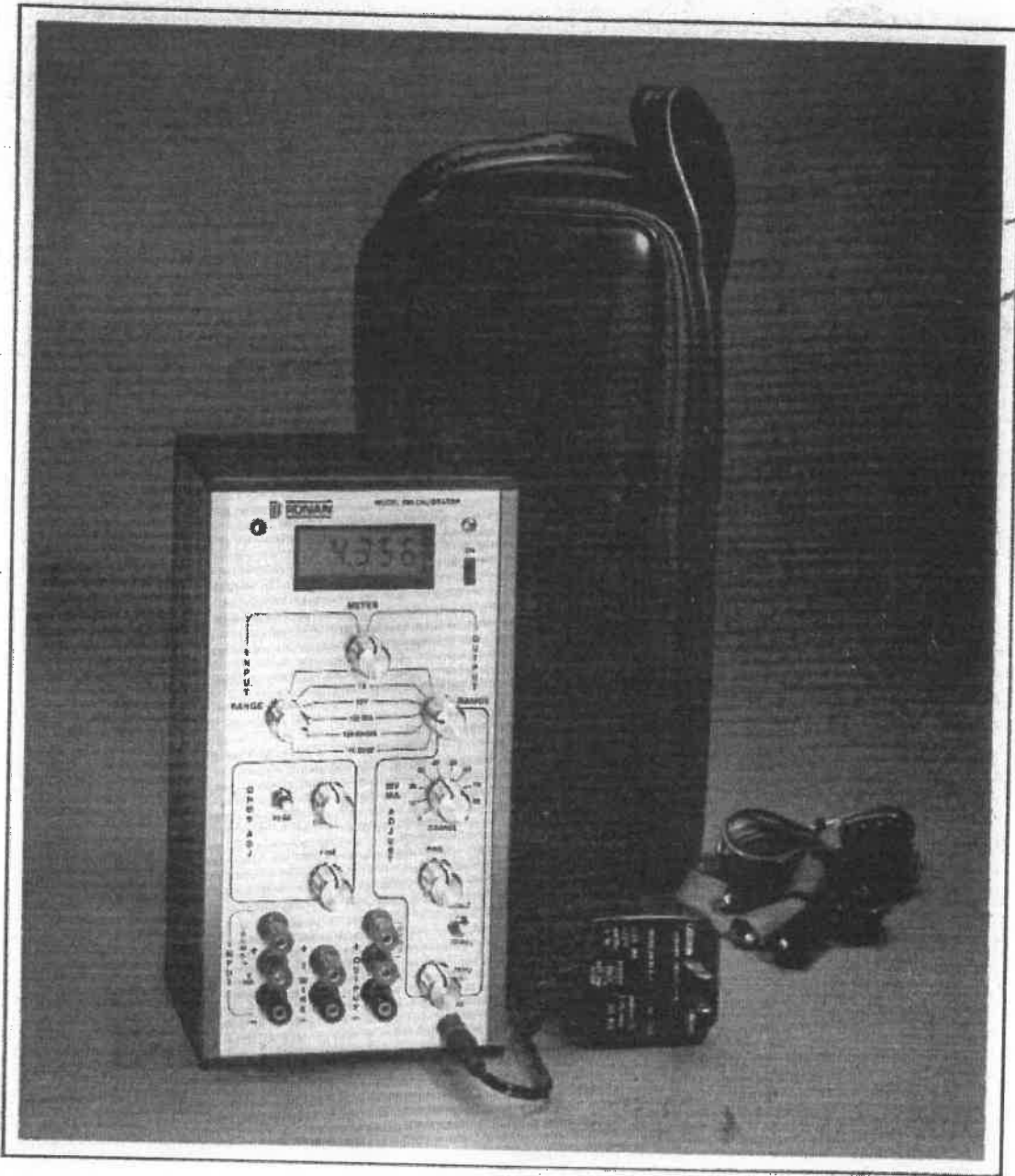


Instruction and Operating Manual Model X85 Calibrator



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1.0 INTRODUCTION

The Ronan Model X85 Calibrator is a versatile, portable instrument developed to calibrate instruments and systems utilizing current, voltage or ohms inputs and outputs. In addition to the usual mA and volts ranges, the Model X85 has a resistance capability that permits calibration and measuring of Resistance Temperature Detecting (RTD) systems. Input and output variables can be measured with a resolution of 0.01% of range by the Integral 4½ digit meter featuring a liquid crystal display. A meter input/output switch gives the calibrator the capability of monitoring an input variable while simultaneously supplying a preset, calibrated output signal—a feature facilitating the calibration of signal transmitters. High input-output isolation is maintained while the digital meter is monitoring either input or output variables through the use of isolated floating power supplies. The input terminals are protected against overvoltages of up to 200VDC or peak AC. The highly efficient designs utilized in the Model X85 provide long operating life between charges of the small, light-weight nickel cadmium battery.

The Model X85 provides a set of "2 wire" terminals that allow it to accurately simulate a 2-wire transmitter in a voltage-powered current loop.

2.0 SPECIFICATIONS

INPUT

Voltage, mA or ohms

INPUT IMPEDANCE

Voltage Input: 10 megohms

Current Input: 10 ohms

Ohms Input: 1 mA from internal current source

INPUT/OUTPUT RANGES

0 to 100mV,	10 uV resolution
0 to 1V,	0.1 mV resolution
0 to 10V,	1mV resolution
0 to 100 mA,	10 uA resolution
0 to 100 ohms,	.01 ohm resolution
0 to 1 kohm,	0.1 ohm resolution

ACCURACY

Voltage Input/Output ranges:	± 0.05% of range
100 mA Output:	± 0.05% of range, 0 to 60 mA
100 mA Input:	± 0.05% of range
100 ohms In/Out:	± 0.07% of range
1 kohm In/Out:	± 0.05% of range

High accuracy internal meter provides input and output readings within stated accuracies.

OUTPUT IMPEDANCE

Voltage Outputs: less than 5 ohms
Current Outputs: greater than 1 megohm

2-WIRE TRANSMITTER OUTPUT

Maximum supply voltage: 40VDC
Maximum load resistance at 24VDC supply and 20 mA signal: 1000 ohms
Accuracy: 0.1% of range

TEMPERATURE EFFECTS

$\pm 0.005\%$ reading, $\pm 0.002\%$ full scale/ $^{\circ}\text{C}$

RECOMMENDED OPERATING TEMPERATURE

0 to $+50^{\circ}\text{C}$

INPUT/OUTPUT ISOLATION

Up to 300 VRMS isolation provided between input and output on voltage and mA ranges.

WARM-UP TO RATED ACCURACY

30 sec.

POWER REQUIREMENTS

Single, internal 6V rechargeable nickel cadmium battery. Battery charger operates from AC line, 115VAC, 60 Hz (standard) or 220VAC, 50 Hz (optional).

BATTERY LIFE

Greater than 10 hours for mV, volts and ohms input/output ranges and mA input range. Greater than 4 hours on mA range with 20 mA continuous output.

LOW BATTERY INDICATION

"←" on display indicates battery needs recharging.

RECHARGE TIME

14 hours

WEIGHT

3 lbs., 15 oz. (1.79 kg.)

SIZE

8.375" (21.27cm.) high by 4.375" (11.11 cm.) wide by 3.5" (8.89 cm.) deep.

AREA USE CLASSIFICATION

Designed for Class 1, Division 2, Group D locations.

3.0 OPERATION

3.1 OPERATING CONTROLS

Refer to Figure 3-1 for the operating control locations.

Marking

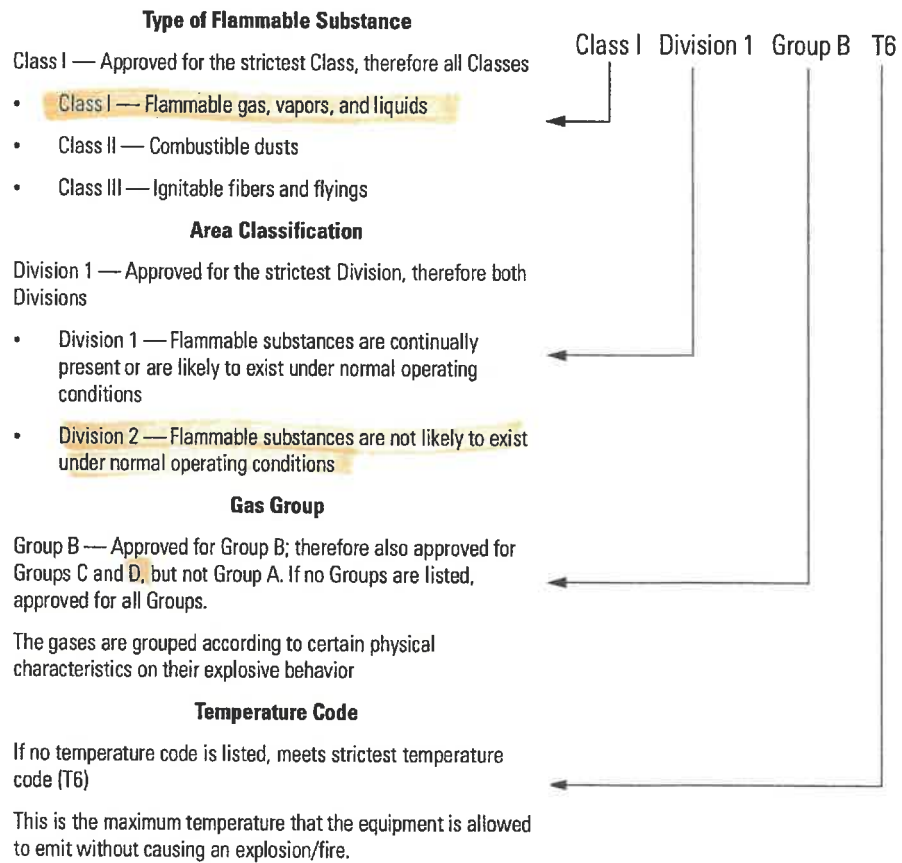
The rules for marking the electrical equipment are uniformly laid down in the standards relating to general technical requirements. The equipment must be distinctively marked in accordance to the classified area in which it can be installed.

The minimal marking must indicate the following:

- Class
- Division
- Group
- The maximum safe operating temperature or temperature range, based on a 40°C ambient.
- Any special conditions that have to be observed (such as NEC section 500-5(d))

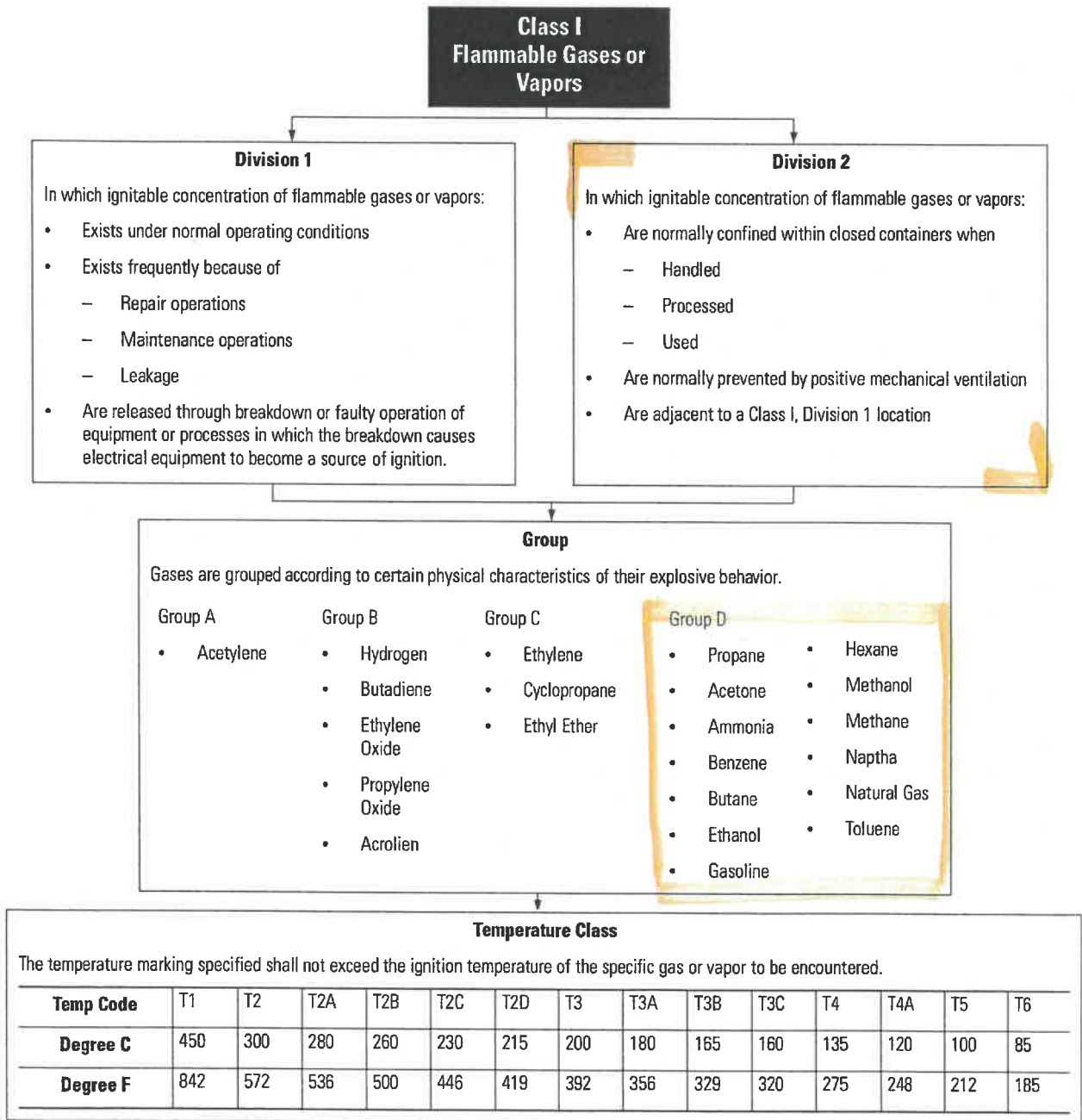
Execution to NEC/CEC Standards

Figure 4.



