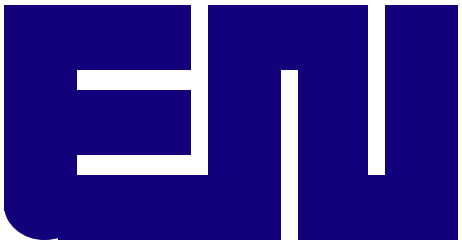
ULTRA SERIES

OWNERS MANUAL

MODELS
UA
UB
UC



ELECTRO-NUMERICS, INC.

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ULTRA Series Owners Manual

500-206 Rev. D

June 2000

INTRODUCTION

This manual is designed to provide all information to the user to install, wire and calibrate the *ULTRA* SERIES Digital Panel Meters. The *ULTRA* SERIES panel meters feature modularly designed plug-in cards. From the basic building blocks of Main Modules and seventeen Input Signal Conditioning Modules, the user can order a meter to meet his specific application in measurement and control. Each of the Signal Conditioning Modules should be specified with range and scaling at the time of ordering.

BASIC METER TYPES BY MODEL (MAIN BOARDS and POWER SUPPLIES)

All main boards contain the ac or dc power supply for the meter, plug-in positions for Input and Output Cards, I/O connectors and a bright LED display.

UA0__ 3 1/2 Digit display, 120Vac powered
UA1__ 3 1/2 Digit display, 230Vac powered
UA2__ 3 1/2 Digit display, 9-32Vdc powered
UB0__ 3 1/2 Digit display + Dummy zero, 120Vac powered
UB1__ 3 1/2 Digit display + Dummy zero, 230Vac powered
UB2__ 3 1/2 Digit display + Dummy zero, 9-32Vdc powered
UC0__ 4 Digit display, 120Vac powered
UC1__ 4 Digit display, 230Vac powered
UC2__ 4 Digit display, 9-32Vdc powered

INPUT SIGNAL CONDITIONING BOARDS (VOLTAGE , CURRENT and POTENTIOMETRIC BOARDS)

Each of the main boards accepts one plug-in input signal conditioner board. These boards accept the signal to be measured (dc voltage, thermocouple, ac current etc.) and provide the proper range and scaling to be displayed by the main board. The UA and UB models are the same except a dummy zero is added to the display on the UB models. The UB model main board is not offered with the RTD temperature, Resistance or Thermocouple input modules.

		UA MODELS	UC MODELS
UVI	1 to 4	199.9mV to 199.9 Vdc	99.99mV to 99.99Vdc ranges
UCI	1 to 6	19.99uA to 1.999 Amp	9.999uA to 999.99mA
UPO	1 to 2	0 to 100% with potentiometer	0 to 100.00% with potentiometer
UAV	1 to 5	199.9mV to 650 Vavg.	99.99mV to 650 Vavg.
UAI	1 to 7	19.99uA to 5 Aavg.	9.999uA to 5 Aavg.
UTV	1 to 5	199.9mV to 650 Vrms	99.99mV to 650 Vrms
UTI	1 to 7	19.99uA to 5 Arms	9.999uA to 5 Arms

FREQUENCY BOARD

F Frequency measurements (50Hz. to 20kHz.)
100Hz to 20kHz. 1999 50Hz. to 20kHz. 9999

		UA MODELS	UC MODELS
		RTD TEMPERATURE and RESISTANCE BOARDS	
URT	1&2	+/-199.9 °F &°C	+/-99.99 °C & °F
URX	1	-200 to 830 °C	-200.0 to 830.0 °C
URX	2	-328 to 1526 °F	-328.0 to 999.9 °F
URS	1 to 4	19.99 ohms to 19.99 kohms	9.999 ohms to 9.999kohms
		THERMOCOUPLE BOARDS	
UTJ	1&2	-40 to 760°C, -40 to 1400°F	-40.0 to 760.0 °C, -40.0 to 999.9 °F
UTK	1&2	-40 to 1260°C, -40 to 1999°F	-40.0 to 999.9 °C, -40.0 to 999.9 °F
UTT	1&2	-184 to 371°C, -300 to 700°F	-184.0 to 371.0 °C, -300.0 to 700.0 °F

TRANSDUCER PROCESS BOARDS

U____P	+/-190mV TO 11Vdc = +/-1999 No Excitation Supply	+/-9999
U____E	+/-190mV TO 11Vdc = +/-1999(UA) With 10 or 15 Vdc Excitation Supply	+/-9999

STRAIN GAUGE BOARD

U____S		+/-1999	+/-9999
	With 1 to 10 Vdc Excitation Supply		

ANALOG OUTPUT BOARDS

Each main board will accept one plug-in Analog Output Card. This card conditions the displayed reading to proportional voltage or current outputs to drive an external device such as a chart recorder.

U____H	Standard analog output
U____J	0 to 5Vdc output, maximum load 2k ohm, compliance voltage 12Vdc.
U____K	0 to 10Vdc output, maximum load 2k ohm, compliance voltage 12Vdc.
U____L	0 to 1mA output, sink or source, compliance voltage 12Vdc.
U____M	4/20mA output, sink or source, compliance voltage 12Vdc.
U____Y	4/20mA output - External power supply, sink only, compliance voltage 40Vdc.
U____N	0 to 1mA output - Ext. power supply, sink only, compliance voltage 40Vdc.

RELAY CONTROL OUTPUT BOARDS

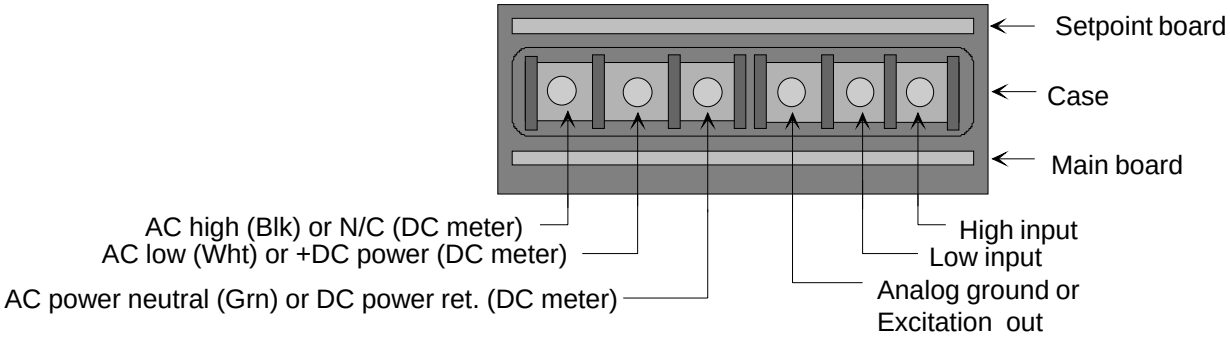
Each main board will accept one plug-in Control Output Card. These cards provide one or two setpoints with 10 Amp relay contacts.

