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CONTENTS

1.1.1 INPUT RANGES AND RESOLUTION

Installing the correct Range Module (Col. 1) and LSI chip (Col. 3) converts model ranges as shown in the following chart.

RANGE DESIGNATOR	RANGE	IC TYPE	INPUT SENSOR TYPE	RESOLUTION MODEL 40X	RESOLUTION MODEL 41X
J (NBS)	-328 to +1712°F -200 to +933°C	K7500	Iron Constantan*	1°	0.1°
2J (J NBS)	-328 to +1712°F -200 to +933°C	K7502	Iron-Constantan*	1°	0.1°
K (NBS)	-208 to +2552°F -133 to +1400°C	K7500 K7501 K7502	Chromel-Alumel*	1°	0.1°
T (NBS)	-328 to +752°F -200 to +400°C	K7500	Copper-Constantan*	1°	0.1°
2T (T NBS)	-328 to +752°F -200 to +400°C	K7502	Copper-Constantan*	1°	0.1°
R (NBS)	+32 to +3252°F 0 to +1788°C	K7500	Platinum-Platinum* 13% Rhodium	1°	0.1°
S (NBS)	+32 to +3252°F 0 to +1788°C	K7500	Platinum-Platinum* 10% Rhodium	1°	0.1°
B (NBS)	912 to +3392°F 489 to +1866°C	K7500	Plat. 30% Rhod./* Plat. 6% Rhod.	1°	0.1°
FC (DIN)	-327.9 to +1651.9°F -199.9 to +899.9°C	K7501	Iron-Constantan*	1°	0.1°
CC (DIN)	-327.9 to +1111.9°F -199.9 to +599.9°C	K7501	Copper-Constantan*	1°	0.1°
E (NBS)	-327.9 to +1951.9°F -199.9 to +1066.6°C	K 7501 or K 7502	Chromel-Constantan*	1°	0.1°
P3 & P4 (DIN)	-387.9 to +1631.9 F -233.3 to +888.8°C		3 or 4-wire RTD 0.00385 α	1°	0.1°
P5 & P6 (USA)	-387.9 to +1631.9°F -233.3 to +888.8°C		3 or 4-wire RTD 0.00392α	1°	0.1°
C3 & C4	-75.0 to +400°F -60.0 to +200.0°C		2 or 4-wire (CU4) 3-wire (CU3) RTD	1°	0.1°
TF TC	32.0 to 212.0°F 0.0 to 100.0°C		THERMISTOR	1°	0.1
K1	-10 to +25 mV		Linear Voltage	10μV	1μV
K2	-100 to +250 mV		Linear Voltage	100μV	10μV
K3	-1 to +2.5 V		Linear Voltage	1 mV	100μV
K4	-10 to +25 V		Linear Voltage	10mV	1 mV
K5	+100 to +2500 digits (Models 400, 402); +1000 to 25000 digits (Models 410, 412)		Linear Voltage	0.001	0.0001
I1	0 to 100%		4 to 20 mA Current Transmitter	0.1%	0.01%
I2	0 to 100%		10 to 50 mA Current Transmitter	0.1%	0.01%
I3	+100 to +2500 digits (Models 400, 402); +1000 to +25000 digits (Models 410, 412)		4 to 20 mA Current Transmitter	0.001	0.0001
1000 mV†	-0.5 V to +1 V	K7501	Linear Voltage	1mV	100μV

*Thermocouple Type Sensor

†Available in Models 408 and 418 only.

1.2 DESCRIPTION OF THE MODELS

The following table lists Trendicators by model, and shows the range and number of input points accepted by each.

MODEL →	400A	402A	403A	405A	406	407	408A	409A	410A	412A	415A	418A
NO. POINTS →	1	5	1	10	1	1	1	10	1	5	1	1
MULTIRANGE →	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	YES
RANGE ↓												
J	X	X	X	X	X	X			X	X	X	
K	X	X	X	X	X	X	X		X	X	X	X
T	X	X	X	X	X	X			X	X	X	
R	X	X	X	X	X	X			X	X	X	
S	X	X	X	X	X	X			X	X	X	
B	X	X	X	X	X	X			X	X	X	
FeCon	X	X		X	X	X	X		X	X		X
CuCon	X	X		X	X	X	X		X	X		X
E	X	X		X	X	X	X		X	X		X
PT3 & PT4	X				X		X	X	X			X
CU3 & CU4	X			X[3]	X			X	X			
THC & THF	X				X			X	X			
K1 – K4	X	X		X	X	X[4]			X	X		
1000 mV							X					X
I1 – I3	X				X				X			

Note 1: Models 408A and 418A available in °C only.
Note 2: Models 406 and 407 must be used with Models 400A or 410A.
Note 3: Model 405A may be used with CU4 when CU4 is connected 2-wire.
Note 4: Model 407 can be used for K1 range only.

1.2.1 SINGLE RANGE MODELS

Models 400A, 402A, 410A and 412A are all single range instruments which can be adapted to accept any range (PT, CU, TH and I ranges excepted on Models 402A/412A). Two of these single range models, the 402A and 412A, have push-buttons to select any 1 of 5 points within a chosen range. Models 400A and 402A have standard resolutions, while Models 410A and 412A have higher sensitivity (see paragraph 1.1.1). Optional battery pack (see Models 406 and 407) is available for Models 400A and 410A.

pushbuttons below the display. Model 400 and Model 402 are standard resolution instruments while Models 410 and 412 are high resolution instruments (refer to table in 1.1.1). A portable battery pack option is available for Models 400/410 indicators. Refer to 1.2.3.2. Model 400 and Model 410 can accommodate pcb (printed circuit board) options designed to extend the capability of the basic instrument. Refer to 1.2.3.3.

1.2.2 Multirange Models

Models 403, 408, 415, and 418 have pushbutton-selectable ranges. Models 403 and 408 have standard resolution while Models 415 and 418 have high resolution. Models 403 and 415 accept NBS type J, K, T, R, S, and B thermocouple inputs. Models 408 and 418 accept DIN type FeCon and CuCon thermocouple inputs, NBS type E and K thermocouple inputs, 4-wire PT RTD (alpha = .00385), and 1000 mV linear input

1.2.3 Options

1.2.3.1 External Switching Stations, Models 405 and 409

The External Switching Stations provide input switching of ten points for use with a single range indicator. The External Switching Stations are housed in the same rugged case design as a basic indicator. Each may be rack-mounted beside another switcher or indicator. Pushbuttons are in two rows of five and are numbered 1 10, 11-20, etc. Each row is interlocked to prevent simultaneous input selection. Option 001A (refer to 1.2.3.3) may be used with one or more switchers, and blanks the display if simultaneous selections are made from two rows. Model 405 is used for thermocouple ranges, linear voltage ranges, the 1000 mV range, and 2-wire operation on the C4 range. Model 409 is used for all RTD and thermistor ranges.

1.2.3.2 Power Packs, Models 406 and 407

Models 406 and 407 are batterypack/chargers with low battery LED indicator. Model 407, in conjunction with its indicator, is also a precision calibrator.

The Power Pack is housed in e carrying case (see Figure 3-5 in Section 3). Interconnections between the Power Pack and indicator are made in the rear. Signal input connections to the Power Pack unit are made in front using 5-way binding posts. Model 406 may have either two or four input terminals, the latter for RTD and Thermistor ranges. Model 407 has two input terminals only and is used for thermocouple and K1 ranges only.

The Power Pack operates from AC or internal battery power. The battery pack is charged whenever the instrument operates from AC.

Model 407 has the additional capability to operate as a calibration voltage source for calibration of thermocouple instruments. The output is adjusted via the FINE and COARSE controls on the front panel. The FINE control incorporates a push-pull ON/OFF switch for the calibrator output. When ON, the calibrator output voltage is displayed on the indicator and available at the front terminals. After the COARSE adjustment is made, the FINE control is used which provides a vernier range of approximately + /-20 uV with 1 uV or 0.1° resolution. Output voltage is from -10 to + 100 millivolts.

1.2.3.3 Printed Circuit Board Options

The following printed circuit board (pcb) options are available for increased versatility of Series 400 indicators. Any one of these pcb options can be installed in Models 400/410 indicators. Additional pcb options can be accommodated by using the Model 411 option chassis. Any two options can be installed in the Model 411 option chassis for usage with any indicator model. Note however, that the option chassis must be located no further than 45.7 cm (18.00") from the indicator or another 411 option chassis. The Model 411 Option Chassis is provided with all necessary hardware, labels, and installation drawings.

Option 001A is used in conjunction with Models 405 or 409 switching stations to provide blanking of the display if simultaneous pushbutton selections are made from two rows.

Option 002A provides BCD output of the indicator display for external display or processing.

Options 003A/004A provides a single digital setpoint capability with manual or automatic reset, out-of-limit LED indication, and relay contact actuation. Option 004A provides an additional hysteresis "deadband" control for two position or on/off operation.

Option 005A provides an isolated analog output which is proportional to the indicator display. The output is ideal for use with strip chart recorders or other applications where an analog voltage input is required.

1.3 PHYSICAL DESCRIPTION

All Series 400 instrument cases are constructed of die cast aluminum covered with textured vinyl paint. Case dimensions are 72mm x 144mm x 173mm (2.84" x 5.768" x 6.82"). The case inserts into a panel cutout of 68mm x 138mm (2.68" x 5.44"). These dimensions are shown on the outline dimensional drawing found in Section 6. Net instrument weight is approximately 1.7 kg (2.5 lbs).

The portable Power Pack unit measures 144mm x 144mm x 200mm (5.67" x 5.67" x 7.78"); weight is 4.8 kg (10.5 lbs).

1.4 WARRANTY REPAIR

This unit is warranted to be free of defective materials or workmanship and to give satisfactory service for one year. Refer to the inside back cover of this manual for complete terms of the warranty. If the unit malfunctions, return it to the factory for evaluation. If evaluation shows the instrument to be defective under terms of the warranty, it will be repaired or replaced at no charge. Refer to 2.2 for instrument repacking and return instructions.

This WARRANTY is VOID if the unit shows evidence of having been opened or tampered with or shows evidence of damage due to excessive current or voltage, heat, moisture, vibration, or misuse.

In any event, no warranites or obligations beyond replacement or repair of the unit will be assumed.

1.5 SPECIFICATIONS

Ambient Operating Temperatures:
0 to 50°C; 32 to 122°F
Ambient Humidity:
0 to 70% at 0 to 50°C for rated accuracy.
Power:

100, 120, 220, or 240 VAC 48-400 Hz

Segment sizes for Linearization:

Range	Segment (°F)
R, S	70°
B	80°
K	60°
J	60° > 32°F 20° < 32°F
T	30° > 32°F 20° < 32°F
PT-100	30° < 32°F < 50°
Fe Con	20° < 32°F < 60°
Cu Con	40° < 32°F < 30°
E	30° < 32°F < 60°

Stability with temperature:

Cold junction: (TC ranges only)

0.025 degrees/degree from 10 to 40°C (50 to 104°F) for base metal types; 0.05 degrees/degree for noble metals

Instrument zero:

1 μV/°C for Models 400A and 402A except 2 μV/°C on I_3 range

0.5 μV/°C for Models 410A and 412A except 1.5 μV/°C on I_3 range

Instrument span:

0.01% RDG/°C for Models 400A and 402A except 0.02% RDG/°C on I_3 range

0.005% RDG/°C for Models 410A and 412A except 0.015% RDG/°C on I_3 range

Stability with time:

Instrument zero:

No measurable zero drift

Instrument span:

0.1% of RDG/yr for transmitter and voltage ranges; less than 1°/yr for TC, RTD, and TH ranges.

