TECHNE INC.

INSTRUCTION MANUAL

MODEL TECAL ACCU-TEMP

TEMPERATURE MONITOR

ITS-90

S/N_____________

Tecal Accu-Temp

INSTRUCTION MANUAL

Table of contents

1. GENERAL INFORMATION

1.1 FEATURES

The Techne Inc. programmable Platinum RTD Temperature Monitor utilizes microprocessor technology to produce a stable, high accuracy instrument with simple "customized" calibration capability. "Customized" calibration provides the ability to digitally calibrate the instrument to match the specific calibration curve of a Platinum RTD to optimize system accuracy. The use of non-volatile RAM (Random Access Memory) allows the instrument to be easily programmed by simply entering the Platinum RTD sensor coefficients into memory.

The features include:
(See options on page 2 for additional features)

- Programmable Calibration
- Accepts Either 10, 25 or 100 ohm Platinum RTD Sensors
- Either Front Panel or Remote Selection of two different sensors, each with its own calibration program
- Extremely Accurate; +0.005 to 0.013°C
- Wide temperature Range; -218°C to +660°C
- °C or °F or Resistance in Milliohms
- Resolution and Repeatability of 0.001°

1.2 INSTRUMENT IDENTIFICATION AND OPTIONS

The instrument model number, serial number and other pertinent data is given on the rear of the instrument. The model number will appear as:

AccuTemp- ____ - ____ - Etc,
Model Options

Option number	Description
06	Rack/Panel Mount Brackets (pair)
07	Instrument Wired 230 Volt Operation.
08	Analog Output
14	RS-232C Interface
15	IEEE-488 Interface
16A	Reduced Sensor Excitation Current
18	Using a Sensor with an R_0 of 200 ohms
19	Using a Sensor with an R_0 of 400 or 500 ohms
20	Using a Sensor with an R_0 of 1000 ohms
27	0.001°F or °C Resolution. Ohms resolution remains at 0.001 ohms.
32	Resistance Range Extension to 410 Ohms to accommodate 100 Ω R_0 Sensors which operate to 850°C
33	0.001°F or °C Resolution **plus** ohms resolution to 0.0001 ohms.

1.3 TECHNICAL SPECIFICATIONS
(See options on page 2)

Instrument Range (See Note Page 4)	-218.00°C to 660.00°C or -360.00°F to +1220.00°F or 0.000 to 340.000 ohms
Instrument Uncertainty (Single Measurement Mode) @ 25°C+3°C Calibration in Accordance with ITS-90 **(Also see option 27 and option 33 on page 61)**	±0.10°C for 10 Ohm Sensors ±0.007°C for 25 ohm sensors ±0.013°Cfor 100 ohm sensors ±0.002 ohms or 15 ppm.
Calibration Check Interval	1 Year
Resolution and Repeatability	0.001° on both °C and °F scales, 0.001 on ohms
Excitation Current	1 milliamp DC (nominal)
Sensor Type	Platinum RTD R_0 = 10 ohms, 25 ohms or 100 ohms. Any Alpha from (nominally) 0.00385 to 0.003925
Sensor Coefficients	Rtp plus the required sensor coefficients, the number of which are dependent on the sub-range.

Operating Ambient Temp.	5° to 45°C
Non-operating Ambient Temp.	-20° to +65°C
Humidity	Less than 80% non-condensing
Warm-up Time	Within specifications upon turn-on, optimum performance after 2 hours.
Temperature Coefficient (Reference 23°C ambient)	±2 ppm +0.0001Ω/°C
Display	0.4" high red LEDs: six digits plus F, ohms, C and polarity indicator. Also "Channel" indication along with "Local" or "Remote" control status.
Display Update	Approximately every second
Display Overrange	Display reads EEEEEE for input over 340 ohms
Weight	Net 9 lbs. (4kg) Shipping 12 lbs. (5kg)
Power	115 VAC standard, 230 VAC optionally, 50/400 Hz, 12 VA nominal, supplied with a six foot 3 wire line cord.
Size	3 1/2" High x 8 1/2" Wide x 11 3/8" Deep, Half Rack

INTENTIONALLY

BLANK

1.4 WARRANTY

Techne warrants its products to be free from defects in material and workmanship for one year after date of shipment, provided the units have been used within published ratings. The warranty is limited to our repairing or replacing without charge, F. O. B. our factory any defective product if returned to our plant, transportation prepaid. No other representation or warranty, either expressed or implied, is made, and in no event shall Instrulab be liable for consequential or other damages.

1.5 UNPACKING AND SHIPPING

After having unpacked the instrument, carefully examine it and any enclosed accessories for physical damage and compliance with the packing list. If any of the articles are missing or damaged, inspect the packing case for signs of damage or theft during shipment and immediately report it to the carrier.

If it should become necessary to return the instrument to Instrulab Inc., use the original packing material, if possible.

When returning instruments to the factory, give a full description of the failure and the mode of operation that was used when the instrument failure occurred. Please include the name and phone number of someone we can contact, should we have any questions. Ship via UPS or parcel post prepaid to:

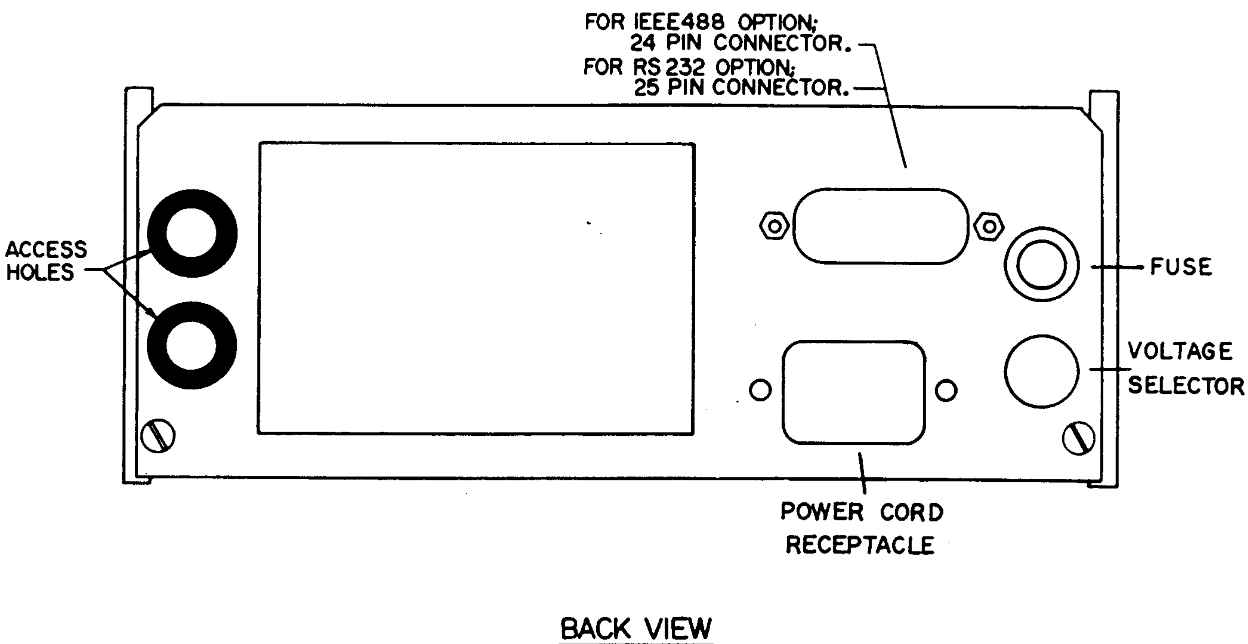
Techne Inc.
University Park Plaza
743 Alexander Road
Princeton, N.J. 08540