SETPOINT BOARDS

U____X	Single setpoint board
U____R	Dual setpoint board

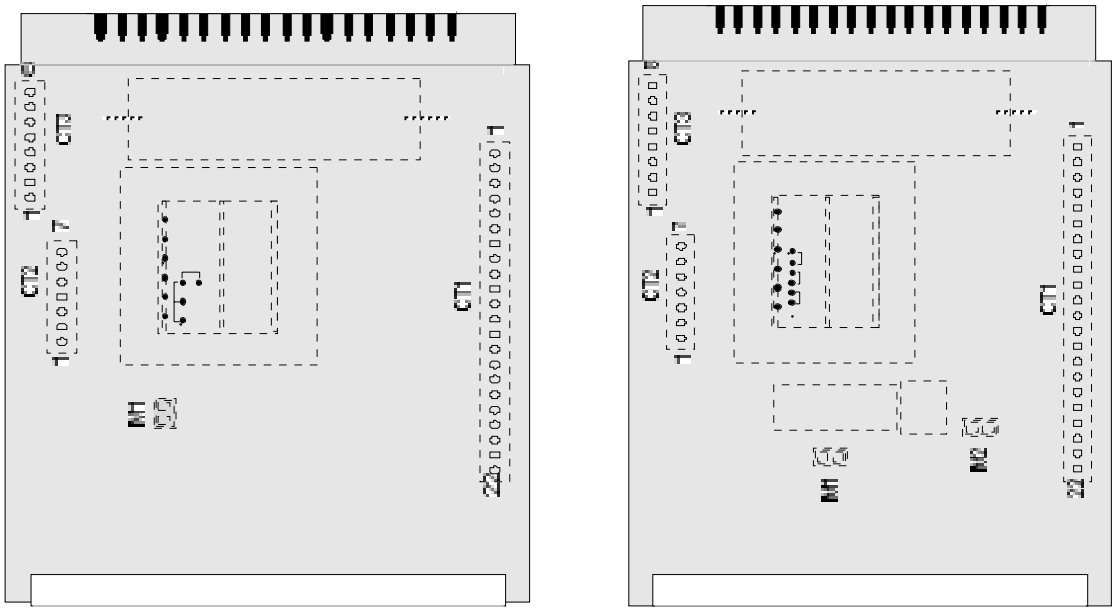
POWER CONNECTIONS

The power connections are made to screw terminals 1, 2 and 3. The high side to the power mains is be connected to terminal #1, the low side to terminal #2 and power ground to terminal #3. The remaining terminals (4, 5 and 6) are used for connecting the signal leads. The signal ground, if applicable is connected to terminal #4, the signal return, or low side is connected to terminal #5 and the high side to terminal #6. Refer to the drawing below for a rear view of the meter showing the power and signal screw terminal connector. The main board solder tabs are set to 120Vac by default. It 230Vac is required these solder tabs must be re-configured. See the table and illustrations below.



POWER SOLDER TAB SETTINGS

POWER	JOIN SOLDER TAB(S)
120 Vac	Close A & C, Open B
230 Vac	Close B, Open A & C

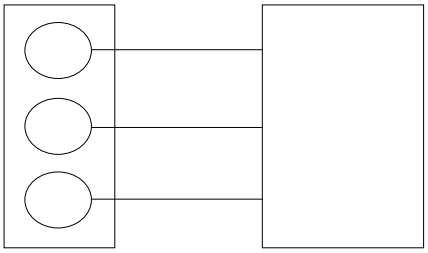


INPUT SIGNAL CONNECTIONS

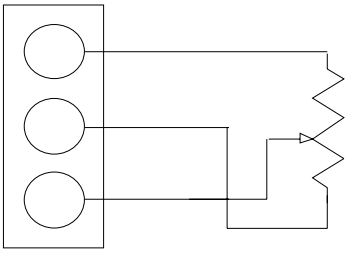
There are many types of transducers available for connection to the ULTRA SERIES meter. Depending on the type used, select the connection configuration from those show on the next few pages. If you cannot find a suitable configuration, call the factory for technical assistance.