Repeatability:

±1 digit except on listed 410A, 412A, 415A ranges:

±2 μV on K1, CU and TH ranges,

±0.2°C or F on R, S, and B ranges,

±0.2°F below -200°F on T range.

Accuracy

RANGE DESIGNATOR	TYPE OF INPUT	RANGE	ACCURACY (all ±) includes max. linearization error.	
			400A/402A 403A/408A	410A/412A 415A/418A
J	Iron-Constantan Thermocouple	-328°F to +1712°F -200°C to +933°C	1° 1°	0.6°F 0.5°C
K	Chromel-Alumel Thermocouple	-208°F to +2552°F -133°C to +1400°C	1.5° < 0° < 1° 1°	1.2° < 0° < 0.8° 0.8° < 0° < 0.5°
T	Copper-Constantan Thermocouple	-328°F to +752°F -200°C to +400°C	1° 1°	0.5°F 0.5°C
R	Platinum-Platinum 13% Rhodium Thermocouple	+32 to +3252°F 0 to +1788°C	3° < 350°F < 2° 2°	3° < 350°F < 1.5° 2° < 200°C < 1° 0.6° above 800°C
S	Platinum-Platinum 10% Rhodium Thermocouple	+32 to +3252°F 0 to +1788°C	3° < 600°F < 2° 2°	2° < 600°F < 1.5° 2° < 315°C < 1° 0.5° above 800°C
B**	Plat. 30% Rhod/ Plat. 6% Rhod Thermocouple	+912 to +3392°F +489 to +1866°C	4° 2.5°	2.5° 1°
FeCon	DIN Thermocouple Iron-Constantan	-200°C to +900°C	1°	0.4°
CuCon	DIN Thermocouple Copper-Constantan	-200°C to +600°C	1°	0.4° < 0°C < 0.2°
E	E(NBS) Thermo-couple Chromel-Constantan	-328°F to +1952°F -200°C to +1066°C	1° 1°	0.7° 0.4°
PT3 & PT4	PT-100 RTD	-388 to +1632°F -233 to +888°C	1° 1°	0.7° < -328° < 0.4° 0.3° < -200° < 0.2°
CU3 & CU4	CU-10 RTD	-75 to +400°F -60 to +200°C	1° 1°	1.0° 1.0°
THF & THC	YSI Thermistor Series 700	+32 to +212°F 0 to +100°C	0.4° 0.2°	0.40° 0.20°
I1*	4-20 mA Transducer Current Transmitter	0 to 100%	1 count	0.01% of reading ±1 count
I2*	10-50 mA Transducer Current Transmitter	0 to 100%	1 count	0.01% of reading ±1 count
I3	4-20 mA Transducer Current Transmitter	Span Digits Adj. (20 mA input): +1000 to +2500, 400A and 402A; +10000 to 25000, 410A and 412A. Offset Digits Adj. (4 mA input): ±5 times span to max. of -1000 +2000 for 400A and 402A; ±5 times span to max. of -10000 +20000 for 410A and 412A	2 counts	0.02% of reading and 1 count
K1*	25 Millivolt Range Linear Voltage	-10 mV to +25 mV	1 count	0.01% of reading ±2 counts
K2*	250 Millivolt Range Linear Voltage	-100 mV to +250 mV	1 count	0.01% of reading ±1 count
K3*	2.5 Volt Range Linear Voltage	-1V to 2.5V	1 count	0.01% of reading ±1 count
K4*	25 Volt Range Linear Voltage	-10V to 25V	1 count	0.01% of reading ±1 count

Resolution for Thermocouple and PT-100 models; 400A/402A/403A/408A = 1°
410A/412A/415A/418A = 0.1°

*Special scaling available from 200 to 26000 counts full scale on these ranges. Consult factory.

**Lookup table can be easily developed to use "B" range below 912°F (489°C) down to room temperature. Formula in manual.

Normal Mode Noise Rejection:
56 db at 50 Hz
60 db at 58 Hz and above
(3 pole, low-pass filter with 6 Hz poles; 1 pole on K3, K4)

Common Mode Noise Rejection:
110 db at 50 Hz; 120 db at 58 to 62 Hz (250Ω unbalance)
(up to 230 VDC or VAC RMS)

RFI Suppression:
Power line and sensor RFI filtering included

Reliability:
30,000 hours MTBF, calculated and demonstrated

Input:
Bipolar potentiometric operational amplifier with an input impedance at room temperature of:

22 megohms for thermocouple ranges
71 kΩ for RTD and thermistor ranges.
12.5 ohms for I1 transducer ranges (4-20 mA)
5 ohms for I2 transducer ranges (10-50 mA)
6 ohms for I_3 transducer ranges (4-20 mA)
1,000 megohms for K1, K2, K3 ranges
10 megohms for K4 & K5 range

Open T/C or Break Detection:
On TC ranges, 30 nanoamp, negative DC. Allows parallel connection of most other controllers with negligible interaction. RTD ranges inherently upscale break detect.

Source Resistance Effect:
TC ranges: 1.5 μV offset/50Ω.
P4 & P6 range: 0.03°C/Ω offset in +I and -V leads; 0.001°C/Ω in +V and -I leads.
P3 & P5 range: add 2.5°C/Ω unbalance between +I, +V, and -V leads.
C4 range: 0.02°C/Ω offset in +I -V leads and 0.002°C/Ω in +V and -I leads.
C3 range: add 25.9°C/Ω unbalance between +I, +V and -V leads.

Overload Protection:
TC, linear voltage, RTD and TH ranges: 120vAC or DC continuous. 230vAC or DC for 5 minutes without damage.
I1 range: up to 80 mA
I2 range: up to 200 mA
I_3 range: up to 80 mA

Measurement Time:
0.3 second per reading at low magnitudes
Up to 1.5 seconds per integration

Instrument span:

0.01% RDG/°C for Models 400 and 402 except 0.02% RDG/°C on I_3 range
0.005% RDG/°C for Models 410 and 412 except 0.015% RDG/°C on I_3 range

Stability with time:

Instrument zero:

No measurable zero drift

Instrument span:

0.1% of RDG/yr for transmitter and voltage ranges; less than 1°/yr for TC, RTD, and TH ranges.

Repeatability:

±1 digit except on listed 410 , 412 , 415 ranges:
±2 μV on K1, CU and TH ranges,
±0.2° C or F on R, S, and B ranges,
±0.2° F below -200° F on T range.

PCB Option Specifications:

BCD Data Output (Option 002A):

Output Logic Level: positive true, 8-4-2-1 BCD digits, TTL/CMOS compatible
Fanout: two standard TTL inputs

Single Limit Digital Alarm/Setpoint (Options 003A/004A):

Setpoint Range: -3999. to +3999. (In Model 410, the setting represents the four most significant digits).
Deadband Range (004A): 0 to 9
Relays: Form C, 115 VAC, 1A
Reset: Manual or Automatic (switch selectable)
Resolution: +/- 1° C or F.

Analog Output (005A):

Output Accuracy: +/- 2 mV, +/- 0.25% of reading
Ouput: 1 mV/degree F or C (isolated)
Load Impedance: 5k ohm (minimum)

SECTION 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

The Series 400 indicators are rugged, but they must be properly packed. Instruments are shipped in a custom-designed carton or shipping, but damage may occur. When you receive your instrument, look for evidence of transit damage as it is unpacked. If damage is found, ask the carrier to prepare a Damage Inspection Report and notify our Instrument Repair Department immediately. If your instrument has arrived in good condition, perform the functional test described in 2.3 to verify proper operation.

2.2 REPACKING, RETURNING THE INSTRUMENT

The original shipping container should be retained in case the instrument must be returned for repair or modification. When returning an instrument for any reason, advise us of the model number, serial number, your name, billing address, shipping address, phone number and a description of the malfunction or modification. This information will enable our Instrument Repair Department to expedite the return of your instrument. Instruments being returned to the factory shall be shipped freight prepaid.

Instruments being returned for warranty service must also refer to the original purchase date on packing lists and purchase orders. Instruments without this information will be processed as a non-warranty repair at current service rates.

If the original shipping container has been discarded, pack your instrument for shipping as follows:

a. Select a strong cardboard box of sufficient size to allow an inch of packing material around all sides of the unit.

b Ensure that the printed circuit boards are secured and front and rear panels are firmly in place.

c Wrap the instrument in plastic or strong paper. Place it centrally in the shipping container, and pack polyfoam, bubblepack, or rubberized hair around all six sides of the instrument.

d. Tape the carton flaps securely and label the container "FRAGILE, DELICATE INSTRUMENT". Ship the instrument, freight prepaid(do not ship by U.S. mail).

2.3 INSTRUMENT CHECKOUT PROCEDURE

An instrument functional checkout may be made as follows:

a. Remove the rear cover.

b. For thermocouple and K1-K5 ranges short all input terminals with copper wire (NOTE 1). Connect RTD ranges per NOTE 2, and TH ranges per NOTE 3. Leave terminals open on I ranges.

c. Apply power to the instrument. The display should approximate the appropriate readout in the table below.

INPUT TYPE	SIGNAL INPUT TERMINALS	READOUT
Thermocouples (see note 1)	shorted	room temperature
RTD	(see note 2)	0°C or 32°F
K1, K2, K3, K4, K5	shorted	0 ± 10 μV
I1, I2	open	-25.00%
I_3	open	-0.25 Span + (Offset)
TC/TF Thermistor	(see note 3)	0°C/32°F

NOTE 1: For "B" thermocouple range, simulate the TC input with a millivolt calibrator. Example: a 4.833mV input should produce a display of about 1832°F (1000°C).
NOTE 2: Connect +V and +I, and -V and -I. Connect a resistor equal to the RTD R_o between +V and -V.
NOTE 3: Connect two resistors, 25.42kΩ from +I to +V.100k from +V to -I.

2.4 CONFIGURING THE INSTRUMENT, GENERAL

The instrument is configured at the factory for various power, range, and display requirements as stated on the initial order. However, the instrument can easily be reconfigured to accommodate any future changes as required by the user.

The following paragraphs describe power voltage selection, range programming, and display programming (°C/°F and decimal point placement).

2.4.1 Selecting Power Voltage

As specified in the initial order, the instrument is configured to operate from a 100, 115, or 220VAC 48-400Hz power source. Units operating on 115 or 220VAC can be reconfigured to operate on the alternate voltage (115 or 220VAC) by cutting clad and/or adding jumpers on the Main Board PCB as shown in Figure 2-1.

CORNER OF PCB ADJACENT TO POWER PLUG:

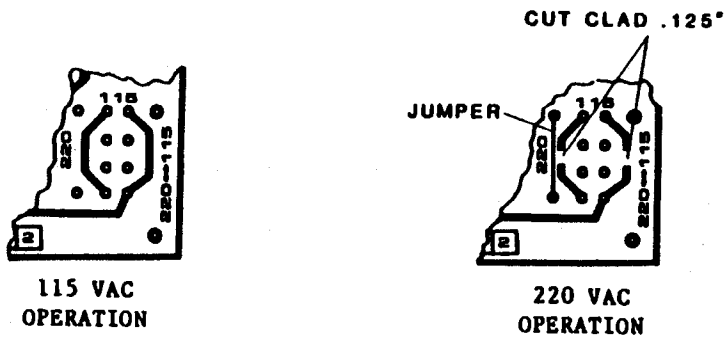


FIGURE 2-1. POWER VOLTAGE CONFIGURATION

2.4.2 Range Programming

In order for the instrument to operate on a specific range, it must have the proper combination of analog programming module and PMOS LSI chip. The table in paragraph 1.1.1. shows the correlation. For example, to operate in the "J" range, a "J" type module and a K7500 LSI chip must be installed. Installation of the module and chip is shown in Figure 2-2.

