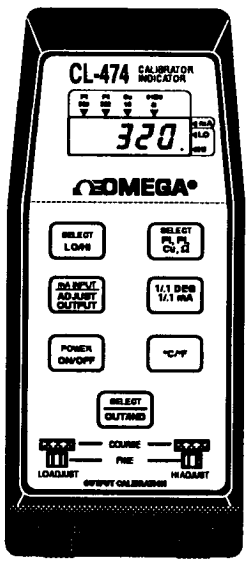
CL474

Digital RTD Calibrator and Indicator



OMEGA®

An OMEGA Technologies Company

Operator's Manual

M411/1091

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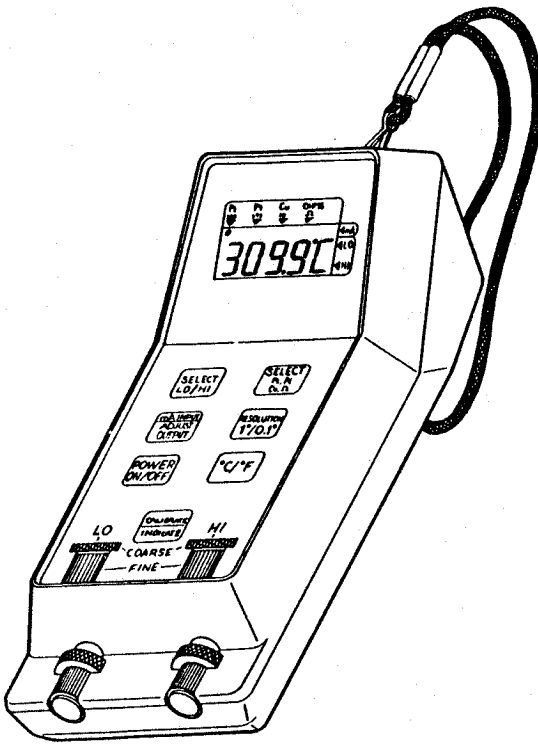

309.9C
SELECT LO/HI
SELECT
RA
DA
RESOLUTION 1°/0.1°
°C/°F
POWER ON/OFF
LO
HI
COARSE
FINE

Section 1
INTRODUCTION

1.1 INTRODUCTION

The hand-held, battery operated, RTD Calibrator/Indicator is used for calibration (output) or indication (input) of RTD or resistance devices. The instrument also functions as an isolated milliameter for measuring the output from a current transmitter. The following ranges are provided:

- RTD, Pt100, α = .00385
- RTD, Pt100, α = .00392
- RTD, Cu10
- ohms
- milliamps (input only)

This portable, rugged, and accurate instrument features intrinsically safe design for operation in hazardous environments (approval pending).

A principal feature of the instrument is the capability to output the LO or HI calibration value while simultaneously measuring current with the isolated milliammeter. This feature in a hand-held instrument provides an ideal means of calibrating isolated and non-isolated transmitters anywhere in the field. The instrument is also switch selectable to accept voltage input from transmitters with a 40-200 mV calibration output.

The instrument is controlled from a 7-key keyboard in conjunction with dual Coarse and Fine calibrator output adjust controls. For ease of operation, the keyboard buttons are conveniently color keyed to the appropriate display legend and the input/output jack overlay. Input or output measurements are shown on an easy to read liquid crystal display (LCD). Display resolution is keyboard selectable for 1° or 0.1° reading for Pt RTD ranges and 1 ohm or 0.1 ohm for the ohm range. Resolution is fixed at 1° for the Cu10 range and 0.01 mA for the milliamp range. The temperature display is keyboard selectable for °C or °F readings. The calibrator output is keyboard selectable for a preset high or low range output.

Six miniature banana jacks at the head of the instrument provide quick connection of input/output leads. The instrument is powered by an easily replaceable NEDA 1604 9-volt transistor radio battery.

The RTD Calibrator/Indicator is housed in a textured, high impact ABS plastic case. Overall dimensions are 8.35 in (21.2 cm) L x 3.75 in (9.5 cm) W x 2.75 in (7 cm) H. Weight is approximately 16 ounces (454 grams).

1.2 UNPACKING AND INSPECTION

Before placing the RTD Calibrator/Indicator in service, inspect the instrument for possible shipping damage, inventory contents for correct accessories and options, and check the instrument for proper operation. Promptly report physical damage, missing items, or improper operation to the factory.

The following is provided as standard with each RTD Calibrator/Indicator unit:

- 9-volt transistor radio battery
- Carrying case
- One 4-wire RTD leadset with stackable mini banana plugs
- One pair mA input test leads with mini banana plugs
- Two 3" (76 mm) jumper leads with mini banana plugs
- Two mini banana-to-a ligator clip lead adapters
- Four mini banana-to-spade lug adapters
- Instruction Manual

After inspection, use the following procedure to verify that the instrument is functional. This test can be used whenever a quick check of instrument operation is needed (see Figure 2-1 and refer to 2.1.1 for the description of control functions):

STEP 1: With no test leads connected to input, turn instrument ON by pressing **POWER ON/OFF** key. Observe that the display is active and shows either HI or LO calibrator value (black dot next to HI or LO).

STEP 2: Depending on which output is active (HI or LO) turn appropriate COARSE OUTPUT ADJUST control full clockwise, then counterclockwise. Observe that displayed value increments and decrements accordingly. This shows that calibrator source is functional. Note that RTD ranges will show overrange display (three columns of dashes) when both FINE and COARSE output controls are at adjustment extremes. Press the **SELECT LO/HI** key and test the alternate COARSE OUTPUT ADJUST control as described above.

STEP 3: Place instrument in indicate mode by pressing **CALIBRATE/INDICATE** key. Verify that neither HI or LO output is indicated on display.

STEP 4: Press **SELECT Pt, Pt, Cu, OHMS** key once for each type input shown on upper portion of display (Pt385, Pt392, Cu, and ohms). Verify that display range indication (black dot below labeled range) changes with each press of the **SELECT Pt, Pt, Cu, OHMS** key.

STEP 5: Turn instrument OFF.

1.2.1 Repair or Warranty Service

Direct all warranty and repair requests/inquiries to OMEGA Customer Service Department, telephone number (203)359-1660. Before returning any instrument, please contact the OMEGA Customer Service Department to obtain an authorized return (AR) number. The designated AR number should then be marked on the outside of the return package.