VOLTAGE and CURRENT MEASUREMENTS

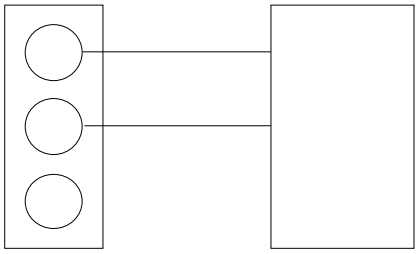
AC VOLTAGE or CURRENT MEASUREMENTS



POTENTIOMETER MEASUREMENTS

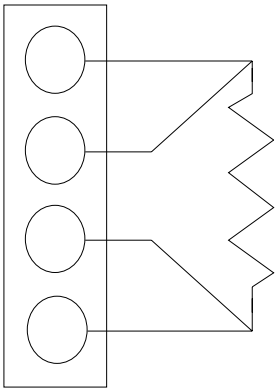


AC COUPLED FREQUENCY MEASUREMENTS

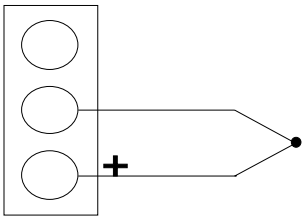


DC COUPLED FREQUENCY MEASUREMENTS

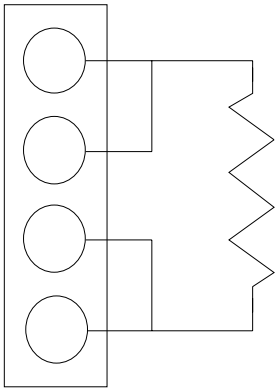
FOUR WIRE RTD CONNECTIONS



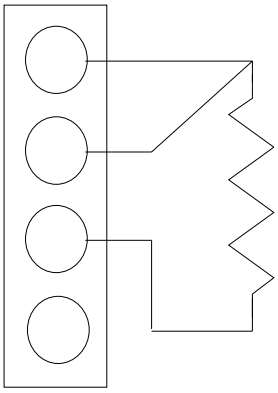
THERMOCOUPLE MEASUREMENTS



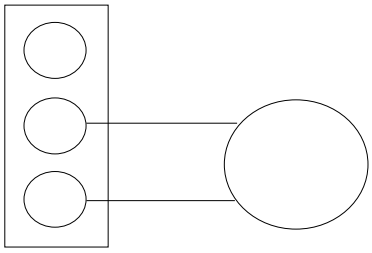
TWO WIRE RTD CONNECTIONS



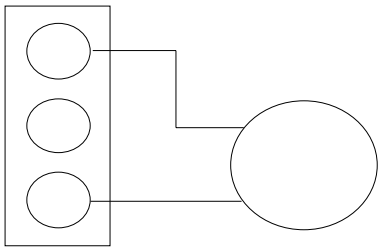
THREE WIRE RTD CONNECTIONS



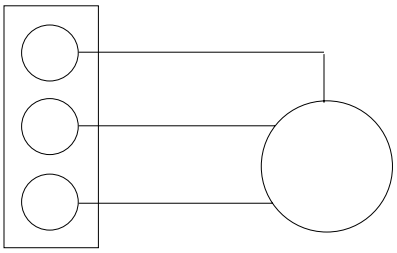
TWO WIRE TRANSDUCER
(INTERNAL EXCITATION NOT USED)



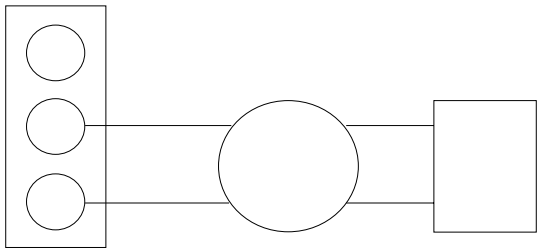
TWO WIRE TRANSDUCER CONNECTIONS
(USING INTERNAL EXCITATION SUPPLY)



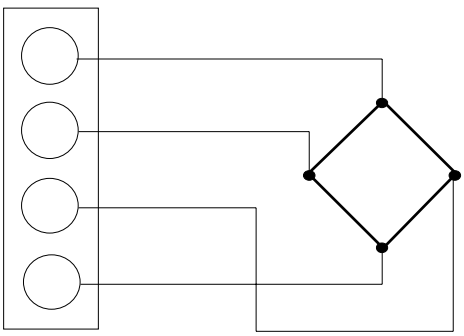
THREE WIRE TRANSDUCER CONNECTIONS



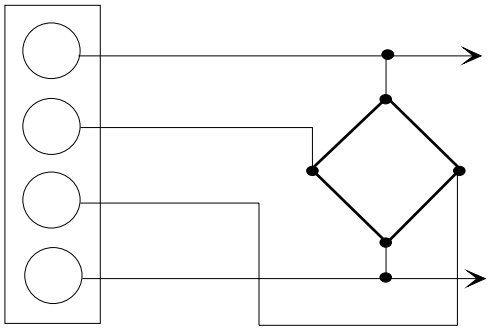
FOUR WIRE TRANSDUCER WITH EXTERNAL EXCITATION



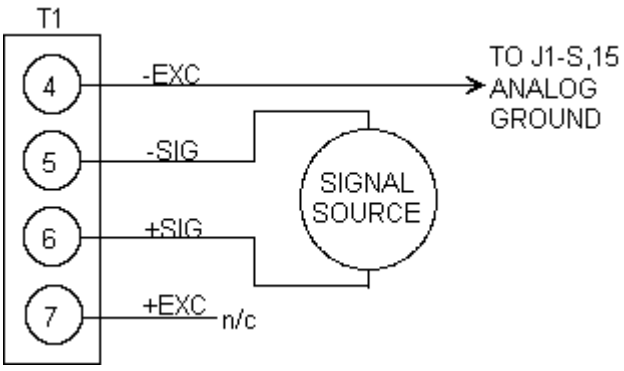
FOUR WIRE STRAIN GAUGE CONNECTIONS



SIX WIRE STRAIN GAGE CONNECTIONS

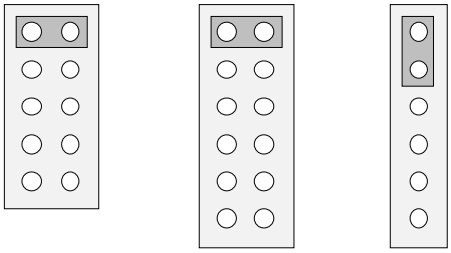


MILLIVOLT SIGNAL CONNECTIONS



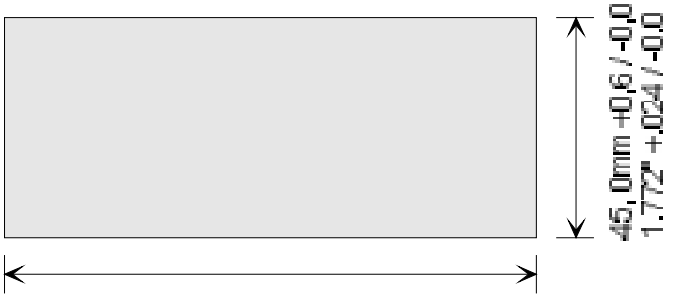
DECIMAL POINT and DISPLAY FUNCTION CHART

Setting up the display is accomplished by installing shorting bars onto a pin forest located on the front of the display board. In order to access the pin forest either the window must be removed or the meter removed from its case. On models UA and UB the polarity sign and the least significant digit may be turned on or off by either adding or removing a shorting bar. Refer to the top chart to the right for the shorting bar designators and the functions for each meter type. The second chart illustrates the physical positions of all the pin forest pins by model type. Note that the position in which the shorting bar is placed on meter model UC is vertical while the other models are horizontal. Also note that there can be more than one shorting bar on the pin forest depending on the number of features selected, however do not select more than one decimal point.