Hazardous (Classified) Locations in Accordance with Article 500, NEC - 1990

Figure 5. Class I Diagram



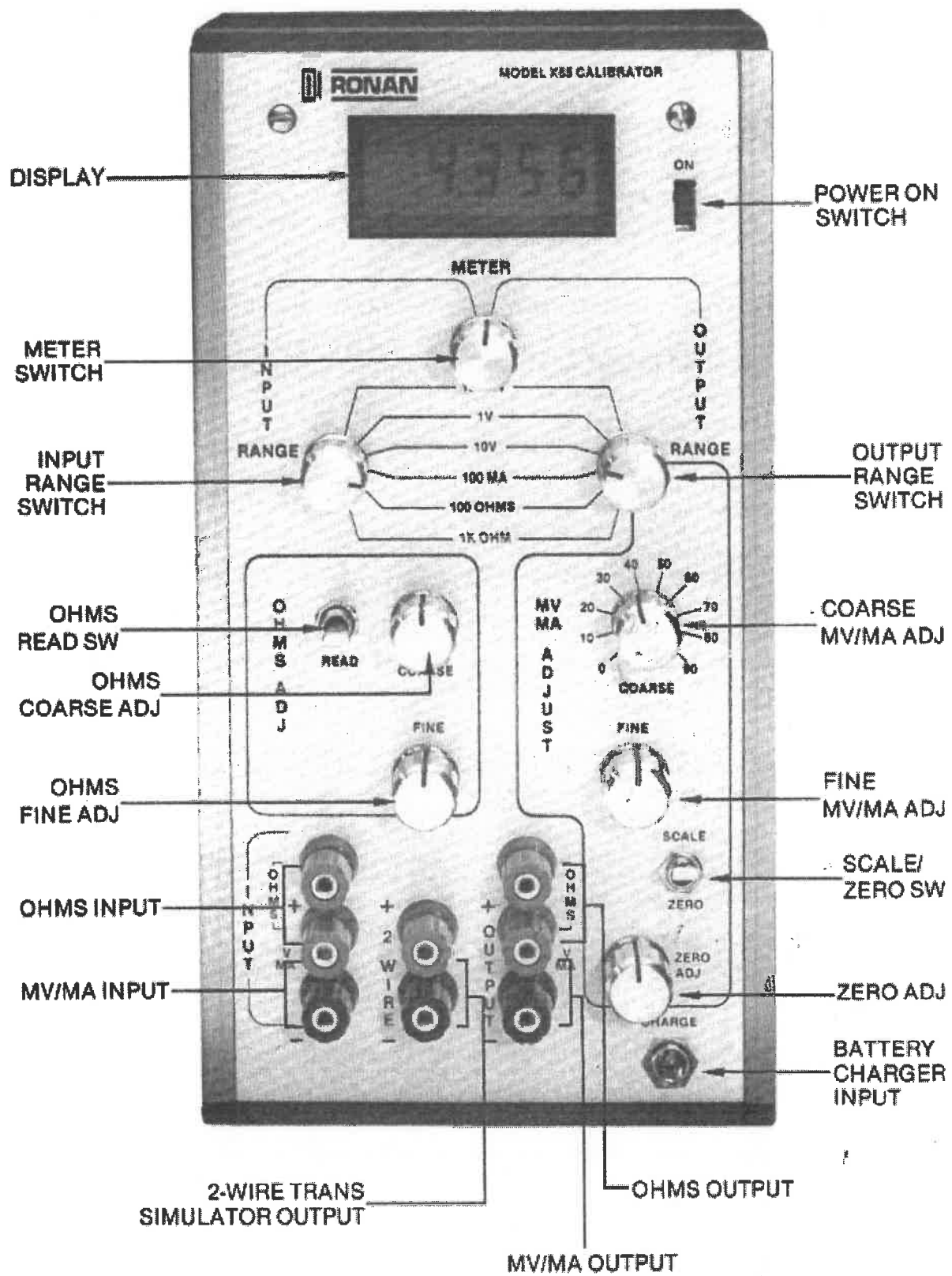


FIGURE 3-1 OPERATING CONTROLS

3.1.1 POWER ON SWITCH

Connects internal nickel cadmium battery to instrument circuits.

3.1.2 METER SWITCH

Two position switch selects either input or output variables for display on the internal digital meter.

3.1.3 INPUT RANGE SWITCH

Six position switch selects input range of measured variable. The METER switch must be in the input position to measure the input variable. A set of input binding posts is provided to connect variables to be measured. A separate set of output terminals is provided for settable output variables. The instrument can provide a previously set output variable at the output terminals while simultaneously measuring a signal at the input terminals.

- a) 100mV: Measures DC voltages in the range of 0 to + 100 mV with 10 micro-volt resolution.
- b) 1V: Measures DC voltages in the range of 0 to + 1V with 100 microvolt resolution.
- c) 10V: Measures DC voltages in the range of 0 to + 10V with 1 millivolt resolution.
- d) 100mA: Measures DC current in the range of 0 to 100mA with 10 microamp resolution.
- e) 100 ohms: Measures resistances in the range of 0 to 100 ohms with 10 micro-ohm resolution.
- f) 1kohm: Measures resistances in the range of 0 to 1000 ohms with 0.1 ohm resolution.

NOTE: The meter will measure accurately to 110% of the above ranges. However, do not use above 110% of range as the meter readout is subject to substantial errors. The meter will also indicate small negative inputs, (up to about 4% of range) so there is no discontinuity at zero.

3.1.4 OUTPUT RANGE SWITCH

Six position switch selects output range of selected variable. The METER switch must be in the OUTPUT position to measure the output, though the output will be maintained at the output terminals when the METER switch is in the INPUT position.

- a) 100 mV: Outputs DC voltages in the range of 0 to + 100mV with 10 microvolt resolution.
 - b) 1V: Outputs DC voltages in the range of 0 to 1 volt with 100 microvolt resolution.
 - c) 10V: Outputs DC voltages in the range of 0 to 10 volts with 1 millivolt resolution.
 - d) 100mA: Outputs DC current in the range of 0 to 60mA with 10 microamp resolution.
 - e) 100 ohms: Outputs resistance in the range of 0 to 100 ohms with 10 micro-ohm resolution.
 - f) 1kohm: Outputs resistance in the range of 0 to 1kohm with 0.1 ohm resolution.
- See OHMS ADJ section for ohms output calibration procedure.

3.1.5 OHMS ADJ, COARSE AND FINE CONTROLS AND READ SWITCH

These controls are used to set the output resistance in either the 100 OHMS or 1KOHM output mode. An isolated, passive resistor is internally connected across the OHMS output terminals. To read the value of this resistance, and adjust it, the METER switch must be in the INPUT position, and input RANGE switch must be in either the 100 or 1KOHM position and the momentary OHMS READ switch must be depressed. The resistor value will now be displayed on the meter and can be adjusted using the 10 turn COARSE and FINE controls. When the READ switch is released the resistor will be switched back to the OHMS output terminals.

CAUTION: If an input is connected, the + input must be removed from the calibrator while depressing the READ switch to measure the ohms output.

3.1.6 MV, MA ADJUST

This section contains the controls used for adjusting the voltage and current output values at the OUTPUT "+" and "-" binding posts.

- a) COARSE Select Switch: Ten position switch selects output values in increments of 10% of range.
- b) FINE Adj: Provides for fine adjustments of output between steps of the COARSE select switch.
- c) SCALE-ZERO Switch: Allows selection of either of two output settings at the output "+" and "-" binding posts. In the SCALE position the output as set on the COARSE and FINE controls is switched to the OUTPUT binding posts. In the ZERO position the output as set on the ZERO ADJ control is switched to the output binding posts.
- d) ZERO ADJ: Ten turn potentiometer allows setting an independent "zero" value in the range of zero to ten percent of output range.

3.1.7 INPUT/OUTPUT BINDING POSTS

Three binding posts are provided for applying input variables. A red "+" post and a black "-" post are provided to accept voltage and current inputs. A third red post and the red "+" post (ohms) are used to connect resistances to be measured. Three output posts corresponding to the three described above are provided to output voltage, current and ohms. An additional pair of posts labeled "2-WIRE" are used when the calibrator is to simulate a two-wire transmitter. When used as a two-wire transmitter, the OUTPUT RANGE switch must be in the 100MA position.

3.1.8 CHARGE CONNECTOR

Receptacle for battery charger input.

3.2 THERMOCOUPLE INPUTS

The Model X85 can be used to measure thermocouples by using one of the following procedures:

3.2.1 EXTERNAL REFERENCE JUNCTION

Connect the thermocouple to be measured, reference junction and Model X85 calibrator as shown in Figure 3-2, a or b.

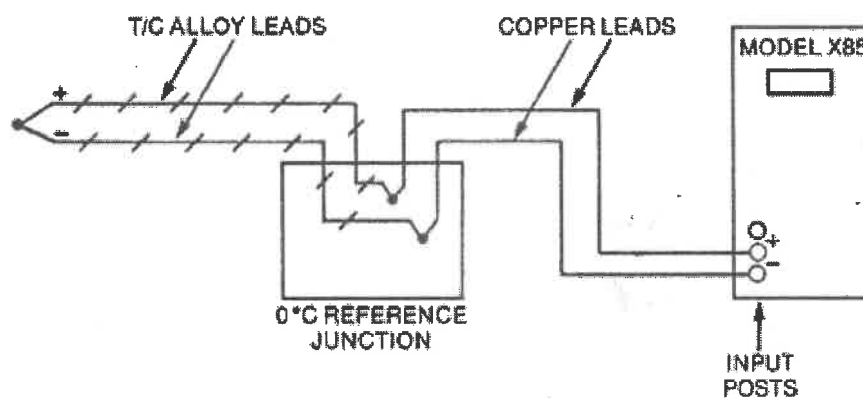


FIGURE 3-2,a

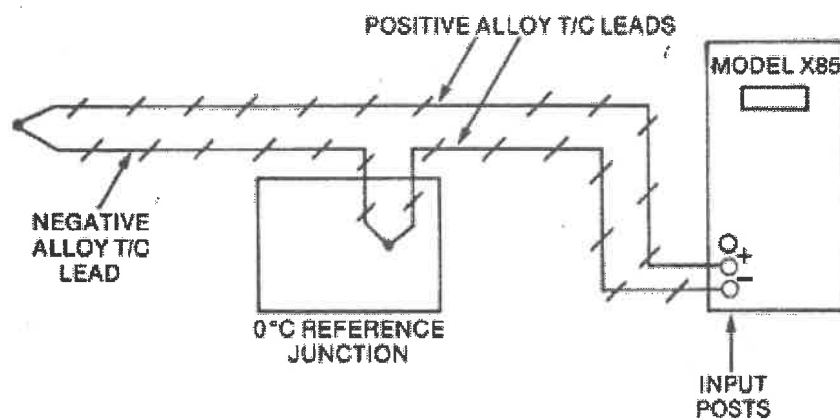


FIGURE 3-2,b

THERMOCOUPLE MEASUREMENTS USING EXTERNAL REFERENCE JUNCTION.

3.2.1.1 Set the METER switch to the INPUT position.

3.2.1.2 Set the INPUT RANGE switch to the 100MV position.

3.2.1.3 Connect the copper or T/C alloy leads from the reference junctions to the V "+" and "-" INPUT posts. For temperatures above 0°C, connect the lead that originates at the T/C positive alloy to the "+" input terminal, the lead originating from the negative polarity alloy (RED) to the input "-" terminal. The T/C voltage is now displayed on the digital meter in mV. The mV reading can now be converted to temperature by consulting the T/C tables. If there is a minus polarity indication on the meter, either the temperature of the T/C is below 0°C or the leads are reversed. In either case, reverse the leads so that a positive reading is obtained on the display. The meter will indicate negative values but is accurate only for positive readings.

3.2.2 DIRECT T/C CONNECTION TO CALIBRATOR

A T/C may be connected directly to the Model X85 calibrator as shown in Figure 3-3.

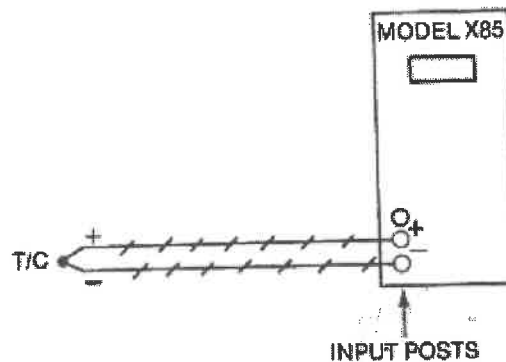


FIGURE 3-3
DIRECT CONNECTION OF T/C TO X85 CALIBRATOR

When this setup is used there is a T/C junction at the binding post of the calibrator which opposes the output of the T/C junctions to be measured. To find the correct "hot" junction temperature this opposition voltage must be determined and added to the voltage indicated on the digital readout.

3.2.2.1 Set the METER Switch to the INPUT position.

3.2.2.2 Set the INPUT RANGE switch to the 100MV position.

3.2.2.3 Connect the T/C positive alloy lead to the "+" INPUT binding post. Connect the T/C negative (RED) alloy lead to the "-" INPUT binding post.

3.2.2.4 Measure with a thermometer the temperature at the INPUT binding posts. (This should be the same as the ambient temperature surrounding the Model X85).

3.2.2.5 Using the T/C tables, look up the MV output for the kind of T/C used at the temperature measured in Step 3.2.2.4. Observe the MV reading on the display and add the MV from the tables to the value on the display.

3.2.2.6 Look up in the T/C tables the total value found in Step 3.2.2.5. The corresponding temperature from the tables is the temperature of the measured T/C.

3.3 THERMOCOUPLE SIMULATION

3.3.1 EXTERNAL REFERENCE JUNCTION

If an external reference junction is to be used, connect the Model X85 and the reference junctions as shown in Figure 3-4.

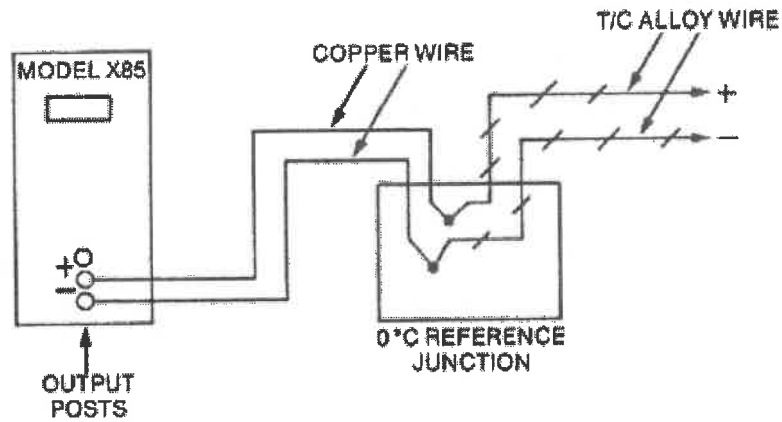


FIGURE 3-4
THERMOCOUPLE SIMULATION USING EXTERNAL REFERENCE JUNCTION

3.3.1.1 Set the METER switch to the output position.

3.3.1.2 Set the OUTPUT RANGE switch to the 100MV position.

3.3.1.3 Set the SCALE-ZERO switch to the SCALE position and adjust the COARSE and FINE output control to the mV value given in the T/C tables for the temperature to be simulated.

NOTE: If the instrument or system to be calibrated, uses an external reference junction to read the T/C inputs, then neither reference junction is required and copper wire can be connected directly between the two. The T/C voltage can be directly set as in Steps 3.3.1.1 through 3.3.1.3.

3.3.2 THERMOCOUPLE SIMULATION WITHOUT USE OF EXTERNAL REFERENCE JUNCTION
Connect the Model X85 to the instrument or system being calibrated as shown in Figure 3.5.

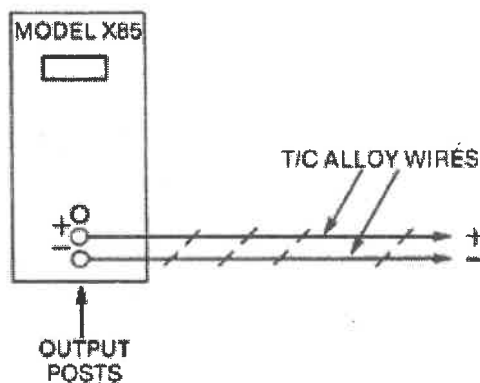


FIGURE 3-5
THERMOCOUPLE SIMULATION USING DIRECT CONNECTION

3.3.2.1 Set the METER switch to the output position.

3.3.2.2 Set the OUTPUT RANGE switch to the 100MV position.

3.3.2.3 Set the SCALE-ZERO switch to the SCALE position.

- 3.3.2.4 Measure the ambient temperature at the X85 output terminals and lookup in the T/C tables the mV of the T/C being simulated at the ambient temperature measured. (This is an error voltage that is added to the internal voltage generated by the calibrator.
- 3.3.2.5 Look up in the T/C tables the mV output of the T/C at the temperature to be simulated. Subtract the MV value found in Step 3.3.2.4 from this value.
- 3.3.2.6 Using the COARSE and FINE output controls, set the answer found in Step 3.3.2.5 on the digital read-out. If the answer in Step 3.3.2.5 was negative, reverse the output leads and set the value up as a positive value on the readout.