1.6 PRELIMINARY CHECK-OUT

Please use the following procedure before applying power for the first time:

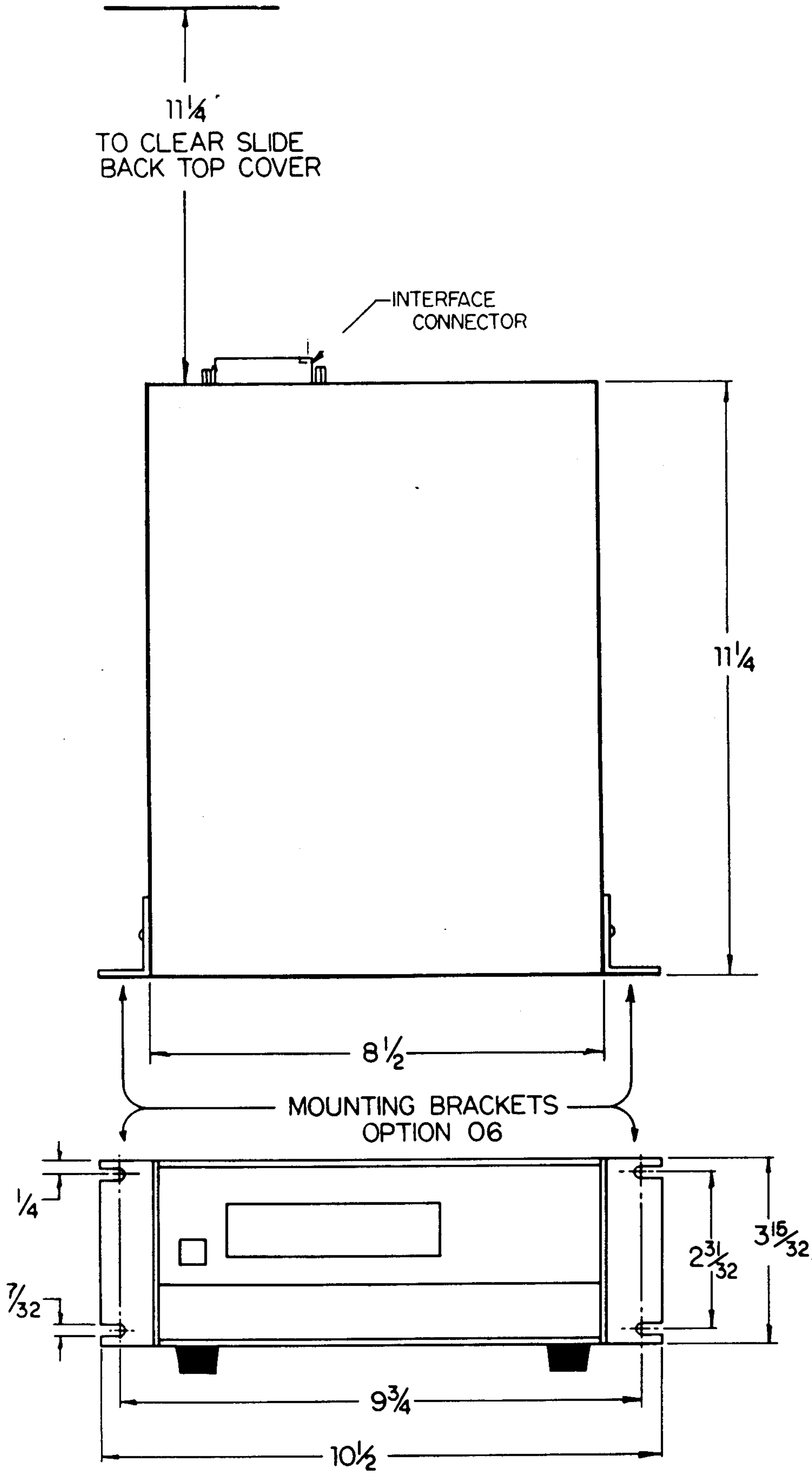
1. Remove the two top screws at the rear of the case.
2. Slide the top cover to the rear to inspect the instrument.
3. Verify that the vertical board(s), Display Board and option Board(s) and their cables are properly seated in their connectors.