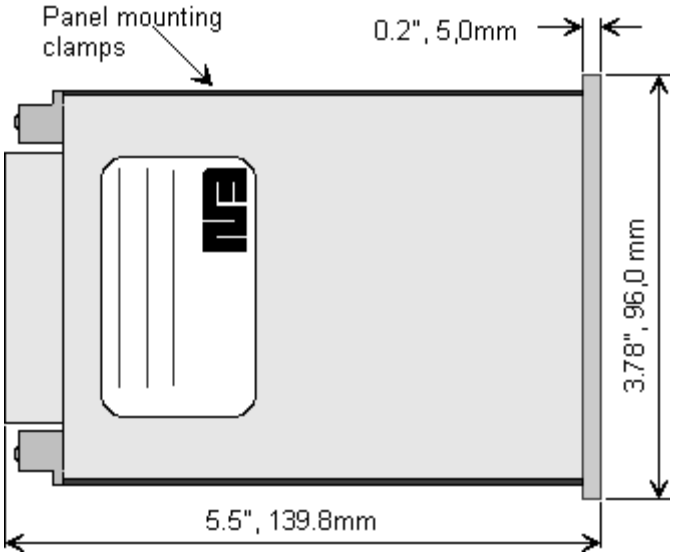


J1 (MAIN BOARD) INPUT / OUTPUT PIN CHART

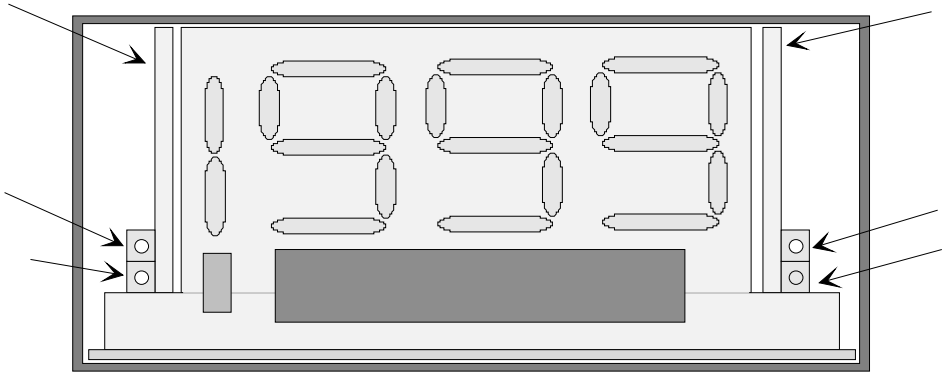
PANEL CUTOUT



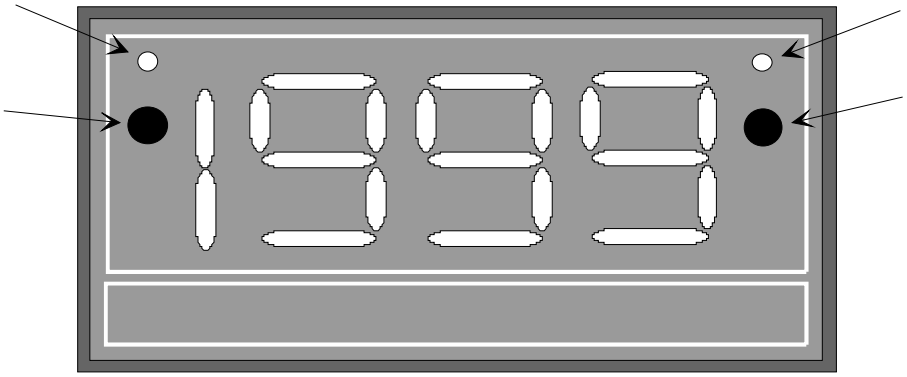
CASE DIMENSIONS



ZERO and SPAN ADJUSTMENT CONTROLS



SETPOINT ADJUSTMENT CONTROLS



DC VOLTAGE, CURRENT and POTENTIOMETRIC INPUT MODULES

Modules UVI 1 through 4 are configured to accept DC voltage from 200mV to 199.9 volts in four ranges. Modules UCI 1 through 6 cover current ranges from 19.99uA to 1.999 Amps in 6 ranges. Both modules may be scaled to various displayed readings within their ranges.

The zero adjustment is designed to compensate for a narrow range of offsets.
Modules UPO 1 through 2 are used in conjuction with a 1kOhm (-1), or 5kOhm (-2) potentiometer to display a ratio of 0 to 100%. Excitation voltage to drive the potentiometers is included.

SPECIFICATIONS

Input

Type	Single ended, bipolar
Accuracy (at 25°C)	+/-0.05% of RDG, +/-1 count
Polarity	Automatic
Warmup to rated accuracy	10 minutes

Adjustment controls

Voltage or current ranges	
Span & zero	+/-4% of reading
Potentiometric ranges	
Span	-5 to 10% of reading
Zero	5 to -10% of reading

Common mode (dc to 60 Hz, power to analog ground)

Common mode rejection	120dB
Common mode voltage	+/-1500Vp

Normal mode (50 to 60Hz)

normal mode rejection	75dB

Temperature Coefficient

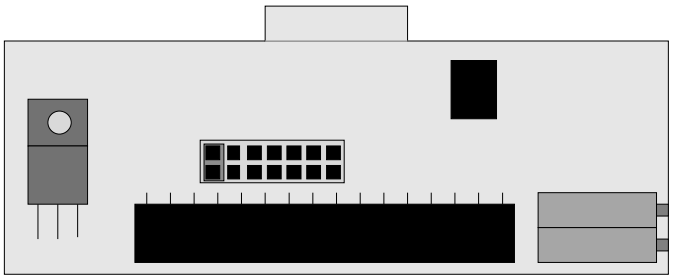
Span	+/-0.01% of reading / °C
Zero	+/-0.2 counts / °C

Maximum overload

Voltage ranges	250Vp
Current ranges	See table below

UCI MODULES

RANGE		MAXIMUM INPUT CURRENT
UA/UB	UC	
19.99uA	9.999uA	3mA
199.9uA	99.99uA	12mA
1.999mA	999.9uA	35mA
19.99 mA	9.999mA	100mA
199.9mA	99.99mA	500mA
1.999A	999.9mA	2.2A



VOLTAGE		
UA & UB Input Value	UC	Shorting bar locations
0 to +/-199.9mV dc	0 to +/-99.99mVdc	W1-B,D
0 to +/-1.999Vdc	0 to +/-999.9mVdc	W1-B,G
0 to +/-19.99Vdc	0 to +/-9.999Vdc	W1-B,E,G
0 to +/-199.9Vdc	0 to +/-99.99Vdc	W1-B,F,G