3.4 2-WIRE TRANSMITTER SIMULATOR

Terminals are provided for 2-wire transmitter simulation. The calibrator is connected to the system to be calibrated as shown in Figure 3-6:

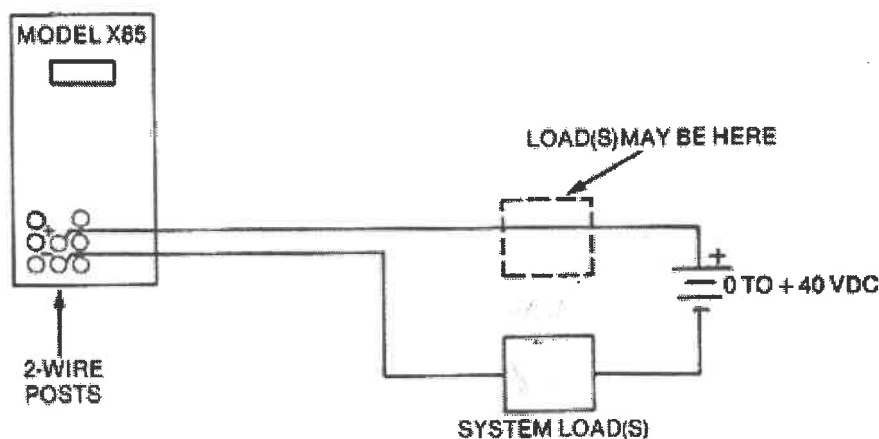


FIGURE 3-6
2-WIRE TRANSMITTER SIMULATION

- 3.4.1 Set the METER switch to the OUTPUT position.
- 3.4.2 Set the OUTPUT RANGE switch to the 100MA position.
- 3.4.3 Set the SCALE-ZERO switch to the SCALE position.
- 3.4.4 Connect the external current loop to the 2-wire output posts observing polarity as shown in Figure 3-6.
- 3.4.5 Adjust the COARSE and FINE output controls for the required calibration current.

NOTE: If there is to be repeated calibration between two current levels, the lower current may be adjusted on the ZERO ADJ control and the higher current level may be set up as above. The SCALE-ZERO switch then allows convenient and fast switching between the two current levels.

3.5 TRANSMITTER CALIBRATION

A transmitter with either mV, mA or RTD inputs and mA or V output can be calibrated with the test configurations shown in figure 3-7. The output of the transmitter can be measured while it is receiving a calibration signal from the Model X85.

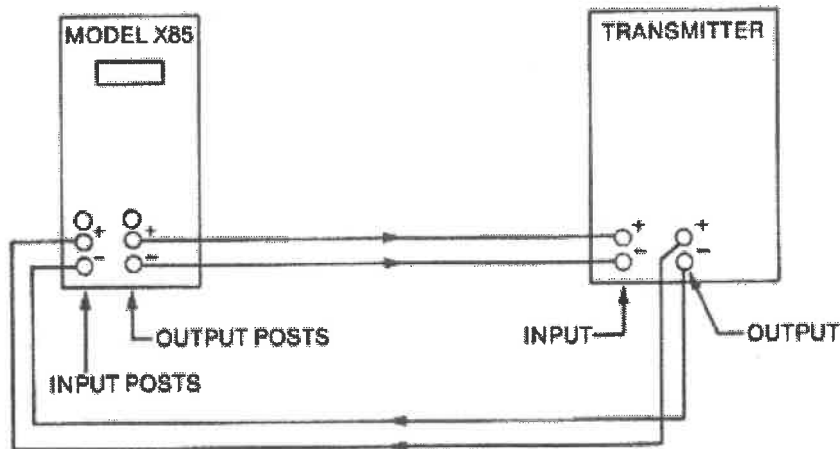


FIGURE 3-7
TRANSMITTER CALIBRATION

- 3.5.1 Set the METER switch to the OUTPUT position.
- 3.5.2 Set the OUTPUT RANGE switch to the input variable required by the transmitter to be calibrated.
- 3.5.3 Set the INPUT RANGE switch to the range corresponding to the output of the transmitter.
- 3.5.4 Set the SCALE-ZERO switch to the SCALE position.
- 3.5.5 Connect from the appropriate OUTPUT posts on the calibrator to the input terminals of the transmitter.
- 3.5.6 Connect from the transmitter output to the V, MA INPUT posts on the calibrator.
- 3.5.7 Adjust the COARSE and FINE output controls for the required calibration value. (For ohms output see the OHMS ADJ section 3.1.5 for the output calibration procedure).
- 3.5.8 Set the METER switch to the INPUT position. The transmitter output, corresponding to the calibrated input level from the calibrator, is now displayed on the digital indicator.

NOTE: If there are to be repeated calibrations between two calibration levels, the lower level (0 to 10% of range) may be adjusted on the ZERO ADJ control and the higher calibration level may be set up on the COARSE and FINE controls. The SCALE-ZERO switch then allows convenient and fast switching between the two levels.

3.6 OHMS MEASUREMENT

- 3.6.1 Set the METER switch to the INPUT position. Set the INPUT RANGE switch to either the 100 OHM or 1K OHM position.
- 3.6.2 If the calibrator test leads are going to be used, short the ends together and observe the reading on the DPM. (Typically .2 ohms). The test lead resistance should then be subtracted from the total OHMs reading when the unknown resistance is measured. When resistance temperature detectors, (RTD's) are measured, their leads can be a significant percentage of the RTD value. For accurate RTD measurements, the lead resistance should be eliminated, measured, or calculated and subtracted from the total measurement.

3.7 DIRECT OUTPUT LOOP CURRENT MEASUREMENT

The Model X85 indirectly measures the output current when the METER switch is in the OUTPUT position and the OUTPUT RANGE switch is in the 100 MA position. The DPM indicates the current that flows, or would flow, if a current loop is closed from the OUTPUT + to OUTPUT - binding post. To directly measure the current in the loop, (DPM indicates 00.00 MA if loop is open), connect the calibrator into the current loop as shown in Figure 3-8.

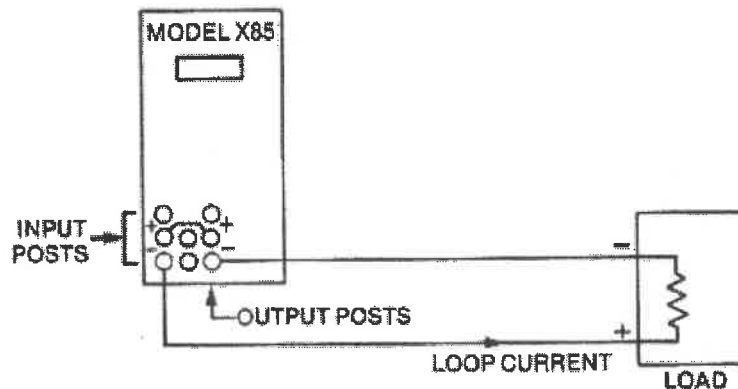


FIGURE 3-8
DIRECT OUTPUT LOOP CURRENT MEASUREMENT

- 3.7.1 Set the METER switch to the INPUT position. Set both the INPUT and OUTPUT RANGE switches to the 100 MA position. The loop current is now directly monitored by the calibrator and is settable with the MA ADJUST controls.

3.8 CIRCUIT PROTECTION

The V and OHMS input ranges to the Model X85 calibrator are protected against overvoltages up to ± 200 VDC or peak AC. The input circuits are designed to withstand ± 200 V without the use of fuses. The 100 mA input range will withstand overrange currents up to 240 mA. Input currents above 240 mA can cause damage to an internal current sense resistor. (A voltage source capable of supplying 240 mA will produce this current at 2.4V output).

The voltage output ranges are fuse protected against the application of high voltage to the output terminals. This fuse is rated at 125 MA and is located on the FUNCTION SWITCH board. In the 2-wire transmitter simulation mode the output circuits are not fuse protected but are protected against the application of a reverse DC voltage to the 2-wire terminals. The voltage powering a 2-wire current loop that is to be calibrated should be limited to 40 VDC to avoid possible damage to the calibrator. When the OUTPUT RANGE switch is in the 100 mA position, the OUTPUT + post is connected directly to an internal positive power supply. Avoid connecting the OUTPUT + post, either directly or through a low resistance, to the UPPER OHMS input post or to the 2-wire " - " output post. If these posts are connected together, an internal fuse, F1 on the power supply board will blow.

3.9 RECHARGEABLE BATTERY

The Model X85 calibrator is powered by a rechargeable nickel cadmium battery. The battery voltage ranges from 6.5 to 7.5 volts at full charge to about 5.5V at the minimum value before recharging. With proper care, the battery can be expected to last for years.

3.9.1 RECHARGING

WARNING: DO NOT CHARGE IN HAZARDOUS AREAS.

A wall receptable plug-in battery recharger is supplied with the calibrator. The plug on the end of the charger cord is inserted into the receptacle labeled "CHARGE" on the calibrator front panel. A charge time of 14 to 16 hours is recommended to fully charge the battery. Moderate overcharging, for example an extra 24 hours occasionally, should not harm the battery. Care should be taken so as not to leave the instrument recharging for long periods of time.

CAUTION: Use only the recharger supplied with the instrument, the use of another charging system may cause catastrophic damage to the battery.

An internal circuit detects when the battery needs to be recharged and indicates this with a symbol (—) on the upper left corner of the display. When this symbol appears, the calibrator should be recharged immediately. Possible cell damage can occur if the battery is allowed to discharge much beyond this. If the calibrator is inadvertently left on for long periods of time and deeply discharged, the following steps should be taken to ascertain if it has undergone an uncorrectable "cell reversal". First, charge the battery for at least 20 hours. Measure the battery voltage with an accurate DVM as follows. See the OUTPUT RANGE switch to the 10V position. Connect the DVM " — " input to the OUTPUT " — " terminal. Carefully touch the DVM " + " input lead to the inside of the CHARGE receptacle. The DVM should indicate more than 6.2V. If the reading on the DVM is below 6.2V, repeat the charge cycle and re-measure the battery. If the voltage is still below 6.2V the battery must be replaced.

CAUTION: Do not short the center pin of the receptacle to the outer shell as this will place a short circuit across the battery.

The battery should not be consistently recharged after only a shallow discharge as it has a discharge cycle memory and will eventually not be able to provide its rated capacity. Occasional shallow discharges or random depth discharges are allowable as long as there are frequent deep discharges and full charge cycles.

4.0 CIRCUIT DESCRIPTION

4.1 GENERAL (Drawing X85-1005)

The major functional blocks of the Model X85 are a 4 1/2 digit meter, a power supply circuit, an output voltage amplifier and an output current amplifier. The digital meter is switched to measure input variables or output variables. The ohms output capability is a passive resistor consisting of two potentiometers that are across the OHMS output terminals.

The circuits are contained on five printed circuit boards including a display board for the digital panel meter. All of the circuits are mounted to the front panel and remain functional when the top cover is removed and the front panel and circuit boards are taken out of the enclosure. Calibration adjustment controls are easily accessible from the back when the circuitry is removed from the enclosure.

4.2 INPUT CIRCUITS (Schematics X85-1000 and X85-1003)

Figures 4-1 a, b, and c are block diagrams of the input measuring circuit in the voltage, current and ohms measuring modes of operation. Volts and mV are applied directly to the DPM measuring circuit. Scaling is accomplished by the input range switch, deck S2-C, in the DPM circuitry. The meter buffer amplifier is included in the auto-zero loop of the DPM giving excellent stability over long time periods and ambient temperature variations. Schematics X85-1000 and X85-1003 show the detailed circuits utilized in the input buffer amplifier and DPM.

Figure 4-1, b illustrates the input current measurement circuit. An internal 10 OHM resistor is connected across the input terminals and the meter amplifier measures the voltage drop across the resistor caused by the input current.

When measuring ohms, Figure 4-1, c, a precision current source is connected to the INPUT + terminal by switch deck S2-B. The current source supplies 1mA through the resistance to be measured and, again, the meter amplifier measures the voltage drop across the resistance.