DIMENSION DRAWINGS



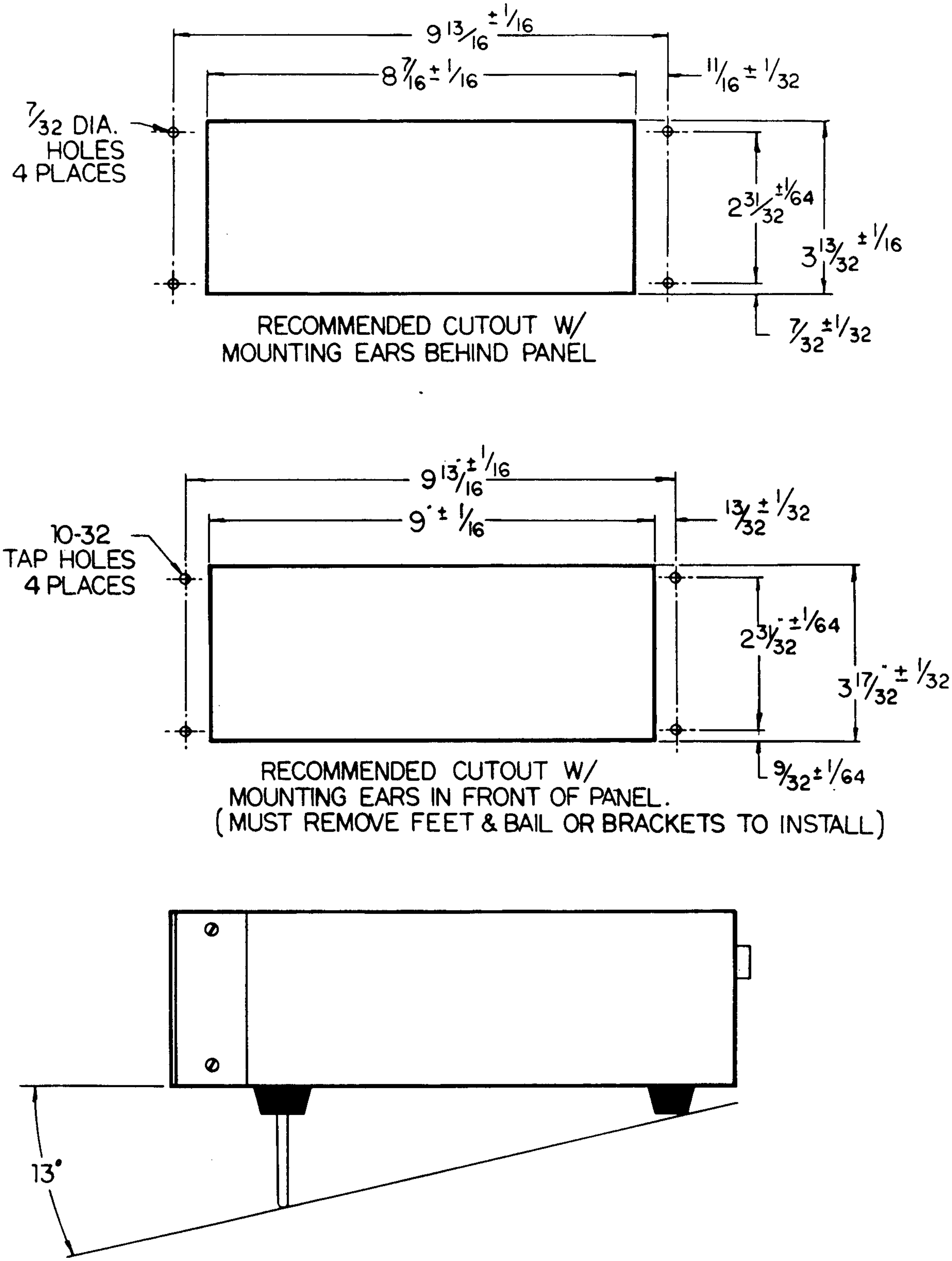
Case Outline Drawing

Figure 1a

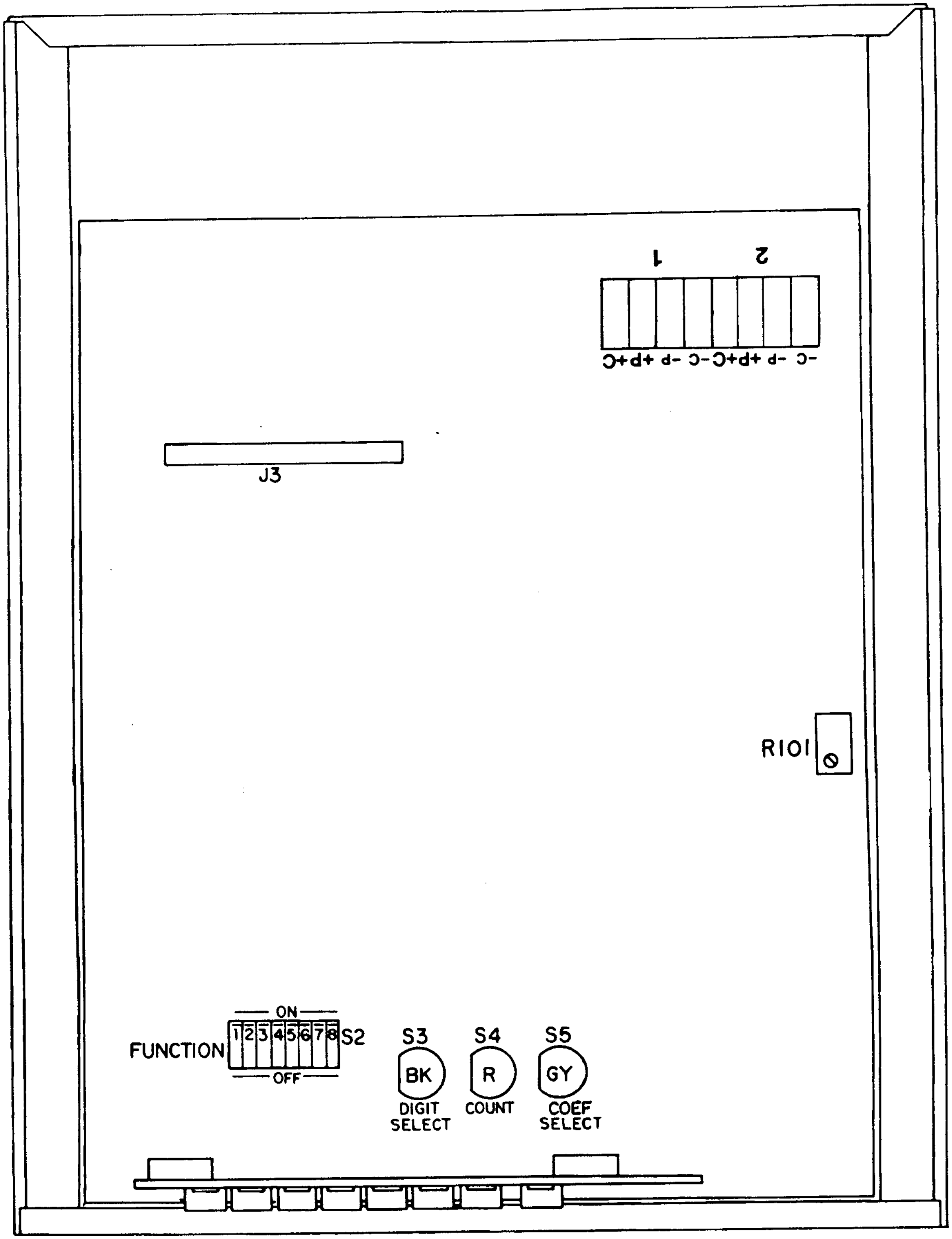


Case Outline Drawing

Figure 1b



Case Outline Drawing
Figure 1c



TOP VIEW

Top View of Instrument Showing Programming Switches
Figure 2

2.0 STANDARD OPERATION

2.1 SENSOR CONNECTIONS

Sensors are connected to a terminal strip that is located directly under the top cover of the instrument

To connect the sensor leads, remove the top cover, insert the leads through the hole in the back panel and connect to the four terminals as shown on the terminal strip diagram. Note the input number on the terminal strip when making your connections, since each input will be individually calibrated to a specific sensor.