CURRENT		Shorting bar locations	Value R7 shunt
UA & UB Input Value	UC		
0 to +/-19.99uAdc	0 to +/-9.999uAdc	W1-B,D	10k,1/4 watt
0 to +/-199.9uAdc	0 to +/-99.99uAdc	W1-B,D	1k,1/4 watt
0 to +/-1.999mAdc	0 to +/-999.9uAdc	W1-B,D	100 Ohms, 1/4 watt
0 to +/-19.99mAdc	0 to +/9.999mAdc	W1-B,D	10 Ohms, 1/4 watt
0 to +/-199.9mAdc	0 to +/-99.99mAdc	W1-B,D	1 Ohm, 1/4 watt
0 to +/-1.999Adc	0 to +/-999.9mAdc	W1-B,D	0.1 Ohm, 1/4 watt

POTENTIOMETRIC UA, UC & UC Potentiometer value	UA / UB Display reading	UC Display reading	Shorting Bar locations
1k Ohm	0 to 100.0%	0 to 100.00%	W1-A,C,D
5k Ohm	0 to 100.0%	0 to 100.00%	W1-C,D

CALIBRATION PROCEDURE for VOLTAGE and CURRENT INPUTS

A] Apply 0 volts or current to the input.
B] Adjust the zero control for a display of 000, (0000, UC)
C] Apply full scale voltage or current to the input.
D] Adjust the span control for a display of 1999, (9999, UC)

CALIBRATION PROCEDURE for POTENTIOMETRIC INPUT

A] Rotate the external pot fully counter clockwise (CCW).
B] Adjust the meters zero control for a display reading of 000, (0000, UC).
C] Rotate the external pot fully clockwise (CW).
D] Adjust the meter span control for a display reading of 1000 (9999, UC).

AC VOLTAGE & CURRENT INPUT MODULES

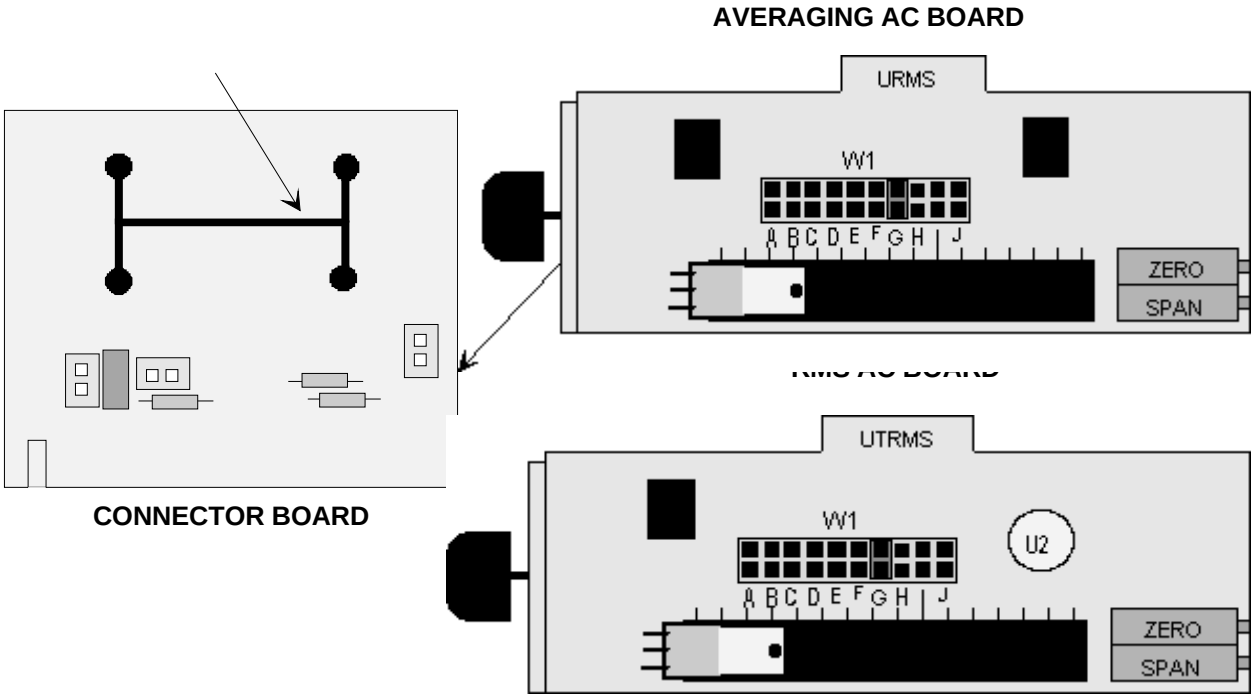
These modules are designed to accept AC voltages and currents. The UAV and UAI series are averaging modules while the UTV and UTI are RMS measuring devices capable of converting complex waveforms. There are five voltage ranges and seven current ranges. Refer to the range tables on the following page for specific ranges and their shorting bar locations.

SPECIFICATIONS

Input	**UAV/UAI**	**UTV/UTI**
Type	Single ended	Single ended
Accuracy at 25°C		
Max. Error	+/-0.1% of rdg. +/-1 count	+/-0.1% of rdg. +/-1 count
Warm up to rated accuracy	10 minutes	10 minutes
Temperature Coefficient		
Zero	200uV / °C	+/-0.15mV/°C
Span	0.01%rdg./°C	+/-0.03% rdg./°C

Common mode (Analog to ac ground)

	UAV/UAI	**UTV/UTI**
CMR (dc to 60 Hz)	120dB	120dB
CMV (dc to 60 Hz)	+/-1500Vp	+/-1500Vp
Frequency range (to rated accuracy)		
ac coupled	47Hz to 1kHz	47Hz to 5kHz
dc coupled	N/A	9Hz to 5kHz



