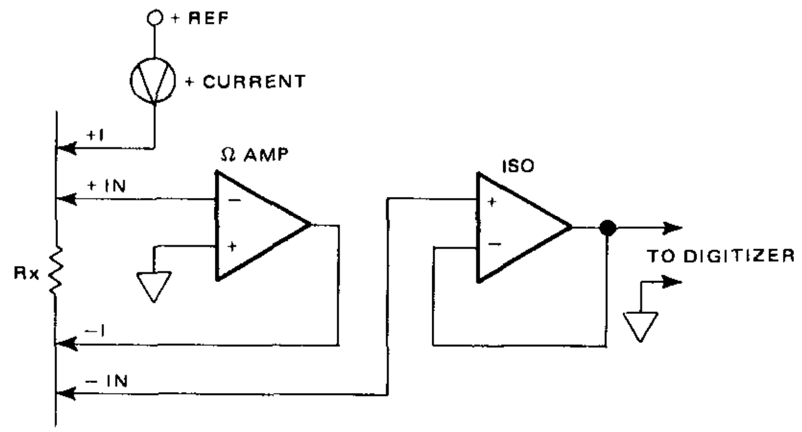
Figure 4.4 - Signal Flow of Switching Board



RANGE	K1	K2	K3	K4	K5	K6
r.01		■	■	■		
r.1	■	■	■			
r1	■	■				
r10		■				
r100				■		
r1K					■	
r10K						■

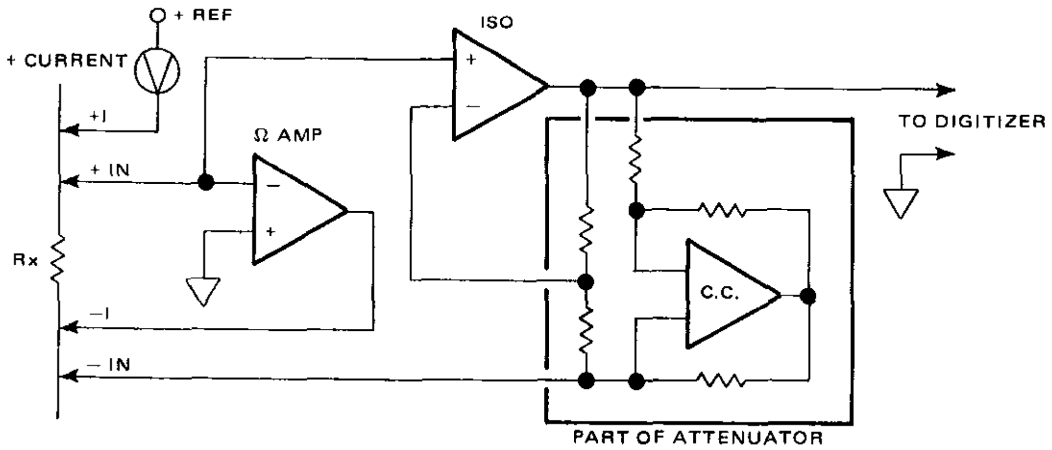
■ RELAY ENERGIZED

Figure 4.5 - Ohms Converter



RANGE	CURRENT	FULL SCALE OUT
10 KΩ	1 mA	−10V
100 KΩ	100 μA	
1000 KΩ	10 μA	
10 MΩ	1 μA	
100 MΩ	100 nA	

(a)



RANGE	CURRENT	GAIN	F.S. OUT
10Ω	10.1 mA	99	+10V
0.1 KΩ	11.1111 mA	9	+10V
1 KΩ	1.11111 mA	9	+10V

(b)

Figure 4.6 - Ohms Measurement Systems

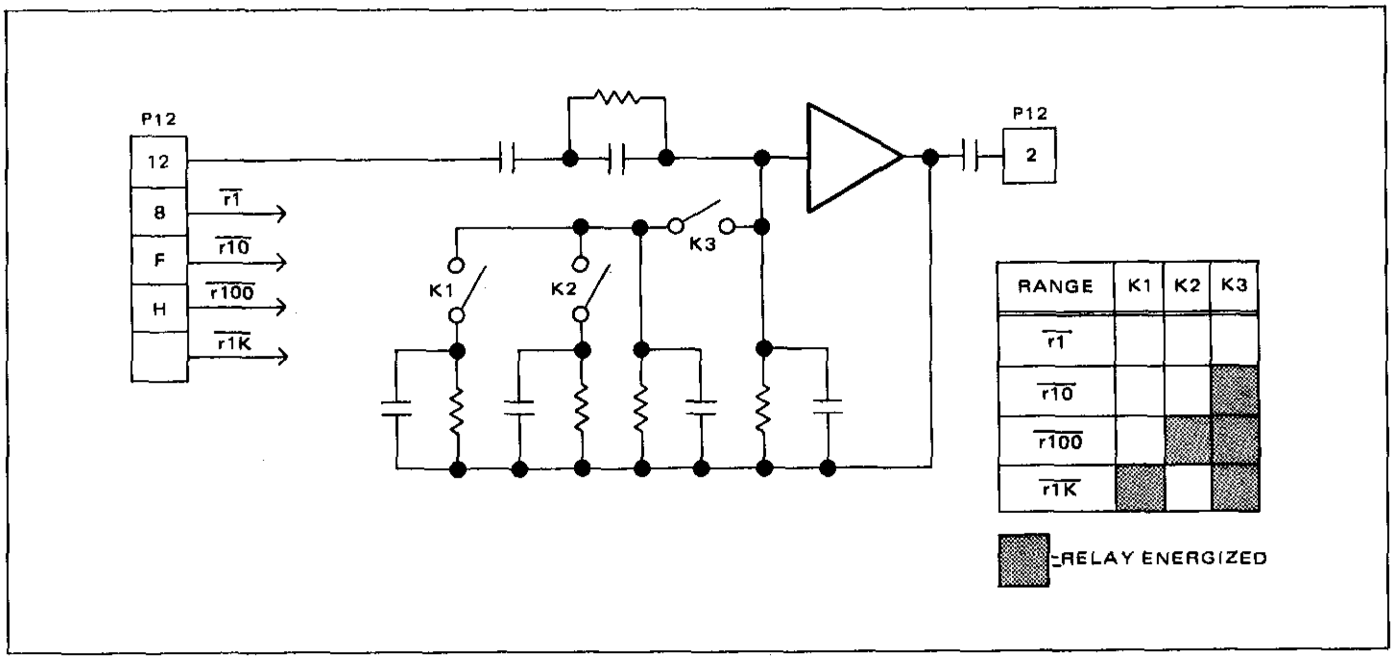


Figure 4.7 - Scaling Amplifier

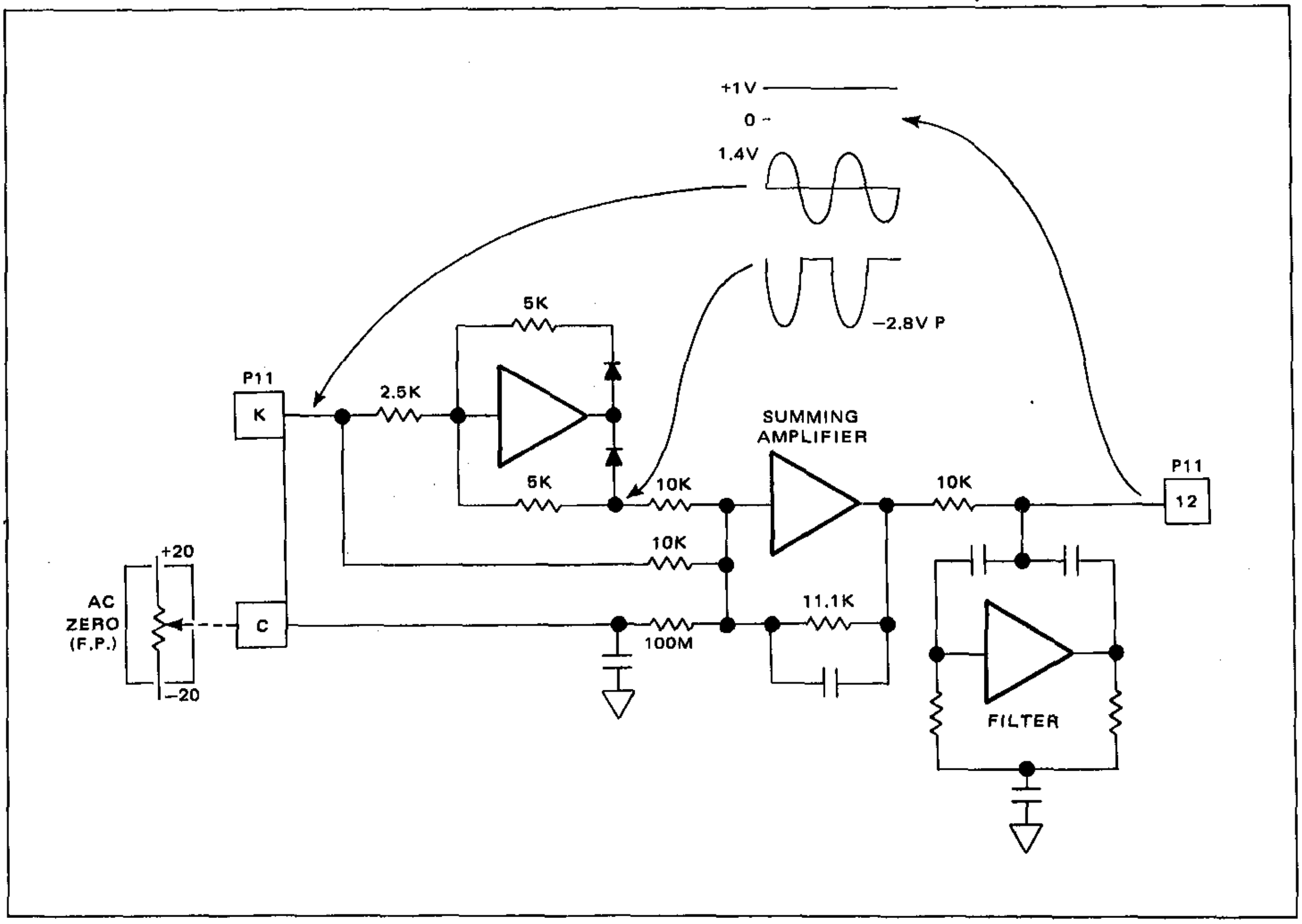


Figure 4.8 - Averaging AC Converter

4.21 Averaging AC Converter.

4.22 The Averaging AC Converter receives the scaled input from the Scaling Amplifier and generates a positive dc equivalent for the DVM measurement section. The circuitry is mounted on a single printed circuit board and occupies location J11 on the Main Logic board. The circuitry, shown simplified in figure 4.8, consists of an active rectifier, a summing amplifier, and an active filter circuit.

4.23 Referring to figure 4.8, a full scale input (1.414 volts peak) is shown applied to the input of the active rectifier. The active rectifier consists of an operational amplifier having two polarity selective feedback loops (one positive, one negative), and the closed loop gain of the circuits is set at 2. The output of the negative going feedback loop is fed through a resistor to the summing node of the summing amplifier. Also fed to this summing node and through a resistor is the full wave input signal. The summing amplifier adds the two inputs, averages them and multiplies the signal by 1.11 to produce the dc equivalent of the RMS input, or 1 volt dc. The ripple content is attenuated by the summing amplifier. A full scale input of 100 Hz would result in a ripple at the summing amplifier output of ≈50 millivolts. Further ripple attenuation is provided by the active 3-pole filter. For the same example, the filter would increase the ripple attenuation to ≈5 millivolts.

4.24 RMS AC Converter.

4.25 The circuitry is shown simplified in figure 4.9. The Scaling Amplifier consists of an operational amplifier with a fixed input impedance and four feedback paths. The feedback path for the one volt range is permanently wired into the circuit; the 10, 100, and 1000 volt range feedback paths are connected in parallel to the 1 volt feedback path by relays K1, K2, and K3. The scaling amplifier supplies an accurate 1 volt output on each range selected with full range inputs applied.

4.26 The active rectifier is an operational amplifier with two polarity selective feedback paths (one conducting only with a positive amplifier output and the other conducting only with a negative amplifier output). The voltage developed across the positive conducting leg is applied through a 10K resistor to the summing node of the log amplifier along with the full wave signal through a 20K resistor from the output of the scaling amplifier. These two inputs are combined and, due to the non-linear feedback loop of the log amplifier (consisting of Q14A and Q15A) produce the log of the combined signal at Ⓒ. This signal is fed through an identical path (consisting of transistors Q15B and Q14B) to the input of the summing amplifier.

4.27 The summing amplifier converts the signal to a dc level. The ripple content of the dc level is attenuated and the output reduced to provide a dc equivalent of the RMS value of the ac input signal.

4.28 Attenuator.

4.29 The Attenuator board is a single printed circuit board and occupies connector J7 on the Main Logic board. The Attenuator consists of a relay controlled voltage divider used on dc function that provides selectable scaling factors of X1, X.1, and X.01; a relay controlled feedback network used in conjunction with the isolator that provides selectable gain factors of X1, X10, and X100; and current compensation circuitry used in conjunction with the ohms converter.

4.30 Isolator.

4.31 The Isolator is a single printed circuit board and occupies connector J8 on the Main Logic board. The Isolator consists of a high open-loop-gain amplifier, a bootstrap amplifier, and a 3-pole filter. The amplifier is used potentiometrically and operates in conjunction with the attenuator board as shown in figure 4.10.

4.32 The bootstrap amplifier generates the + and − supply voltages for the input stages of the isolator, causing them to track the input signal. This results in an effective input impedance of greater than 10,000 megohms. The filter is an active 3-pole Bessel type connected by relay K1 to a point between the gain stage and the post amplifier of the isolator. The filter increases normal mode noise rejection from 10 to 48 dB (at 59 Hz) when K1 is energized. Filter selection is through the front panel switch or the remote programming option.

4.33 Switching Bypass.

4.34 The Switching Bypass board is a printed circuit jumper board and occupies connector J5. The Bypass board replaces the Switching board when the Ohms and AC converter options are not used in the DVM. The signals are routed through the Bypass board in exactly the same manner as in the Switching board when the dc function is selected. A block diagram of the Signal Conditioning section with the Bypass board installed is shown in figure 4.11.

4.35 INTEGRATION.

4.36 The Model 5900 uses an improved version of the standard dual slope integration method of analog-to-digital conversion, called delayed dual slope. As in the standard technique, the input signal is integrated for a set time

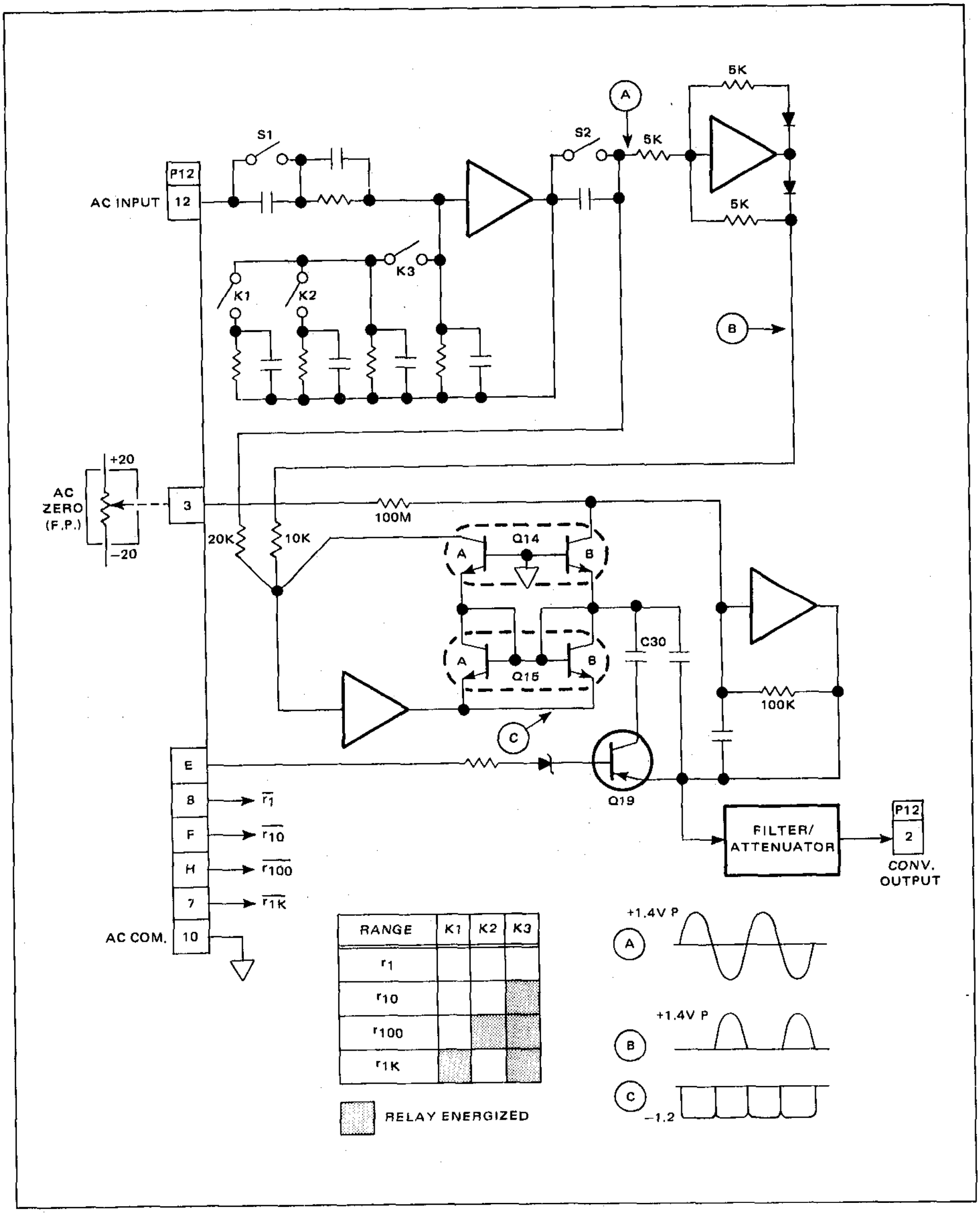


Figure 4.9 - RMS AC Converter

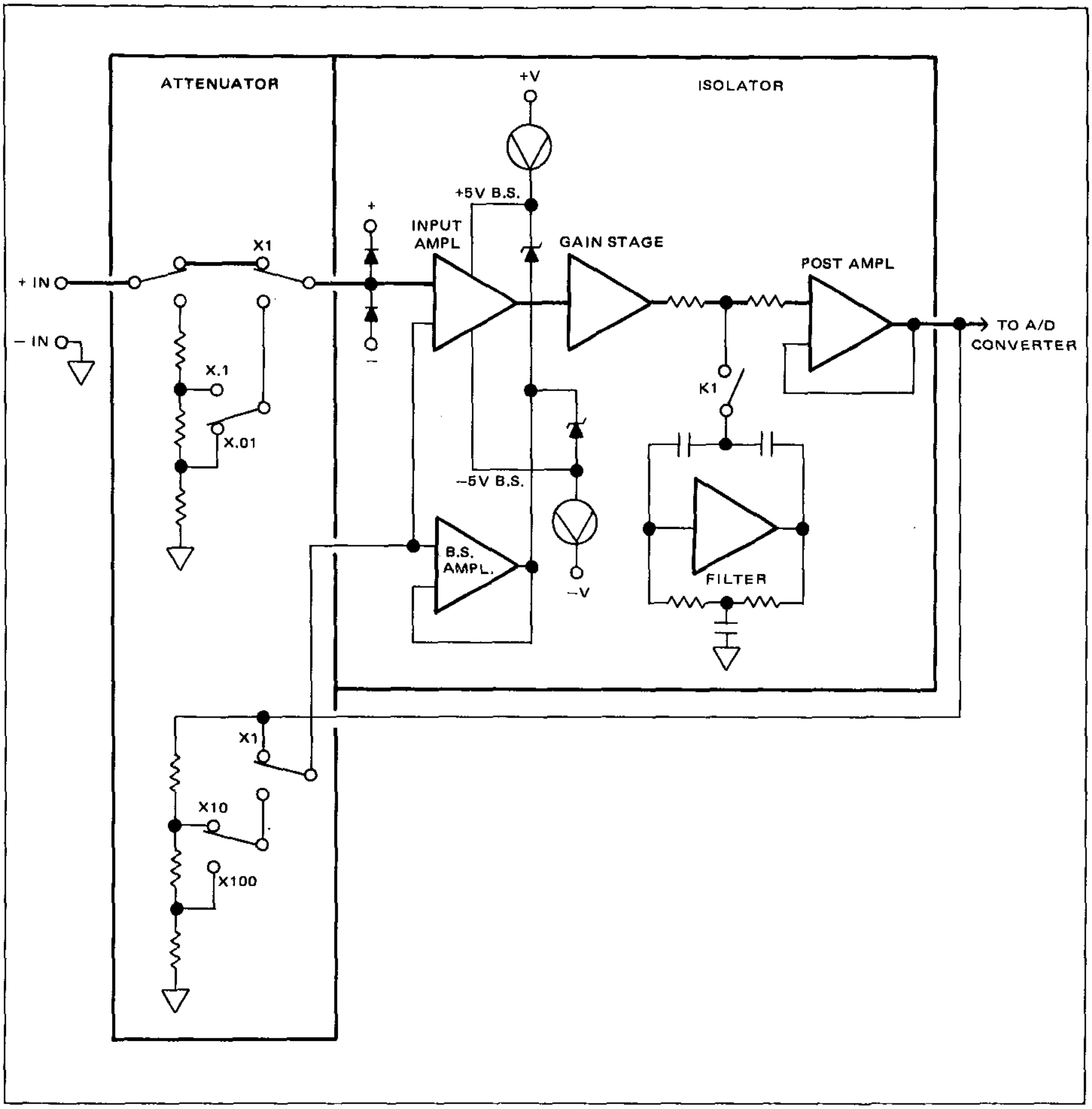


Figure 4.10 - Attenuator/Isolator DC

period to produce a voltage that is directly proportional to the input signal. At the conclusion of this signal integration period, the input signal is removed from the integrator and replaced by a fixed reference voltage whose polarity is opposite that of the input signal. This causes the integrate output voltage to discharge at a linear and fixed rate for a time period that is directly proportional to the voltage developed during the signal integration period. This reference integration time period is measured and displayed in the instrument readout. The transition from signal to reference integration in the A to D sequence, is accompanied by switch noise in the form of spikes. Due to this and normal mode noise which may accompany the input signal, the standard dual slope technique is subject to noise induced errors with input signals at or near zero. The delayed dual slope technique used in the Model 5900 DVM minimizes this source of measurement error by generating a period of non-measurement or delay between the two integration

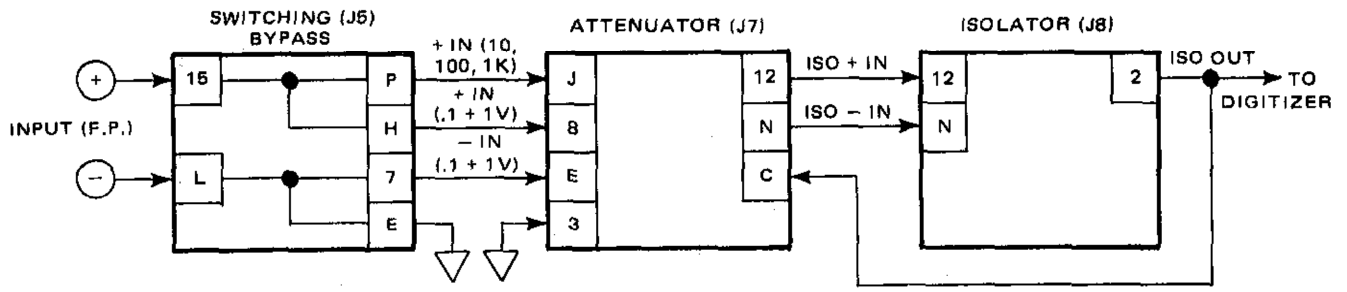


Figure 4.11 - Signal Flow, Switching Bypass

periods. The circuitry used to perform this task include both the Digitizer and portions of the Display/Logic section. In the Digitizer, shown in simplified form in figure 4.12, this is reflected as an adjustment to the basic shape of the integrator output signal as shown in figure 4.13. The 'delay' portion of the integration cycle is initiated immediately following the signal integrate period and is the result of two factors. First, an analog level equal to 180 digits and of a polarity that resists the axis crossing from occurring, is produced at the integrator output by a network called the feed forward circuitry. Second, a capacitor in the feedback network of the gain stage that follows the integrator adds to the total delay period. The total effect is a fixed delay of the axis crossing signal of 200 digits.

4.37 Digitizer.

4.38 The circuitry that performs the A/D conversion is mounted on the single, printed circuit Digitizer board and occupies connector J9 on the Main Logic board. The circuitry includes: an integrator and switching network, a gain stage, null detector, transformer driver, signal and reset logic, switch controls and + and − reference supplies.

4.39 INTEGRATOR.

4.40 The Integrator consists of an operational amplifier with a capacitive feedback path to convert the dc levels applied to its input to a corresponding ramp voltage at the integrator output. The use of a dual FET input stage provides a correspondingly high input impedance and permitting capacitor input coupling during the integration period and allowing auto-zeroing during reset. The feed forward circuitry is a voltage divider network that takes a portion of the reference voltage and applying it to the non-inverting input of the integrator. This results in an equal amount of voltage appearing at the integrator output.

4.41 The integrator switches consist of junction FET's, controlled by circuitry located on the Digitizer. Referring to figure 4.12, switch S1 conducts during the signal integration period, switch S2 or S3 during reference integration and S4 and S5 during reset. The output of the integrator is coupled to the following Gain Stage through two FET's connected as current generators. The purpose of these generators is to prevent loading of the Integrator while maintaining reasonable coupling to the gain stage input.

4.42 GAIN STAGE.

4.43 The gain stage greatly increases the amplitude of the integrator output especially in the area near zero to provide a more clearly defined axis crossing signal for the null detector to respond to. The gain stage also exhibits low pass filter characteristics which, as previously discussed, adds to the total delay of the integration sequence. This reduces the total noise response of the system and reduces the wide band response requirements of the null detector. The circuit consists of a potentiometric amplifier with a programmed gain control, providing gains of 300 for stage inputs of up to 13 mV and decreasing to 14 for signals above this level.

4.44 NULL DETECTOR.

4.45 The Null Detector consists of an inverting, open-loop amplifier with an output swing of 5 volts. The Null Detector converts the amplified analog signal (ramp) from the integrator to a digital level (logic 1 ≈ +5 volts and logic 0 ≈ 0 volts). This digital signal, called either the null detector output or axis signal is used on the Digitizer board for determining the polarity of the reference to be used for the reference integration and, by way of the transformer driver and transformer T1, the circuitry of the Display/Logic section of the main assembly.

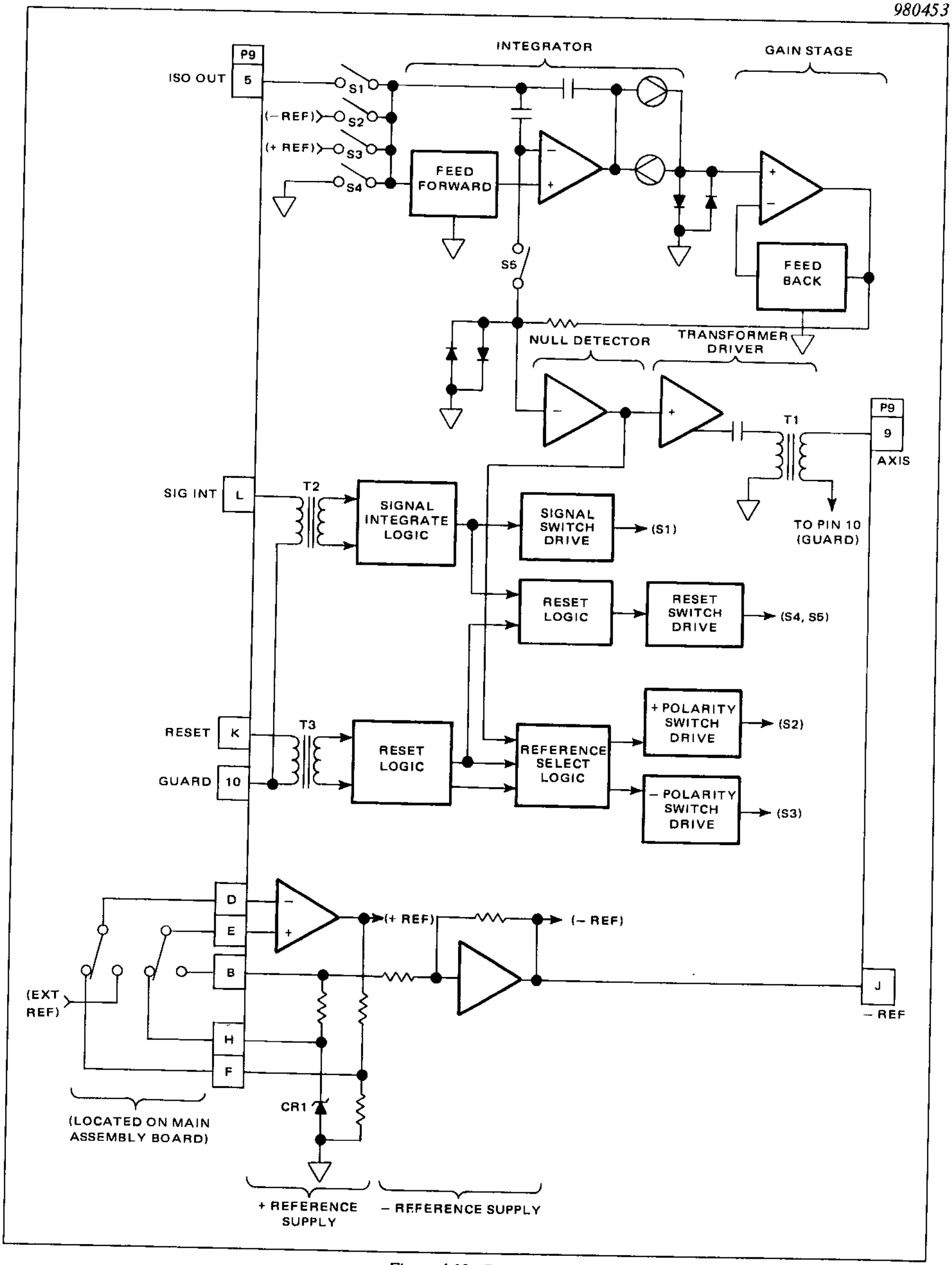


Figure 4.12 - Digitizer

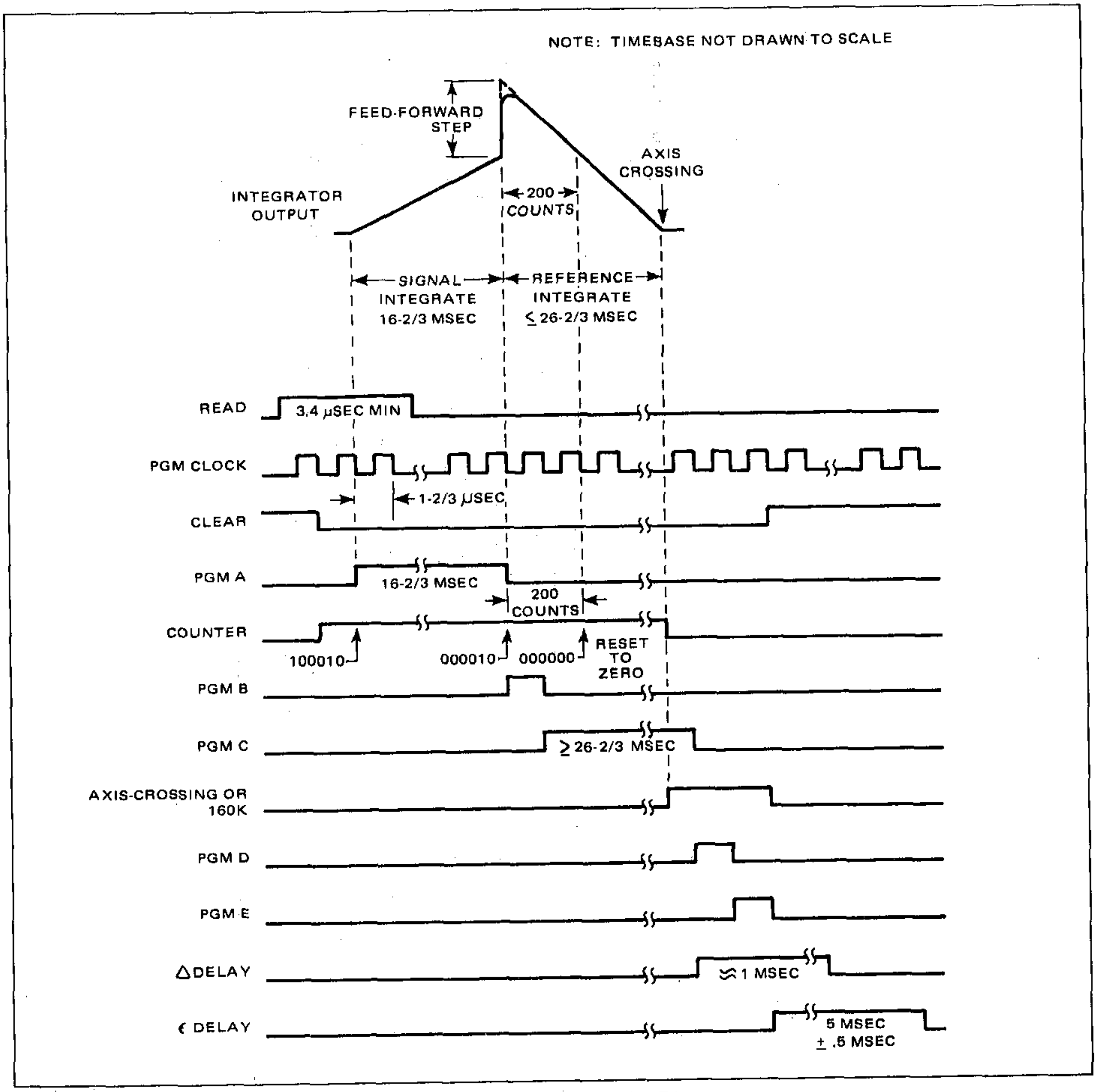


Figure 4.13 - Integration Timing Diagram

4.46 TRANSFORMER DRIVER.

4.47 This circuit consists of a complementary emitter-follower, capacitor coupled to the isolation transformer T1.

4.48 SIGNAL AND RESET LOGIC.

4.49 This circuitry operates from pulse data obtained through isolation transformers T2, T3 and originating from control circuitry of the Display/Logic section. The data is converted into control signals for operating the integration switches.

4.50 DIGITIZER LOGIC.

4.51 The Digitizer Logic receives its timing information through isolating data transformers T2 and T3. The logic converts this information into control signals that operate the FET switches. The timing of the input data and switch operation is provided in figure 4.13.

4.52 Ratio, Standard.

4.53 The standard ratio consists of relay K1 on the interconnect board. When nonenergized, this relay routes the

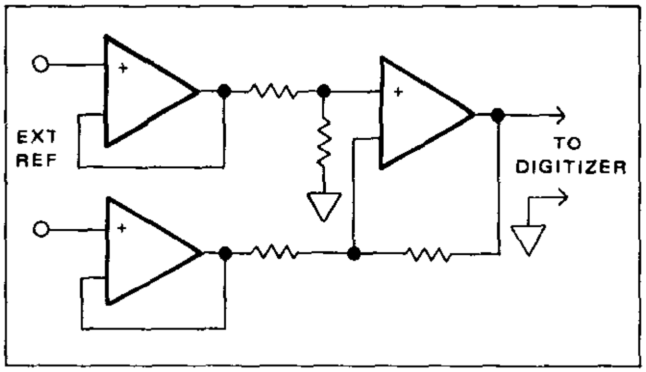


Figure 4.14 - 4-Wire Ratio Option

outputs of the internal zener reference bridge to the reference amplifier (both located on the reference amplifier assembly) and produces a fixed + and − 10 volts; when energized (Ratio selected) the relay reroutes the signal flow, replacing the zener input with the EXT REF input and converting the +10 output amplifier to a noninverting gain of one amplifier.

4.54 Ratio Option.

4.55 The four wire ratio circuitry is mounted on a single printed circuit board and occupies connector J14 on the Main Logic board. The 4-wire ratio option eliminates ground loop errors in ratio measurements by permitting the reference input common lead to float in reference to the signal input common. The circuitry, shown in figure 4.14, consists of two gain-of-one isolation amplifiers driving a differential potentiometric amplifier. Field installation of the ratio board requires removal of jumpers W1 and W2 on the Main Logic board.

4.56 Display Board.

4.57 The Display board is a single printed circuit board and occupies connectors J1 and J2 on the Main Logic board. The display board is located directly behind and parallel to the front panel of the instrument; the function and range control knobs on the front panel are connected by shafts to the rotary switches on the display board. A mechanical interlock attached between the two shafts prevents the manual selection of incorrect function/range combinations. The display board contains the function, the manual and autorange, and the annunciator circuitry. The circuit is shown in simplified block form in figure 4.15 and described below.

4.58 FUNCTION AND RANGE SWITCHES.

4.59 These generate a negative true output and operate only in local control (programming not selected). The function switch has three positions generating outputs (from left to right) of $\overline{AC}$, $\overline{DC}$, and $\overline{\Omega}$. The range switch has nine positions and generates the outputs shown in table 4.2.

