models 261c and 262c

instruction manual
mi-1436

728

DIGITEC instrumentation

UNPACKING AND SHIPPING

After unpacking, carefully examine the instrument for physical damage that may have occurred in transit. If any damage is noted, immediately contact United Systems Corporation for further instructions.

If it should become necessary to return the instrument to United Systems Corporation, make certain that at least four inches of padding material surrounds the instrument to prevent damage during shipment. When returning instruments to the factory, give a full description of the failure of the instrument and the mode of operation that was used when the instrument failure occurred. Ship via REA Express, motor truck, or air freight PREPAID to:

United Systems Corporation
918 Woodley Road
Dayton, Ohio 45403

For foreign countries: Please contact your local representative for instructions.

WARRANTY

UNITED SYSTEMS CORPORATION guarantees all instruments and accessories to be free from defects in material and workmanship, when subjected to normal use and service. This guarantee is expressly limited to the servicing and/or adjusting of an instrument returned, freight prepaid, to the factory or to the nearest factory authorized Service Center within one (1) year from date of delivery; and to the repairing, replacing or adjusting of parts (excepting lamps, fuses and batteries) which upon examination shall be found defective. UNITED SYSTEMS CORPORATION assumes no liability in connection with the sale of such products beyond that specifically provided hereinabove.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

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MODEL 261C

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MODEL 262C
DIGITAL VOLT-OHMETER

1. GENERAL INFORMATION

The DigiTec Model 262C is a versatile, portable, solid state digital multimeter capable of measuring voltage, current, and resistance and providing a digital display.

1.1 Features

The outstanding features of these models are:

High accuracy
Three-and-a-half digit display
Overload protection
High input impedance
One hand operation
Metal Case
Convenient carrying handle
Auto polarity
Integral battery power
Front panel zero adjustment

1.2 Instrument Identification

The instrument model number, serial number, and other pertinent data is given on the identification tag on the rear cover of the instrument.

1.3 Precautions

1.3.1 GENERAL PRECAUTIONS

Do not exceed 500 VDC between the COM jack and chassis ground.

When using the AC ranges, care must be exercised to maintain the proper ground relationships. A shock hazard may exist if improper grounding of the case is not observed.

The maximum calibrated voltage on the 1000 volt ACV range is 500 volts. DO NOT EXCEED 550 VOLTS.

When using the 200 ohm range, zero should be adjusted with the input leads shorted. By zeroing with the input leads shorted, any error introduced by the lead resistance will be cancelled.

A current over three amperes, even of short duration, applied in the DCmA or ACmA functions will fail fuse F2. Check this fuse before returning the multimeter to the factory for repair.

1.3.2 BATTERIES

The nickel-cadmium batteries employed in these units give an extremely stable output for long periods of time (up to 8 hours), but it is imperative that certain constraints be observed in their use. The unit must never be allowed to operate after the batteries are fully discharged. This will result in the batteries becoming polarized in a reverse direction, rendering them useless for further operation.

To prevent this occurrence there are three rules to be observed in operating the instrument.

1. Before the instrument is used the first time, or any time the instrument has sat idle for an extended period of time, connect to AC power and allow batteries to charge for approximately 15 minutes, with the function switch set at OFF.
2. Switch the instrument OFF after voltage on BATT CHECK position drops below 4.6 volts. FURTHER CONTINUOUS DISCHARGING MAY PERMANENTLY DAMAGE THE BATTERIES.
3. Make sure function switch is set at OFF when instrument is not in use.

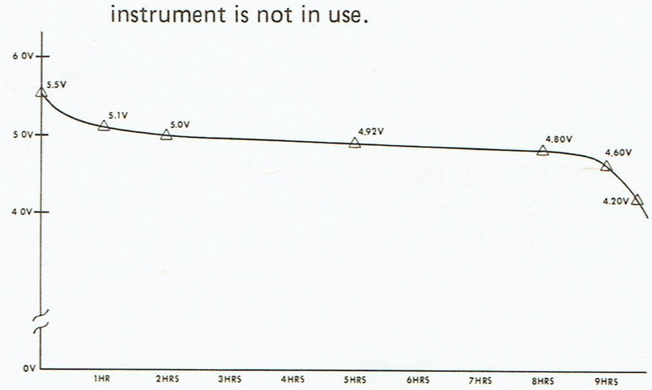


Figure 1
Typical Discharge Curve

1.4 Technical Specifications

FUNCTION	RANGE	RESOLUTION	INPUT IMPEDANCE	FREQUENCY	ACCURACY	OVERLOAD PROTECTION
DC Volts	000 to ±.1999	100µV	11MΩ	N/A	±(.05% of Reading +.05% of Full Scale)	±1000VDC
	.000 to ±1.999	1mV				
	0.00 to ±19.99	10mV				
	00.0 to ±199.9	100mV				
	000. to ±1000.	1V			±(.1%R +.1%FS)	
AC Volts	000 to .1999	100µV	10MΩ Shunted By 20pf	50Hz to 10KHz	±(.25%R +.1%FS)	150V RMS
	.000 to 1.999	1mV				
	0.00 to 19.99	10mV				550V RMS
	00.0 to 199.9	100mV				
	000. to 500.	1V		50Hz to 1KHz		
AC mA			INTERNAL SHUNT			
	000 to .1999	0.1µA	1000Ω	50Hz to 10KHz	±(.4%R +.1%FS)	1 amp
	.000 to 1.999	1µA	100Ω			
	0.00 to 19.99	10µA	10Ω			
	00.0 to 199.9	100µA	1.0Ω*		±(.75%R +.2%FS)	
	000. to 1999.	1mA	0.1Ω*	50Hz to 1KHz		3.0 amp
DC MA			INTERNAL SHUNT			
	000 to ±.1999	0.1µA	1000Ω	N/A	±(.2%R +.1%FS)	±1 amp
	.000 to ±1.999	1µA	100Ω			
	0.00 to ±19.99	10µA	10Ω			
	00.0 to ±199.9	100µA	1Ω*		±(.65%R +.2%FS)	
	000. to ±1999.	1mA	0.1Ω*			±3.0 amp
Kilohms			I TEST	OPEN CIRCUIT VOLTAGE		
	000 to .1999	0.1Ω	1mA	+8.5VDC	±(.1%R +.1%FS)	±200VDC
	.000 to 1.999	1Ω	100µA	+3.5VDC		
	0.00 to 19.99	10Ω	10µA			
	00.0 to 199.9	100Ω	1µA			
	000. to 1999.	1000Ω	0.1µA		±(.2%R +.1%FS)	

*Terminal to terminal resistance is slightly greater due to resistance of fuse, R59, switch, and wiring.

Voltage Coefficient	5PPM/volt above 250 volts
Response Time	To rated accuracy: DC 0.7 seconds, AC (all ranges except "2") 2 seconds, AC "2" range 4 seconds average, kΩ 1.5 seconds average
Reading Rate	4 samples/sec nominal
Display	Three full digits, digit 1 indicator, illuminated minus sign, illuminated overrange indicator
Isolation	500VDC input low to power ground
Rejection	DC ranges, 60 Hz: Common Mode 100dB on .1999V range (drops 20dB for each successive range) normal mode = 35db (20dB/decade above 60Hz)
Operating Ambient	60° to 110°F
Power Requirements	105/125VAC, 50/60Hz, 7VA. "S" suffix - 210/250VAC
Weight (approximate) Model 262A	Net: 6 pounds. Shipping: 8 pounds.

2. OPERATION

2.1 Power Connection

The power applied to this instrument can be either 115 or 230 VAC, depending on the position of the switch on the back panel.

Readings may be unstable if earth ground is not used when using line power.

DO NOT EXCEED DISCHARGING LIMITS. REFER TO 1.3 PRECAUTIONS. To operate on battery power, disconnect the line cord and place the FUNCTION and RANGE switches to the desired positions.

Charging the batteries is accomplished by connecting the instrument to AC line power. This automatically charges the batteries at the maximum rate. The charge time under these conditions is 12 hours. The FUNCTION switch can be turned on allowing the instrument to operate normally while the batteries are charging. The charge time, however, is greatly increased, the charge rate being approximately 1/10 of the maximum rate.

Under these conditions the battery may never come to full charge. For best performance, a continuous 12 hour charge with the unit turned off is recommended. This will yield typically 8 hours of continuous battery power.

2.2 Warm-Up Period

This instrument may be operated immediately but should be allowed to warm up for 20 minutes for maximum stability.

2.3 Zero Adjustment

To maintain maximum accuracy, the zero position should be checked. To do this, the following procedure should be followed:

1. After warm-up, check zero by shorting the input leads. Trim the ZERO adjustment as necessary.
2. For optimum accuracy, readjust ZERO before using each function-range combination.

2.4 Input Terminals

There are four banana jacks on the front panel of this unit. The two jacks marked COM are the circuit common and return for the remaining two jacks. The COM jacks are internally connected to chassis ground through a 0.05μfd 500 volt capacitor, therefore, the maximum voltage differential between chassis ground and COM jacks is 500VDC. The jack marked mA/KΩ provides the positive interrogating current to measure resistance and accepts the AC and DC current for measurement. The VOLTS jack is used to make all voltage measurements.

2.5 Input Grounding Precautions

External ground currents of power line frequency, if extremely large, can result in normal or common mode interference. While AC rejection ratios are high, the signal and case grounds should be common at the instrument whenever possible.

2.6 Digital Display

The instrument readout consists of solid state light emitting diodes. The parameter under measurement will appear in convenient decimal form complete with decimal point and polarity information.

All readings are positive unless a negative sign to the left of the readout indicates a negative reading. The decimal display capacity is to three significant digits, plus a one thousand indicator.

If the maximum digital readout capacity (1999) is exceeded, an O/R (overrange) light will illuminate. DO NOT EXCEED VALUE LISTED UNDER OVERLOAD PROTECTION IN THE TECHNICAL SPECIFICATIONS 1.4.

3. CIRCUIT DESCRIPTION

The measurement circuitry is located on two boards; the Signal Conditioning board (lower) and the analog board (upper).

3.1 Signal Conditioning Board (See Figures 2 through 6)

The Signal Conditioning Board receives the unknown current or voltage to be measured. The AC and DC voltages and currents are converted and/or attenuated to between zero and ±200 millivolts DC. This DC millivolt level is fed to the DVM board. Resistance measurement is made by measuring the voltage across the unknown resistance while passing a constant and known current through it.

3.1.1 DCV AND CONSTANT CURRENT ATTENUATOR

In DCV position of the FUNCTION switch, the input DC voltage is applied to a voltage divider on all RANGE switch positions except 200mV. On the 200mV range, the voltage is fed to the DVM board without change. For each of the other RANGE switch positions there is a tap on the voltage divider. Each tap is the wiper on a potentiometer and can be adjusted for precise voltage attenuation.

In the KΩ position of the FUNCTION switch, the same voltage divider controls the current through Q1 of the Constant Current Generator. For each position of the RANGE switch, a part of the voltage divider and an additional variable resistor are in series between the +9.4 volt supply and Q1.

3.1.2 CONSTANT CURRENT GENERATOR

The Constant Current Generator feeds a regulated, positive, DC current out the mA/KΩ jack. The current is supplied by Q1 which is always biased on. The amount of current varies from 0.1 microamp to one milliamp depending on the RANGE switch position.

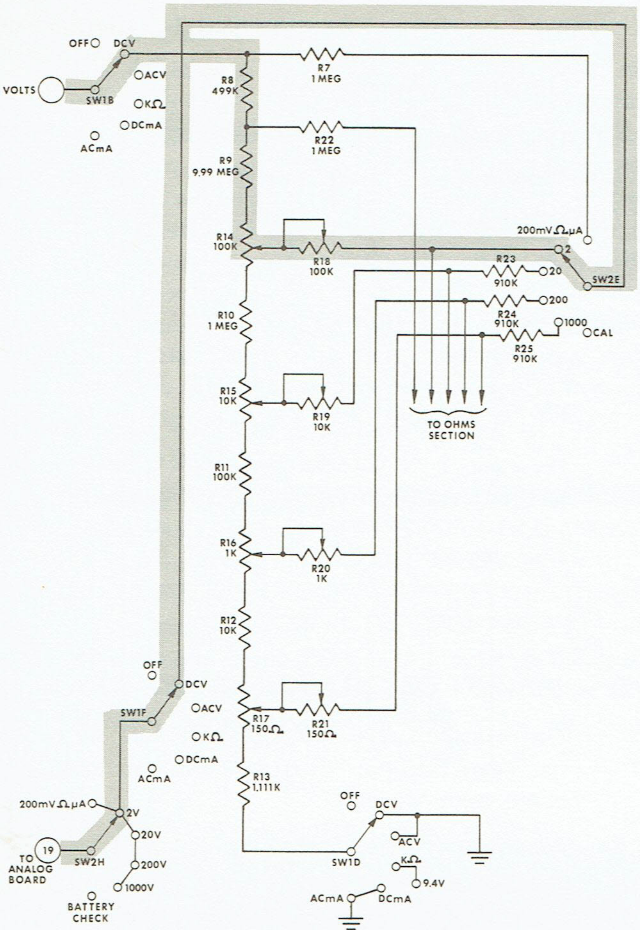


Figure 2
Signal Flow
D.C. Volts

3.1.3 AC AND DCmA TO VOLTAGE CONVERTER

The AC and DCmA to Voltage Converter feeds the current being measured through a precision resistor to ground. There is a separate resistor for each position of the RANGE switch. The voltage drop across a resistor is tapped off and fed through a different deck of the RANGE switch. DC voltage is fed through isolation resistor R58 to the DVM board. AC voltage is fed to the AC Converter Protection circuit. Diodes D7 and D8 are for overcurrent protection and will carry overrange currents until Fuse F1 blows.

3.1.4 ACV ATTENUATOR

The input AC voltage is applied to a four resistor voltage divider. The RANGE switch (SW2F) taps off between each resistor to vary the attenuation with varying switch positions.

3.1.5 FREQUENCY COMPENSATOR

The Frequency Compensator is comprised of capacitors. These capacitors are selected by switching RANGE switch SW2G, and are used in keeping a flat frequency response in the different amplitude ranges of ACV and ACmA.