SHORTING BAR LOCATIONS BY RANGE

VOLTAGE		SHORTING BAR LOCATIONS			
UA / UB Input voltage	UC	AC COUPLED PLUG-IN BRD	CONNECTOR BOARD	DC COUPLED PLUG-IN BRD	CONNECTOR BOARD
199.9 mVac	99.99mVac	W1-A,F,G,H,**J**	W3,W4	W1-A,F,G,H,**I,J**	**W2**,W3,W4
1.999Vac	999.9mVac	W1-A,E,G,H,**J**	W3,W4	W1-A,E,G,H,**I,J**	**W2**,W3,W4
19.99Vac	9.999Vac	W1-A,B,G,H,**J**	W3,W4	W1-A,B,G,H,**I,J**	**W2**,W3,W4
199.9Vac	99.99Vac	W1-A,C,G,H,**J**	W3,W4	W1-A,C,G,H,**I,J**	**W2**,W3,W4
650Vac	650Vac	W1-A,C,G,H,**J**	NONE	W1-A,C,G,H,**I,J**	**W2**

CURRENT		SHORTING BAR LOCATIONS		
UA / UB Input Current		AC COUPLED	DC COUPLED	R14 VALUE
19.99uA	9.999uA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	10k Ohm
199.9uA	99.99uA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	1k Ohm
1.999mA	999.9uA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	100 Ohms
19.99mA	9.999mA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	10 Ohms
199.9mA	99.99mA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	1 Ohm
1.999A	999.9mA	W1-A,F,G,H	W1-A,F,G,H,**I,J**	0.1 Ohm
5.00A*	5.00A*	W1-D,F,G,H	W1-D,F,G,H,**I,J**	0.01 Ohm
19.99A*	9.999A*			
199.9A*	99.99A*			
1999A*	999.9A*			

*Use a 50mV shunt to accept the input from a 5 Amp current transformer.
Range 7 will display readings of 19.99**0** Amps, 199.9**0** and 1999.**0** Amps when using models UA or UB main boards or 9.999, 99.99 and 999.9 Amps when using the UC main board. The bold **0**'s indicates the UB main board is being used.
When AC current ranges 19.99uA, (9.999uA UC) through 199.9 mA, (99.99mA UC) are used, the value of the resistors listed in the R14 column must be installed in the bottom two holes of resistor R14 located on the

small end connector board. Also two 0 ohm resistors, or jumper wires, must be installed between the upper and lower holes at each end of position R14. These positions are marked with an A and B.

1.999 Amp, (999.9 mA UC) and 5.00 Amp ranges

When using these two ranges, a four wire power resistor must be installed at location R14 on the small end connector board. The Electro-Numerics part numbers for these two resistors are 0.1 Ohm 260-121and 0.01 Ohm 260-120.

When using these two ranges, many nonstandard readings may be displayed by installing a resistor at location R9 on the plug-in board. The approximate span and R9 value are listed in the tables below and assume that the full scale input signal for both ranges has been applied.

SPECIAL FULL SCALE COUNTS FOR UA AND UB MAIN BOARDS

RANGE SPAN	R9	RANGE SPAN	R9
1900 to 1999	none	525 to 575	18.7k
1720 to 1900	1M	475 to 525	16.5k
1560 to 1720	301k	435 to 475	14.7k
1415 to 1560	174k	390 to 435	13.0k
1285 to 1415	120k	355 to 390	10.7k
1165 to 1285	90.9k	325 to 355	9.35k
1055 to 1165	68.1k	295 to 325	8.66k
955 to 1055	59.0k	270 to 295	7.32k
860 to 955	47.5k	250 to 270	6.65k
775 to 860	36.5k	230 to 250	5.90k
700 to 775	30.1k	210 to 230	5.23k
635 to 700	25.5k	190 to 210	4.64k
575 to 635	22.6k		

SPECIAL FULL SCALE COUNTS FOR UC MAIN BOARDS

RANGE SPAN	R9	RANGE SPAN	R9
9500 to 9999	none	265 to 2875	18.7k
8600 to 9500	1M	2375 to 2625	16.5k
7800 to 8600	301k	2175 to 2375	14.7k
7075 to 7800	174k	1950 to 2175	13.0k
6425 to 7075	120k	1775 to 1950	10.7k
5825 to 6425	90.9k	1625 to 1775	9.35k
5275 to 5825	68.1k	1475 to 1625	8.66k
4775 to 5275	59.0k	1350 to 1475	7.32k
4300 to 4775	47.5k	1250 to 1350	6.65k
3875 to 4300	36.5k	1150 to 1250	5.90k
3500 to 3875	30.1k	1050 to 1150	5.23k
3175 to 3500	25.5k	950 to 1050	4.64k
2875 to 3175	22.6k		

When using the UC main board, remove the shorting bar from location M2 on the main board.

CALIBRATION PROCEDURE for VOLTAGE or CURRENT

A] Apply zero voltage or current to the input and adjust the zero control for a displayed reading of 000, (0000, UC).

B] Apply a full scale voltage or current to the input and adjust the span control to toggle between 1999, (9999, UC), and over range. If special scaling is required, set the displayed reading to the desired reading.

C] Repeat steps A] and B] if necessary.

FREQUENCY / RATE MODULE

The F input module provides a method of measuring frequency or rate. A pre-scaling circuit covers frequencies from 100Hz to 20k Hz. in nine ranges.

SPECIFICATIONS

Input

dc input ..... single ended
ac input ..... single ended
Maximum input voltage 150Vrms
Full span frequency range ..... 100Hz to 20kHz

Minimum measurable frequency
UA, UB 100Hz
UC 500Hz

Accuracy (at 25 °C)

UA, UB ..... +/-0.1%F.S. +/-1 count
UC ..... +/-0.1%F.S. +/-2 count
Warmup to rated accuracy ..... 10 minutes

Common mode (analog to power grounds)

Common mode rejection (dc to 60 Hz) 120dB
Common Mode Voltage (dc to 60 Hz) ..... +/-1500Vp

Temperature coefficient

Zero ..... +/-0.1 count / °C
Span ..... +/-0.01% rdg. / °C

Adjustment controls

Zero control ..... 400 to full scale
Span control ..... Varies with scale range

Trigger control

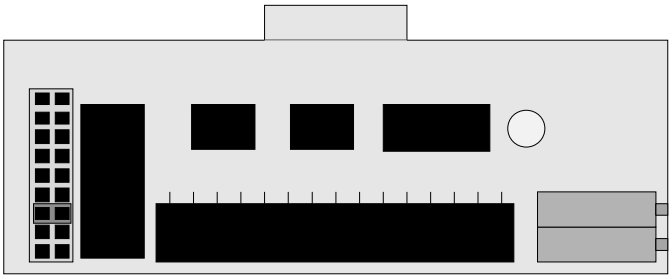
100mV hysteresis ..... -1 to 4V
10mV ..... -0.1 to .4V

The minimum stable reading is 100 counts.
The input sensitivity is dependent on the frequency range and hysteresis selected.