The terminals are marked -c, -p, +P, and +C. If your sensor leads are marked with the letters -c, -p, +P, and +C simply connect to the indicated terminals as. If your sensor has four unmarked leads, connect the two leads with a common connection to the -c & -p terminals and the other two leads to the +P & +C terminals. The order is not important, just as long as the leads with the common connections are connected to the terminals with a common polarity. Interchanging of leads -p & -c or the leads +P & +C will not affect the instrument's accuracy. Failure to use a four-lead system will result in a reading error.

NOTE: If sensor(s) were purchased from Techne Inc. at the time of purchase of the instrument, the unit will be preprogrammed with sensor coefficients.

2.2 POWER CONNECTION

The standard model is designed to operate 115 VAC +10%. Models designed for 230 VAC operation contain the option number 07. We recommend that a 3 wire U-ground receptacle be used. The instrument is within rated specification at turn on. Optimum performance is obtained after 2 hours.

When the instrument is first turned on, the display will read "ItS-90", then it will light all segments, along with all decimal points. Then, if Option 14 is installed, it will read "rS-232" or, if Option 15 is installed, it will read "IEEE 07". The two numbers are the instrument address. Instrument will then commence to read sensor input.

2.3 MATCHING THE INSTRUMENT TO A SPECIFIC SENSOR

2.3.1 IDENTIFYING ITS-90 SUB RANGES AND COEFFICIENTS

1. Instrument can be programmed for any range or sub range that falls within the limits of:

   -218.7916°C (TP of Oxygen) to +660.323 °C (FP of Aluminum)
   (See note page 4)

2. The actual range depends on the calibration of your sensor and may be negative temperatures, positive temperatures or a combination of both.

3. The following table lists the "a, b, and c " coefficients for various sub ranges that may be programmed into the instrument.

LOWEST CALIBRATION TEMP. °C		°C		HIGHEST CALIBRATION TEMP. °C	ASSIGNED COEFFICIENT IDENTIFICATION 0	1	2	3	4	5	6
		0.00	to	962	Rtp	a7	b7	c7	(See note page4)		
		0.00	to	660	Rtp	a7	b7	c7	-	-	-
		0.00	to	419	Rtp	a8	b8	0	-	-	-
		0.00	to	231	Rtp	a9	b9	0	-	-	-
		0.00	to	156	Rtp	a10	0	0	-	-	-
-38	to	+0.01	to	29	Rtp	a5	b5	0	-	-	-
-189	to	+0.01			Rtp	-	-	-	a4	b4	0
-218	to	+0.01			Rtp	-	-	-	a3	b3	C1

Rtp = Resistance of sensor at the triple point of water, i.e. +0.01°C.

2.3.2 FORMATTING THE ITS-90 COEFFICIENTS

1. The coefficients received with your sensor(s) should appear similar to the following example.

   Sub range = -189 to +500°C (419°C)

   Rtp = 25.4768 ohms
   a4 = -1.6448498E-04
   b4 = -5.2486782E-04
   a8 = -9.2035954E-06
   b8 = -1.1031022E-04

2. Entry of Rtp is directly as listed. Be sure to observe decimal point.

3. The required format for coefficient entry is as follows:

COEFFICIENT POLARITY
P=Positive
-=Negative

COEFFICIENT ID#
$0=R_{tp}$
1,2&3=Pos. Temp. Coef.
4,5&6=Neg. Temp. Coef.

EXPONENT
Single Digit Entry

FIRST 5 DIGITS
FROM COEFFICIENT

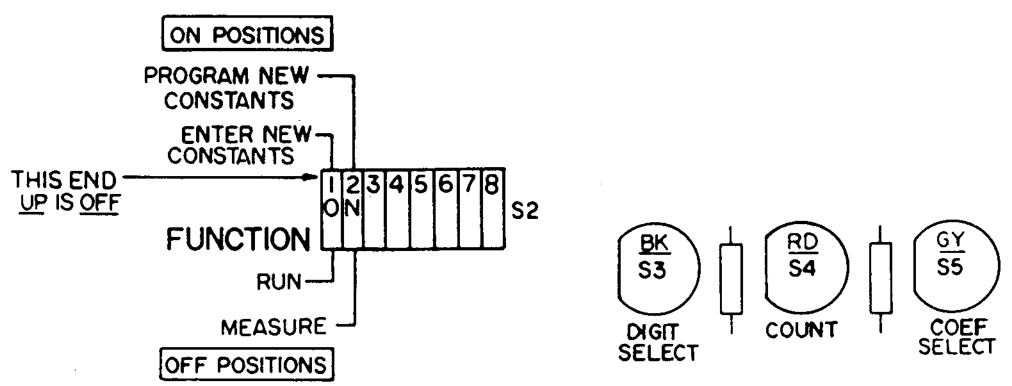
NOTE that correct formatting of the Coefficients requires the relocation of only the exponent to the beginning of the string.

2.3.3 PROGRAMMING THE COEFFICIENTS INTO MEMORY

Since the two inputs (input 1 & 2) are digitally independent of each other, the programming procedure must be performed for both inputs. Select the desired input using the front panel input selection switch and proceed with the programming, then depress the input switch to change the input selection and proceed to program the second sensor.

First remove the two top cover retaining screws and slide off the top cover, then turn on the power. A warm-up period is not necessary since only the digital coefficients are being programmed. Now locate the function switch and the black, red, and gray pushbutton switches, near the front of the instrument. (See figure 2 for component locations.)

At this time, [prior to programming) the FUNCTION switch, positions #1 and 2 should be in the "off" position. See figure 3.



Close up of S2 Showing Sensor Coefficent
Programming Switches Figure
Figure 3

1. Move the FUNCTION switch, position 2 to the "on" position. A small number "0" should appear in the far right hand side of the digital display. This indicates that Rtp, is ready to be programmed. You will also note that the far left hand digit is flashing This indicates that this digit will accept a change in numerical value. Use the RED COUNT button to change this digit to the number desired.

2. After the first digit is programmed, advance to the second digit by pressing the BLACK DIGIT SELECT button. The second digit should now flash. Now program the number for this digit just like the first digit, using the RED COUNT button.

3. Now program the rest of the digits using the BLACK and RED buttons, until all digits have been programmed.

4. To move to the next constant, press the GRAY COEF SELECT button. The number "1" should appear in the far right hand side of the display and the first digit should be flashing.

5. Proceed using the GRAY, RED, and BLACK push buttons until all coefficients are programmed. You will notice that each time the GRAY button is pressed, the number at the far right hand side will change, from 1 to 2 to 3, etc. until all coefficients have been programmed.

6. After all the coefficients have been programmed, press the GRAY button once more. All digits should stop flashing and the instrument should indicate "rEAdY".