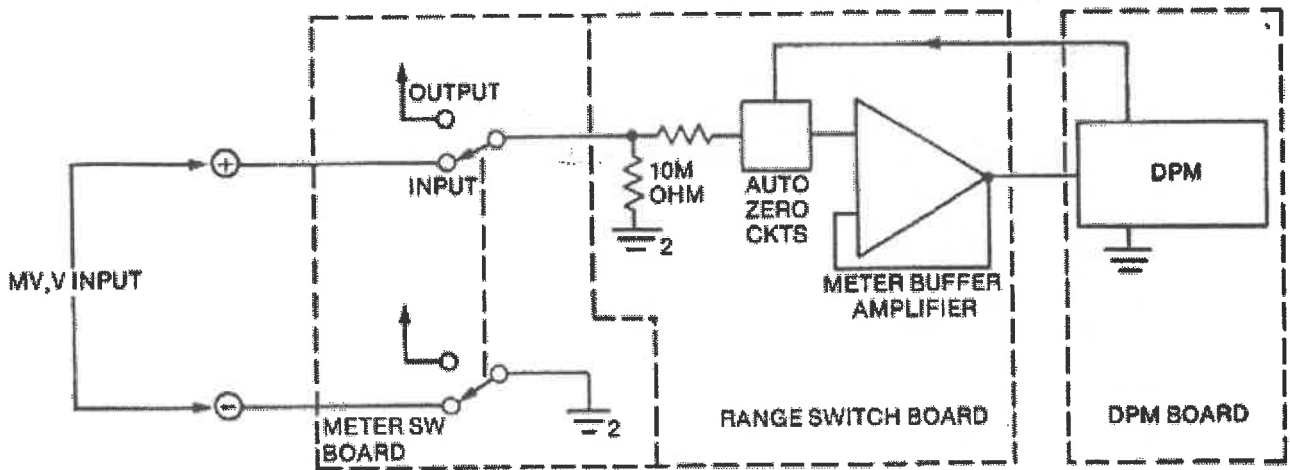


FIGURE 4-1,a
VOLTS INPUT CIRCUIT

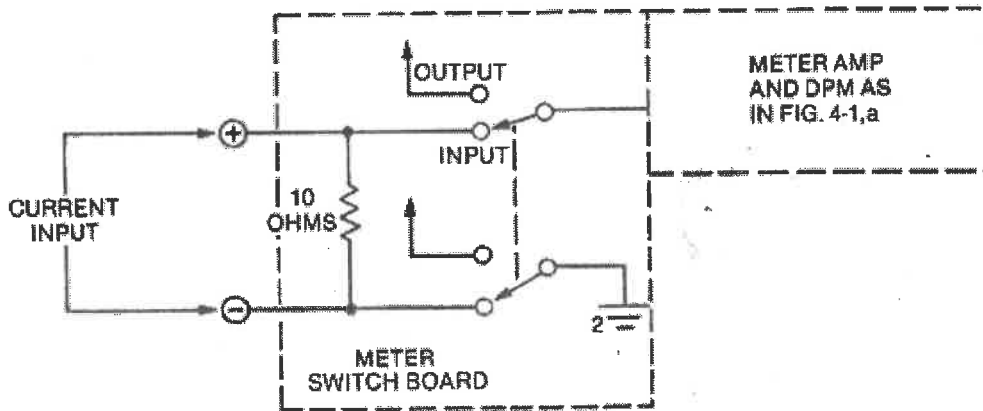


FIGURE 4-1, b
MA INPUT CIRCUIT

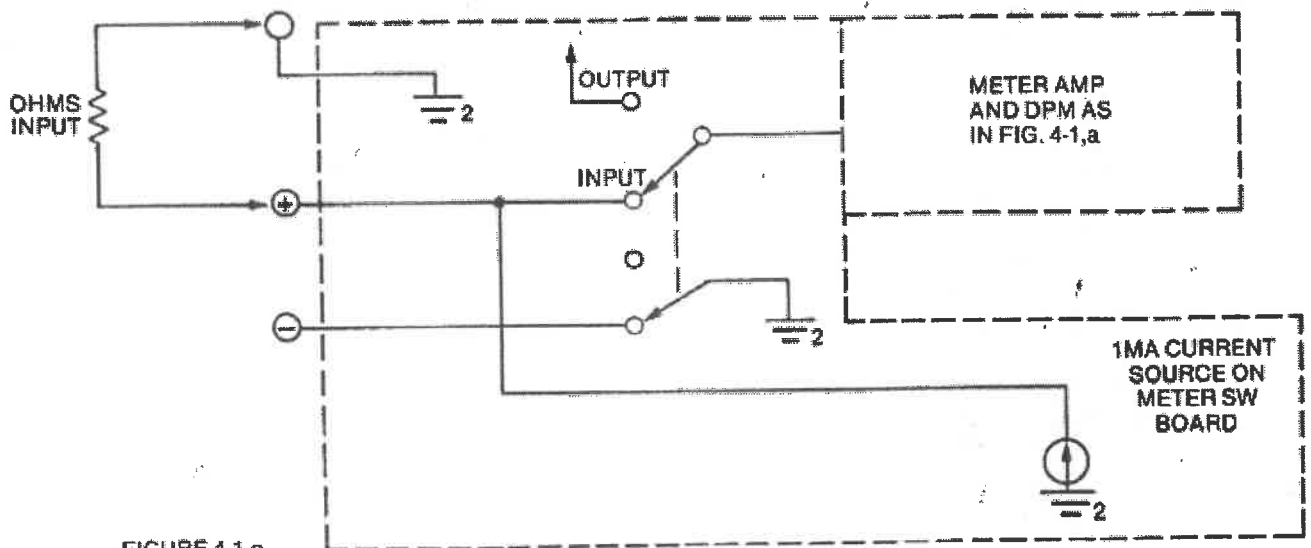


FIGURE 4-1,c
OHMS INPUT CIRCUIT

4.3 DPM BUFFER AMPLIFIER (Schematic X85-1003)

The DPM buffer amplifier consists of amplifier U2 and associated components. Resistor R8 provides protection against high input voltages. The field-effect transistor switches, Q1 and Q3, are synchronized with the DPM timing to include amplifier U2 in the auto-zero loop. Switch Q1 is on only during the Integrate up period of the DPM cycle. Switch Q3 is on during the auto-zero and Integrate down periods. The voltage waveform at the output of U2, pin 6, is a pulse whose amplitude equals the applied input voltage during the integrate up period and zero at other times. The dual comparator circuit, U4, provides the interface between the DPM and the switches Q1 and Q3. The zero control, R27, provides a small input offset adjustment.

The scaling for the DPM is selected by a deck on the INPUT RANGE switch, S2-C, or by a deck on the OUTPUT RANGE switch, S1-D. Potentiometer R29 is used to adjust the meter accuracy on the 1V range and potentiometer R28 adjusts the accuracy on the 10V range. Switch decks on both the INPUT and OUTPUT RANGE switches, S2-A and S1-B, are used to position the decimal point on the DPM correctly.

4.4 DIGITAL PANEL METER (Schematic X85-1000)

The DPM has a 4½ digit liquid crystal display (LCD) and uses the dual slope method of analog to digital conversion. The plus and minus voltages required to power the DPM enter the card at the DIP connector pins 11 (+14V) and 4 (-14V). The plus 14V is regulated to +5V by R25, CR9 and Q3 which powers all the analog and digital circuits. The unregulated -14V goes to U1 and is reduced to -8V through zener diode CR8 and supplied to U2 and U7.

The analog portion of the converter is made up of the quad switch U2, the integrator U1, and comparator U7. An input resistor to the integrator, R1, is located on the DPM board. On the 1 and 10 volt ranges, other resistors are added in series with R1 and are located on the function switch board. A precision reference voltage is provided by CR2 and associated components.

The conversion cycle contains three segments: An auto-zero period, an integrate "up" period (unknown input is applied to the integrator), and an integrate "down" period (reference voltage is applied to the integrator). The auto-zero and integrate up periods last for 10,000 clock pulses, the integrate down period lasts until the integrator output returns to zero when a transfer occurs which causes the reference voltage to be disconnected from the integrator.

The timing for the analog to digital conversion is controlled by U6 and U5. Integrated circuit U6 is a 4½ digit counter, latch, and decoder-driver. U5 is a counter that controls the sequencing for the conversion cycle. Counter U5 advances one count for each pulse at the carry output, pin 28, of U6. This occurs once every 10,000 clock pulses. When U5 is reset, pin 2 goes high putting the circuit in the auto-zero time period. The polarity of the comparator output at the end of the Integrate up period is latched into flip-flop U8A. The outputs of U8A are gated through U9A and U9B which control the switch drivers U3A and U3B. If the analog input signal is positive, pin 1 of U8A is high, the output of U3A is high turning on the switch between pins 10 and 11 of IC2. If the analog input signal is negative, pin 2 of U8A is positive causing switch Q1 to be turned on by U3B, pin 13.

A clock circuit, that runs at 40 KHz, utilizes U11B, U11C and associated components. The clock is applied to the counter section of U6.

4.5 VOLTAGE OUTPUT AMPLIFIER (Schematics X85-1003 and X85-1004).

The voltage output circuit consists of amplifier U1 and associated components on Schematic X85-1003 and a reference voltage and input resistors on Schematic X85-1004. From Schematic X85-1003, resistors R1, R2 and R4 are output range select resistors and transistor Q2 is the output stage. Resistor R11 limits the short circuit output current to about 60 MA. Diodes CR1, 2, 5 and 6 provide protection against the application of a large voltage across the output binding posts. Fuse F1 will blow if the applied voltage is above about 12.5 volts at 125 MA.

The output FINE and COARSE ADJUST controls are shown on schematic X85-1004. A precision reference voltage is generated by zener diode CR8, amplifier U2-A and associated components. Potentiometer R20 is used to adjust the voltage at pin 7 of U2-A to -4.0 volts with respect to output ground. (2-wire output "-" binding post.)

The ten position switch, S1, on Schematic X85-1004, provides the COARSE output adjustment steps and potentiometer R10 allows a fine adjustment of the output voltage between the steps of the COARSE control. The SCALE/ZERO switch, S2, selects either the COARSE and FINE output circuits or the ZERO ADJ control circuit, R14, to be connected to the summing junction of the voltage output amplifier, U1, of Schematic X85-1003.

4.6 CURRENT OUTPUT AMPLIFIER (Schematic X85-1003)

The current output amplifier consists of amplifier U3, field-effect transistor Q4, transistor Q5 and

associated components. The current output amplifier receives a signal from the voltage amplifier, U1, in the range of 0 to 1 volt. The output of U3 controls the current output stage, Q5 through Q4. The output current flows through R12 developing a voltage that is fed back to the minus input of U3 (pin 2). The amplifier always maintains an equality between the voltages at pin 3 and pin 2, therefore the current flowing through R12 (and the output current loop) is controlled by the voltage applied to input pin 3. Resistors R20 and R22 and CR8 provide a voltage feedback when there is no external loop connected to the current output binding posts. Refer to section 3.7 for direct output loop current measurement.

4.7 CURRENT SOURCE (Schematic X85-1002)

Schematic X85-1002 contains the current source used for ohms measurements and the METER SWITCH. The METER SWITCH is a five pole, two position switch that connects the digital panel meter to measure INPUT or OUTPUT values.

Amplifier U1 and associated components make up a precision 1 mA current source that is connected to the INPUT + post when the INPUT RANGE switch is in one of the ohms input positions. A stable input voltage from the reference zener, CR3, is applied to the inverting input of U1 through R3. Amplifier U1 controls the conduction of transistor output stage Q1 so that the voltage at U1, pin 2 is equal to the voltage at U1, pin 3. The reference voltage of CR3 is thereby dropped across the stable resistor, R3 causing 1 mA to flow through the output stage consisting of Q1 and Q2. Potentiometer R7 provides a means of adjusting the voltage of CR3. The diode CR3 protects the circuitry against positive input voltages in excess of +200V. Transistors Q1 and Q2 have large breakdown voltage ratings and will withstand the applications of large negative voltages to the ohms input terminals up to 200 volts without damage.

4.8 POWER SUPPLY (Schematic X85-1004)

The power supply utilizes the 6 volt potential from the battery and generates the voltages required to operate the calibrator. A non-saturating DC-DC converter consisting of transformer T1, oscillator, U1, field-effect transistors Q1 and Q2 and the secondary rectifiers and filters perform the voltage conversion. Integrated circuit U1 is a symmetrical oscillator operating at about 20 KHz. The oscillator alternately turns on the V-MOS switches, Q1 and Q2, which switch the 6V battery to both sections of the primary winding of transformer T1. Two separate power supplies are provided: plus and minus V2 which operate the DPM and DPM input amplifier, and plus and minus V3 which operate the voltage and current output amplifiers. The secondary voltage at winding 4-5 of T1, and full wave rectified by BR1, is added in series with the 6V battery to generate +V3.

The comparator, U2B, and associated components monitor the battery voltage and send a signal to the panel meter to indicate when the battery needs to be recharged. When the battery is low, the output of U2B goes from high to low and couples a signal across the opto-isolator, U3 to the DPM board.

5.0 CALIBRATION

5.1 CALIBRATION INTERVAL

The Model X85 calibrator's accuracy, as set at the factory, should hold for an indefinite period. However, it is recommended that its performance be checked at six month intervals against accurate standards to insure that it is performing within its rated specifications. Internal adjustments should not be performed without an accurate measurement of the performance with precision laboratory equipment to establish the need for recalibration. The calibrator may be returned to RONAN ENGINEERING COMPANY for recalibration, or it can be recalibrated in any standards laboratory.

5.1.1 CALIBRATION SEQUENCE

Any recalibration should follow the procedures of steps 5.3.1 through 5.3.7 in sequence. The accuracy of the mA and ohms measurements depends on the accuracy of the digital meter when measuring voltage. Although there are adjustments for the accuracy of the mA and ohms measurements, these should not be performed until the input voltage measurement accuracy is validated by performing calibration step 5.3.2.

5.2 EQUIPMENT REQUIRED

The calibration set-ups described below are selected to require the minimum amount of precision

equipment. Alternate test configurations can be used if the equipment is sufficiently accurate, (0.01% of reading or better)

- a) Secondary DC voltage standard, $\pm 0.005\%$ R ± 50 microvolts or better
- b) Precision, stable resistor, 100 OHMs $\pm 0.005\%$
- c) Digital Voltmeter, or null meter with 100 microvolt resolution or better
- d) Stable, adjustable power supply capable of 50 mA output current, or adjustable current source

5.3 CALIBRATION PROCEDURE

5.3.1 REMOVAL OF CIRCUITRY FROM ENCLOSURE

The tests outlined in the following sections can be performed without removing the calibrator from its enclosure. If adjustments need to be made, then remove the front panel and attached circuit boards from the enclosure by removing the four screws in the top plate, then the top plate, then slide the front panel assembly out of the enclosure.

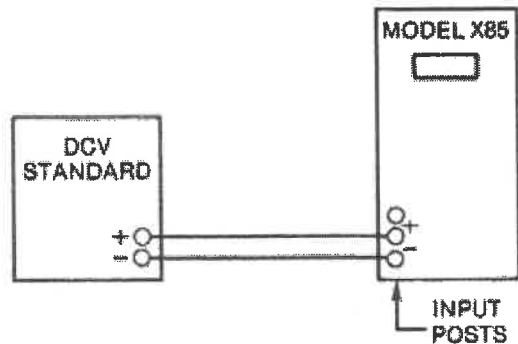


FIGURE 5-1
INPUT VOLTAGE TEST

5.3.2 INPUT VOLTAGE MEASUREMENT

5.3.2.1 Connect the X85 calibrator and the DC voltage standard as shown in Figure 5.1.

5.3.2.2 Set the calibrator METER switch to the INPUT position. Set the INPUT RANGE switch to the 100MV position.

5.3.2.3 Set the polarity switch of the DC standard to "0" or short the calibrator "+" input lead to the "-" input lead. If the calibrator DPM does not indicate zero, ± 2 digits, adjust R27 on the RANGE SWITCH board. Refer to Figure 5.2 for the location of the adjustment controls.

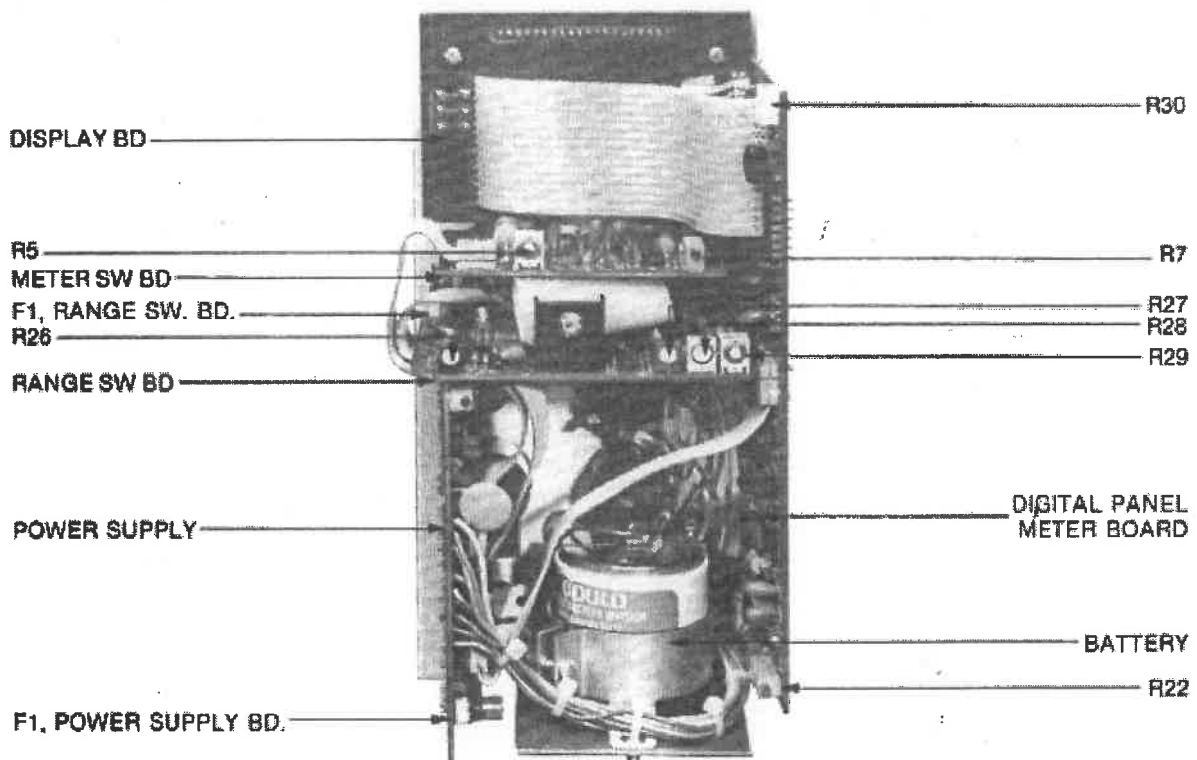


FIGURE 5-2 LOCATION OF CALIBRATION CONTROLS

- 5.3.2.4 Set the polarity switch of the DC standard to the "+" position and reconnect the inputs to the Model X85, if necessary. Set the DC calibration to 0-1-0-0-0V. If the DPM on the Model X85 doesn't read within $100.00\text{mV} \pm .05\text{MV}$, adjust R22 on the DPM board for $100.00 \pm .02\text{MV}$.
- 5.3.2.5 Set the INPUT RANGE switch to the 1V position. Repeat step 5.3.2.4 using a setting of 1-0-0-0-0 on the DC voltage standard (there is no separate ZERO control for the 1 and 10V ranges). If the full scale readout on the DPM doesn't indicate within $1.0000 \pm .0005\text{V}$, then R29 on the RANGE SCALE board should be adjusted for $1.0000 \pm .0002\text{V}$.
- 5.3.2.6 Set the INPUT RANGE switch to the 10V position. Repeat step 5.3.2.4 using a setting of 10-0-0-0-0 on the DC voltage standard. If the full scale readout on the DPM doesn't indicate within $10.0000 \pm .005\text{V}$, then R28 on the RANGE SW board should be adjusted for $10.0000 \pm .002\text{V}$.
- 5.3.3 INPUT CURRENT MEASUREMENT
- 5.3.3.1 Connect the X85 calibrator and the DC voltage standard as shown in Figure 5-3.