The beveled corner of the module (Pin 1) must be aligned correctly when installed (Pin 1 on module to Pin 1 on socket). When installing the PMOS LSI chip, the notched end of the chip points away from the zero and span pots. Exercise care

when installing and removing these components. For example, the best way to remove the LSI chip (to prevent lead damage) is to apply gentle upward pressure (alternating one end, then the other) with fingers or wide screwdriver.

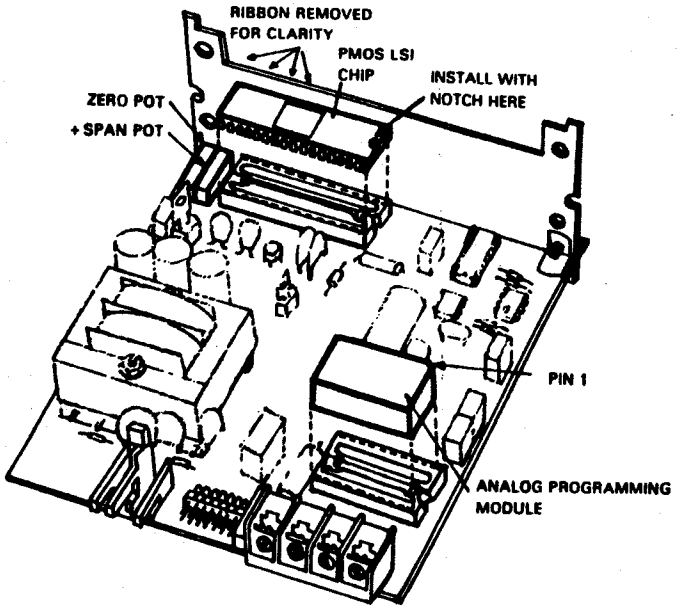


FIGURE 2-2. INSTALLING THE LSI CHIP AND ANALOG PROGRAMMING MODULE

2.4.3. °F/°C and Decimal Point Programming

A mini-DIP switch assembly configures the display for °F or °C range and decimal point placement. The switch assembly is located behind the plexiglas front panel and just below the display as shown in Figure 2-3. Figure 2-3 shows 5 seven segment LEDs used in high resolution instruments (Models 41X). For other instruments (Models 40X), the rightmost seven segment LED is not installed.

The leftmost switch, marked C/F, selects Celsius or Fahrenheit readout. For °C readout, slide the switch upwards. For °F readout, slide the switch downwards. If the instrument has a rocker type switch assembly, press the upper portion of the switch for °C readout or press the lower portion of the switch for °F readout. Both switch types may be actuated with a ball point pen or small screwdriver.

NOTE

For all "K", "I", and thermistor (TC/TF) ranges, set the C/F switch to F. Set the C/F switch to C for the 1000mV range on Models 408 or 418.

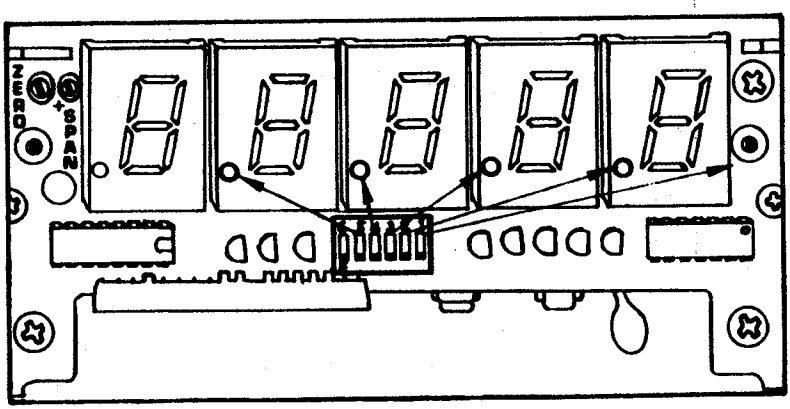


FIGURE 2-3. DISPLAY CONFIGURATION, °C/°F AND DECIMAL POINT

The remaining switches, marked 5, 4, 3, 2, 1, set the decimal point. To place the decimal point in the desired position (see Figure 2-4), slide the appropriate switch to the up position (ON) with the remaining switches in the down position (OFF). If the instrument has a rocker type switch assembly, press the upper portion of the switch to illuminate the appropriate decimal point. The remaining switches should be off (lower portion pressed). If no decimal point is desired, switch #1 must be set ON for Models 41X and switch #2 set ON for Models 40X (switch #1 not operable on Models 40X). The remaining decimal point select switches must be set OFF.

2.5 MOUNTING THE INSTRUMENT

2.5.1 Panel Mounting

Panel mounting hardware is supplied standard with the instrument. Install as shown in Figure 2-4. The instrument bezel butts against the front of the mounting panel; the mounting bracket fits over the instrument rear panel. The bracket screws force it against the rear of the mounting panel, locking the instrument in place. Panel cutout dimensions are 68mm x 138mm (2.68" x 5.44").

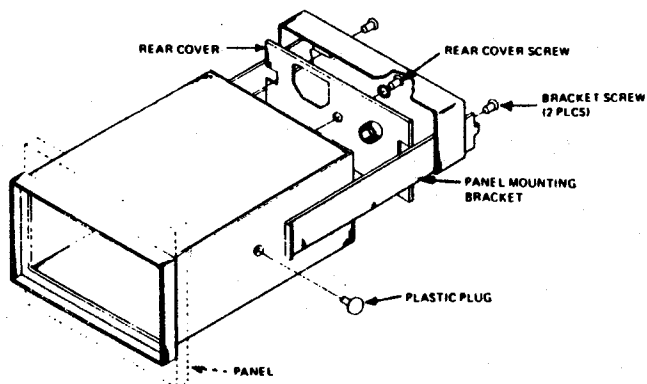


FIGURE 2-4. PANEL MOUNTING

2.5.2 Bench Mounting (Option 00W5)

Option 00W5 provides convenient bench-top use of the instrument. The bench mount features no-skid rubber feet and an adjustable pivot to change the vertical viewing angle. It is shown in Figure 2-5.

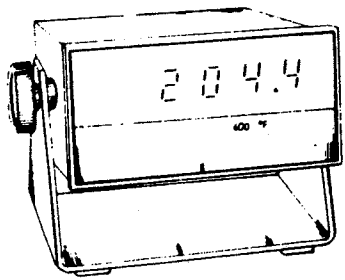


FIGURE 2-5. BENCH MOUNT

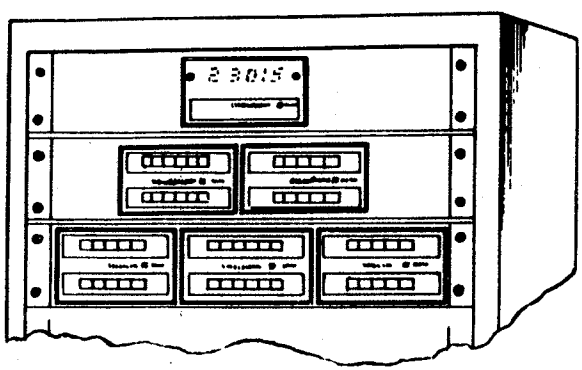


FIGURE 2-6. INSTRUMENTS IN RACK MOUNT ADAPTERS

2.5.3 Rack Mounting (Option 0W6—)

Rack mounting adapters 90mm x 483mm (3.5" x 19") are available with cutouts for one, two, or three instruments (Option 0W61, 0W62, or 0W63) which are installed with panel mounting hardware as described in 2.5.1. Rack mounted instruments are shown in Figure 2-6.

2.6 OPTION INSTALLATION

Various options are offered which may be installed by the factory or by the user. These include all PCB options and Power Pack units. The following paragraphs detail installation of these options.

2.6.1 Installing PCB Options in Models 400/410 Indicators

When a Model 400 or 410 indicator is ordered from the factory with a PCB option, the board is installed in the instrument before shipment. In the event a PCB option is ordered separately, this procedure is used to install the board in the instrument.

a. If instrument is installed, remove panel mounting bracket, then disconnect sensors, grounding wires, and power ground screw.

b. Remove the front plexiglas panel (two screws).

c. Remove two screws (front of instrument) which secure display board to chassis.

d. Slide board assembly outward from the front.

e. Turn board assembly over so that component side of main board is up.

f. Invert PCB option board and place over main board, component side to component side, except Option 002, which is installed with its component side facing away from the main board component side.

g. Attach PCB option board to display board with two screws and lockwashers included in kit as shown in Figure 2-7.

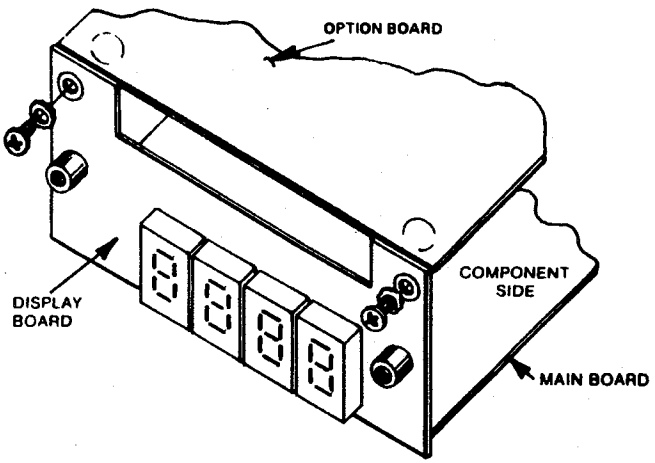


FIGURE 2-7. INSTALLING OPTION BOARD ON DISPLAY BOARD

h. Connect ribbon cable P1 on the option board to connector P2 on the main board. Cable must be inserted so that paint stripe on plug is visible. See Figure 2-8.

i. Slide board assemblies back into chassis, affix label (which identifies screw terminals on option board) to inside edge of case, and re-assemble instrument, reversing steps a, b, and c. For Options 002, 003A, 004A, and 005A only, do not re-install rear cover. Proceed to next step.

j. For options 003A, 004A, and 005A only, connect ground lead terminated in spade lug from the option board to chassis ground screw as shown in Figure 2-8, then re-install rear cover. For Option 002A, fasten bracket on circuit side of pcb to chassis cross bar using chassis ground screw on cross bar, then re-install rear cover.