NOTE

If you are aware of an error in programming one or more of the coefficients, continue with the programming procedure, then go back through the procedure a second time and make your changes. This technique allows you to retain the coefficients that are correct and change only those coefficients that are incorrect
.

7. Go back to the FUNCTION switch, S2, and move position 1 to the "on" position and then move it back to the "off" position. The display will read "buSY". After about 1 second, the display should change to "donE".

During the 1 second pause, the instrument programs the sensor coefficient data, that you programmed, into the non-volatile memory and checks to see if the information was programmed properly. If it was programmed properly, the instrument will respond with the word "donE" on the display. If the data was not programmed properly, a number followed by the word "Error" will appear on the display. if this should happen, turn the instrument "off" then back "on" again and return to step 1 and repeat the entire programming procedure again.

8. After the instrument has told you that it is "done", move the FUNCTION switch, position 2, to the "off" position. Make sure that position 1 is also in the "off" position at this time. The instrument should now be reading the temperature of your sensor.

   Now depress the "CHANNEL" switch on the front panel and repeat the programming procedure for the second RTD sensor.

2.3.4 PROGRAMMING EXAMPLES:

SAMPLE #1: Sub range = -189 to +500°C (419°C)

Rtp = 25.4768 ohms
a4 = -1.6448498E-04
b4 = -5.2486782E-04
a8 = -9.2035954E-06
b8 = -1.1031022E-04

Using the sample coefficients listed above, their entry would appear as follows:

.1 Turn ON instrument

.2 Operate SW #2 of S2 to ON

.3 | 0 | 2 | 5 | 4 | 7 | 6 | 8 | | 0 | Enter Rtp using ‘DIGIT SELECT’ and COUNT’ button.

.4 Press "COEF SELECT" button.

.5 | 6 | - | 9 | 2 | 0 | 3 | 6 | | 1 | Enter a8 Enter a8 using "DIGIT SELECT" and "COUNT" buttons

.6 Press "COEF SELECT" button

.7 | 4 | - | 9 | 2 | 0 | 3 | 6 | | 2 | Enter b8 using "DIGIT SELECT and "COUNT" buttons

.8 Press "COEF SELECT" button

.9 | 0 | P | 0 | 0 | 0 | 0 | 0 | | 3 | There is There is no "c" coefficient for this sub range. Enter as zeros using “DIGIT SELECT” and “COUNT” buttons.

.10 Press "COEF SELECT" button

.11 | 4 | - | 1 | 6 | 4 | 4 | 8 | | 4 | Enter a_4 using "DIGIT SELECT" and "COUNT" buttons   .

.12 Press "COEF SELECT" button

.13 | 4 | - | 5 | 2 | 4 | 8 | 7 | | 5 | Enter b4 using "DIGIT SELECT" and "COUNT" buttons

.14 Press "COEF SELECT" button

.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 6 | There is no “c” coefficient for this sub range. Enter as zeros using "DIGIT SELECT" and "COUNT" buttons

.16 Press "COEF SELECT" button

.17 | R | E | A | D | Y | | | | |

.18 Operate SW #1 of S2 to ON. Entries are now being programmed into memory

.19 When display reads "done" operate SW #1 and #2 of S2 to OFF

.20 Programming is now complete.

SAMPLE #2:

.1 Sub Range -189 to +500°C (419°C)

.2 Coefficients

Rtp = 100.0246 ohms
a4 = -9.8769E-04
b4 = -3.0704E-04
a8 = -5.8230E-04
b8 = 1.1108E-05

.3 Entry into the instrument of SAMPLE #2 coefficients should appear as follows

.4 | 1 | 0 | 0 | 0 | 2 | 4 | 6 | | 0 | Enter Rtp

.5 | 4 | - | 5 | 8 | 2 | 3 | 0 | | 1 | Enter a8

.6 | 5 | P | 1 | 1 | 1 | 0 | 8 | | 2 | Enter b8

.7 | 0 | P | 0 | 0 | 0 | 0 | 0 | | 3 | Enter as Zero's

.8 | 4 | - | 9 | 8 | 7 | 6 | 9 | | 4 | Enter a4

.9 | 4 | - | 3 | 0 | 7 | 0 | 4 | | 5 | Enter b4

.10 | 0 | P | 0 | 0 | 0 | 0 | 0 | | 6 | Enter as Zero's

For details on realizing the ITS-90, changes from the IPTS-68, differences between T90 and T68 (and T76), and means of approximating the ITS-90, see NIST Technical Note 1265, entitled "Guidelines for Realizing the International Temperature Scale of 1990 (ITS-90)", by B. W. Mangum and G. T. Furukawa.

THIS PUBLICATION IS AVAILABLE FROM:

NIST
Office of Publications and Programs Inquiries
Room E128, Administration Building
Gaithersburg, MD 20899
(301) 975-3058

2.4 CHECKING CURRENT SENSOR COEFFICIENTS

.1 Operate "FUNCTION" switch position 2 to "ON". (See Fig. 3)

.2 "0" constant is displayed. 0=Rtp.

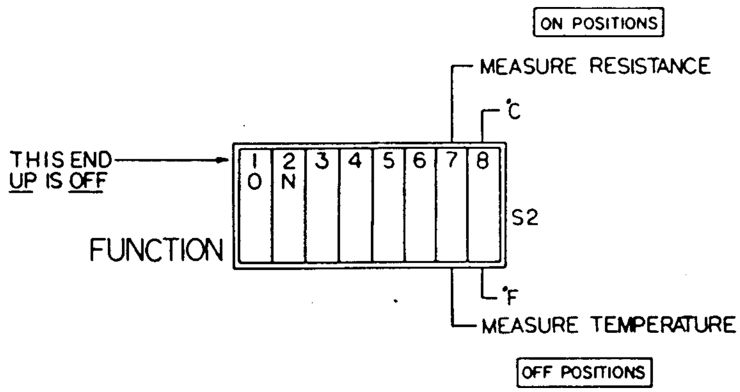
.3 Operate the gray "COEF SELECT" pushbutton and note the constant that is displayed each time the pushbutton is depressed.

.4 Operate "COEF SELECT" pushbutton after constant "6" is displayed. All blinking should stop. Instrument reads "READY".

.5 Operate "FUNCTION" switch 2 to "OFF". Instrument will commence reading sensor input.

2.5 SELECTING THE SCALE; °F, OHM, °C.

This former front panel option is now standard on all models. However, should the front panel °F, ohm, °C switch become disabled; engineering units can still be selected using internal DIP switch labeled FUNCTION S2. [See Fig. 2 & 4]



Close Up of S2 Showing Scaling Switches
Figure 4

You will notice that the switch has 8 positions. The switch position can easily be changed by pressing on the rocker arm of the switch with a pencil point or stylus.