4.60 DATA ENCODE.

4.61 The output of the range switch is converted to positive true 1248 BCD logic by this circuitry. The BCD

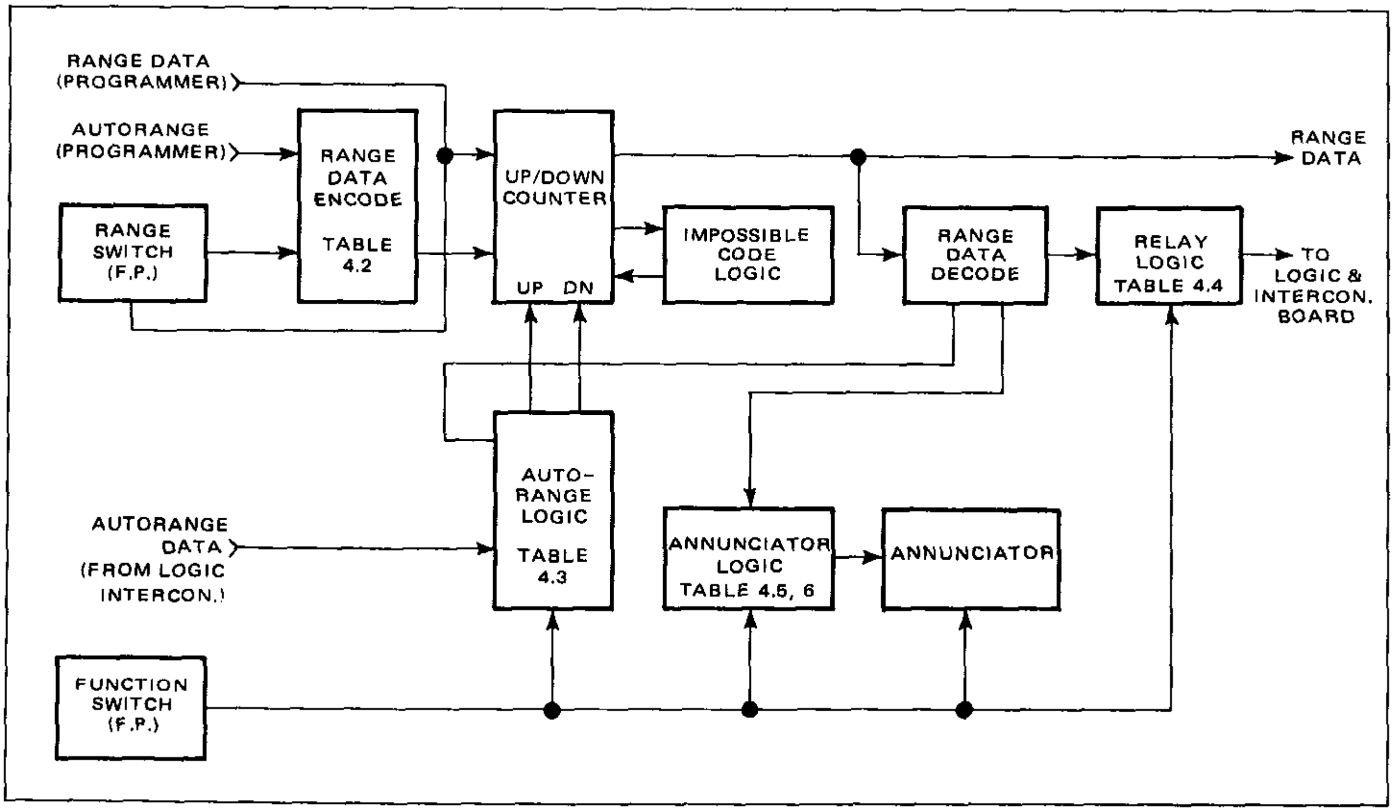


Figure 4.15 - Display Board

Table 4.2 - Range Switch Code

RANGE SWITCH	SWITCH OUTPUT	DATA ENCODE OUTPUT				BINARY WEIGHT
		A	B	C	D	
10 Ω	$\overline{R2}$	F	T	F	F	2
.1	$\overline{R3}$	T	T	F	F	3
1	$\overline{R4}$	F	F	T	F	4
10	$\overline{R5}$	T	F	T	F	5
100	$\overline{R6}$	F	T	T	F	6
1000	$\overline{R7}$	T	T	T	F	7
AUTO	–	F	F	F	F	0
10M	$\overline{R8}$	F	F	F	T	8
100M	$\overline{R9}$	T	F	F	T	9

output is the same as produced by the programmer for remote range selection and is shown in table 4.2. The four BCD output lines from the data encode are applied to the up/down counter.

4.62 UP/DOWN COUNTER.

4.63 The up/down counter is a decade counter capable of counting up from 0 to 9 and overflowing to 0, counting down from 9 to 0 and overflowing to 9, being preset to the BCD input, and being cleared to zero. In manual range the up/down counter is held in the preset mode and the output of the counter always equals the BCD code from the data encode circuitry. In autorange the BCD input from the range data encode is inhibited and the output of the counter is controlled by the autorange logic.

4.64 AUTORANGE LOGIC.

4.65 The autorange logic generates the control pulses for advancing the counter up or down. Data are received from the function switch and from the range data decode circuit, a BCD to 10-line converter. If no range change is required the circuitry generates no control signals and the counter is not advanced. An up range signal is generated during the Program D period if an up range 160% signal is true and the $\overline{\text{up range}}$ inhibit signal is not false (see table 4.3). One up range signal is generated per measurement cycle. A down range signal is generated during the Program D period if the down range 15% signal is true and the $\overline{\text{down range}}$ inhibit signal is not false (see table 4.3). One down range signal of this type is generated for each measurement cycle. In the event that the counter is in a forbidden range (not available for the function selected), during the clear period, the counter is made to down range at the clock rate until the counter is in an available range. The autorange circuitry then operates normally to select the most appropriate range. The forbidden ranges are indicated in table 4.3. If the counter output produces an 'impossible code' (as could happen when the instrument is turned on and autorange is selected), the impossible code logic resets the counter to zero; the autorange circuitry then selects the appropriate range.

Table 4.3 - Autorange Logic

DATA	INHIBIT					FORBIDDEN RANGE					
	$\overline{\text{UP RANGE}}$		$\overline{\text{DOWN RANGE}}$								
$\overline{DC}$			F								
$\overline{AC}$				F					F		
Ω	F					F					
$\overline{\Omega}$		F			F		T	T			
$\overline{R0}$										F	
$\overline{R1}$											F
$\overline{R2}$					F	F					
$\overline{R3}$			F						F		
$\overline{R4}$				F							
$\overline{R7}$	F										
$\overline{R8}$							F				
$\overline{R9}$		F						F			

Table 4.4 - Relay Logic Coding

RANGE	FUNCTION						
	Ω		DC			AC	
	.1 + .1	1 + 100	.1 + 1	1 + 100	100 + 1000	.1 + 1	1 + 100
10 Ω	■						
.1	■	■	■				
1	■	■	■	■		■	■
10				■	■	■	■
100					■	■	■
1000						■	■
10M							
100M							

■ ENERGIZED

Table 4.5 - Annunciator Logic

INPUT	ANNUNCIATOR											
	PGM	FILTER	RATIO	DC	AC	Ω	KΩ	MEG		NO	+	–
$\overline{\text{SYSTEM CONTROL}}$	F									SEE TABLE 4.6		
$\overline{\text{FILTER}}$		F										
$\overline{\text{RATIO}}$			F									
$\overline{\text{DC}}$				F							F	F
$\overline{\text{AC}}$					F							
$\overline{\Omega}$						F	F	F	F			
W1 (JUMPER						IN	IN	IN	IN			
W2 (JUMPER)					IN							
$\overline{\text{R2}}$						F						
$\overline{\text{R8}}$							T	F				
$\overline{\text{R9}}$							T		F			
+ POLARITY											T	
– POLARITY												T

4.66 RELAY LOGIC.

4.67 The relay logic is generated by data from the range data decode and the function switch and is used via optically coupled isolators on the Main Logic board to control the attenuator range relays. The codes as shown in table 4.4 indicate the attenuator relay closure.

4.68 ANNUNCIATOR LOGIC.

4.69 The annunciator logic controls the selection of the annunciator lamps as shown in tables 4.5 and 4.6.

4.70 MAIN LOGIC AND CONTROL CIRCUITRY.

4.71 This circuitry, shown in the block diagram of figure 4.16, is located on the Main Logic board and consists of the control and display logic. In general this circuitry controls all instrument operation including the integration cycle, 'times' the output of the digitizer, and converts this information into data compatible with the Display board.

4.72 Control Logic.

4.73 This circuitry controls the operation of the instrument and consists of the program logic, program counter,

Table 4.6 - "NO" Annunciator Logic

INPUT	NO									
UP RANGE 160%	T									
CLEAR		T	T	T	T	T	T			
$\overline{\text{R0}}$		F								
$\overline{\text{R1}}$			F							
$\overline{\text{R2}}$						F				
$\overline{\text{R3}}$							F			
$\overline{\text{R7}}$				F						
$\overline{\text{R8}}$					F					
$\overline{\Omega}$				T	T	T			F	
$\overline{\text{AC}}$							F			F
PROGRAM								T		
$\overline{\text{SYSTEM CONTROL}}$								T		
W1 JUMPER									OUT	
W2 JUMPER										OUT

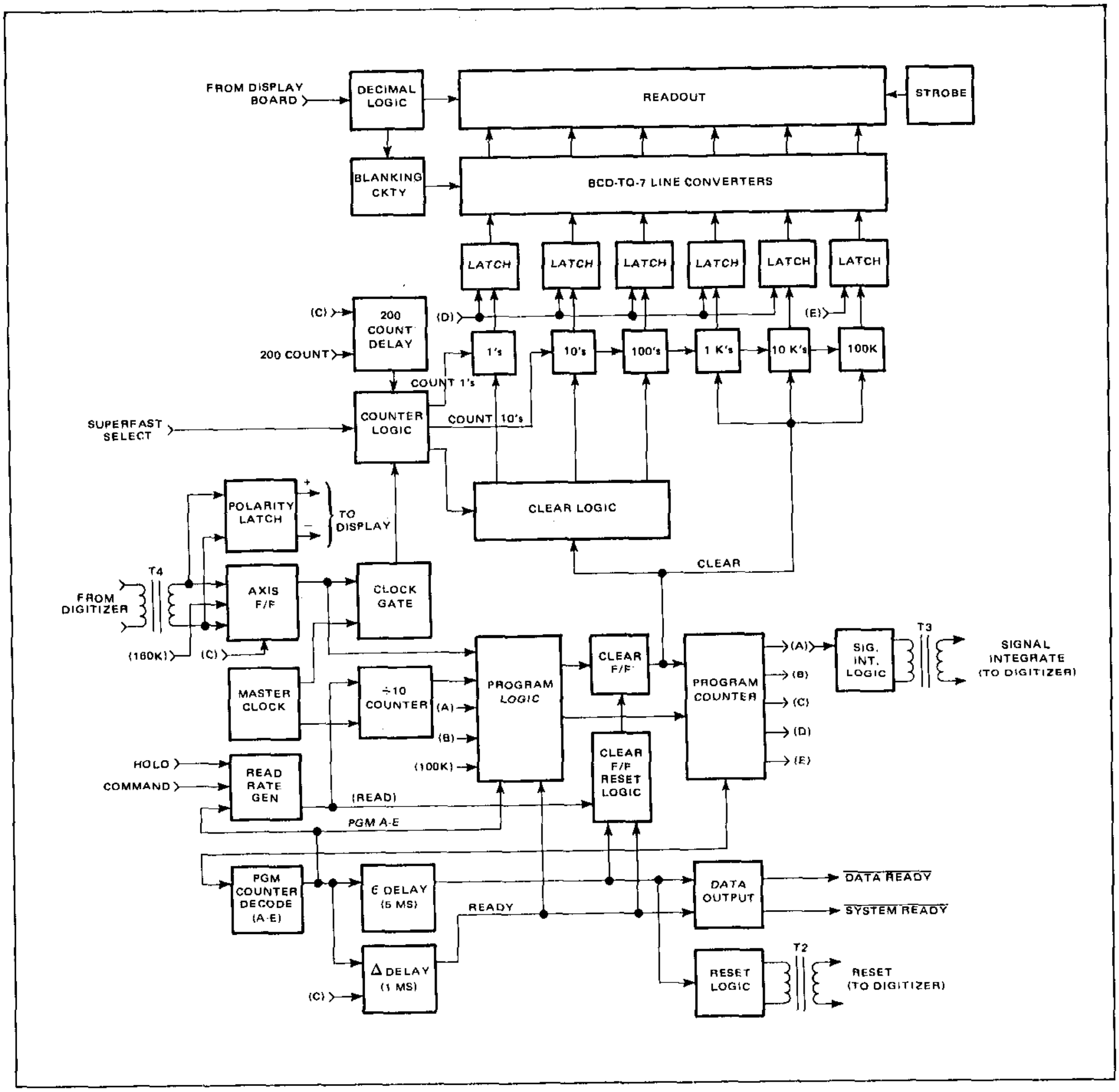


Figure 4.16 - Main Logic & Control Block Diagram

program clock, read rate generator, master clock, clear logic, and counter logic. The instrument operates on a five step program cycle produced by the program circuitry. This consists of a five stage shift register (or program counter), a program clock, and control logic. The five outputs of the program counter correspond to the five program states (PGM A, PGM B, PGM C, PGM D, and PGM E). Only one output of the counter is true at any time during the measurement cycle of the instrument and all of the outputs are false when the instrument is in clear. The program counter is advanced by a gated square wave from the program clock. The program clock output is driven by and equal to the master clock frequency divided by 10 or 600 kHz and is synchronized with the counter at the start of each measurement cycle. The correlation between the master and program clocks causes a 10 count lag between the program counters advancing during the signal integration period and the counter.

4.74 Program Cycle.

4.75 Preceding the start of the measurement cycle, the instrument is in a clear state with the counter set to 100000 and the logic in the reset state. Upon receipt of a read command, whether from the read rate generator or by an external command, the clear signal is removed and the counter begins counting. After ten clock counts (100010) the program counter advances to PGM A. Program A, via the pulse transformer T3, initiates the signal integrate period of the integration cycle on the digitizer board. Program A is terminated after the counter is advanced 100,000 counts. The period is a precise 16-2/3 millisecond and the counter now reads 000010 (the counter overflows to zero at 199,999). At the completion of Program A, Program B is initiated, lasting for 200 clock cycles. This period corresponds to and provides the required digital delay for the analog delay period between the signal and reference integrate periods of the digitizer as described in paragraph 4.36. At the completion of the 200 count delay (PGM B), the 1's, 10's, and 100's decades of the counter are reset, causing the counter to read 000000. At the same time the program counter is advanced to Program C, which in turn enables the axis crossing detector. The program counter remains in this state until (1) an axis crossing signal is received, indicating the reference integration period of the digitizer is completed or (2) the counter reaches 160,000, indicating an overload condition. One of these two inputs causes the axis flip-flop output to go true, inhibiting the clock gate and stopping the counter. The program counter is advanced to Program D and the Δ (delta) delay is initiated. The delta delay lasts for about 1 millisecond and prevents the ready line from going through until after the program counter has completed its cycle. Program D lasts for one program clock cycle and strobes all but the 100K latches. The program counter then advances to Program E which also lasts for one program clock cycle and strobes the 100K latch. At the end of Program E, the Program A-E line goes false, resetting the read rate oscillator, starting the ϵ (epsilon) delay which lasts for 5 milliseconds and generates the reset signal for the digitizer, and generates the clear signal which sets the counter to 100,000 and resets the logic. At the end of the delta delay, the ready line goes true generating the $\overline{\text{DATA READY}}$ output signal and enables the program logic to receive a new read command. At the completion of the epsilon delay, the $\overline{\text{SYSTEM READY}}$ signal is generated and indicates that the instrument is able to accept an external read command. This returns the circuitry to the state at the start of the program cycle.

4.76 Display Logic.

4.77 This circuitry consists of the counter, latches, BCD-to-7 line converters, display strobe, clear logic, decimal logic, and the counter control logic. The counter consists of five series connected decade counters and a J-K flip-flop, and is capable of counting from 000000 to 199999 and then overflowing to 000000. The counter is driven by the 6 MHz master clock by way of the clock gate and the counter logic. The clock gate permits the counter to advance only during the measurement cycle. The counter logic circuitry routes the clock signal for normal or superfast operation. The clear logic operates in conjunction with the clear flip-flop and the counter logic to clear all or portions of the counter depending on normal or superfast operation for different parts of the measurement cycle. The latches store the information from the counters from the last measurement cycle in the form of BCD data. The units through 10K latches are strobed (the information at the input of the latch is transferred to the latch output 1 at Program D; the 100K latch is strobed at Program E. The data from the latches are converted to be compatible with the seven segment LED displays by the BCD-to-7 line converter. The converters are also used in conjunction with the decimal logic to provide leading zero blanking. The LEDs on the readout board are controlled by the BCD-to-7 line converters and powered by the driver decoder strobing circuit. This consists of a one-shot driven by a 120 Hz signal. The strobe permits the LED's to operate at their greatest efficiency while maintaining low overall power consumption.

4.78 Superfast.

4.79 This is a high speed operating mode in which the instrument is effectively converted to a four decade instrument. The actual selection of this mode and timing considerations are covered under paragraphs 2.68 and 2.105. Basically the superfast mode is achieved by bypassing the least significant decade (1's) with the counter logic. At the start of a superfast measurement cycle, the 1's decade is in the clear mode and the 6 MHz clock is applied directly to the input of the 10's decade. The signal integration time of the digitizer is reduced from 16-2/3 milliseconds to 1.6-2/3 milliseconds. The 200 digit time period must remain the same as in the standard measurement operation so the instrument is converted back to standard operation during the 200 count delay. At its completion the operation reverts back to superfast and the reference integration period is measured at the same rate the signal integration period was generated.

4.80 Power Supplies.

4.81 There are two separate power supplies used in the Model 5900; one provides the voltage levels required for operating the analog portions of the instrument and the other provides the voltage levels for the digital/display, data output, and programming. The two supplies use a common transformer core and primary winding but the supplies themselves are completely isolated to maintain the common

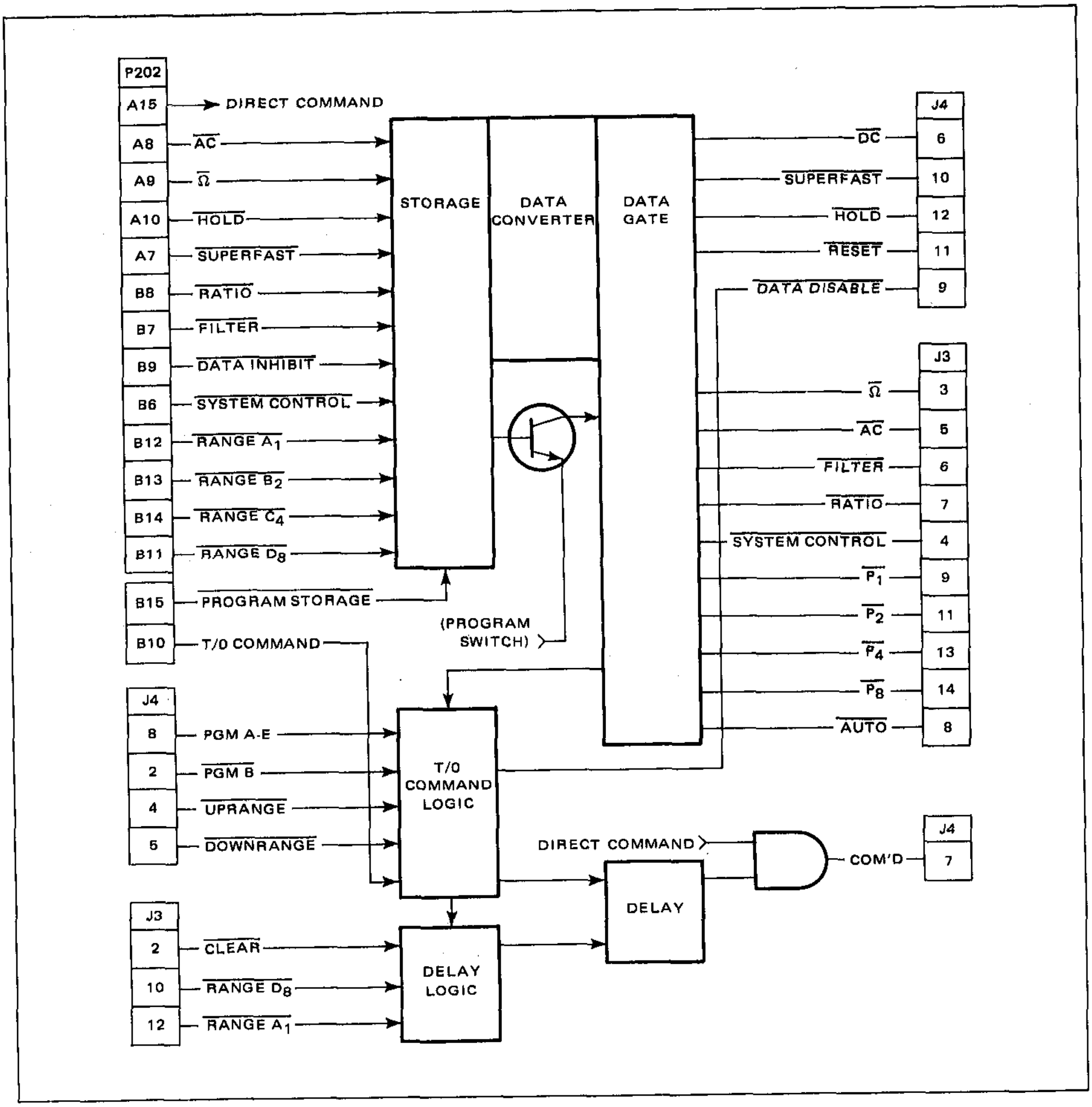


Figure 4.17 - Program Block Diagram

mode rejection characteristics of the instrument. The analog supply provide outputs of ±25 volts, ±20 volts, and −40 volts, all referenced to analog common (mecca). The digital supply provides outputs of +5 volts, +5 volts unregulated, and +150 volts, all referenced to digital common.

4.82 Program.

4.83 The program board is an option provided to allow external remote operation of the instrument. The circuitry is mounted on a single printed circuit board. The board is located above and parallel to the Main Logic board and mounted to the Main Logic board on standoffs. Electrical connection between the Main Logic board and the Program board is by way of two cables (J3-J3A and J4-J4A). A portion of one end of the Program board extends through the rear panel of the instrument, through an opening provided for that purpose. This portion of the board forms an edge connector and is designated P202 PROGRAM INPUT.

4.84 The circuitry, shown simplified in figure 4.17, consists of the program logic, data gate, and the command/timeout circuitry. The program logic converts the control line data generated at P202 to correspond to the instrument control lines. The data gate passes or rejects the converted data; the gate is enabled when the program switch is operated and system control is selected on P202. A series of inputs with their outputs are shown in table 4.7. The timeout circuitry generates the necessary timeouts for delayed remote programming. The timeout periods are covered under paragraph 2.99.

Table 4.7 - Program Logic Conversion

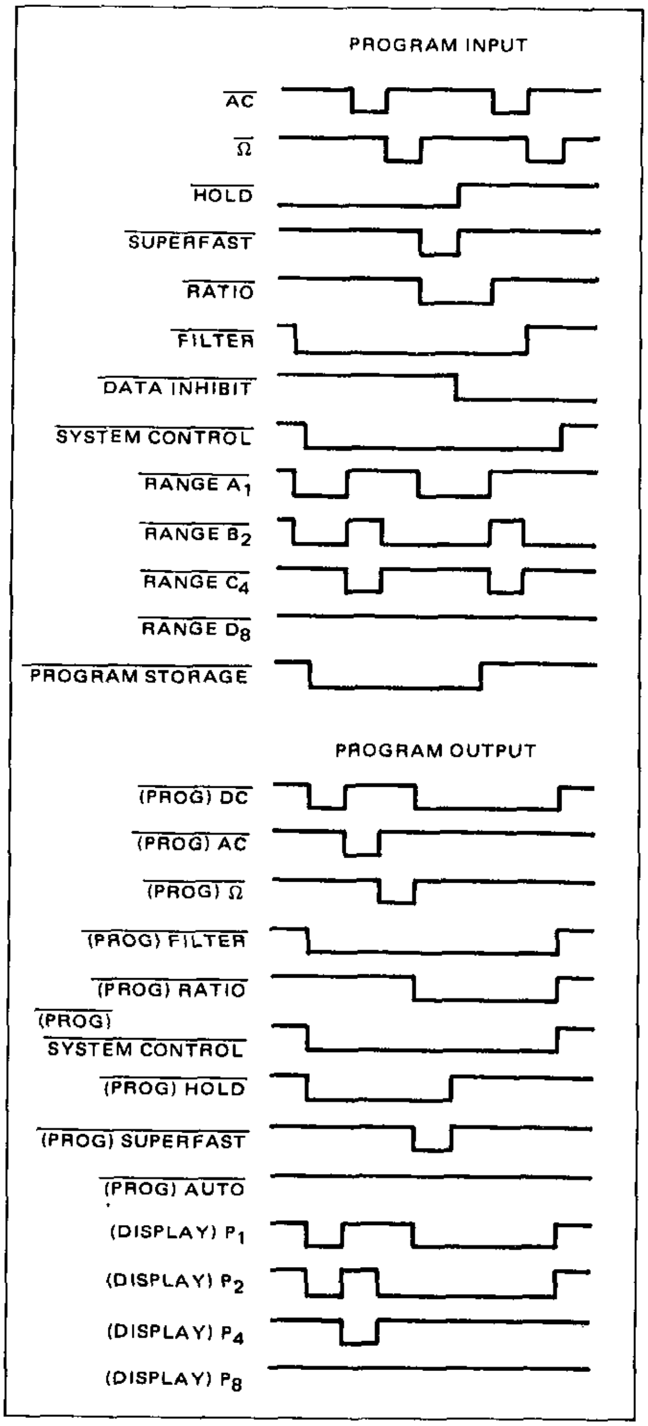


Table 5.1 - Required Calibration Equipment

Function	Qty	Item	Minimum Use Specifications	Suggested Equipment
DC	(1)	Saturated Standard Cell Bank (6 cells)	1 ppm, certified	EPPLEY 106
	(2)	DC Voltage Sources	0.1 ppm resolution	FLUKE 332B
	(1)	Voltage Divider Adjustable	0.1 ppm linearity	FLUKE 720A
	(1)	10:1 Voltage Divider, Fixed	1 ppm, Output Z ≤10 Kohms	Fabricated*
	(1)	100:1 Voltage Divider, Fixed	1 ppm, Output Z ≤10 Kohms	Fabricated*
	(2)	Null Detector/μVoltmeters	1 μV sensitivity	FLUKE 845AR
AC	(1)	Thermal Transfer Standard	35 ppm @ 400 Hz, 50 ppm @ 40 kHz	HOLT 6A
	(1)	Thermal Voltage Converter	50 ppm @ 100 kHz	HOLT 11
	(1)	AC Voltage Source	1 ppm resolution	HP745A/746A
	(1)	Pulse Generator*	10 volts variable, 50Ω output	TEKTRONIX 2101
Ω	(8)	Resistance Standards		
		10Ω	10 ppm	ESI SR1 with corrections
		100Ω	10 ppm	ESI SR1 with corrections
		1 KΩ	10 ppm	ESI SR1 with corrections
		10 KΩ	10 ppm	ESI SR1 with corrections
		100 KΩ	10 ppm	ESI SR1 with corrections
		1 MΩ	10 ppm	Fabricated*
		10 MΩ	50 ppm	ESI SR1 with corrections
		100 MΩ	80 ppm	Fabricated*
OTHER	(1)	Momentary Switch, SPST	–	–
	(1)	Phillips head screwdriver #1	–	–
	(1)	Insulated Adjustment tool	–	JFD5284
	(1)	10 Kohm 1/4 Watt 5% Carbon Resistor	5%	–
	(1)	1 Megohm 1/4 Watt 5% Carbon Resistor	5%	–

*See Text

5.1 SCOPE.

5.2 This section describes the calibration of the Keithley Model 5900 DMM and the following options:

Model 52 Ohms/DC Converter

Model 32 AC/DC Converter, RMS

Model 33 AC/DC Converter, Averaging

Model 62 4-Wire Ratio

5.3 GENERAL.

5.4 The Keithley Model 5900 undergoes rigorous testing and is precisely calibrated under closely controlled conditions, prior to leaving the plant. The procedure provided in this section is designed to recalibrate the Model 5900 and to keep the instrument operating within specifications for indefinite periods of time. If the instrument is equipped with the rear panel selectable input option, set the FRONT/REAR switch to the appropriate position for each of the checks in this section calling for the application of input signals to the instrument.

5.5 Required Equipment.

5.6 A list of the equipment required for calibration is provided in table 5.1. The specific types of equipment in the Suggested Equipment column are acceptable for calibration and provided as a guide in selecting suitable equipment; instruments having operating characteristics equal to or better than those indicated may be substituted.

5.7 Fabricated Calibration Equipment.

5.8 Two fixed voltage dividers, 10:1 and 100:1, are required for dc range calibration. The dividers provide the required accuracy and low output impedance not normally available on commercial equipment. The specifications of the dividers are indicated in table 5.2.

5.9 Two standard resistors are called out for ohms calibration, for which no commercially available standard resistors having the required accuracy are presently available. These can be fabricated by mounting precision resistors in a standard minibox on 5-way binding posts.

Table 5.2 - Fixed Voltage Dividers

Ratio	Range Used on	Output Impedance	Accuracy
10:1	1V 100V	≤10 KΩ	The absolute accuracy of each divider must be known to 1 ppm with the operating voltage applied (i.e., the voltage coefficient must also be known)
100:1	0.1V 1000V		

Suitable types of resistors for the two ranges are listed below.

1 Megohm 2 ppm TC wirewound of known value

100 Megohm 25 ppm TC metal film of known value

5.10 DC Voltage Sources.

5.11 To produce voltage levels of necessary accuracy, special techniques are required. Suitable methods of generating these voltages are shown in figures 5.1 and 5.2.

5.12 10 VOLT SOURCE

5.13 A precise and traceable source of 10 volts is required, not only for calibrating the 10 volt range, but also as a reference for generating highly accurate .1, 1, 100, and 1000 volt levels. The 10 volt source used must satisfy the following requirements.

a. It must be traceable to the National Bureau of Standards;

b. It must have a total accuracy of 1.1 ppm;

c. It must have a low output impedance.

A source filling these requirements is shown in figure 5.1. This circuit consists of a null detector, 7-decade voltage divider, a dc voltage supply, and a bank of saturated standard cells. Two advantages of this particular hookup are that; (a) there is minimal loading of the standard cells and (b) stability, not accuracy, is the primary requirement of the dc voltage supply.

5.14 The output of this circuit is set to a precise 10 volts by setting the voltage divider to the value of the standard cells. The dc voltage source is then adjusted to produce a null on the null detector. The accuracy of the 10 volt source is within 1.1 ppm.

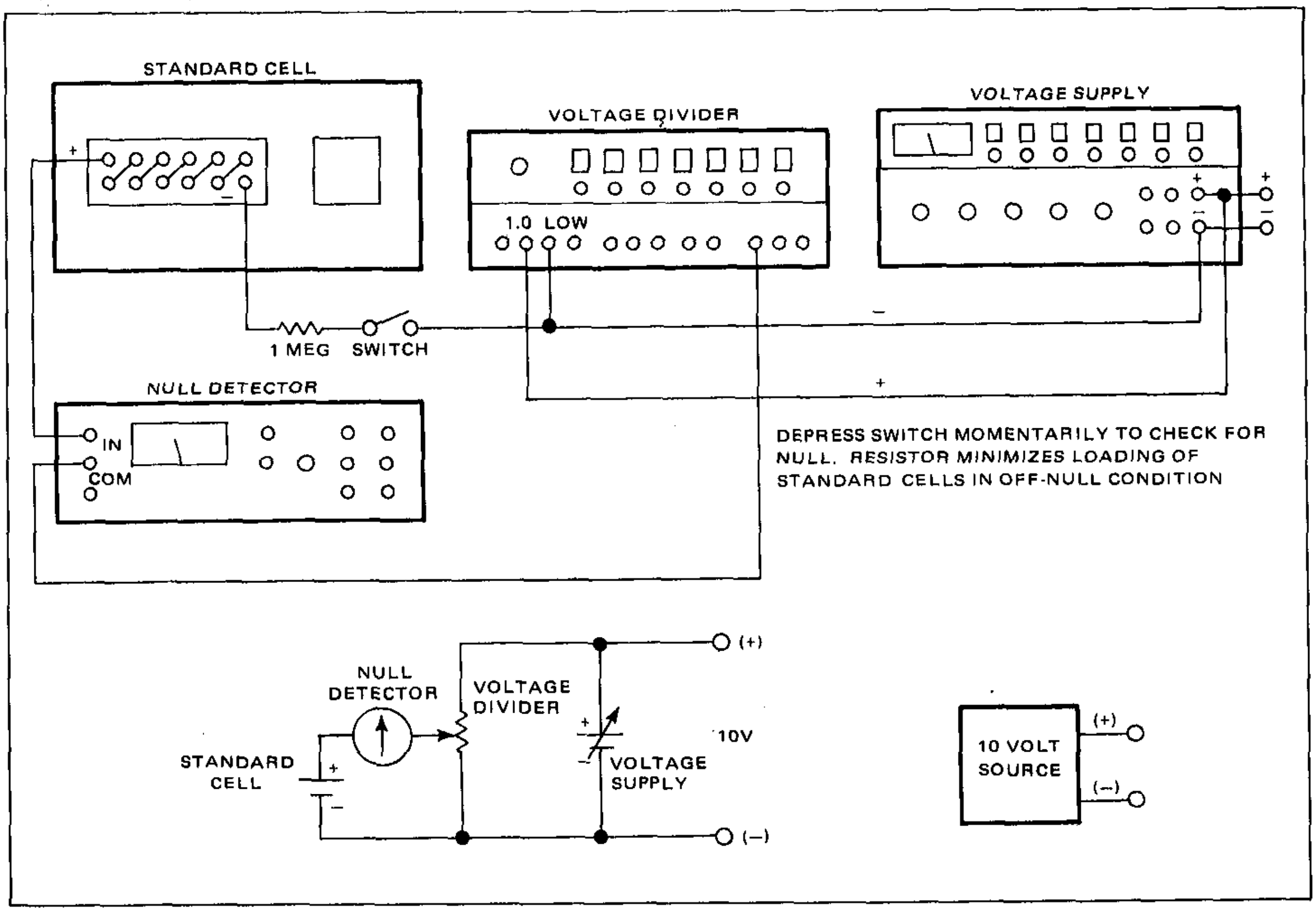


Figure 5.1 - 10 Volt Source

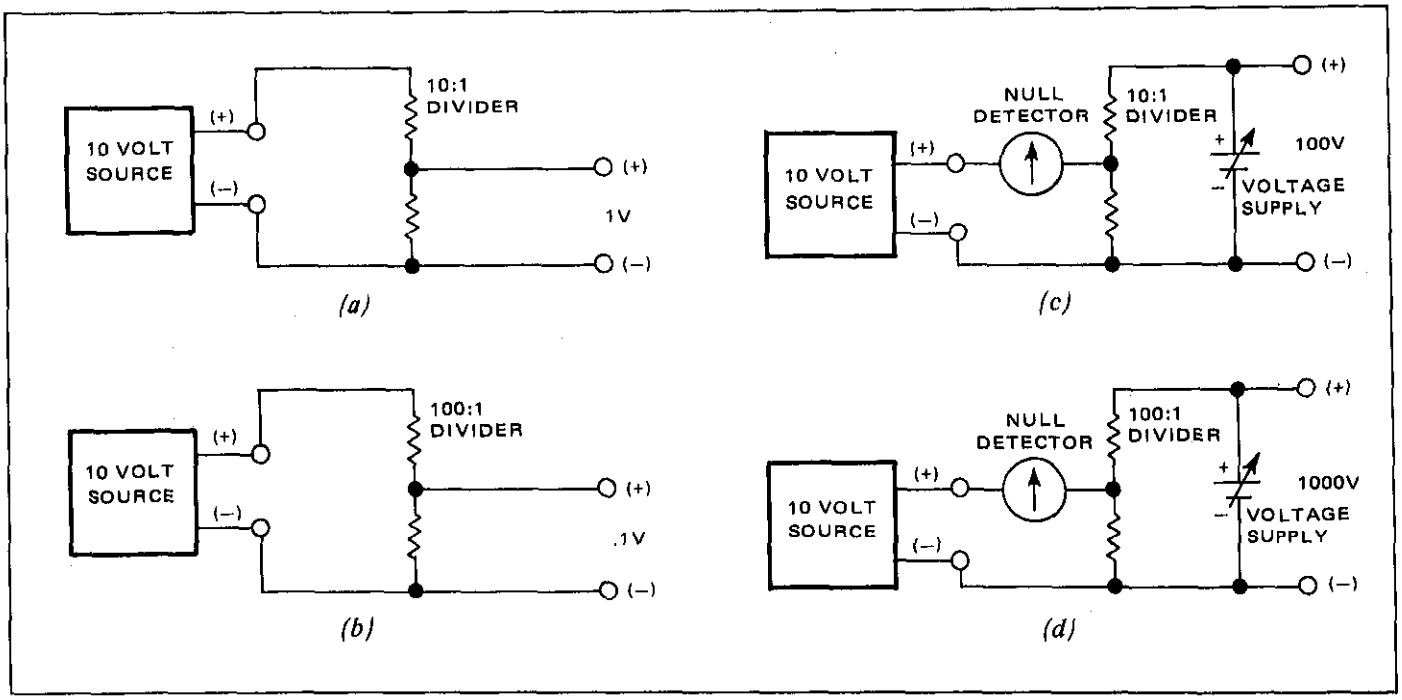


Figure 5.2 - Generating Accurate DC Levels

Table 5.3 - DC Source Accuracies

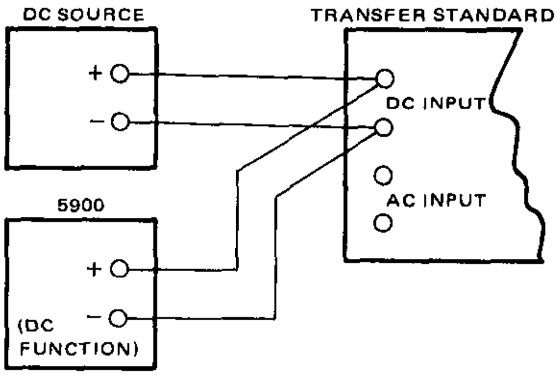
Range	10 Volt Source	Fixed Divider	Total Accuracy	24 hr. DMM Accuracy	Times Better
10	1.1 ppm	–	1.1 ppm	10 ppm	9
1	1.1 ppm	1 ppm	2.1 ppm	10 ppm	4.8
.1	1.1 ppm	1 ppm	2.1 ppm	20 ppm	4.8
100	1.1 ppm	1 ppm	2.12 ppm	10 ppm	4.7
1000	1.1 ppm	1 ppm	2.12 ppm	10 ppm	4.7

5.15 OTHER SOURCES.

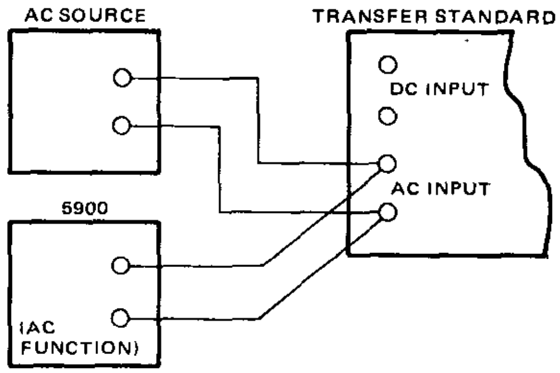
5.16 The remainder of the dc sources can be generated by the circuits shown in figure 5.2. Each of these hookups use a calibrated 10 volt source having the characteristics of the one previously described.

5.17 ACCURACY, DC.

5.18 The accuracy of the dc voltage sources is obtained by adding the various sources of error in each hookup; errors in this discussion are defined in parts per million (ppm). For the 10 volt source, the error is the sum of the standard cell bank (certified at 1 ppm) and the voltage divider (0.1 ppm), giving a constant 1.1 ppm. In table 5.3 is shown the errors of each voltage source, the total accuracy of each hookup, the accuracy of the Model 5900 DMM, and the degree to which the sources exceed the required accuracy of the DMM (4 to 10 times better is the suggested accuracy ratio per MIL-M-38793).