CAUTION: Set the power supply output to zero before connecting it into the circuit.

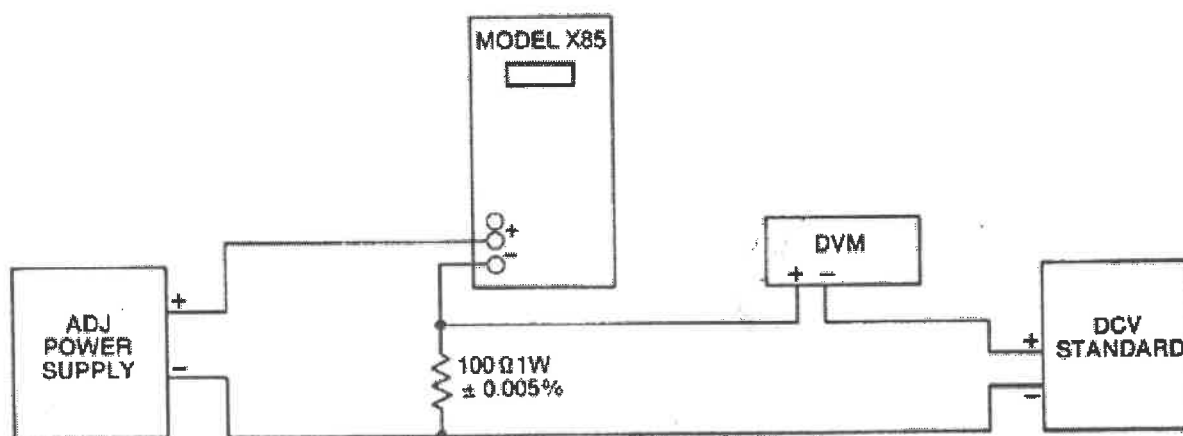


FIGURE 5-3
CURRENT MEASUREMENT VERIFICATION

- 5.3.3.2 Set the METER switch on the calibrator to the INPUT position. Set the INPUT RANGE switch to the 100MA position.
- 5.3.3.3 Slowly turn up the power supply until the Model X85 indicates approximately 50 mA (the exact value of this current isn't important).
- 5.3.3.4 Adjust the DC voltage standard until a null is obtained on the digital volt meter (zero ± 200 microvolts — set the DVM to a scale with 100 microvolt resolution).
- 5.3.3.5 The setting of the DC voltage standard divided by 100 equals the DC mA flowing into the Model X85's input. The readout of the Model X85 should equal the setting of the voltage standard divided by 100 $\pm .05$ mA. Potentiometer R5 on the METER SWITCH board may be used to adjust the Model X85's readout if necessary.
- 5.3.4 OHMS MEASUREMENT
- Connect the Model X85 and the precision 100 OHM resistor as shown in Figure 5-4. Connect the resistor directly to the OHMS input binding posts of the Model X85 to eliminate errors caused by lead lengths.

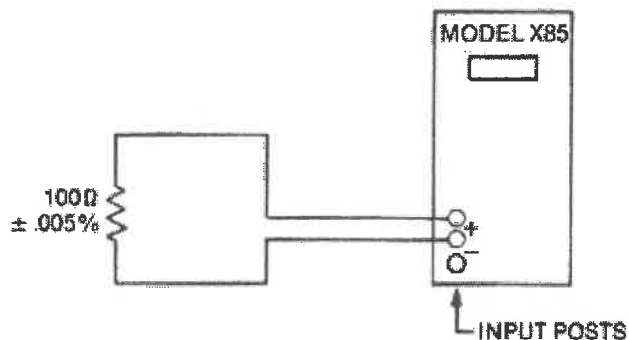


FIGURE 5-4
OHMS MEASUREMENT VERIFICATION

5.3.4.2 Set the METER switch to the INPUT position. Set the INPUT RANGE switch to the 100 OHMs position. The readout of the Model X85 should indicate $100.00 \pm .07$ OHMs. Potentiometer R7 on the meter switch board may be used to adjust the OHMs accuracy if necessary.

5.3.5 OUTPUT VOLTAGE CALIBRATION

The output voltage is settable by the COARSE and FINE output controls and is measured by the internal panel meter. The output voltage setting is within the error limits of the digital panel meter.

5.3.6 OUTPUT CURRENT CALIBRATION

5.3.6.1 Connect the Model X85, DVM, DC voltage standard and the precision 100 OHM resistor as shown in Figure 5-5.

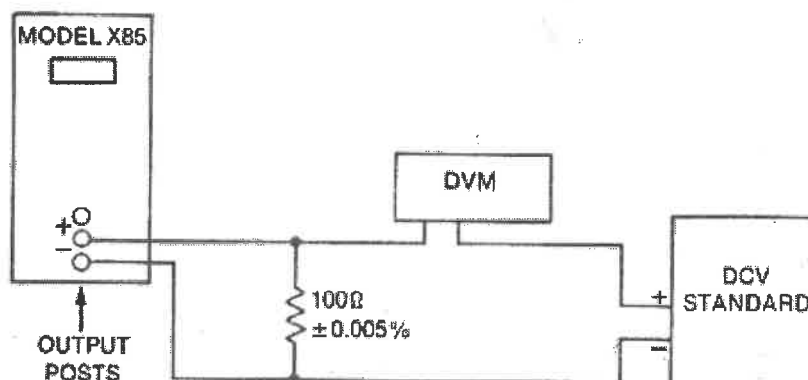


FIGURE 5.5
CURRENT OUTPUT VERIFICATION

5.3.6.2 Set the Model X85's METER switch to the OUTPUT position. Set the OUTPUT RANGE switch to the 100 MA position. Set the SCALE/ZERO switch to the SCALE position. Set the DVM to a range that has 100 microvolt resolution. Set the DC VOLTAGE STD to 100 MV.

5.3.6.3 Set the OUTPUT COARSE control to 0 and adjust the FINE control for an output of 1.00 mA as indicated on the Model X85's panel meter. The DVM should indicate $zero \pm 2MV$. Potentiometer R26 on the range switch board is to adjust this point if necessary.

5.3.6.4 Set the DC VOLTAGE STD to 5-0-0-0 volts. Set the Model X85 OUTPUT COARSE control to 50 and adjust the FINE control for an output of 50.00 MA as indicated on the Model X85's panel meter. The DVM should indicate $zero \pm 5 MV$. There is no adjustment for this output, it should remain within the required accuracy when step 5.3.6.3 is performed. A precision resistor, R12, on the RANGE SWITCH circuit board determines the accuracy of the MA OUTPUT.

5.3.7 OHMS OUTPUT

Two precision potentiometers are connected across the OHMS output terminals except when the OHMS READ switch is pressed down (they are then switched to the OHMS INPUT terminals). The value of this resistor is as indicated on the Model X85 panel meter with the METER switch in the INPUT position and the INPUT RANGE switch in either the 100 OHMS or 1K OHM position, and the READ switch pressed down. The accuracy of this reading is the same as the OHMS MEASUREMENT accuracy of 5.3.4.

6.0 TROUBLESHOOTING GUIDE

Table 6-1 is given to assist at troubleshooting for some specific malfunctions. For further assistance refer to the schematics and circuit description sections of this manual. RONAN ENGINEERING COMPANY does maintain a service and repair department where the calibrator may be sent for repair and recalibration.

NOTE: When the front panel and circuit boards are removed from the enclosure, inspect the three DIP connectors on the power supply board to ensure that the plugs are firmly seated.

ABNORMALTY	POSSIBLE CAUSE	CORRECTIVE ACTION
NO DISPLAY	a) low or bad battery	Charge battery, then measure battery voltage per section 3.9.1. If battery voltage is good, check fuse, F1, on the power supply board.
No voltage output. Display indicates output voltage.	F1, range sw board	Check fuse, F1, on range switch board.
No current output in 100 MA position, voltage output ok.	Q4, Q5, U3, CR7 or associated components. Range switch board.	Replace defective component.
Display erratic on both input & output settings.	Meter buffer amp or DPM board.	Use schematic and text to assist in locating defect.
Gross inaccuracy when measuring OHMS. Voltage measurements ok.	Q1, Q2, U1 and associated components meter switch board.	Replace defective component.
Gross inaccuracy when measuring current. Voltage measurements ok.	Resistor R1, R2, or R5 on meter switch board.	Replace defective components.

7.0 BATTERY REPLACEMENT

The calibrator may be returned to RONAN ENGINEERING COMPANY for battery replacement or the battery may be replaced by following this recommended procedure:

- 1) Remove the circuit boards from the enclosure by using the procedure given in Section 5.3.1.
- 2) Unplug the DIP connector cable from the socket nearest the battery.
- 3) Unsolder and remove the red wire from the + battery terminal.
- 4) Loosen the screw holding the outside back leg of the battery clamp to the bracket.
- 5) Loosen the screw that tightens the battery clamp and remove the battery enough so that the black wire can be unsoldered and removed from the - battery terminal.
- 6) Solder the black wire to the - terminal of the new battery and insert the battery into the clamp and reassemble in the reverse order of that used for removal of the battery.

**DISPLAY BOARD
X85-1001-2**

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1		P. C. Bd	X85-1001A	
2					
3	1	Hamlin	U1	4 1/2 Digit LCD Display .25" Long Pins	390 9-313-070
4	1	Stackpole	S1	Slideswitch DPDT	S9022CD00-0
5					
6	14	AMP		"F" Posts, Strip of 10	1-380953-3
7					
8	1	AMP		Jumper Cable 2" 14 Cond.	1-88665-3
9	1	AMP		Jumper Cable 4.5" 14 Cond.	1-88684-3
10					
11	4	A.B.	R1, 2, 3, 4	Resistor, 1/4W, 5% 220K	RC07GF224J

**METER SWITCH BOARD
X85-1002-2**

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1			P.C. Board	X85-1002B
2	1	Amp		15 Conductor Flex Cable 4.5" Long	1-88684-4
3	1	Richey Elect.		Dip Cable, 14 Pin, 5" Long	X85B11-2
4	1	Grayhill	S1	Switch, 4 Pole, 2 Pos	71BY231999
5					
6	1	A.B.	R6	Resistor, 1/4W, 5% 3.9K	RC07GF392J
7	1	A.B.	R4	Resistor, 1/4W, 5% 12K	RC07GF123J
8	1	Mepco	R2	Resistor, 1/8W, 1% 1K Ohm	RN55C1001
9	1	Jordan	R1	Resistor, Wire Wound 100 Ohm	J135-10 ± 0.1%
10	1	Jordan	R3	Resistor, Wire Wound 2.46K	J110-2.46K ± 0.1%
11	1	Beckman	R7	Potentiometer, Cermet 20K	89PR20K
12	1	Beckman	R5	Potentiometer, Cermet 1K Ohm	72P1K
13					
14	2	Fairchild	CR1, CR2	Diode, Signal	IN4148
15	1	Fairchild	CR4	Diode, Rectifier	IN4005
16	1	National	CR3	Diode, Zener 2.46V	LM336Z
17					
18	1	National	Q1	H.V. Transistor, NPN	92PU10
19	1	Motorola	Q2	H.V. Transistor, PNP	2N6519, MPSA92
20					
21	2	ITT	C1, C2	Capacitor, Tant. 6.8MFD/35V	TAGA6.8K35
22	1	Arco	C3	Capacitor, Dipped Mica 220pfd	DM15-221J
23					
24	1	National	U1	OP Amp	LM308N

POWER SUPPLY BOARD
X85-1004-2

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1				P.C. Board	X85-1004B
2					
3			1		
4					
5	1	A.B.	R26	Resistor, 1/4W, 5% 2.7K	RC07GF272J
6	2	A.B.	R15, 21	Resistor, 1/4W, 5% 8.2K	RC07GF822J
7	3	A.B.	R17, 18, 19	Resistor, 1/4W, 5% 27K	RC07GF273J
8					
9	1	Mepco	R8	Resistor, 1/8W, 1% 2.21K	RN55C2211
10	1	Mepco	R7	Resistor, 1/8W, 1% 2.87K	RN55C2871
11	1	Mepco	R6	Resistor, 1/8W, 1% 3.83K	RN55C3831
12	1	Mepco	R5	Resistor, 1/8W, 1% 5.38K	RN55C5381
13	1	Mepco	R4	Resistor, 1/8W, 1% 8.06K	RN55C8061
14	1	Mepco	R3	Resistor, 1/8W, 1% 13.3K	RN55C1332
15	1	Mepco	R22	Resistor, 1/8W, 1% 12.4K	RN55C1242
16	1	Mepco	R23	Resistor, 1/8W, 1% 15K	RN55C1502
17	1	Mepco	R2	Resistor, 1/8W, 1% 26.7K	RN55C2672
18	1	Mepco	R24	Resistor, 1/8W, 1% 33.2K	RN55C3322
19	2	Mepco	R13, 16	Resistor, 1/8W, 1% 17.8K	RN55C1782
20	1	Mepco	R1	Resistor, 1/8W, 1% 80.6K	RN55C8062
21	2	Mepco	R11, 12	Resistor, 1/8W, 1% 140K	RN55C1403
22	1	Mepco	R25	Resistor, 1/8W, 1% 20.5 K	RN55C2052
23	1	Jordan	R9	Resistor, W.W. 17.87 ± 0.1%	J110-17.87K ± 0.1%
24	1	Beckman Electro Techniques	R20	Potentiometer, Cermet 20K	89PR20K
25	2	Techniques	R10, 14	Potentiometer, Wire Wound 50K	850-10T 50K
26					
27	7	Fairchild	CR1, 2, 3, 4, 5, 6, 7	Diode Signal	IN4148
28	1	National	CR8	Diode Zener 2.49V	LM336Z
29	2	Siliconix	Q1, Q2	V MOS Power FET	VN66AF
30	1	Arco	C6	Capacitor, Dipped Mica 390pfd	DM15-391J
	1	Sprague	C7	Capacitor, Disc .05/500V	5HK-S50
31	5	ITT	C1, 2, 3, 4, 5	Capacitor, Tant. 6.8MFD/35	TAGA6.8K35
32	1	National	U2	Amplifier/Comparator	LM392N
33	1	TI	U3	Opto Isolator	TIL119
34	1	RCA	U1	Mono/Astable Multivibrator	CD4047BE
35	1	C & K	S 2	SPDT Switch	7101P3DAB
36					
37	1	Mag-Devices	T1	Transformer	X85B1
38					
39	1	Grayhill	S1	Switch, 1 Pole, 10 Pos	71BY232025
40	1	Varo	BR1	Rectifier Bridge	VE47
41	1	Littlefuse	F1	Fuse, 500 MA	273.500
42	1	Littlefuse		Fuse Holder	281005
43	2	Circuit Ass'y. Corp.	J1, J3	IC Socket, 14 Pins, Low Profile, Gold Plated	CA-14L S2-10SD
44	1	Circuit Ass'y. Corp.	J2	IC Socket, 16 Pins, Low Profile, Gold Plated	CA-16L S2-10SD