To avoid processing delays, also please be sure to include:

1. Returnee's name, address, and phone number.
2. Model and Serial numbers.
3. Repair instructions.

Section 2
OPERATION

2.1 GENERAL OPERATION

See Figures 2-1 and 2-3 for locations of all controls, connectors, and indicators described in the following paragraphs.

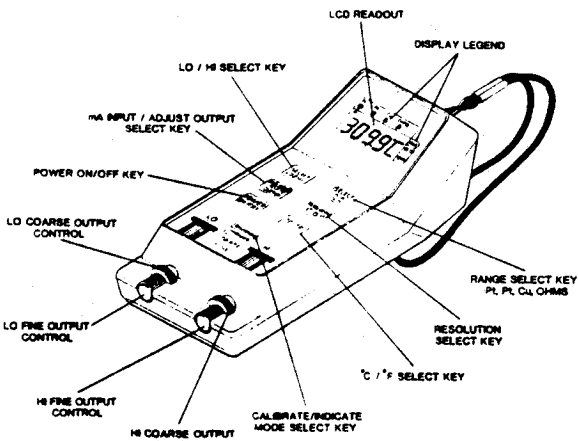


FIGURE 2-1. RTD CALIBRATOR/INDICATOR UNIT

2.1.1 Keyboard Function Description

POWER ON/OFF key: Controls power to instrument. Press once for **ON** and the LCD display is active. Press again for **OFF** and the LCD display is inactive. The instrument will be in the calibrate/adjust output mode when first turned on.

CALIBRATE/INDICATE key: Selects indicate or calibrate/adjust output mode for RTD or ohm ranges. To switch modes, press the **CALIBRATE/INDICATE** key:

> The calibrate/adjust output mode is shown by a HI or LO range output calibrator value on display. In this mode, the instrument provides adjustment of a simulated RTD signal or straight resistance of which the value is shown on the LCD readout but not given at the output. The displayed output is given only when the mA input display is selected. (This form of staging, adjust output then give output, avoids interaction between internal and external measurement current.) Note that the mA input can only be read by first placing the instrument in the calibrate/adjust output mode. Refer to **mA INPUT/ADJUST OUTPUT** key description below.
>
> The indicate mode is shown on the display by the absence of a HI or LO range output indication. In this mode, the instrument reads the value of an RTD or resistance input.

SELECT Pt, Pt, Cu, OHM key: Selects the type of input the instrument will measure or calibrate. The selected input type is shown on the LCD readout as a dot under the appropriate portion of the display legend (Pt385, Pt392, Cu, or ohm). Each time the **SELECT Pt, Pt, Cu, OHM** key is pressed, the display indication steps to the next range in sequence, left to right and back again to "Pt385".

°C/°F key: Selects Celsius or Fahrenheit readout for RTD ranges. The LCD readout shows the temperature scale selected as °C or °F. To change from one scale to the other, press the **°C/°F** key as required. This key is inactive for the ohm and mA ranges.

RESOLUTION 1°/0.1° key: Selects 1° or 0.1° display resolution for Pt. RTD ranges and 1 ohm or .1 ohm display resolution for the ohm range. This key is inactive in the mA input mode.

To change from one display resolution to the other, press the **RESOLUTION 1°/0.1°** key as required. When the instrument is in the high resolution mode (0.1° or 0.1 ohm), an auto-ranging feature is in effect:

> When the limit (either positive or negative) has been reached for the high resolution range, the instrument will automatically switch to the low resolution mode (1° or 1 ohm) and continue the reading up to the absolute limit of that range. Thus, an overrange input or output is always shown on the lower resolution of that range. Note that the RTD Calibrator/Indicator will not automatically switch back from low to high resolution display when the input/output returns to within the high resolution range of the instrument.

SELECT LO/HI key: Selects which of two calibrator output ranges (LO or HI) is to appear at the RTD input/output jack when mA input is displayed. Also selects which of two calibrator outputs is to be displayed for output adjustment when instrument is in calibrate/adjust output mode. The selected output range is shown on the LCD as a dot to the left of the appropriate portion of the display legend (LO or HI). Each time the **SELECT LO/HI** key is pressed, the instrument switches to the other output range.

mA INPUT/ADJUST OUTPUT key: Switches instrument between calibrate/mA input display and calibrate/adjust output modes. Press this key once and the instrument displays the input from the mA input terminals — indicated on the LCD by a dot to the left of the mA display legend. With the mA input on display, the calibrator value last selected is output from the instrument. Press this key again and the instrument displays the last range selected by the **SELECT Pt, Pt, Cu, OHM** key; however, the displayed value is no longer given at the output. The output is released only when the mA input is selected for display. Also refer to **CALIBRATE/INDICATE** key description above.

2.1.2 Display Indicators

The LCD readout has indicators for low battery, overrange input/output, °C/°F temperature scale, and negative polarity. The display also has indicators for range/function select (ohm, mA, Pt385, Pt392, and Cu) and calibrator HI/LO output. These are shown as a dot next to the appropriate portion of the display legend.

2.1.3 Calibrator Output Controls

Each calibrator output range (LO and HI) is controlled individually by 10-turn Coarse and Fine output controls. The Coarse control provides a coarse adjustment of the calibrator output to within the range of the Fine control. The Fine control provides a fine adjustment of the calibrator output value to within 0.1° or 0.1 ohm depending on range used.

2.1.4 Internal Slide Switches

Two slide switches inside the battery compartment are used to configure the instrument. These switches are the RTD switch and the mA switch. Always check the switch settings and set them as appropriate before calibrating an instrument (mA switch) or reading a sensor (RTD switch).

To access the switches, remove the battery cover on the case bottom and lift the battery out. (Loosen the cover screw just enough to free the cover — the screw will stay on the cover by its washer.) A label on the inside of the battery cover (see Figure 2-2) shows the switch positions. Replace the cover after setting the switches.

TIP: To avoid unnecessary opening of the battery compartment, note the switch settings on a small piece of masking tape. Place the tape on the back of the instrument near the cover.

WARNING

Do not open battery compartment or expose instrument's open battery compartment in an explosive or potentially hazardous environment.

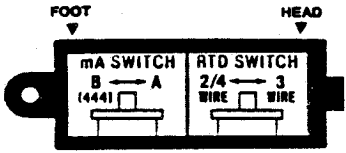


FIGURE 2-2. LABEL, BATTERY COMPARTMENT COVER

RTD Switch

The slide switch closest to the jacks at the head of the instrument is the RTD switch. This switch, which is active only in the indicate mode, selects the RTD type (2-, 3-, or 4-wire) to be read.