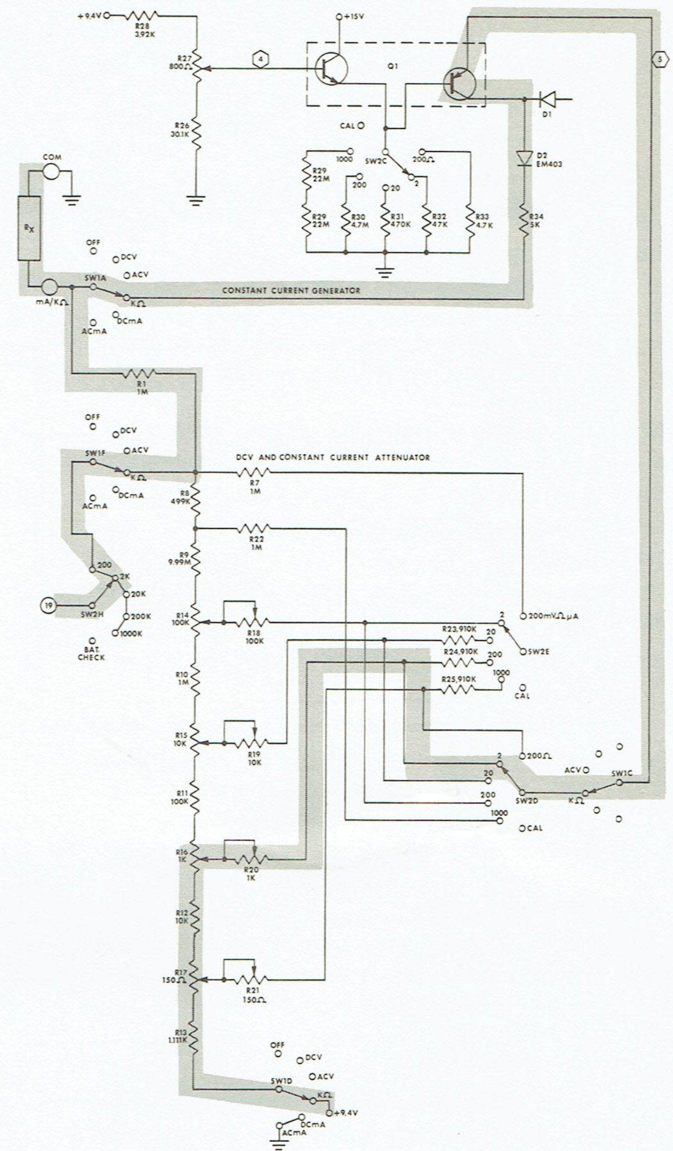


Figure 3
Signal Flow
KΩ

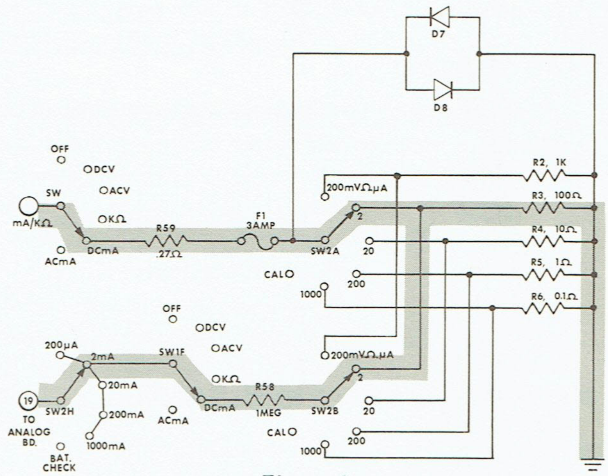


Figure 4
Signal Flow
DCmA

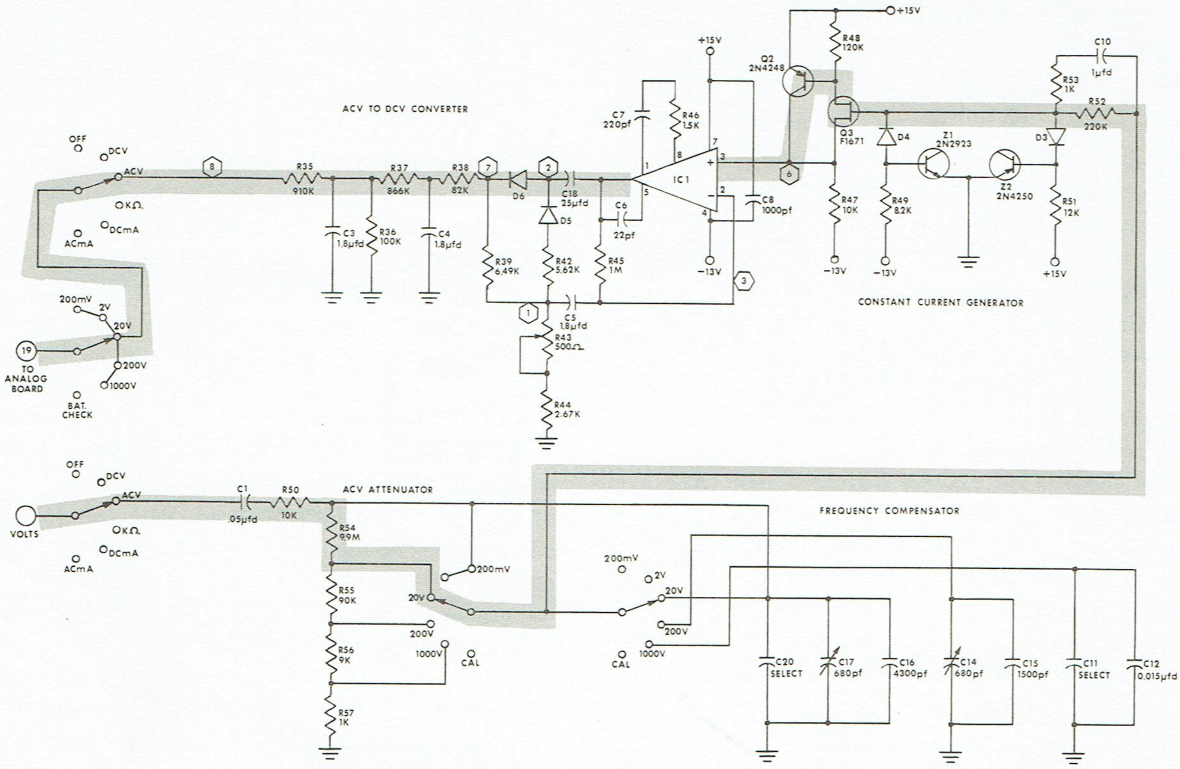


Figure 5
Signal Flow
A.C. Volts

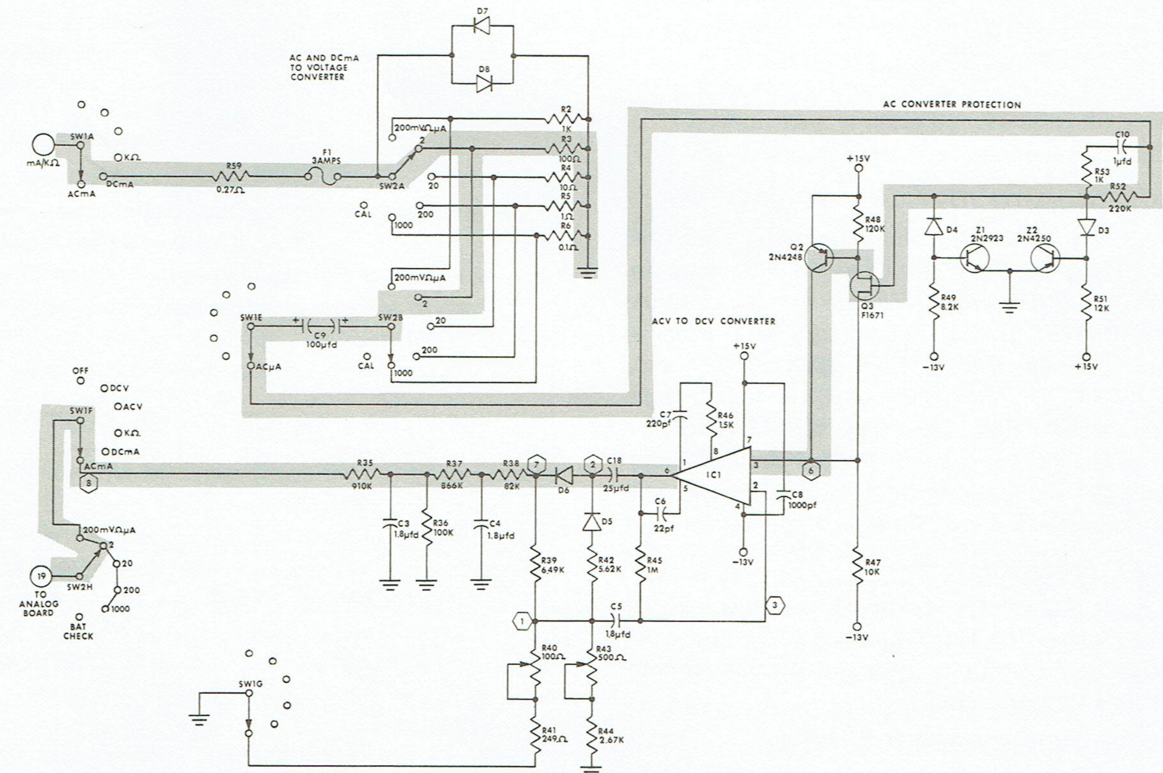


Figure 6
Signal Flow
ACmA

3.1.6 AC CONVERTER PROTECTION

The AC Converter Protection circuit receives AC voltage from the ACmA to Voltage Converter or from the ACV Attenuator. Because two volts rms is the maximum voltage during normal operation, the AC voltage is passed through without change.

Transistors Z1 and Z2 are used as two-lead, Zener diodes with a reverse breakdown voltage of approximately seven volts. The DC power supplies keep them biased on, keeping their bases at approximately seven volts DC from ground, therefore, any over voltage is limited to approximately seven volts peak, protecting the ACV to DCV Converter.

3.1.7 ACV TO DCV CONVERTER

The zero to two volt AC is applied to the base of Q3, a high input impedance FET. Transistor Q2 is driven by Q3 and provides low output impedance for IC1 . IC1 is an operational amplifier with the gain controlled by R43 in the "2" range, and by R40 in all other ranges. Diode D6 clips the negative half cycle and the RC network averages the positive pulses to a constant and proportional DC level.

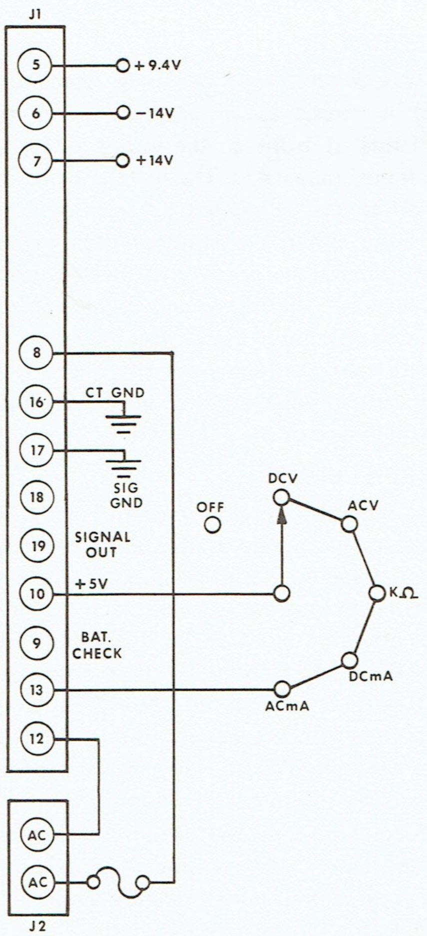


Figure 7
Connection Diagram
Signal Conditioning Board

3.1.8 DECIMAL POINT CONTROL

The Decimal Point Control is one deck of the RANGE switch used to provide a signal return for the decimal point circuit on the A/D board.

3.2 Analog Board (See Figures 8 through 12)

The analog board accepts the zero to 200mV positive or negative level from the Signal Conditioning board, translates it to a digital equivalent and provides the digital readout. The analog board also contains the power supply which powers all of the instrument.

3.2.1 DUAL SLOPE INTEGRATION

These meters operate using the principle of dual slope integration. This technique operates by feeding an unknown voltage through a resistor to the noninverting input of an amplifier with capacitive feedback (illustrated in Figure 8). The output is a ramp voltage with slope proportional to the magnitude of the input voltage. The larger the input voltage, the greater the slope of the output voltage.

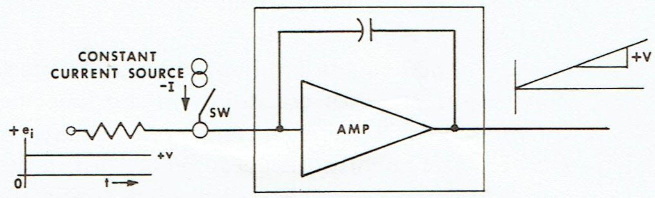


Figure 8 Integrator Operation

At some finite time t_0 (See Figure 9), a constant current source is connected in parallel with the current generated by the input voltage. The amplifier output is then proportional to the algebraic sum of the two currents. The constant current source provides current of opposite polarity to and of greater magnitude than that generated by the input voltage; the output voltage will return to zero at a rate proportional to the difference in the two currents.

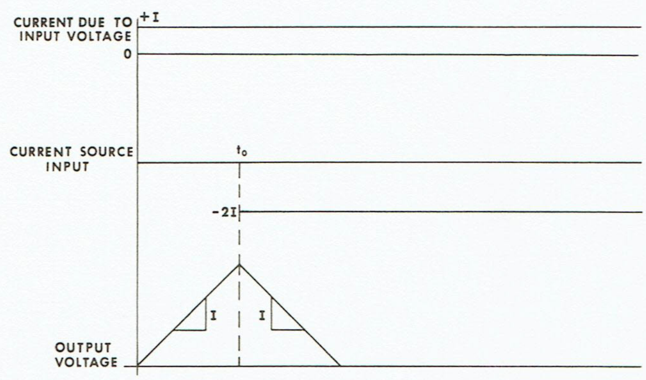


Figure 9 Integrator Input/Output Timing

The greater the magnitude of the input voltage, the larger positive value the output voltage will obtain in a given period of time, and the longer it will take for a fixed current source to return the output to

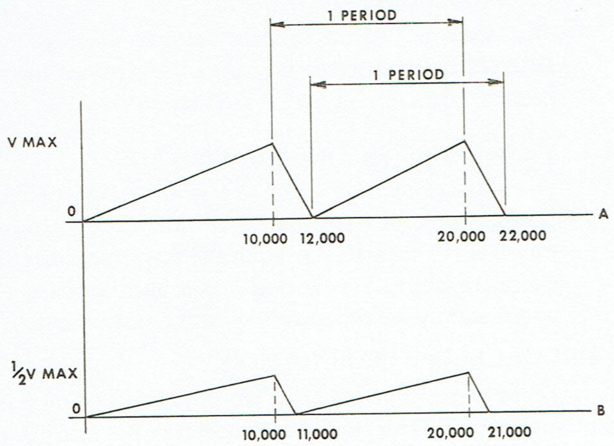


Figure 10
Measurement Cycle

zero. This time to return to zero is measured as an indication of the magnitude of the input voltage.