DC. With DMM used to monitor DC output, dc source is adjusted to desired voltage. Transfer standard is then used per manufacturer instructions.



AC. The ac source is adjusted to produce a null on transfer standard. The ac source output is now calibrated and can be used as a precision source for the recalibration of the 5900 AC Converter.
NOTE: Because of the low input impedance of the transfer standard, the DMM input leads must be connected as close to the transfer standard input terminals as possible.

Figure 5.3 - AC Source

Table 5.4 - AC Source Accuracies

INPUT		ACCURACY				
AC Source		Thermal Transfer Standard	DC Source	Total AC Source	Model 33 (Spec)	Model 32 (Spec)
Volts	Freq					
1, 10, and 100 Volts	400 Hz	35 ppm	10 ppm	45 ppm	200 ppm	
	500 Hz					600 ppm
	50 kHz	50 ppm		60 ppm		1800 ppm
	100 kHz				400 ppm	
500 Volts	40 kHz	50 ppm		60 ppm	400 ppm	
						900 ppm
1000 Volts	400 Hz	52 ppm		62 ppm	200 ppm	
						600 ppm

5.19 AC Voltage Sources.

5.20 The generation of accurate ac signals for calibrating the ac converter ranges, requires the use of a thermal transfer standard and a precise dc standard as well as a stable ac source. Sufficient accuracy can be obtained by using a dc source and the Model 5900 being calibrated (immediately after the dc calibration has been completed). The circuitry connections are shown in figure 5.3. Information on the use of the transfer standard can be obtained from the operators manual accompanying the standard. The 5900 is used to set the dc source to the desired voltage; the thermal transfer standard is then used to calibrate the output of the ac source. The calibrated ac source is used to calibrate the 5900 ac converter. This procedure is repeated for each range.

5.21 ACCURACY, AC.

5.22 The accuracy of the ac source is equal to the sum of the transfer standard accuracy and the accuracy of the dc source. The accuracy of the setup for each range and frequency used in the calibration procedures as well as the specified accuracy of the converters is provided in table 5.4.

5.23 PRELIMINARY PROCEDURE.

5.24 Warmup.

5.25 Apply power to the instrument and allow two (2) hours of warmup time before calibrating with instrument covers in place.

5.26 Familiarization.

5.27 Prior to starting the procedure, read all of the steps and verify that all of the necessary equipment, tools, and miscellaneous hookup cables required for the calibration procedure are readily available. Verify that all of the equipment used in the calibration is warmed up for the period prescribed by the manufacturer to reach full accuracy.

5.28 Calibration Points.

5.29 The location of the calibration points (except ac) used in the calibration procedure are shown in figure 5.4. The ac calibration points are shown in figure 5.8. Access to the calibration points is gained by removal of the top cover; the cover is secured to the DMM by captive screws located in each of the four corners of the cover. Directly beneath the cover is located a metal shield with access holes to calibration points (except ac). The shield is part of the instrument internal guard system and helps to reduce noise. For reference, an abbreviated form of the basic calibration procedure is silkscreened to the top of the shield. The shield is to be left in place unless specific instructions are given for removal.

5.30 Environmental Considerations.

5.31 The ambient temperature of the calibration environment shall be held to 23°C ± 1°C.

NOTE

In instruments equipped with the optional 4-wire ratio option it is necessary to remove the 4-wire ratio circuit board and connect jumpers W2 and W3 on the interconnection board. The shield is removed for access to the circuit board and then replaced prior to calibration of the instrument.

5.32 RECALIBRATION PROCEDURE.

5.33 The procedure is designed to produce the highest accuracy in the least number of steps while minimizing interaction between adjustments. To ensure accuracy, do

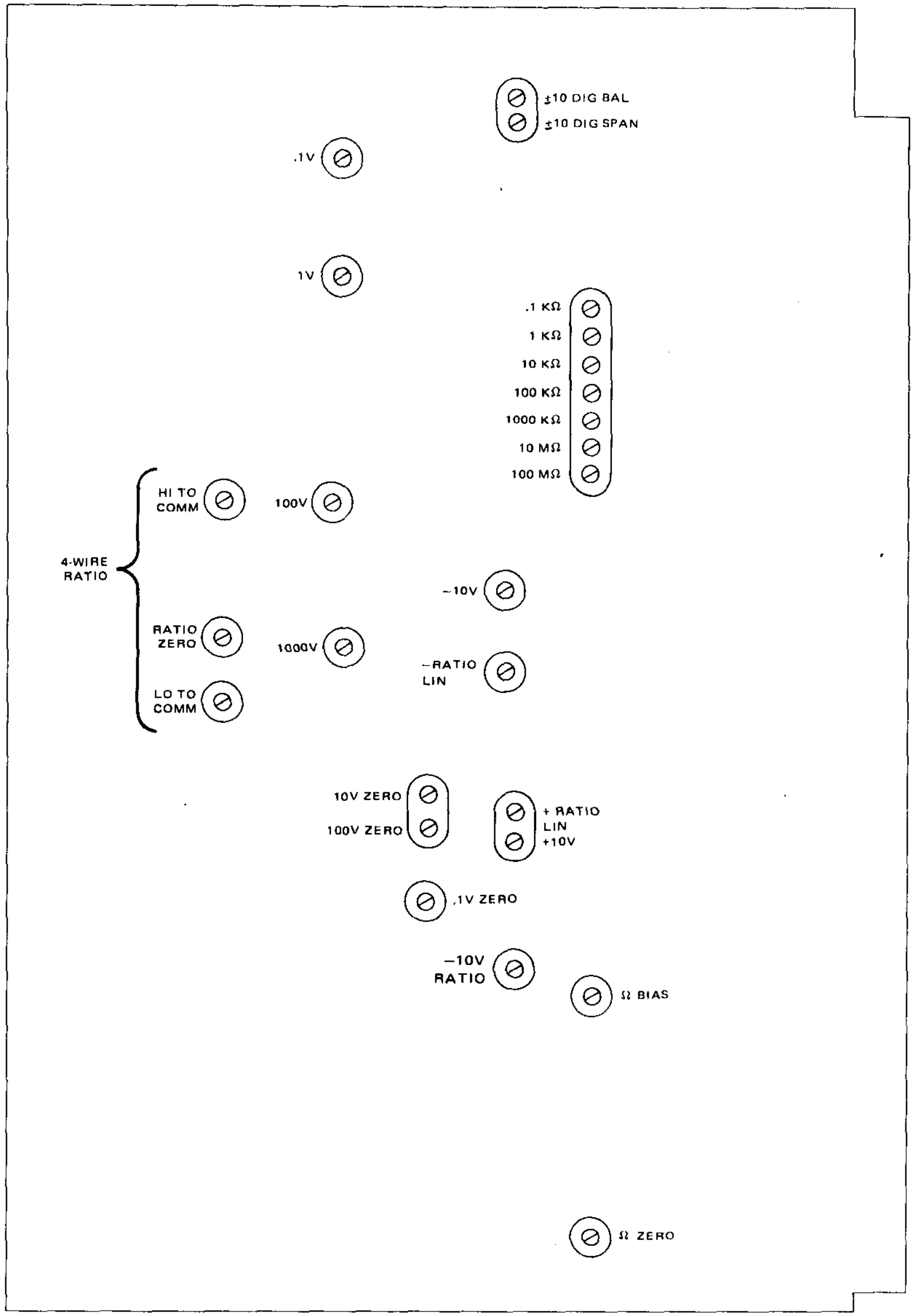


Figure 5.4 - Adjustment Locations

not deviate from the order of adjustments as given in the procedure.

WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.34 Isolator Zero.

a. Select DC function and .1 volt range. Short the ± input terminals; connect microvoltmeter to ANALOG OUTPUT terminals. Set DC OFFSET (front panel) to the center of its mechanical span.

b. Adjust R14 (.1V Zero) on Isolator for a microvoltmeter reading of less than 100 microvolts.

c. Replace the jumper across the ± INPUT terminals with a 1 Megohm resistor. Adjust R3 (100V ZERO) for a reading of less than 1 millivolt.

d. Replace the resistor with a jumper. Select 10V range. Adjust R7 (10V Zero) for a reading on the microvoltmeter of less than 20 microvolts.

e. Repeat the above steps until all ranges are zeroed within the indicated tolerance.

5.35 DC Voltage Zero and Gain.

a. Select DC function and 10V range. Apply an input of +00.0010V. Observe readout and reverse polarity of input (−00.0010V). Adjust R27 (±10 DIGIT BAL) for same readout for "+" or "−" inputs. Adjust R40 (±10 DIGIT SPAN) for ± 10 digits.

b. Apply inputs listed in following tables to the front panel input terminals and the rear panel ratio input terminals. Select mode as listed for each step and adjust indicated control for a readout of ±10.0000.

F/P Input	Ratio Input	Select Mode	Adjust (on Digitizer)
−1.00000V	+1.00000V	Ratio	R5 (−RATIO LIN)
+1.00000V	+1.00000V	Ratio	R64 (+RATIO LIN)
−10.0000V	+10.0000V	Ratio	R2 (−10V RATIO)
−10.0000V		DC	R4 (−10V)
+10.0000V		DC	R57 (+10V)

c. Repeat the above steps as required until all steps are calibrated.

d. Verify that the voltage at the ANALOG OUTPUT terminals (on rear panel) is the same as the voltage on the input terminals at various input levels (±10V, ±1V, etc.).

5.36 DC RANGE CALIBRATION.

5.37 Apply inputs listed in the following table. Select DC function and range as listed for each step. Adjust the indicated control for a readout equal to the input voltage.

Input	Range	Adjust
+.100000V	.1	R18 (.1V)
−.100000V	.1	R18 (.1V)
+1.00000V	1	R5 (1V)
−1.00000V	1	R5 (1V)
+100.000	100	R11 (100V)
−100.000	100	Verify
+1000.00	1000	R13 (1000V)
−1000.00	1000	Verify

5.38 OHMS CALIBRATION (Figure 5.4).

5.39 Ohms Zero.

a. Select Ω-MΩ function and the 10 Megohm range. Short the ± INPUT and ± CURRENT terminals together. Adjust R56 (Ω ZERO) for zero readout.

b. Remove short from INPUT and CURRENT terminals. Connect a 10 Megohm standard resistor across the ± INPUT terminals. Do not connect the + CURRENT lead (figure 5.5).

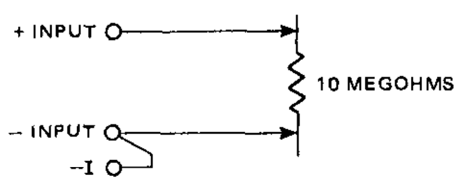


Figure 5.5 - Ohms Input Connection

c. Adjust R9 (Ω BIAS) for a readout of zero.

5.40 OHMS RANGE.

a. Connect standard resistors to the input in the order listed in the following table. Select range as listed for each step and adjust the indicated control for a readout equal to the standard resistor value. Connect as shown in figure 5.6.

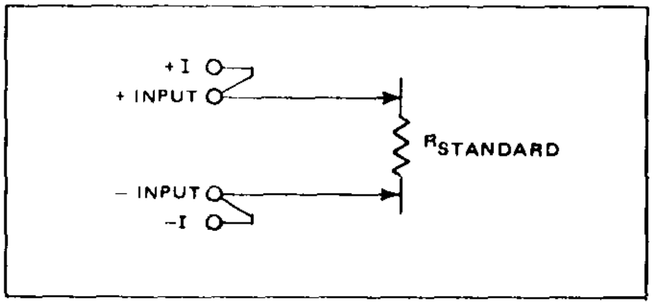


Figure 5.6 - Connections for Ohms Range Adjustment

Standard Resistor	Range	Adjust
100M	100M	R51 (100M)
10M	10M	R47 (10M)
1M	1000K	R45 (1000K)
100K	100K	R43 (100K)
10K	10K	R5 (10K)

b. Connect input with 4-wire configuration (figure 5.7) and complete the adjustments of the low ranges.

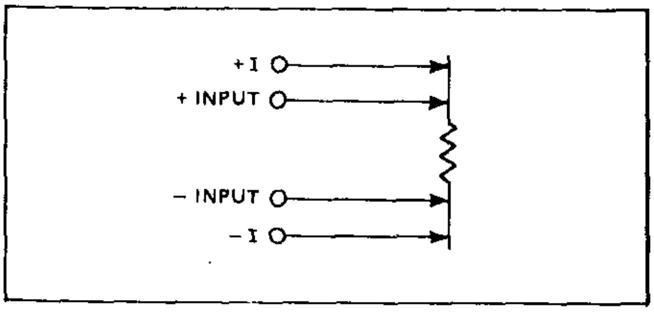


Figure 5.7 - 4-Wire Connections

Standard Resistor	Range	Adjust
1K	1K	R22 (1K)
100	.1K	R36 (.1K)
10	10	No adjustment; verify accuracy

5.41 AC CALIBRATION (Model 33).

5.42 AC Converter Zero (Figure 5.8).

a. Remove Scaling Amp, insert Scaling Amp Bypass card (Keithley P/N 5900-410617) in its place, and install AC Converter on extender. Select AC function, any range, and leave input open.

b. Connect the microvoltmeter with a 10 kilohm resistor in series with the positive lead to TP3, with negative side to TP6 (common). Adjust R35 for a microvoltmeter reading of less than 10 μvolts.

c. Connect the + microvoltmeter lead alternately between TP5 and TP1. Adjust R5 so that the voltages at TP5 and TP1 are equal (balanced) within approximately ±10 μvolts (opposite polarities). The voltage at each of the two test points must be less than ±20 μvolts.

5.43 Frequency Response.

a. Depress FILTER switch. Apply 1 volt at 400 Hz and record readout. Apply 1 volt at 100 kHz and adjust C13 for same readout (±10 digits) as obtained with 400 Hz.

b. Remove extender from AC Converter; remove Scaling Amp Bypass card. Install AC Converter and Scaling Amp into instrument.

c. Apply the inputs listed in the following table and adjust the indicated control on Scaling Amp for a readout equal to the input.

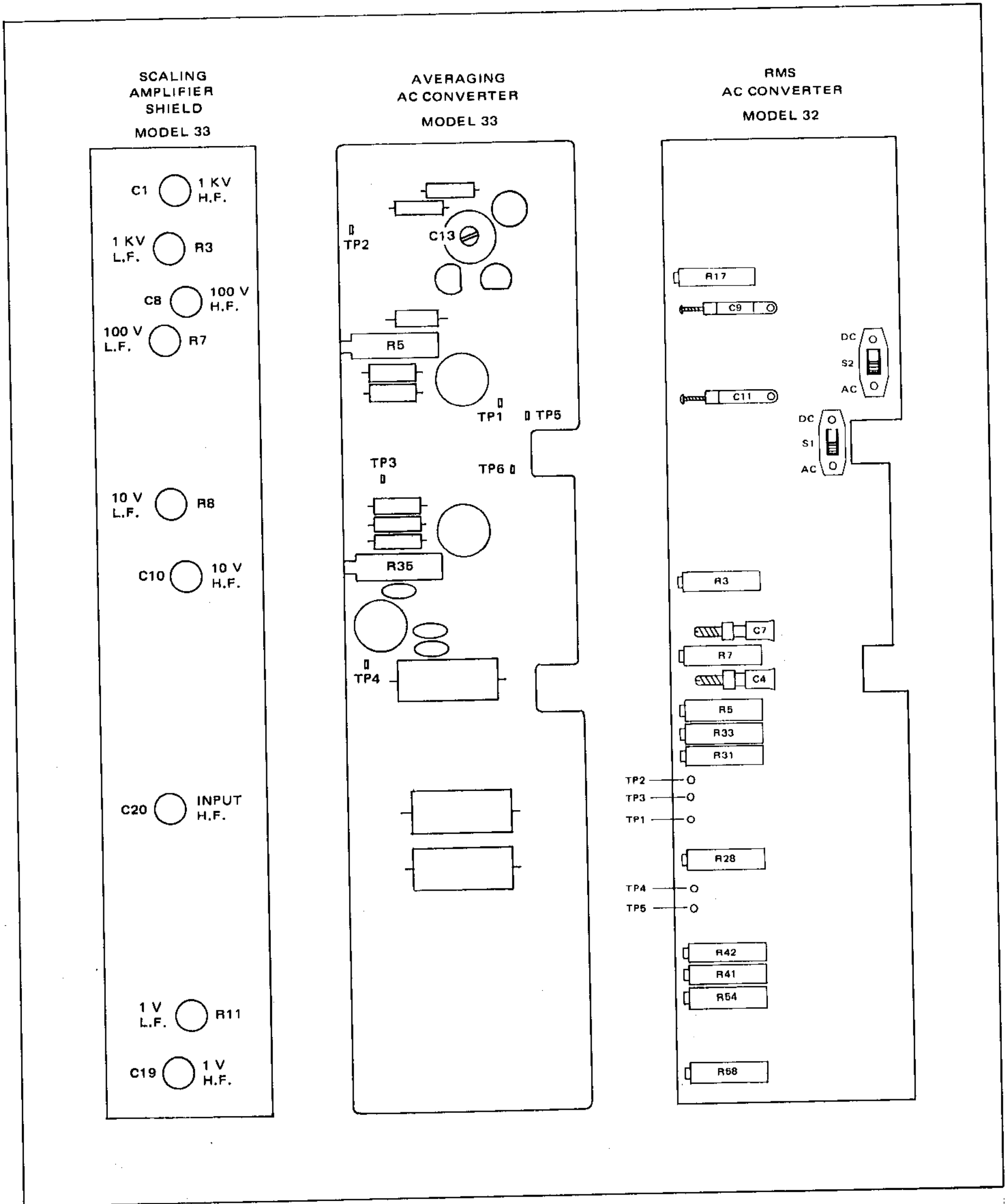


Figure 5.8 - AC Adjustment Locations

E_{in}	Freq.	Adjust
.01000	400 Hz	AC OFFSET (front panel)
1.00000	400 Hz	R11 (1V L.F.)
10.0000	400 Hz	R8 (10V L.F.)
100.000	400 Hz	R7 (100V L.F.)
1000.00	400 Hz	R3 (1000V L.F.)
–	–	C1 (1000V H.F.) set to center of span
500.00	40 kHz	C20 (INPUT H.F.)
1.00000	100 kHz	C19 (1V H.F.)
10.0000	100 kHz	C10 (10V H.F.)
100.000	100 kHz	C8 (100V H.F.)

5.44 RMS AC CALIBRATION (Model 32).

NOTE

Use 10 KΩ resistor in series with + lead of microvoltmeter.

a. Set DVM power switch to off. Extract converter. Set S1 and S2 to DC (away from center of board), replace converter and set power switch to on. Select AC and 1 volt range on DVM front panel. Allow 10 minutes for temperature to stabilize.

b. Connect jumper across DVM input terminals. Connect the microvoltmeter to TP1 (+) and TP5 (–). Adjust R17 for a microvoltmeter reading of 0 ± 30 μV. Remove + microvoltmeter lead from TP1. Turn R41 fully clockwise.

c. Connect microvoltmeter + lead to TP4. Adjust R42 for a microvoltmeter reading of +20 μV ± 10 μV.

d. Connect + microvoltmeter lead to TP2. Adjust R33 for a microvoltmeter reading of 0 ± 30 μV. Remove microvoltmeter + lead from TP2.

e. Connect + microvoltmeter lead to TP3. Adjust R31 for 0 ± 30 mV. Remove + microvoltmeter lead from TP3.

f. Connect + microvoltmeter lead to TP4. Adjust R41 counterclockwise until the voltage at TP4 reads 0 ± 5 μV. Remove microvoltmeter leads and remove jumper across DVM input.

g. Apply –1.00000V DC and note DVM display.

h. Reverse polarity of input to +1.00000V DC and adjust R28 to obtain approximately the same DVM display as obtained in step g. Repeat steps g and h until the two readings are within .01% of each other. Remove DC supply from DVM input.

i. Apply +0.10000 to DVM input and note DVM display.

j. Reverse polarity of input to –0.10000 and verify DVM display is within ±5 digits of the reading obtained in step i. If not, use R31 to balance the readings.

NOTE

R54 is an FSV adjustment and is reset only if major repairs have been performed on the converter. In this event, perform the following adjustment:

Apply a calibrated 1.00000V RMS pulse train with a crest factor of 7 and a period of 1 millisecond (1 kHz repetition rate). Adjust R54 for a readout of 1.00000. Remove the pulse generator from the DVM input and continue with the calibration procedure starting at step k.

k. Set power switch on DVM to off, extract converter, set S1 and S2 to AC (toward center of board). Replace converter in DVM. Reapply power and allow 10 minutes for temperature to stabilize. Select FILTER.

l. Connect the AC source to the DVM input terminals. Apply the inputs listed in the following table and adjust the indicated control for the proper readout.

Range	INPUT		Adjust	Readout
	AC Voltage	Freq		
1V	1.0000	500 Hz	R58	1.00000
1V	.1000	500 Hz	a.c.offset	0.10000
Repeat steps for R58 and a.c. offset until no adjustment is required.				
1000V	1000.0	500 Hz	R3	1000.00
1000V	500.00	40 kHz'	C11*	500.000
1V	1.0000	50 kHz	C9*	1.00000
10V	10.000	500 Hz	R7	10.0000
10V	10.000	50 kHz	C7*	10.0000
100V	100.00	500 Hz	R5	100.000
100V	100.00	50 kHz	C4*	100.000
*Use an insulated screwdriver when adjusting the capacitors. High voltage present on C11.				

5.45 4-WIRE RATIO CALIBRATION.

NOTE

DC calibration of the instrument must be completed before calibrating 4-wire ratio. The DC calibration must be performed with the 4-Wire Ratio board removed and jumpers installed across W2 and W3 on the interconnection board.

a. Install 4-Wire Ratio board; remove jumpers across W2 and W3. Select RATIO, 10V RANGE, and DC function.

b. Connect −1.0V to front panel INPUT terminals; connect +1.0V to REF INPUT terminals on rear panel. Connect a jumper from high side of reference input to ANALOG COMMON (on rear panel).

c. Adjust R12 on 4-Wire Ratio board for a readout of −10.0000 (figure 5.9).

d. Increase voltage at INPUT terminals to −10.0 volts; increase REF INPUT to +10.0 volts. Adjust R10 for a readout of −10.0000.

e. Repeat steps b through c until both are achieved without further adjustment.

f. Remove jumper from high side of reference input to common. Connect the jumper between low reference input and common. Adjust R9 for a readout of −10.0000. Remove jumper and verify that the readout does not change by more than one digit.

g. Apply +1.0V to both signal and reference inputs. Verify a readout of +10.0000.

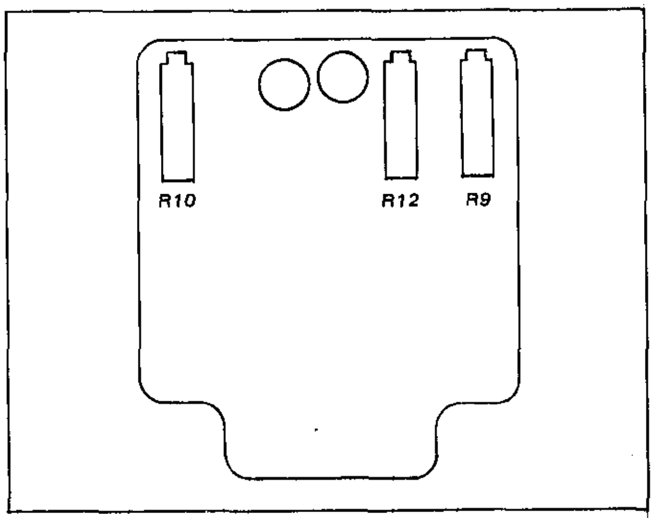


Figure 5.9 - 4-Wire Ratio Adjustment Locations

5.46 TROUBLESHOOTING

5.47 This procedure is provided to aid in locating the cause of an instrument malfunction. The procedure consists of a systematic basic instrument operation check, a table of symptoms and probable causes, and a brief description of major areas of the instrument circuitry from a troubleshooting standpoint. To eliminate as much as possible redundant material, frequent reference is made to information located in other sections of the manual.

5.48 Troubleshooting Equipment

5.49 The equipment listed in table 5.1 can be used for the procedure with the addition of an oscilloscope such as the Tektronix type 453. Access to the main circuitry is gained by removal of the top cover and shield.

5.50 Power Supply Check

WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.51 Before proceeding with the analog and digital circuitry, check that all the supply voltages are present. If a discrepancy is found, proceed to table 5.5.

Table 5.5 - Power Supply Check

Low or Zero output of Supply: 1. Set power switch to OFF. 2. Remove all plug in boards to eliminate possible source of shorts. 3. Apply power and recheck supply output. a. If normal, check plug in boards b. If low, check components on main board for excessive heat dissipation. No output of any Supply: 1. Disconnect power cable from line voltage and back of instrument. 2. With power switch on, check for continuity (Low DC resistance) between HI (pin 2) and LO (pin 1) of J203 (typically, 110 volt range is 12Ω, 220 volt range is 35Ω). An open indicates a failure of F201, S201, S202, or T1.

5.52 Operational Check

5.53 The check consists of narrowing down the problem to a specific area or circuit. This is done by checking out the basic instrument functions in a prescribed sequence and referring to the troubleshooting guide when the instrument fails to perform as indicated.

5.54 Preliminary Instrument Setup

a. Select DC function, 1 Range, Filter OUT, Ratio Out, Data Output Out, Remote Control Out, and Rate Control fully clockwise.

b. Verify the line voltage selector on the DMM rear panel is positioned for the available line voltage and connect power cable.

c. Perform the checks indicated in Table 5.6 if the instrument fails to provide the indicated output, refer to table 5.7 for assistance.

5.55 Circuit Descriptions

5.56 The remaining paragraphs describe the operation of the instrument circuitry from the standpoint of specific operating characteristics. These are to be used in troubleshooting to verify proper operation. The majority of the circuitry operates in a linear flow; that is, a signal is generated at one point and processed, encoded, decoded, or converted through various other circuits. If the output of one of the circuits is incorrect, the circuit is bad.

Table 5.6 - Operational Check

Step	Input	Annunciator	Display *
1.	a. Connect jumper across + and – input b. Set power switch on	+ or –	0.00000
2.	a. Remove jumper from input b. Apply +1 volt to input (DC source)	+	1.00000
3.	Reverse Polarity of input source	–	1.00000
4.	Select 100 mV range on DMM	NO	.160000
5.	Reduce input to –0.1 volt (DC source)	–	100.000
6.	Select 10 volt range on DMM	–	00.1000
7.	Select 100 volt range on DMM	–	000.100
8.	Select 1000 volt range on DMM	–	0000.10
9.	Increase input voltage to –200 volts	–	0200.00
10.	Reduce DC Source and remove source from input		
*May require adjustment of front panel offset			

5.57 MEASUREMENT LOGIC. These circuits are covered in paragraphs 5.58 through 5.63 and include the control and display logic. Symptoms of a failure in this area is the Display does not change with a change of input signal (see block diagram in figure 4.16 and schematic - figure 6.3)

5.58 CLOCK OSCILLATOR. The clock oscillator runs continuously at 6 MHz. If there is no signal, repair the clock. (5 MHz for 50 Hz operation). Q1, U38C, Y1, U13A

5.59 DECADE COUNTERS. These IC's (U14-U18, U33A) are the decade counters and are driven by the 6 MHz clock and run only during measurement cycle. If they do not run, replace them.

5.60 LATCHES. These IC's (U7-U11, U38B) store the information appearing at the input line (2, 6, 7, 3) upon receipt of a transfer pulse (PGMD) the stored date

Table 5.7 - Troubleshooting Guide

Symptom	Diagnosis	Probable Cause	Reference
Display Blank		Power Supply	Para. 5.50
Left 3 digits blank		Leading Zero Blanking	Para. 5.61
Decimal point wrong position	Range Logic	Annunciator Logic	Para. 5.66
Display does not change with a change in input signal	Instrument locked up	Clock	Para. 5.58
		Decade Counters	Para. 5.59
		Measurement Logic	Para. 5.57
		Control Logic	Para. 5.63
		Digitizer Logic	Para. 5.64
		Isolator	Para. 5.65
Display numbers incorrectly formed	BCD to 7-Line Converters		Para. 5.61
Manual range selection incorrect	Range Logic	Manual Range Encoding	Para 4.56 – 4.59
Readout does not Zero properly	Offset Error	DC Offset Adjust	R 60
		Isolator	Para. 5.65
		Digitizer Logic	Para. 5.64
Reading Unstable	Isolator	Oscillation	Para. 5.65
		Attenuator Relays	Table 5.9 Table 5.10
Improper Reading	Out of Calibration		Para. 5.1-5.45
	Non Linear	Isolator	Para. 5.65
		Integrating Capacitor	C8
	Will not read full scale	Digitizer Logic	Table 5.8
		Isolator	Table 5.9

appears and remains at output lines (16, 10, 9, 15) until the next transfer pulse. (PGMD).

5.61 BCD TO 7-LINE CONVERTERS. These units U1 through U6 convert the data from the counters to 7-line for the display and provide the leading zero blanking function. These units may be checked by swapping if a malfunction is suspected.

5.62 READ-OUT. The LED's on the readout board (LED 1 through LED 6) are controlled by the BCD to 7-line converters and are powered by the driver decades strobing circuit (U44, Q19). Failure of strobe circuit is indicated by blank display or excessive current drain from +5V regulated supply.

5.63 CONTROL LOGIC. This circuit controls the operation of the instrument and consists of the program logic (U38B, U38D, U13D, U32A, U38A, U36A-E), program counter (U37), read rate generator (Q43, Q42, Q9, Q10, U31B, U30A), program clock (U39), clear logic (U28A, B, U29B), counter clear logic (U19A, U13F, U27B, U27A, U34C, U20A, C, D, U13E, U34D), decimal logic (U41), auto range logic (U40A, D, U26A, U19B, D), are axis crossing/polarity logic (Q2, Q3, U32C, U30B, U26B, U29A). Failure of any of above circuits would be indicated by a locked-up display. See figure 4.13 for timing and waveform diagram.

5.64 DIGITIZER LOGIC AND 10V REFERENCE AMPLIFIER. (See block diagram, figure 4.12 and schematic figure 6.13). This circuitry performs the A/D conversion. It is mounted on a single PC Board and mates with connector J9 on main logic board. The circuitry includes: integrator and switching network, gain stage, null detector, transformer driver, signal and reset logic, switch controls and ±10 volt reference supplies (see paragraph 4.38 through 4.51 for theory of operation). For troubleshooting chart on digitizer and 100 reference amplifier see table 5.8.

Table 5.8 - Troubleshooting Chart – Digitizer and 10V Reference Amplifier

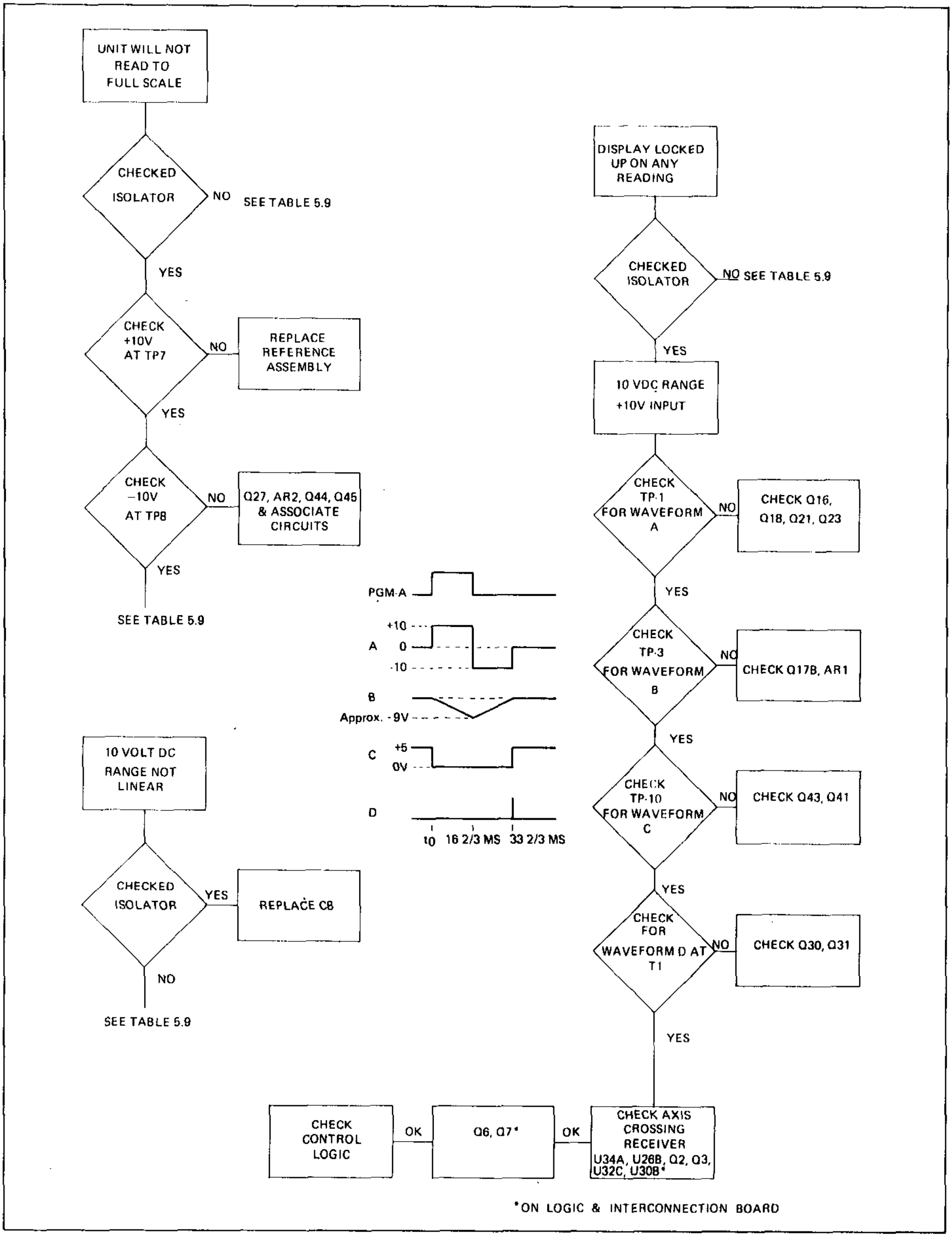


Table 5.9 - Troubleshooting Chart — Isolator and Attenuator Boards

Sympton	Probable Cause
1. Unstable, Noisy Reading on all functions	a. Oscillation of AR2, or AR4 b. Bad Q6 c. Filter circuit AR5 K1 (Isolator) d. Attenuator relays K1, K2, K3, K4
2. Won't Read Full Scale	a. Q8 or Q9 b. See table 5.8
3. Display locked on overload	a. Q7 b. AR3 (Check AR4 pin 6 if 20 volts replace AR3) c. Q6 d. Q2, Q3, Q4, or Q5 e. See table 5.8
4. Excessive Input Bias Current	a. Adjust R3, R7 b. Q1 failure if cannot adjust

5.65 ISOLATOR. The isolator is a single printed circuit board and mates with connector J8 on the main logic board. The isolator operates in conjunction with the attenuator board as shown in figure 4.10. See table 5.9 for troubleshooting information.

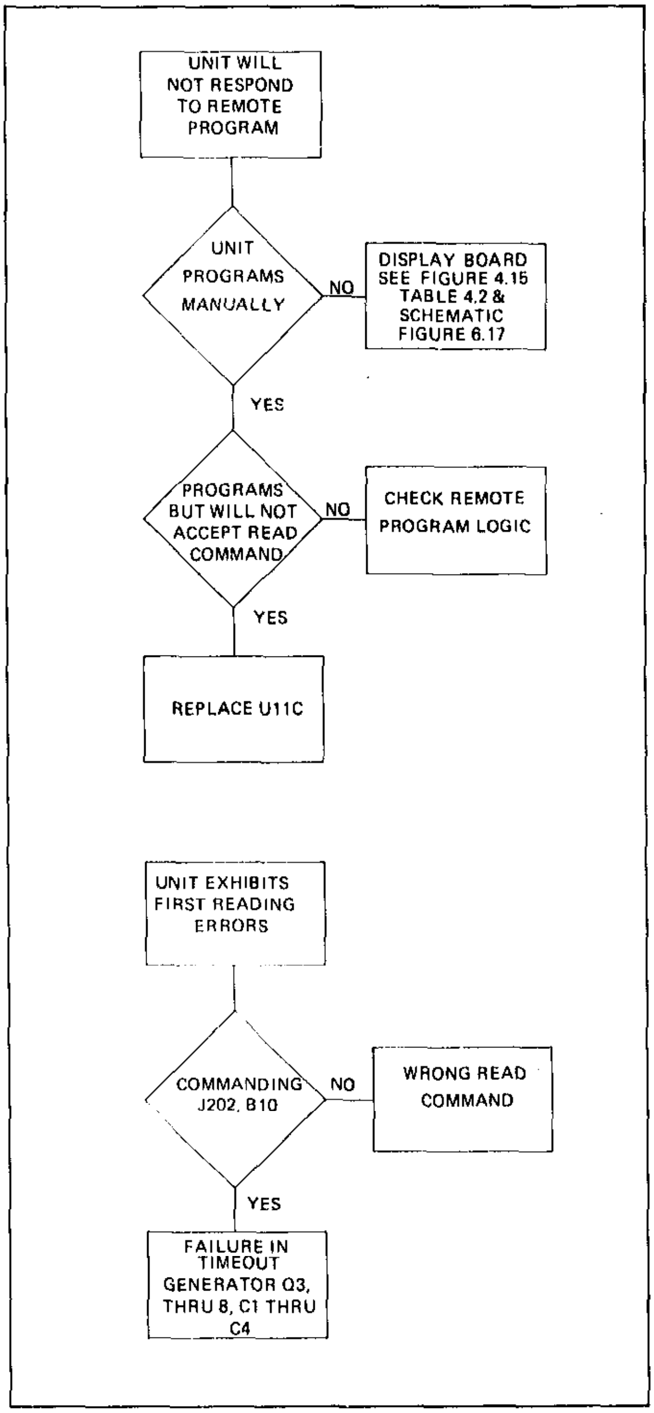
5.66 ANNUNCIATOR LOGIC. This logic controls the selection of annunciator, autoranging and polarity as shown in tables 4.5 and 4.6, and schematic figure 6.17. Failure of these circuits would cause improper range coding, improper annunciation, improper decimal placement, or improper autoranging.

5.67 OPTIONAL ACCESSORIES. Options include AC converter, RMS AC converter, ohms converter, remote programming, and four-wire ratio. See troubleshooting guide table 5.10 for more information.