- Slide this switch towards the head of the instrument for 3-wire RTDs.
- Slide this switch towards the foot of the instrument for 2- or 4-wire RTDs, or straight resistance.

mA Switch

The slide switch farthest from the jacks at the head of the instrument is the mA switch. This switch selects the type of input to be read at the mA input terminals.

- Slide this switch towards the head of the instrument for 4-20 mA input (position "A").
- Slide this switch towards the foot of the instrument for 40-200 mV input (position "B"). Note that the instrument converts a 40-200 mv input to a 4-20 mA display reading. (The "444" designation refers to the Rosemount Model 444 transmitter.)

2.1.5 Instrument Connections

Input/output connections are made at the head of the instrument (see Figure 2-3). The jacks are color coded for general polarity as follows: RED positive (+), BLACK negative (−).

The RTD jacks are numbered and referenced by RTD lead function: "V+" is jack #1, "V−" is jack #2, "I−" is jack #3, and "I+" is jack #4.

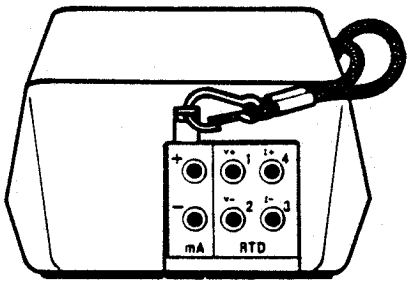


FIGURE 2-3. INPUT/OUTPUT JACKS

For the mA input, use the test lead terminated in two single mini-banana plugs on one end and one dual mini-banana plug on the other end. (This end plugs into mA input jacks.) Use the banana plug adapters (alligator and mini-to-standard) supplied with the instrument to attach the mA input leads as required.

For RTD connections, use the 4-wire leadset supplied. This leadset has four individual mini-banana plugs on one end and stackable mini-banana plugs on the other end. (This end plugs into RTD jacks.) Use the mini-banana to spade lug adapters supplied with the instrument to attach the RTD input/output leads to barrier strip screw terminals. The wires of the RTD leadset are color coded as follows:

RTD JACK	LEAD COLOR
V + /1	red
V − /2	black
I − /3	green
I + /4	white

Note that you must use jumpers (supplied with the instrument) on the instrument end of the 4-wire leadset when *indicating a 2-wire RTD or ohm source only.* This is discussed in 2.3 and illustrated on page 2-15.

2.2 CALIBRATE MODE

Two calibrator output ranges are alternately available from the instrument. The calibrator outputs, designated LO and HI, are controlled individually by 10-turn Coarse and Fine controls as described in 2.1.3. The output controls are located at the foot of the instrument. The left Output Adjust controls adjust the calibrator LO output. The right Output Adjust controls adjust the calibrator HI output. Both LO and HI outputs can be adjusted over the entire temperature and ohm range. If the output is adjusted beyond that of the range selected, three columns of dashes replace the digit data on the display. This is the instrument's overrange indication.

Set the calibrator LO output for the minimum or negative full scale value and the calibrator HI output for the maximum or positive full scale value of the range being output. The two outputs can then be switched back and forth for easy adjustment of the instrument being calibrated.

The important thing to remember about the calibrate mode is that the output is given only when the mA input is selected for display. When adjusting the output with the value on display, the calibrator output is inactive — the instrument is in the calibrate/adjust output mode. The instrument will be in this mode when it is first turned on or when the **CALIBRATE/INDICATE** key is pressed with the instrument currently reading a sensor input.

2.2.1 Transmitter Calibration

When calibrating transmitters, the calibrator supplies the input signal while simultaneously measuring the current (or calibration voltage) output from the transmitter. The following describes how to use the instrument for transmitter calibration after the required connections have been made.

In order to properly read the mA input, check the mA switch setting before proceeding with transmitter calibration. Set the switch as required. The setting of this switch depends on whether the transmitter being calibrated gives a 4-20 mA signal only or a 40-200 mV calibration signal. Refer to 2.1.4 for the discussion of this switch.

With the mA switch in the proper position, place the instrument in the calibration/adjust output mode (LO or HI shown on the display). Press the **SELECT Pt, Pt, Cu, OHM** key as required to display the desired range. (Select temperature scale and resolution as required.) Note that the calibrator value is NOT being output at this time. This allows the instrument to use an internal excitation current for the simulated RTD signal (that is, a particular resistance). With the output range on display, adjust the appropriate output controls at the foot of the instrument for the

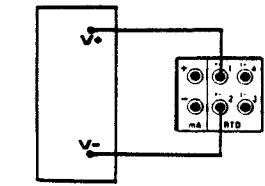
desired value. Press the **SELECT LO/HI** key to set the value of the alternate calibrator output.

Then press the **mA INPUT/ADJUST OUTPUT** key to measure the input at the mA input jacks. The last selected output value as adjusted (do not disturb the output control settings) will now be given as the calibrator output reading is replaced by the mA input reading (transmitter output). With mA displayed, press the **SELECT LO/HI** key as required to give the output values (lower and upper span limits) to the transmitter input. The easy selection between two calibrated signals with immediate transmitter output readings makes calibration a simple task.

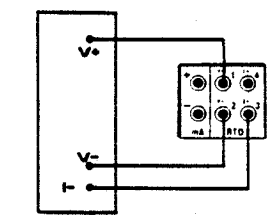
The display can be switched at any time between mA input and calibrator output value (press **mA INPUT/ADJUST OUTPUT** key). Just remember that the transmitter will no longer have the input signal when the calibrator value is on display.

2.2.2 Operation Guide, Calibrate Mode

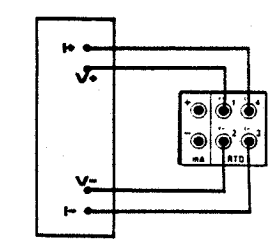
RTD/RESISTANCE INDICATOR - RECORDER CALIBRATION
1. Connect instrument RTD output to RTD/ohm input.
2. Turn instrument ON. Observe that instrument is in calibrate/adjust output mode with LO or HI indicated on LCD.
3. Select Pt385, Pt392, Cu, or ohms range.
4. Select °F or °C display.
5. Select 1° or 0.1° resolution (Cu10 fixed at 1° resolution).
6. Select LO or HI calibrator output.
7. Observe display and adjust appropriate COARSE and FINE controls for desired output setting. Two points of the span can be calibrated by adjusting the LO output for the lower span limit and the HI output for the upper span limit of the calibration range.
8. Press **mA INPUT/ADJUST OUTPUT** key to release calibrator output. Proceed with calibration, switching between LO and HI calibrator outputs as required for the calibration adjustments. (Be careful not to disturb output control settings.)