The measurement process in the meter is based on a 10,000 count cycle illustrated for the maximum meter input in Figure 10 View A.

After 10,000 counts a current source is initiated. Clock pulses are then counted from the time the current source is initiated until zero voltage is obtained. This count is then decoded and fed to the output LEDS as a digital voltage readout. Figure 10, View B, shows a cycle for half the maximum input; the input is integrated for a longer portion of the 10,000 count cycle, but what is significant is still the second portion of the cycle when the voltage goes from its maximum positive value to zero. The rest of this section will explain how this process is accomplished.

3.2.2 MOS CHIP

The central component of these meters is the MOS integrated circuit chip. It contains several functions, all of which must be understood before proceeding (See Figure 11). The operation of this unit is as follows:

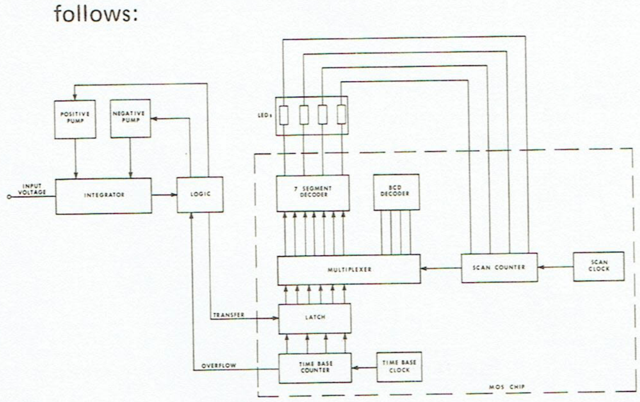


Figure 11
Block Diagram
Analog Board

A free running oscillator (time base clock) with an externally adjustable output frequency drives a time base counter circuit with a capacity of 9999. The 10,000th pulse clears the time base counter and activates the overflow output for one pulse width. The counter output is directed to a latch circuit which assumes and retains the instantaneous output state of the counter in response to an enabling signal (transfer input).

The outputs of the latch are in turn directed to a multiplexer which is a serializing circuit intended to feed the parallel information in the latch to the next circuit one word at a time. The multiplexer moves from one latch position to the next in response to a series of scan counter pulses, "reading" the output at each position. The counter is in turn driven by another externally controlled free running oscillator (scan clock). Four scan counter positions are also brought out as outputs; their use will be shown later.

The multiplexer output is then directed to two functions. The first is a circuit which produces a 7 bit output required by the LEDS (Light Emitting Diodes) used in the Digital Readout Display. The second circuit takes the serial output of the multiplexer and converts it to serial BCD output.

3.2.3 INTEGRATOR

The operational amplifier with capacitor feedback (IC3) functions as an integrator. The field effect transistors in front of the inputs (Q14) are to give high input impedance. The voltage to be measured is applied to the non-inverting input of the amplifier, producing either a positive or negative current (depending upon the polarity of the measured voltage). This results in a ramp voltage at the amplifier output. The output ramp is then forced to zero by applying a current having the same polarity as that generated by the measured voltage but of greater magnitude to the inverting input of the amplifier.

3.2.4 CURRENT PUMPS

Supplying this forcing current which drives the output ramp to zero is the purpose of two current pumps (one for positive input, one for negative input). They operate as follows: The zener diode D11 keeps the emitter of Q9 at a potential of 3.7 volts when Q5 is conducting, it will be observed that since the base and collector of Q9 are tied together, the component is operating as a diode. When no current flows through R20 or R21, the base of Q9 is at 10 volts. The base emitter junction is thus reverse biased. If Q5 conducts, however, R20 is tied to ground. Since the emitter of Q9 remains at 3.7 volts, the base emitter junction is now forward biased.

When the junction begins conducting, Q8 is turned on and becomes a constant current source. Its current output is fed to the inverting input of the integrator (IC3). The 2K adjustable resistor, R23, controls the

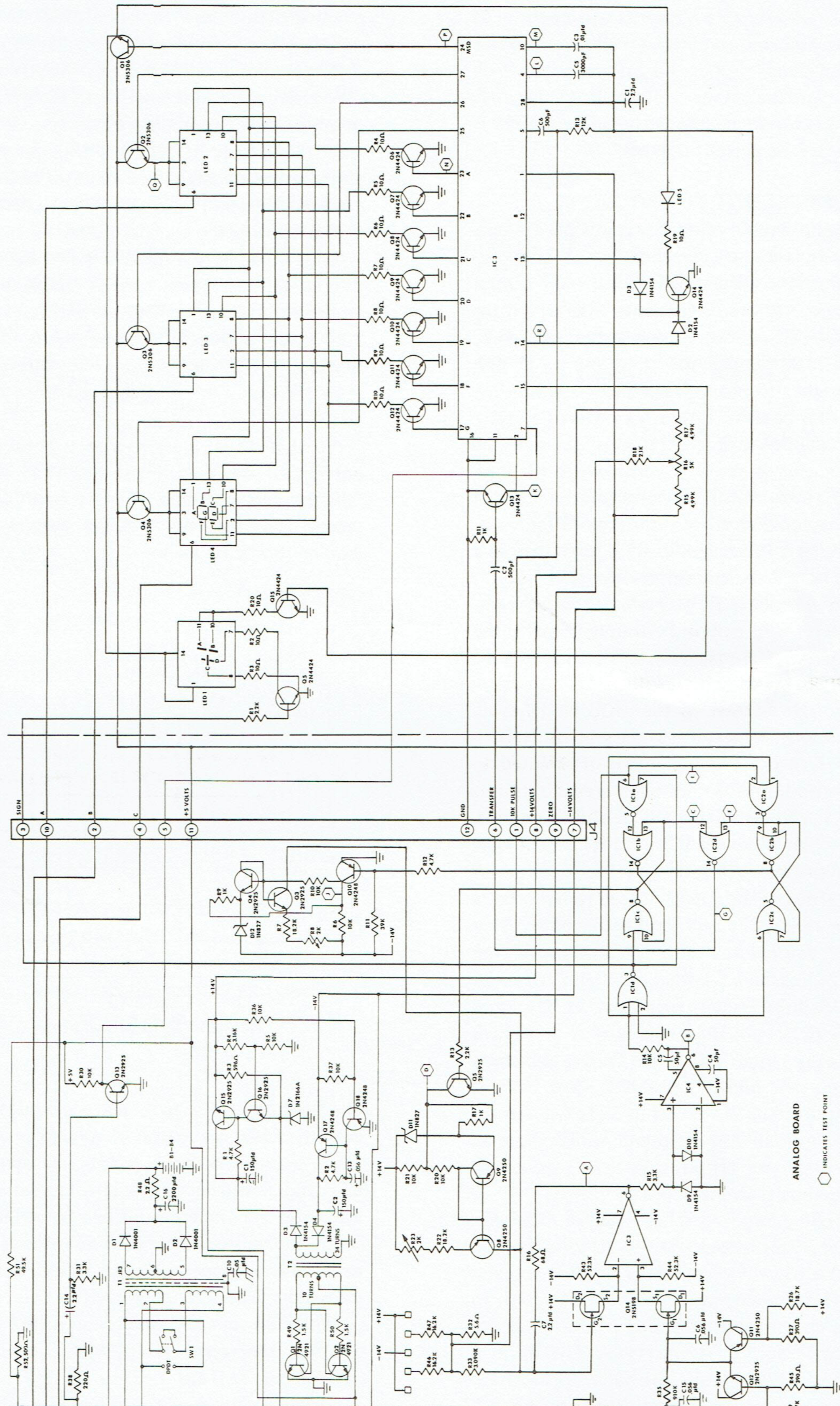


Figure 12
Analog Board

amount of current which the transistor supplies. The negative current pump operates in exactly the same manner, except that it supplies negative current which is needed when the input voltage is of negative polarity. It remains to be shown how Q5 or Q10 is biased on to start the current pumps.

3.2.5 LOGIC

IC4 is an op-amp circuit which compares the voltages on its inverting and non-inverting inputs (comparator). If the algebraic difference is negative the output of the device goes to minus ten volts. Similarly if the algebraic difference is positive, the output will go to plus 10 volts. Since the inverting input of this comparator is tied to ground, the device will switch according to the polarity of the non-inverting input. Thus, when the integrator output is positive the comparator output is plus 10 volts; when the integrator output is even slightly negative (on the order of 1 millivolt) the comparator output is minus ten volts. The former output is recognized by a logic gate as a logic "1"; the later is recognized as logic "0".

IC1d is a two input NOR gate which has one input tied to ground. This means it simply inverts the comparator output (i.e. negative voltage yields logic 1, positive voltage yields logic zero).

Recall that the counter in the MOS chip has an overflow bit output when the counter reaches 10,000. This output (a negative going pulse) is directed to inputs of IC1a and of IC2a. The comparator output is connected to the other input of IC2a and its complement to the other input of IC1a. So when the logic zero 10K pulse comes through, if the comparator output is positive, the output of IC1a will be a positive pulse, and IC2a will ignore the pulse. Similarly, if the comparator output is negative, the output of IC2a will be a positive pulse and IC1a will ignore the 10K pulse. When the output of IC1a goes high, it drives IC1b low. Since the output of IC1d is also low, IC1c goes high. This biases Q5 on, and starts the positive current pump. Once IC1c goes high, it holds the output of IC1b low. Thus IC1c will remain high and the positive current pump will operate as long as the comparator output is positive, and count pulses will accumulate in the counter.

When the comparator switches negative, however, IC1d goes high. This causes IC1c to go low, thereby shutting off the current pump. Recalling the concept of dual scope integration, the accumulated count is to be transferred to the latch, decoded and displayed as a digital voltage reading at this time. Therefore, a transfer pulse is needed. While the gates on IC1 have been operating as described above, the gates on IC2 have been in the following state: The output of IC2a is forced low since the lead which brings the 10K pulse is usually high. IC2c is also initially low due to the fact that the output of the comparator is initially positive. Thus both inputs of IC2b are low and its output is high, holding IC2c low.

Now consider IC2d. One input, that which is connected to IC2c is low. When IC1c goes low due to the comparator switching, both inputs of IC2d go low and stay low until zero crossing; then the current pump shuts off and the integrator begins integrating positively again. This causes the output of IC2d to go high producing the transfer pulse.

When the test voltage is negative and it is necessary to operate the negative current pump, the operation is essentially the same. The only difference is that the 10K pulse is directed through Gate IC2a and from that point, the roles of gates IC1a through c and gates IC2a through c are interchanged from that described above.

So then there are two signals between the analog portion of the circuit and the MOS chip. The first tells the current pump when to begin operation. The second tells the chip that the output is zero and a reading should be taken.

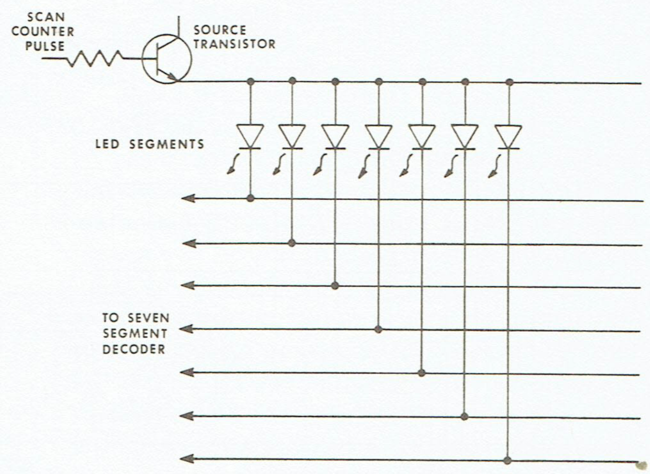


Figure 13
Readout Synchronization

3.2.6 DISPLAY BOARD

The lighting of the light emitting diodes (LED) in the output display is a matter of synchronization between the 7 segment decoder and the counter pulses. Each LED has seven lighting segments which in combination form the numerals. Each set of seven diodes has a common transistor power source which we shall refer to as the source transistor. There are four source transistors Q1-Q4, one for each LED.

When an output appears on the seven segment decoder, the segments for that numeral are tied to ground on all four LEDS (Q6-Q12). The numeral appears on only one LED, however, the one whose source transistor is connected to the counter output which is high at that instant. Thus it takes two things to light an LED segment (i.e. make a complete circuit): The seven segment output which ties the cathode to ground and the ring counter pulse which applies voltage to the anode through the source transistor.

When the scan counter advances to its next position, it reads a different multiplexer output. It also enables the next LED to display this second numeral. This process is repeated until the last position is reached, and the cycle begins again. Thus only one LED is ever lit at a time, but the speed of switching creates the illusion that the numerals are continuously lit.

4. CALIBRATION (See Figure 8)

To calibrate this instrument, remove the four screws on the bottom cover and remove the Cover. DO NOT REMOVE THE TOP COVER, except in Step E of 4.2. Calibration must be performed in the following sequence.

4.1 Necessary Calibration Equipment

A. DC voltage standard – DigiTec Model 311 Precision Calibrator or equivalent (.01% Accuracy).
B. AC voltage standard – Hewlett Packard 745A AC Calibrator or equivalent.
C. Resistance standard – Electro Scientific Industries Dekabox with 0 to 2 megohms at ±0.02% or equivalent.
D. Calibrated DC current source 0 to 2 amps at 0.1% – Kepco Model PCX7-2(C) and DigiTec Model 311.
E. Screwdriver.

4.2 DC Volts

A. Place the RANGE switch in the 200mV, Ω μA position and the FUNCTION switch to DCV.
B. Short the input to ground and adjust the front panel ZERO control for a digital display of zero.
C. Apply +200.0mV to the input and adjust R23 for a digital display of 00.0 with the O/R indicator illuminated.
D. Apply -200.0mV to the input and adjust R8 for a digital display of 00.0 with the O/R indicator illuminated.
E. Adjust R200 for a digital display of 199.9mV.
F. Rotate the RANGE switch to the 2 volt range.
G. Apply +2.000 volts to the input.
H. Adjust R14 for a digital display of .000 with the O/R indicator illuminated.
I. Rotate the RANGE switch to the 20 volt range.
J. Apply + 20.00 volts to the input.
K. Adjust R15 for a digital display of 0.00 with the O/R indicator illuminated.
L. Rotate the RANGE switch to the 200 volt range.
M. Apply +200.0 volts to the input.
N. Adjust R16 for a digital display of 00.0 with the O/R indicator illuminated.
O. Rotate the RANGE switch to the 1000 volt range.
P. Apply +1000. volts to the input.
Q. Adjust R17 for a digital display of 1000.

4.3 DC Current

No adjustments can be made on the current ranges. The following procedure is only for checking the current ranges.