5.68 BOARD REVISION.

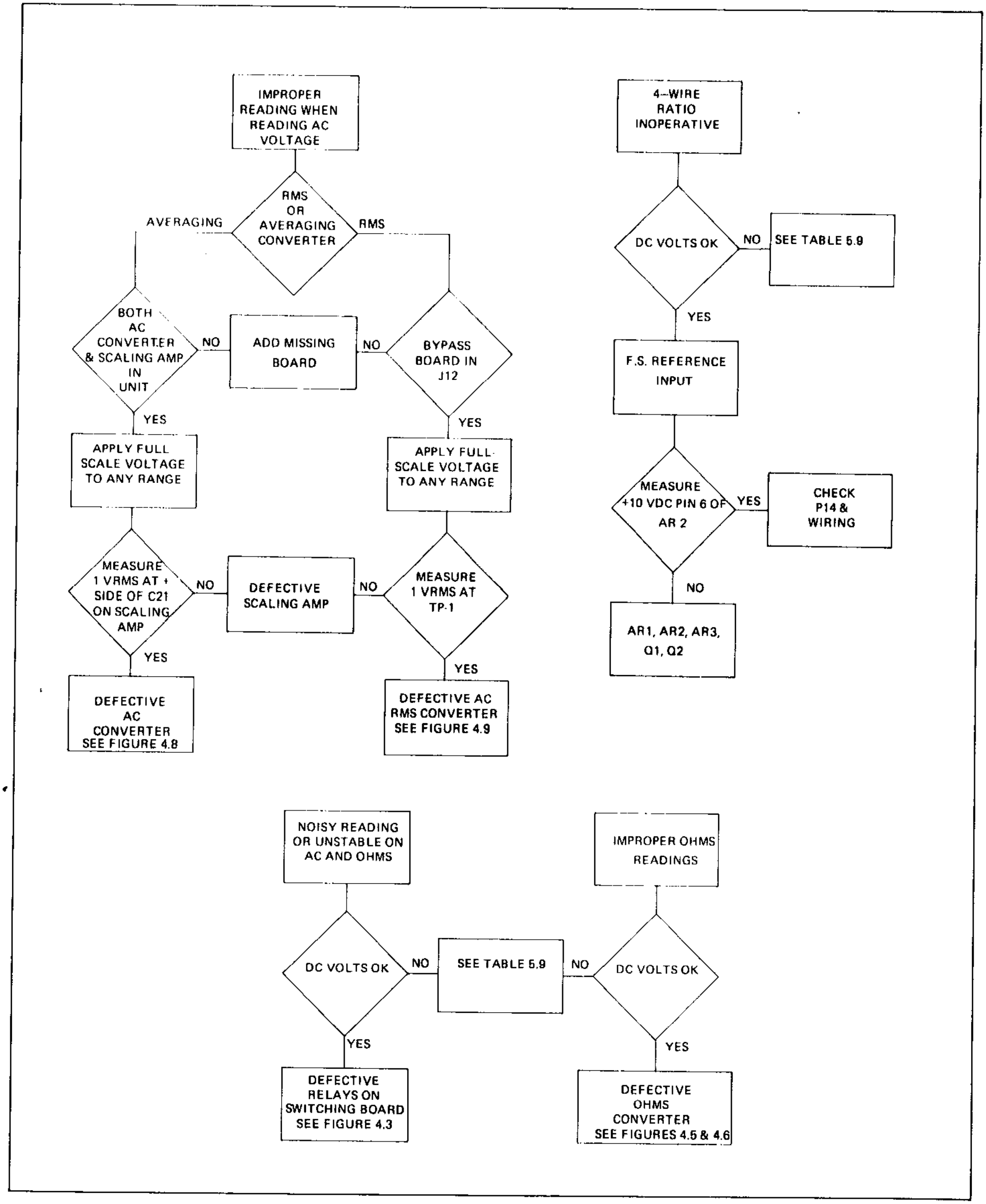
5.69 Every effort is made to keep the manual concurrent with the instrument despite changes to the design, which are an inevitable adjunct of the manufacturing process. The manual is updated and periodically reprinted throughout the year. In between printings, Addendums and Errata Sheets are added to the manual if required to implement the reprinted copy.

Table 5.10 - Troubleshooting Chart – Optional Accessories



5.70 Any design change is accompanied by an updating of a board revision. Such change could be as simple as a revised hole size or as complex as major modifications of the circuitry. The revision of a board is indicated by the letter preceding the assembly number stamped on the board; the revision of the assembly drawing in Section 6 or on an Errata Sheet is indicated by the letter following the assembly number, located below the drawing. Comparing the revision letters can indicate how closely the drawing corresponds to the board.

Table 5.10 - Troubleshooting Chart–Optional Accessories (continued)

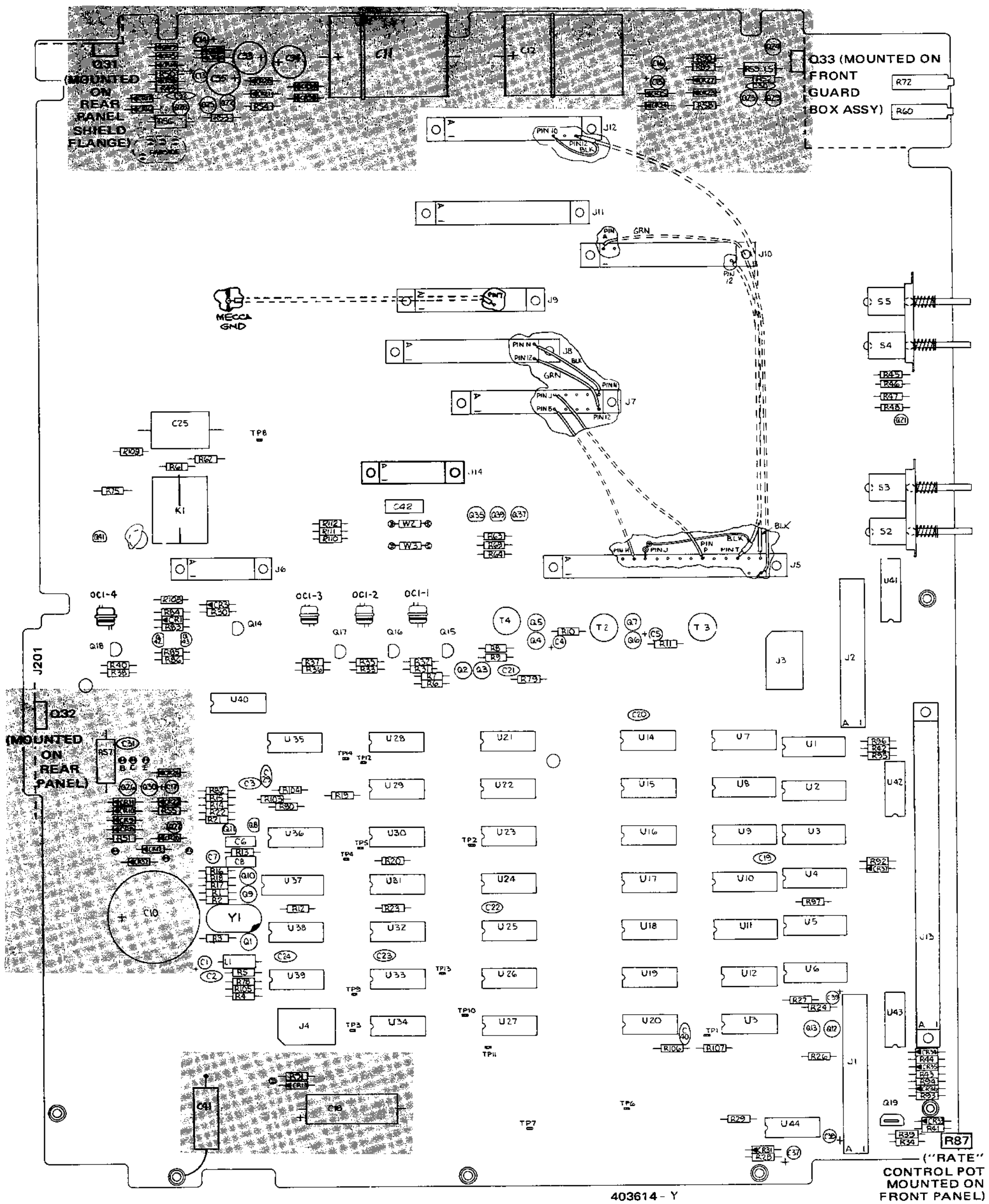


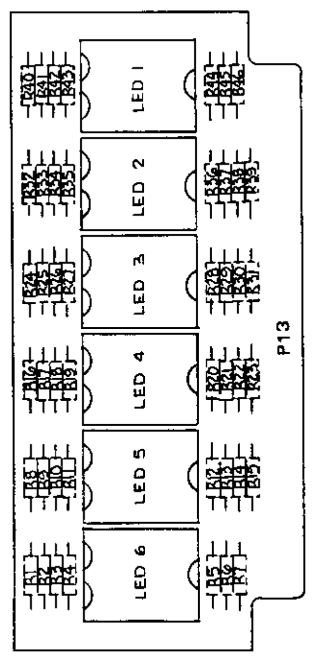
SECTION 6 DRAWINGS

Signal	DISPLAY (Figure 6.17) J1	DISPLAY (Figure 6.17) J2	PROGRAM (Figure 6.15) J3/J3A	PROGRAM (Figure 6.15) J4/J4A	SWITCHING (Figure 6.8) J5	SWITCHING (Figure 6.8) J6	ATTENUATOR (Figure 6.6) J7	ISOLATOR (Figure 6.10) J8	DIGITIZER (Figure 6.13) J9	OHMS CONVERTER (Figure 6.25) J10	AC CONVERTER (Figure 6.19) J11	RMS BYPASS * J11	SCALING AMPLIFIER (Figure 6.23) J12	RMS CONVERTER (Figure 6.21) * J12	READOUT (Figure 6.3) J13	4-WIRE RATIO (Figure 6.27) J14	PRINTER OUTPUT (Figure 6.3) J15	OTHER
POWER & COMMONS																		
+5V Unregulated																13		Power Supply (Figure 6.4)
+5V	8			14		E											B3	Power Supply (Figure 6.4)
+20V							A	3	C	J	2		D	D		F		Power Supply (Figure 6.4)
−20V							1	A	1	H			5	5		5		Power Supply (Figure 6.4)
+26V								C										Power Supply (Figure 6.4)
−26V					A			7										Power Supply (Figure 6.4)
−40V									4									Power Supply (Figure 6.4)
+150V	A																	Power Supply (Figure 6.4)
Conv. Common											5		3					
Digital Common	10			J		B								C			B1	
Mecca					6		D	E	A	2	3		A			4		Mecca (Common for analog circuits, +20V, −20V, −26, and −40V supplies)
					E		F	F	2	7	F							
							3		3	11	J		C					Digital Common (Common for +5V and +150V supplies)
									6	B								
									7	N								
NUMERICAL DATA																		
1_1																	A21	Figure 6.3, zone C-15
1_2																	A18	Figure 6.3, zone C-15
1_4																	A20	Figure 6.3, zone D-15
1_8																	A19	Figure 6.3, zone D-15
10_1																	B21	Figure 6.3, zone C-14
10_2																	A22	Figure 6.3, zone C-14
10_4																	B20	Figure 6.3, zone D-14
10_8																	B22	Figure 6.3, zone D-14
100_1																	B17	Figure 6.3, zone C-13
100_2																	B19	Figure 6.3, zone C-13
100_4																	B16	Figure 6.3, zone D-13
100_8																	B18	Figure 6.3, zone D-13
$1\ K_1$																	B13	Figure 6.3, zone C-12
$1\ K_2$																	B15	Figure 6.3, zone C-12
$1\ K_4$																	B12	Figure 6.3, zone D-12
$1\ K_8$																	B14	Figure 6.3, zone D-12
$10\ K_1$																	B6	Figure 6.3, zone C-11
$10\ K_2$																	B10	Figure 6.3, zone C-11
$10\ K_4$																	B7	Figure 6.3, zone C-12
$10\ K_8$																	B9	Figure 6.3, zone C-12
100K																	B8	Figure 6.3, zone B-2
CONTROL SIGNALS																		
.1 + 1V							4											Figure 6.3, zone A-6
$\overline{.1 + 1V\ Range_1}$		F																Figure 6.3, zone A-5
$\overline{.1 + 1V\ Range_2}$		4																Figure 6.3, zone A-5
.1 + 1V (+ Input)					H		8											
.1 + 1V (− Input)																		(hard-wired)
1 + 100V Rng Rly		E																Figure 6.3, zone B-5
1 + 100V Range							2											Figure 6.3, zone B-6
10 + 100 + 1 KV (+ In)					F		3											(hard-wired)
+10V Ref									B	3								Figure 6.3, zone B-4
−10V Ref									3									
100 + 1 KV Rng Rly		D																Figure 6.3, zone A-6
100 + 1000V Rng							5											Figure 6.3, zone A-7
4-Wire Ratio Out																3		Figure 6.3, zone B-4
+5V B/S (Bootstrap)								5										Figure 6.3, zone A-2
−5V B/S (Bootstrap)								6										Figure 6.3, zone A-2
6 MHz	7																	Figure 6.3, zone D-2
$\overline{A1\ Range}$						3												Figure 6.3, zone C-8
AC																	A1	Figure 6.3, zone B-2
$\overline{AC}$						A												Figure 6.3, zone B-1, B-6
AC Common					1								10	10/A				+ Input Shield
AC Conv. Out					8						12			2				
AC In (Input)													12	12				Shield to J5-J
AC Zero														3				Figure 6.3, zone B-2
$\overline{Auto}$		J	8															
Axis (T1-T4)																		Figure 6.3, zone C-1
$\overline{B2\ Range}$		N																Figure 6.3, zone C-8
Bootstrap Com							1	10										
Bridge Tap																		Figure 6.3, zone B-4
$\overline{C4\ Range}$		L				5												Figure 6.3, zone C-8
Clear	9		2															Figure 6.3, zone D-4
$\overline{Command}$																		Figure 6.3, zone E-2
+ Current (+I)					S													Front Panel Input Term; Shield to J5-E
− Current (−I)					11													Front Panel Input Term.

Signal	DISPLAY (Figure 6.17) J1	DISPLAY (Figure 6.17) J2	PROGRAM (Figure 6.15) J3/J3A	PROGRAM (Figure 6.15) J4/J4A	SWITCHING (Figure 6.8) J5	SWITCHING (Figure 6.8) J6	ATTENUATOR (Figure 6.6) J7	ISOLATOR (Figure 6.10) J8	DIGITIZER (Figure 6.13) J9	OHMS CONVERTER (Figure 6.25) J10	AC CONVERTER (Figure 6.19) J11	RMS BYPASS * J11	SCALING AMPLIFIER (Figure 6.23) J12	RMS CONVERTER (Figure 6.21) * J12	READOUT (Figure 6.3) J13	4-WIRE RATIO (Figure 6.27) J14	PRINTER OUTPUT (Figure 6.3) J15	OTHER
$\overline{D8\ Range}$		K				10												Figure 6.3, zone D-8
DC																		Figure 6.3, zone B-2
$\overline{DC}$	4			5														Figure 6.3, zone B-1
DC Wiper																		Figure 6.3, zone A-2
$\overline{Data\ Disable}$				9														Figure 6.3, zone A-2, C-5
$\overline{Data\ Ready\ Out}$																		Figure 6.3, zone C-6
Downrange (15%)																		Figure 6.3, zone E-8
$\overline{Downrange}$	D			5														
Ext Ref Hi																		Figure 6.3, zone B-3
Ext Ref Lo																		Figure 6.3, zone B-3
Ext Supply Volt																		Figure 6.3, zone A-2
Filter																		Figure 6.3, zone A-2
$\overline{Filter}$		6	6											E				Figure 6.3, zone A-1, B-6
Filter Select																		Figure 6.3, zone B-7
$\overline{Filter\ Switch}$		2																Figure 6.3, zone A-1
Hold																		Figure 6.3, zone B-2
$\overline{Hold}$		3		12														Figure 6.3, zone B-1
+ In																		Figure 6.3, zone B-4
− In																		Figure 6.3, zone B-4
+ Input					15													Front Panel Input Term; Shield to J5-J
− Input					L													Front Panel Input Term.
Iso +In							12	12										
Iso −In							W											
Iso Out							C	2	5									Figure 6.3, zone B-3
No																		Figure 6.3, zone B-2
$\overline{No}$	1																	Figure 6.3, zone B-1
Ohms (Ω)																		Figure 6.3, zone A-2
$\overline{Ohms\ (\Omega)}$		8	3			1												Figure 6.3, zone A-1
Ohms Amp In					V					12								
Ohms Amp Out					M													
+ Ohms I (+ Ω I)					16													
$\overline{PGMB}$																		Figure 6.3, zone B-5
PGMD	6																	Figure 6.3, zone C-4
PGM (Switch)		8																Figure 6.3, zone A-3
− Polarity	7																	Figure 6.3, zone C-3
+ Polarity	3																	Figure 6.3, zone C-3
$\overline{Prog\ 1}$ ($\overline{P1}$)		9	9															
$\overline{Prog\ 2}$ ($\overline{P2}$)		10	11															
$\overline{Prog\ 4}$ ($\overline{P4}$)		11	13															
$\overline{Prog\ 8}$ ($\overline{P8}$)		12	14															
Prog (Switch)																		Figure 6.3, zone A-3
Prog A thru E (A-E)																		Figure 6.3, zone E-4
Range A_1																		Figure 6.3, zone C-8
Range B_2																		Figure 6.3, zone C-8
Range C_4																		Figure 6.3, zone D-8
Range D_8																		Figure 6.3, zone D-8
Ratio																		Figure 6.3, zone A-2
$\overline{Ratio}$		5	7															Figure 6.3, zone A-1
$\overline{Ratio\ SW}$		O																Figure 6.3, zone A-1
Ratio Rly Dr		A																Figure 6.3, zone B-4
Reset (T2-T3)																		Figure 6.3, zone C7
$\overline{Reset}$				11														Figure 6.3, zone C-6
$\overline{r.01}$																		
$\overline{r.1}$																		
$\overline{r1}$																		
$\overline{r10}$														F				
$\overline{r100}$														H				
$\overline{r1K}$														7				
$\overline{r10K}$																		
Sig Int (T3-T2)																		Figure 6.3, zone C-7
$\overline{Sig\ Integrate}$																		Figure 6.3, zone B-2
Scaling Amp (S/A) Out																		
$\overline{Superfast}$				10														Figure 6.3, zone D-5
$\overline{Superfast\ In}$																		Figure 6.3, zone D-5
$\overline{System\ Control}$																		Figure 6.3, zone A-2
$\overline{System\ Control}$																		Figure 6.3, zone A-1
$\overline{System\ Dir.\ Cmd}$																		Figure 6.3, zone E-2
System Ready Out																		Figure 6.3, zone C-6
Uprange (160%)																		Figure 6.3, zone D-8
$\overline{Uprange}$																		
Zener																		Figure 6.3, zone B-4

* WHEN INSTRUMENT IS EQUIPPED WITH RMS CONVERTER (J12) THE RMS BYPASS BOARD (J11) IS ALSO USED



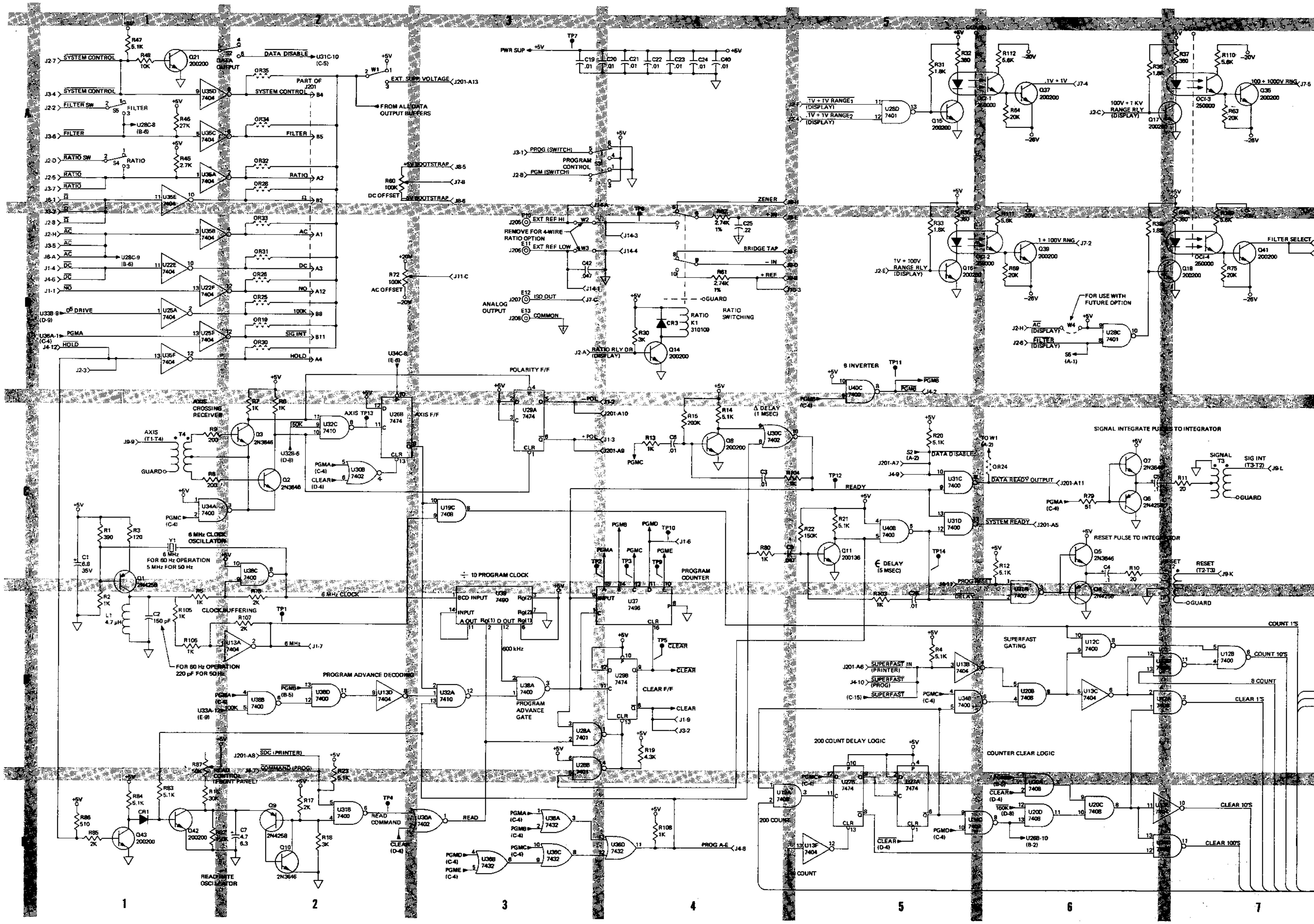


NOTES:

1. Reference designators shown as "U" on schematic and parts list may be identified on Logic and Interconnection Board as "M".
2. Power Supply Components Shaded.

Figure 6.1 - Layout, Logic and Interconnection (403614)

Figure 6.2 - Layout, Readout (403857)



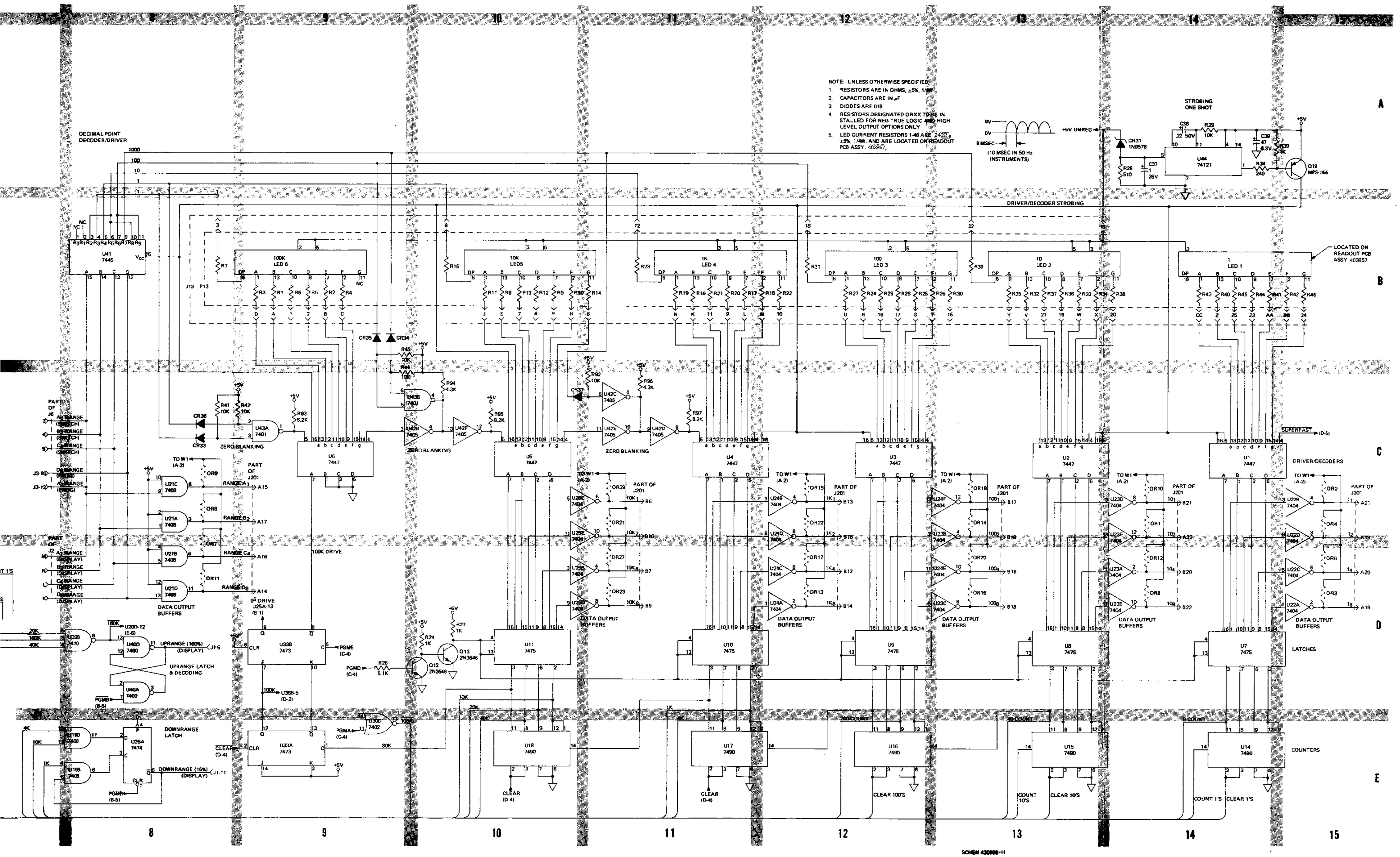


Figure 6.3 - Schematic, Logic and Interconnection

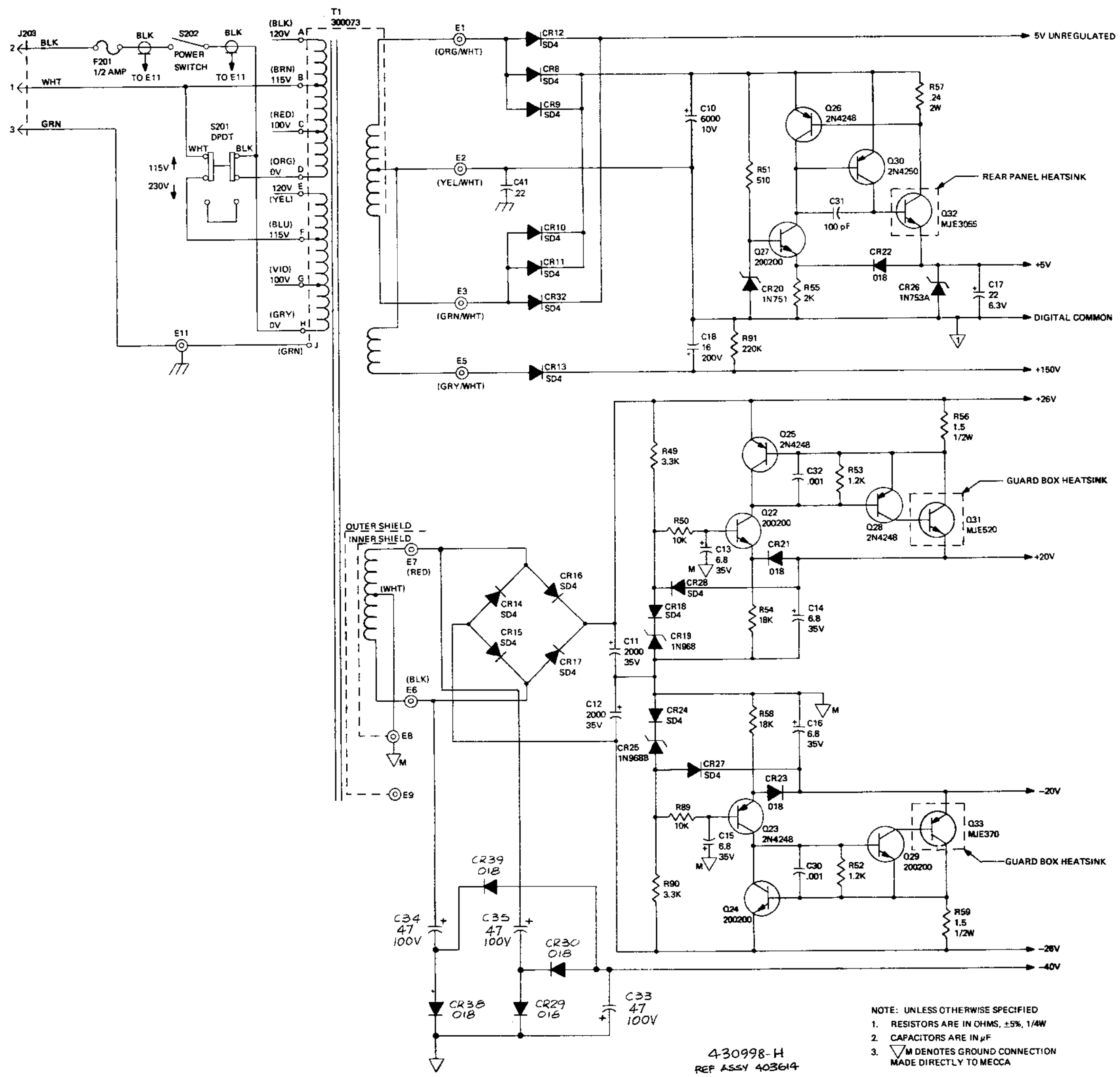


Figure 6.4 - Schematic, Power Supply

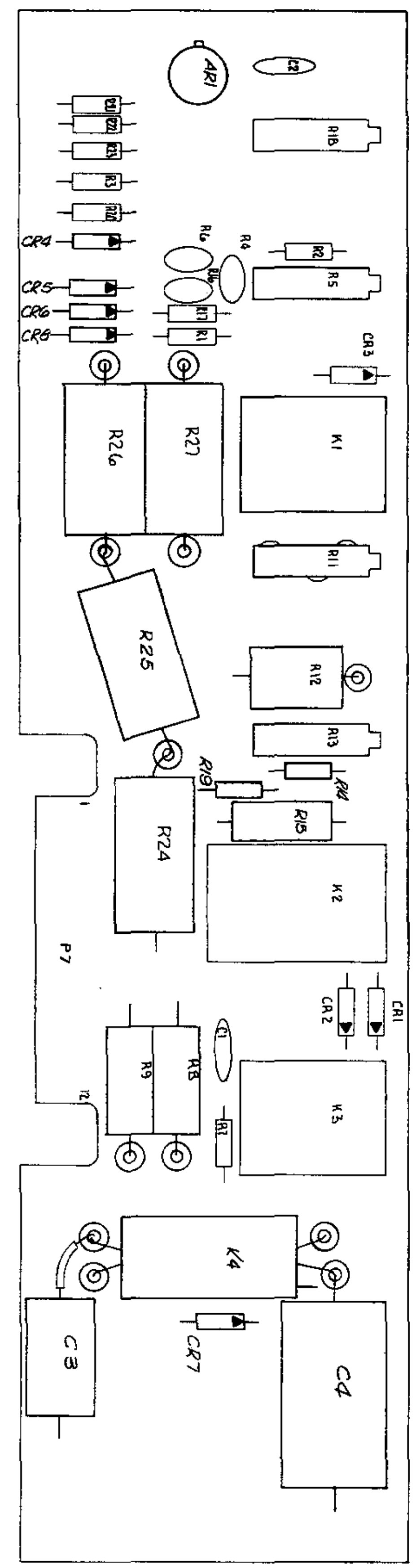


Figure 6.5 - Layout, Attenuator (403623)

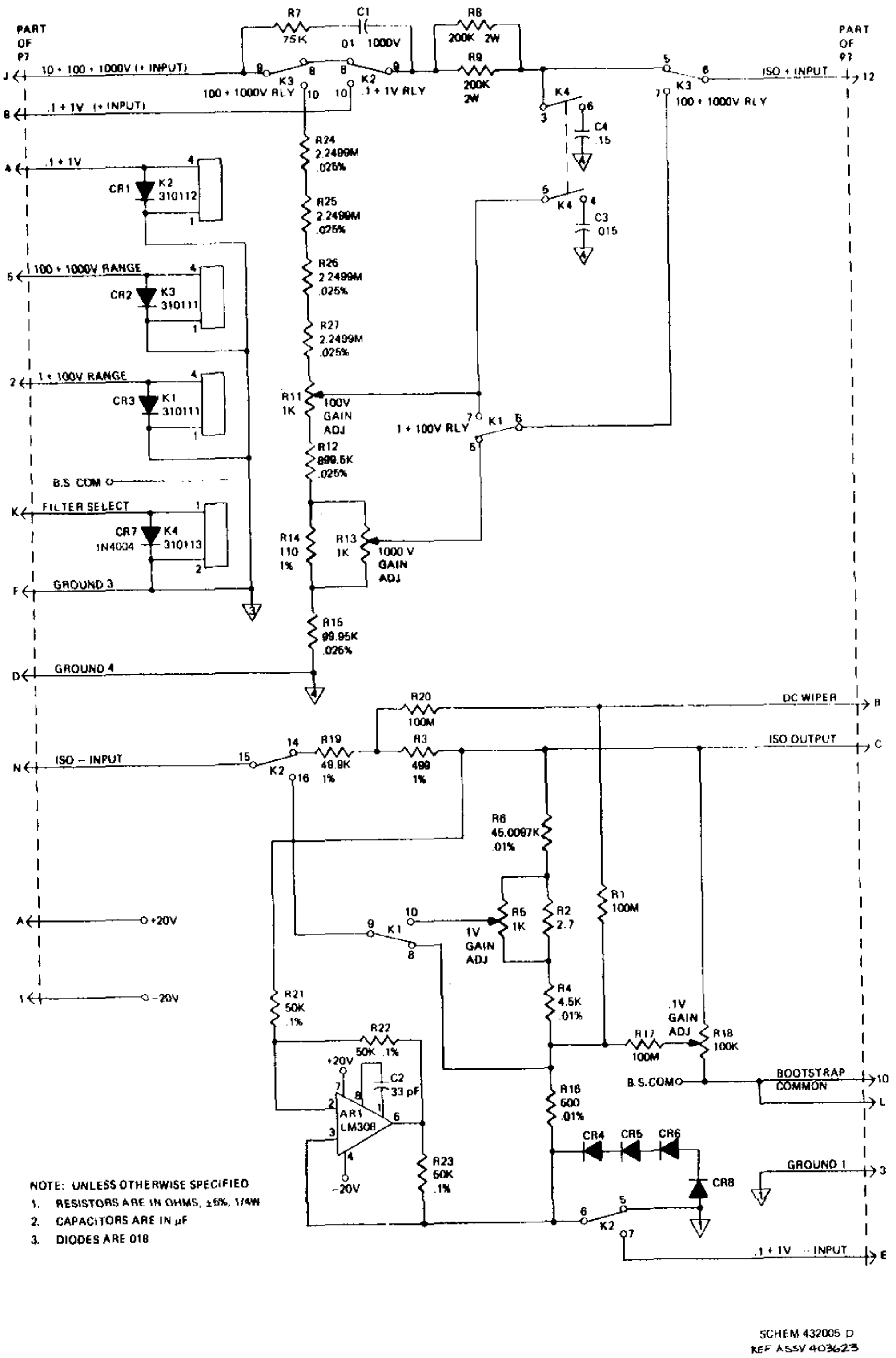
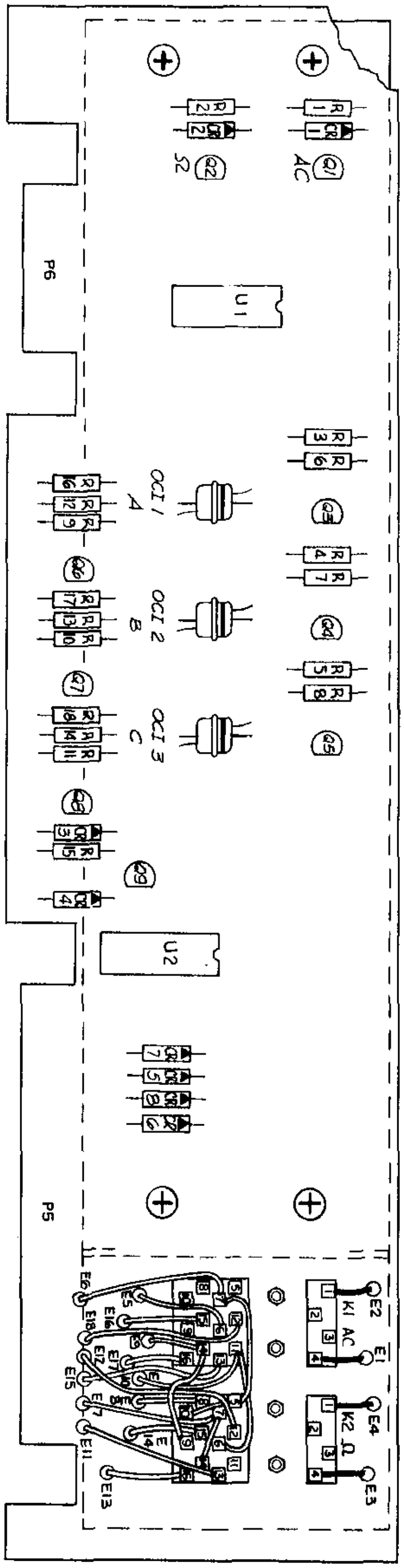


Figure 6.6 - Schematic, Attenuator



403625-D

Figure 6.7 - Layout, Switching (403625)