FULL SCALE RANGE (Hz)	MINIMUM INPUT WITH	
	10mV HYSTERESIS	100mV HYSTERESIS
100 to 2000	15 mV p/p	125 mV p/p
2000 to 5000	30 mV p/p	125 mV p/p
5000 to 20000	90 mV p/p	175 mV p/p

INPUT FREQUENCY RANGES		
UA,UB FREQUENCY SPAN	UC FREQUENCY SPAN	W1 SHORTING BAR LOCATION
100 to 200 Hz	500 to 1000 Hz	B,E
200 to 400 Hz	1000 to 2000 Hz	C,F
400 to 800 Hz	2000 to 4000 Hz	C,G
500 to 1000 Hz	2500 to 5000 Hz	D,F
1 to 2 kHz	5 to 10 kHz	E,F
2 to 4 kHz	10 to 20 kHz	E,G
2.5 to 5 kHz	12.5 to 20 kHz	D,H
5 to 10 kHz		E,H
10 to 20 kHz		E,I

HYSTERESIS TABLE	
HYSTERESIS	**W1 SHORTING BAR LOCATION**
10 Mv 100 Mv	A none



SELECTING THE RANGE

A] Determine the maximum frequency, F, and the display reading required, D.

B] To determine the range, R, use one to the following equations depending on the main board used.

UA, UB	**UC**
R = (2000 / D) x F	R = (1000 / D) x F

CALIBRATION PROCEDURE

ZERO AND SPAN ADJUSTMENTS

A] Remove any signal from the input and short the high and low inputs together. Adjust the zero control for a display of 000.

B] Apply the full scale frequency and adjust the span control until the display toggles between 1999 (9999 UC) and over range.

C] Repeat steps A] and B] if necessary.

TRIGGER POINT ADJUSTMENTS

A] If the input signal does not produce a reading on the display, it may not have enough amplitude. Verify that it is within specifications. Adjust if necessary.

RTD TEMPERATURE & RESISTANCE INPUT MODULES

DESCRIPTION

TEMPERATURE

The URT and URX temperature modules are used in conjunction with a 100 ohm platinum temperature sensor (RTD) to display temperature measurements. The URT1 module is calibrated in ^{o}C while the URT2 is in ^{o}F. Both modules have a resolution of 0.1 degree. The URX1 module is calibrated in ^{o}C and the URX2 in ^{o}F. Both modules have a resolution of 1.0 degree.

RESISTANCE

The four modules, URS1 through URS4, convert the output from 2 or 4 wire sensors to display resistance.

All temperature and resistance modules provide open sensor detection and indication.

SPECIFICATIONS

Input

Type ..... Differential, bipolar
Configuration ..... 2, 3 or 4 wire

Accuracy (at 25ºC) Also, see chart below
URS1 through URS4) ..... +/-0.05% rdg.+/-1 count

Temp. coefficient (URS1 &2 through URX1 & 2)
Zero ..... +/-0.05 degree /ºC
Span ..... +/-0.006% rdg. / ºC

Temperature Coefficient (URS1 through URS4).
URS1 AND URS2 ..... 2.5 Mohms / ºC
URS3 ..... 25 Mohms / ºC
URS4 ..... 250 ohms / ºC

Zero adjustment ..... +/-6 ºC (+/-12ºF)

Open sensor ind. (B=Blank, F=Flashing Digit)
UA, UB 1BBB
UC ..... FFFF

Normal mode rejection (50 to 60 Hz.) *50dB*

Over voltage limit (differential) 15Vp

Common Mode (Analog ground to power ground)
Common mode rejection 120dB
Common mode voltage ..... 1500 Vp

TEMPERATURE SENSOR SPECIFICATIONS
Material ..... Platinum
Resistance at 0ºC ..... 100 ohms
Calibration curve DIN43760
Temperature coefficient ..... 0.00385 ohm / ohm / ºC

Sensor tolerance
Class 1 ..... +/-0.15ºC, +/-0.002T T=-200 to 650 ºC
Class 2 ..... +/-0.03ºC, +/-0.005T T=-200 to 850 ºC

Lead resistance
2 wire connection ..... Add 2.6 ºC, (4.7 ºF) per ohm change to specified error.
3 or 4 wire connection ..... 20 ohms maximum

MODEL	RANGE(UA)	RANGE (UC)	ACCURACY
URT1 URT2	-199.9 to 199.9 ºC -199.9 to 199.9 ºF	-99.99 to 99.99 ºC -99.99 to 99.99 ºF	+/-0.1 ºC +/-0.05% rdg. +/-0.2 ºF +/-0.05% rdg.
URX1 URX2	-200 to 830 ºC -328 to 1526 ºF	-200.0 to 830.0 ºC -328.0 to 999.9 ºF	+/-0.3 ºC +/-0.2% rdg. +/-0.5 ºF +/-0.2% rdg.

TEMPERATURE		
MODULE	**RANGE**	
	UA,UB	**UC**
URT1	-199.9 to 199.9 ºC	+/-99.99 ºC
URT2	-199.9 to 199.9 ºF	+/-99.99 ºF
URX1	-200 to 830 ºC	-200.0 to 830.0 ºC
URX2	-328 to 1526 ºF	-328 to 999.9 ºF

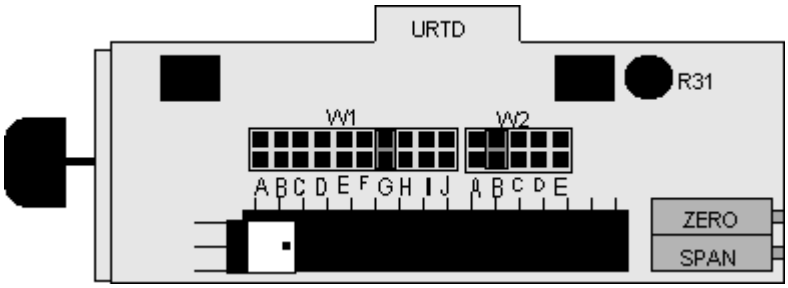
RESISTANCE			
MODULE	**UA, UB**	**UC**	**EXCITATION**
URS1	0 to 19.99 ohms	0 to 9.999 ohms	4.2 mA
URS2	0 to 199.9 ohms	0 to 99.99 ohms	4.2 mA
URS3	0 to 1999 ohms	0 to 999.9 ohms	420 uA
URS4	0 to 19.99 kohms	0 to 9.999 kohms	42 uA

CONFIGURATION PROCEDURE

A] Select the module type from the TEMPERATURE or RESISTANCE tables depending on the range required. Be sure the maximum input is within the range limits specified in the tables.