A. Rotate the FUNCTION switch to DCmA and the RANGE switch to 200μA.
B. Short the input to ground and adjust the front panel ZERO control for a zero display.
C. Apply 200.0μA DC to the input. Readout should display between 199.4 and O/R 00.6.
D. Change the RANGE switch to 2.
E. Apply 2.000mA to the input. Readout should display between 1.994 and O/R .006.
F. Change the RANGE switch to 20.
G. Apply 20.00mA to the input. Readout should display between 19.94 and O/R 0.06.
H. Change the RANGE switch to 200.
I. Apply 200.0mA to the input. Readout should display between 198.3 and O/R 017.
J. Change the RANGE switch to 1000.
K. Apply 2.000mA to the input. Readout should display between 1983. and O/R 017.

4.4 Ohms

A. Rotate the FUNCTION switch to the KΩ position, and the RANGE switch to 1000.
B. Short the input leads mA/KΩ and COM and adjust the front panel ZERO control for a digital display of zero.
C. Apply 2 meg to the input and adjust R27 for a digital display of 000. with the O/R indicator illuminated.
D. Change the RANGE switch to the 200 position.
E. Repeat Step B.
F. Apply 200.0K ohms to the input and adjust R18 for a digital display of 00.0 with the O/R indicator illuminated.
G. Change the RANGE switch to the 20 position.
H. Repeat Step B.
I. Apply 20.00K ohms to the input and adjust R19 for a digital display of 0.00 with the O/R indicator illuminated.
J. Change the RANGE switch to the 2 position.
K. Repeat Step B.
L. Apply 2.000K ohms to the input and adjust R20 for a digital display of .000 with the O/R indicator illuminated.
M. Change the RANGE switch to the 200 DCmV, Ω, μA position.
N. Repeat Step B.
O. Apply 200 ohms, then 150, 100, and 20 to the input and adjust R21 for best overall accuracy.

4.5 AC Volts

A. Rotate the FUNCTION switch to ACV and the

RANGE switch to 2.

B. Short the input and adjust front panel ZERO control for a zero display.
C. Apply 2.000V at 200 Hz to the input.
D. Adjust R43 for a digital display of .000 with the O/R indicator illuminated.
E. Change the RANGE switch to the 20 volt position.
F. Repeat Step B.
G. Apply 20.00 volts at 200Hz to the input.
H. Adjust R40 for a digital display of 0.00 with the O/R indicator illuminated.
I. Change the 20.00 volts to 100Hz, then 1KHz, and 10KHz. Adjust C17 for the best overall accuracy.
J. Change the RANGE switch to the 200 volt position.
K. Repeat Step B.
L. Apply 200.0 volts to the input at 100Hz, then 1KHz, and 10KHz. Adjust C14 for the best overall accuracy.

4.6 AC Current

No adjustments can be made in the current ranges. The following procedure is only for checking the ranges.

A. Rotate the FUNCTION switch to 200A.
B. Apply 200.0 A at 100Hz to the input. Readout should display between 199.0 and 01.0.
C. Change the RANGE switch to 2. Apply 2.000mA at 100Hz to the input. Readout should display between 1.990 and O/R .010.
D. Change the RANGE switch to 20. Apply 20.00mA at 100Hz to the input. Readout should display between 19.90 and O/R 0.10.
E. Change the RANGE switch to 200. Apply 200.0mA at 100Hz to the input. Readout should display between 198.1 and O/R 01.9.
F. Change the RANGE switch to 1000. Apply 2 amp at 100Hz to the input. Readout should display between 1981 and O/R 019.

5. TROUBLESHOOTING

5.1 Introduction

If the instrument operates but is inaccurate, perform the Calibration procedures before troubleshooting.

Before attempting to troubleshoot an instrument, read the circuit description while studying the schematics. After a good understanding of circuit operation is gained, proceed to the following troubleshooting suggestions. Troubleshooting suggestions are given in two forms: (1) Symptom/repair logic trees, and (2) Schematics and timing diagram testpoint waveforms.

REPAIR PROCEDURE. The input impedance of this instrument is extremely high. To maintain this impedance, and thus the stability of the instrument, the printed circuit board must be thoroughly cleaned and coated after any repair in the input circuitry. To make any repairs in this section, the following procedure must be used.

1. Remove the plastic coating from the board with methylene chloride.
2. Make repairs as necessary with a SMALL, LOW TEMPERATURE iron.
3. Clean board with Freon TE – protect potentiometers to prevent removal of lubricants.
4. Spray with Urethane seal coat (CRC No. 2049) or equivalent.
5. Wait 48 hours before reapplying power to board.

5.2 General Instructions

The following pages present logic diagrams for troubleshooting some of the more common trouble symptoms of the 262C meter. All instructions which have to do with ground checks, continuity checks or resistance checks are to be performed with POWER OFF.

5.2.1 NECESSARY TROUBLESHOOTING EQUIPMENT

This equipment is required in addition to the Calibration equipment given in 4.1.

A. Oscilloscope – Tektronix 535 or equivalent.
B. Voltmeter – DigiTec Model 262 or equivalent.
C. Jumper leads.

5.2.2 RESISTANCE CHECKS

Resistance checks on the transistors are to be performed as follows: Check resistance in both directions between base and collector and between base and emitter. Resistance should read high in one direction and low (less than 20 ohms) in the other direction. Resistance should be high in both directions between emitter and collector. If any of these readings do not check as described above, replace the transistor, Noting the way the transistor is set into the board.

All soldering should be done with an iron whose wattage is less than 2 watts.

A resistance check on a diode is made by checking resistance in both directions across a diode. Resistance should read high in one direction and low (less than 20 ohms) in the other direction.

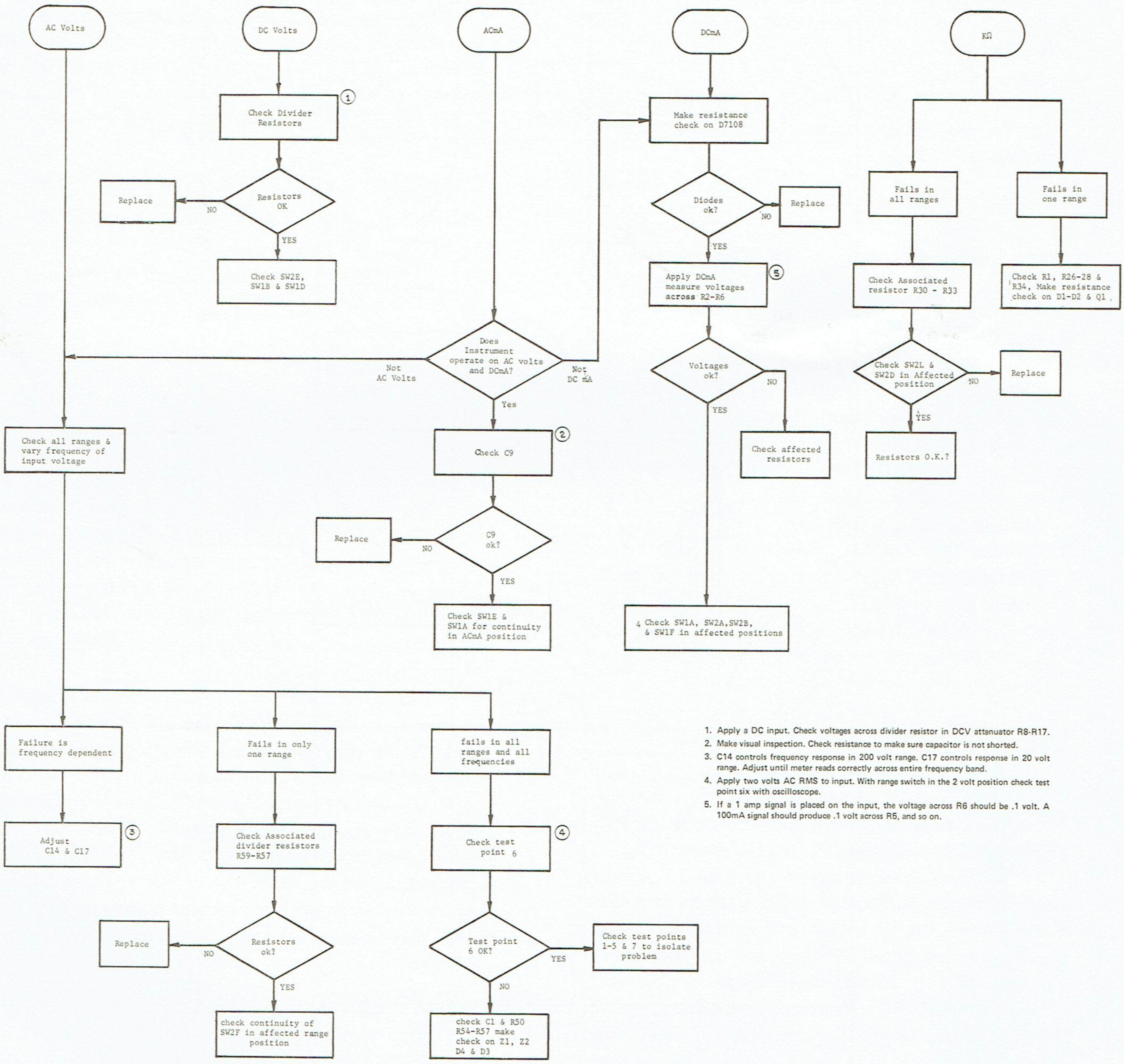
A resistance check on a zener diode is somewhat similar to a diode. Resistance should always read low in one direction. Resistance should read open in the other direction for the lower ranges of the ohmeter. In the higher ranges, this resistance may go to some finite value depending on the standard cell used in the ohmeter.

5.2.3 PRELIMINARY DIAGNOSIS

The 262C Meter essentially consists of three boards: The signal conditioning board, the analog board and the display board. The first step in diagnosing a failure is to decide which of the three boards contains the fault. For this purpose there are some specific guidelines.

If the meter operates correctly in any of its functions but fails in others, the problem is in the signal conditioning board and chart 5.3 should be employed. If meter fails in all functions and all ranges and for both polarities of input, the signal path from the input terminals to the output should be checked for continuity. If a varying display is obtained but is somehow unsatisfactory in all functions, the problem is either in the analog board or the display board and charts 5.4 thru 5.9 should be used. The signal conditioning board can always be qualified by following the procedure in chart 5.3.

5.3 SYMPTOM: Fails on only one or two positions of function switch



1. Apply a DC input. Check voltages across divider resistor in DCV attenuator R8-R17.
2. Make visual inspection. Check resistance to make sure capacitor is not shorted.
3. C14 controls frequency response in 200 volt range. C17 controls response in 20 volt range. Adjust until meter reads correctly across entire frequency band.
4. Apply two volts AC RMS to input. With range switch in the 2 volt position check test point six with oscilloscope.
5. If a 1 amp signal is placed on the input, the voltage across R6 should be .1 volt. A 100mA signal should produce .1 volt across R5, and so on.

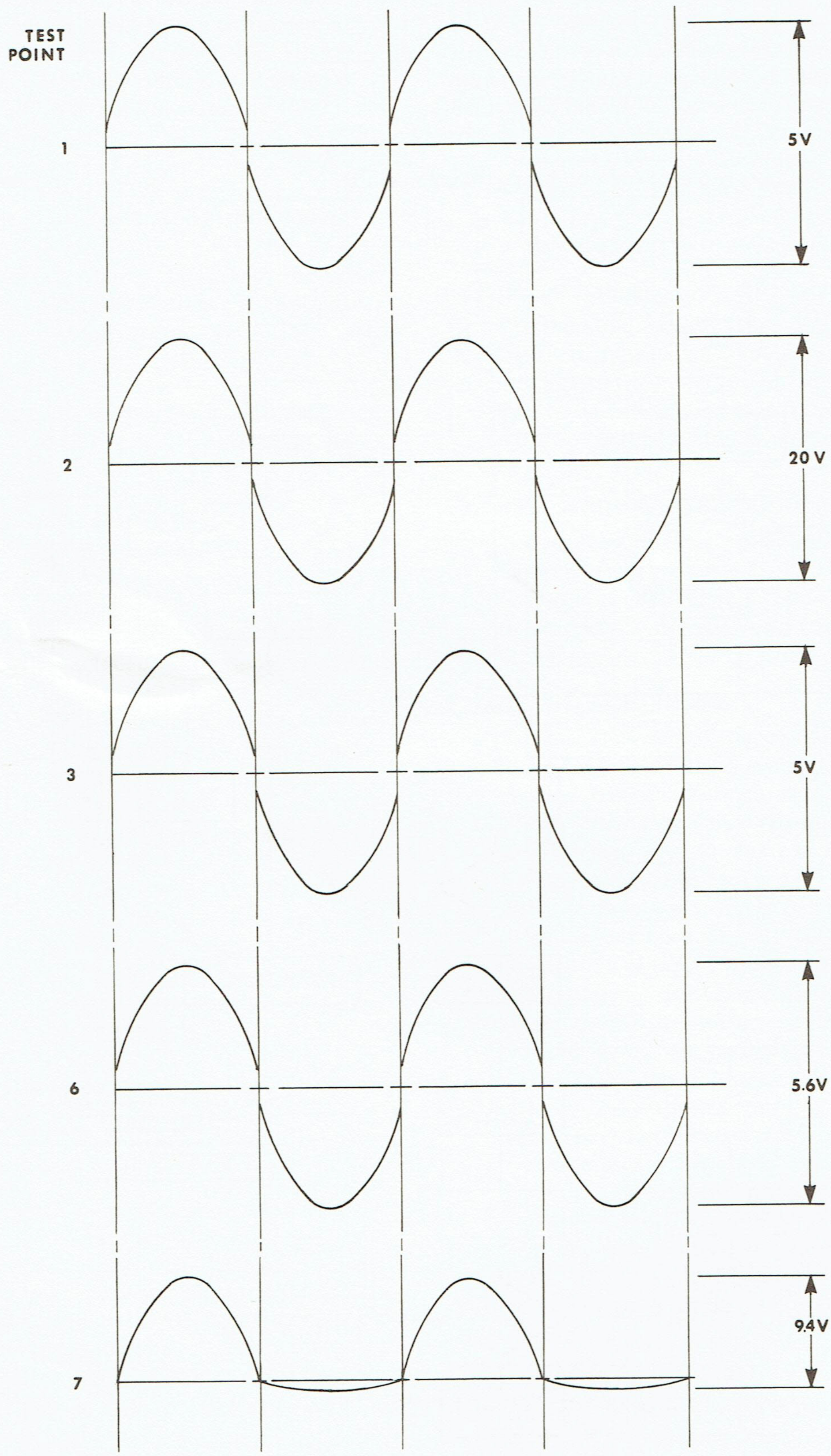
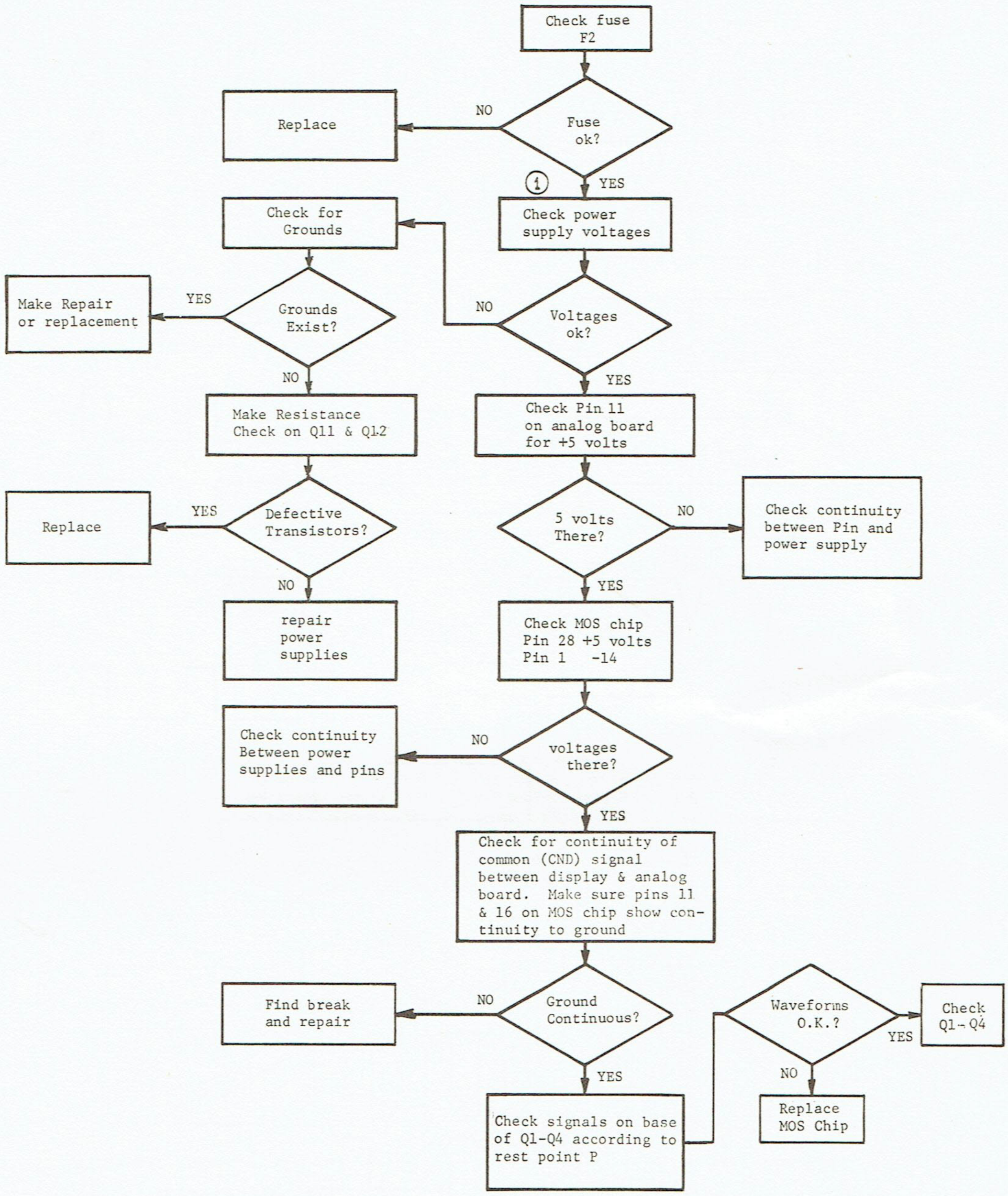