**DPM BOARD
X85-1000-2**

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1			P.C. Board	X85-1000B
2	1	Richey Elect		Dip Conn Cable, 14 Pin	o6/06/14-6"
3					
4	1	A.B.	R11	Resistor, 1/4W, 5% 1.5K	RC07GF152J
5					
6					
7	2	A.B.	R25, 24	Resistor, 1/4W, 5% 5.6K	RC07GF562J
8	1	A.B.	R23,	Resistor, 1/4W, 5% 10K	RC07GF103J
9	3	A.B.	R5, 9, 10	Resistor, 1/4W, 5% 27K	RC07GF273J
10					
11	6	A.B.	R8, 15, 17, 19,	Resistor, 1/4W, 5% 68K	RC07GF683J
			20, 26		
12	6	A.B.	R4, 6, 7, 16,	Resistor, 1/4W, 5% 100K	RC07GF104J
			18, 28		
13	2	A.B.	R21, 2	Resistor, 1/4W, 5% 220K	RC07GF224J
14	1	A.B.	R3	Resistor, 1/4W, 5% 470K	RC07GF474J
15					
16	1	Mepco	R29	Resistor, 1/8W, 1% 40.2K	RN55C4022
17	1	Mepco	R13	Resistor, 1/8W, 1% 619K	RN55C6193
18					
19	1	Jordan	R1	Resistor, Wire Wound 12.45K \pm .1%	J100-12.45K \pm 0.1%
20	1	Jordan	R12	Resistor, Wire Wound 307.4K \pm .1%	J100-307.4K \pm 0.1%
21					
22	1	Beckman	R22	Potentiometer, 20K	89PR20K
23	1	Beckman	R30	Potentiometer, 1T, 50K	72P50K
24	2	Beckman	R14, R27	Not Used	
25	1	Arco	C13	Not Used	
26	4	Arco	C5, 6, 11, 12	Dipped Mica 220pfd	DM15-221J
27	2	Arco	C2, C4	Dipped Mica 390pfd	DM15-391J
28	1	Sprague	C7	Capacitor, Ceram Disc. .001MFD	5GA-D10
29					
30					
31	1	Southern Elec. Corp.	C1	Capacitor, Polypropylene .33MFD \pm 10%	MPP11-.33MFD \pm 10%
32	1	ITT	C8, 9, 10	Capacitor, Tantalum 6.8MFD	TAGA6.8K35
33	1	ITT	C3	Capacitor, Tantalum 47MFD/6V	TAGA47K6.3
34					
35	4	Fairch.	CR1, 10, 11, 12	Diode Low Leakage IN457A	IN457A
36	4	Fairch.	CR4, 5, 6, 7	Diode, Signal	IN4148
37	1	Motorola	CR3	Diode, Zener 4.3V	IN749
38	1	Motorola	CR9	Diode, Zener 5.6V	IN752A
39	1	Motorola	CR8	Diode, Zener 6.2V	IN825A
40	1	National	CR2	Diode, Zener 2.49V	LM336Z
41					
42	1	National	U1	Op-Amp	LF355N
43	1	PMI	U7	Comparator	CMP02CP
44	1	National	U3	Quad Comparator	LM3302N
45					
46	1	RCA	U2	Quad Switch	CD4066BE
47	1	RCA	U8	Dial "D" Flip Flop	CD4013BE
48	1	RCA	U9	Triple 3-Input and Gate	CD4073BE
49	1	RCA	U11	Quad 2-Input N and Gate	CD4011BE
50	1	RCA	U10	Quad 2-Input Excl. or Gate	CD4070BE
51	1	RCA	U5	Octal Counter	CD4022BE

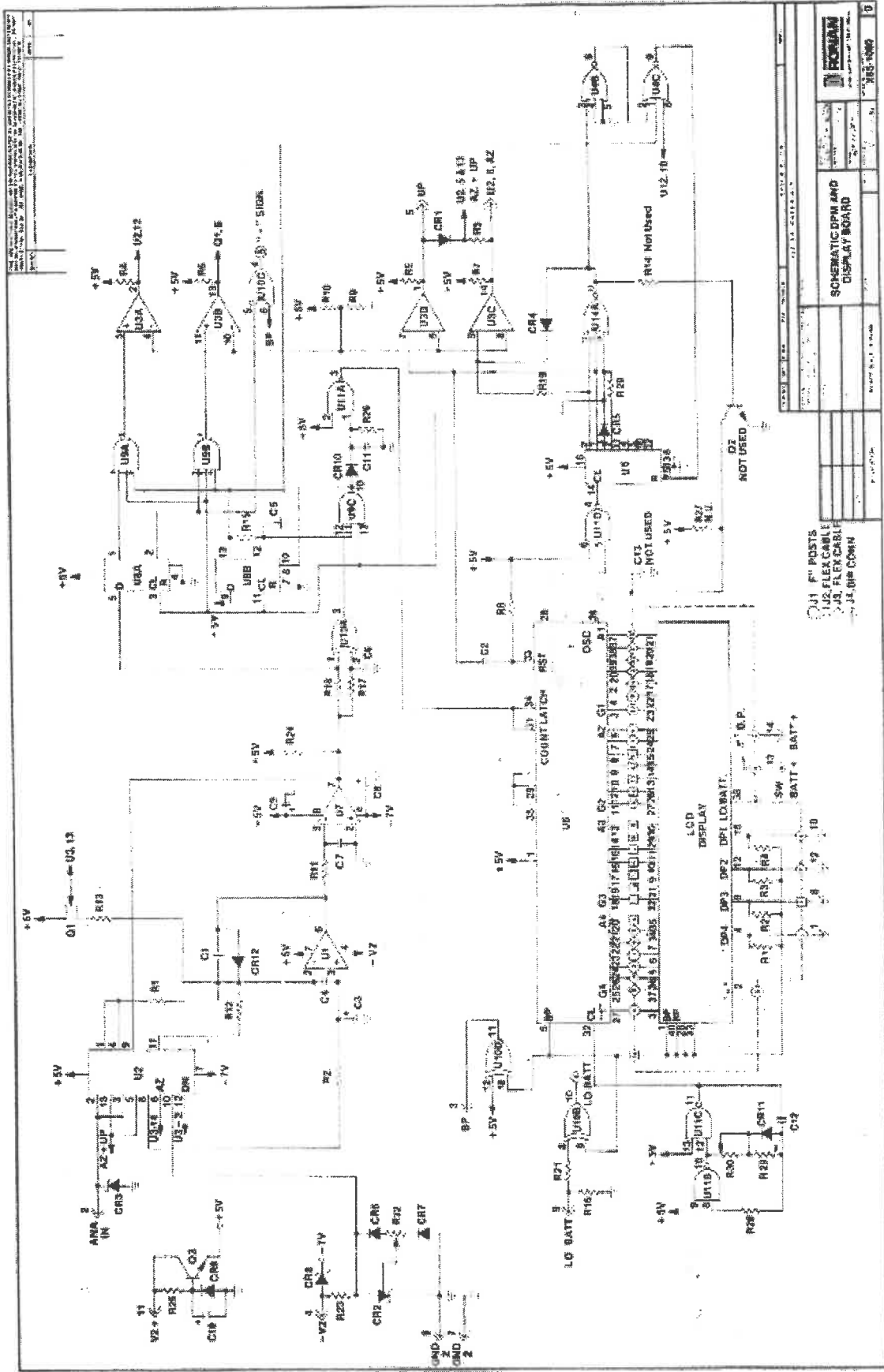
52	1	Intersil	U6	4 1/2 Digit Counter, Decoder	ICM7224IPL
53	1	RCA	U4	Triple 3-Input N or Gate	CD4025BE
54					
55	1	Motorola	Q1	Field-Effect Transistor, N Ch.	MPF4392 or 2N4392
56	1		Q2	Not Used	
57	1	National	Q3	Transistor, NPN	92PU01

X85 FRONT PANEL AND ENCLOSURE PARTS

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1	C & K		Switch (Ohms Read)	7209P3YZQ
2					
3	1	D & B Power		Battery Charger	NB50-5 Charger w/60BO85 Cord, Hole + 3015-102
4	5	H.H. Smith		Miniature Binding Posts, Red	3015-103
5	3	H.H. Smith		Miniature Binding Posts, Black	3015-103
6					
7	1	Switch-Craft		Receptacle	712A
8	1	Gould		Battery, NiCad	6.0V/450B
9	8	Kurtz-Kasch		Knobs	32013
10	8	H.H. Smith		Ring Nut	1120
11	2	H.H. Smith		Spacers 3/8 Long, 4-40 Thd.	8402
12					
13	1	Mallory or Sprague		Capacitor Clamp	VR6B-Mallory 4-36-14M- Sprague
14	1	Electro Techniques		100 Ohm Pot	850-10T- 100 Ohms
15	1	Electro Techniques		1K Ohm Pot	850-10T- 1K Ohms
16	2			Test Lead Sets, Mini-Plug to STD Alligator Clips	
17					
18	1	Ronan		Battery Plate	X85B8
19	1	Ronan		Battery Bracket	X85B9
20	1	Ronan		Front Panel	X85C10
21	2	Ronan		Side Extrusion	X85C5
22	2	Ronan		End Plate	X85B6
23	1	Ronan		Bottom Plate	X85C7
24	1	Ronan		Display Window	X85A4
25	1	Ronan		Battery Insulator	X85B16
26	1	Sprague		Capacitor, Ceram. Disc. .05MFD/500V	5HK-S50

**RANGE SWITCH
X85-1003-2**

ITEM NO.	QTY REQ'D.	MFG.	CODE	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.
1	1		P. C. Bd	X85-1003B	
2	1	Richey Elect		Dip Cable, 16 Pin, 8"	X85B11-7
3	1	A.B.	R17	Resistor, 1/4W, 5% 33 OHM	RC07GF330J
4	2	A.B.	R7, 9	Resistor, 1/4W, 5% 22 OHM	RC07GF220J
5	1	A.B.	R5	Resistor, 1/4W, 5% 220 OHM	RC07GF221J
6	1	A.B.	R22	Resistor, 1/4W, 5% 5.6K	RC07GF562J
7	1	A.B.	R20,	Resistor, 1/4W, 5% 10K	RC07GF273J
8	5	A.B.	R6,13, 21, 23, 24	Resistor, 1/4W, 5% 27K	RC07GF273J
9	2	A.B.	R8, 16	Resistor, 1/4W, 5% 150K	RC07GF154J
10	2	A.B.	R14, 15	Resistor, 1/4W, 5% 470K	RC07GF474J
11	2	A.B.	R3, 18	Resistor, 1/4W, 5% 10M	RC07GF106J
12	1	A.B.	R11	Resistor, 1W 5% 270 OHM	RC32GF271J
13	1	Mepco	R1	Resistor, 1% M. Film 402 OHM	RN55C4020
14	1	Mepco	R2	Resistor, 1% M. Film 4.02K	RN55C4021
15	1	Mepco	R4	Resistor, 1% M. Film 40.2K	RN55C4022
16	1	Beckman	R28	Potentiometer, Cermet, 1T	82PAF50
17	1	Beckman	R29	Potentiometer, Cermet, 1T	62PA500
18	2	Beckman	R26, 27	Potentiometer, Cermet, 1T	62PA100K
19					
20	1	Jordan	R12	Resistor, Wire Wound $\pm 0.01\%$ 10 OHM	J110-10 \pm 0.01%
21	1	Jordan	R25	Resistor, Wire Wound $\pm 0.1\%$ 12.47K	J110-12.47K \pm 0.1%
22	1	Jordan	R19	Resistor, Wire Wound 102.27K	J110-102.27K \pm 0.1%
23	1	Jordan	R10	Resistor, Wire Wound 112.0K	J110-112.0K \pm 0.1%
24					
25	1	Arco	C8	Capacitor, Dipped Mica 220 PFD	PM15-221J
26	1	Sprague	C7	Capacitor, Ceram. Disc. .001MFD	5GA-D10
27	1	Sprague	C3	Capacitor, Dipped Mica .005MFD	TG-DSO
28	4	ITT	C1, 2, 5, 6	Capacitor, Tant. 6.8MFD/35V	TAGA6.8K35
29	2	Kemet	C4, C9	Capacitor, Ceram. .05MFD	C321C503Z- SU1CA
30	1	MOT	CR7	Diode, Rectifier	IN4005
31	1	Fairchild	CR8	Diode, Low Leakage	IN457A
32	2	Fairchild	CR5, 6	Diode, Signal	IN4148
33	2	Motorola	CR1, 2	Diode, Zener - 12V	IN5349A
34					
35	1	National	Q2	Transistor, NPN	92PU01A
36	1	Motorola	Q5	Transistor, NPN	MJE243
37	3	Motorola	Q1, 3, 4	Field-Effect Trans. N CH.	MPF4392, 2N44392
38	1	Thermalloy		Heat Sink (Q5)	6073B
39					
40	2	PMI	U2, U1	OP-Amp, Low Power	OP20HP
41	1	National	U3	OP-Amp	LM312HC
42	1	National	U4	Dual Comparator	LM393N
43	1	Grayhill	S1	Switch, 6 Pole, 6 Pos	71BY231998
44	1	Grayhill	S2	Switch, 4 Pole, 6 Pos	71BSF30-2-2-6N
45	1	Littlefuse	F1	Fuse 125 MA	273.125
46	1	Littlefuse	F1	Fuse Holder	281005



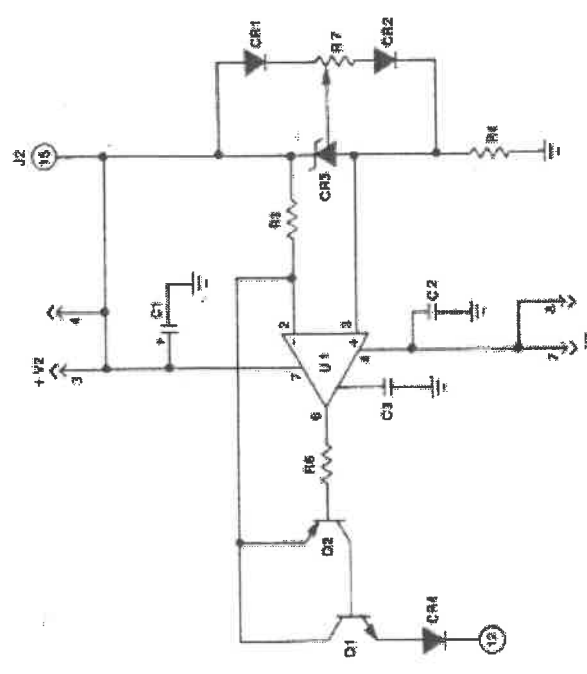
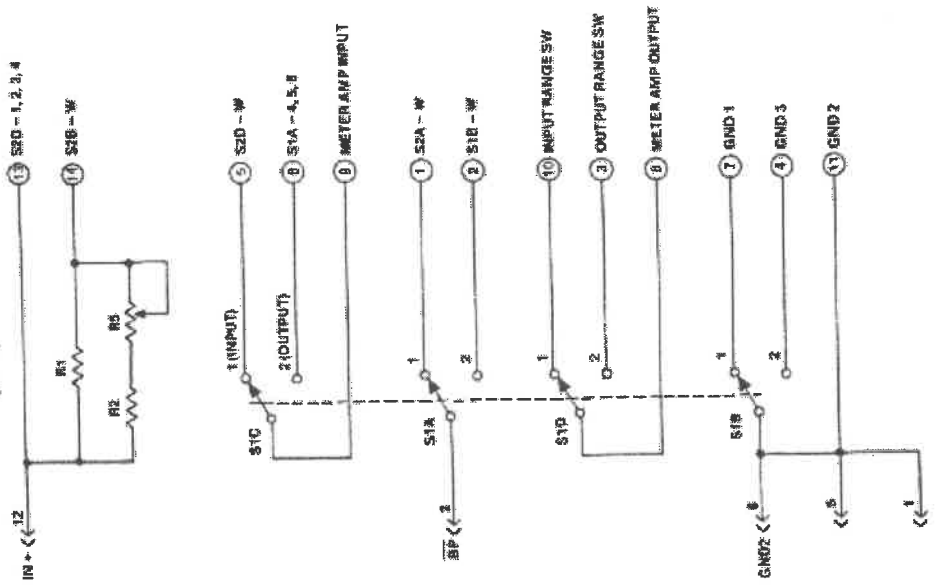
- 1.0" POSTS
- U12 FLEX CABLE
- U13 FLEX CABLE
- U14 8-pin COMB

SPM AND DISPLAY BOARD

REV	DATE	BY	CHKD

FORM 100-1000

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NOTE:
 ○ = FLEX STRIP TO RANGE SW BD
 → = DIP CONN TO P.S. BD

ITEM NO.	QTY	CONNECTION	PART NUMBER	DESCRIPTION	SPEC
LIST OF MATERIALS					
METER SWITCH BOARD					
DO NOT REUSE DRAWING					
APPLICATION					
SIZE D4					
PART ASSY					
MATERIAL					
METER SWITCH BOARD					
REV. 1					
DATE: 1982					
DRAWN BY: [Signature]					
CHECKED BY: [Signature]					
APPROVED BY: [Signature]					
METER SWITCH BOARD					
REV. 1					
DATE: 1982					

ADDENDUM NO. 2

OUTPUT CURRENT

Calibrator Serial No's below 11037 used an indirect method of measuring output current. When the calibrator was used in the output current mode the display would indicate the same current output whether or not a current loop was connected across the output terminals. A design change is incorporated in Serial No's 11037 or higher whereby the display indicates only the actual current flowing in the external loop connected to the output terminals. If the loop is opened the output current indications will fall below 0.1 mA. Section 3.7 in the manual is no longer applicable.