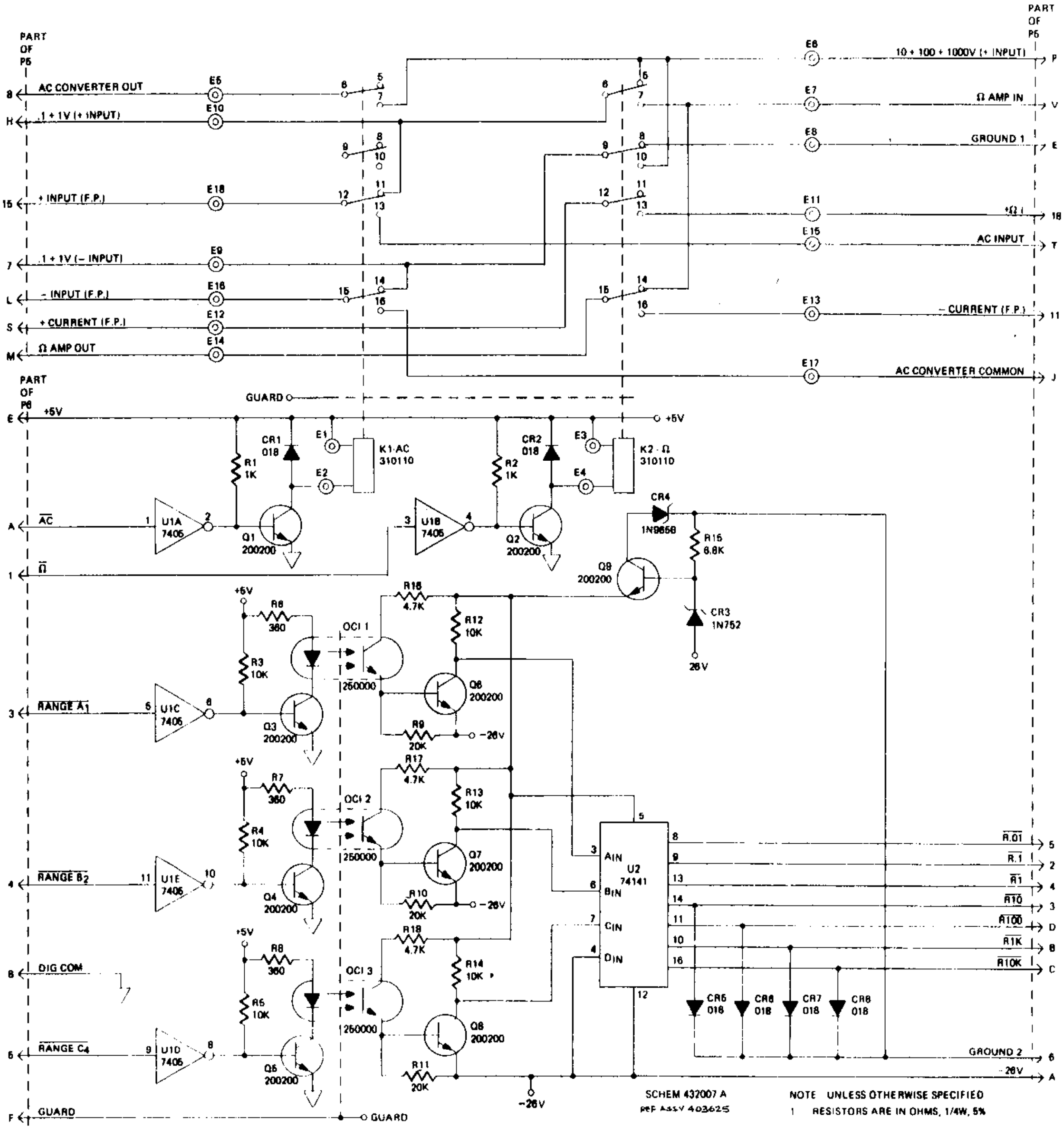
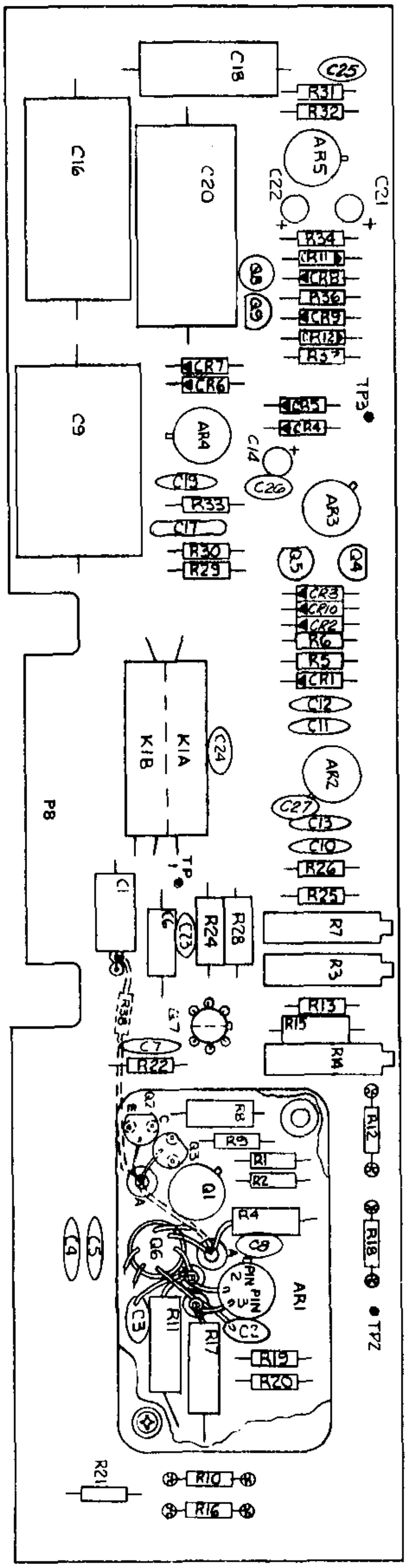


Figure 6.8 - Schematic, Switching



403624-P

Figure 6.9 - Layout, Isolator (403624)

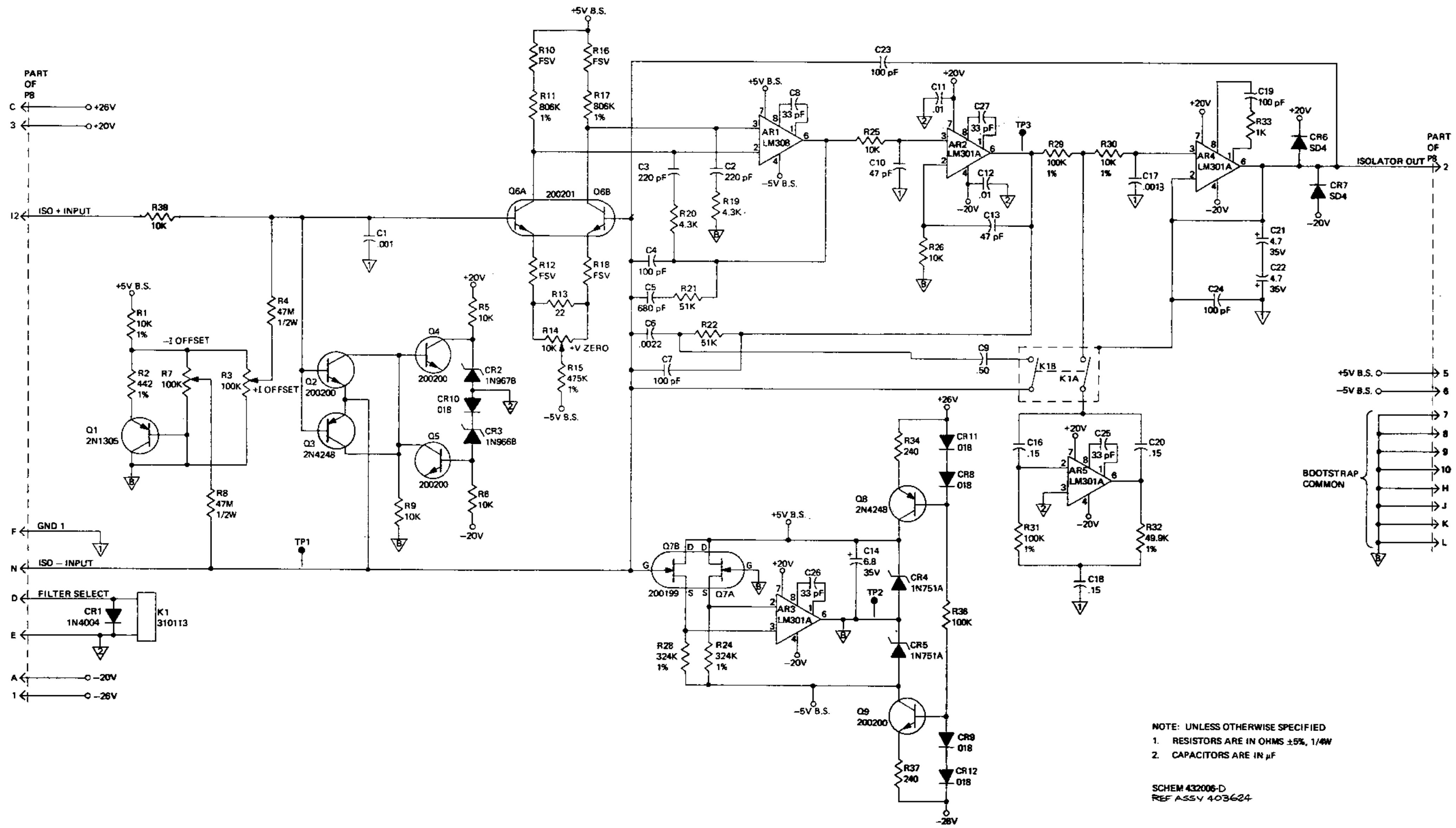


Figure 6.10 - Schematic, Isolator

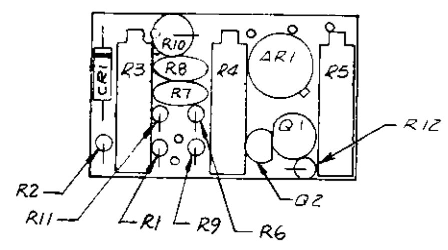


Figure 6.11 - Layout, 10V Reference Amplifier (403916)

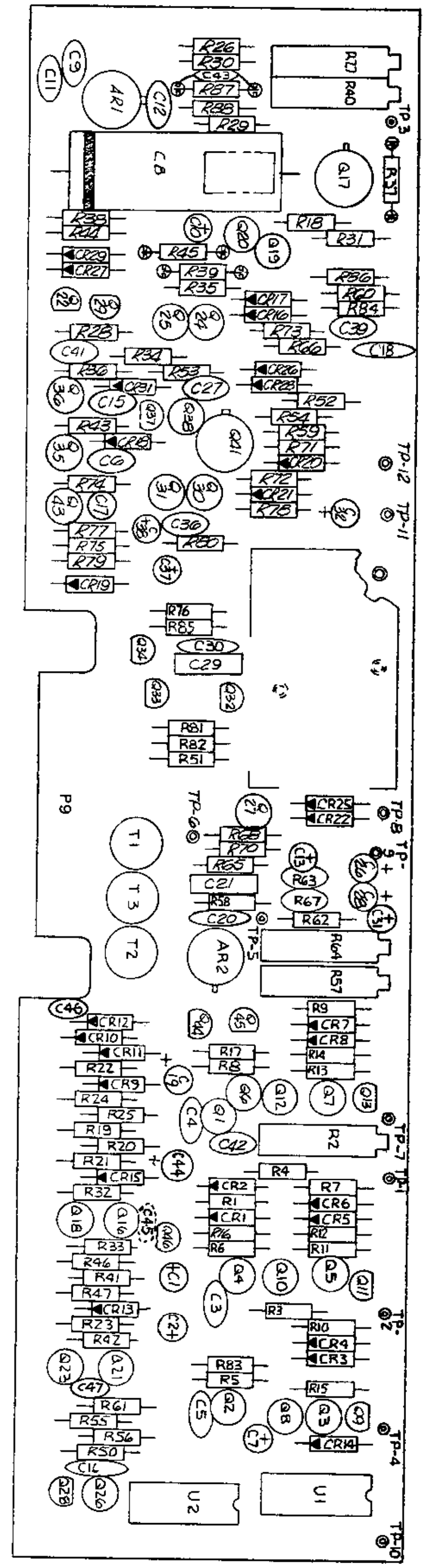
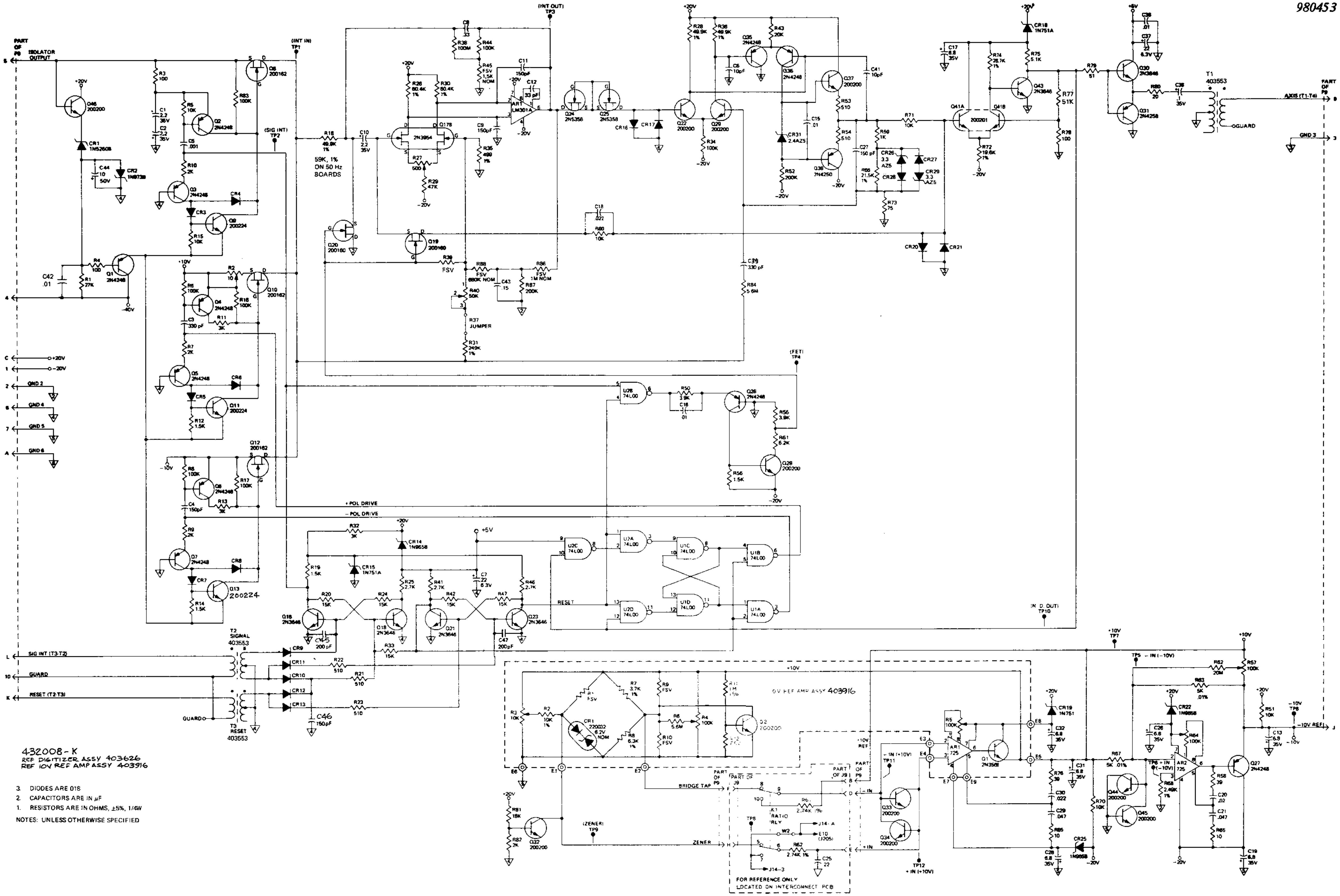


Figure 6.12 - Layout, Digitizer (403626)



432008-K
REF DIGITIZER ASSY 403626
REF 10V REF AMP ASSY 403916

3. DIODES ARE 018
2. CAPACITORS ARE IN µF
1. RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 6.13 - Schematic, Digitizer and 10V Reference Amplifier

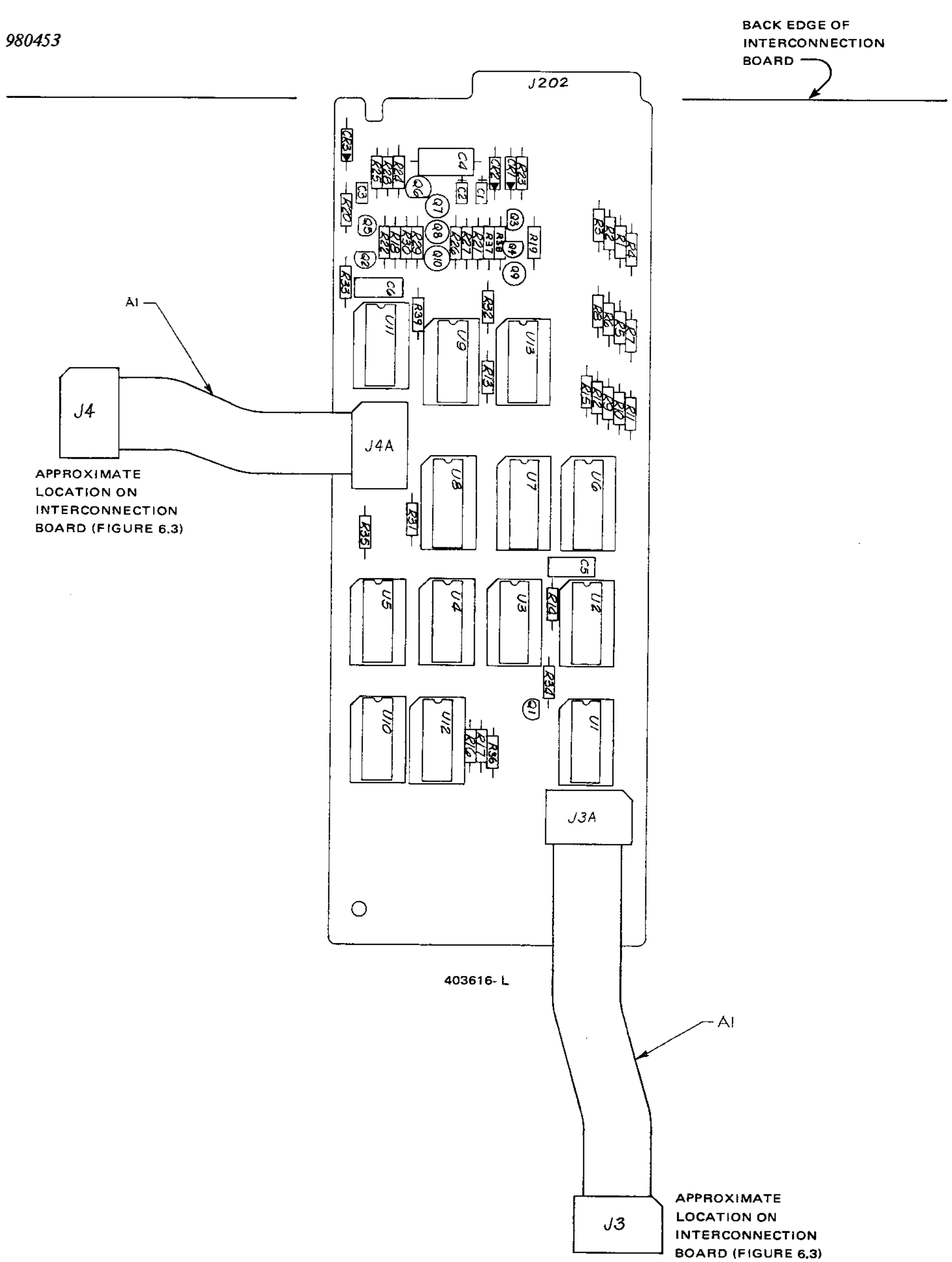


Figure 6.14 - Layout, Program (403616)

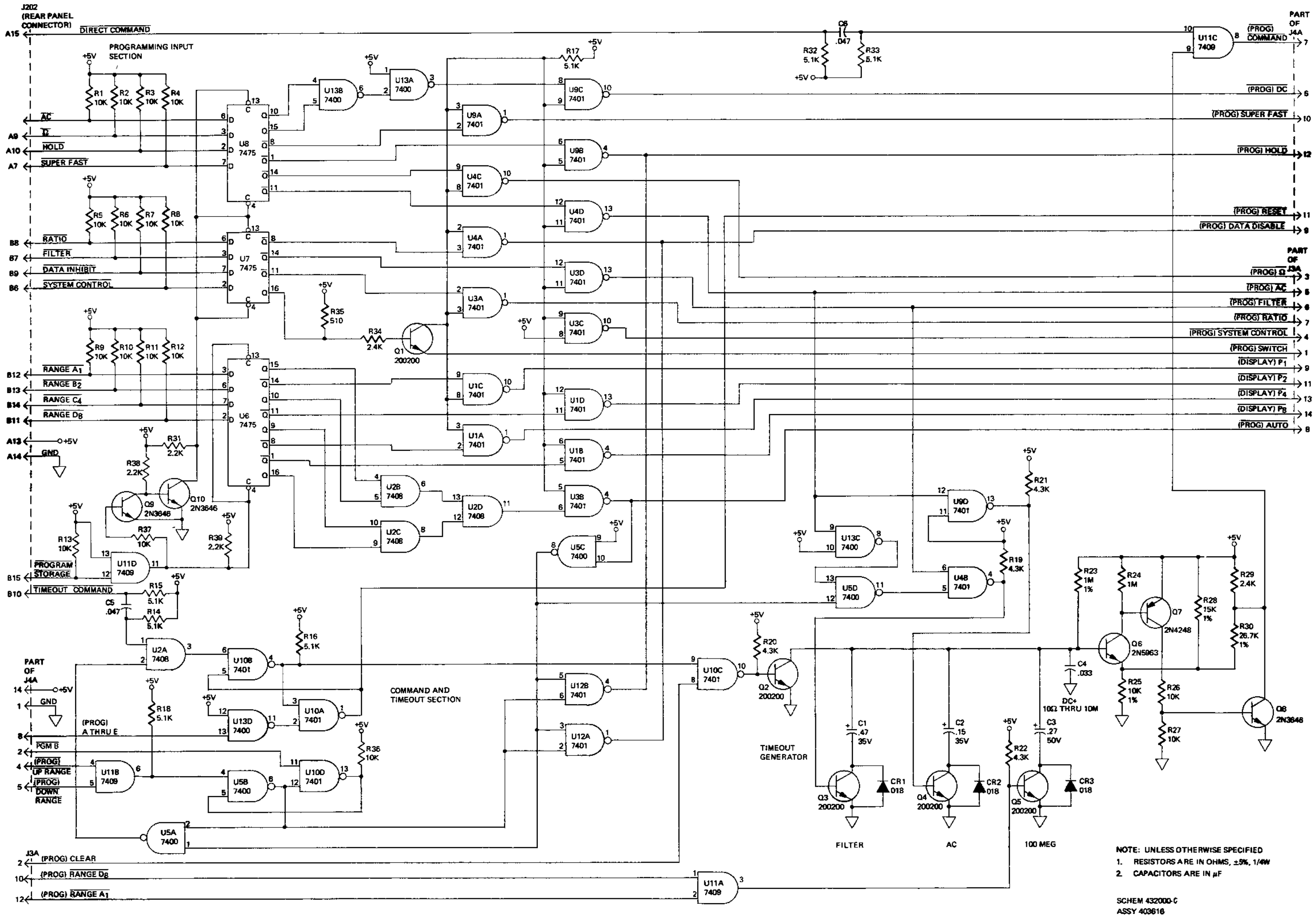


Figure 6.15 - Schematic, Program

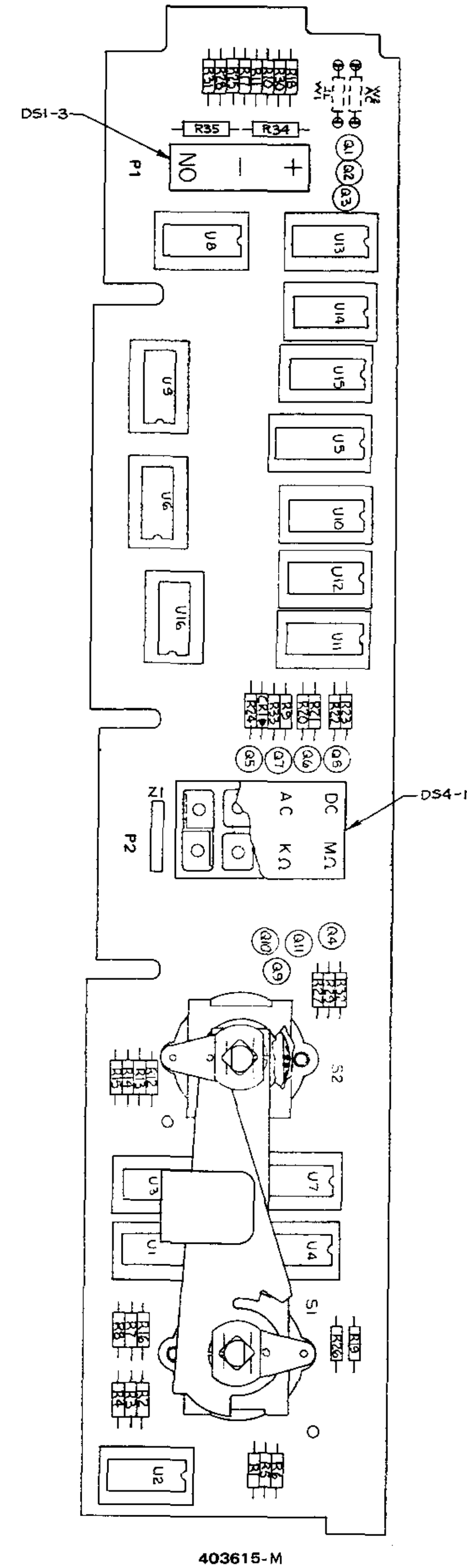


Figure 6.16 - Layout, Display (403615)

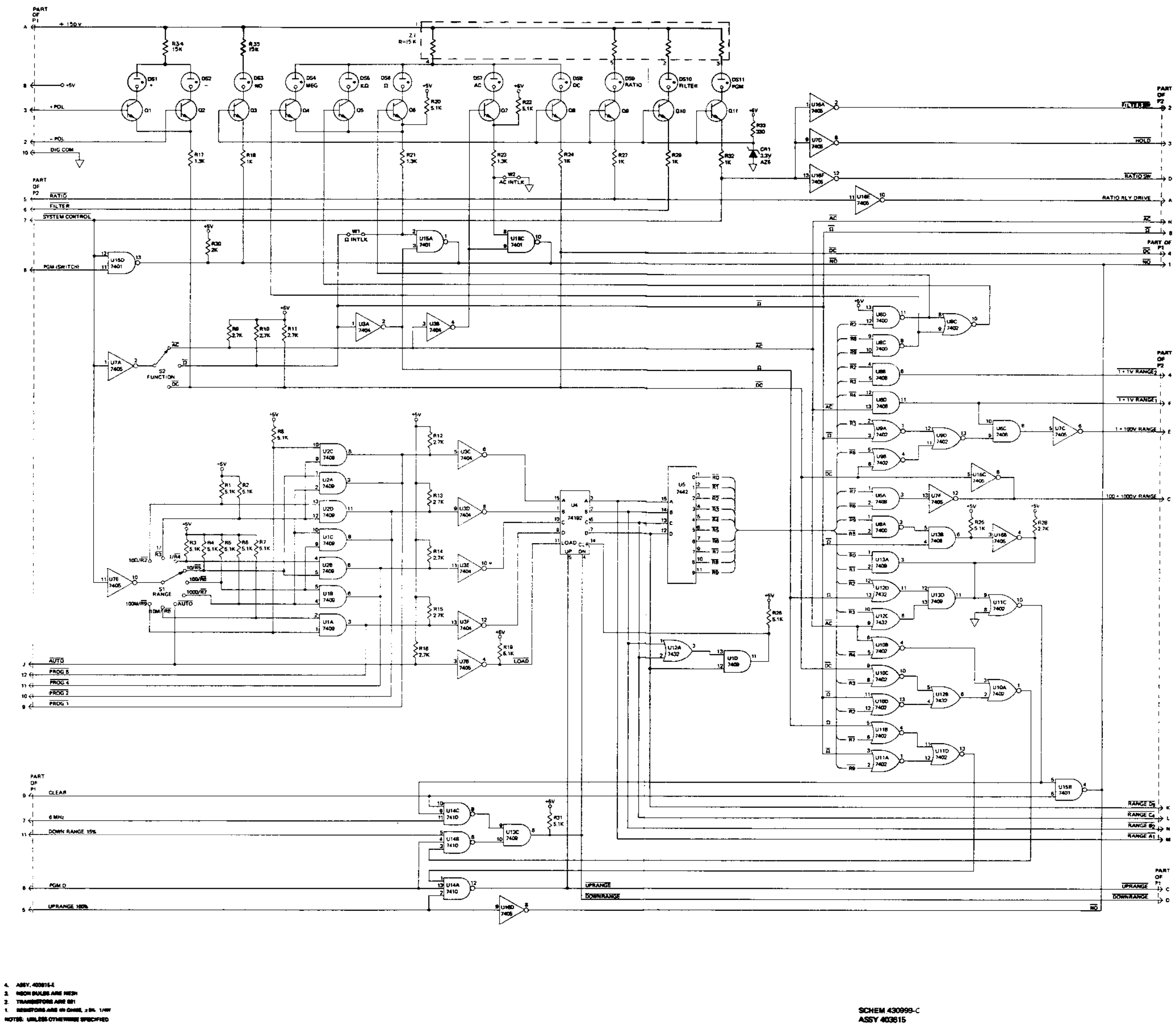


Figure 6.17 - Schematic, Display

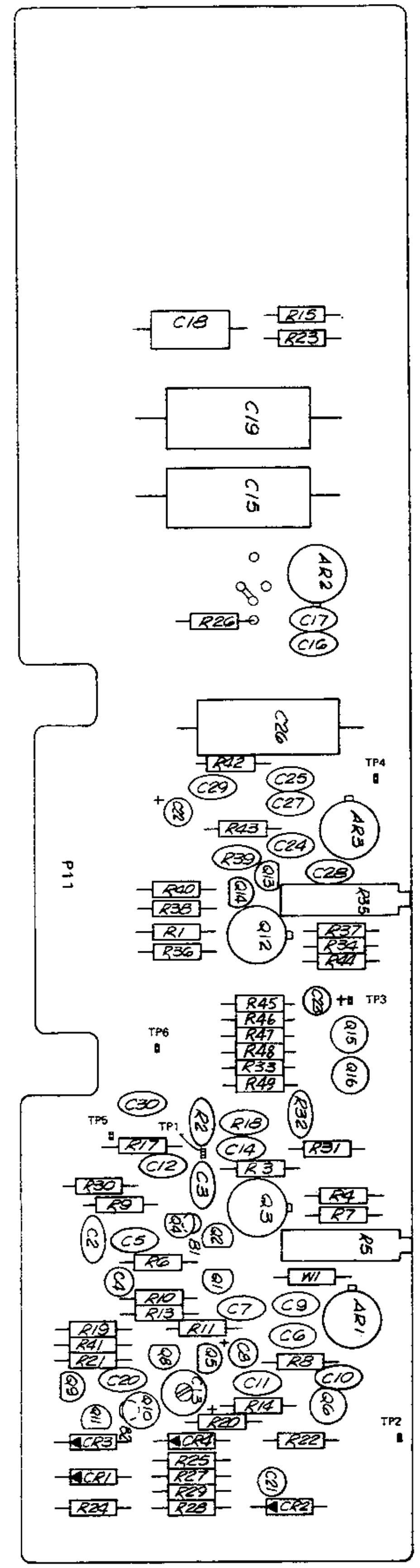
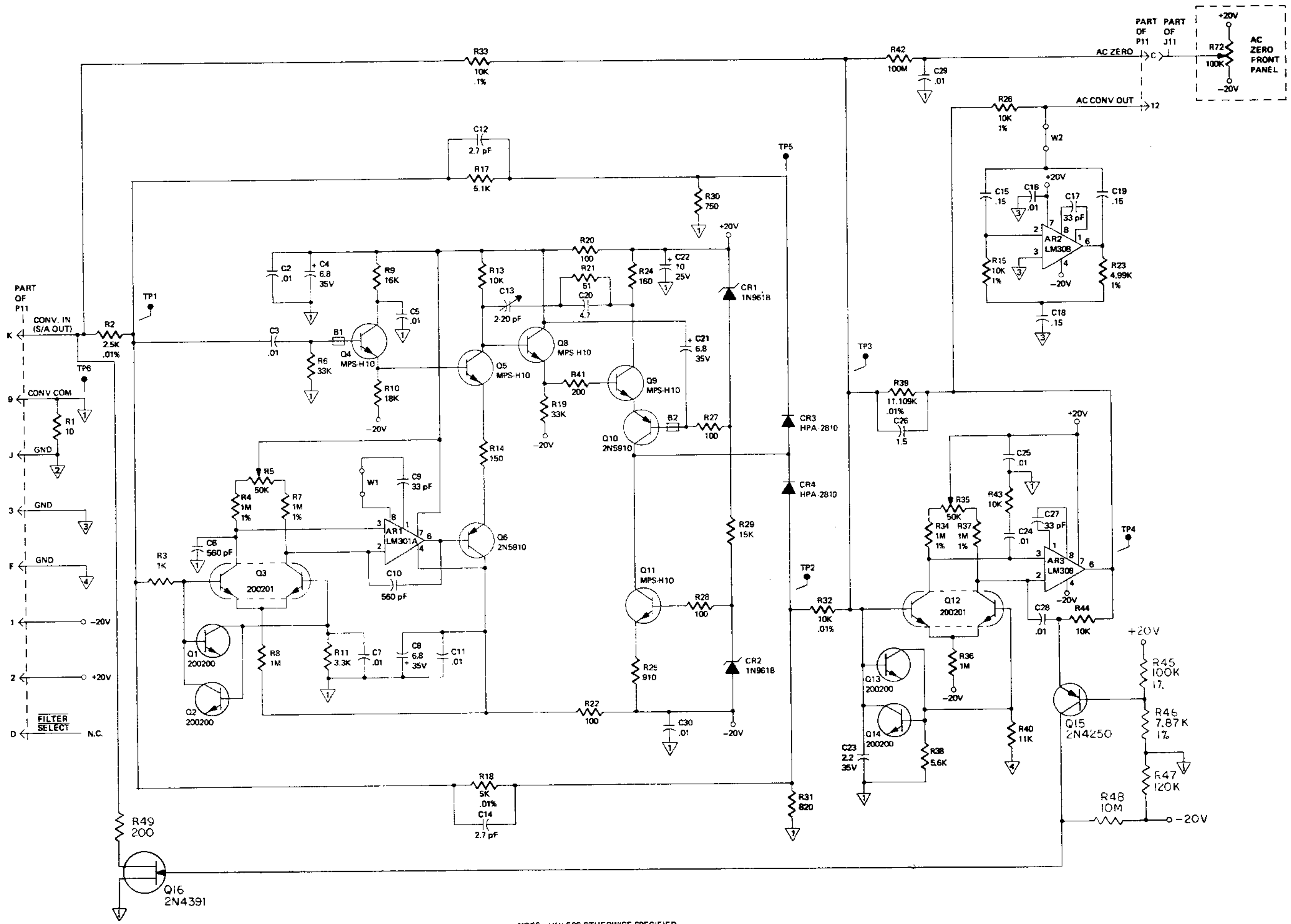


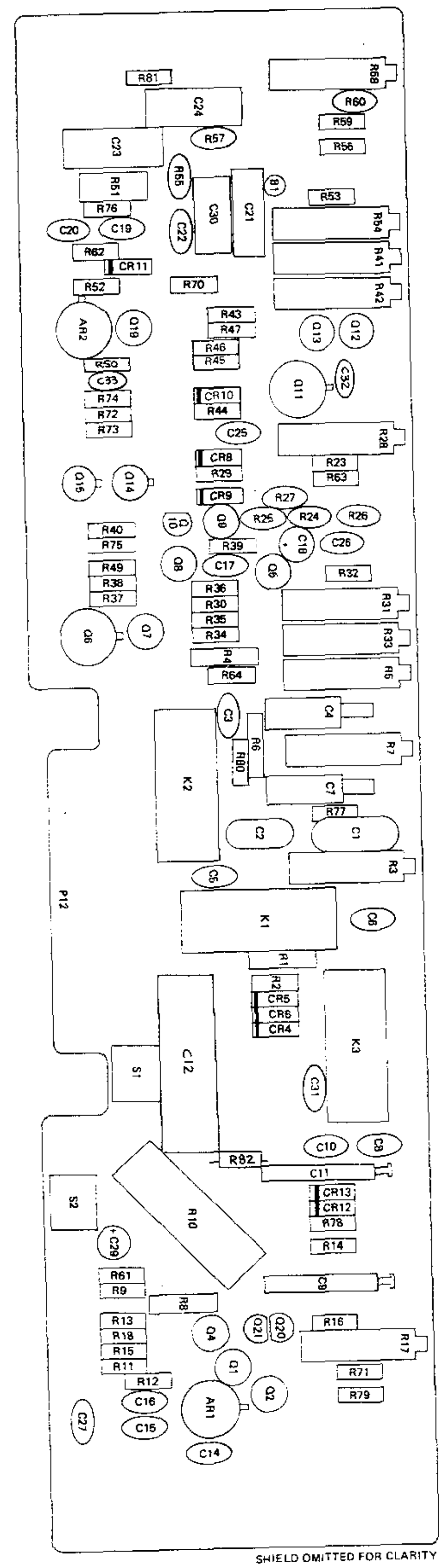
Figure 6.18 - Layout, AC Converter (403667)



NOTE: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
2. CAPACITORS ARE IN μF