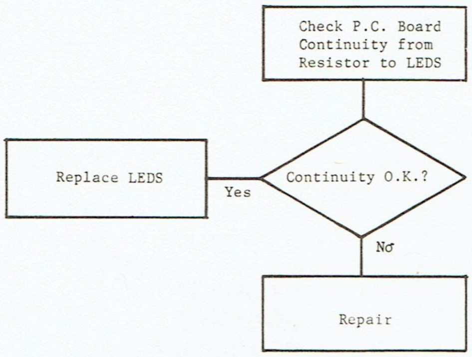
Figure 14
Waveforms
Signal Conditioning Board

5.4 SYMPTOM: Display will not light



(1) Pin 7 of analog board should read +14 volts; Pin 6 should read -14 volts. Pin 10 should read +5 volts.

5.5 SYMPTOM: One segment missing on one LED



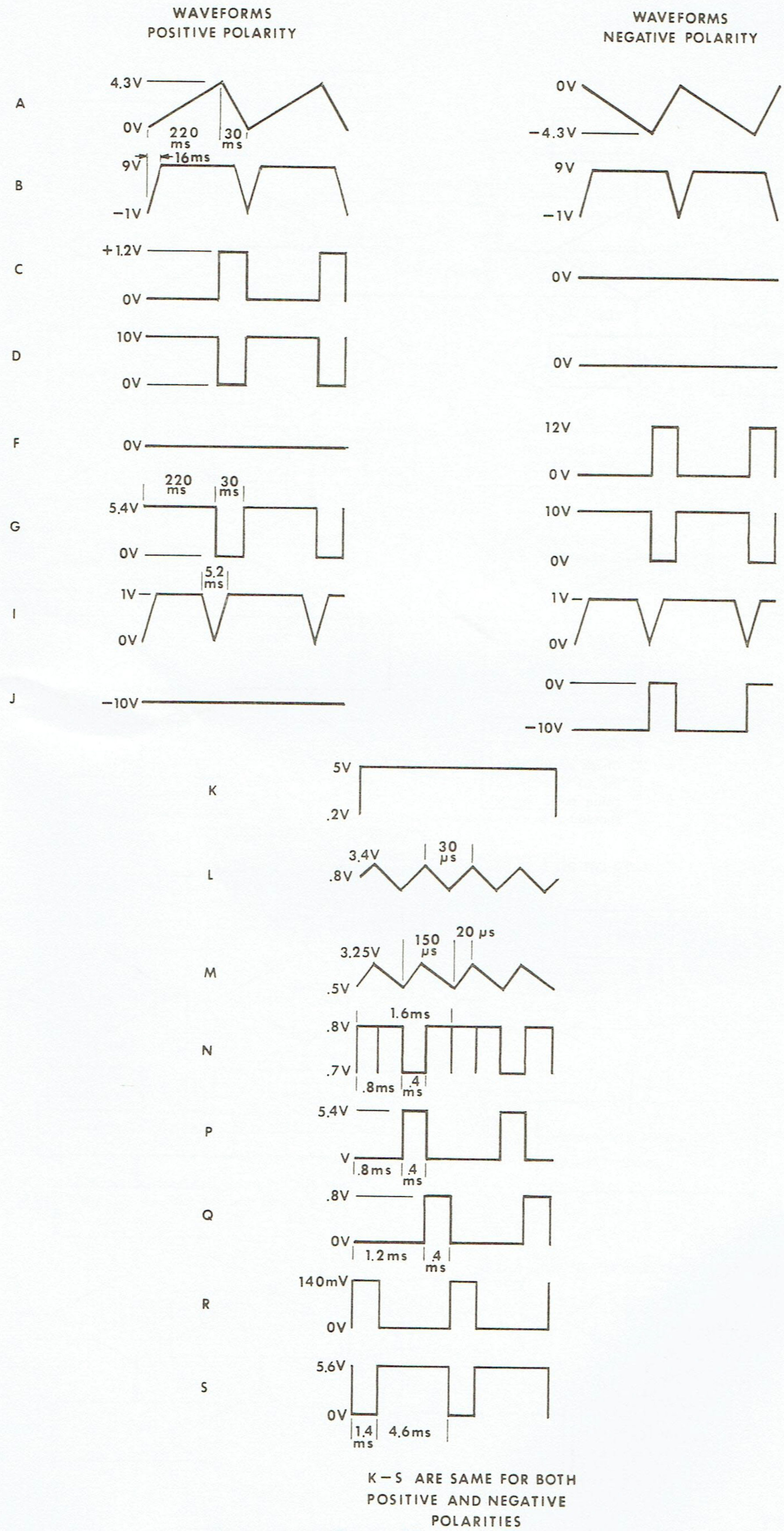
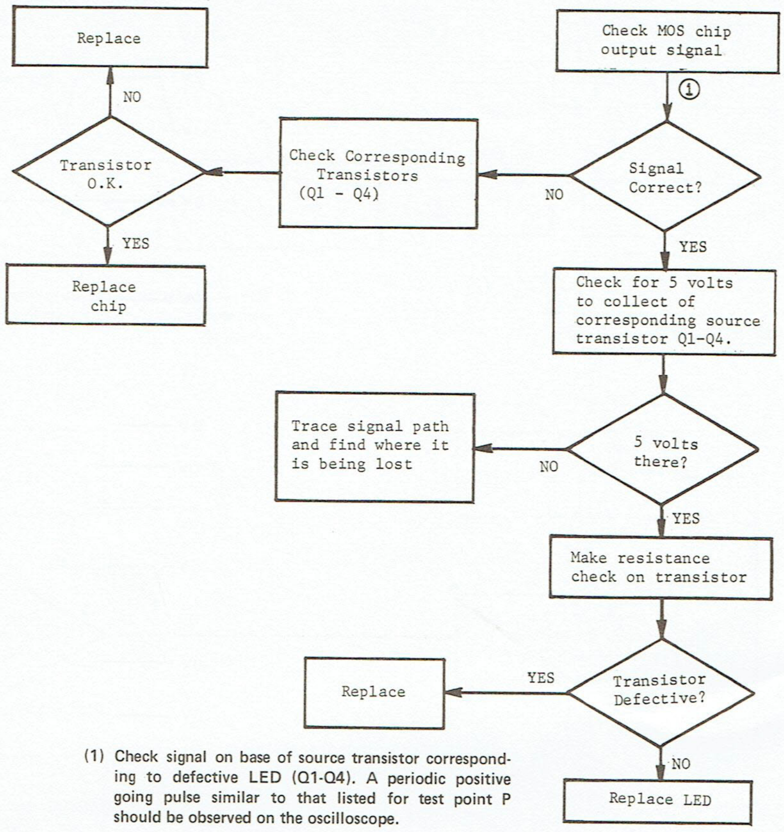


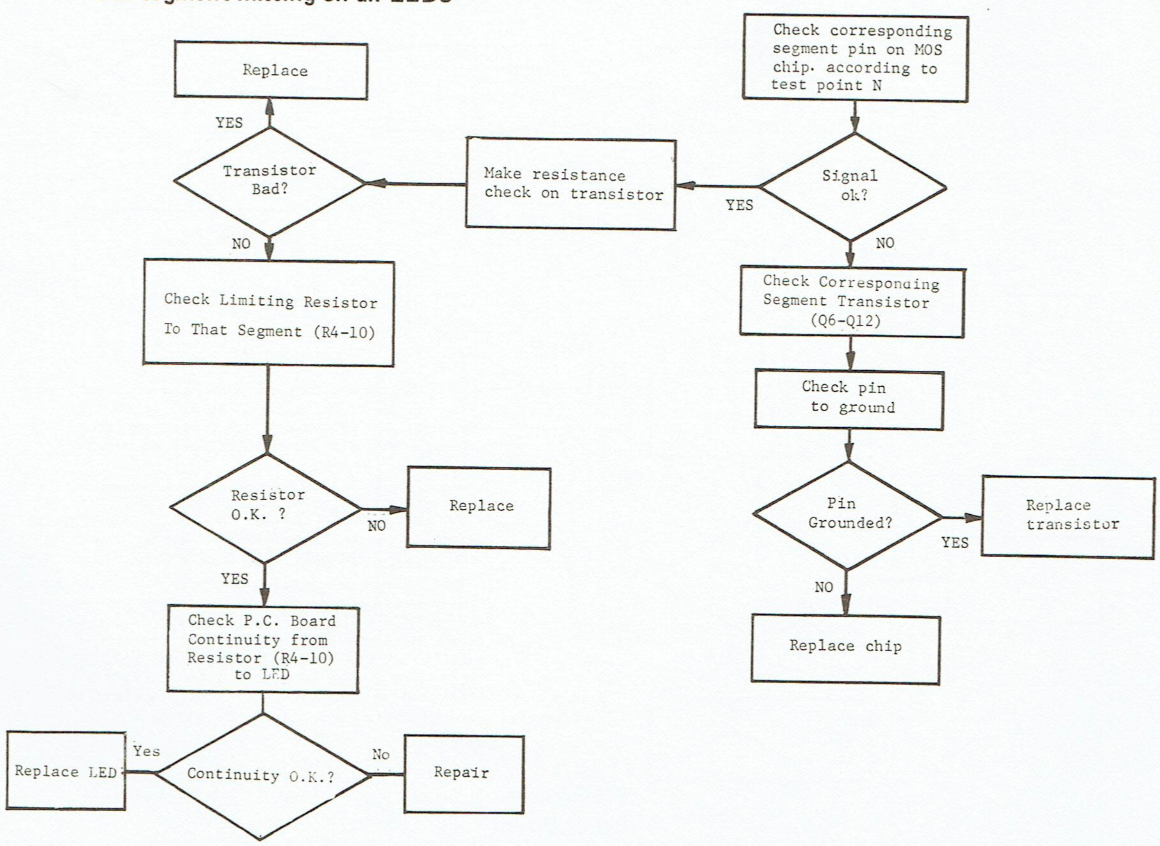
Figure 15
Waveforms
Analog Board

5.6 SYMPTOM: One LED fails

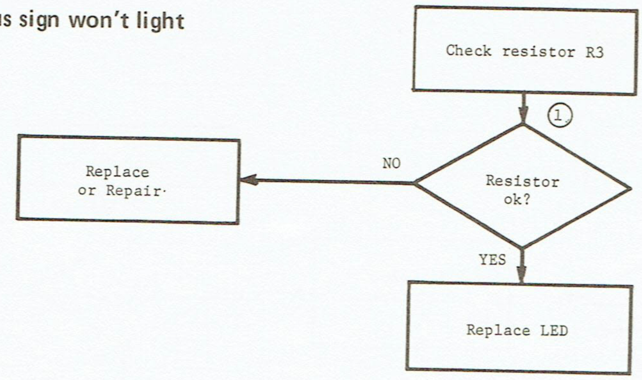


(1) Check signal on base of source transistor corresponding to defective LED (Q1-Q4). A periodic positive going pulse similar to that listed for test point P should be observed on the oscilloscope.