ADDENDUM NO. 1

This addendum contains the circuit description, parts list and schematic of the digital panel meter board installed in Model X85 Calibrators, beginning with serial number 10076.

DIGITAL PANEL METER (X85-1006)

The digital panel meter (DPM) performs an analog to digital conversion with 4 ½ digit accuracy utilizing the dual slope conversion method. The digital output is displayed on a 7-segment liquid crystal display. The voltages required to power the DPM enter the card at DIP connector pins 11 (+14V) and 4 (-14V). The +14V is regulated to +5V by R20, CR9 and Q1.

The analog input signal enters the card at connector pin 2 and is applied to the inverting amplifier, U6. Amplifier U6 is used to interface the analog to digital (A to D) converter circuit with the buffer amplifier, U2, and range switching circuitry on PC board X85-1003. During the initial portion of the A to D conversion period, "auto-zero", the voltage offsets of the buffer amplifier and U6 are sampled and subsequently cancelled out during the input signal integration period.

There are two "auto zero" circuit loops, one consisting of the circuitry contained in the A to D chip set, U3 and U9 and one around U2 on the RANGE SWITCH board and U6 on the DPM board. The BUSY signal, which goes high during the autozero period controls the autozero circuits external to the A to D chip set. During autozero, switches "A" and "C" of U1 are ON, switch "B" OFF, and the offset voltage at the output of U6 is stored on capacitor C4. During the "integrate up" period switches "A" and "C" of U1 are OFF and switch "B" is ON. This applies the stored offset voltage to the inverting input of U6 cancelling the offset voltages that were present during the autozero interval.

The clock for the A to D converter is made up of U5A and B, R5, R6, R7 and C2. The proper clock frequency is 50 kHz (20 microseconds/clock). The clock is applied to U3 which provides the logic control and switches for the A to D conversion cycle. Integrated circuit U9 contains the analog section of the A to D converter: a buffer amplifier, an amplifier used for the integrator and a comparator circuit.

A latch-decoder-driver circuit, U8, is used to take the BCD data from U3 and drive the 7-segment LCD displays. The AND Gates U4-A, B, C and D are used to eliminate race conditions when transferring data to the latches in U8. The OR Gates in U10 cause an over-range number to be latched into U8 when the input exceeds 200% of full scale. The flip-flop consisting of U11 controls the most significant digit of the display which is either a "1" or is blanked.

The full scale indication of the display is defined as 10,000 counts or a display of 1-0-0-0-0 (location of decimal point variable) though the DPM will indicate up to $\pm 1-9-9-9-9$. Any input signal above this (over-range) will have a unique display indicating the over-range condition. All inputs are conditioned by the buffer amplifier, U2, on the range switch board and U6 on the DPM board for a full scale voltage of 1V at the DPM input. The required reference voltage for this input, 1V, is provided by the reference zener, CR8 and the stable voltage divider made up of R3 and R4. The reference adjust resistor, R22, is adjusted for a full scale readout (100.00) when 100.00 mV is applied to the input and the input range switch is in the 100mV position (See Section 5: CALIBRATION).

A voltage translation circuit between U3, Pin 28 and U1 is provided by one of the comparators of the dual comparator, U2. The second comparator of U2 provides the required interface signals to U4 on the RANGE SWITCH board through J4. This signal called "UP" at J4, Pin 5 is used to control the buffer amplifier on the RANGE SWITCH board, i.e., the buffer amplifier is caused to be in the auto-zero or normal mode of operation.

ROMAN ENGINEERING COMPANY
PARTS LIST

DPM BOARD, X85 X85-1006-2

REV
SHT. 1 OF 2

ITEM NO.	QTY. REQ.	IDENT.	DESCRIPTION	PART NUMBER	MFG. OR CODE	RIR NO.
1	1		P.C. Board	X85-1006A		
2	1		Dip Conn. Cable, 14 Pin, 6"	X85B11-3	Richey	
3	2	R18, 19	Resistor, 1/4W, 5%, 47 Ohm	RC07GF470J	AB	
4	1	R20	Resistor, 1/4W, 5%, 5.6K	RC07GF562J	AB	
5	1	R16	Resistor, 1/4W, 5%, 10K	RC07GF103J	AB	
6	2	R8, 11	Resistor, 1/4W, 5%, 36K	RC07GF363J	AB	
7	1	R13	Resistor, 1/4W, 5%, 22K	RC07GF223J	AB	
8	5	R6, 14, 15, 21, 23	Resistor, 1/4W, 5%, 100K	RC07GF104J	AB	
9	1	R10	Resistor, 1/4W, 5%, 300K	RC07GF304J	AB	
10	1	R9	Resistor, 1/4W, 5%, 470K	RC07GF474J	AB	
11						
12	1	R7	Resistor, 1/8W, 1%, 19.1K	RN55C1912	Mepco	
13						
14	1	R17	Resistor, 1/8W, 1%, 150K	RN55C1503	Mepco	
15						
16	1	R22	Potentiometer, Cermet, 20K	89PR20K	Beckman	
17	1	R5	Potentiometer, Cermet, 20K	72P20K	Beckman	
18						
19	1	R1	Resistor, Wire Wound, 12.47K	J110-12.47K + 0.1%	Jordan	
20	1	R2	Resistor, Wire Wound, 125K	J110-125K + 0.1%	Jordan	
21	1	R3	Resistor, Wire Wound, 7.30K	J110-7.3K + 0.1%	Jordan	
22	1	R4	Resistor, Wire Wound, 5.0K	J110-5.0K + 0.1%	Jordan	
23	1	R12	Resistor, 0.1%, M. Film, 125K	RN55C1253	Mepco	
24						
25	2	C3, 6	Capacitor, Dipped Mica, 100 pfd	DM15-101J	Arco	

RONAN ENGINEERING COMPANY
PARTS LIST

DPM BOARD, X85

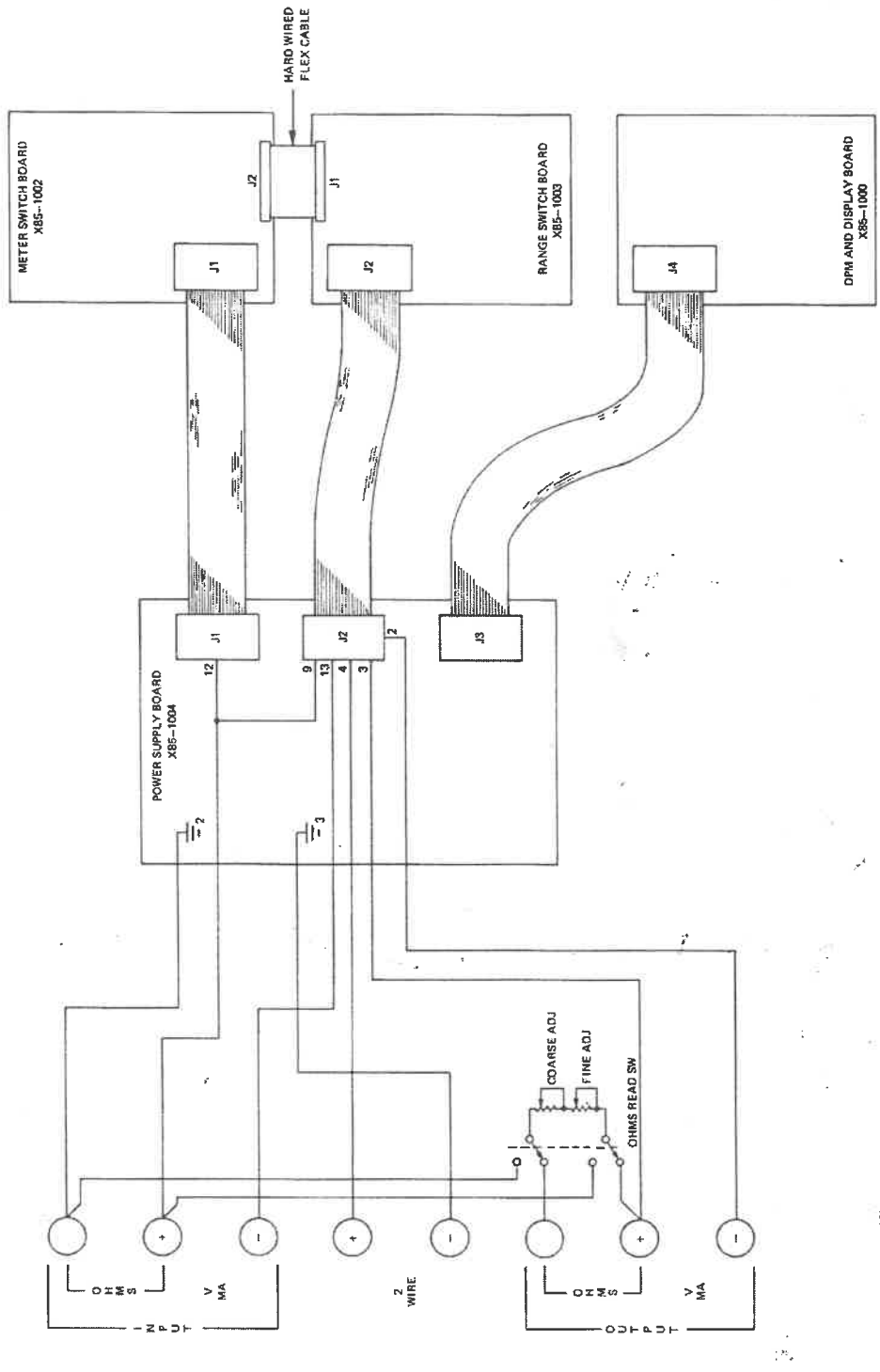
X85-1006-2

REV.
SHT. 2 OF 2

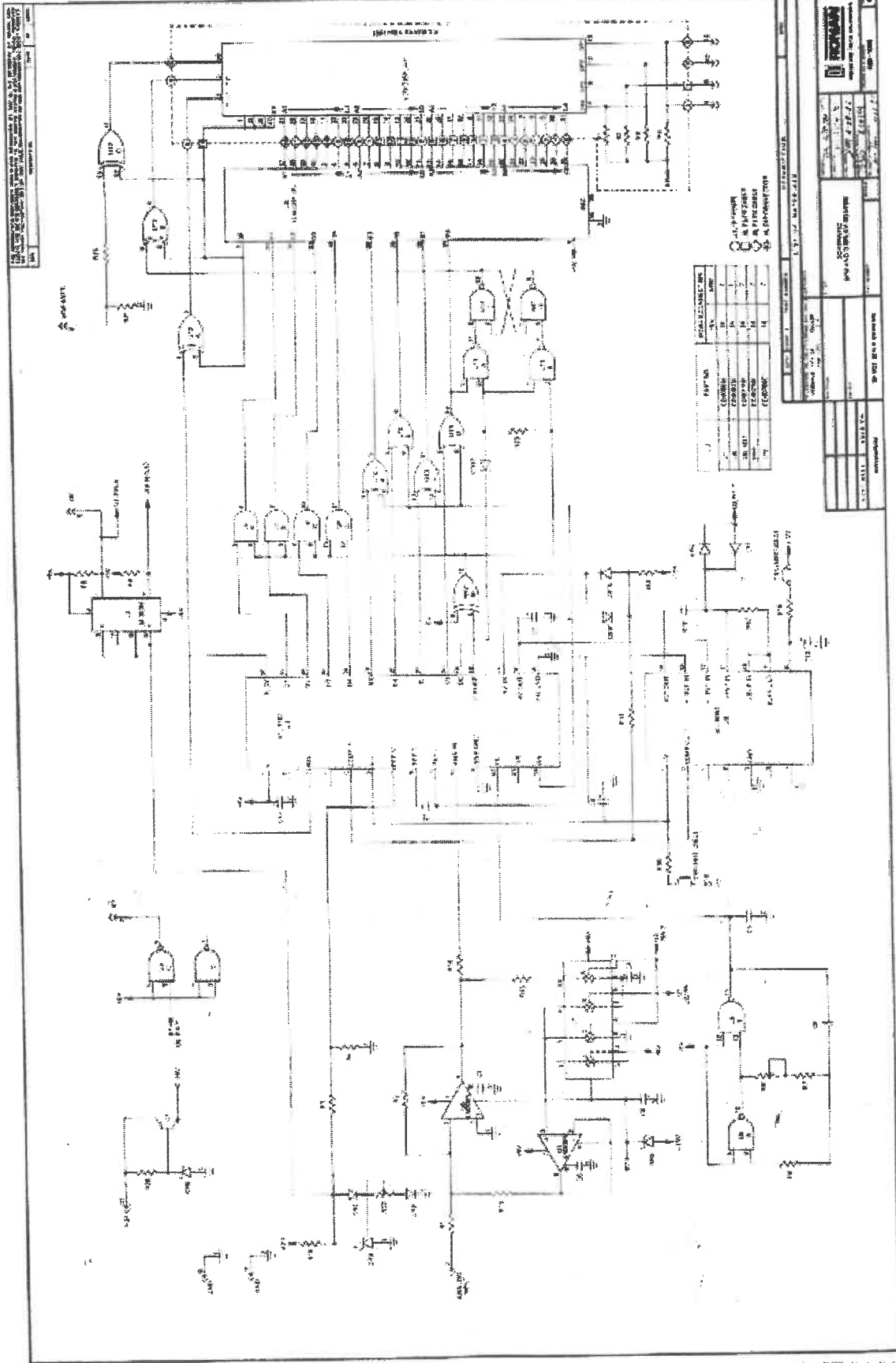
ITEM NO.	QTY. REQ.	IDENT.	DESCRIPTION	PART NUMBER	MFG. OR CODE	RIR NO.
26	2	C2,5	Capacitor, Dipped Mica, 220 pfd	DM15-221J	Arco	
27	5	C4,8,9,10,12	Capacitor, Tantalum 6.8mfd/35V	TAGA6.8K35	ITT	
28	1	C7	Capacitor, Tantalum 1mfd/35V	TAGA1.0K35	ITT	
29	1	C1	Capacitor, Polyester, .1mfd	C280MAH/AIM	Mepco	
30						
31	1	C11	Capacitor, Polypropylene, .33mfd + 10%, 200V	MPPI1-.33 + 10%-200V	Sth. Elect.	
32						
33	1	CR8	Diode Zener, 2.49V	LM336Z	National	
34	2	CR6,7	Diode, Signal	1N4148	Fairchild	
35	5	CR1,2,10,11,12	Diode, Low Leakage	1N457A	Fairchild	
36	2	CR3,9	Diode, Zener, 1N752A, 5.6V	1N752A	Motorola	
37	2	CR4,5	Jumper			
38						
39	1	Q1	Transistor, NPN	2N6715	National	
40	1	U2	Dual Comparator	LM393N	National	
41	2	U6,7	Op Amp	LM308N	National	
42	2	U5,11	Quad 2-Input Nand Gate	CD4011BE	RCA	
43	1	U12	Quad Exclusive Or Gate	CD4070BE	RCA	
44	1	U10	Quad 2-Input Or Gate	CD4071BE	RCA	
45						
46	1	U13	Logic Circuit (1/2 of Pair)	ICL71C03CPI or ICL71C03ACPI	Intersil	
47	1	U9	Analog Circuit (1/2 of Pair)	ICL8052CPD or ICL8052ACPD	Intersil	
48	1	U8	Latch/Decoder/Driver	ICM72111PL	Intersil	
49	1	U1	Quad Switch	CD4066BE	RCA	
50	1	U4	Quad 2-Input Nand Gate	CD4081BE	RCA	