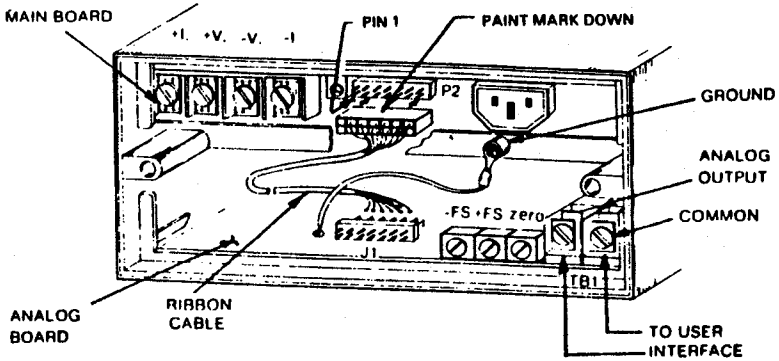


FIGURE 2-8. TYPICAL OPTION INSTALLATION, REAR VIEW OF INSTRUMENT

2.6.2 Installing PCB Options in Model 411 Option Chassis

The Model 411 Option Chassis accommodates any two PCB options for additional expansion capability of Series 400 indicators. As specified on the initial order, the front panel can either be blank or provided with one or two cutouts to expose thumbwheel switches and alarm LEDs for options 003A or 004A. Installation details differ depending on which combination of options are installed. Refer to the Model 411 installation drawings in Section 6.

Option 002A, the BCD Data Output board, must be installed in the lower slot of the option chassis for clearance of the PCB edge connector. A special rear cover, p/n 411-2040-00, is used to accommodate Option 002A. Other options may be used in either slot of the option chassis.

Note that the Model 411 option chassis must be located no further than 45.7 cm (18.00 inches) from the indicator or another Model 411 option chassis.

2.6.3 Installing the Instrument in a Power Pack Case

When ordered together, the indicator and Power Pack are mated together at the factory. If shipped separately, assemble as follows:

a. Remove the indicator rear plate; it is no longer required.

MODEL 406 HOOKUP TABLE

RANGE TYPE	TERMINALS			
	+V	-V	+I	-I
TC RANGE	VARIES	RED	--	--
K1-K5	WHITE	RED	--	--
I1 - I3	--	--	WHITE/ BLACK	WHITE/ RED
RTD & TH	WHITE	RED	WHITE/ BLACK	WHITE/ RED

MODEL 407 HOOKUP TABLE

RANGE TYPE/ CALIBRATOR WIRE	TERMINALS	
	+V	-V
TC RANGE	VARIES	RED
K1 RANGE	WHITE	RED

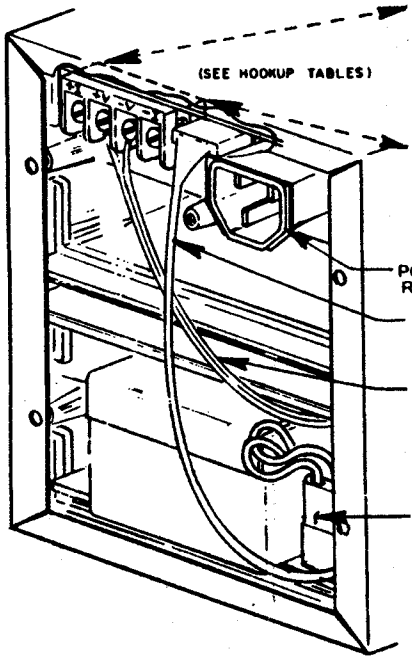


FIGURE 2-9. INDICATOR INSTALLATION IN A POWER PACK CASE

b. Remove the rear cover of the Power Pack.

c. If there are plastic plugs inthe sides of the indicator case, pry them out with a screwdriver; slide the indicator into the power pack upper section from the front.

d. Connect the battery I/O cable from the Power Pack board to P2 on the indicator as shown in Figure 2-9 (paint stripe visible on connector plug when connected).

e. Connect the front panel binding posts (from BEHIND the panel) to the rear input terminals of the indicator in parallel, using appropriate lengths of twisted pair wire (voltage, current, RTD, thermistor ranges) or thermocouple extension wire (thermocouple ranges). See Figure 2-9 for the correct polarity of various applications.

f. Plug the battery connector into the battery board as shown in Figure 2-9.

g. Install Power Pack rear cover.

h. Connect the AC power cord and verify that the LED display lights immediately. If it doesn't, disconnect the power cord and recheck all connections including the power voltage jumpers. Contact the Instrument Repair Department if the unit still isn't working.

2.7 INPUT/OUTPUT CONNECTIONS

2.7.1 Basic (Models 400/410) and Multirange Instruments

All signal input connections are made to the rear of the instrument using screw terminals. To gain access to the recessed terminal strip, the rear cover place must be removed. The four signal input terminals are located in the upper-left corner, and are labeled +I, +V, -V, and -I. See Figure 2-10.

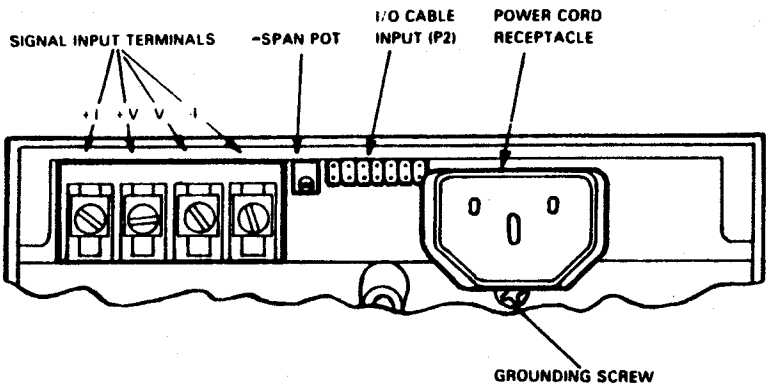


FIGURE 2-10. BASIC AND MULTIRANGE INSTRUMENT REAR VIEW

Connections for the various types of signal input wires is shown in Figure 2-11. The input wires must pass through the rear cover grommet. Recommended points for grounding are also shown. For better noise rejection, the sensor and shield (if used) should be grounded at the source or instrument. Never ground sensor or shield at both points. Current transmitter (I1-I3) input wires are not normally grounded. The ground point for the instrument is located on the horizontal cross bar (see Figure 2-10).

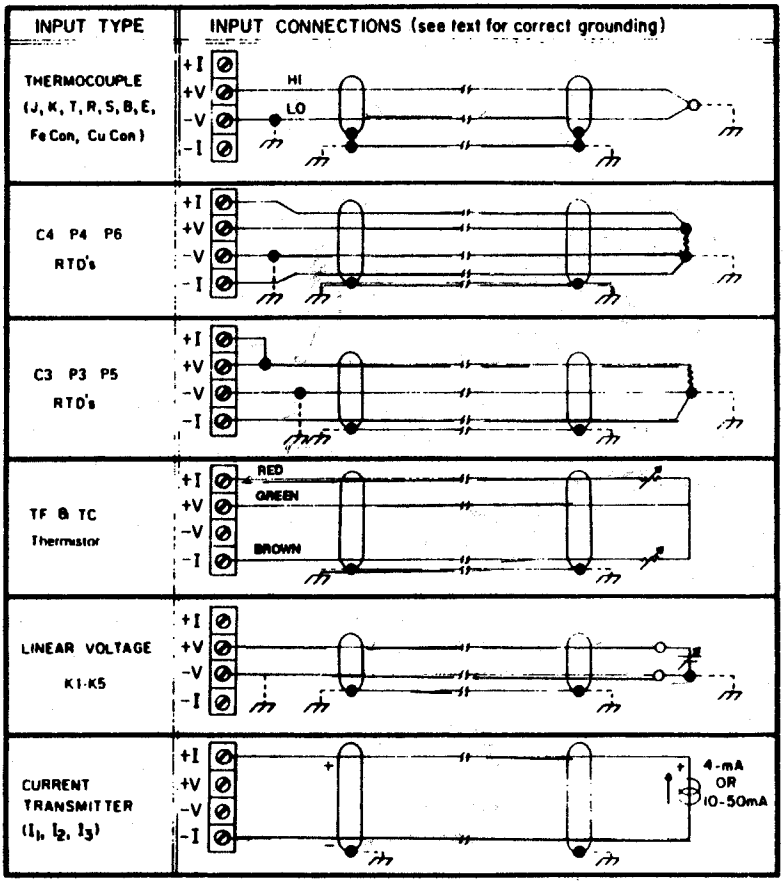


FIGURE 2-11. SIGNAL CONNECTION DIAGRAMS

2.7.2 Five Input Switching Units, Models 402/412

Figure 2-12 shows signal connections for Models 402/412. The same type of thermocouple wire as the signal inputs being switched is used to connect the common output from the switch board to the input terminals labeled +V and -V. Up to five pairs of signal input wires (+ and -) can be connected to the input terminal strip.

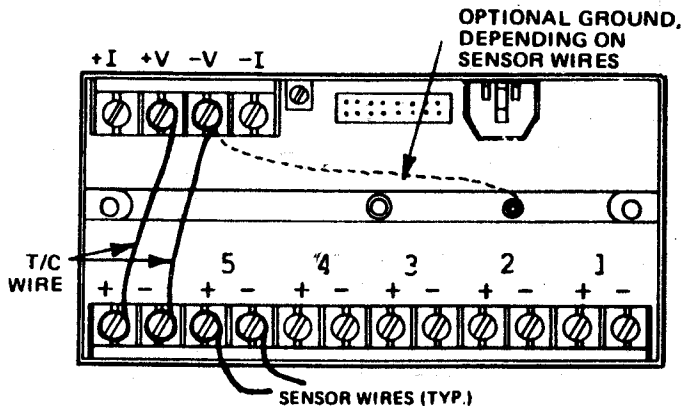


FIGURE 2-12. MODELS 402/412 REAR VIEW, SIGNAL CONNECTIONS

2.7.3 Power Pack Units, Models 406/407

The signal input connections for Model 406 and 407 Power Packs are made at the front of the instrument to binding posts. See Figure 3-5 in Section 3. Although the posts are arranged differently from the rear terminals, the connections are the same as shown on the connection diagrams of Figure 2-11. The posts are clearly marked +I, +V, -V, and -I as applicable to the type of input used.

Connections to the posts may be made in several ways. If the signal wire terminates with a standard banana plug, it may be inserted directly into the end of the binding post. By unscrewing the binding post cap, signal input wires up to 14 AWG may be terminated by wrapping around the post or by inserting the wire through the hole provided in the post. The cap should be tightened against the wire to make a secure connection.

2.7.4 External Switching Stations, Models 405/409, and Switch Error Board, Option 001A

The Model 405 External Switching Station accommodates thermocouple, linear voltage, and current inputs. Up to ten pairs of signal leads (+ and -) can be connected to the rear terminal strips of the Model 405 External Switching Stations. See Figure 2-13.