5.7 SYMPTOM: One segment missing on all LEDS

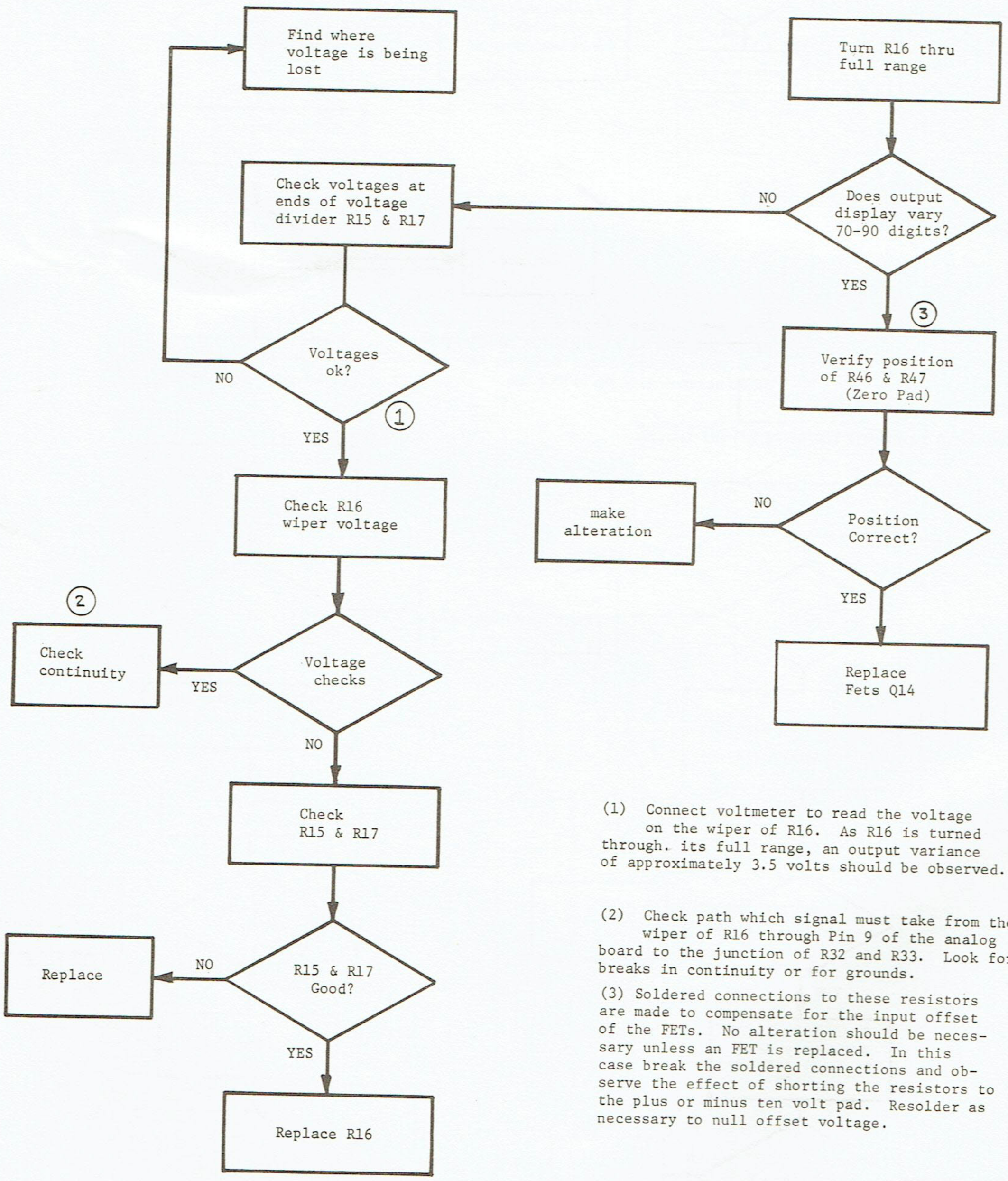


5.8 SYMPTOM: Minus sign won't light



1. Jumper pin to ground momentarily. Minus sign should light; if not, a defective LED is indicated.

5.9 SYMPTOM: Unit will not zero

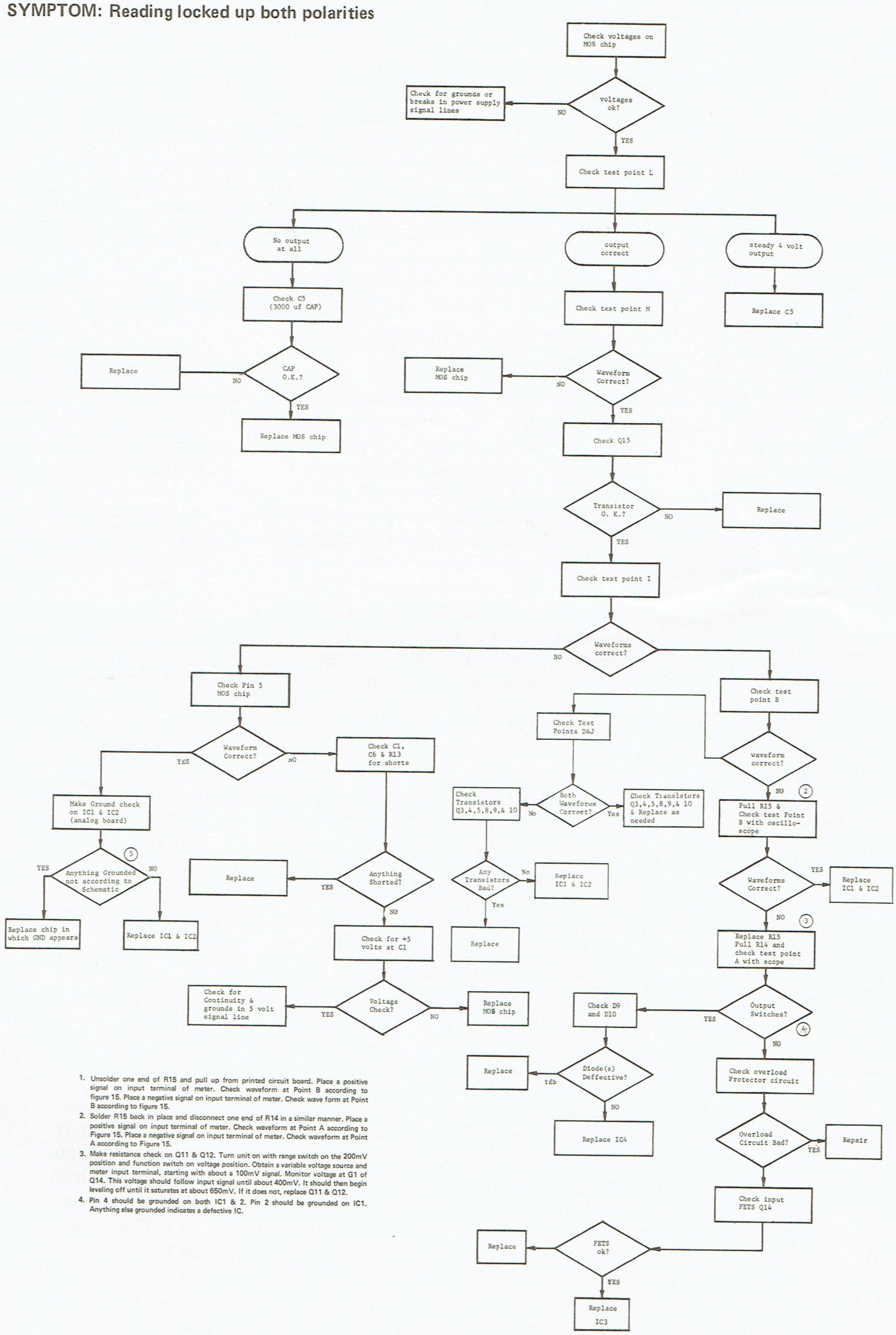


(1) Connect voltmeter to read the voltage on the wiper of R16. As R16 is turned through its full range, an output variance of approximately 3.5 volts should be observed.

(2) Check path which signal must take from the wiper of R16 through Pin 9 of the analog board to the junction of R32 and R33. Look for breaks in continuity or for grounds.

(3) Soldered connections to these resistors are made to compensate for the input offset of the FETs. No alteration should be necessary unless an FET is replaced. In this case break the soldered connections and observe the effect of shorting the resistors to the plus or minus ten volt pad. Resolder as necessary to null offset voltage.

5.10 SYMPTOM: Reading locked up both polarities



1. Unsolder one end of R15 and pull up from printed circuit board. Place a positive signal on input terminal of meter. Check waveform at Point B according to figure 15. Place a negative signal on input terminal of meter. Check wave form at Point B according to figure 15.
2. Solder R15 back in place and disconnect one end of R14 in a similar manner. Place a positive signal on input terminal of meter. Check waveform at Point A according to Figure 15. Place a negative signal on input terminal of meter. Check waveform at Point A according to Figure 15.
3. Make resistance check on Q11 & Q12. Turn unit on with range switch on the 200mV position and function switch on voltage position. Obtain a variable voltage source and meter input terminal, starting with about a 100mV signal. Monitor voltage at G1 of Q14. This voltage should follow input signal until about 400mV. It should then begin leveling off until it saturates at about 650mV. If it does not, replace Q11 & Q12.
4. Pin 4 should be grounded on both IC1 & 2. Pin 2 should be grounded on IC1. Anything else grounded indicates a defective IC.

6. REPLACEMENT PARTS

Replacement parts for the components shown on the schematics and component location drawings are listed in alpha-numerical order by reference designator under their respective assemblies. Each list can be found adjacent to its respective component location diagram.

Parts Ordering

It is recommended that replacement parts be purchased directly from United Systems Corporation. The minimum charge is $10.00 on all orders. The order should be sent to:

United Systems Corporation
918 Woodley Road
Dayton, Ohio 45403

For each replacement part the following information should be included:

Instrument Model Number
Instrument Serial Number
Part Reference Designator
Part Description
Part Stock Number

SIGNAL CONDITIONING BOARD

Symbol	Description	Stock Number
C1	Capacitor, mylar, .05μfd, at 600VDC	56-10205CXA503J6
C2	Capacitor, mylar, .1μfd at 200VDC	56-10205BYB104J2
C3, 4, 5	Capacitor, tantalum, 1.8μfd at 20VDC	56-10221A185K20
C6	Capacitor, mica, 22pfd at 500VDC	56-10210A220HP5
C7	Capacitor, mica, 220pfd at 500VDC	56-10210A221FL5
C8	Capacitor, ceramic, 1000pfd at 1K VDC	56-10215A102JT10
C9	Capacitor, electrolytic, 100μfd at 6VDC	56-10217AE107K6
C10	Capacitor, mylar, 1μfd at 500VDC	56-10211BLW105JR5
C11	Capacitor, ceramic, selected, at 1K VDC	
C12	Capacitor, ceramic, .015μfd at 50VDC	56-11741
C14, 17	Capacitor, variable, 140 to 680pfd at 175VDC	56-10226-681
C15	Capacitor, ceramic, 1500pfd at 1K VDC	56-10215B152JT10
C16	Capacitor, mica, 4300pfd at 500VDC	56-10210C432FL5
C18	Capacitor, electrolytic, 25μfd at 25VDC	56-10201BT256N25
C19	Capacitor, mica, 50pfd at 500VDC	56-10210A500FL5
C20	Capacitor, mica, 150pfd at 500VDC	56-10210A151HL5
D1	Diode, clipper	40-07199-02
D2	Diode, power, EM403	40-07787-03
D3, 4, 5, 6	Diode, signal, 1N4154	40-09297
D7, 8	Diode, power, EM401	40-07787-01
F1	Fuse, 3 amp	52-11737
F2	Fuse, slow blow, 1/8 amp. for 110VAC	52-09309-01 (110VAC)
	1/16 amp. for 220VAC	52-09309-08 (220VAC)
IC1	Integrated circuit, operational amplifier, Motorola MC1709CG	40-09280
J1, 2	Connector, individual, bisexual pins	51-11736
Q1	Transistor, pair, special	40-11039
Q2	Transistor, 2N4248	40-09437
Q3	Transistor, FET, F1671.	40-07963
R1, 7, 58	Resistor, carbon, 1 meg, 5%, 1/4W	55-10101HM001
R2	Resistor, wire wound, 1K, 0.1%, 1W	55-10121BDK001
R3	Resistor, wire wound, 100Ω, 0.1%, 1W	55-10121BDA100
R4	Resistor, wire wound, 10Ω, 0.1%, 1W	55-10121BDA010
R5	Resistor, wire wound, 1Ω, 0.5%, 1W	55-10121DDA001
R6	Resistor, wire wound, 0.1Ω, 0.5%, 1W	55-10121DLA000R1
R8	Resistor, film, 499K, 1%, 3/4W	55-10111ELK499
R9	Resistor, film, 9.99 meg, 0.5%, 1W	55-10165DJM009R99
R10, 22, 45	Resistor, film, 1 meg, 0.5%, 3/4W	55-10111DJM001
R11, 36	Resistor, film, 100K, 0.5%, 3/4W	55-10111DJK100
R12	Resistor, film, 10K, 0.5%, 3/4W	55-10111DJK010
R13	Resistor, film, 1.111K, 0.1%, 3/4W	55-10111BJK001R111

SIGNAL CONDITIONING BOARD (cont.)