Front Panel Switch must be in °F position or removed.

The following chart will aid you in setting the switches.

DESIRED READING	SWITCH POSITION 7	SWITCH POSITION 8
Ohms	ON	OFF
°F	OFF	OFF
°C	EITHER	ON

If the instrument has a front panel scale select switch, the scale will be selected on the front panel and the internal FUNCTION switch positions 7 & 8 must remain in the "off" positions.

2.6 CHECKSUM VERIFICATION OF PROGRAMMED VARIABLES

The Accu-Temp insures the integrity of the programmed variables stored in the Zero Power RAM (ZPRAM) by the use of checksums. The checksum for each set of variables is programmed into the ZPRAM when the set of variables is programmed. Then, each time the instrument is turned on, the checksum of each set of variables is computed and compared to programmed checksum. In the case of an error, the Accu-Temp displays a message, as below, to indicate which set of variables needs to be reprogrammed and waits until the variables have been checked.

P	r	o	g						1	Sensor Coefficients for Sensor #1

This indicates there is an error in the Sensor coefficients or the Zero Offset Correction. The Accu-Temp will display "Prog 1" until FUNCTION switch, position 2 is moved to the ON position. Refer to 2.3.3 of the manual for programming instructions for the Sensor Coefficients and 3.1.2 for verification of Zero Offset Correction.

NOTE: The Accu-Temp will ignore the setting of the front panel selector switch and will automatically select Sensor #1.

If the Sensor Coefficients and Zero Offset Correction are checked without being reprogrammed, (Refer to 2.4 and 3.1.2.1 of the Accu-Temp manual) both the resistance reading and the temperature readings may be incorrect and the "Prog 1" message will be displayed the next time the instrument is turned on.

P	r	o	g						2	= Sensor Coefficients for Sensor #2

This indicates there is a error in the Sensor Coefficients or the Zero Offset Correction for Sensor #2. The Accu-Temp will display "Prog 2" until FUNCTION switch, position 2 is moved to the ON position. Refer to 2.3.3 of the manual for programming instructions for the Sensor Coefficients and 3.1.2 for verification of Zero Offset Correction.

NOTE: The Accu-Temp will ignore the setting of the front panel selector switch and will automatically select Sensor #2.

If the Sensor Coefficients and Zero offset Corrections are checked without being reprogrammed, (Refer to 2.4 and 3.1.2.1 of the manual) both the resistance reading and the temperature readings may be incorrect and the "Prog 2" message will be displayed the next time the instrument is turned on.

P	r	o	g	I	E	E		E	= IEEE-488 Interface Address

This indicates there is a problem with the IEEE-488 primary address. The Accu-Temp will display "Prog IEEE" until FUNCTION switch, position 3, is moved to the ON position. Refer to the options manual for programming instructions for the IEEE-488 primary address.

If the primary address is checked without being reprogrammed, the instrument will read resistance and temperature correctly but the interface may not work and the "Prog IEEE" message will be displayed the next time the instrument is turned on.

P	r	o	g		2	3		2	RS-232C Interface parameters

This indicates there is a problem with the RS-232C Interface parameters. The Accu-Temp will display "Prog 232" until FUNCTION switch, position 3 is moved to the ON position. Refer to the options manual for programming instructions for the RS-232C interface parameters.

If the parameters are checked without being reprogrammed, the instrument will read resistance and temperature correctly, but the interface may not work and the "Prog 232" message will be displayed the next time the instrument is turned on.

3.0 CALIBRATION PROCEDURES

The Model Accu-Temp Temperature Monitor is calibrated in accordance with the International Temperature Scale of 1990 (ITS-90). The Accu-Temp conforms to the R vs T tables generated by formulas from the NIST Technical Note 1265 within the range of -218 to +660°C.

The instrument is burned-in and factory calibrated prior to shipment. It is designed to remain in calibration for a minimum of one {1} year before a recalibration check is required.

There is only one calibration adjustment and it applies to both channels. This adjustment, if necessary, is performed during the Calibration of Ohmmeter Section (3.1) and is normally made at Full Scale.

3.1 CALIBRATION OF OHMMETER SECTION

Instrument accuracy, as an Ohmmeter, is ±20 PPM or ±0.003 Ohms, whichever is greater.

To verify calibration and linearity, readings should be made at 3 or 4 points, such as:

	INSTRUMENT ACCURACY	CALIBRATION STANDARDS ACCURACY (3:1 RATIO)
10 Ohms	±0.003 ohms (300ppm)	±0.001 ohms (100ppm)
100 Ohms	±0.003 ohms (30ppm)	±0.001 ohms (10ppm)
200 Ohms	±0.004 ohms (20ppm)	±0.0013 ohms (7ppm)
300 Ohms	±0.006 ohms (20ppm)	±0.002 ohms (7ppm)

Suitable calibration equipment would be:

Resistor Card or
Standard Resistors or
Decade Resistance Box.

Be sure to use 4 wire connection.

After connections are made, the Accu-Temp should be closed up and allowed to "soak" for a minimum of 45 minutes.

3.1.1 FULL SCALE CALIBRATION ADJUSTMENT

If there is a problem at low end calibration, i.e. 10 ohms, there is a "Zero" adjustment available. See Paragraph 3.1.2. This calibration, if required, must be performed before full scale calibration.

R101 is the only analog adjustment and is for full scale or for the highest resistance to which the instrument is used. It adjusts both channels. A clockwise rotation increases the reading.

It is acceptable to calibrate only one channel as they will track each other within ±1 LSD.

When making an adjustment, the top cover should be opened only as long as necessary. After closing the top cover, wait 5 to 10 minutes before taking a new reading.

3.1.2 ZERO OFFSET CORRECTION

This correction is initially made at the factory and should not normally need to be made again, unless U2 is replaced.

MODEL ______________________________ S/N _____________

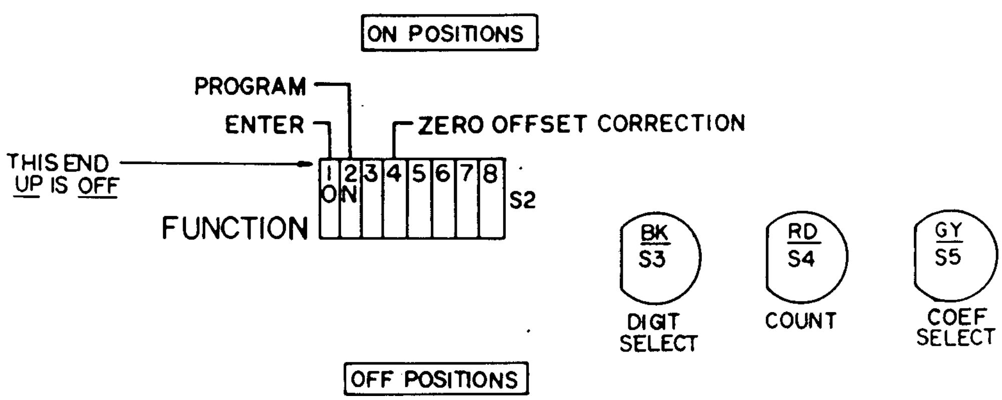
ZERO OFFSET CORRECTION, INPUT 1 _______________ OHMS

ZERO OFFSET CORRECTION, INPUT 2 _______________ OHMS

3.1.2.1 VERIFYING CURRENT ZERO OFFSET CORRECTIONS.

First, verify that the factory measured offset corrections are present in memory for each channel.