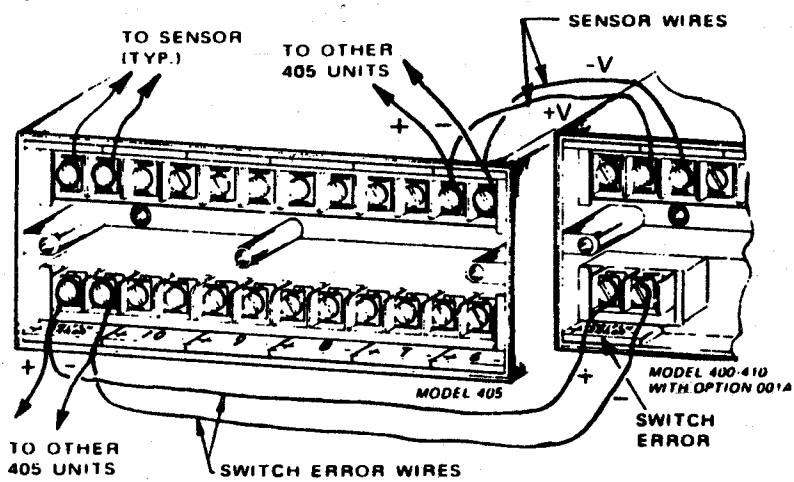


FIGURE 2-13. MODEL 405 REAR VIEW, SIGNAL CONNECTIONS

A pair of terminals (+ and -) on the upper right is the common output which is connected to the indicator's + V and - V input terminals. The common output can also be used as an input to another Model 405 unit. A pair of terminals (+ and -) on the lower left is the switch error output which is connected to the + and - input of the switch error board in the indicator or Model 411 option chassis.

The Model 409 External Switching Station accomodates up to ten sets of 3 or 4-wire RTD or themistor inputs (+ I, + V, -V, and -I). See Figure 2-14.

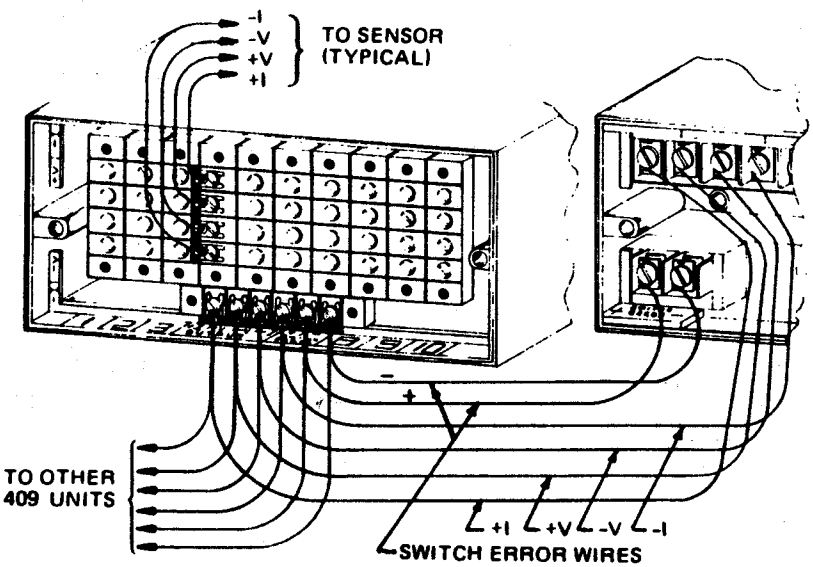


FIGURE 2-14. MODEL 409 REAR VIEW, SIGNAL CONNECTIONS

All connections are usually made to the Fanning strips supplied with the Model 409 unit. Signal leads are crimped and soldered to the Fanning strips and then installed on the appropriate terminals at the switching unit. Input terminals are arranged in ten vertical banks of four. Output terminals (common output + I, + V, -V, -I and switch error + and -) are placed horizontally directly below the input terminals. The common output can also be used as an input to another Model 409 unit. The switch error output (+ and -) is connected to the + and - input of the switch error board in the indicator or Model 411 option chassis.

2.7.5 BCD Data Output Board (Option 002A)

External connections to the BCD Data Output Board are made via the 30-pin mating connector provided with the option. Using the mating connector supplied, a cable is fabricated by the user as required. Cable connections are shown in Figure 2-15.

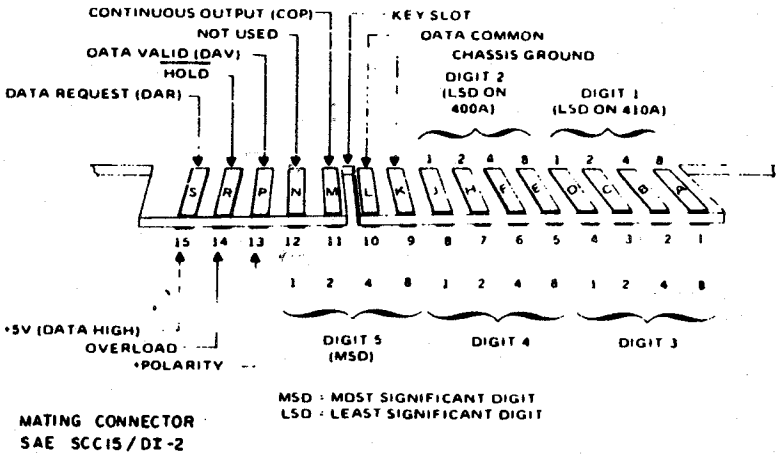


FIGURE 2-15. DATA OUTPUT PIN ASSIGNMENTS (OPTION 002A)

All outputs are TTL compatible, and fanout is two standard TTL inputs. Input commands require only 250 μA sink current; therefore, they are both TTL and CMOS compatible. Data outputs are positive true, 8-4-2-1 BCD. Note that terminals A, B, C, and D are unused in applications using a standard resolution indicator.

Although the data output is fully isolated from the indicator's sensor input and power line connections, good wiring practices should be followed for cabling outputs. Both data common and chassis ground are provided for cable shielding. Also,

the command lines DAR and $\overline{\text{HOLD}}$ should not be too closely bundled to the data output lines in order to prevent possible crosstalk. Maximum recommended cable length is 7.62 meters (25 feet) to peripheral. Data output should also be kept away from sensor input wires to prevent possible crosstalk.

The + polarity line is independently "true" (high) for positive displays, and "false" (low) for negative displays.

Overload is "true" (high) for an overload (over scale or broken sensor) indication on the display (all dashes), and "false" (low) for normal in-range readings.

Data common is provided for logic low reference, as is the data outputs' +5V supply for logic high reference. Current capability of the +5V output is 500 μA maximum which allows up to 10 unused TTL inputs to be wired high externally.

Timing for the data valid is shown in Figure 2-16. The positive going edge of DAV should be used for triggering an external printer or other device. The DAV pulse is low for approximately 3.5 msec during the data update, and no BCD outputs should be taken during this period.

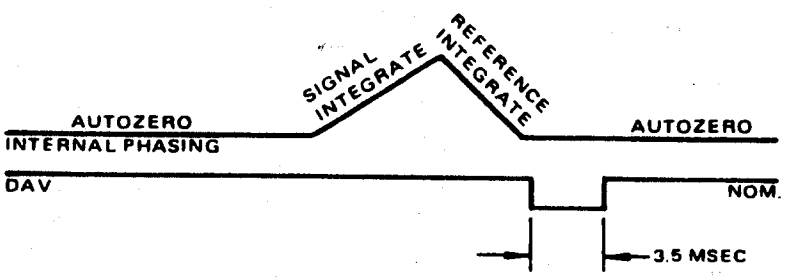


FIGURE 2-16. OPTION 002A, DATA OUTPUT TIMING DIAGRAM

If the DAR line is held high indefinitely, no further DAV transitions occur after the first. If continuous DAV updates are desired for each encoding (that is, for a DAV interrupt scheme), the continuous output (COP) may be wired or switched directly to the DAR command line. In this mode a DAV update occurs after every encoding.

Unless the command line $\overline{\text{HOLD}}$ is low (ground contact closure), the indicator takes continuous readings as in normal operation. When $\overline{\text{HOLD}}$ is taken low, the last readings are displayed indefinitely, and no new conversions are made. In this mode, DAV is high continuously. Displayed data is valid on the output lines, however, and could be utilized if desired.

The normal command for data output is the data request (DAR) line. If the unit is not in hold ($\overline{\text{HOLD}}$ = 1 or open), then a positive edge transition on DAR causes one subsequent DAV output pulse at the next completed encoding time. Each positive edge on DAR causes only one DAV update if the DAR pulse conforms to Figure 2-17.

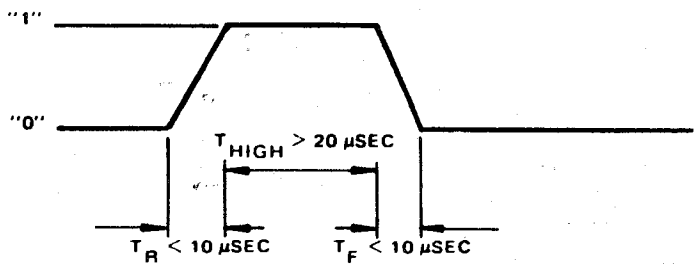


FIGURE 2-17. DAR COMMAND FORMAT

2.7.6 Alarm Setpoint Boards (Options 003A/004A)

External connections for alarm relay contacts and relay reset inputs for both Alarm Setpoint boards (Options 003A/004A) are made to terminal strip TB1 on the Alarm Setpoint board. See Figure 2-18. Relay contacts have a rating of 1 A @ 120 VAC and can be used to operate various annunciator devices upon alarm. A normally open, momentary contact switch is connected by the user as required for manual reset of the alarm relay.

WARNING: Lethal AC power voltages may be present on barrier terminals. Exercise caution when working in this area.

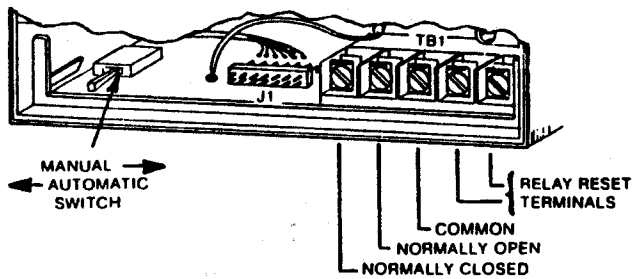


FIGURE 2-18. TB1 ON ALARM SETPOINT BOARDS (OPTIONS 003A/004A)

2.7.7 Analog Output Board (Option 005A)

A pair of screw terminals on terminal strip TB1 provides the output connection from the Analog Output board (Option 005A). See Figure 2-19. Use a twisted pair cable for connecting the analog output to the external device input.

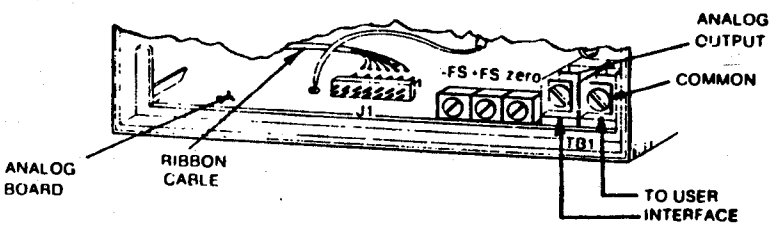
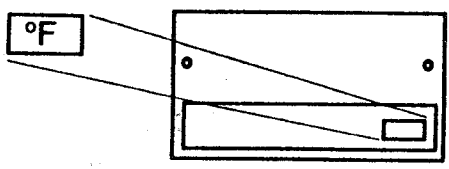


FIGURE 2-19. ANALOG OUTPUT TERMINALS (TB1)

2.8 AFFIXING UNITS LABEL TO FRONT PANEL

Included with the indicator is a sheet of adhesive backed labels for engineering units. Peel off the label appropriate to your indicator's configuration and affix in the space provided on the lower right corner of the front panel.



SECTION 3

OPERATION

3.1 APPLYING POWER TO THE INSTRUMENT

Power is applied to the instrument as long as the instrument is plugged into an active AC power source. To remove power, unplug the power cord from the instrument or AC outlet.