2-WIRE RTD INDICATOR
OR RECORDER



3-WIRE RTD INDICATOR
OR RECORDER



4-WIRE RTD INDICATOR
OR RECORDER

CONNECTION DIAGRAMS — INDICATOR/RECORDER CALIBRATION

TRANSMITTER CALIBRATION

1. Remove battery compartment cover and position mA switch according to type transmitter being calibrated:

   The "A" position is for transmitters where the calibrator must be inserted into the 4-20 mA current loop in order to read the output.

   The "B" position accommodates transmitters with a 40-200 mV calibration output.

   Replace battery compartment cover after positioning the mA switch.

   WARNING

   Do not open battery compartment or expose instrument's open battery compartment in an explosive or potentially hazardous environment.

2. Remove sensor from transmitter input and connect instrument RTD output to transmitter input using 4-wire leadset supplied. Connect transmitter output to instrument mA input jacks using 2-wire test lead supplied.

3. Turn instrument ON. Observe that instrument is in calibrate/adjust output mode with LO or HI indicated on LCD.

4. Select Pt385, Pt392, or Cu range.

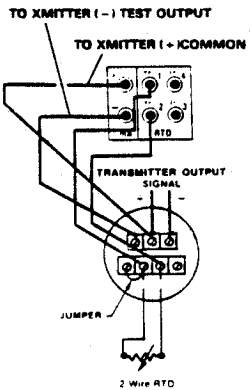
5. Select °F or °C display.

6. Select 1° or 0.1° resolution (Cu10 fixed at 1° resolution).

7. Select LO or HI calibrator output.

8. Observe display and adjust appropriate COARSE and FINE controls for desired output setting (consult transmitter's specifications or operating instructions for calibration values with appropriate readings). Two points of the span can be calibrated by adjusting the LO output for the lower span limit and the HI output for the upper span limit of the calibration range. Press **SELECT LO/HI** key as required to display the alternate values.

9. Press **mA INPUT/ADJUST OUTPUT** key to release calibrator output and to read value at mA input jacks. Proceed with transmitter calibration, switching between LO and HI calibration outputs as required for the calibration adjustments. (Be careful not to disturb output control settings.)



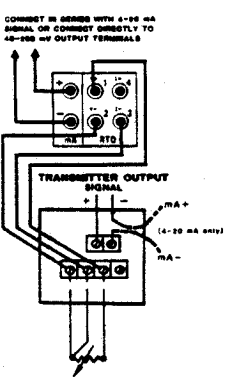
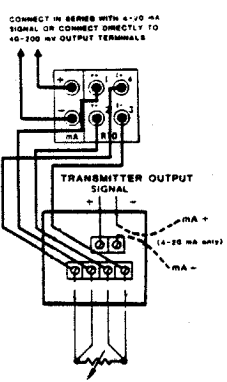


Diagram above shows a typical Model 444 transmitter calibration hook-up (mA switch in "B" position).



CONNECTION DIAGRAMS — RTD TRANSMITTER CALIBRATION

Nickel 120 RTD

°F	°C	Resistance in Ohms
-94	-70	73.10
-76	-60	79.62
-58	-50	86.17
-40	-40	92.76
-22	-30	99.41
-4	-20	106.15
+14	-10	113.00
+32	0	120.00
+50	+10	127.17
+68	+20	134.52
+86	+30	142.06
+104	+40	149.79
+122	+50	157.74
+140	+60	165.90
+158	+70	174.27
+176	+80	182.85
+194	+90	191.64
+212	+100	200.64
+230	+110	209.86
+248	+120	219.30
+266	+130	228.96
+284	+140	238.85
+302	+150	248.97
+320	+160	259.37
+338	+170	269.92
+356	+180	280.79
+374	+190	291.96
+392	+200	303.46
+410	+210	315.31
+428	+220	327.53
+446	+230	340.14
+464	+240	353.14
+482	+250	366.53
+500	+260	380.31
+536	+280	409.07
+572	+300	439.43

The Nickel 120 RTD range can be derived by using the instrument's Ohms range and referring to the table on the left.

2.3 INDICATE MODE

The indicate mode is shown on the display by no dot next to HI or LO. When the instrument is in the indicate mode, it provides an excitation current through the external resistance. The resulting voltage drop is measured and translated into a particular temperature or resistance reading.

Since the I+ and I− jacks provide the excitation current, indication of straight resistance and 2-wire RTDs requires jumpers at the instrument input. A pair of jumper leads are supplied with the instrument for this purpose. These jumpers connect the unconnected "I" jack(s) to the appropriate "V" jack(s). The stackable mini-banana plugs at the instrument end of the 4-wire leadset accommodate these jumpers.

In order to properly read the input, check the RTD switch setting before using the instrument in the indicate mode. Set the switch as required for the input type to be read. Refer to 2.1.4 for the discussion of this switch.

Place the instrument in the indicate mode. Connect the input observing proper polarity **(use jumpers as required)**. To measure an input, select the appropriate range, resolution, and temperature scale if applicable.

NOTE

The mA input is not read in the indicate mode. To read the mA input, the instrument must be placed in the calibrate/adjust output mode first.

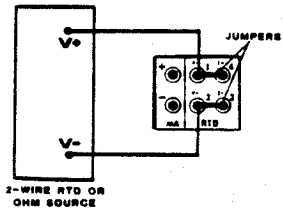
RTD/OHM INPUT

1. Remove battery compartment cover and position RTD switch according to input being read. Replace battery compartment cover after positioning the RTD switch.

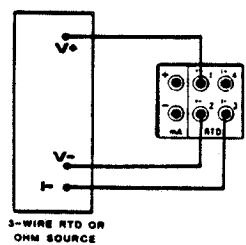
WARNING

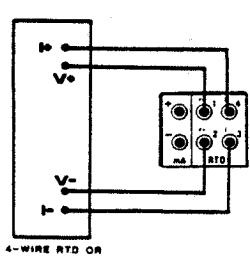
Do not open battery compartment or expose instrument's open battery compartment in an explosive or potentially hazardous environment.