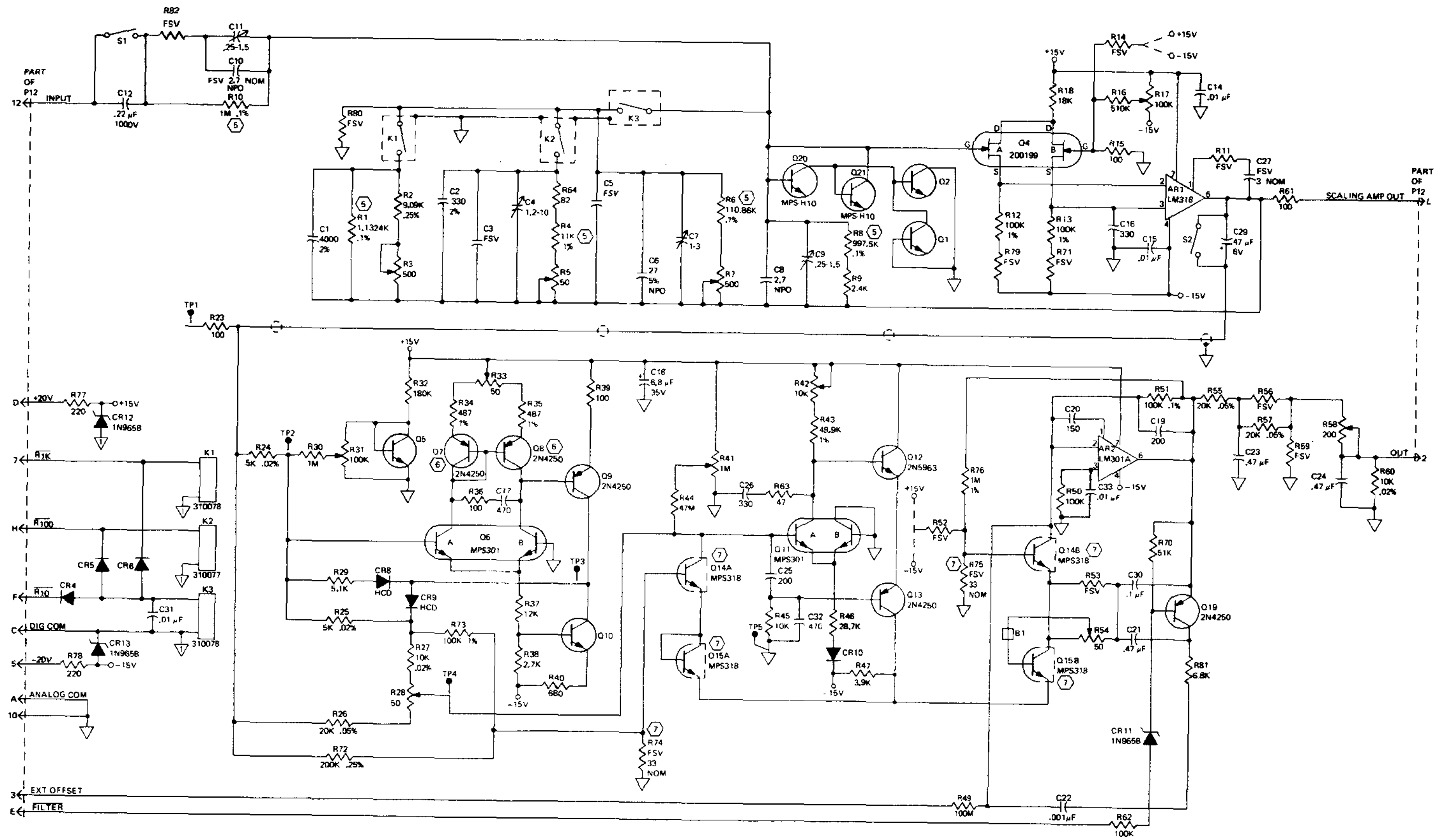
SCHEM 432022 B
REF ASSY 403667

Figure 6.19 - Schematic, AC Converter



403774 K

Figure 6.20 - Layout, RMS Converter (403774)



NOTES: UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE IN OHMS, ±5%, 1/4W
2. CAPACITORS ARE IN pF
3. DIODES ARE 018
4. TRANSISTORS ARE 200200
5. R1, R4, R6, R8, AND R10 ARE RESISTOR SET 010721
6. Q7 AND Q8 ARE MATCHED PAIR 200112
7. Q14, Q15, R74, AND R75 ARE LOG TRANSISTOR KIT 403865
8. ASSY 403774

432056-F
REF ASSY 403774

Figure 6.21 - Schematic, RMS Converter

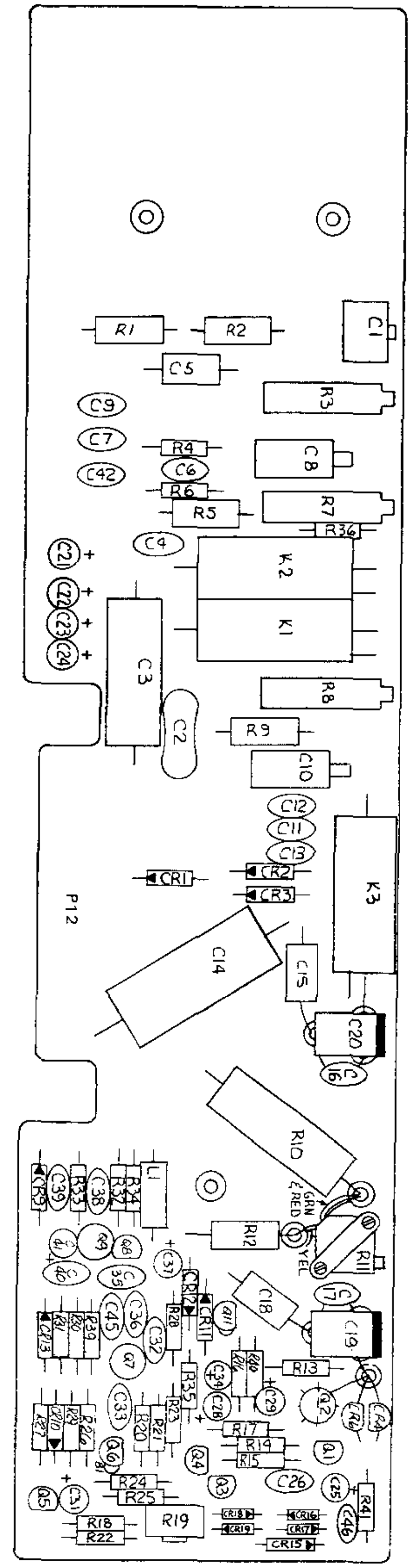
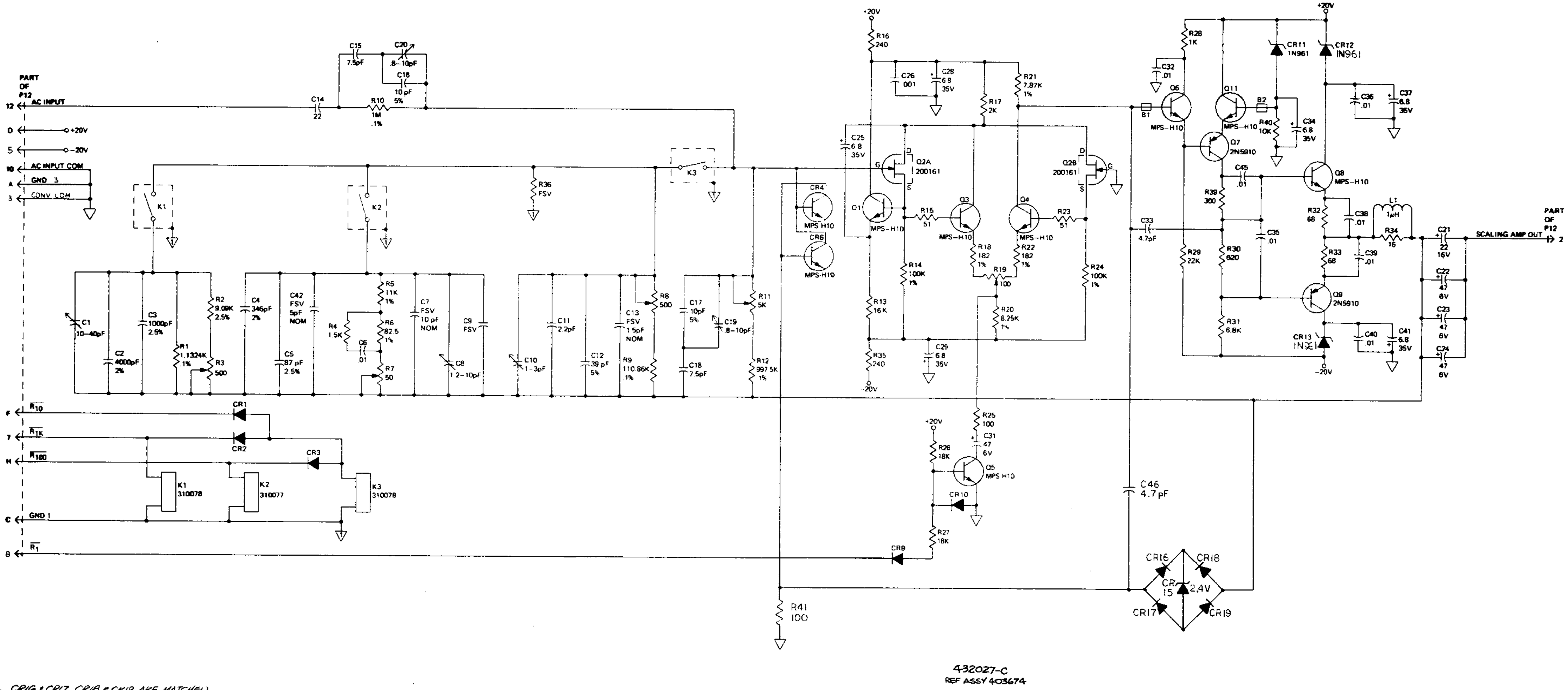


Figure 6.22 - Layout, Scaling Amplifier (403674)



5. CR16 & CR17, CR18 & CR19 ARE MATCHED HP 5082-2800 DIODES
4. ASSY 403674
3. DIODES ARE 018
2. CAPACITORS ARE IN μF
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 6.23 - Schematic, Scaling Amplifier

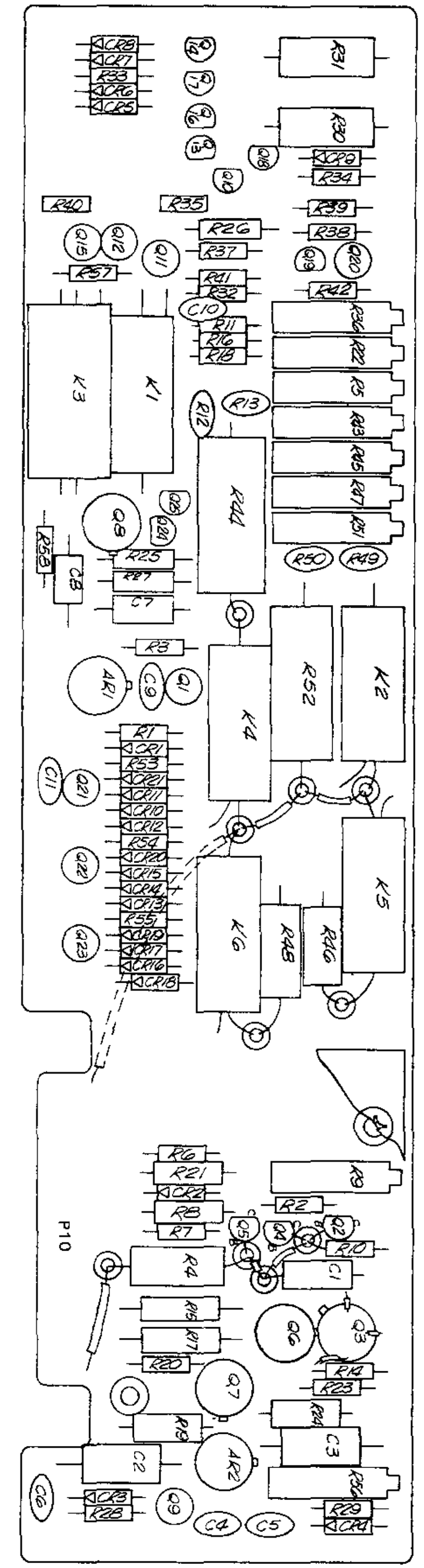


Figure 6.24 - Layout, Ohms Converter (403627)

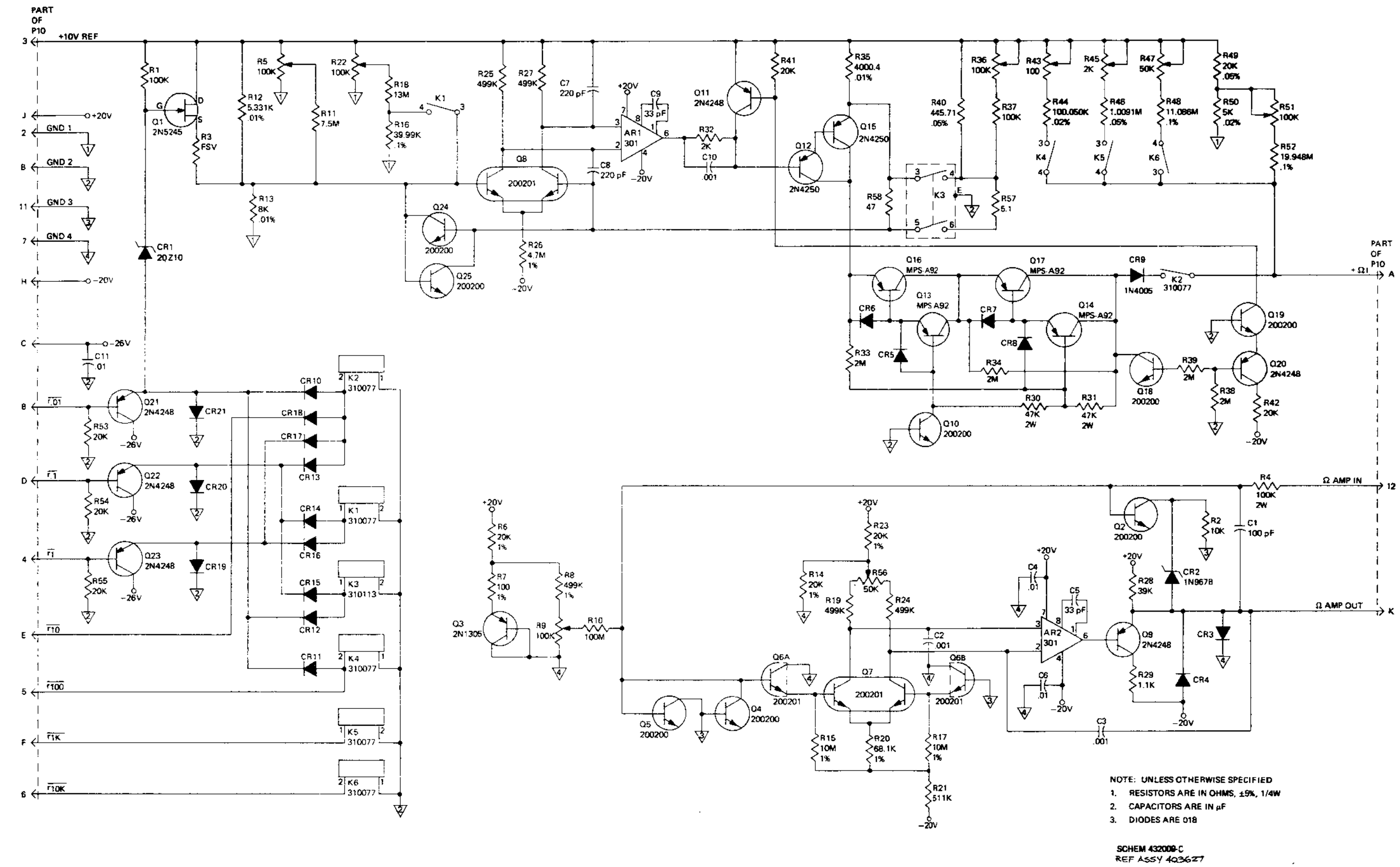


Figure 6.25 - Schematic, Ohms Converter

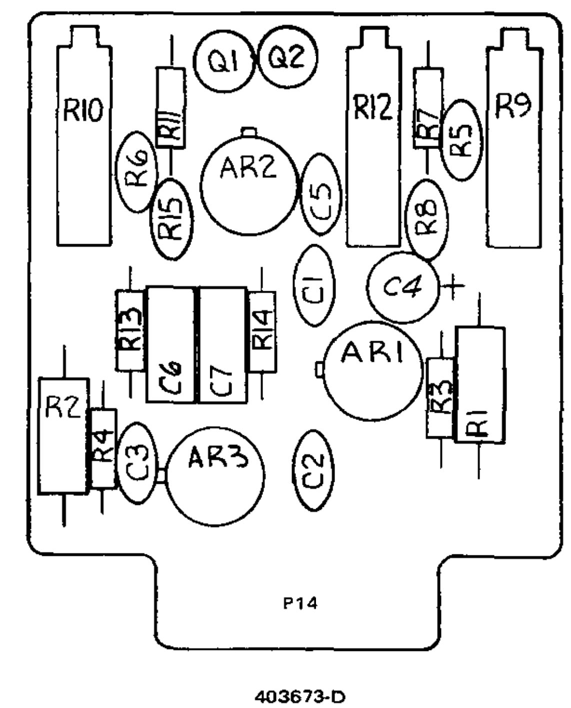


Figure 6.26 - Layout, 4-Wire Ratio (403673)

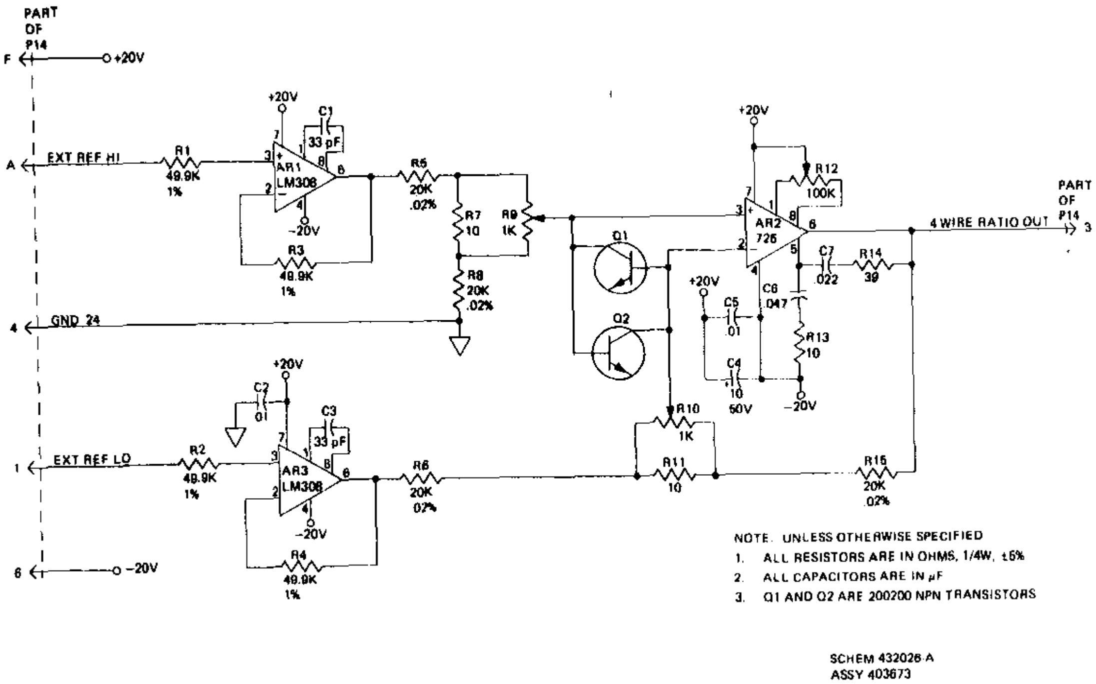


Figure 6.27 - Schematic, 4-Wire Ratio

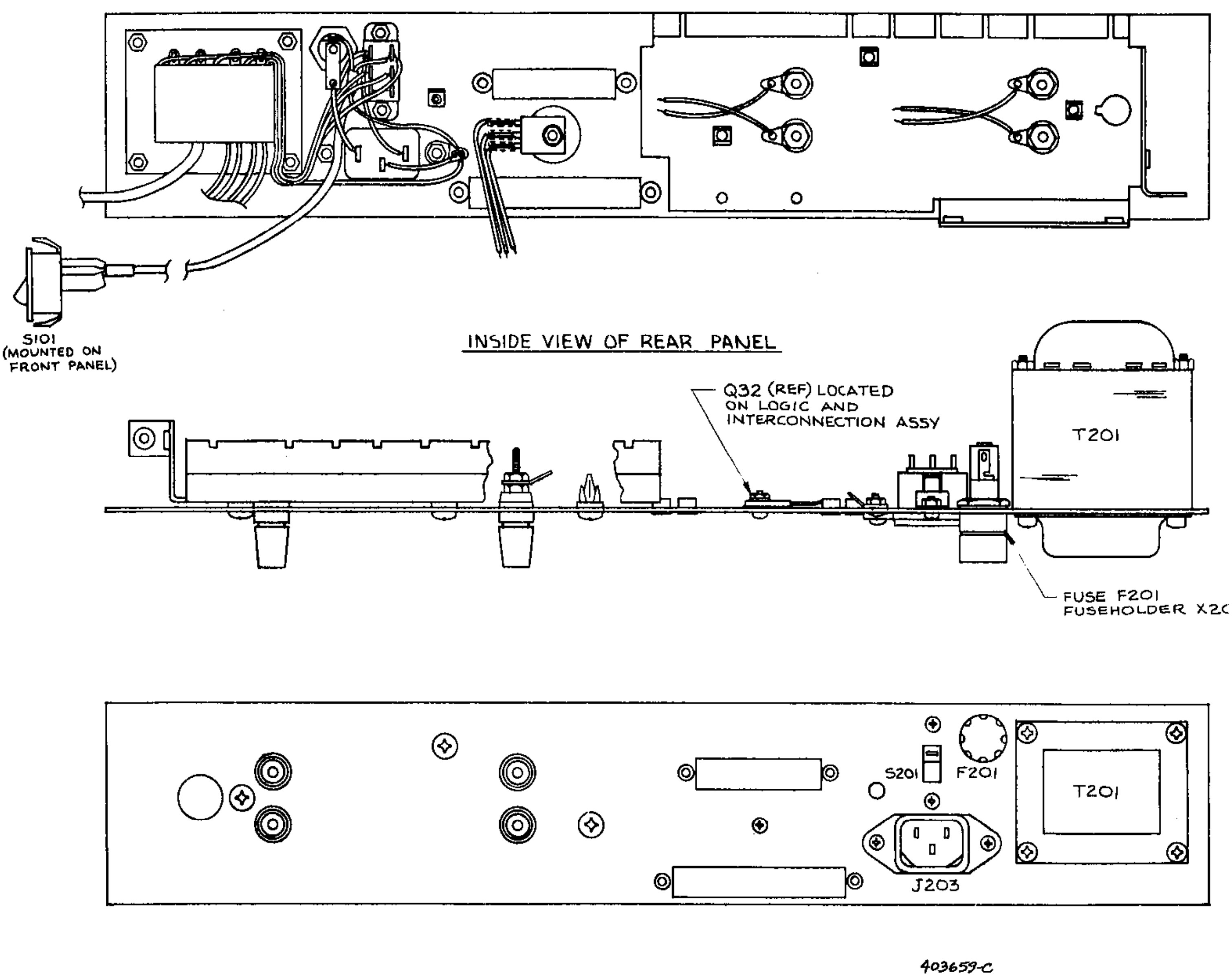
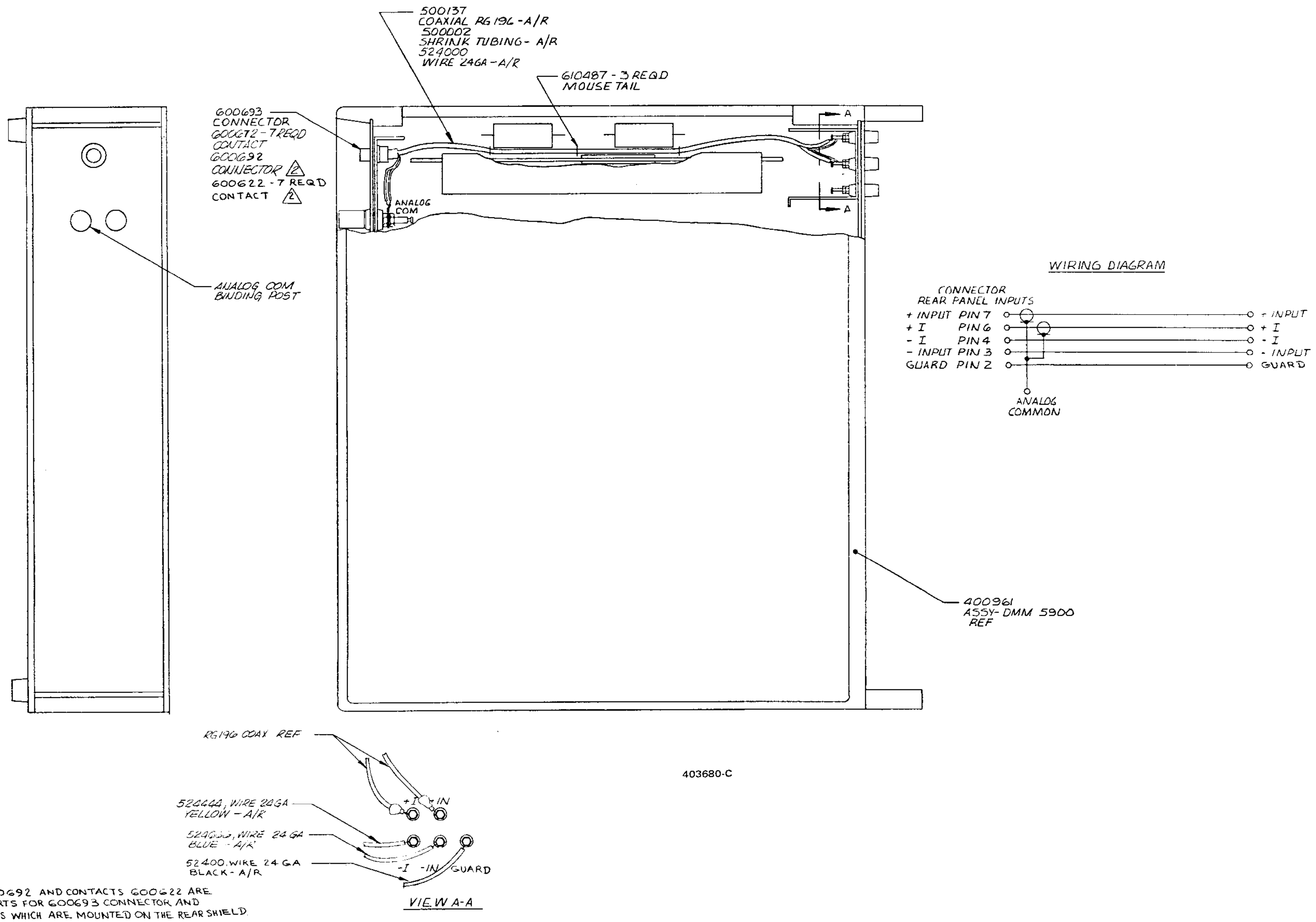
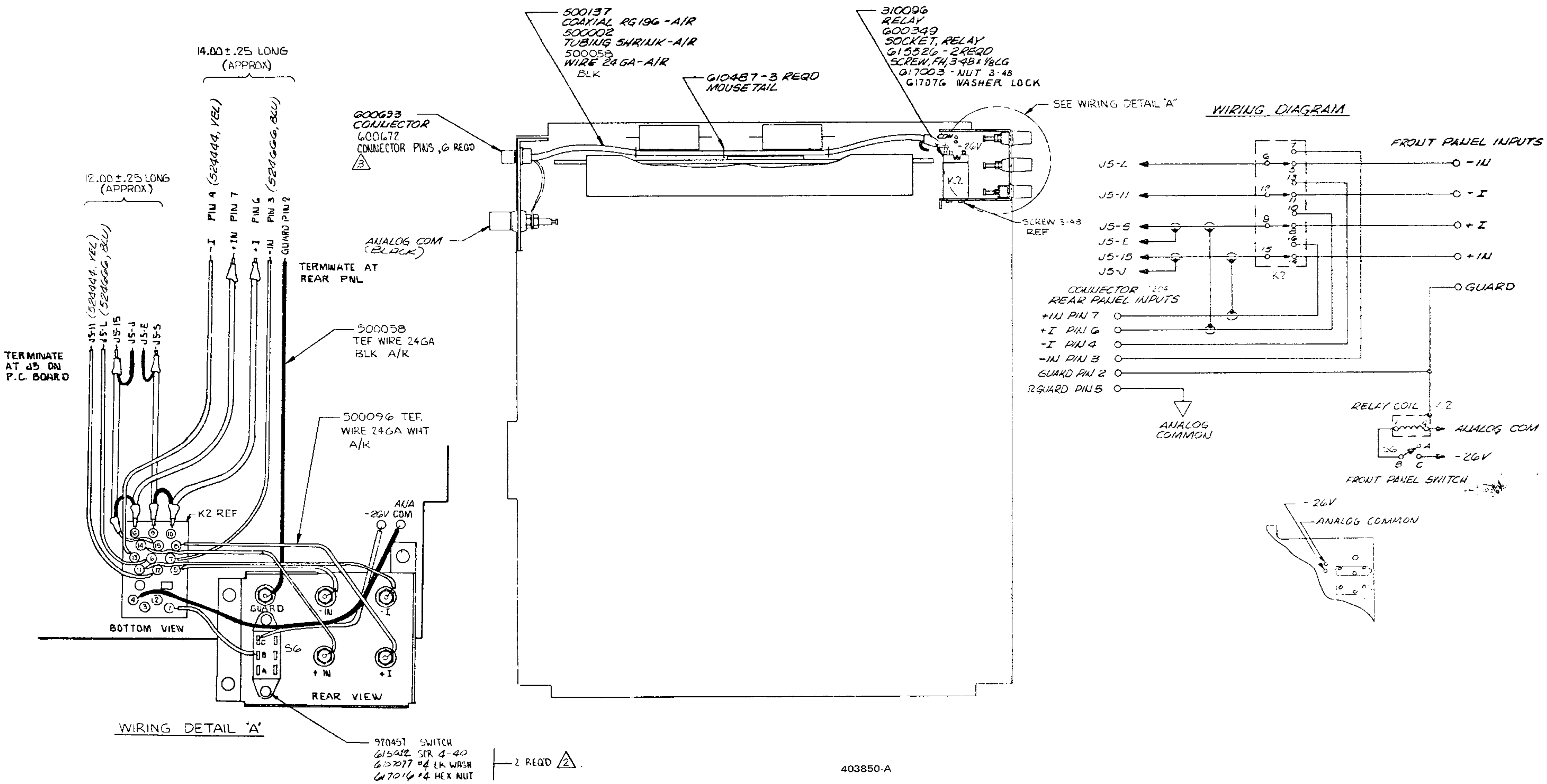


Figure 6.28 - Layout, Rear Panel (403659)



2 CONNECTOR 600692 AND CONTACTS 600622 ARE THE MATING PARTS FOR 600693 CONNECTOR AND 600672 CONTACTS WHICH ARE MOUNTED ON THE REAR SHIELD.

Figure 6.29 - Layout, Parallel Front-Rear Input



△3 MATING CONNECTOR FOR 600693 IS 600692, FEMALE PINS ARE 600622

△2 USE LOCTITE 920056 ON SCREWS

Figure 6.30 - Layout, Switchable Front-Rear Input

7.1 This section contains lists of replaceable parts arranged in the order of the following subassemblies:

7.2 Manufacturers are identified by FSC numbers listed in table 7.2, "List of Suppliers". The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, H4-2, and their supplements.

7.3 The Keithley part number consists of a 5900 prefix followed by a six digit number. For example, 5900-110126 is a 6.8 µF tantalum capacitor. Certain parts having 21793 listed in the "FSC" column are specially selected semiconductors. For some of these, standard commercial parts will serve as satisfactory replacements. These parts are identified in table 7.1 along with the commercial equivalent.

Table 7.1

Semiconductor Type:	Equivalent:
018 Diode	Texas Instruments 1N4448
021 Transistor	MPS A42

Table 7.2 - List of Suppliers

FSC	NAME	FSC	NAME
00779	AMP, INC. HARRISBURG, PENNSYLVANIA	04222	AEROVOX CORP. (Hi-Q Division) MYRTLE BEACH, SOUTH CAROLINA
01121	ALLEN BRADLEY CO. MILWAUKEE, WISCONSIN	04713	MOTOROLA, INC. (Semiconductor Products Division) PHOENIX, ARIZONA
01295	TEXAS INSTRUMENTS, INC. DALLAS, TEXAS	05397	UNION CARBIDE CORP. (Materials Systems Division) CLEVELAND, OHIO
02111	SPECTROL ELECTRONICS CORP. CITY OF INDUSTRY, CALIFORNIA		
02114	FERROXCUBE CORP. SAUGERTIES, NEW YORK	06665	PRECISION MONOLITHICS SANTA CLARA, CALIFORNIA
03888	PYROFILM CORP. WHIPPANY, NEW JERSEY	07263	FAIRCHILD SEMICONDUCTOR MOUNTAIN VIEW, CALIFORNIA

Table 7.2 - List of Suppliers continued

FSC	NAME	FSC	NAME
07716	TRW ELECTRONIC COMPONENTS (IRC) BURLINGTON, IOWA	71471	AEROVOX CORP. (Cinema Plant) MONCKS CORNER, SOUTH CAROLINA
08257	NPC ELECTRONICS CANOGA PARK, CALIFORNIA	71590	CENTRALAB ELECTRONICS MILWAUKEE, WISCONSIN
08806	GENERAL ELECTRIC (Miniature Light Division) CLEVELAND, OHIO	71785	TRW ELECTRONIC COMPONENTS (Cinch Division) ELK GROVE VILLAGE, ILLINOIS
09023	CORNELL-DUBILIER ELECTRONICS SANFORD, NORTH CAROLINA	72136	ELECTRO MOTIVE MFG. CO., INC. WILLIMANTIC, CONNECTICUT
10389	CHICAGO SWITCH, INC. CHICAGO, ILLINOIS	73138	BECKMAN INSTRUMENTS, INC. FULLERTON, CALIFORNIA
11237	CTS KEENE, INC. PASO ROBLES, CALIFORNIA	73445	AMPEREX ELECTRONIC CORP. HICKSVILLE, LONG ISLAND, NEW YORK
13571	ELECTRONIC RESEARCH CO. OVERLAND PK., KANSAS	74970	E. F. JOHNSON CO. WASECA, MINNESOTA
15636	ELEC-TROL, INC. SAUGUS, CALIFORNIA	75915	LITTELFUSE, INC. DES PLAINES, ILLINOIS
17856	SILICONIX, INC. SANTA CLARA, CALIFORNIA	76493	J. W. MILLER CO. COMPTON, CALIFORNIA
18612	VISHAY RESISTOR PRODUCTS MALVERN, PENNSYLVANIA	79727	C-W INDUSTRIES WARMINSTER, PENNSYLVANIA
21793	DANA LABORATORIES, INC. IRVINE, CALIFORNIA	80131	ELECTRONICS INDUSTRIES ASSOC. WASHINGTON, D.C.
22045	JORDAN ELECTRIC CO. VAN NUYS, CALIFORNIA	81349	MILITARY SPECIFICATION
24796	PARELCO, INC. SAN JUAN CAPISTRANO, CALIFORNIA	82389	SWITCHCRAFT, INC. CHICAGO, ILLINOIS
27014	NATIONAL SEMI-CONDUCTOR CORP. SANTA CLARA, CALIFORNIA	87730	UNITED MINERAL & CHEMICAL CORP. NEW YORK CITY, NEW YORK
27556	IMB ELECTRONIC PRODUCTS, INC. SANTA FE SPRINGS, CALIFORNIA	91293	JOHANSON MFG. CO. BOONTON, NEW JERSEY
50434	HEWLETT PACKARD CO. PALO ALTO, CALIFORNIA	91637	DALE ELECTRONICS, INC. COLUMBUS, NEBRASKA
52763	STETTNER-TRUSH CAZENOVIA, NEW YORK	95275	VITRAMON, INC. BRIDGEPORT, CONNECTICUT
56289	SPRAGUE ELECTRIC CO. (Pacific Division) LOS ANGELES, CALIFORNIA	99800	AMERICAN PRECISION INDUSTRIES, INC. (Delevan Division) EAST AURORA, NEW YORK

403614 -- Assy., PCB, LOGIC & INTERCONNECTION (Figure 6.3)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
C1	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C2*	130142	CAP	MICA	150 PFD		5%	72136	DM5-181J
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C4	110129	CAP	TANTA	.1 MFD	35 V	20%	05397	T368A104M035AS
C5	110129	CAP	TANTA	.1 MFD	35 V	20%	05397	T368A104M035AS
C6	120310	CAP	POLY	.01 MFD	250 V	10%	73445	C280MAE/A10K
C7	110156	CAP	TANTA	4.7 MFD	6 V	1%	05397	T368A475K006AS
C8	120308	CAP	POLY	.047 MFD	250 V	10%	73445	C280MAE/A47K
C10	110128	CAP	ELECT	6000 MFD	10 V	−10% +75%	56289	36D602G010AA2A
C11	110067	CAP	ELECT	2000 MFD	35 V		87730	2000DXW35
C12	110067	CAP	ELECT	2000 MFD	35 V		87730	2000DXW35
C13	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C14	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C15	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C16	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C17	110127	CAP	TANTA	22 MFD	6 V	20%	05397	T368B226M006AS
C18	110066	CAP	ELECT	16 MFD	200 V		73445	C436AR/L16
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C20	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C25	120290	CAP	MYLAR	.22 MFD	100 V	20%	73445	C281AH/A220K
C29	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C30	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C31	101145	CAP	CERAM	100 PFD	500V	10%	04222	TCD-DI-1N5600-100
C32	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C33	110178	CAP	ELECT	47 MFD	100 V	10%		100VBSL47
C34	110178	CAP	ELECT	47 MFD	100 V	10%		100VBSL47
C35	110178	CAP	ELECT	47 MFD	100 V	10%		100VBSL47
C37	110143	CAP	TANTA	1 MFD	35 V	20%	05397	T368A105M035AS
C38	110148	CAP	TANTA	.22 MFD	50 V	10%	05397	T368A224K050AS
C39	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C40	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C41	120090	CAP	MYLAR	.22 MFD	600 V	5%	27556	ZA1101J
C42	120308	CAP	POLY	.047 MFD	250 V	10%	73445	C280MAE/A47K
CR1	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR8	210004	DIODE	SILICO		1N4004		81349	1N4004
CR9	210004	DIODE	SILICO		1N4004		81349	1N4004

*In 50 Hz units only:

C2	130094	CAP	MICA	220 PFD	500V	5%	72136	SCDM10-221J

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION				FSC	MANU P/N
CR10	210004	DIODE	SILICO		1N4004	81349	1N4004
CR11	210004	DIODE	SILICO		1N4004	81349	1N4004
CR12	210004	DIODE	SILICO		1N4004	81349	1N4004
CR13	210004	DIODE	SILICO		1N4004	81349	1N4004
CR14	210004	DIODE	SILICO		1N4004	81349	1N4004
CR15	210004	DIODE	SILICO		1N4004	81349	1N4004
CR16	210004	DIODE	SILICO		1N4004	81349	1N4004
CR17	210004	DIODE	SILICO		1N4004	81349	1N4004
CR18	210004	DIODE	SILICO		1N4004	81349	1N4004
CR19	220011	DIODE	SILICO	ZENER	1N968B	81349	1N968B
CR20	220007	DIODE	SILICO	ZENER	1N751A	81349	1N751A
CR21	211083	DIODE	SILICO		018	21793	211083
CR22	211083	DIODE	SILICO		018	21793	211083
CR23	211083	DIODE	SILICO		018	21793	211083
CR24	210004	DIODE	SILICO		1N4004	81349	1N4004
CR25	220011	DIODE	SILICO	ZENER	1N968B	81349	1N968B
CR26	220040	DIODE		ZENER	1N753A	81349	1N753A
CR27	210004	DIODE	SILICO		1N4004	81349	1N4004
CR28	210004	DIODE	SILICO		1N4004	81349	1N4004
CR29	211083	DIODE	SILICO		018	21793	211083
CR30	211083	DIODE	SILICO		018	21793	211083
CR31	220049	DIODE		ZENER	1N957B	81349	1N957B
CR32	210004	DIODE	SILICO		1N4004	81349	1N4004
CR33	211083	DIODE	SILICO		018	21793	211083
CR34	211083	DIODE	SILICO		018	21793	211083
CR35	211083	DIODE	SILICO		018	21793	211083
CR36	211083	DIODE	SILICO		018	21793	211083
CR37	211083	DIODE	SILICO		018	21793	211083
CR38	211083	DIODE	SILICO		018	21793	211083
CR39	211083	DIODE	SILICO		018	21793	211083
J1	453505	CONN	12 PIN	MODIFIED		21793	453505
J2	453505	CONN	12 PIN	MODIFIED		21793	453505
J5	600228	CONN	18 PIN		252-18-30-160	71785	252-18-30-160
J6	600671	CONN	6 PIN		252-06-30-160	71785	252-06-30-160
J7	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J8	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J9	600670	CONN	10 PIN		252-10-30-160	71785	252-10-30-160
J10	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J11	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J12	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J13	600575	CONN	25 PIN		252-25-30-160	71785	252-25-30-160
J14	600671	CONN	6 PIN		252-06-30-160	71785	252-06-30-160
K1	310109	RELAY			5 V	24796	R10E-2515-1