To eliminate shock hazard and/or possible instrument damage, always remove the power cord from either the instrument or power source before a range (programming module) change is made (single range models) and/or a sensor rewired (all models).

3.2 USING BASIC UNITS (MODELS 400/410)

The Models 400/410 indicators are single range indicators with a single input. Once the instrument is configured for the desired range (refer to 2.4) measurements can be made by connecting the appropriate sensor to the rear input terminals (refer to 2.7.1). Observe operating guidelines per 3.1 above.

3.3 USING THE MULTIRANGE UNITS (MODELS 403/415/408/418)

Multirange units accommodate six ranges which are selectable by a row of pushbuttons below the display. Each pushbutton is labeled with a particular range. To use a particular range, connect the sensor to the instrument (power OFF), press the appropriate pushbutton, and apply instrument power. The pushbuttons are interlocked so that only one pushbutton is selected at one time.

When using a multirange unit with the Model 406 or 407 Power Pack, the front panel binding posts of the power pack unit may be used for TC ranges if the interconnect between indicator and power pack binding posts is of the appropriate type

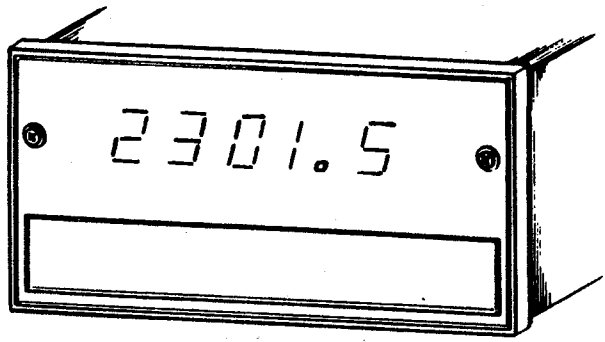


FIGURE 3-1. FRONT PANEL, BASIC INDICATOR (MODEL 410 SHOWN)

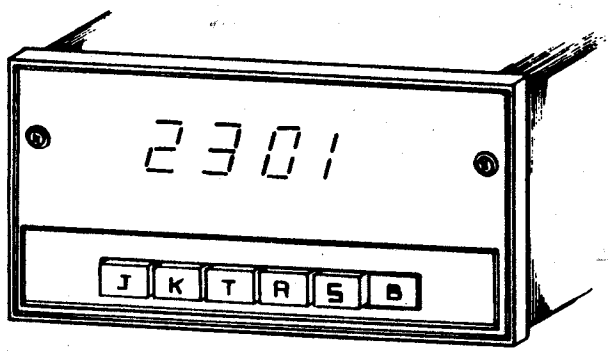


FIGURE 3-2. FRONT PANEL, MULTIRANGE UNIT (MODEL 403 SHOWN)

thermocouple wire. Otherwise, the binding posts may be bypassed, with signal input wires connected directly to the rear input terminals of the indicator in normal fashion. Note however that the rear of the instrument must be covered when making this connection in order to prevent thermal instability which results in inaccurate readings. A small hole may be drilled to thread the thermocouple wire through the rear cover near the input terminals, or if wire is smaller than 24 AWG, it can be routed between the edge of the case and rear cover. When using the multirange unit with the Model 407 Power Pack, the transfer standard (calibrator output) is effective only for the type thermocouple wire used to make the interconnection between the front panel binding posts and indicator input terminals. Refer to 3.6 for usage of the Models 406/407 Power Packs. Refer to 2.6.3 for indicator installation in a power pack unit.

3.4 USING THE 5-INPUT SWITCHING UNITS (MODELS 402/412)

The 5-input switching units accommodate five inputs of the same range as determined by the analog program module and LSI chip installed (refer to 1.1.1). Inputs are selected by a row of pushbuttons directly below the display. The pushbuttons are numbered 1-5. Pressing a particular pushbutton selects that input point for display. The pushbuttons are interlocked so that only one pushbutton is selected at one time.

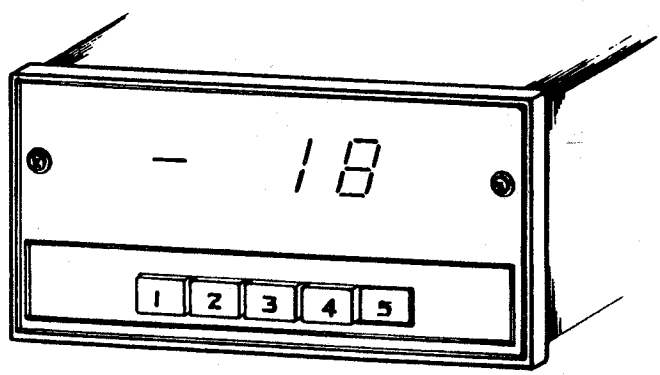


FIGURE 3-3. FRONT PANEL, 5-INPUT SWITCHING UNIT (MODEL 402 SHOWN)

3.5 USING THE EXTERNAL SWITCHING UNITS (MODELS 405/409) AND SWITCH ERROR BOARD (Option 001A)

The External Switching Units provide 10 switchable inputs to a single indicator. Inputs are selected by two rows of front panel pushbuttons labeled 1-10. (Special numbering available. Contact factory.) Pressing a particular pushbutton selects that input point for display. Each row of pushbuttons are interlocked so that only one pushbutton within that row is selected at one time. Installation of the Switch Error Board (Option 001A) into the measuring system provides switch error indication by blanking the display if two or more pushbutton switches (from two or more rows) are depressed simultaneously.

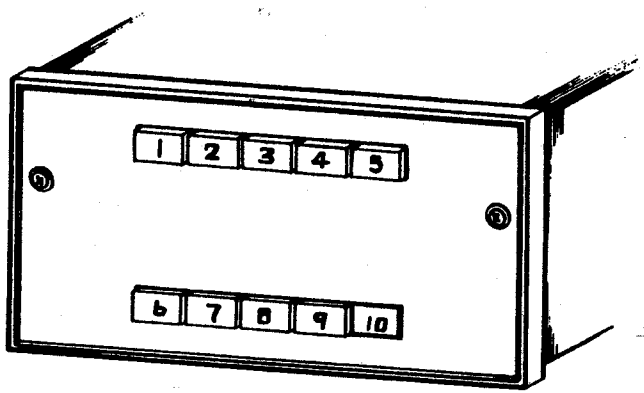


FIGURE 3-4. FRONT PANEL, EXTERNAL SWITCHING UNIT (MODELS 405/409)

3.6 USING THE POWER PACK UNITS (MODELS 406/407)

3.6.1 Battery Power Switch and Low Battery Indicator

The rocker type battery power switch is located on the bottom left portion of the instrument front panel. See Figure 3-5. When the top portion of the switch is pressed, battery power is supplied to the indicator. When the bottom portion of the switch is pressed, battery power is removed from the indicator, and if the unit is plugged into an AC power source, AC power is then supplied to the indicator.

The low battery LED indicator is located directly left of the battery power switch. The LED indicator lights if the battery charge is low when operating the instrument from batteries. The LED indicator is off when the instrument is operating from AC (battery being charged), or when the battery is fully charged.

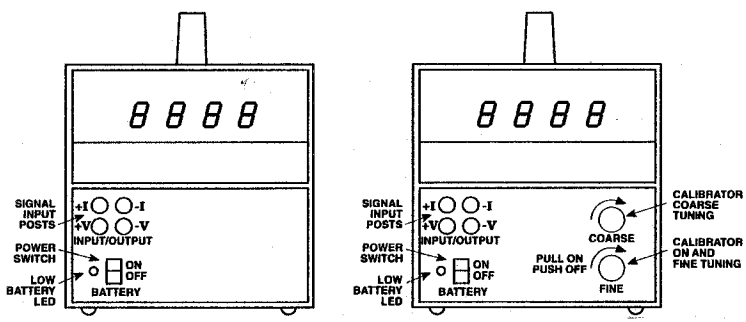


FIGURE 3-5. FRONT VIEW, MODELS 406 AND 407 POWER PACKS

3.6.2 Charging the Battery

To charge the battery, install the AC power cord into the input receptacle (see Figure 2-11) at the rear of the instrument and connect the cord to the appropriate AC power source as required by the instrument. (Be sure that the instrument is pro-

perly configured for the power voltage being used; refer to 2.4.1). The battery charges slightly faster when the battery power switch is off, but the battery charges with the switch in either position. A full charge should occur in 10-12 hours with the battery power switch in the OFF position. The battery, a 10V sealed lead-acid module, may be recharged up to 500 times, depending on the charge-discharge history. The unit operates about 2-5 hours continuously per charge.

3.6.3 Replacing the Battery

When it becomes necessary to replace the battery (p/n 400-4200-xx), the following steps are recommended.

a. Remove the rear cover of the carrying case (4 screws).

b. Remove all interconnecting cables between the indicator and Power Pack unit.

c. Slide the indicator and Power Pack unit out from the front of the carrying case.

d. Remove the front panel (2 screws) from the Power Pack unit and slide the pcb assembly out from the front.

e. Disconnect the battery connector from the printed circuit board (pcb).

f. On the top of the metal shield over the battery module (towards the rear) are two phillips head screws. Remove these two screws and lockwashers.

g. Lift the end of the metal shield (the end nearest the screw holes) until the battery is cleared; slide out old battery assembly.

h. Insert new battery in the same position while lifting metal shield for clearance.

i. Re-assemble the Power pack unit: Insert 2 screws with lockwashers on top of metal shield. Reconnect battery connector onto pcb contacts. Slide pcb assembly back into Power Pack unit case and re-install front panel (2 screws).

j. Re-install indicator and Power Pack unit into carrying case.

k. Re-connect interconnecting wires between Power Pack unit and indicator (binding post interconnections and ribbon cable to indicator P2).

l. Place rear cover over back of carrying case, align screw holes and install 4 screws.

3.6.4 Using the Model 407 Potentiometer

The Model 407 Power Pack/Potentiometer, after being calibrated per the procedures in Section 4, can be used as a calibration source for voltage or equivalent thermocouple output. Output impedance in all cases is ten ohms. AC or battery power can be used in the calibrator mode with the battery switch in either the OFF or ON position, although battery charging is faster in the OFF position. However, if the low battery LED is ON (lit), make sure the display is stable or place the unit on line operation to avoid runaround.

When the Model 407 is used to calibrate an instrument, ensure that the unit is using the correct range for the instrument being calibrated.

After the output connections have been made, apply power to the instrument (battery switch ON, or connect unit to AC power source). See Figure 3-5 for location of controls. Turn the calibrator source ON by pulling out the inner (smaller) knob of the FINE output control. The output is then adjusted to the desired value (read on the indicator display) by using the 10-turn COARSE output control knob and the 4-turn FINE output control knob as required.

3.6.4.1 Millivolt Source

Model 407 using the K1 range will output -10 mV to +25 mV, or the full K1 range. The readout on the display accurately represents the voltage at the front panel binding posts. The post material is brass, and care must be taken to use low thermal connections (copper wire) to avoid parasitic thermocouple effects. Calibrate

the external unit at the points desired by adjusting the COARSE and FINE controls until the indicator reads the desired voltage, then adjust the unit under calibration to read the appropriate value.