Refer to general programming procedures in paragraph 2.3.3. After SW #2 of function switch S2 is pushed to ON. Operate SW #4 of S2 to ON. You are now in the Program mode.



Close up of S2 showing Zero Offset
Correction Programming Switches
Figure 8

Operate COEF SELECT pushbutton until menu #7 is displayed by the extreme right hand digit.

								7

This display indicates the Zero Offset Correction that is currently in memory for the input selected. Compare this reading to the listing, if it agrees, check the other input. If it does not agree, adjust it in accordance with paragraph 3.1.2.2. Note that the display gives an extra decade of resolution over what is normally displayed. This menu will not come up if SW #4 of S2 is not ON.

To check the other input, press COEF SELECT until the display reads READY. Operate SW #2 and SW #4 of S2 to OFF. Display commences to read sensor input. Operate input selector switch to the other input. Repeat Paragraph 3.1.2.1.

3.1.2.2 PROGRAMMING NEW ZERO OFFSET CORRECTIONS INTO MEMORY.

For assistance, refer to Paragraph 2.3.3 for general programming procedures. Operate SW #2 & 4 of S2 to ON. Operate CONSTANT SELECT pushbutton until Menu #7 is displayed by the extreme right hand digit.

								7

This display indicates the ZERO OFFSET CORRECTION that is currently in memory for the input selected.

Use the COUNT and DIGIT SELECT pushbuttons to change the display to read the desired numbers. Note that the display gives an extra decade of resolution over what is normally displayed. This menu will not come up if SW #4 of S2 is not ON.

Operate COEF SELECT until the display reads READY.

Operate SW #1 of S2 to ON. Selected values are now being entered into memory.

When display reads DONE, operate SW #1,2 & 4 of S2 to OFF. Instrument will commence reading sensor input.

If the other input is to be done, operate the Input Selector Switch and repeat the procedure.

Full scale calibration should be done after any adjustment to ZERO OFFSET CORRECTION.

3.1.2.3 DETERMINING NEW ZERO OFFSET CORRECTIONS.

If for some reason the offset amount does not appear to be correct, a new offset can be determined. The preferred method is to use a 1 ohm (or alternately 10 ohms) standard resistor. Adjust the Zero Offset until the instrument reads the 1 ohm (or 10 ohm) Resistor exactly. See Paragraph 3.1.2.2 for programming instructions. Allow 2 to 3 hours of soak time between adjustments. Both channels need to be adjusted. Record new offset corrections with polarity.

An alternate, but less accurate method (by 1 to 2 LSD) is to short the four (4) input terminals together. Adjust the Zero offset until the instrument reads 0.000. See Paragraph 3.1.2.2 for programming instructions. The instrument has a “live” zero and will read negative numbers. Allow a two (2) hour warm-up when using this method. Do both channels. Record new data.

3.2 VERIFYING RESISTANCE TO TEMPERATURE CALCULATIONS

This section of the calibration procedure verifies the microprocessor controlled digital math function.

This Accu-Temp function is not subject to aging or temperature drift, and has no adjustments. It will only calculate erroneously if there is a component failure. Therefore frequent verification is not necessary, if at all.

3.2.1 PROCEDURE OUTLINE

To verify the Accu-Temp math calculations you will need:

A) A Decade Resistance Box with 0.001 ohm resolution. Accuracy is not important in this application.

B) Four wire lead wire.

C) An R vs T Table for a Platinum RTD calculated in accordance with ITS-90 or

D) Use the Sample Math Test listed in this section.

The Accu-Temp will be used to read the resistance of the decade box.
The instrument calculated temperature is then compared to the temperature obtained from the RvsT table.

If you are using the RvsT table for your sensor, this will also check the programming of the coefficients.

3.2.2 PROCEDURE

3.2.2.1 Program the Accu-Temp with the proper coefficients or the RvsT table that you are using.

3.2.2.2 Disconnect the sensor and connect the Decade Resistance Box.

3.2.2.3 Switch the Accu-Temp to OHMS and adjust the Decade Resistance Box until the instrument reads exact value in Ohms of the first selected temperature.

3.2.2.4 Operate "UNITS" Switch to °F and °C. Compare instrument calculated temperature to the RvsT table. It should agree within +0.01°.

3.2.2.5 Repeat for additional points, as desired.

3.2.2.6 When the test is concluded, disconnect the Resistance Decade Box and reconnect sensor. Observe correct terminal markings.

NOTE

If the coefficients were changed for this test, be sure to reprogram the Accu-Temp with the coefficients for the sensor you are currently using.

Close up case and allow for the proper warm-up period.

3.3 SPOT CHECK OF SYSTEM ACCURACY

A simple, but effective, system calibration check can be performed using an Ice Bath.

Periodically immerse the system RTD sensor in a distilled water Ice Bath.

The distilled water Ice Bath may not read exactly 0.000°C but the readings should be consistent from test to test.

While this spot check will not verify full range system accuracy, the constancy of the Ice Bath readings is a useful indicator of system stability.

ITS-90

Accu-Temp MATH TEST

TOLERANCE = ± .01°C or °F

I. 25.5 ohm SPRT

0 = 025.4767	1 = 5-1.1733	2 = 4-1.0562
3 = 7-6.6604	4 = 4-1.6385	5 = 4-5.2488
6 = OPO.0000		

OHMS	°C	°F	OHMS	°C	°F
5.414	___-190.00	___-310.00	54.589	___300.00	___ 572.00
15.146	___-100.00	___-148.00	63.696	___400.00	___ 752.00
25.476	___ 0.00	___ 32.00	72.507	___500.00	___ 932.00
35.483	___+100.00	___+212.00	81.013	___600.00	___1112.00
45.185	___+200.00	___+392.00	85.967	___660.00	___1220.00

II. 100 ohm PRT

0 = 099.8526	1 = 4-5.1229	2 = 4-1.9492
3 = OPO.0000	4 = 4-5.6753	5 = 4-2.5843
6 = OPO.0000		

OHMS	°C	°F	OHMS	°C	°F
25.620	___-180.00	___-292.00	177.054	___200.00	___392.00
59.384	___-100.00	___-148.00	213.884	___300.00	___572.00
99.849	___ 0.00	___ 32.00	249.555	___400.00	___752.00
139.049	___ 100.00	___ 212.00	284.060	___500.00	___932.00