2. Connect RTD or resistance input to instrument using 4-wire leadset supplied. Use input jumpers as required.
3. Turn instrument ON. Observe that instrument is in calibrate/adjust ouput mode with LO or HI indicated on LCD.
4. Select indicate mode by pressing **CALIBRATE/INDICATE** key. Observe that neither HI or LO is shown on LCD readout.
5. Select Pt385, Pt392, Cu, or ohm range as applicable.
6. Select °F or °C as applicable.
7. Select 1°/0.1° or 1 ohm/.1 ohm resolution as applicable.
8. Observe and/or record display reading.



INPUT JUMPERS MUST BE USED AS SHOWN ABOVE FOR 2-WIRE RTD/OHM INDICATION





CONNECTION DIAGRAMS — RTD/OHM INDICATION

2.4 MAINTENANCE

Normal maintenance of the instrument consists of replacing the battery as required, cleaning the instrument case as required, and calibration once a year as outlined in Section 3.

2.4.1 Battery Replacement

The instrument uses a NEDA 1604 (or equivalent) 9-volt transistor radio battery. A carbon zinc battery should provide approximately 400 hours of continuous operation.

WARNING

For RTD Calibrator/Indicators with intrinsic safety approval: The replacement battery must be the exact type battery as specified on the approval label on the case bottom.

When battery voltage reaches approximately 6.3 volts, the display will show a low battery warning by flashing the words "LOW BAT". A minimum of 2 hours of operation time remains upon initial appearance of the low battery warning — replace the battery at the earliest opportunity. When the battery voltage drops below 5.5 volts, the display will show three columns of dashes (overrange indication) in addition to the flashing words "LOW BAT".

To replace the battery, remove the battery compartment cover on the case bottom (loosen the retaining screw just enough to free the cover — the screw will then be held on the cover by its washer). Remove the battery by pulling on the connector (not on the wires) and install the new battery. Re-install the battery compartment cover.

WARNING

Do not open the battery compartment or expose the instrument's open battery compartment in an explosive or potentially hazardous environment.

2.4.2 Instrument Cleaning

The instrument should be cleaned with a soft, damp cloth using mild soap and water. To effectively remove grease or heavy oils from the instrument, non-abrasive mechanics soap may be used. Abrasive cleaning agents should not be used for cleaning the instrument.

Section 3
CALIBRATION

3.1 CALIBRATION PROCEDURE

Equipment Required:

Precision resistance decade box: resolution, .01 ohm; accuracy, ±.02%.
Precision milliamp source: resolution, 1 μA; accuracy ±.01% (±2 μA).
Potentiometer adjusting tool

Refer to Figure 3-1 for locations of pot adjustments.

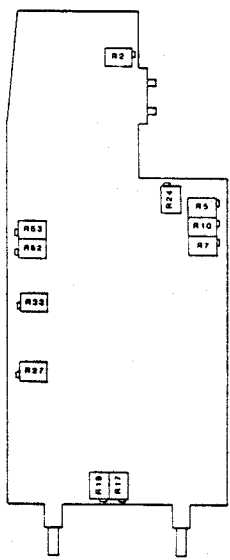


FIGURE 3-1. POTENTIOMETER ADJUSTMENT/TESTPOINT LOCATIONS

3.1.1 Disassembly

a. Remove battery from instrument (refer to 2.4.1).

b. Remove bottom case half from printed circuit board assemblies by extracting three screws from case bottom and one screw holding wrist strap lug.

c. Remove top case half from printed circuit board assemblies by extracting screw on clad side of Analog board between output controls.

d. Re-connect battery to connector.

3.1.2 RTD/Ohm Calibration

a. Set RTD switch to 2-/4-wire position.

b. Set mA switch to "A" position.

c. Connect precision resistance decade box to instrument input using supplied 4-wire leadset: connect V + and I + jacks to one terminal of decade box; connect V – and I – jacks to other terminal of decade box. Use supplied mini-banana adapters as required to connect decade box.

d. Turn instrument on and wait five minutes for stabilization.

e. Select: indicate mode, Pt392 range, °F readout, .1° resolution

f. Set decade box to 100.00 ohms.

g. Adjust R24 for a display reading of 32.0 °F.

h. Set decade box to 176.90 ohms.

i. Adjust R27 for a display reading of 390.0 °F.

j. Set decade box to 59.00 ohms.

k. Adjust R33 for a display reading of – 150.0 °F.

l. Repeat steps 3.1.2.e through 3.1.2.k until no further adjustments are required.

m. Select Pt385 range.

n. Set decade box to 175.43 ohms

o. Adjust R17 for a display reading of 390.0 °F

p. Select: Cu10 range, °C readout.

q. Set decade box to 9.04 ohms.

r. Adjust R7 for a display reading of 0 °C.

s. Select °F readout.

t. Adjust R5 for a display reading of 32 °F.

u. Select °C readout.

v. Set decade box to 16.780 ohms.

w. Adjust R19 for a display reading of 200 °C.

x. Select °F readout; display should read 392 °F.

y. Repeat steps 3.1.2.p through 3.1.2.x until no further adjustments are required for correct display readings.

z. Select ohms range.

aa. Select decade box to 0.00 ohms.

bb. Adjust R10 for display readings of 00 and 0.0 for 1 ohm and .1 ohm ranges respectively.

cc. Set decade box to 1000.0 ohms.

dd. Adjust R52 for a display reading of 1000 ohms.

ee. Set decade box to 390.0 ohms.

ff. Select .1 ohm resolution.

gg. Adjust R53 for a display reading of 390.0 ohms.

hh. Repeat steps 3.1.2.z through 3.1.2.gg until no further adjustments are required for correct display readings.

3.1.3 mA Input Calibration

a. Observing proper polarity, connect precision mA source to mA input jacks of instrument.

b. Set instrument to calibrate/mA input mode.

c. Adjust mA source output to 32.00 mA.

d. The display should read 32.00 mA. If not, adjust R10 for correct reading.

e. Adjust mA source output to 3.20 mA.

f. The display should read 3.20 mA. A correction of 0.01 may be made by adjusting R10.

g. IF R10 WAS ADJUSTED FOR THE mA READINGS, RECHECK THE OHMS RANGE (3.1.2.z through 3.1.2.hh).

h. Carefully reassemble instrument.

CALIBRATION COMPLETED

Section 4
THEORY OF OPERATION

(See diagrams in Appendix)

4.1 GENERAL

The calibrator/indicator unit is physically divided into two printed circuit board assemblies: the Analog Board, and the Digital Board. Functionally, the instrument consists of two main sections: an RTD/resistance calibrator, and an RTD indicator/ohmmeter.

Two custom CMOS integrated circuits are utilized to digitize and display the analog input signals.