Symbol	Description	Stock Number
R14, 18	Resistor, variable, 100K, 20%, 1/4W	55-10162KK100
R15, 19	Resistor, variable, 10K, 20%, 1/4W	55-10162KK010
R16, 20	Resistor, variable, 1K, 20%, 1/4W	55-10162KK001
R17, 21	Resistor, variable, 150Ω, 20%, 1/4W	55-10162KA150
R23, 24, 25, 35	Resistor, carbon, 910K, 5%, 1/4W	55-10101HK910
R26	Resistor, film, 30.1K, 1%, 3/4W	55-10111ELK030R1
R27	Resistor, variable, 800Ω, 20%, 1W	55-10151KA800
R28	Resistor, film, 3.92K, 1%, 3/4W	55-10111ELK003R92
R29A, B	Resistor, carbon, 22 meg, 10%, 1/4W	55-10101JM022
R30	Resistor, carbon, 4.7 meg, 10%, 1/4W	55-10101JM004R7
R31	Resistor, carbon, 470K, 10%, 1/4W	55-10101JK470
R32	Resistor, carbon, 47K, 10%, 1/4W	55-10101JK047
R33	Resistor, carbon, 4.7K, 10%, 1/4W	55-10101JK004R7
R34	Resistor, wire wound, 5K, 5%, 5W	55-10123HLK005
R37	Resistor, film, 866K, 1%, 3/4W	55-10111ELK866
R38	Resistor, carbon, 82K, 10%, 1/4W	55-10101JK082
R39	Resistor, film, 6.49K, 1%, 3/4W	55-10111ELK006R49
R40	Resistor, variable, 100Ω, 10%, 3/4W	41-11611-04
R41	Resistor, film, 249Ω, 1%, 3/4W	55-10111ELA249
R42	Resistor, film, 5.62K, 1%, 3/4W	55-10111ELK005R62
R43	Resistor, variable, 500Ω, 10%, 3/4W	41-11611-06
R44	Resistor, film, 267K, 1%, 3/4W	55-10111ELK002R67
R46	Resistor, carbon, 1.5K, 10%, 1/4W	55-10101JK001R5
R47	Resistor, carbon, 10K, 5%, 1/4W	55-10101HK010
R48	Resistor, carbon, 120K, 5%, 1/4W	55-10101HK120
R49	Resistor, carbon, 8.2K, 5%, 1/4W	55-10101HK008R2
R50	Resistor, carbon, 10K, 10%, 1W	55-10103JK010
R51	Resistor, carbon, 12K, 5%, 1/4W	55-10101HK012
R52	Resistor, carbon, 220K, 5%, 1/4W	55-10101HK220
R53	Resistor, carbon, 1K, 5%, 1/4W	55-10101HK001
R54	Resistor, film, 9.9 meg, 0.1%, 1W	55-10165BJM009R9
R55	Resistor, film, 90K, 0.1%, 3/4W	55-10111BJK090
R56	Resistor, film, 9K, 0.1%, 3/4W	55-10111BJK009
R57	Resistor, film, 1K, 0.1%, 3/4W	55-10111BJK001
R59	Resistor, wire wound, 0.27Ω, 10%, 2W	55-10124JA000R27
SW1	Switch, rotary, FUNCTION	43-11733
SW2	Switch, rotary, RANGE	43-11734
Z1	Diode, zener, 2N2923	40-04233-03
Z2	Diode, zener, 2N4250	40-09952

MISCELLANEOUS

Description	Stock Number
Input Terminal, Red	50-09551-01
Input Terminal, Black	50-09551-02
Input Terminal, White	50-09551-04
Knob, switch	50-11049
Window, red plexiglass	32-11716
Knob, handle, knurled	26-11951
Washer, handle, curved spring	12-10542-02
Washer, handle, flat	12-10531-16
Ball, handle detent	21-11953
Spacer, handle	26-11950
Bumper, rubber	18-10581-03
Operators manual	MI-1284-1

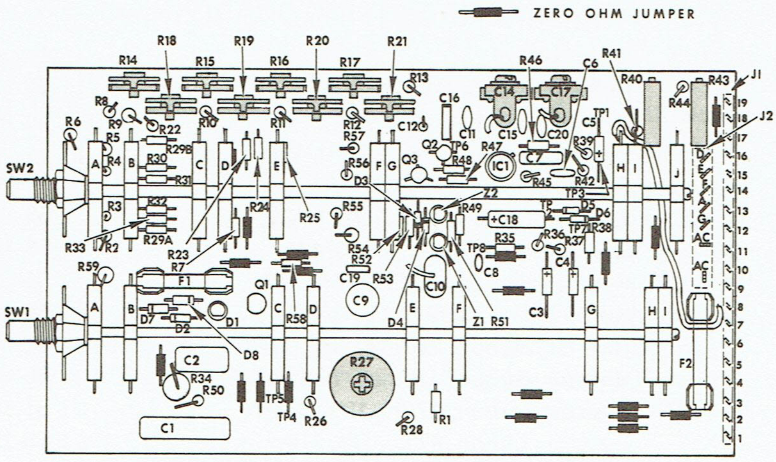


Figure 16
Signal Conditioning Board Component Location Diagram

PARTS LIST
ANALOG BOARD

Symbol	Description	Stock Number
C1, 2	Capacitor, Alum electrolytic 150mfd @ 2500V	56-13217F157N25
C4, 5	Capacitor, ceramic 47pf @ 1000V	56-10215A470KT10
C6, 13, 15	Capacitor, metallized polyester, .056mfd @ 2500V	56-13218D563J2R5
C7	Capacitor, metallized polyester 2.2mfd, ± 10% @ 100VDC	56-13218D225J1
C10	Capacitor, ceramic, .05mfd @ 600VDC	56-10215H503FT6
C11, 12	Capacitor, ceramic, .01 mfd @ 50VDC	56-10215B103KTR5
C14	Capacitor, tantalum, 2.2mfd, +50%-20%, @ 1600V	56-12731A225N16
C16	Capacitor, alum electrolytic 2200mfd @ 1000V	56-132176228N10
D1, 2	Diode, power, IN 40001	40-07787-01
D3, 4, 9, 10	Diode, 1/2 watt @ 25PIV	40-09297
D7	Diode, zener IN466A, 9.4V±2%	40-09069-01
D11, 12	Diode, zener, IN827A, 6.2V±2%	40-12364
IC1, 2	Integrated circuit, nor gate, Motorola MC717	40-09353
IC3	Integrated circuit, operational amplifier Fairchild 741C	40-12484
IC4	Integrated circuit, operational amplifier Fairchild 709C, Motorola MC1709CG	40-09280
R1, 2, 12	Resistor, carbon, 4.7K, 1/4 watt, 10%	55-10101JK004R7
R3	Resistor, wire wound, 1 watt, 1%, 596Ω	55-10121DDA596
R4	Resistor, molded metal firm, 3.16K, 1/4W 1%	55-13260ELK003R16
R5, 36, 37	Resistor, molded metal film, 10K, 1/4W, 1%	55-13260ELK010
R6, 10, 14, 20, 21, 30	Resistor, carbon, 10K, 1/4W, 10%	55-10101JK010
R7, 22	Resistor, molded metal film, 1/4W, 1%, 18.2K	55-13260EJK018R2
R8, 23	Resistor, variable, 2K, 1/2W	55-13261JK002
R9, 17	Resistor, wire wound, 1W, 1%, 1K	55-10121DDK001
R11	Resistor, carbon, 39K, 1/4W, 10%	55-10101JK039
R13	Resistor, carbon, 2.2K, 1/4W, 10%	55-10101JK002R2
R15	Resistor, carbon, 3.3K, 1/4W, 10%	55-10101JK003R3
R16	Resistor, carbon, 68Ω, 1/4W, 10%	55-10101JA068
R32	Resistor, carbon, 10Ω, 1/4W, 10%	55-10101JA010

ANALOG BOARD (cont.)

Symbol	Description	Stock Number
R33	Resistor, molded metal film, 3.09K, 1/4W, 1%	55-13260EJK003R09
R35	Resistor, carbon, 910K, 1/4W, 5%	55-10101HK910
R38	Resistor, carbon, 220Ω, 1/4W, 10%	55-10101JA220
R26, 29	Resistor, molded metal film, 1/4W, 1%, 18.7K	55-13260ELK018R7
R27, 45	Resistor, molded metal film, 1/4W, 1%,174Ω	55-10101JA390
R41, 43	Resistor, molded metal film, 1/4W, 1%, 52.3K	55-13260ELK052R3
R48	Resistor, wire wound, 2W, 10%, 2.2Ω	55-10124JA002R2
R49, 50	Resistor, carbon, 1/4W, 10%, 1.5K	55-10101JK001R5
R51	Resistor, molded metal film, 1/4W, 1%, 49.5K	55-13260ELK049R5
R52	Resistor, molded metal film, 1/4W, 1%, 500Ω	55-13260ELA500
R46, 47	Resistor, film 1/2W, 1%, 16.2K	55-10111ELK016R2
Q3, 4, 5, 12, 13, 15, 16	Transistor, special	40-04233-05
Q8, 9, 11	Transistor, signal PNP 2N4250	40-09952
Q10, 17, 18	Transistor, signal 2N4248	40-09437
Q14	Transistor, FET 2N5198	40-12930
T1	Transformer, power	42-13516
T2	Transformer, inverter	42-13451
	Pin Connector (12 pos)	51-13342

PARTS LIST
DISPLAY BOARD

Ref. Des.	Description	Stock Number
C1	Capacitor, ceramic, 2.2mfd @ 1600V	56-12731A225N16
C2, 6	Capacitor, ceramic, 500pfd @ 1000V	56-10215A501RT10
C3	Capacitor, ceramic, 0.01μfd @ 500V	56-10215B103KTR5
C5	Capacitor, ceramic, 0.003μfd @ 1000V	56-10215B302JE10
D2, 3	Diode, signal, in 4154 25V PIV	40-09297
IC1	Integrated circuit, 4 digit counter/display decoder	40-13188
LED 1	LED readout (+, -, 1)	40-12373
LED 2, 3, 4	LED readout (numerals)	40-12219
LED 5	LED diode	40-13268J
R1	Resistor, carbon, 2.2K, 1/4 watt, 10%	55-10101JK002R2
R2, 3, 4-10, 19, 20	Resistor, carbon 10Ω, 1/4 watt, 10%	55-10101JA010
R11, 21, 22, 23	Resistor, carbon, 1K, 1/4 watt, 10%	55-10101JK001
R13	Resistor, carbon, 12K, 1/4 watt, 10%	55-10101JK012
R15, 17	Resistor, molded metal film, 4.99K, 1%	55-10169ELK004R99
R16	Resistor, variable, 5K	55-13262JK005
R18	Resistor, molded, metal film, 2.1K, 1%	55-10169ELK002R1
Q1-4	Transistor, 2N5306	40-09277
Q5-15	Transistor, Special	40-11439

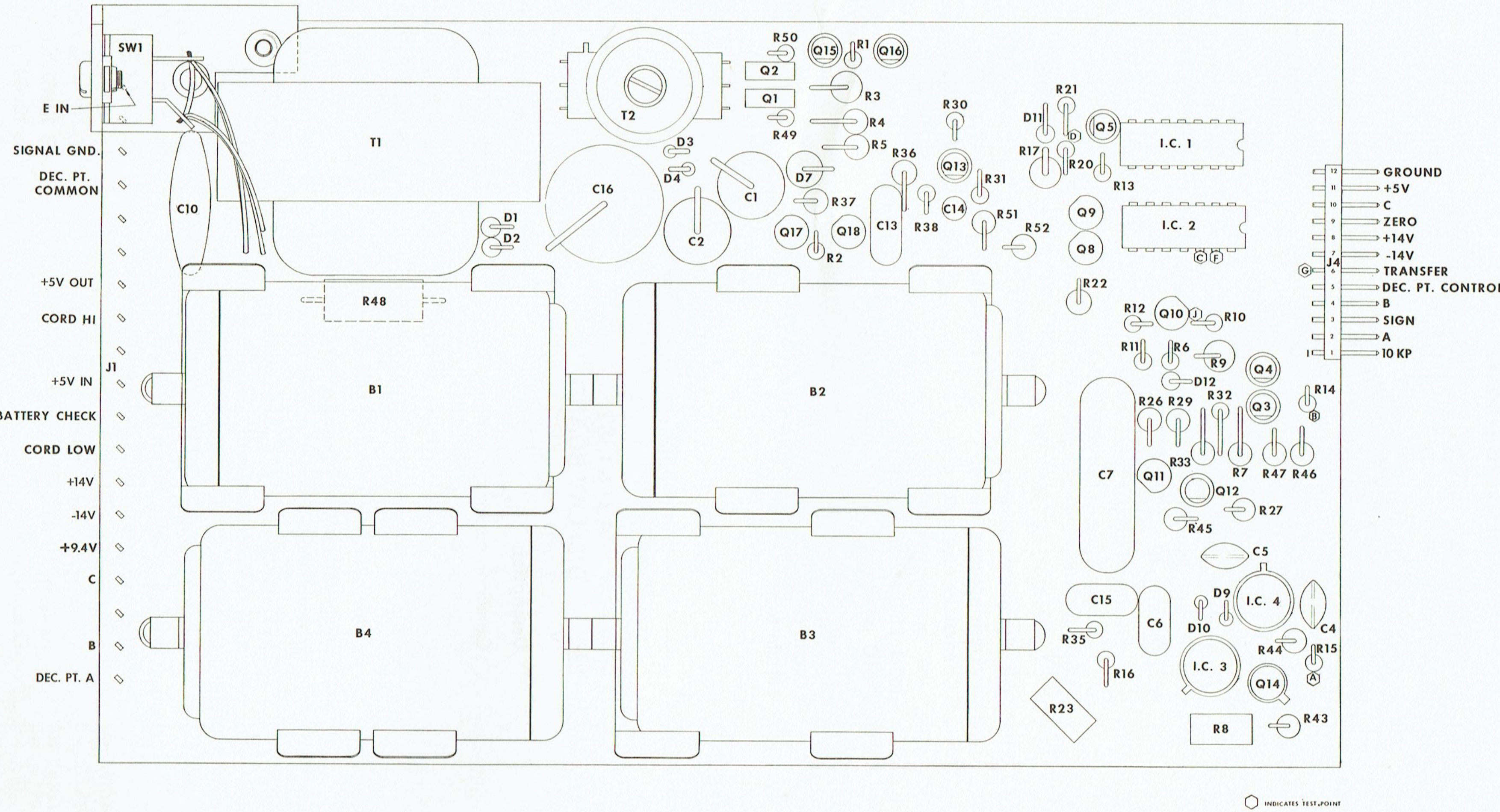


Figure 17
Component Location
Analog Board

MODEL 261C
DIGITAL VOLT-OHMETER

1. GENERAL INFORMATION

The DigiTec Model 216C is a digital volt-ohmeter which measures D.C. voltage and resistance, providing a digital display. The 261C employs dual slope integration. Consequently the analog board is identical to that of the Model 262C. The signal conditioning board of the 261C is also extremely similar to that of the 262C.

The operating instructions, circuit descriptions, and troubleshooting logic which pertain to the D.C. volts and ohms sections of the 262C also apply to the Model 261C.

1.1 Features

The outstanding features of these models are:

High accuracy	One hand operation
Three-and-a-half digit display	Metal Case
	Convenient carrying handle
Overload protection	Auto polarity
High input impedance	LED Display

Front panel zero adjustment

1.2 Technical Specifications

FUNCTION	RANGE	RESOLUTION	INPUT IMPEDANCE		ACCURACY	OVERLOAD PROTECTION
DC Volts	000 to ±.1999	100μV	11MΩ		±(.05% of Reading +.05% of Full Scale)	±1000VDC
	.000 to ±1.999	1mV				
	0.00 to ±19.99	10mV				
	00.0 to ±199.9	100mV				
	000. to ±1000.	1V			±(.1%R +.1%FS)	
			I TEST	OPEN CIRCUIT VOLTAGE		
Kilohms	000 to .1999	0.1Ω	1mA	+8.5VDC	±(.1%R +.1%FS)	±200VDC
	.000 to 1.999	1Ω	100μA	+3.5VDC		
	0.00 to 19.99	10Ω	10μA			
	00.0 to 199.9	100Ω	1μA			
	000. to 1999.	1000Ω	0.1μA		±(.2%R +.1%FS)	

Voltage Coefficient	5PPM/volt above 250 volts
Response Time	To rated accuracy: DC 0.7 seconds, Ω1.5 seconds average.
Reading Rate	Equal to power line frequency
Display	Three full digits, digit 1 indicator, illuminated minus sign, illuminated overrange indicator
Isolation	500VDC input low to power ground
Rejection	DC ranges, 60 Hz: Common Mode 100dB on .1999V range (drops 20dB for each successive range)
Operating Ambient	60° to 110°F
Power Requirements	105/125VAC, 50/60Hz, 7VA.
Weight (approximate) Model 261C	Net: 6 pounds. Shipping: 8 pounds.