4. THEORY OF OPERATION

The instrument consists of three basic sections:

1. Analog section
2. Analog to Digital section
3. Digital section

ANALOG SECTION

The purpose of the analog section is to convert the resistance of the Platinum RTD into voltages that can be measured by the Analog to Digital Conversion section. This is done by using a current generator to send a nominal 1 mA (on standard model) current through the RTD and an internal reference resistor connected in series (See Fig. 7). The voltage across the RTD (e1-e2) is equal to the current (I) times the resistance (R_{RTD}), i.e.

$$(e1 - e2) = I\ R_{RTD}$$

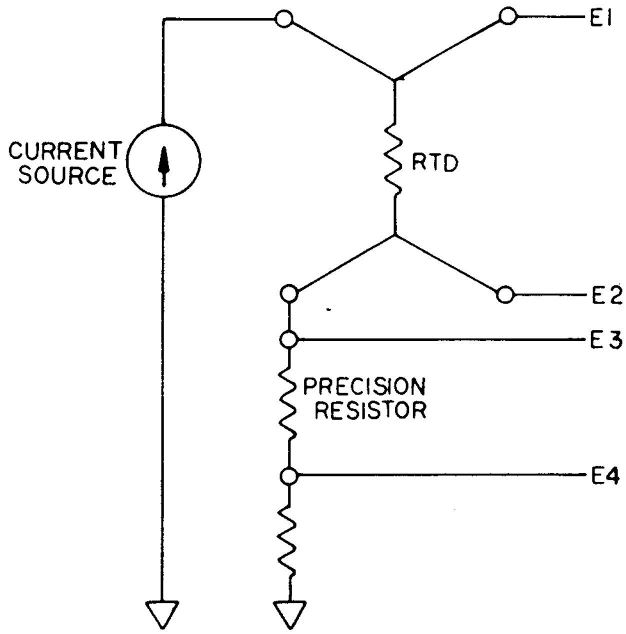
$$\text{Similarly, } (e3 - e4) = I\ R_{REF}$$

Since the RTD and the reference resistor are connected in series, the ratio of the voltages will be equal to the ratio of the resistances, i.e.

$$R_{RATIO} = \frac{(e1 - e2)}{(e3 - e4)} = \frac{I\ R_{RTD}}{I\ R_{REF}} - \frac{R_{RTD}}{R_{REF}}$$

The reference resistor is adjusted to exactly 100 Ohms so that:

$$R_{RATIO} = \frac{R_{RTD}}{100 \text{ Ohms}}$$



Ratio Measuring Technique
Figure 9

ANALOG TO DIGITAL CONVERTER SECTION

The purpose of the Analog to Digital Converter section is to transform the analog inputs (e1, e2, e3, and e4) into digital numbers that the Digital section can use to compute the resistance and temperature of the RTD.

Each resistance measurement cycle consists of four conversions, one for each input voltage. Since the computation of the resistance depends on the differences of voltages (e1 - e2 and e3 - e4), any zero-offset errors in the A-to-D Converter will be canceled by the subtraction, as long as the zero-offset does not change significantly during a measurement cycle. Since the computation of the resistance is the ratio of two voltages ([e1 - e2]/[e3 - e4]) a small change in the scale factor of the A-to-D Converter will be divided out, if it does not change significantly during a measurement cycle.

The basic accuracy of the instrument is determined by the linearity of the A-to-D Converter and the accuracy and stability of the reference resistor. The dual slope integration technique is used for its excellent linearity and inherent noise rejection. The reference resistor has a low temperature coefficient, less than 1 PPM/°C.

DIGITAL SECTION

The Digital section controls the operation of the A-to-D Converter, computes the resistance and temperature of the RTD, displays the proper engineering units on the front panel, and allows the user to enter and store the coefficients for a particular RTD.

At the end of each measurement cycle, the Digital section computes the resistance of the RTD. It then averages this resistance with the last three readings. If the new resistance differs from the average by less than 7 milliohms, the average is used. If the difference is more than 7 milliohms, then the new reading is used. This technique divides random noise by a factor of 4, but allows the instrument to respond quickly to large changes in resistance.

The temperature is then computed using the formulas from NIST Technical Note 1265 and the coefficients of the RTD being measured. The instrument then display the new reading in the selected engineering units.

5. TROUBLESHOOTING

The following troubleshooting hints will help you to locate most user associated problems. Please contact the factory if your problem cannot be solved using this guide.

PROBLEM
Front Panel "UNITS switch reads only resistance, will not measure temperature--front panel switch does not Change scale.

POSSIBLE CAUSE
FUNCTION switch set incorrectly--position #7 & 8 should be in "off" position. See section 2.5.

PROBLEM
Display reads incorrect scale (°F, ohm , °C) from that desired.

POSSIBLE CAUSE
FUNCTION switch set incorrectly, see section 2.5.
Instrument is operating in the remote mode, change the instrument back to the local mode.

PROBLEM
Instrument was working OK, but suddenly displays erratic unstable readings.

POSSIBLE CAUSE
Loose sensor lead.

PROBLEM
Display reading drifts down.

POSSIBLE CAUSE
Sensor high potential lead is open. (Terminal "+P")

PROBLEM
Display reading drifts up.

POSSIBLE CAUSE
Sensor low potential lead is open. (Terminal "-p")

PROBLEM

Display reads "OPEN"

POSSIBLE CAUSE

Sensor element is open or either current lead is open.

PROBLEM

Temperature readings are incorrect when compared to a known temperature.

POSSIBLE CAUSE

Check resistance reading against your R vs T table. If resistance is correct and temperature is incorrect, then and error was made in programming. If both resistance and temperature readings are incorrect, check calibration of the instrument (see section 3). Also check to make sure that the calibration coefficients are for the sensor that you are using. Check for sensor damage by testing in an ice bath.

PROBLEM

Instrument works OK, but will not operate from the remote terminal (options 14 & 15).

POSSIBLE CAUSE

Loose remote card (see figure 2). Loose wire, connecting remote card to the rear of instrument. Loose or broken interface cable. On RS-232C models (option 14) check Baud rate, word length, parity and stop bit requirements; reprogram if necessary. On IEEE-488 models (option 15) check to make sure the address has been programmed correctly.

PROBLEM

Display reads one of the following messages:
PROG 1   PROG 2   PROG IEEE   PROG 232

POSSIBLE CAUSE

These messages mean that a programmed variable has changed. See paragraph 2.7, "Checksum Verification of Programmed Variables".