Integrated circuit Z4 on the Analog Board performs the conversion of the analog input to the digital equivalent via dual-slope integrator coupled to a zero-cross detect amplifier. A patented low noise, high gain amplifier is used as an integrator. Battery voltage is also monitored by this IC. IC Z4 uses three low power op-amps for a total current consumption of 30 μA.

IC Z17 on the Digital Board is comprised of LSI digital circuitry. This IC provides the timing signals for the analog circuitry of IC Z4 on the Analog Board and senses the axis crossing of the dual slope converter. An internal counter, in conjunction with a ROM controlled binary rate multiplier, performs a piece-wise linearization on the signal. IC Z17 stores the linearized results and directly drives the LCD readout.

Seven separate, normally open, momentary contact, pushbutton switches on the Digital Board comprise the instrument keyboard. These switches are gated by CMOS gates and switches in order to drive various LCD segments and/or address the custom LSI IC Z17.

4.2 RTD/RESISTANCE CALIBRATOR WITH mA INDICATOR

The RTD/resistance calibrator circuitry is located on the Analog Board. (See sheet 2 of Analog Board schematic.) Pot tandems R39 and R40 (LO) and R42 and R43 (HI) provide the resistance source. With the instrument in the calibrate/adjust output mode, relay K3 is energized which causes a excitation current to flow through one of the selected pot tandems.

An isolated excitation current is produced by a current generator circuit. This circuit is powered by an isolated power supply comprised of

transformer T1 and bridge rectifier CR7. For RTD ranges, zeners CR4 and CR5 and R46 provide the current which is switched on by FET Q3. For straight resistance, op-amp Z5 along with CR4 and CR5 provide a constant current which is independent of the applied resistance. The constant current is enabled by turning on FET Q2 and turning off FET Q3. The resulting voltage drop across the pot tandem is read by Z4 via the SIG HI line. Depending on the selected range, this voltage is converted to a particular temperature or resistance value by IC Z17 on the Digital Board. The current generator is in use when adjusting the output on display and when indicating an external RTD or resistance input.

When the mA input is selected for display, the signal (resistance value) is output as relay K3 is de-energized to remove the internal measurement current and relay K1 is energized to connect the selected pot tandem to the V and I outputs at the instrument jacks. At this time, relay K2 is de-energized to apply the derived mA input to the input of the LSI Z4. Relay K2 also switches the BP (not) signal to the MA input of the LCD (DS1, on Digital Board) to indicate the mA display mode.

The LO and HI lines from the Digital Board control relay drivers Q6 and Q7 respectively to indicate on the LCD a HI or LO output. The K4 relay contacts route the BP (not) signal to DS1 as appropriate.

4.2.1 Isolated mA Input

The mA input is applied to shunt resistor R4 in the normal current measuring mode. The shunt resistor is removed and the signal passed directly when the instrument is used to accept voltage input from those transmitters provided with a calibration voltage output. Fuse F1 and zener CR1 provide input protection. Capacitor C1 decouples spurious noise from the signal input.

Transformer T1 and rectifier CR7 are used to provide isolated power to multiplexer Z3 and the current generator. Mux Z3 selects the current requirements of ohms range resolution (1° or .1°) and RTD ranges.

4.3 RTD INDICATOR/OHMMETER

Refer to the Analog Board schematic. RTD or resistance inputs are connected to jacks J3-J6. Fuse F3 and diodes CR3 and CR15 provide input protection against overcurrent and overvoltage. Capacitors C20 and C21 decouple spurious noise from the input. The measurement current for a particular RTD or resistance input is given by switch S2. Relays K1 and K3 are both de-energized when the instrument is in the indicate mode. This brings the V + and V − inputs directly to the SIG HI and SIG LO lines and the current generator at the I + (hot) and I − (return) outputs.

Section 5
SPECIFICATIONS

5.1 SPECIFICATIONS

5.1.1 Functional

Range/Span/Resolution

Range	Span	Resolution
Curve: IPTS-68/ DIN 43760		
Pt385	-153.2°F to +398.3°F (102.9°C to +103.5°C)	0.1°
R_0 100	-388°F to +1660°F (-233°C to +904°C)	1°
Curve: IPTS-68		
Pt392	-153.2°F to +398.3°F (-102.9°C to +203.5°C)	0.1°
R_0 100	-388°F to +1660°F (-233°C to +904°C)	1°
Curve: Minco 16-9		
Cu 10 R_{25} 10	-58°F to 482°F (-50°C to +250°C)	1°
Ohms:		
Input	2.0Ω to 399.2Ω	0.1Ω
	2Ω to 1000Ω	1Ω
Output	2.0Ω to 399.2Ω	0.1Ω
	2Ω to 950Ω	1Ω
mA Input	0.00mA to 39.92mA (mA switch "A")	0.01mA
	0.0mV to 399.2mV (mA switch "B")*	0.1mV

* — Readout in mA as in switch "A" setting.

Input Impedance (Indicate Mode):

RTD and ohms: greater than 15 Megohms
Isolated mA: "A" setting, approximately 11 ohms; "B" setting, 190 kohms nominal.

Output Impedance (Calibrate Mode)

Calibrate/Adjust Output Mode: greater than 100 Megohms
Calibrate/mA Input Display: less than one ohm between V+ and I+ jacks and V− and I− jacks. A resistance equal to the setting of the selected LO or HI potentiometer exists between the two "V" jacks and the two "I" jacks.

Overload Protection: Input fuse and diode clamping protection (7.5 volts maximum DC).

Display: 4-digit liquid crystal display (LCD) with 0.4" (10 mm) digit height.

Turn On Time: 5 seconds

Battery: Instrument requires one 9-volt transistor radio battery, NEDA 1604 or equivalent. Battery provides approximately 400 hours of continuous operation.

5.1.2 Performance

Noise Rejection

NMRR: 50 dB @ 50/60 Hz ± 1 Hz, 0.1° range.
35 db @ 50/60 Hz ± 1Hz, 1° range.
Maximum: 0.5 VAC RMS

CMRR (100 ohms unbalance):
140 dB @ 50/60 Hz ± 1 Hz, 0.1° range.
120 dB @ 50/60 Hz ± 1 Hz, 1° range.
Maximum: 150 VAC RMS

Accuracy* at 72°F, ±5°F (22°C, ±3°C):

Pt.385, Pt.392, and Cu10 Sensors, Input and Output:

1° range: ±0.1% rdg. ±1.8°F/ ±1.0°C
0.1° range: 0.1% rdg. ±0.45°F/0.25°C

*Includes all errors due to linearization, A/D conversion, internal instrument noise at 22°C ±3°C ambient temperature without zero or span adjustment for 24 hours. 3 wire RTD indication: add 2.5°C/Ω lead unbalance and .005°C/Ω lead resistance.