2. CALIBRATION

To calibrate this instrument, remove the four screws on the top cover and remove the Cover. Calibration must be performed in the following sequence.

2.1 Necessary Calibration Equipment

A. DC voltage standard — Digitec Model 311 Precision Calibrator or equivalent (.01% Accuracy).
B. Resistance standard — Electro Scientific Industries Dekabox with 0 to 2 megohms at ±0.02% or equivalent.

2.2 DC Volts

A. Place the RANGE switch in the 200mV, Ω, μA position and the FUNCTION switch to DCV.
B. Short the input to ground and adjust the front panel ZERO control for a digital display of zero.
C. Apply +200.0mV to the input and adjust B23 for a digital display of 00.0 with the O/R indicator illuminated.
D. Apply -200.0mV to the input and adjust R8 for a digital display of 00.0 with the O/R indicator illuminated.
E. Adjust R200 for a digital display of 199.9mV.
F. Rotate the RANGE switch to the 2 volt range.
G. Apply +2.000 volts to the input.
H. Adjust R14 for a digital display of .000 with the O/R indicator illuminated.
I. Rotate the RANGE switch to the 20 volt range.
J. Apply 20.00 volts to the input.
K. Adjust R15 for a digital display of 0.00 with the O/R indicator illuminated.
L. Rotate the RANGE switch to the 200 volt range.
M. Apply +200.0 volts to the input.
N. Adjust R16 for a digital display of 00.0 with the O/R indicator illuminated.
O. Rotate the RANGE switch to the 1000 volt range.
P. Apply +1000. volts to the input.
Q. Adjust R17 for a digital display of 1000.

2.3 Ohms

A. Rotate the switch to the 2000K position.
B. Short the input leads Ω and COM and adjust the front panel ZERO control for a digital display of zero.
C. Apply 2 meg to the input and adjust R27 for a digital display of 000. with the O/R indicator illuminated.
D. Change the switch to the 200K position.
E. Repeat Step B.
F. Apply 200.0K ohms to the input and adjust R18 for a digital display of 00.0 with the O/R indicator illuminated.
G. Change the switch to the 20K position.
H. Repeat Step B.
I. Apply 20.00K ohms to the input and adjust R19 for a digital display of 0.00 with the O/R indicator illuminated.
J. Change the switch to the 2K position.
K. Repeat Step B
L. Apply 2.000K ohms to the input and adjust R20 for a digital display of .000 with the O/R indicator illuminated.
M. Change the switch to the 200 position.
N. Repeat Step B.
O. Apply 200 ohms, then 150, 100, and 20 to the input and adjust R21 for best overall accuracy.

SIGNAL CONDITIONING BOARD

Symbol	Description	Stock Number
C2	Capacitor, mylar, .1μfd at 200VDC	56-10205BYB104J2
D1	Diode, clipper	40-07199-02
D2	Diode, power, EM403	40-07787-03
F2	Fuse, slow blow, 1/8 amp. for 110VAC	52-09309-01 (110VAC)
	1/16 amp. for 220VAC	52-09309-08 (220VAC)
J1, 2	Connector, individual, bisexual pins	51-11736
Q1	Transistor, pair, special	40-11039
R1, 7	Resistor, carbon, 1 meg, 5%, 1/4W	55-10101HM001
R8	Resistor, film, 499K, 1%, 3/4W	55-10111ELK499
R9	Resistor, film, 9.99 meg, 0.5%, 1W	55-10165DJM009R99
R10, 22	Resistor, film, 1 meg, 0.5%, 3/4W	55-10111DJM001
R11	Resistor, film, 100K, 0.5%, 3/4W	55-10111DJK100
R12	Resistor, film, 10K, 0.5%, 3/4W	55-10111DJK010
R13	Resistor, film, 1.111K, 0.1%, 3/4W	55-10111BJK001R111
R14, 18	Resistor, variable, 100K, 20%, 1/4W	55-10162KK100
R15, 19	Resistor, variable, 10K, 20%, 1/4W	55-10162KK010
R16, 20	Resistor, variable, 1K, 20%, 1/4W	55-10162KK001
R17, 21	Resistor, variable, 150Ω, 20%, 1/4W	55-10162KA150
R23, 24, 25	Resistor, carbon, 910K, 5%, 1/4W	55-10101HK910
R26	Resistor, film, 30.1K, 1%, 3/4W	55-10111ELK030R1
R27	Resistor, variable, 800Ω, 20%, 1W	55-10151KA800
R28	Resistor, film, 3.92K, 1%, 3/4W	55-10111ELK003R92
R29A, B	Resistor, carbon, 22 meg, 10%, 1/4W	55-10101JM022
R30	Resistor, carbon, 4.7 meg, 10%, 1/4W	55-10101JM004R7
R31	Resistor, carbon, 470K, 10%, 1/4W	55-10101JK470
R32	Resistor, carbon, 47K, 10%, 1/4W	55-10101JK047
R33	Resistor, carbon, 4.7K, 10%, 1/4W	55-10101JK004R7
R34	Resistor, wire, 5K, 5%, 5W	55-10123HLK005
SW1	Switch, rotary	

MISCELLANEOUS

Description	Stock Number
Input Terminal, Red	50-09551-01
Input Terminal, Black	50-09551-02
Input Terminal, White	50-09551-04
Knob, switch	50-11049
Window, red plexiglass	32-11716
Cap, handle, knurled	26-11951
Washer, handle, curved spring	12-10542-02
Washer, handle, flat	12-10531-16
Ball, handle detent	21-11953
Spacer, handle	26-11950
Bumper, rubber	18-10581-03

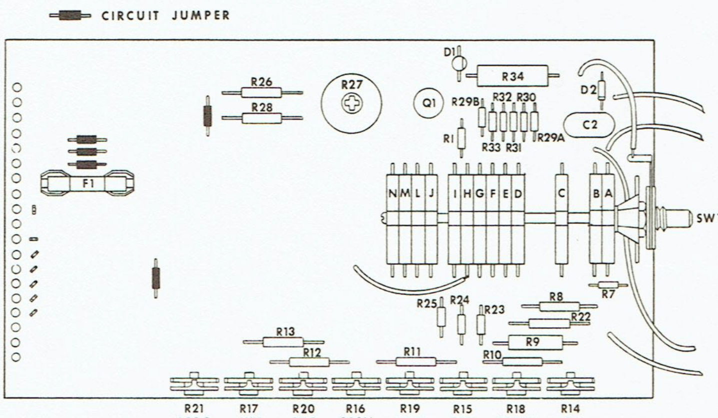


Figure 18
Signal Conditioning Board Component Location Diagram

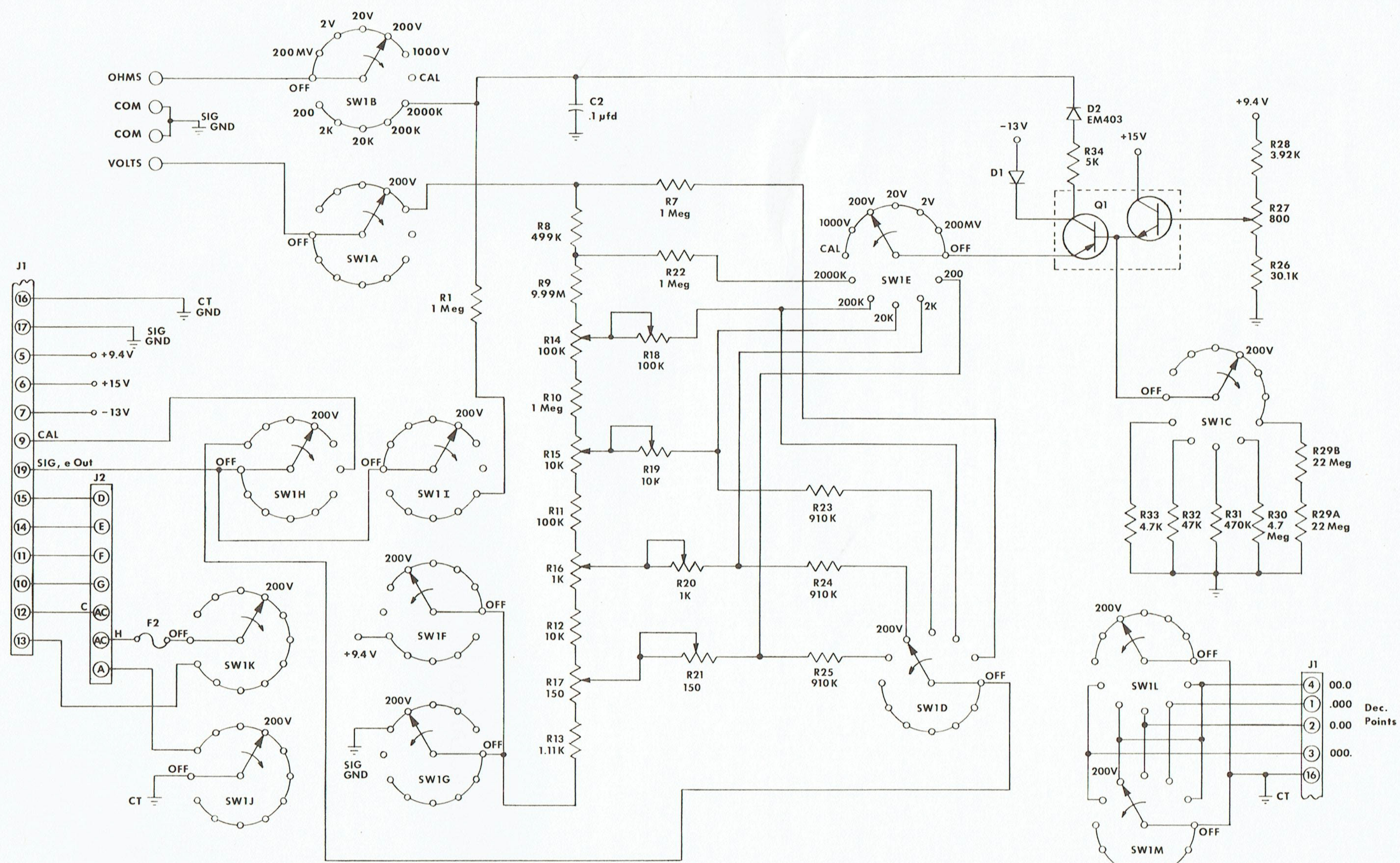
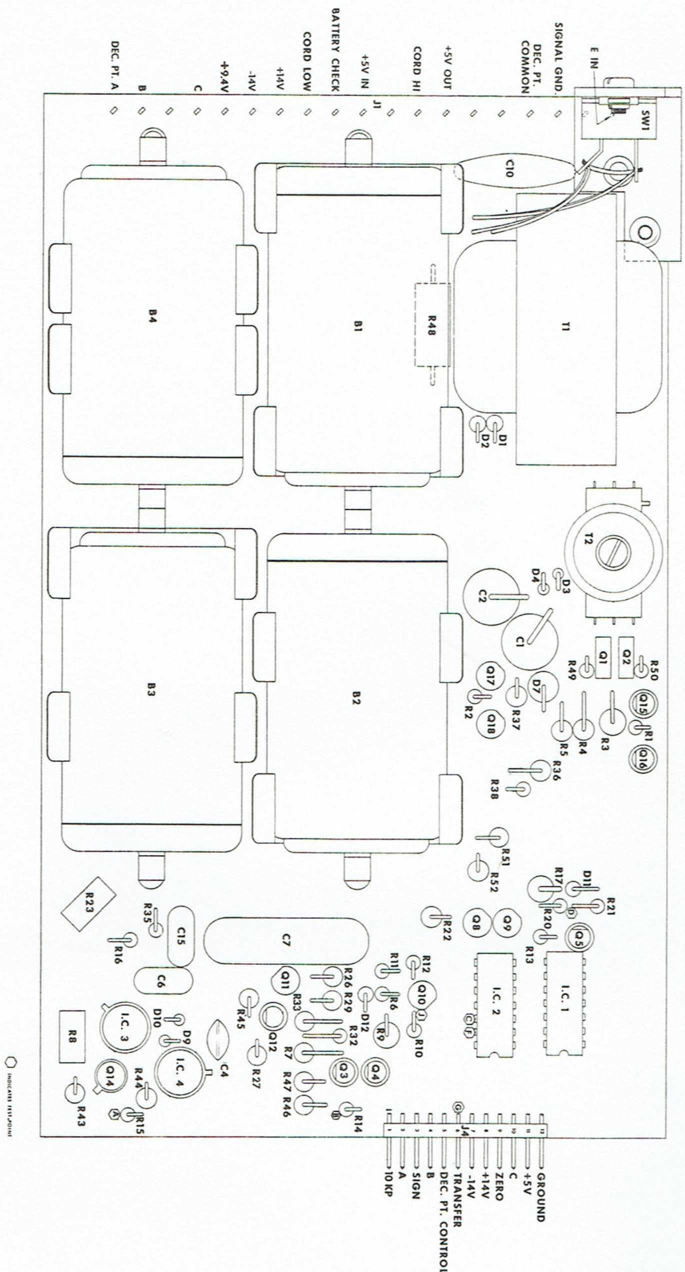
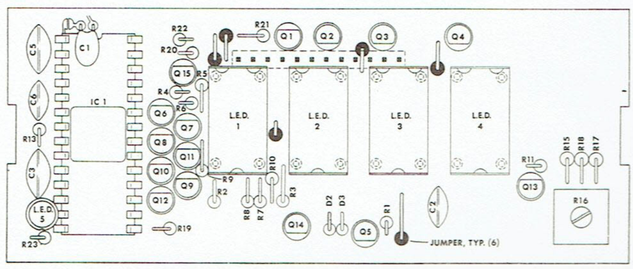


Figure 19
Signal Conditioning Board Schematic

ANALOG BOARD



DISPLAY BOARD



Component Location
Analog Board and Display Board

Manufactured by

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