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION				FSC	MANU P/N
L1	310055	CHOKE	RF	4.7 μH	9310-28	76493	9310-28
OCI-1	250000	ISOLATOR		OPTICALLY COUPLED		01295	TIL108
OCI-2	250000	ISOLATOR		OPTICALLY COUPLED		01295	TIL108
OCI-3	250000	ISOLATOR		OPTICALLY COUPLED		01295	TIL108
OCI-4	250000	ISOLATOR		OPTICALLY COUPLED		01295	TIL108
Q1	200099	TRANS			2N4258	81349	2N4258
Q2	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q3	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q4	200099	TRANS			2N4258	81349	2N4258
Q5	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q6	200099	TRANS			2N4258	81349	2N4258
Q7	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q8	200200	TRANS		NPN	200200	21793	200200
Q9	200099	TRANS			2N4258	81349	2N4258
Q10	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q11	200136	TRANS	SILICO	NPN	2N5963	81349	2N5963
Q12	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q13	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q14	200200	TRANS		NPN	200200	21793	200200
Q15	200200	TRANS		NPN	200200	21793	200200
Q16	200200	TRANS		NPN	200200	21793	200200
Q17	200200	TRANS		NPN	200200	21793	200200
Q18	200200	TRANS		NPN	200200	21793	200200
Q19	200167	TRANS		PNP	MPS-U55	04713	MPS-U55
Q21	200200	TRANS		NPN	200200	21793	200200
Q22	200200	TRANS		NPN	200200	21793	200200
Q23	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q24	200200	TRANS		NPN	200200	21793	200200
Q25	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q26	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q27	200200	TRANS		NPN	200200	21793	200200
Q28	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q29	200200	TRANS		NPN	200200	21793	200200
Q30	200068	TRANS		PNP	2N4250	80131	2N4250
Q31	200155	TRANS	SILICO	NPN	MJE520	04713	MJE520
Q32	200130	TRANS	SILICO	NPN	MJE3055	04713	MJE3055
Q33	200154	TRANS	SILICO	PNP	MJE370	04713	MJE370
Q35	200200	TRANS		NPN	200200	21793	200200
Q37	200200	TRANS		NPN	200200	21793	200200
Q39	200200	TRANS		NPN	200200	21793	200200
Q41	200200	TRANS		NPN	200200	21793	200200
Q42	200200	TRANS		NPN	200200	21793	200200
Q43	200200	TRANS		NPN	200200	21793	200200

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
R1	000391	RES	CARBON	390 OHM	5%	1/4W	81349	RC07GF391J
R2	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R3	000121	RES	CARBON	120 OHM	5%	1/4W	81349	RC07GF121J
R4	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R5	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R6	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R7	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R8	000201	RES	CARBON	200 OHM	5%	1/4W	81349	RC07GF201J
R9	000201	RES	CARBON	200 OHM	5%	1/4W	81349	RC07GF201J
R10	000200	RES	CARBON	20 OHM	5%	1/4W	81349	RC07GF200J
R11	000200	RES	CARBON	20 OHM	5%	1/4W	81349	RC07GF200J
R12	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R13	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R14	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R15	000204	RES	CARBON	200 K	5%	1/4W	81349	RC07GF204J
R16	000303	RES	CARBON	30 K	5%	1/4W	81349	RC07GF303J
R17	000202	RES	CARBON	2 K	5%	1/4W	81349	RC07GF202J
R18	000302	RES	CARBON	3 K	5%	1/4W	81349	RC07GF302J
R19	000432	RES	CARBON	4.3 K	5%	1/4W	81349	RC07GF432J
R20	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R21	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R22	000154	RES	CARBON	150 K	5%	1/4W	81349	RC07GF154J
R23	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R24	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R26	000512	RES	CARBON	5.1 K	5%	1/4W	81349	RC07GF512J
R27	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R28	000511	RES	CARBON	510 OHM	5%	1/4W	81349	RC07GF511J
R29	000103	RES	CARBON	10 K	5%	1/4W	81349	RC07GF103J
R30	000302	RES	CARBON	3 K	5%	1/4W	81349	RC07GF302J
R31	000182	RES	CARBON	1.8 K	5%	1/4W	81349	RC07GF182J
R32	000361	RES	CARBON	360 OHM	5%	1/4W	81349	RC07GF361J
R33	000182	RES	CARBON	1.8 K	5%	1/4W	81349	RC07GF182J
R34	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R35	000361	RES	CARBON	360 OHM	5%	1/4W	81349	RC07GF361J
R36	000182	RES	CARBON	1.8 K	5%	1/4W	81349	RC07GF182J
R37	000361	RES	CARBON	360 OHM	5%	1/4W	81349	RC07GF361J
R38	000182	RES	CARBON	1.8 K	5%	1/4W	81349	RC07GF182J
R39	000102	RES	CARBON	1 K	5%	1/4W	81349	RC07GF102J
R40	000361	RES	CARBON	360 OHM	5%	1/4W	81349	RC07GF361J
R41	000103	RES	CARBON	10 K	5%	1/4W	81349	RC07GF103J
R42	000103	RES	CARBON	10 K	5%	1/4W	81349	RC07GF103J
R43	000103	RES	CARBON	10 K	5%	1/4W	81349	RC07GF103J

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION				FSC	MANU P/N
R44	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R45	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R46	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R47	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R48	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R49	000332	RES	CARBON	3.3 K	5% 1/4W	81349	RC07GF332J
R50	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R51	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R52	000122	RES	CARBON	1.2 K	5% 1/4W	81349	RC07GF122J
R53	000122	RES	CARBON	1.2 K	5% 1/4W	81349	RC07GF122J
R54	000183	RES	CARBON	18 K	5% 1/4W	81349	RC07GF183J
R55	000202	RES	CARBON	2 K	5% 1/4W	81349	RC07GF202J
R56	001738	RES	CARBON	1.5 OHM	5% 1/2W	81349	RC20GF1R5J
R57	020576	RES	WW	.24 OHM	5% 2 W	07716	BWH Series
R58	000183	RES	CARBON	18 K	5% 1/4W	81349	RC07GF183J
R59	001738	RES	CARBON	1.5 OHM	5% 1/2W	81349	RC20GF1R5J
R60	040235	POT	CERMET	100 K	10%	73138	89PR100K
R61	010778	RES	METAL	2.74 K	1% 1/10W	81349	RN55C2741F
R62	010778	RES	METAL	2.74 K	1% 1/10W	81349	RN55C2741F
R63	000203	RES	CARBON	20 K	5% 1/4W	81349	RC07GF203J
R64	000203	RES	CARBON	20 K	5% 1/4W	81349	RC07GF203J
R69	000203	RES	CARBON	20 K	5% 1/4W	81349	RC07GF203J
R72	040235	POT	CERMET	100 K	10%	73138	89PR100K
R75	000203	RES	CARBON	20 K	5% 1/4W	81349	RC07GF203J
R78	000202	RES	CARBON	2 K	5% 1/4W	81349	RC07GF202J
R79	000510	RES	CARBON	51 OHM	5% 1/4W	81349	RC07GF510J
R80	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R82	000154	RES	CARBON	150 K	5% 1/4W	81349	RC07GF154J
R83	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R84	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R85	000202	RES	CARBON	2 K	5% 1/4W	81349	RC07GF202J
R86	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R87	040272	POT		50 K	10%	11237	200
R89	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R90	000332	RES	CARBON	3.3 K	5% 1/4W	81349	RC07GF332J
R91	000224	RES	CARBON	220 K	5% 1/4W	81349	RC07GF224J
R92	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R93	000822	RES	CARBON	8.2 K	5% 1/4W	81349	RC07GF822J
R94	000432	RES	CARBON	4.3 K	5% 1/4W	81349	RC07GF432J
R95	000822	RES	CARBON	8.2 K	5% 1/4W	81349	RC07GF822J
R96	000432	RES	CARBON	4.3 K	5% 1/4W	81349	RC07GF432J
R97	000822	RES	CARBON	8.2 K	5% 1/4W	81349	RC07GF822J
R103	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R104	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R105	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R106	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R107	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R108	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R109	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R110	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R111	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R112	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
S2	600683	SWITCH PUSHBUTTON 600683	21793	600683
S3	600683	SWITCH PUSHBUTTON 600683	21793	600683
S4	600683	SWITCH PUSHBUTTON 600683	21793	600683
S5	600683	SWITCH PUSHBUTTON 600683	21793	600683
T2	403553	TRANSFORMER PULSE 403553	21793	403553
T3	403553	TRANSFORMER PULSE 403553	21793	403553
T4	403553	TRANSFORMER PULSE 403553	21793	403553
TP1	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP2	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP3	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP4	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP5	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP6	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP7	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP8	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP9	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP10	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP11	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP12	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP13	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP14	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
U1	230132	INTEGRATED CIRCUIT 7447	01295	7447
U2	230132	INTEGRATED CIRCUIT 7447	01295	7447
U3	230132	INTEGRATED CIRCUIT 7447	01295	7447
U4	230132	INTEGRATED CIRCUIT 7447	01295	7447
U5	230132	INTEGRATED CIRCUIT 7447	01295	7447
U6	230132	INTEGRATED CIRCUIT 7447	01295	7447
U7	230065	INTEGRATED CIRCUIT 7475	01295	7475
U8	230065	INTEGRATED CIRCUIT 7475	01295	7475

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	KEITHLEY P/N	DESCRIPTION		FSC	MANU P/N
U9	230065	INTEGRATED CIRCUIT	7475	01295	7475
U10	230065	INTEGRATED CIRCUIT	7475	01295	7475
U11	230065	INTEGRATED CIRCUIT	7475	01295	7475
U12	230028	INTEGRATED CIRCUIT	SN7400	01295	SN7400
U13	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U14	230037	INTEGRATED CIRCUIT	7490	01295	7490
U15	230037	INTEGRATED CIRCUIT	7490	01295	7490
U16	230037	INTEGRATED CIRCUIT	7490	01295	7490
U17	230037	INTEGRATED CIRCUIT	7490	01295	7490
U18	230037	INTEGRATED CIRCUIT	7490	01295	7490
U19	230114	INTEGRATED CIRCUIT	7408	01295	7408
U20	230114	INTEGRATED CIRCUIT	7408	01295	7408
U21	230114	INTEGRATED CIRCUIT	7408	01295	7408
U22	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U23	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U24	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U25	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U26	230072	INTEGRATED CIRCUIT	SN7474	01295	SN7474
U27	230072	INTEGRATED CIRCUIT	SN7474	01295	SN7474
U28	230029	INTEGRATED CIRCUIT	SN7401	01295	SN7401
U29	230072	INTEGRATED CIRCUIT	SN7474	01295	SN7474
U30	230030	INTEGRATED CIRCUIT	SN7402	01295	SN7402
U31	230028	INTEGRATED CIRCUIT	SN7400	01295	SN7400
U32	230031	INTEGRATED CIRCUIT	SN7410	01295	SN7410
U33	230035	INTEGRATED CIRCUIT	SN7473	01295	SN7473
U34	230028	INTEGRATED CIRCUIT	SN7400	01295	SN7400
U35	230064	INTEGRATED CIRCUIT	SN7404	01295	SN7404
U36	230116	INTEGRATED CIRCUIT	7432	01295	7432
U37	230080	INTEGRATED CIRCUIT	7496	01295	7496
U38	230028	INTEGRATED CIRCUIT	SN7400	01295	SN7400
U39	230037	INTEGRATED CIRCUIT	7490	01295	7490
U40	230028	INTEGRATED CIRCUIT	SN7400	01295	SN7400
U41	230071	INTEGRATED CIRCUIT	7445	01295	7445
U42	230073	INTEGRATED CIRCUIT	SN7405	01295	SN7405
U43	230029	INTEGRATED CIRCUIT	SN7401	01295	SN7401
U44	230133	INTEGRATED CIRCUIT	74121	01295	74121
W2	600245	JUMPER	L-2007-1LP		L-2007-1LP
W3	600245	JUMPER	L-2007-1LP		L-2007-1LP
Y1	920627	CRYSTAL	6 MHz	13571	6 MHz

403857 – Assy., PCB, READOUT (Figure 6.3)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
LED1	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
LED2	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
LED3	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
LED4	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
LED5	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
LED6	210065	L.E.D.	DISPLAY		HP5082-7750		50434	HP5082-7750
R1	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R2	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R3	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R4	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R5	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R6	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R7	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R8	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R9	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R10	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R11	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R12	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R13	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R14	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R15	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R16	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R17	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R18	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R19	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R20	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R21	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R22	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R23	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R24	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R25	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R26	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R27	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R28	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R29	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R30	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R31	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R32	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R33	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R34	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J
R35	000241	RES	CARBON	240 OHM	5%	1/4W	81349	RC07GF241J

403857 -- Assy., PCB, READOUT *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R36	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R37	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R38	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R39	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R40	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R41	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R42	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R43	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R44	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R45	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R46	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J

403623 - Assy., PCB, ATTENUATOR (Figure 6.5)

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
C1	100046	CAP CERAM .01 MFD 1000 V 20%	56289	C023B102K103M
C2	100012	CAP CERAM 33 PFD 500 V 10%	71471	TCD-DI-1(N750)
C3	120309	CAP POLY .015 MFD 200 V 5%	27556	PA2C153J
C4	120313	CAP POLY .15 MFD 200 V 5%	27556	PA2C154J
CR1	211083	DIODE SILICO 018	21793	211083
CR2	211083	DIODE SILICO 018	21793	211083
CR3	211083	DIODE SILICO 018	21793	211083
CR4	211083	DIODE SILICO 018	21793	211083
CR5	211083	DIODE SILICO 018	21793	211083
CR6	211083	DIODE SILICO 018	21793	211083
CR7	210004	DIODE SILICO 1N4004	81349	1N4004
CR8	211083	DIODE SILICO 018	21793	211083
K1	310111	RELAY 28 V	24796	R10E-2314-2
K2	310112	RELAY 28 V	24796	R10E-2315-2
K3	310111	RELAY 28 V	24796	R10E-2314-2
K4	310113	RELAY REED R4092-3	15636	R4092-3
R1	000107	RES CARBON 100 M 5% 1/4W	81349	RC07GF107J
R2	001796	RES CARBON 2.7 OHM 5% 1/4W	01121	See Descrpt.
R3	010027	RES METAL 499 OHM T-0 1% 1/8W	81349	RN60D4990F
R4	010769	RES METAL 4.5 K .01%	18612	HP202
R5	040229	POT CERMET 1 K 10%	73138	89P Series
R6	010770	RES METAL 45.0097 K .01%	18612	HP202
R7	000753	RES CARBON 75 K 5% 1/4W	81349	RC07GF753J
R8	001806	RES CARBON 200 K 5% 2 W	01121	See Descrpt.
R9	001806	RES CARBON 200 K 5% 2 W	01121	See Descrpt.
R11	040229	POT CERMET 1 K 10%	73138	89P Series
R12	020640	RES WW, SET	21793	020640
R13	040229	POT CERMET 1 K 10%	73138	89P Series
R14	010161	RES METAL 110 OHM T-0 1% 1/8W	81349	RN60D1100F
R15	020640	RES WW, SET	21793	020640
R16	010768	RES METAL 500 OHM .01%	18612	HP202-M
R17	000107	RES CARBON 100 M 5% 1/4W	81349	RC07GF107J
R18	040235	POT CERMET 100 K 10%	73138	89PR100K
R19	010033	RES METAL 49.9 K 1% 1/8W	81349	RN60D4992F
R20	000107	RES CARBON 100 M 5% 1/4W	81349	RC07GF107J
R21	010616	RES METAL 50 K .1% 1/10W	81349	RN55C5002B
R22	010616	RES METAL 50 K .1% 1/10W	81349	RN55C5002B
R23	010616	RES METAL 50 K .1% 1/10W	81349	RN55C5002B
R24	020640	RES WW, SET	21793	020640

403623 – Assy., PCB, ATTENUATOR *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R25	020640	RES WW, SET	21793	020640
R26	020640	RES WW, SET	21793	020640
R27	020640	RES WW, SET	21793	020640
AR1	230103	INTEGRATED CIRCUIT AMP LM308	27014	LM308

403625 – Assy., PCB, SWITCHING (Figure 6.7)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	220019	DIODE	SILICO	ZENER	1N752A		81349	1N752A
CR4	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083
K1	310110	RELAY			5 V		24796	R10E-2445-1
K2	310110	RELAY			5 V		24796	R10E-2445-1
OCI-1	250000	ISOLATOR		OPTICALLY COUPLED			01295	TIL108
OCI-2	250000	ISOLATOR		OPTICALLY COUPLED			01295	TIL108
OCI-3	250000	ISOLATOR		OPTICALLY COUPLED			01295	TIL108
Q1	200200	TRANS		NPN	200200		21793	200200
Q2	200200	TRANS		NPN	200200		21793	200200
Q3	200200	TRANS		NPN	200200		21793	200200
Q4	200200	TRANS		NPN	200200		21793	200200
Q5	200200	TRANS		NPN	200200		21793	200200
Q6	200200	TRANS		NPN	200200		21793	200200
Q7	200200	TRANS		NPN	200200		21793	200200
Q8	200200	TRANS		NPN	200200		21793	200200
Q9	200200	TRANS		NPN	200200		21793	200200
R1	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R2	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R3	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R4	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R5	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R6	000361	RES	CARBON	360 OHM		5% 1/4W	81349	RC07GF361J
R7	000361	RES	CARBON	360 OHM		5% 1/4W	81349	RC07GF361J
R8	000361	RES	CARBON	360 OHM		5% 1/4W	81349	RC07GF361J
R9	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R10	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R11	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R12	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R13	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R14	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R15	000682	RES	CARBON	6.8 K		5% 1/4W	81349	RC07GF682J
R16	000472	RES	CARBON	4.7 K		5% 1/4W	81349	RC07GF472J

403625 – Assy., PCB, SWITCHING *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R17	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R18	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
U1	230073	INTEGRATED CIRCUIT SN7405N	01295	SN7405N
U2	230034	INTEGRATED CIRCUIT 74141	01295	74141

403624 – Assy., PCB, ISOLATOR (Figure 6.9)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
C1	120004	CAP	POLY	.001 MFD	500 V		08257	KSO Series
C2	101175	CAP	CERAM	220 PFD	100 V	10%	71471	SCD1X5F
C3	101175	CAP	CERAM	220 PFD	100 V	10%	71471	SCD1X5F
C4	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C5	101099	CAP	CERAM	680 PFD	1000 V	10%	71471	SCD2X5F
C6	121092	CAP	MYLAR	.0022 MFD	100 V	10%	09023	WMF1D22
C7	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C8	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C9	120271	CAP	POLY	.5 MFD	50 V	5%	27556	PV2A504J
C10	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C12	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C13	101182	CAP	CERAM	47 PFD	500 V	10%	71471	TCD-DI-2(N750)
C14	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C16	120313	CAP	POLY	.15 MFD	200 V	5%	27556	PA2C154J
C17	100032	CAP	MICA	.0013 MFD	100 V	10%	72136	DM19F132J
C18	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C19	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C20	120313	CAP	POLY	.15 MFD	200 V	5%	27556	PA2C154J
C21	110163	CAP	TANTA	4.7 MFD	35 V	20%	05397	T368B475M035AS
C22	110163	CAP	TANTA	4.7 MFD	35 V	20%	05397	T368B475M035AS
C23	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C24	101145	CAP	CERAM	100 PFD	500 V	10%	04222	TCD-DI-1N5600-100
C25	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C26	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C27	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
CR1	210004	DIODE	SILICO		1N4004		81349	1N4004
CR2	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR3	220035	DIODE		ZENER	16 V	5%	81349	1N966B
CR4	220007	DIODE	SILICO	ZENER	1N751A		81349	1N751A
CR5	220007	DIODE	SILICO	ZENER	1N751A		81349	1N751A
CR6	210004	DIODE	SILICO		1N4004		81349	1N4004
CR7	210004	DIODE	SILICO		1N4004		81349	1N4004
CR8	211083	DIODE	SILICO		018		21793	211083
CR9	211083	DIODE	SILICO		018		21793	211083
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	211083	DIODE	SILICO		018		21793	211083
CR12	211083	DIODE	SILICO		018		21793	211083
K1A	310113	RELAY	REED		R4092-3		15636	R4092-3
K1B	310113	RELAY	REED		R4092-3		15636	R4092-3
Q1	200191	TRANS		PNP	2N1305		81349	2N1305

403624 – Assy., PCB, ISOLATOR *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
Q2	200200	TRANS		NPN	200200			21793	200200
Q3	200088	TRANS	SILICO	PNP	2N4248			80131	2N4248
Q4	200200	TRANS		NPN	200200			21793	200200
Q5	200200	TRANS		NPN	200200			21793	200200
Q6	200201	TRANS	DUAL	NPN	200201			21793	200201
Q7	200199	TRANS	DUAL		200199			21793	200199
Q8	200088	TRANS	SILICO	PNP	2N4248			80131	2N4248
Q9	200200	TRANS		NPN	200200			21793	200200
R1	010529	RES	METAL	10 K	T-0	1%	1/10W	81349	RN55C1002F
R2	010277	RES	METAL	442 OHM		1%	1/8W	81349	RN60D4420F
R3	040235	POT	CERMET	100 K		10%		73138	89PR100K
R4	001810	RES	CARBON	47 M		5%	1/2W	01121	See Descrpt.
R5	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R6	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R7	040235	POT	CERMET	100 K		10%		73138	89PR100K
R8	001810	RES	CARBON	47 M		5%	1/2W	01121	See Descrpt.
R9	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R10	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R11	010779	RES	METAL	806 K		1%	1/4W	81349	RN65E8063F
R12	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R13	000220	RES	CARBON	22 OHM		5%	1/4W	81349	RC07GF220J
R14	040232	POT	CERMET	10 K		10%		73138	89PR10K
R15	010429	RES	METAL	475 K		1%	1/8W	81349	RN60D4753F
R16	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R17	010779	RES	METAL	806 K		1%	1/4W	81349	RN65E8063F
R18	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R19	000432	RES	CARBON	4.3 K		5%	1/4W	81349	RC07GF432J
R20	000432	RES	CARBON	4.3 K		5%	1/4W	81349	RC07GF432J
R21	000513	RES	CARBON	51 K		5%	1/4W	81349	RC07GF513J
R22	000513	RES	CARBON	51 K		5%	1/4W	81349	RC07GF513J
R24	010106	RES	METAL	324 K	T-0	1%	1/8W	81349	RN60D3243F
R25	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R26	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R28	010106	RES	METAL	324 K	T-0	1%	1/8W	81349	RN60D3243F
R29	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R30	010529	RES	METAL	10 K	T-0	1%	1/10W	81349	RN55C1002F
R31	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R32	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R33	000102	RES	CARBON	1 K		5%	1/4W	81349	RC07GF102J
R34	000241	RES	CARBON	240 OHM		5%	1/4W	81349	RC07GF241J

403624 -- Assy., PCB, ISOLATOR *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R36	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R37	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R38	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
AR1	230103	INTEGRATED CIRCUIT LM308	27014	LM308
AR2	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR3	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR4	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR5	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
TP1	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP2	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP3	600786	POST TEST POINT 1-87022-0	00779	1-87022-0

403916 – Assy., PCB, 10V REFERENCE (Figure 6.12)

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
CR1*	220032	DIODE ZENER 403686	21793	403686
Q1	200196	TRANS NPN 2N3568	81349	2N3568
Q2**	200200	TRANS NPN 200200	21793	200200
R1*	020654	RES WW FSV 403686 1%	22045	J-90
R2	020641	RES WW 10 K 1% .05 W	22045	J-90
R3	040232	POT CERMET 10 K 10%	73138	89PR10K
R4	040235	POT CERMET 100 K 10%	73138	89PR100K
R5	040236	POT CERMET 200 K 10%	73138	89PR200K
R6	000565	RES CARBON 5.6 M 5% 1/4W	81349	RC07GF565J
R7	010774	RES METAL 3.7 K .01%	18612	V53-1
R8	010773	RES METAL 6.3 K .01%	18612	V53-1
R9*	020655	RES WW FSV 403686 1%	22045	J-90 86
R10*	010941	RES METAL FSV 403686 ZENER BRIDGE	21793	010941
R11**	010879	RES METAL 1 M 1% 1/10W	81349	RN55D1004F
R12**	012007	RES METAL 23.2 K NOM FSV 1%	21793	012007
AR1	230127	INTEGRATED CIRCUIT	06665	SSS725C

*Zener Ref FSV Kit 403686

**Part of temperature compensation circuit and may not be installed in all assemblies

All other components are Ref Amp Assy 403917

403626 – Assy., PCB, DIGITIZER (Figure 6.12)

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
C1	110125	CAP TANTA 2.2 MFD 35 V 20%	05397	T368B225M035AS
C2	110125	CAP TANTA 2.2 MFD 35 V 20%	05397	T368B225M035AS
C3	101098	CAP CERAM 330 PFD 1000 V 10%	56289	C016B102E331K
C4	101642	CAP CERAM 150 PFD 500 V 10%	71471	SCD1X5F
C5	101174	CAP CERAM .001 MFD 500 V 10%	04222	SCD-DI-2X5F-1000
C6	100006	CAP CERAM 10 PFD 500 V	71471	TCDI-1(N750)
C7	110127	CAP TANTA 22 MFD 6 V 20%	05397	T368B226M006AS
C8	120253	CAP POLY .33 MFD 100 V 5%	71785	863UW
C9	101642	CAP CERAM 150 PFD 500 V 10%	71471	SCD1X5F
C10	110125	CAP TANTA 2.2 MFD 35 V 20%	05397	T368B225M035AS
C11	101642	CAP CERAM 150 PFD 500 V 10%	71471	SCD1X5F
C12	100012	CAP CERAM 33 PFD 500 V 10%	71471	TCD-DI-1(N750)
C13	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C15	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C16	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C17	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C18	100068	CAP CERAM .02 MFD 100 V 20%	56289	C023B101H203M
C19	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C20	100068	CAP CERAM .02 MFD 100 V 20%	56289	C023B101H203M
C21	120308	CAP POLY .047 MFD 250 V 10%	73445	C280MAE/A47K
C26	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C27	130142	CAP MICA 150 PFD 5%	72136	DM5-181J
C28	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C29	120308	CAP POLY .047 MFD 250 V 10%	73445	C280MAE/A47K
C30	100068	CAP CERAM .02 MFD 100 V 20%	56289	C023B101H203M
C31	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C32	110126	CAP TANTA 6.8 MFD 35 V 20%	05397	T368B685M035AS
C36	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C37	110127	CAP TANTA 22 MFD 6 V 20%	05397	T368B226M006AS
C38	110129	CAP TANTA .1 MFD 35 V 20%	05397	T368A104M035AS
C39	101098	CAP CERAM 330 PFD 1000 V 10%	56289	C016B102E331K
C41	100006	CAP CERAM 10 PFD 500 V	71471	TCDI-1(N750)
C42	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C43	110165	CAP TANTA .15 MFD 35 V 10%	05397	T368A154K035AS
C44	110158	CAP TANTA 10 MFD 50 V 10%	05397	T362C106K050A
C45	101644	CAP CERAM 200 PFD 1000V 20%	71471	GPDX5F201K
C46	101642	CAP CERAM 150 PFD 500 V 10%	71471	SCD1X5F
C47	101644	CAP CERAM 200 PFD 1000V 20%	71471	GPDX5F201K
CR1	220054	DIODE ZENER 1N5260B	81349	1N5260B
CR2	220059	DIODE ZENER 33 V 5%	81349	1N973B
CR3	211083	DIODE SILICO 018	21793	211083
CR4	211083	DIODE SILICO 018	21793	211083
CR5	211083	DIODE SILICO 018	21793	211083
CR6	211083	DIODE SILICO 018	21793	211083
CR7	211083	DIODE SILICO 018	21793	211083
CR8	211083	DIODE SILICO 018	21793	211083

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION				FSC	MANU P/N
CR9	211083	DIODE	SILICO		018	21793	211083
CR10	211083	DIODE	SILICO		018	21793	211083
CR11	211083	DIODE	SILICO		018	21793	211083
CR12	211083	DIODE	SILICO		018	21793	211083
CR13	211083	DIODE	SILICO		018	21793	211083
CR14	220022	DIODE	SILICO	ZENER	1N965B	81349	1N965B
CR15	220007	DIODE	SILICO	ZENER	1N751A	81349	1N751A
CR16	211083	DIODE	SILICO		018	21793	211083
CR17	211083	DIODE	SILICO		018	21793	211083
CR18	220007	DIODE	SILICO	ZENER	1N751A	81349	1N751A
CR19	220007	DIODE	SILICO	ZENER	1N751A	81349	1N751A
CR20	211083	DIODE	SILICO		018	21793	211083
CR21	211083	DIODE	SILICO		018	21793	211083
CR22	220022	DIODE	SILICO	ZENER	1N965B	81349	1N965B
CR25	220022	DIODE	SILICO	ZENER	1N965B	81349	1N965B
CR26	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		1/4M3.3AZ5
CR27	211083	DIODE	SILICO		018	21793	211083
CR28	211083	DIODE	SILICO		018	21793	211083
CR29	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5		1/4M3.3AZ5
CR31	221177	DIODE	SILICO	ZENER	018	04713	1/4M.2.4AZ5
Q1	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q2	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q3	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q4	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q5	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q6	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q7	200088	TRANS	SILICO	PNP	2N4248	80131	2N4248
Q8	200162	SWITCHES	FET	MATCHED SET		21793	200162
Q9	200224	TRANS			200224	21793	200224
Q10	200162	SWITCHES	FET	MATCHED SET		21793	200162
Q11	200224	TRANS			200224	21793	200224
Q12	200162	SWITCHES	FET	MATCHED SET		21793	200162
Q13	200224	TRANS		NPN	200224	21793	200224
Q16	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q17	200161	TRANS	SELECTED	FET	E415	17856	E415
Q18	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q19	200160	TRANS	FET		E-304	17856	E-304
Q20	200160	TRANS	FET		E-304	17856	E-304
Q21	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646
Q22	200200	TRANS		NPN	200200	21793	200200
Q23	200037	TRANS	SILICO	NPN	2N3646	80131	2N3646

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
Q24	200203	TRANS E-201	17856	E-201
Q25	200203	TRANS E-201	17856	E-201
Q26	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q27	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q28	200200	TRANS NPN 200200	21793	200200
Q29	200200	TRANS NPN 200200	21793	200200
Q30	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q31	200099	TRANS 2N4258	81349	2N4258
Q32	200200	TRANS NPN 200200	21793	200200
Q33	200200	TRANS NPN 200200	21793	200200
Q34	200200	TRANS NPN 200200	21793	200200
Q35	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q36	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q37	200200	TRANS NPN 200200	21793	200200
Q38	200068	TRANS PNP 2N4250	80131	2N4250
Q41	200201	TRANS DUAL NPN 200201	21793	200201
Q43	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q44	200200	TRANS NPN 200200	21793	200200
Q45	200200	TRANS NPN 200200	21793	200200
Q46	200200	TRANS NPN 200200	21793	200200
R1	000273	RES CARBON 27 K 5% 1/4W	81349	RC07GF273J
R2	040240	POT CERMET 10 OHM 20%	73138	89PR10
R3	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R4	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R5	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R6	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R7	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R8	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R9	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R10	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R11	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R12	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R13	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R14	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R15	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R16	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R17	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R18*	010621	RES METAL 49.9 K T-0 1% 1/10W	81349	RN55C4992F
R19	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R20	000153	RES CARBON 15 K 5% 1/4W	81349	RC07GF153J
R21	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J

*In 50 Hz units, R18 is:

R18 010642 RES METAL 59 K T-0 1% 81349 RN55D5902F

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R22	000511	RES	CARBON	510 OHM		5%	1/4W	81349	RC07GF511J
R23	000511	RES	CARBON	510 OHM		5%	1/4W	81349	RC07GF511J
R24	000153	RES	CARBON	15 K		5%	1/4W	81349	RC07GF153J
R25	000272	RES	CARBON	2.7 K		5%	1/4W	81349	RC07GF272J
R26	010013	RES	METAL	60.4 K	T-2	1%	1/8W	81349	RN60C6042F
R27	040228	POT	CERMET	500 OHM		10%		73138	89PR500
R28	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R29	000473	RES	CARBON	47 K		5%	1/4W	81349	RC07GF473J
R30	010013	RES	METAL	60.4 K	T-2	1%	1/8W	81349	RN60C6042F
R31	010502	RES	METAL	249 K		1%	1/8W	81349	RN60D2493F
R32	000302	RES	CARBON	3 K		5%	1/4W	81349	RC07GF302J
R33	000153	RES	CARBON	15 K		5%	1/4W	81349	RC07GF153J
R34	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R35	010027	RES	METAL	499 OHM	T-0	1%	1/8W	81349	RN60D4990F
R36	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R37	600245	JUMPER			L-2007-1LP				L-2007-1LP
R38	000107	RES	CARBON	100 M		5%	1/4W	81349	RC07GF107J
R39	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R40	040234	POT	CERMET	50 K		10%		73138	89PR50K
R41	000272	RES	CARBON	2.7 K		5%	1/4W	81349	RC07GF272J
R42	000153	RES	CARBON	15 K		5%	1/4W	81349	RC07GF153J
R43	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R44	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R45	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R46	000272	RES	CARBON	2.7 K		5%	1/4W	81349	RC07GF272J
R47	000153	RES	CARBON	15 K		5%	1/4W	81349	RC07GF153J
R50	000392	RES	CARBON	3.9 K		5%	1/4W	81349	RC07GF392J
R51	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R52	000204	RES	CARBON	200 K		5%	1/4W	81349	RC07GF204J
R53	000511	RES	CARBON	510 OHM		5%	1/4W	81349	RC07GF511J
R54	000511	RES	CARBON	510 OHM		5%	1/4W	81349	RC07GF511J
R55	000392	RES	CARBON	3.9 K		5%	1/4W	81349	RC07GF392J
R56	000152	RES	CARBON	1.5 K		5%	1/4W	81349	RC07GF152J
R57	040235	POT	CERMET	100 K		10%		73138	89PR100K
R58	000390	RES	CARBON	39 OHM		5%	1/4W	81349	RC07GF390J
R59	000102	RES	CARBON	1 K		5%	1/4W	81349	RC07GF102J
R60	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R61	000622	RES	CARBON	6.2 K		5%	1/4W	81349	RC07GF622J
R62	000206	RES	CARBON	20 M		5%	1/4W	81349	RC07GF206J
R63	010871	RES	MATCHED PAIR	5 K	HP202			18612	HP202
R64	040235	POT	CERMET	100 K		10%		73138	89PR100K

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
R65	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R66	010520	RES METAL 21.5 K 1% 1/10W	81349	RN60D2152F
R67	010871	RES MATCHED PAIR 5 K HP202	18612	HP202
R68	010646	RES METAL 2.49 K T-0 1% 1/10W	81349	RN55C2491F
R70	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R71	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R72	010124	RES METAL 19.6 K T-0 1% 1/8W	81349	RN60D1962F
R73	000750	RES CARBON 75 OHM 5% 1/4W	81349	RC07GF750J
R74	010533	RES METAL 28.7 K 1% 1/10W	81349	RN55C2872F
R75	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R76	000390	RES CARBON 39 OHM 5% 1/4W	81349	RC07GF390J
R77	000513	RES CARBON 51 K 5% 1/4W	81349	RC07GF513J
R78	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF100J
R79	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R80	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R81	000183	RES CARBON 18 K 5% 1/4W	81349	RC07GF183J
R82	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R83	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R84	000565	RES CARBON 5.6 M 5% 1/4W	81349	RC07GF565J
R85	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R86	000105	RES CARBON 1 M 5% 1/4W	81349	RC07GF105J
R87	000204	RES CARBON 200 K 5% 1/4W	81349	RC07GF204J
R88	000684	RES CARBON 680 K 5% 1/4W	81349	RC07GF684J
T1	403553	TRANSFORMER PULSE 403553	21793	403553
T2	403553	TRANSFORMER PULSE 403553	21793	403553
T3	403553	TRANSFORMER PULSE 403553	21793	403553
TP1	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP2	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP3	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP4	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP5	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP6	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP7	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP8	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP9	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP10	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP11	600786	POST TEST POINT 1-87022-0	00779	1-87022-0
TP12	600786	POST TEST POINT 1-87022-0	00779	1-87022-0

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION		FSC	MANU P/N
AR1	230054	INTEGRATED CIRCUIT	LM301A	27014	SL22348
AR2	230090	INTEGRATED CIRCUIT	μA725	07263	μA725
U1	230076	INTEGRATED CIRCUIT	74L00	01295	74L00
U2	230076	INTEGRATED CIRCUIT	74L00	01295	74L00

403616 – Assy., PCB, PROGRAM (Figure 6.14)

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
A1	403682	CABLE Assy.	21793	403682
C1	110152	CAP TANTA .47 MFD 50 V 10%	05397	T368A474K050AS
C2	110165	CAP TANTA .15 MFD 35 V 10%	05397	T368A154K035AS
C3	110153	CAP TANTA .27 MFD 50 V 10%	05397	KR27P50K
C4	121091	CAP MYLAR .033 MFD 100 V 10%	09023	WMF1S33
C5	120308	CAP POLY .047 MFD 250 V 10%	73445	C280MAE/A47K
C6	120308	CAP POLY .047 MFD 250 V 10%	73445	C280MAE/A47K
CR1	211083	DIODE SILICO 018	21793	211083
CR2	211083	DIODE SILICO 018	21793	211083
CR3	211083	DIODE SILICO 018	21793	211083
Q1	200200	TRANS NPN 200200	21793	200200
Q2	200200	TRANS NPN 200200	21793	200200
Q3	200200	TRANS NPN 200200	21793	200200
Q4	200200	TRANS NPN 200200	21793	200200
Q5	200200	TRANS NPN 200200	21793	200200
Q6	200136	TRANS SILICO NPN 2N5963	81349	2N5963
Q7	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q8	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q9	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q10	200037	TRANS SILICO NPN 2N3646	80131	2N3646
R1	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R2	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R3	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R4	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R5	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R6	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R7	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R8	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R9	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R10	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R11	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R12	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R13	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R14	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R15	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R16	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R17	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R18	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R19	000432	RES CARBON 4.3 K 5% 1/4W	81349	RC07GF432J
R20	000432	RES CARBON 4.3 K 5% 1/4W	81349	RC07GF432J
R21	000432	RES CARBON 4.3 K 5% 1/4W	81349	RC07GF432J
R22	000432	RES CARBON 4.3 K 5% 1/4W	81349	RC07GF432J