Ohm Input and Output:

1 ohm and 0.1 ohm ranges: ±0.1% rdg. ±1 count

mA Input (both "A" and "B" mA switch settings):

0.01 mA range: ±0.1% rdg. ±2 counts

Stability With Time

90 days: add ±0.05% rdg.
1 year: add ±0.1% rdg.

Stability With Temperature

Zero: ±1.1 microvolts per °F (±2 microvolts per °C)
Span: ±0.01% rdg. per °F (±0.02% rdg. per °C)

5.1.3 Physical/Environmental

Area Classifications: Factory Mutual and CSA intrinsically safe certification for Class I, Division 1 and 2, Groups C and D (approval pending). Intrinsically Safe Certification per the CENELEC standards for Gas Groups IIB and IIA, Zone 1 (approvals pending). See label at bottom of instrument for applicable approvals.

Operating Range: −4 to 131°F (−20 to 55°C)

Storage Range: −22 to 140°F (−30 to 60°C)

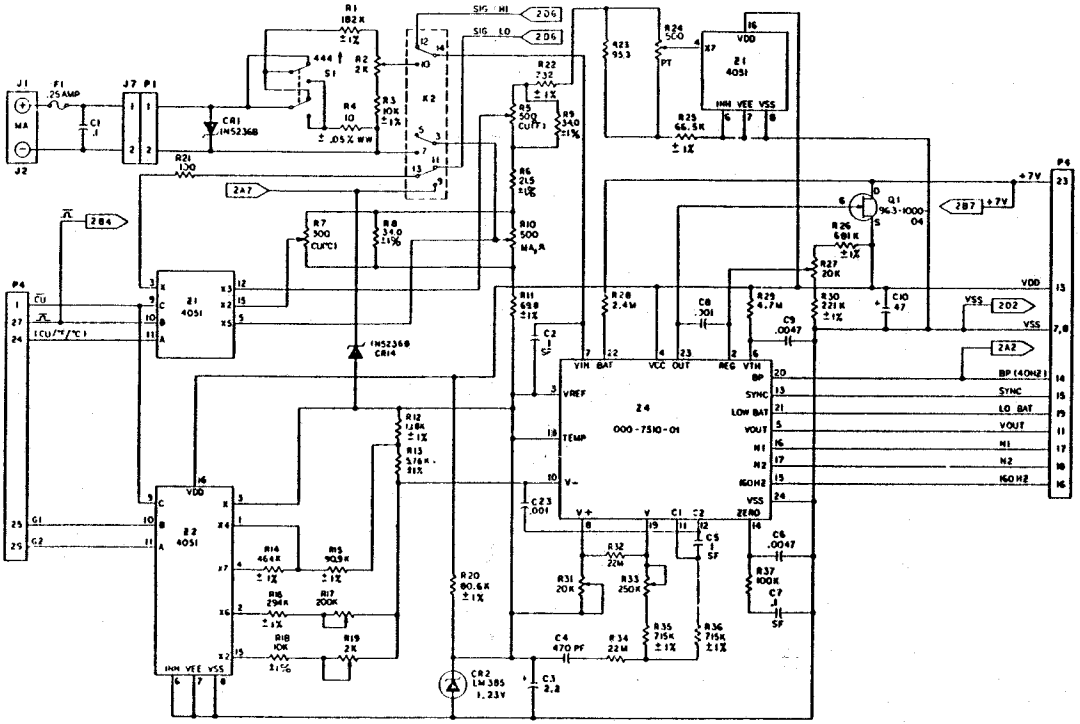
Relative Humidity: 0 to 90%, non-condensing to 99°F (37°C)

Size: 8.35" L x 3.75" W x 2.75" H (21.2 cm x 9.5 cm x 7 cm)

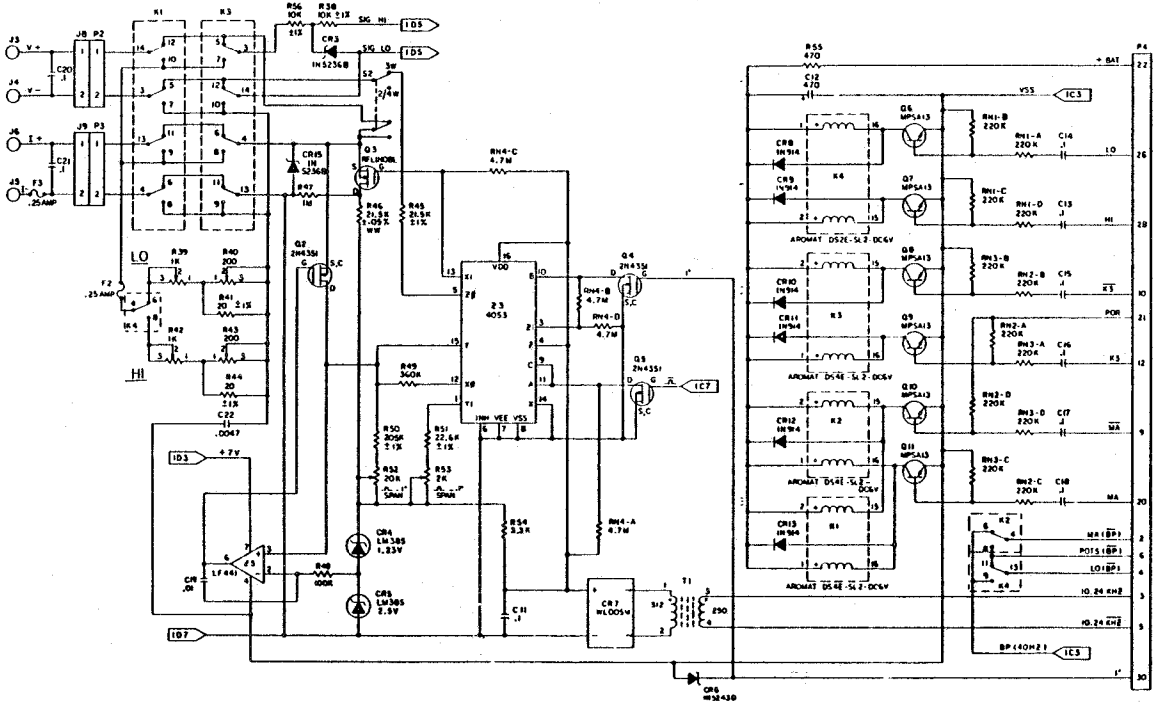
Weight: approximately 16 oz (454 cm)