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REV. NO.	DESCRIPTION	DATE	BY



ITEM NO	QTY	CODE	PART NUMBER	DESCRIPTION	SPEC
LIST OF MATERIALS					
MATERIAL: DECHALKER - 3X2.00 ANHLES - 3X2 - 200 1" W					
MATERIAL: FINISH					
MATERIAL: APPLICATION					
DO NOT SCALE DRAWING					
MATERIAL: NEXT ASSY USED ON					
MATERIAL: TITLE					
MATERIAL: INTERCONNECTION DRAWING					
MATERIAL: MODEL X85					
MATERIAL: DATE					
MATERIAL: DRAWN					
MATERIAL: CHECKED					
MATERIAL: APPROVED					
MATERIAL: QUALITY ASSURANCE					
MATERIAL: SCALE					
MATERIAL: P.O. NUMBER					
MATERIAL: CUSTOMER					
MATERIAL: DRAWING NUMBER					
MATERIAL: X85-1005					
MATERIAL: REV					
MATERIAL: 0					



Legend

○	WIPER
○	RELAY
○	SOLENOID
○	VALVE
○	ACTUATOR
○	SENSOR
○	CONTROL
○	POWER
○	GROUND

REVISIONS

NO.	DATE	DESCRIPTION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

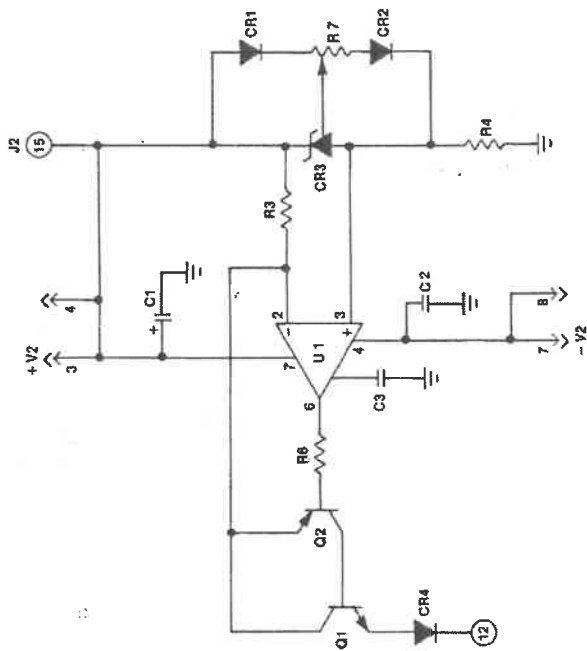
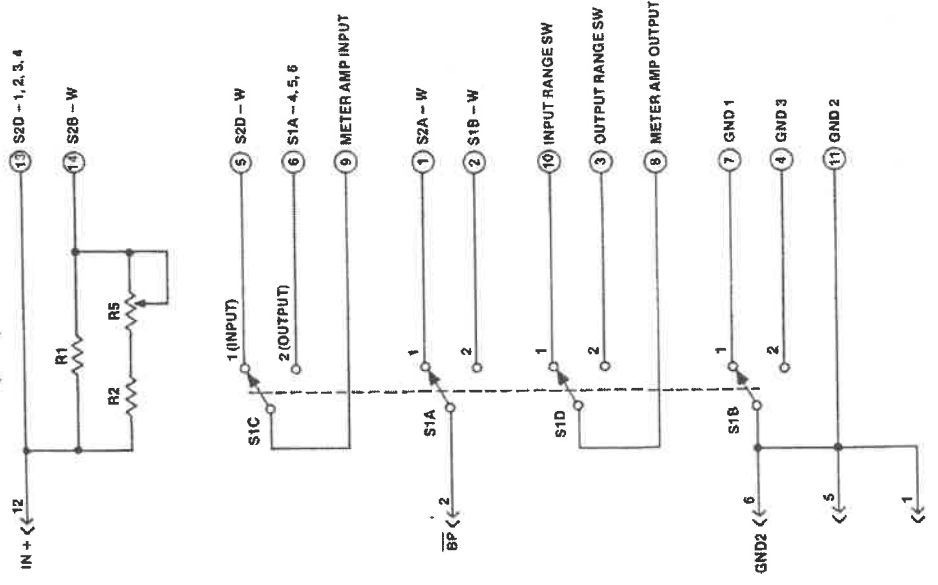
APPROVED: _____

DATE: _____

BY: _____

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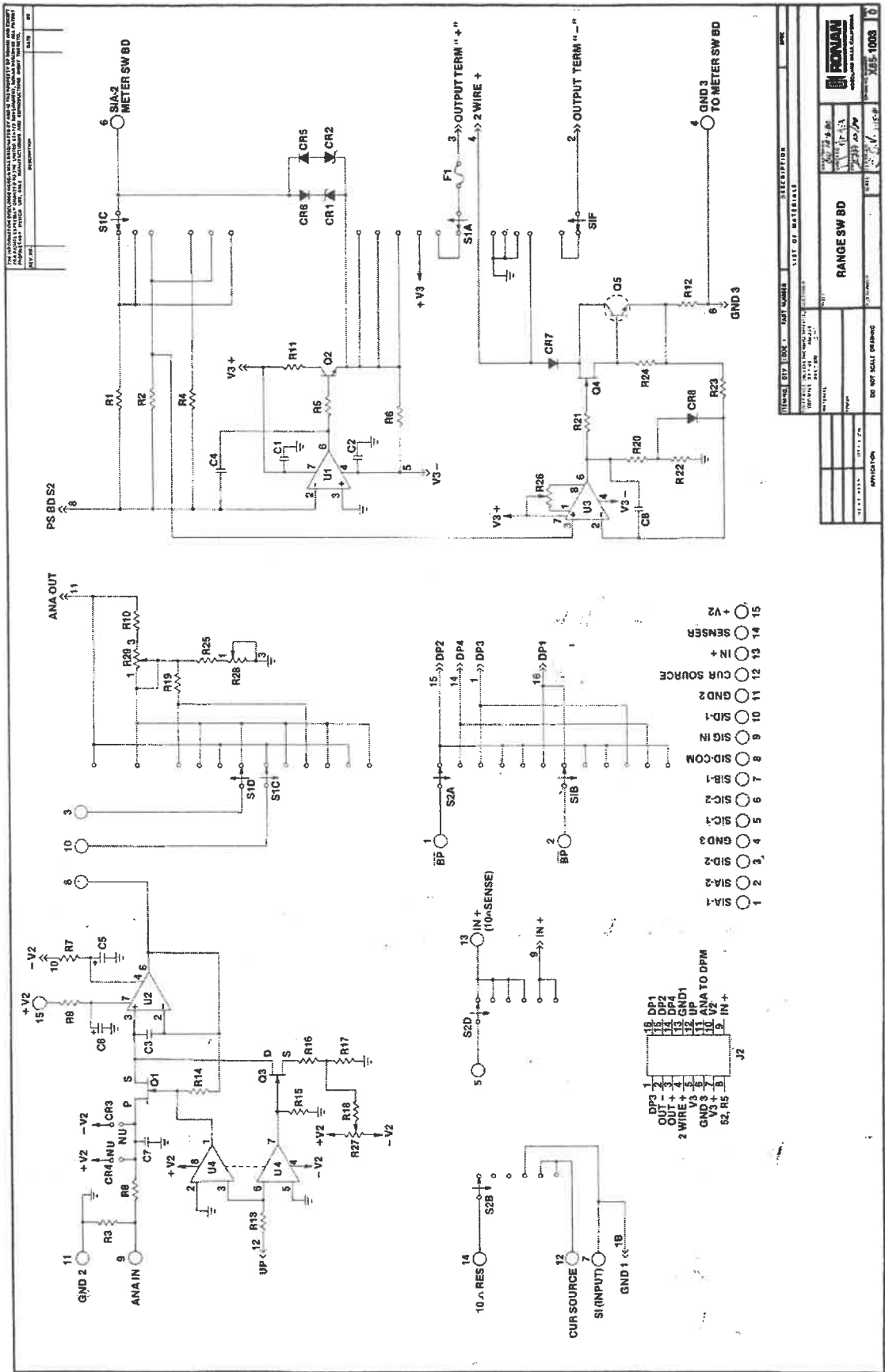
REV. NO.	DESCRIPTION	DATE	BY



J1	
1	GND2
2	BP
3	+V2
4	+V2
5	GND2
6	GND2
7	-V2
8	-V2

NOTE:
 ○ = FLEX STRIP TO RANGE SW BD
 → = DIP CONN TO P.S. BD

ITEM NO.	QTY.	CODE	PART NUMBER	DESCRIPTION	SPEC.
TOLERANCE UNLESS OTHERWISE SPECIFIED: CUSTOMER					
DIMENSIONS: 1/16" ± 0.015" 1/32" ± 0.010" 1/64" ± 0.005" 1/8" ± 0.010"					
MATERIAL:		TITLE: METER SWITCH BOARD			
FINISH:		DRAWN: [Signature]			
NEXT ASSY:		CHECKED: [Signature]			
USED ON:		DATE: 12/22/51			
APPLICATION:		DESIGNED BY: [Signature]			
DO NOT SCALE DRAWING		MATERIAL: [Blank]			
PG. NUMBER		SCALE: [Blank]			
PC NUMBER		DRAWING NUMBER: X85-1002			
REV. 0		WOODLAND HILLS, CALIFORNIA			
		ROMAN			



ITEM NO.	QTY	DESCRIPTION	REVISION
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2	1	RES	
3	1	RES	
4	1	RES	
5	1	RES	
6	1	RES	
7	1	RES	
8	1	RES	
9	1	RES	
10	1	RES	
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12	1	RES	
13	1	RES	
14	1	RES	
15	1	RES	

DO NOT SCALE DRAWING

APPLICATION

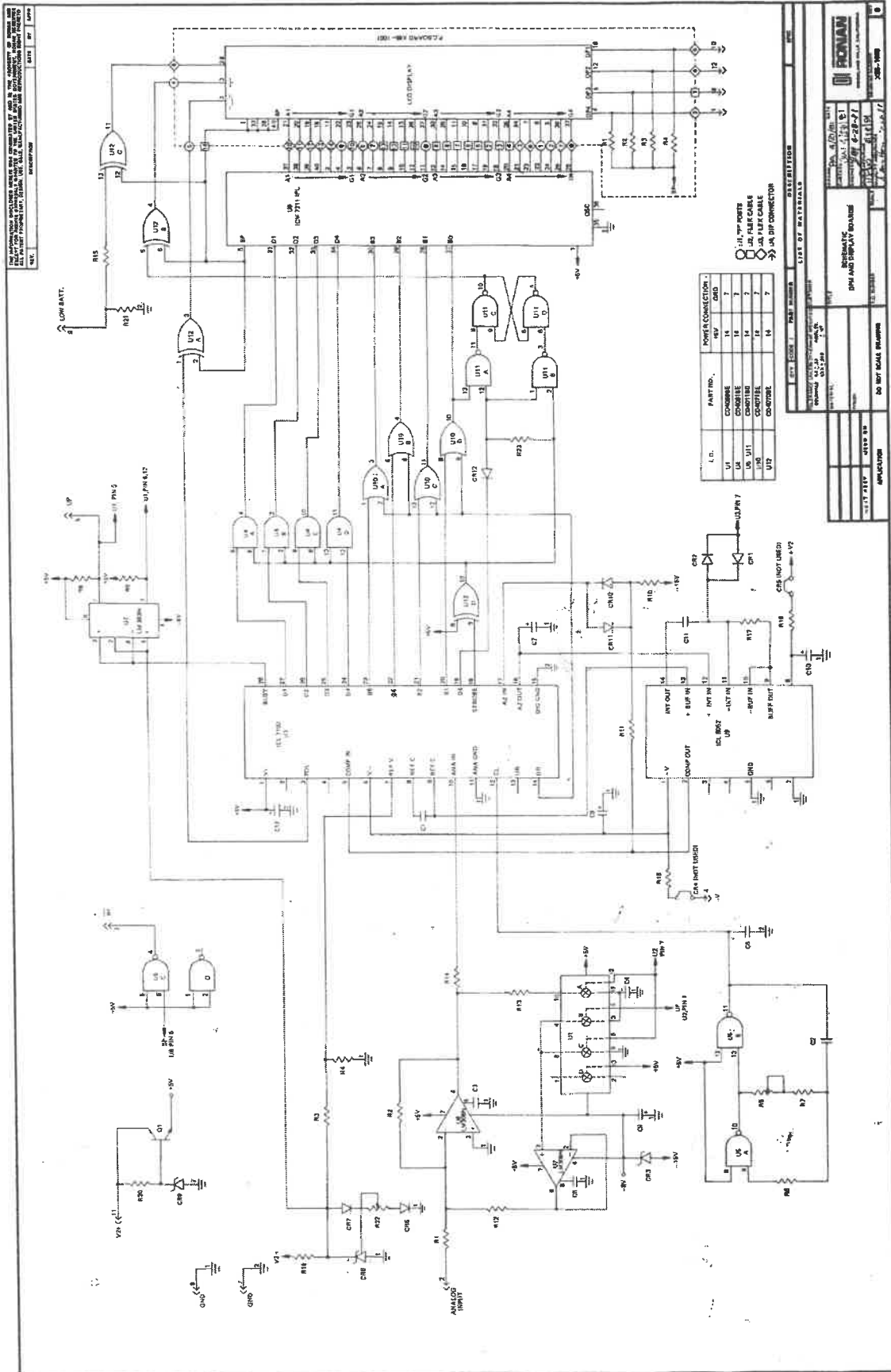
DATE

BY

CHKD

REV

10



AKUMULATOR

VARTA D88 (GOODK)

ORIGINAL BATTERY

046073366

NiCd (5 ĆLANAKA)

5 CELL

FOR ATEX VERSION BATTERY IS HERMETICALLY
SEALED IN BATTERY MODULE CASE.