3.6.4.2 Thermocouple Transfer Standard

A Model 407 configured with a thermocouple range can be used as a precision, linearized voltage source for thermocouple indicator calibration. Only the range type configured in the instrument can be calibrated accurately. Note that reference junction integrity is maintained by the appropriate thermocouple lead wire or extension wire used for the interconnect between the Power Pack binding posts and indicator rear terminals (refer to 2.6.3.e) and between the Power Pack and unit under calibration. Thus, the instrument may be configured to another range with the thermocouple transfer standard applicable to that range by using the appropriate interconnections.

For example, if the Model 407 is to be used to calibrate type J instruments, the type J programming module and 7500 chip is installed in the indicator, and type J thermocouple wire used for the interconnect between Power Pack and indicator rear terminals and between Power Pack and unit being calibrated. Refer to 2.4.2 for range configuration and 2.6.3 for instructions on internal Power Pack connections.

To calibrate an instrument, use the COARSE knob to obtain a close reading of the desired value on the indicator display, then use the FINE control to obtain the precise reading. The unit being calibrated is then adjusted for the same reading. For example, if the ice point value for a type K instrument has to be set to 32 °F, use the COARSE and FINE controls to obtain a reading of 32 °F on the indicator display, then adjust the unit being calibrated to read the same.

For low level thermocouples such as S, R, and B, thermal effects on the input terminals may cause some error. To avoid drafts, place a cloth over the input terminals if necessary. In most cases, less than five minutes is required to stabilize for a precision calibration.

3.6.5 Using the Alarm Setpoint Board (Options 003A/004A)

Controls on the Alarm Setpoint Board include thumbwheel switches for set point value, a toggle switch for automatic/manual reset operation, and on 004A only, a miniature rotary switch for setting deadband.

The options provide Form C contacts at the rear, shown in Figure 2-18. When a limit is reached, as determined by the thumbwheel switch settings, the relay closes and the LED at the front of the board lights. If the comparator is in the Automatic Reset mode the relay will open and the LED turn off when the measured variable returns to a normal condition. If the comparator is in the Manual mode the relay must be reset manually after the measured variable returns to normal. A switch closure across the relay reset terminals, shown in Figure 2-18, resets the relay.

3.6.5.1 Selecting Setpoint Value

There are five thumbwheel switches accessible from the front panel, shown in Figure 3-6. For reference, these switches are identified as S1, and S2-A through S2-D. Four of these switches, S2-A through S2-D, are used to select the numerical setpoint (-3999 to +3999). Switch S1 is used to designate the setpoint as HI or LO.

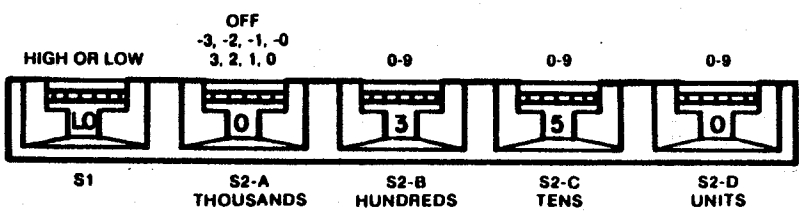


Figure 3-6. THUMBWHEEL SWITCHES ON ALARM SETPOINT BOARD (003A/004A)

As shown in Figure 3-6, S2-D select the thousands, hundreds, tens, and units respectively. Switch S2-A sets the most significant digit (thousands) from which the polarity of the setpoint is determined (+ or-). Switch S2-A also has an OFF setting to disable the setpoint. Switch S1 assigns the selected setpoint as HI or LO. To select a setpoint, simply dial the thumbwheel switches to the desired number. The example in Figure 3-6 shows a LO setpoint of + 350. To set a negative number, dial switch S2-A to -0, -1, -2, or -3 depending on the number of thousands desired.

The alarm relay is actuated when the input is at the exact setpoint setting. The HI/LO setpoint assignment determines what direction the input must take in order to trip the relay. If the setpoint is set HI, the alarm relay on the setpoint board will trip when the input value is equal to or greater than the setpoint value (input goes more positive). For example, for a HI setpoint of + 1000, an alarm trip will occur once the input value reaches + 1000 or more (e.g. + 1001, 1002...etc). If the setpoint is set LO, the alarm relay on the setpoint board will trip when the input value is equal to or less than the setpoint value (input goes more negative). For example, for a LO setpoint of -0099, an alarm trip will occur once the input value reaches -0099 or less (e.g. -0100, -0101...etc).

3.6.5.2 Selecting Manual or Automatic Reset

Toggle switch S4, accessible from the rear of the Alarm Setpoint board, is used to select automatic or manual reset of the alarm relay. See Figure 2-18 in Section 2.

Switch positions AUTO/MAN are etched on the board below the switch. When in the AUTO position, the alarm relay will reset automatically once the measured variable no longer exceeds the setpoint. When in the MAN position, the alarm relay remains tripped even if the measured value no longer exceeds the setpoint. The relay is reset by an external momentary contact switch (normally open) connected to the reset input terminals provided by TB1 on the board (see Figure 2-18).

Note that if the external manual reset switch remains closed, the relay remains untripped regardless of alarm conditions that may still exist or the position of switch S4.

3.6.5.3 Setting Deadband (004A)

Option 004A Alarm Setpoint board is provided with a miniature rotary switch (S3) located on the printed circuit board behind the alarm LED. Switch S3 selects

the desired value of deadband (hysteresis) from 0 to 9. The Alarm Setpoint board must be removed from the chassis to gain access to this switch. A small bladed screwdriver is recommended to actuate the switch. A small notch or triangle within the screwdriver slot (shown in Figure 3-7) indicates the setting.

Settings on the switch represent deadband units which are used to set the return limit after the initial setpoint has been exceeded. The deadband setting is negative for HI setpoints; positive for LO setpoints. A setting of zero indicates no deadband.

The AUTO/MAN switch (S4) must be in the AUTO position for control applications.

The table below shows deadband operation with HI and LO setpoints:

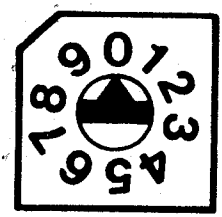


FIGURE 3-7. SWITCH S3

Deadband set to 6:

SETPOINT	READING	ALARM
HI +0100	100 99-94 93	YES YES NO
LO +0100	100 101-106 107	YES YES NO

SECTION 4

CALIBRATION

4.1 TEST EQUIPMENT

a. Thermocouples: a DC calibrator capable of supplying voltages up to 100 mV with better than one microvolt resolution is required. A stable ice bath, accurate to 0.05°F, is also needed.

b. K1, K2, K3, K4,K5 Ranges: a DC calibrator (see item a above) is required, except an output of up to 25V is necessary (K4 range).

c. I_1, I_2, I_3 Ranges: a current calibrator with 1 μA resolution from 4 to 50 mA is required.

d. RTD Ranges: 000.00 to 400.00 ohm calibration pot with 0.01 ohm resolution is required.

e. TH ranges: 1000.0 to 30,000.0 ohm calibration pot with 1.0 ohm resolution is required.

4.2 CALIBRATION PROCEDURE

In all cases, allow instrument to warm up for 30 minutes before calibrating.

4.2.1 THERMOCOUPLES

a. Prepare test wires for ice bath as shown in Figure 4-1.

b. Connect the DC calibrator and ice bath to the instrument as shown in the set-up diagram in Figure 4-2.

c. Refer to calibration chart in Figure 4-3 and perform calibration.

EXAMPLE: For Type K thermocouple. Connect the DC calibrator to instrument +V and -V. Apply 0.000 mV and adjust Front Panel Zero (R44) to give a display of 32°F or 0°C. Apply 54.845 mV and adjust + Span (R45) to give a display of 2500°F. R44 and R45 are visible at the upper left of the display with the front panel plexiglas removed.

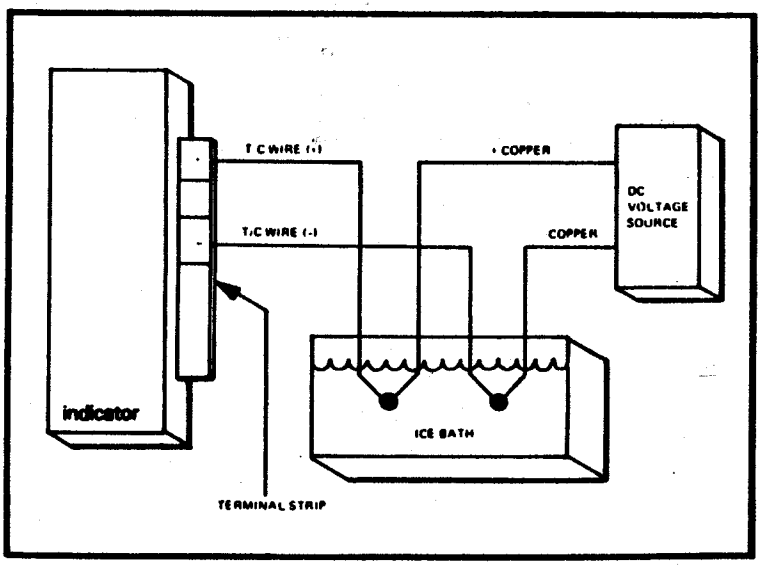


FIGURE 4-1. CALIBRATION SET-UP

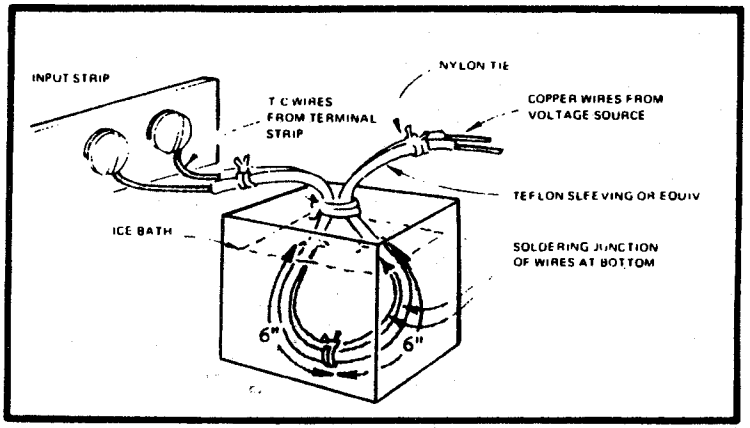


FIGURE 4-2. PREPARING WIRES FOR ICE BATH

NOTE: The B thermocouple output below 912°F (488°C) is only 1.3 μV/°F (2.4 μV/°C). While the instrument linearity is excellent above 912°F, the "B" μV table will better approximate lower temperatures.

4.2.2 LINEAR VOLTAGE RANGES

4.2.2.1 K1, K2, K3, and K4 RANGES

Calibration consists of two mandatory pot adjustments, ZERO and +SPAN. These adjustments are located on the upper left behind the plexiglass front panel (extract two front panel screws). The pots are labeled with their respective function on the PC board.

If required, −SPAN can also be adjusted (R14). This pot is located at the rear of the instrument between the input terminal strip and P2. For all applicable ranges, −SPAN display readings should be verified with the appropriate input voltage per the calibration chart and the −SPAN pot (R14) adjust if necessary.

a. Connect the DC calibrator to the +V and −V terminals of the instrument.

b. Perform calibration per the calibration chart, inputting the appropriate voltage and adjusting the appropriate pot for the desired display reading. Calibration must be performed in the following sequence, (a) Zero, (b) +SPAN, and (c) −SPAN (if necessary).