APPENDIX

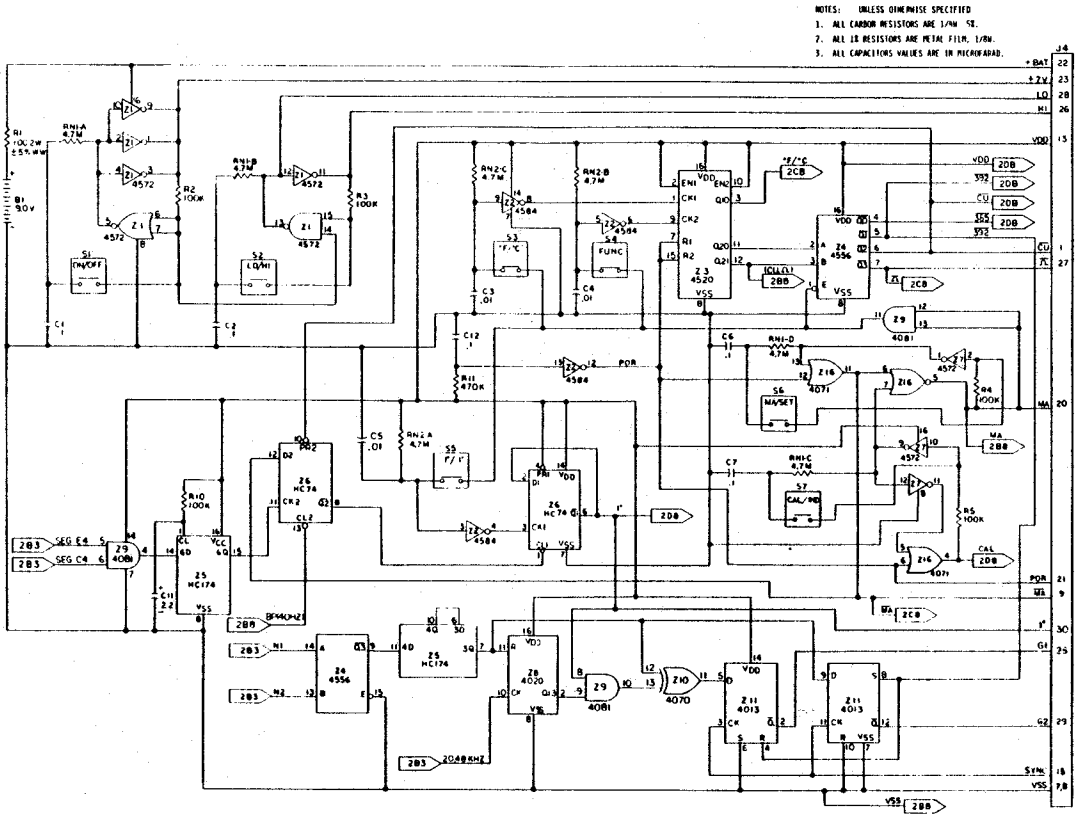
Schematic Diagrams/ Assembly Drawing



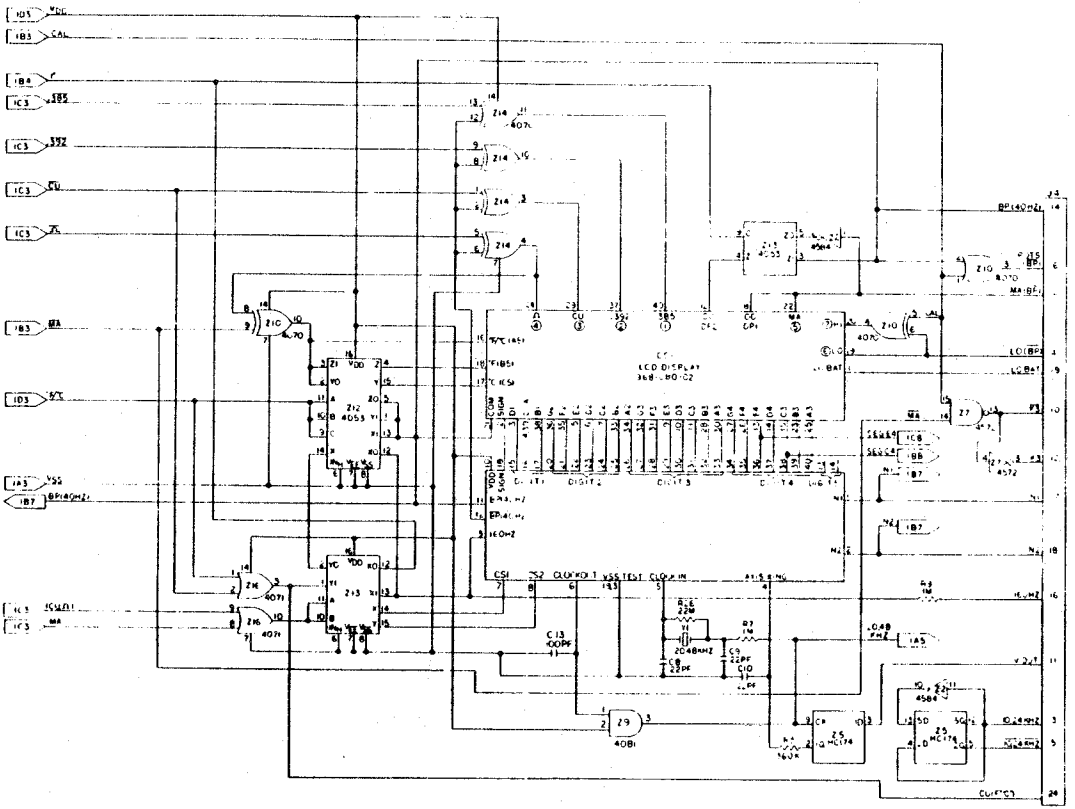
SCHEMATIC DIAGRAM
ANALOG BOARD
1 of 2



SCHEMATIC DIAGRAM
ANALOG BOARD
2 of 2



SCHEMATIC DIAGRAM
DIGITAL BOARD
1 of 2



SCHEMATIC DIAGRAM
DIGITAL BOARD
2 of 2

RTD CALIBRATOR/INDICATOR ASSEMBLY, EXPLODED VIEW