403616 – Assy., PCB, PROGRAM *continued*

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
R23	010650	RES	METAL	1 M		1%	81349	RN55E1004F
R24	000105	RES	CARBON	1 M		5% 1/4W	81349	RC07GF105J
R25	010529	RES	METAL	10 K	T-0	1%	81349	RN55D1002F
R26	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R27	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R28	010676	RES	METAL	15 K		1%	81349	RN55C1502F
R29	000242	RES	CARBON	2.4 K		5% 1/4W	81349	RC07GF242J
R30	010697	RES	METAL	26.7 K		1%	81349	RN55D2672F
R31	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R32	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
R33	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R34	000242	RES	CARBON	2.4 K		5% 1/4W	81349	RC07GF242J
R35	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R36	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R37	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R38	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
R39	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
U1	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U2	230114	INTEGRATED CIRCUIT			7408		01295	7408
U3	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U4	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U5	230028	INTEGRATED CIRCUIT			SN7400		01295	SN7400
U6	230065	INTEGRATED CIRCUIT			7475		01295	7475
U7	230065	INTEGRATED CIRCUIT			7475		01295	7475
U8	230065	INTEGRATED CIRCUIT			7475		01295	7475
U9	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U10	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U11	230115	INTEGRATED CIRCUIT			7409		01295	7409
U12	230029	INTEGRATED CIRCUIT			SN7401		01295	SN7401
U13	230028	INTEGRATED CIRCUIT			SN7400		01295	SN7400

403615 - Assy., PCB, DISPLAY (Figure 6.16)

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
CR1	220031	DIODE SILICO ZENER 1/4M3.3AZ5	04713	1/4M3.3AZ5
DS1	920116	LAMP NEON NE-2H	08806	C2A
DS2	920116	LAMP NEON NE-2H	08806	C2A
DS3	920116	LAMP NEON NE-2H	08806	C2A
DS4	920116	LAMP NEON NE-2H	08806	C2A
DS5	920116	LAMP NEON NE-2H	08806	C2A
DS6	920116	LAMP NEON NE-2H	08806	C2A
DS7	920116	LAMP NEON NE-2H	08806	C2A
DS8	920116	LAMP NEON NE-2H	08806	C2A
DS9	920116	LAMP NEON NE-2H	08806	C2A
DS10	920116	LAMP NEON NE-2H	08806	C2A
DS11	920116	LAMP NEON NE-2H	08806	C2A
Q1	200087	TRANS SILICO 021	21793	200087
Q2	200087	TRANS SILICO 021	21793	200087
Q3	200087	TRANS SILICO 021	21793	200087
Q4	200087	TRANS SILICO 021	21793	200087
Q5	200087	TRANS SILICO 021	21793	200087
Q6	200087	TRANS SILICO 021	21793	200087
Q7	200087	TRANS SILICO 021	21793	200087
Q8	200087	TRANS SILICO 021	21793	200087
Q9	200087	TRANS SILICO 021	21793	200087
Q10	200087	TRANS SILICO 021	21793	200087
Q11	200087	TRANS SILICO 021	21793	200087
R1	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R2	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R3	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R4	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R5	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R6	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R7	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R8	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R9	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R10	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R11	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R12	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R13	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R14	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R15	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R16	000272	RES CARBON 2.7 K 5% ¼W	81349	RC07GF272J
R17	000132	RES CARBON 1.3 K 5% ¼W	81349	RC07GF132J
R18	000102	RES CARBON 1 K 5% ¼W	81349	RC07GF102J
R19	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R20	000512	RES CARBON 5.1 K 5% ¼W	81349	RC07GF512J
R21	000132	RES CARBON 1.3 K 5% ¼W	81349	RC07GF132J

403615 – Assy., PCB, DISPLAY (Figure 6.16) *continued*

REF DES	KEITHLEY P/N	DESCRIPTION				FSC	MANU P/N
R22	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R23	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R24	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R25	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R26	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R27	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R28	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R29	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R30	000202	RES	CARBON	2 K	5% 1/4W	81349	RC07GF202J
R31	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R32	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R33	000331	RES	CARBON	330 OHM	5% 1/4W	81349	RC07GF331J
R34	000153	RES	CARBON	15 K	5% 1/4W	81349	RC07GF153J
R35	000153	RES	CARBON	15 K	5% 1/4W	81349	RC07GF153J
S1	600675	SWITCH	ROTARY			11237	MOD 215
S2	600674	SWITCH	ROTARY			11237	MOD 215
U1	230115	INTEGRATED CIRCUIT		7409		01295	7409
U2	230115	INTEGRATED CIRCUIT		7409		01295	7409
U3	230064	INTEGRATED CIRCUIT		SN7404		01295	SN7404
U4	230067	INTEGRATED CIRCUIT		74192		01295	74192
U5	230074	INTEGRATED CIRCUIT		7442		07716	7442
U6	230114	INTEGRATED CIRCUIT		7408		01295	7408
U7	230073	INTEGRATED CIRCUIT		SN7405		01295	SN7405
U8	230028	INTEGRATED CIRCUIT		SN7400		01295	SN7400
U9	230030	INTEGRATED CIRCUIT		SN7402		01295	SN7402
U10	230030	INTEGRATED CIRCUIT		SN7402		01295	SN7402
U11	230030	INTEGRATED CIRCUIT		SN7402		01295	SN7402
U12	230116	INTEGRATED CIRCUIT		7432		01295	7432
U13	230115	INTEGRATED CIRCUIT		7409		01295	7409
U14	230031	INTEGRATED CIRCUIT		SN7410		01295	SN7410
U15	230029	INTEGRATED CIRCUIT		SN7401		01295	SN7401
U16	230073	INTEGRATED CIRCUIT		SN7405		01295	SN7405
Z1	080014	RES NETWORK		15 K		11237	750-61-R15K

403667 – Assy., PCB, AC CONVERTER (Figure 6.19)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
B2	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
C2	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C4	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C5	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C6	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C7	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C8	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C9	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C10	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C12	100095	CAP	CERAM	2.7±.5 PFD	500 V		56289	C030B102S2R7D
C13	130131	CAP	TRIMMER	2-20 PFD	100 V		73445	C010KA/20E
C14	100095	CAP	CERAM	2.7±.5 PFD	500 V		56289	C030B102S2R7D
C15	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C16	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C17	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C18	120130	CAP	MYLAR	.15 MFD	100 V	5%	27556	XT2B154J
C19	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C20	100081	CAP	CERAM	4.7 PFD	1000 V		56289	C030B102E4R7D
C21	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C22	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C23	110125	CAP	TANTA	2.2 MFD	35 V	20%	05397	T368B225M035AS
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C25	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C26	120025	CAP	MYLAR	1.5 MFD	100 V	10%	27556	XA2B155K
C27	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C28	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C29	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C30	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
CR1	220004	DIODE	SILICO	ZENER	1N961B		81349	1N961B
CR2	220004	DIODE	SILICO	ZENER	1N961B		81349	1N961B
CR3	210035	DIODE	HOT CARRIER		5082-2810		50434	5082-2810
CR4	210035	DIODE	HOT CARRIER		5082-2810		50434	5082-2810
Q1	200200	TRANS		NPN	200200		21793	200200
Q2	200200	TRANS		NPN	200200		21793	200200
Q3	200201	TRANS	DUAL	NPN	200201		21793	200201
Q4	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10

403667 – Assy., PCB, AC CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
Q5	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q6	200178	TRANS		PNP	2N5910			81349	2N5910
Q8	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q9	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q10	200178	TRANS		PNP	2N5910			81349	2N5910
Q11	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q12	200201	TRANS	DUAL	NPN	200201			21793	200201
Q13	200200	TRANS		NPN	200200			21793	200200
Q14	200200	TRANS		NPN	200200			21793	200200
Q15	200068	TRANS		PNP	2N4250			80131	2N4250
Q16	200179	TRANS	FET		KE4391			27014	KE4391
R1	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R2	010902	RES	Matched Pair					21793	010902
R3	000102	RES	CARBON	1 K		5%	1/4W	81349	RC07GF102J
R4	010650	RES	METAL	1 M		1%	1/10W	81349	RN55E1004F
R5	040234	POT	CERMET	50 K		10%		73138	89PR50K
R6	000333	RES	CARBON	33 K		5%	1/4W	81349	RC07GF333J
R7	010650	RES	METAL	1 M		1%	1/10W	81349	RN55E1004F
R8	000105	RES	CARBON	1 M		5%	1/4W	81349	RC07GF105J
R9	000163	RES	CARBON	16 K		5%	1/4W	81349	RC07GF163J
R10	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R11	000332	RES	CARBON	3.3 K		5%	1/4W	81349	RC07GF332J
R13	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R14	000151	RES	CARBON	150 OHM		5%	1/4W	81349	RC07GF151J
R15	010529	RES	METAL	10 K	T-0	1%	1/10W	81349	RN55C1002F
R17	000512	RES	CARBON	5.1 K		5%	1/4W	81349	RC07GF512J
R18	010902	RES	Matched Pair					21793	010902
R19	000333	RES	CARBON	33 K		5%	1/4W	81349	RC07GF333J
R20	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R21	000510	RES	CARBON	51 OHM		5%	1/4W	81349	RC07GF510J
R22	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R23	010829	RES	METAL	4.99 K		1%	1/10W	81349	RN55C4991F
R24	000161	RES	CARBON	160 OHM		5%	1/4W	81349	RC07GF161J
R25	000911	RES	CARBON	910 OHM		5%	1/4W	81349	RC07GF911J
R26	010529	RES	METAL	10 K	T-0	1%	1/10W	81349	RN55C1002F
R27	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R28	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R29	000153	RES	CARBON	15 K		5%	1/4W	81349	RC07GF153J
R30	000751	RES	CARBON	750 OHM		5%	1/4W	81349	RC07GF751J
R31	000821	RES	CARBON	820 OHM		5%	1/4W	81349	RC07GF821J
R32	010903	RES	METAL	10 K		.01%	3 W		500 Series
R33	010808	RES	METAL	10 K		.1%	1/10W	81349	RN55C1002B
R34	010650	RES	METAL	1 M		1%	1/10W	81349	RN55E1004F

403667 – Assy., PCB, AC CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R35	040234	POT	CERMET	50 K		10%		73138	89PR50K
R36	000105	RES	CARBON	1 M		5%	1/4W	81349	RC07GF105J
R37	010650	RES	METAL	1 M		1%	1/10W	81349	RN55C1003F
R38	000562	RES	CARBON	5.6 K		5%	1/4W	81349	RC07GF562J
R39	020657	RES	WW	11.109 K		.01%	.15W	22045	J-110
R40	000113	RES	CARBON	11 K		5%	1/4W	81349	RC07GF113J
R41	000201	RES	CARBON	200 OHM		5%	1/4W	81349	RC07GF201J
R42	000107	RES	CARBON	100 M		5%	1/4W	81349	RC07GF107J
R43	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R44	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R45	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55D1003F
R46	010813	RES	METAL	7.87 K		1%	1/10W	81349	RN55C7871F
R47	000124	RES	CARBON	120 K		5%	1/4W	81349	RC07GF124J
R48	000106	RES	CARBON	10 M		5%	1/4W	81349	RC07GF107J
R49	000201	RES	CARBON	200 OHM		5%	1/4W	81349	RC07GF201J
TP1	600591	TEST POINT			85931-6			00779	85931-6
TP2	600591	TEST POINT			85931-6			00779	85931-6
TP3	600591	TEST POINT			85931-6			00779	85931-6
TP4	600591	TEST POINT			85931-6			00779	85931-6
TP5	600591	TEST POINT			85931-6			00779	85931-6
TP6	600591	TEST POINT			85931-6			00779	85931-6
AR1	230054	INTEGRATED CIRCUIT			LM301A			27014	LM301A
AR2	230103	INTEGRATED CIRCUIT			LM308			27014	LM308
AR3	230103	INTEGRATED CIRCUIT			LM308			27014	LM308
W1	600245	JUMPER			L-2007-1LP				L-2007-1LP

403774 – Assy., PCB, RMS AC CONVERTER

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEADS			56-59065-4B		02114	56-59065-4B
C1	130116	CAP	MICA	4000 PFD	500 V	2%	72136	DM19F402G0
C2	130160	CAP	MICA	330 PFD	500 V	2%	72136	DM15 Series
C3	100100	CAP	CERAM	FSV			21793	100100
C4	130124	CAP	TRIMMER	1.7-10 PFD	250 V		52763	R-TRIKO-122-09SD
C5	100100	CAP	CERAM	FSV			21793	100100
C6	100054	CAP	CERAM	27 PFD	1000 V	5%	56289	C030B102G270J
C7	130123	CAP	TRIMMER	1-3 PFD	250 V		52763	R-TRIKO-122-09SD
C8	100095	CAP	CERAM	2.7±.5 PFD	500 V		56289	C030B102S2R7D
C9	130146	CAP	TRIMMER	.25-1.5 PFD			74970	273-0001-002
C10	100095	CAP	CERAM	2.7±.5 PFD	500 V		56289	C030B102S2R7D
C11	130146	CAP	TRIMMER	.25-1.5 PFD			74970	273-0001-002
C12	120280	CAP	MYLAR	.22 MFD	1000 V	10%	27556	ZA2J224K
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C16	101098	CAP	CERAM	330 PFD	1000 V	10%	56289	C016B102E331K
C17	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
C18	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C19	130076	CAP	MICA	200 PFD	500 V	5%	72136	DM15-201J
C20	101642	CAP	CERAM	150 PFD	500 V	10%	71471	SCD1X5F
C21	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C22	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	TCD-DI-1N5600-100
C23	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C24	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C25	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
C26	101098	CAP	CERAM	330 PFD	1000 V	10%	56289	C016B102E331K
C27	100051	CAP	CERAM	3 PFD	500 V		71471	TCD-B1-0
C29	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C30	120286	CAP	MYLAR	.1 MFD	100 V	20%	73445	C281AH/A100K
C31	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C32	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
C33	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR8	210035	DIODE	HOT CARRIER		5082-2810		50434	5082-2810
CR9	210035	DIODE	HOT CARRIER		5082-2810		50434	5082-2810
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR12	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR13	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
K1	310078	RELAY REED 28 V	15636	R2690-3
K2	310078	RELAY REED 28 V	15636	R2690-3
K3	310078	RELAY REED 28 V	15636	R2690-3
Q1	200200	TRANS NPN 200200	21793	200200
Q2	200200	TRANS NPN 200200	21793	200200
Q4	200199	TRANS DUAL 200199	21793	200199
Q5	200200	TRANS NPN 200200	21793	200200
Q6	200201	TRANS DUAL NPN 200201	21793	200201
Q7	200112	TRANS MATCHED PAIR 200112	21793	200112
Q8	200112	TRANS MATCHED PAIR 200112	21793	200112
Q9	200068	TRANS PNP 2N4250	80131	2N4250
Q10	200200	TRANS NPN 200200	21793	200200
Q11	200220	TRANS DUAL	21793	200220
Q12	200136	TRANS SILICO NPN 2N5963	81349	2N5963
Q13	200068	TRANS PNP 2N4250	80131	2N4250
Q14	403865	TRANS DUAL LOG TRANS KIT	21793	403865
Q15	403865	TRANS DUAL LOG TRANS KIT	21793	403865
Q19	200068	TRANS PNP 2N4250	80131	2N4250
Q20	200197	TRANS SILICO NPN MPS-H10	04713	MPS-H10
Q21	200197	TRANS SILICO NPN MPS-H10	04713	MPS-H10
AR1	230180	INTEGRATED CIRCUIT LM318H	27014	LM318H
AR2	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
R1	010721	RES METAL 1.1324 K MATCHED SET .1%	81349	RN60
R2	010720	RES METAL 9.09 K T-2 .25% 1/10W	81349	RN55C9091C
R3	040228	POT CERMET 500 OHM 10%	73138	89PR500
R4	010721	RES METAL 11 K MATCHED SET 1%	81349	RN60
R5	040225	POT CERMET 50 OHM 20%	73138	89P Series
R6	010721	RES METAL 110.86 K MATCHED SET .1%	81349	RN60
R7	040228	POT CERMET 500 OHM 10%	73138	89PR500
R8	010721	RES METAL 997.5 K MATCHED SET .1%	81349	RN60
R9	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R10	010721	RES METAL 1 M MATCHED SET .1%	81349	RN75
R11	001737	RES CARBON FSV 5% 1/4W	21793	001737
R12	010542	RES METAL 100 K 1% 1/10W	81349	RN55E1003F
R13	010542	RES METAL 100 K 1% 1/10W	81349	RN55E1003F
R14	001737	RES CARBON FSV 5% 1/4W	21793	001737
R15	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R16	000514	RES CARBON 510 K 5% 1/4W	81349	RC07GF514J
R17	040235	POT CERMET 100 K 10%	73138	89PR100K

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R18	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R23	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R24	010899	RES	METAL	5 K		.01%			500 Series
R25	010899	RES	METAL	5 K		.01%			500 Series
R26	010898	RES	METAL	20 K		.05%			500 Series
R27	010904	RES	METAL	10 K		.02%			500 Series
R28	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R29	000512	RES	CARBON	5.1 K		5%	1/4W	81349	RC07GF512J
R30	000105	RES	CARBON	1 M		5%	1/4W	81349	RC07GF105J
R31	040235	POT	CERMET	100 K		10%		73138	89PR100K
R32	000184	RES	CARBON	180 K		5%	1/4W	81349	RC07GF184J
R33	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R34	010684	RES	METAL	487 OHM	T-9	1%	1/10W	81349	RN55E4870F
R35	010684	RES	METAL	487 OHM	T-9	1%	1/10W	81349	RN55E4870F
R36	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R37	000123	RES	CARBON	12 K		5%	1/4W	81349	RC07GF123J
R38	000272	RES	CARBON	2.7 K		5%	1/4W	81349	RC07GF272J
R39	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R40	000681	RES	CARBON	680 OHM		5%	1/4W	81349	RC07GF681J
R41	040239	POT	CERMET	1 M		20%		73138	89PR1M
R42	040232	POT	CERMET	10 K		10%		73138	89PR10K
R43	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R44	000476	RES	CARBON	47 M		5%	1/4W	81349	RC07GF476J
R45	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R46	010533	RES	METAL	28.7 K		1%	1/10W	81349	RN55C2872F
R47	000392	RES	CARBON	3.9 K		5%	1/4W	81349	RC07GF392J
R49	000107	RES	CARBON	100 M		5%	1/4W	81349	RC07GF107J
R50	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R51	020667	RES	WW	100 K		.1%	.15W	22045	J-110
R52	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R53	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R54	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R55	010898	RES	METAL	20 K		.05%			500 Series
R56	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R57	010898	RES	METAL	20 K		.05%			500 Series
R58	040227	POT	CERMET	200 OHM		10%		73138	89P Series
R59	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R60	010904	RES	METAL	10 K		.02%			500 Series
R61	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R62	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R63	000470	RES	CARBON	47 OHM		5%	1/4W	81349	RC07GF470J
R64	000820	RES	CARBON	82 OHM		5%	1/4W	81349	RC07GF820J

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R70	000513	RES	CARBON	51 K		5%	1/4W	81349	RC07GF513J
R71	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R72	010618	RES	METAL	200 K		.25%	1/10W	81349	RN55C2003C
R73	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R74	403865	TRANS	DUAL	LOG TRANS KIT				21793	403865
R75	403865	TRANS	DUAL	LOG TRANS KIT				21793	403865
R76	010496	RES	METAL	1 M	T-0	1%	1/8W	81349	RN60D1004F
R77	000221	RES	CARBON	220 OHM		5%	1/4W	81349	RC07GF221J
R78	000221	RES	CARBON	220 OHM		5%	1/4W	81349	RC07GF221J
R79	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R80	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R81	000682	RES	CARBON	6.8 K		5%	1/4W	81349	RC07GF682J
R82	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
S1	600742	SWITCH	SLIDE		G-111			79727	G-111
S2	600742	SWITCH	SLIDE		G-111			79727	G-111
TP1	600591	POST	TEST POINT		85931-6			00779	85931-6
TP2	600591	POST	TEST POINT		85931-6			00779	85931-6
TP3	600591	POST	TEST POINT		85931-6			00779	85931-6
TP4	600591	POST	TEST POINT		85931-6			00779	85931-6
TP5	600591	POST	TEST POINT		85931-6			00779	85931-6

403674 – Assy., PCB, SCALING AMPLIFIER (Figure 6.21)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
B2	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
C1	130127	CAP	TRIMMER	10-40 PFD			52763	10S-TRIKO-24N750
C2	130116	CAP	MICA	4000 PFD	500 V	2%	72136	DM19F402G0
C3	120275	CAP	POLY	1000 PFD	500/630 V	2.5%	08257	KSC Series
C4	130115	CAP	MICA	346 PFD	500 V	2%	72136	DM15F3460G0
C5	120274	CAP	POLY	87 PFD	500/630 V	2.5%	08257	KSO Series
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C7	100075	CAP	CERAM	10 PFD	1000 V	5%	56289	C030B102E100J
C8	130124	CAP	CERAM	1.7-10 PFD	250 V		52763	R-TRIKO-122-09SD
C9	100100	CAP	CERAM	FSV	100100		21793	100100
C10	130123	CAP	CERAM	1-3 PFD	250 V		52763	R-TRIKO-122-09SD
C11	100050	CAP	CERAM	2.2 PFD	1000 V	5%	56289	C030B102S2R2D
C12	100061	CAP	CERAM	39 PFD	1000 V	5%	56289	C030B102G390J
C13	100084	CAP	CERAM	1.5±.5 PFD	1000 V		56289	C030B102S1R5D
C14	120090	CAP	MYLAR	.22 MFD	600 V	5%	27556	ZA1101J
C15	100077	CAP	GLASS	7.5 PFD	500 V	5%	95275	VY10CA7R5JA
C16	100075	CAP	CERAM	10 PFD	1000 V	5%	56289	C030B102E100J
C17	100075	CAP	CERAM	10 PFD	1000 V	5%	56289	C030B102E100J
C18	100077	CAP	GLASS	7.5 PFD	500 V	5%	95275	VY10CA7R5JA
C19	130125	CAP	PORCE	.8-10 PFD	250 V		91293	JMC2951
C20	130125	CAP	PORCE	.8-10 PFD	250 V		91293	JMC2951
C21	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C22	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C23	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C24	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C25	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C26	101174	CAP	CERAM	.001 MFD	500 V	10%	04222	SCD-DI-2X5F-1000
C28	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C29	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C31	110140	CAP	TANTA	47 MFD	6 V	20%	05397	T368B476M006AS
C32	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C33	100081	CAP	CERAM	4.7 PFD	1000 V		56289	C030B102E4R7D
C34	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C35	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C37	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS
C38	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C39	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C40	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C41	110126	CAP	TANTA	6.8 MFD	35 V	20%	05397	T368B685M035AS

403674 – Assy., PCB, SCALING AMPLIFIER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
C42	100074	CAP	CERAM	5 PFD	1000 V			56289	C030B102E5R0D
C45	100017	CAP	CERAM	.01 MFD	100 V	20%		56289	C023B101F103M
C46	100081	CAP	CERAM	4.7 PFD	1000 V			56289	C030B102E4R7D
CR1	211083	DIODE	SILICO		018			21793	211083
CR2	211083	DIODE	SILICO		018			21793	211083
CR3	211083	DIODE	SILICO		018			21793	211083
CR4	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
CR6	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
CR9	211083	DIODE	SILICO		018			21793	211083
CR10	211083	DIODE	SILICO		018			21793	211083
CR11	220004	DIODE	SILICO	ZENER	1N961B			81349	1N961B
CR12	220004	DIODE	SILICO	ZENER	1N961B			81349	1N961B
CR13	220004	DIODE	SILICO	ZENER	1N961B			81349	1N961B
CR15	220020	DIODE	SILICO	ZENER	1N4370			81349	1N4370
CR16	210017	DIODE	MATCHED PAIR					21793	210017
CR17	210017	DIODE	MATCHED PAIR					21793	210017
CR18	210017	DIODE	MATCHED PAIR					21793	210017
CR19	210017	DIODE	MATCHED PAIR					21793	210017
K1	310078	RELAY	REED		R2690-3			15636	R2690-3
K2	310077	RELAY	REED		R2691-3			15636	R2691-3
K3	310078	RELAY	REED		R2690-3			15636	R2690-3
L1	310068	CHOKE	RF	1 μh	1537-12			99800	1537-12
Q1	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q2	200161	TRANS	SELECTED	FET	E415			17856	E415
Q3	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q4	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q5	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q6	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q7	200178	TRANS		PNP	2N5910			81349	2N5910
Q8	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
Q9	200178	TRANS		PNP	2N5910			81349	2N5910
Q11	200197	TRANS	SILICO	NPN	MPS-H10			04713	MPS-H10
R1	010721	RES	METAL	1.1324 K	Matched Set			81349	RN60
R2	010720	RES	METAL	9.09 K	T-2	.25%	1/10W	81349	RN55C9091C
R3	040228	POT	CERMET	500 OHM		10%		73138	89PR500
R4	000152	RES	CARBON	1.5 K		5%	1/4W	81349	RC07GF152J
R5	010721	RES	METAL	11.000 K	Matched Set			81349	RN60

403674 – Assy., PCB, SCALING AMPLIFIER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R6	010798	RES	METAL	82.5 OHM		1%		81349	RN55C82R5F
R7	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R8	040228	POT	CERMET	500 OHM		10%		73138	89PR500
R9	010721	RES	METAL	110.86 K	Matched Set			81349	RN60
R10	010721	RES	METAL	1 M	Matched Set			81349	RN75
R11	041179	POT	WW	5 K	50-1-1-502			02111	50-1-1-502
R12	010721	RES	METAL	997.5 K	Matched Set			81349	RN60
R13	000163	RES	CARBON	16 K		5%	1/4W	81349	RC07GF163J
R14	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R15	000510	RES	CARBON	51 OHM		5%	1/4W	81349	RC07GF510J
R16	000241	RES	CARBON	240 OHM		5%	1/4W	81349	RC07GF241J
R17	000202	RES	CARBON	2 K		5%	1/4W	81349	RC07GF202J
R18	010583	RES	METAL	182 OHM		1%	1/10W	81349	RN55C1820F
R19	040258	POT	CERMET	100 OHM		20%	.5 W	73138	72XW100
R20	010827	RES	METAL	8.25 K		1%	1/10W	81349	RN55C8251F
R21	010813	RES	METAL	7.87 K		1%	1/10W	81349	RN55C7871F
R22	010583	RES	METAL	182 OHM		1%	1/10W	81349	RN55C1820F
R23	000510	RES	CARBON	51 OHM		5%	1/4W	81349	RC07GF510J
R24	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R25	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R26	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R27	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R28	000102	RES	CARBON	1 K		5%	1/4W	81349	RC07GF102J
R29	000223	RES	CARBON	22 K		5%	1/4W	81349	RC07GF223J
R30	000621	RES	CARBON	620 OHM		5%	1/4W	81349	RC07GF621J
R31	000682	RES	CARBON	6.8 K		5%	1/4W	81349	RC07GF682J
R32	000680	RES	CARBON	68 OHM		5%	1/4W	81349	RC07GF680J
R33	000680	RES	CARBON	68 OHM		5%	1/4W	81349	RC07GF680J
R34	000160	RES	CARBON	16 OHM		5%	1/4W	81349	RC07GF160J
R35	000241	RES	CARBON	240 OHM		5%	1/4W	81349	RC07GF241J
R36	001737	RES	CARBON	FSV		5%	1/4W	21793	001737
R39	000301	RES	CARBON	300 OHM		5%	1/4W	81349	RC07GF301J
R40	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R41	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J

403627 – Assy., PCB, OHMS CONVERTER (Figure 6.23)

REF DES	KEITHLEY P/N	DESCRIPTION					FSC	MANU P/N
C1	120034	CAP	POLY	100 PFD	630 V	5%	08257	KSO Series
C2	120004	CAP	POLY	.001 MFD	500 V	5%	08257	KSO Series
C3	120004	CAP	POLY	.001 MFD	500 V	5%	08257	KSO Series
C4	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C5	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
C7	120227	CAP	POLY	220 PFD	630 V	5%	08257	KSO Series
C8	120227	CAP	POLY	220 PFD	630 V	5%	08257	KSO Series
C9	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C10	100071	CAP	CERAM	.001 MFD	1000 V	20%	56289	C023B102E102M
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	C023B101F103M
CR1	220011	DIODE	SILICO	ZENER	1N968B		81349	1N968B
CR2	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083
CR9	210048	DIODE			600 V		81349	1N4005
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	211083	DIODE	SILICO		018		21793	211083
CR12	211083	DIODE	SILICO		018		21793	211083
CR13	211083	DIODE	SILICO		018		21793	211083
CR14	211083	DIODE	SILICO		018		21793	211083
CR15	211083	DIODE	SILICO		018		21793	211083
CR16	211083	DIODE	SILICO		018		21793	211083
CR17	211083	DIODE	SILICO		018		21793	211083
CR18	211083	DIODE	SILICO		018		21793	211083
CR19	211083	DIODE	SILICO		018		21793	211083
CR20	211083	DIODE	SILICO		018		21793	211083
CR21	211083	DIODE	SILICO		018		21793	211083
K1	310077	RELAY	REED		R2691-3		15636	R2691-3
K2	310077	RELAY	REED		R2691-3		15636	R2691-3
K3	310113	RELAY	REED		R4092-3		15636	R4092-3
K4	310077	RELAY	REED		R2691-3		15636	R2691-3
K5	310077	RELAY	REED		R2691-3		15636	R2691-3
K6	310077	RELAY	REED		R2691-3		15636	R2691-3

403627 – Assy., PCB, OHMS CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
Q1	200101	TRANS FET 2N5245	81349	2N5245
Q2	200200	TRANS NPN 200200	21793	200200
Q3	200191	TRANS PNP 2N1305	81349	2N1305
Q4	200200	TRANS NPN 200200	21793	200200
Q5	200200	TRANS NPN 200200	21793	200200
Q6	200201	TRANS DUAL NPN 200201	21793	200201
Q7	200201	TRANS DUAL NPN 200201	21793	200201
Q8	200201	TRANS DUAL NPN 200201	21793	200201
Q9	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q10	200200	TRANS NPN 200200	21793	200200
Q11	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q12	200068	TRANS PNP 2N4250	80131	2N4250
Q13	200198	TRANS PNP MPS-A92	04713	MPS-A92
Q14	200198	TRANS PNP MPS-A92	04713	MPS-A92
Q15	200068	TRANS PNP 2N4250	80131	2N4250
Q16	200198	TRANS PNP MPS-A92	04713	MPS-A92
Q17	200198	TRANS PNP MPS-A92	04713	MPS-A92
Q18	200200	TRANS NPN 200200	21793	200200
Q19	200200	TRANS NPN 200200	21793	200200
Q20	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q21	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q22	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q23	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q24	200200	TRANS NPN 200200	21793	200200
Q25	200200	TRANS NPN 200200	21793	200200
R1	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R2	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R3	001737	RES CARBON FSV 5% 1/4W	21793	001737[illegible]396J
R4	030005	RES CARBON 100 K 5% 2 W	81349	RC42GF104J
R5	040235	POT CERMET 100 K 10%	73138	89PR100K
R6	010598	RES METAL 20 K 1% 1/8W	81349	RN60C2002F
R7	010137	RES METAL 100 OHM T-0 1% 1/8W	81349	RN60D1000F
R8	010780	RES METAL 499 K 1% 1/8W	81349	RN60E4993F
R9	040235	POT CERMET 100 K 10%	73138	89PR100K
R10	000107	RES CARBON 100 M 5% 1/4W	81349	RC07GF107J
R11	000755	RES CARBON 7.5 M 5% 1/4W	81349	RC07GF755J
R12	010897	RES MATCHED PAIR 5.331 K .01%	21793	010897
R13	010897	RES MATCHED PAIR 8 K .01%	21793	010897
R14	010598	RES METAL 20 K 1% 1/8W	81349	RN60C2002F
R15	010337	RES METAL 10 M 1% 1/2W	91637	DCS1-2
R16	010777	RES METAL 39.99 K T-9 .1% 1/10W	81349	RN55E

403627 – Assy., PCB, OHMS CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
R17	010337	RES	METAL	10 M		1%	1/2W	91637	DCS1-2
R18	000136	RES	CARBON	13 M		5%	1/4W	81349	RC07GF136J
R19	010780	RES	METAL	499 K		1%	1/8W	81349	RN60E4993F
R20	010120	RES	METAL	68.1 K	T-0	1%	1/8W	81349	RN60D6812F
R21	010431	RES	METAL	511 K		1%	1/8W	81349	RN60C5113F
R22	040235	POT	CERMET	100 K		10%		73138	89PR100K
R23	010598	RES	METAL	20 K		1%	1/8W	81349	RN60C2002F
R24	010780	RES	METAL	499 K		1%	1/8W	81349	RN60E4993F
R25	010780	RES	METAL	499 K		1%	1/8W	81349	RN60E4993F
R26	010784	RES	METAL	4.7 M		1%		91637	DC-1/4
R27	010780	RES	METAL	499 K		1%	1/8W	81349	RN60E4993F
R28	000393	RES	CARBON	39 K		5%	1/4W	81349	RC07GF393J
R29	000112	RES	CARBON	1.1 K		5%	1/4W	81349	RC07GF112J
R30	001816	RES	CARBON	47 K		5%	2 W	01121	See Descrpt.
R31	001816	RES	CARBON	47 K		5%	2 W	01121	See Descrpt.
R32	000202	RES	CARBON	2 K		5%	1/4W	81349	RC07GF202J
R33	000205	RES	CARBON	2 M		5%	1/4W	81349	RC07GF205J
R34	000205	RES	CARBON	2 M		5%	1/4W	81349	RC07GF205J
R35	010900	RES	METAL	4000.4 OHM		.01%			
R36	040235	POT	CERMET	100 K		10%		73138	89PR100K
R37	010536	RES	METAL	100 K	T-0	1%	1/10W	81349	RN55C1003F
R38	000205	RES	CARBON	2 M		5%	1/4W	81349	RC07GF205J
R39	000205	RES	CARBON	2 M		5%	1/4W	81349	RC07GF205J
R40	010901	RES	METAL	445.71 OHM		.05%			
R41	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R42	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R43	040226	POT	CERMET	100 OHM		10%		73138	89P Series
R44	020669	RES	WW	100.050 K		.02%		22045	J-160
R45	040230	POT	CERMET	2 K		10%		73138	89PR2K
R46	020612	RES	WW	1.009 M		.05%	1/4W	22045	J-120
R47	040234	POT	CERMET	50 K		10%		73138	89PR50K
R48	010655	RES	METAL	11.086 M	T-9	.1%		03888	PME70
R49	010898	RES	METAL	20 K		.05%			500 Series
R50	010899	RES	METAL	5 K		.01%			500 Series
R51	040235	POT	CERMET	100 K		10%		73138	89PR100K
R52	010656	RES	METAL	19.948 M	T-9	.1%		03888	PME75
R53	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R54	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R55	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R56	040234	POT	CERMET	50 K		10%		73138	89PR50K
R57	001759	RES	CARBON	5.1 OHM		5%	1/4W	81349	RC07GF5R1J
R58	000470	RES	CARBON	47 OHM		5%	1/4W	81349	RC07GF470J

403627 – Assy., PCB, OHMS CONVERTER *continued*

REF DES	KEITHLEY P/N	DESCRIPTION		FSC	MANU P/N
AR1	230054	INTEGRATED CIRCUIT	LM301A	27014	LM301A
AR2	230054	INTEGRATED CIRCUIT	LM301A	27014	LM301A

403673 – Assy., PCB, 4-WIRE RATIO (Figure 6.25)

REF DES	KEITHLEY P/N	DESCRIPTION						FSC	MANU P/N
C1	100012	CAP	CERAM	33 PFD	500 V	10%		71471	TCD-DI-1(N750)
C2	100017	CAP	CERAM	.01 MFD	100 V	20%		56289	C023B101F103M
C3	100012	CAP	CERAM	33 PFD	500 V	10%		71471	TCD-DI-1(N750)
C4	110158	CAP	TANTA	10 MFD	50 V	10%		05397	T362C106K050A
C5	100017	CAP	CERAM	.01 MFD	100 V	20%		56289	C023B101F103M
C6	120308	CAP	POLY	.047 MFD	250 V	10%		73445	C280MAE/A47K
C7	120312	CAP	POLY	.022 MFD	250 V	10%		73445	C280MAE/A22K
Q1	200200	TRANS		NPN	200200			21793	200200
Q2	200200	TRANS		NPN	200200			21793	200200
R1	010033	RES	METAL	49.9 K	T-0	1%	1/8W	81349	RN60D4992F
R2	010033	RES	METAL	49.9 K	T-0	1%	1/8W	81349	RN60D4992F
R3	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R4	010621	RES	METAL	49.9 K	T-0	1%	1/10W	81349	RN55C4992F
R5	010787	RES	METAL	20 K		.02%		18612	V53-1
R6	010787	RES	METAL	20 K		.02%		18612	V53-1
R7	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R8	010787	RES	METAL	20 K		.02%		18612	V53-1
R9	040229	POT	CERMET	1 K		10%		73138	89PR1K
R10	040229	POT	CERMET	1 K		10%		73138	89PR1K
R11	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R12	040235	POT	CERMET	100 K		10%		73138	89PR100K
R13	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R14	000390	RES	CARBON	39 OHM		5%	1/4W	81349	RC07GF390J
R15	010787	RES	METAL	20 K		.02%		18612	V53-1
AR1	230145	INTEGRATED CIRCUIT			MATCHED SET			21793	230145
AR2	230127	INTEGRATED CIRCUIT			SSS725CJ			06665	SSS725CJ
AR3	230145	INTEGRATED CIRCUIT			MATCHED SET			21793	230145

403659 - Assy., REAR PANEL

REF DESIG	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
F201	920204	FUSE SLOW .50A 250V	75915	3AG1/2ASB
J203	600619	CONNECTOR RE CPT	82389	EAC-301
S101	600583	SWITCH PWR SPST	10389	26-099-100
S201	600521	SWITCH DPDT	82389	46256LFR
T201	300073	TRANSFORMER POWER 115V	21793	300073
X201	920099	FUSEHOLDER 3AG MINATURE	75915	342 004

403850 -- Assy., SWITCHABLE FRONT-REAR INPUT

REF DES	KEITHLEY P/N	DESCRIPTION	FSC	MANU P/N
K2	310096	RELAY	24796	R10E-2033-1
S6	920457	SWITCH, SLIDE, DPDT	79727	G126

KEITHLEY

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