4.2.2.2 K5 RANGE

a. Connect the voltage calibrator to the +V and −V terminals (rear panel) of the instrument.

b. Apply 0 volts and adjust the OFFSET pot, located on the analog programming module, to the desired minimum reading. If necessary, the ZERO pot located behind the plexiglass front panel (extract two front panel screws) can be used to fine tune this adjustment.

c. Apply +5 volts and adjust the three span pots as required for the maximum desired reading. The three pots in order of degree of refinement are the C (coarse) pot and FINE pot (both located on the analog programming module), and the +SPAN pot located behind the plexiglass front panel.

d. Re-apply 0 volts input and recheck the display reading. If required, repeat steps b and c above.

4.2.3 CURRENT TRANSMITTER RANGES

4.2.3.1 I1 and I2 Ranges

Calibration consists of two pot adjustments, ZERO and +SPAN. These adjustments are located on the upper left behind the plexiglass front panel (extract two front panel screws). The pots are labeled with their respective function on the PC board.

a. Connect the current calibrator to the +I and −I terminals of the instrument.

b. Perform calibration per the calibration chart, inputting the appropriate current and adjusting the appropriate pot for the desired display reading. The ZERO adjustment should be performed first and the +SPAN adjustment performed next.

4.2.3.2 I3 Range

a. Connect the current calibrator to the +I and −I terminals of the instrument.

b. Apply 4 mA and adjust the OFFSET pot, located on the analog programming module, to the desired minimum reading. If necessary, the ZERO pot located behind the plexiglass front panel (extract two front panel screws) can be used to fine tune this adjustment.

c. Apply 20 mA and adjust the three span pots as required for the maximum desired reading. The three pots in order of degree of refinement are the C (coarse) pot and FINE pot (both located on the analog programming module), and the +SPAN pot located behind the plexiglass front panel.

d. Re-apply 4 mA and recheck the display reading. If required, repeat steps b and c above.

RANGE	SENSOR TYPE	INPUT	ADJUST	READ	INPUT	ADJUST*	READ	INPUT	READ
J, 2J	Iron-Constantan	0 mV	Zero	32°F	39.407	S,oan	1300°F	- 7.519	- 300°F
		0 mV	Zero	0°C	42.283	Span	750°C	- 7.659	- 190°C
K	Chromel-Alumel	0 mV	Zero	32°F	54.845	Span	2500°F	- 4.381	- 200°F
		0 mV	Zero	0°C	52.398	Span	1300°C	- 3.553	- 100°C
T, 2T	Copper-	0 mV	Zero	32°F	20.801	Span	750°F	- 5.341	- 300°F
	Constantan	0 mV	Zero	0°F	20.252	Span	390Cc	- 5.439	- 190°C
R	Platinum-	0 mV	Zero	32°F	19.518	Span	3000°F	-	-
	Platinum 13%	0 mV	Zero	0°C	20.878	Span	1750°C	-	-
	Rhodium								
S	Platinum-	0 mV	Zero	32°F	17.347	Span	3000°F	-	-
	Platinum 10%	0 mV	Zero	0°C	18.504	Span	1750°C	-	-
	Rhodium								
B	Platinum 30%	0 mV	Zero	32°F	13.763	Span	3300°F	-	-
	Rhodium								
	Platinum -	0 mV	Zero	0°C	13.585	Span	1800°C	-	-
	6% Rhodium								
FC	Iron-Constantan	0 mV	Zero	32°F	53.064 mV	Span	1650.0°F	- 8.022 mV	- 320.0°F
	(DIN)	0 mV	Zero	0.0°C	50.320 mV	Span	860.0°C	- 8.006 mV	- 195.0°C
CC	Copper-	0 mV	Zero	32.0°F	31.492 mV	Span	1040.0°F	- 5.405 mV	- 300.0°F
	Constantan (DIN)	0 mV	Zero	0.0°C	33.954 mV	Span	595.0°C	- 5.510 mV	- 190.0°C
E	Chromel-	0 mV	Zero	32.0°F	81.273 mV	Span	1950.0°F	- 8.768 mV	- 324.0°F
	Constantan	0 mV	Zero	0.0°C	76.357 mV	Span	1000.0°C	- 8.273 mV	- 180.0°C
P3, P4	Platinum	100.00Ω	Zero	32.0°F	390.38Ω	Span	1562.0°F		- 328.0°F
	100Ω RTO (DIN)	100.00Ω	Zero	0.0°C	390.38Ω	Span	850.0°C	18.53S2	- 200.0°C
P5, P6	Platinum	100.00Ω	Zero	32.0°F	381.19Ω	+ Span	1472.0°F	17.02Ω	- 328.0°F
	100Ω RTD (USA)	100.00Ω	Zero	0.0°C	381.19Ω	+ Span	800.0°C	17.02Ω	- 200.0°C
C3, C4	Copper RTD	9.04	Zero	32°F	16.91	+ Span	400.0°F	-	-
		6.73	- Span	- 76°F					
		9.04	Zero	0°C	16.74	+ Span	200.0°C		
		6.73	- Span	- 60°C					
TH	Thermistor	T1-100K	Zero	32°F	T1-100K	+ Span	212°F		
		T2-25.425K			T2-1.602K			-	- -
TC	Thermistor	T1-100K	Zero	0°C	T1-100K	+ Span	100°C	-	-
		T2-25.425K			T2-1.602K			-	-
I_1	4-20 mA Transmitter	4.000 mA	Zero	- 0.00%	20.000 mA	Span	100.00%	-	-
I_2	10-50 mA Transmitter	10.000 mA	Zero	- 0.00%	50.000 mA	S,oan	100.00%	-	-
I_3	4-20 mA Transmitter	4.000 mA	Offset*		20.000 mA	C&Fine Span*		-	-
K1	- 10 mV to + 25 mV Linear	0 mV	Zero	- 0.000 mV	25.000 mV	Span	25.000 mV	- 10.000 mV	- 10.000 mV
K2	- 100 mV to + 250 mV Linear	0 mV	Zero	- 0.00 mV	250.00 mV	Span	250.00 mV	- 100.00 mV	- 100.00 mV
K3	- 1V to + 2.5V Linear	0 mV	Zero	- 0.0000 mV	2.5000 mV	Span	2.5000 mV	- 1.0000V	- 1.0000V
1000 mV	- 0.5V to + 1 .0V	0 mV	Zero	- 0.0 mV	1.0000V	Span	1000.0 mV	- 500.0 mV	- 500.0 mV
(408, 418)	Linear								
K4	- 10V to + 25V	0 mV	Zero	- 0.000V	25.000V	Span	25.000V	- 10.000V	- 10.000V
K5	0- 5V	0 mV	Offset*		5.000V	C&Fine Span*		-	-

* Refer to text.

+ Although minus span adjust is normally not required, R14 may be adjusted.

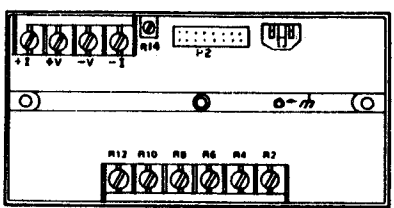
FIGURE 4-3. CALIBRATION CHART

4.2.4 RTD AND TH RANGES

a. Connect resistor(s) as indicated in Figure 2-11.
b. Refer to calibration chart and perform calibration.

4.2.5 Multirange Units

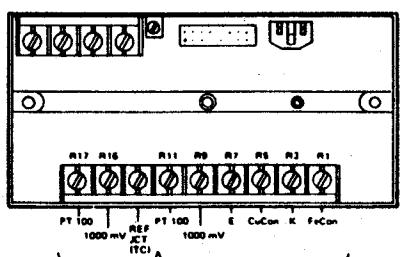
The following charts lists calibration adjustments for multirange instruments. Complete and accurate calibration for all ranges requires that the instrument be returned to the factory. Touch-up span calibration can be achieved by adjusting the appropriate span pot accessible from the rear. On these units, the zero pot (behind the front panel) may be adjusted for a particular range at the expense of remaining ranges being slightly off at zero (ice point). It may be necessary to re-adjust ice point for the particular type thermocouple being used (particularly common with types R, S, and B). Always adjust ice point before adjusting full scale. Minus span pot R14 may be adjusted if desired for a particular range, but is common for all ranges. Input and nominal calibration values are the same as shown in the calibration chart with this section.



TC TYPE	ICE POINT ADJUST	FULL SCALE ADJUST
B	Zero*	R12
J	Zero*	R2
K	Zero*	R4
T	Zero*	R6
R	Zero*	R8
S	Zero*	R10

*Zero adjust is on front panel

MODELS 403, 415



RANGE TYPE	ZERO ADJUST	FULL SCALE ADJUST
Fe Con	Zero*	R1
K	Zero*	R3
Cu Con	Zero*	R5
E	Zero*	R7
PT3, PT4	PT R17	R11
1000mV	mV R16	R9

*Zero adjust is on front panel

MODELS 408, 418

4.2.6 POWER PACK 406 AND 407

a. Connect front panel inputs the same as indicator rear inputs.

b. Adjust according to calibration chart. Model 407 potentiometer switch must be OFF.

c. Models 406 and 407 may be calibrated while line charging or running on batteries.

4.2.7 Analog Output

The Analog Output board is provided with three pots for calibration. See Figure 4-4. Use the calibration set-up shown in Figure 4-2 to calibrate the Analog Output board. Connect a known source to the indicator from which the Analog Output board is converting. Connect a DVM with 100 μV resolution to the output terminals of the Analog Output board. Adjust R18 (zero), R14 (+full scale), and R13 (-full scale) with the appropriate input in that order until the millivolt output agrees with the indicator display in the following fashion:

Analog Output = display counts x 1mV. (This applies to degrees, but not to tenths of degrees.)

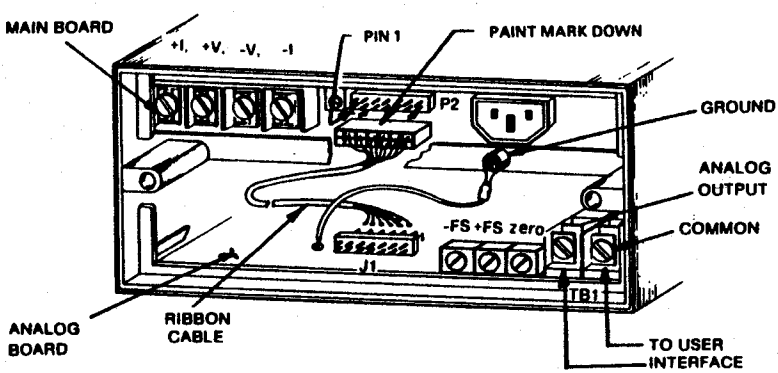
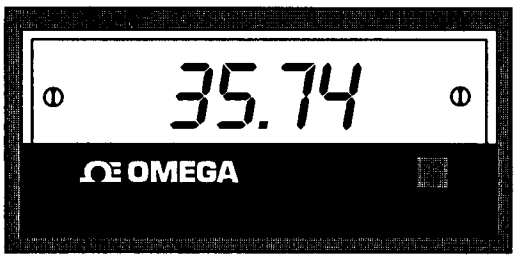


FIGURE 4-4. REAR VIEW, OPTION 005A CALIBRATION POTS

400B SERIES

Digital Temperature Indicator



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Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gages
- Load Cells & Pressure Gages
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

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