B] Observe the CONFIGURATION tables and the board assembly drawing and install jumpers at the locations indicated. When this has been accomplished refer to the calibration procedure and table and perform the calibration steps for the type of input board installed.

C] If the UC main board is used, remove the shorting bar at location M2 located on the main board.



CALIBRATION PROCEDURE

Test equipment required
Resistance decade box with an accuracy of +/-1.0% or better and a resolution of +/-0.01 ohm or better.

URT1, URT2, URX1 and URX2
The basic calibration procedure is the same for all models. See the table below for the resistance values used for each input module and main module type.

A] Connect the resistance decade box output terminals to the meter input terminals.
B] Refer to the table below and set the decade box to the value listed on line A for the module being calibrated. Adjust the meters zero control for the display value indicated.
C] Refer to the table and change the value of the decade box to that shown on line B. Adjust the span control for the display value indicated.
D] Refer to the table again and change the value of the decade box to that shown on line C. Adjust R31 for the display indicated.

LINE	**URT1**		**URT2**		**URX1**		**URX2**	
A... Adjust zero for...	100.00 ohms		93.03 ohms		100.00 ohms		93.03 ohms	
	0000		0000		0000		0000	
	UA,UB	**UC**	**UA,UB**	**UC**	**UA,UB**	**UC**	**UA,UB**	**UC**
B..... Adjust span for....	18.93 ohms -19900	64.30 ohms -9000	48.81 ohms -19900	73.44 ohms -9000	18.93 ohms -19900	18.49 ohms -2000	18.49 ohms -3280	18.49 ohms -3280
	UA,UB	**UC**	**UA,UB**	**UC**	**UA,UB**	**UC**	**UA,UB**	**UC**
C..... Adjust R31 for...	175.47 ohms 19900	134.70 ohms 9000	135.49 ohms 19900	112.06 ohms 9000	384.40 ohms 8300	384.40 ohms 8300	384.40 ohms 15260	293.04 ohms 9999

0 indicates UB main board.

URS1 through URS4

A] Connect the resistance decade box output terminals to the meter input terminals.
B] Set the decade box for a value of 000.00 ohms and adjust the zero control for a display of 000.
C] Change the value of the decade box to 98% of the top end value of the range selected.
D] Adjust the span control until the meter display reads 98% of the module range.

PROCESS VOLTAGE and CURRENT MODULES

DESCRIPTION

The P and E input modules are multifunction boards that provide broad range scaling and zero offsetting for voltage or current inputs.
Selection of all ranges and offsets is accomplished by installing press-on shorting bars at specific points on the module pin forests.
For applications requiring a reverse input signal, the polarity may be inverted by moving one shorting bar.
Meters with as E input module installed also have an excitation voltage output which is settable to either 10 or 15 Vdc. This output may be used to power a variety of input sensors and transducers.

SPECIFICATIONS

Input

Type	Single ended
Accuracy at 25°C	+/-0.05% of rdg. +/-1.0 count
Warmup time to rate accuracy	10 minutes

Temperature Coefficient

Zero	+/-0.2 counts /°C
Span	+/-0.005% of reading / °C

Common mode (ac power to analog grounds)

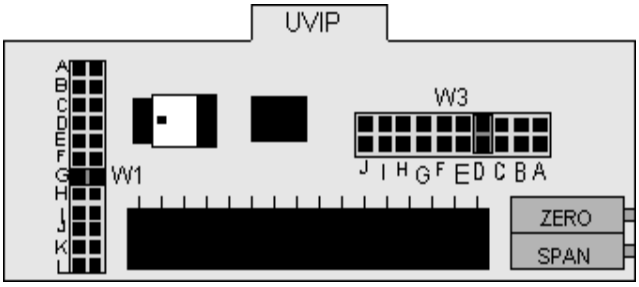
Common mode rejection (dc to 60 Hz)	120dB
Common mode voltage (dc to 60 Hz)	+/-1500Vp

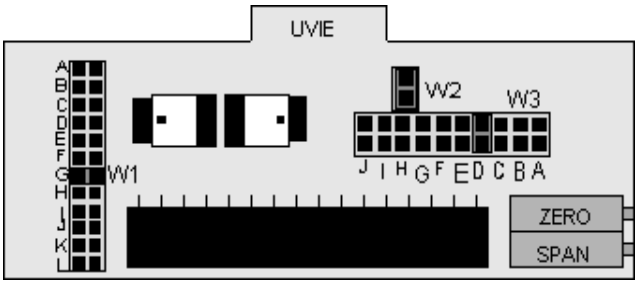
Normal mode rejection (50 to 60 Hz)

INTERNALLY SELECTABLE RANGES

Span	0 to 100% in four gain groups
Zero	-245 to -76mV
	-107 to 67mV
	49 to 220mV
	160 to 326mV
Zero offset control	50% of full span

SELECTABLE EXCITATION	10 or 15 Vdc +/-2%
Excitation current	50mA at 10Vdc
	25mA at 15Vdc
Line regulation	0.2% maximum for 10% change in line voltage
Load regulation	0.5% no load to full load
Voltage ripple (50 to 60 Hz)	0.01%





SELECTING VOLTMETER RANGES

A] Define the largest +/- input signal.
B] Select the lowest range from the voltage range and shorting bar table where the largest input voltage falls between the lower and upper limits of the range. Place the shorting bars at the locations referred to in the table. This procedure will produce a display of +/-1999 or (+/-9999, UC) depending on the type of main board used.

VOLTAGE RANGES and SHORTING BAR LOCATIONS		
RANGE	**W1**	**W3**
+/-190 to 260mV	E	C,G,H,I
+/-260 to 380mV	E	C,F,H,I
+/-360 to 440mV	E	C,E,G,I
+/-430 to 600mV	F	C,G,H,I
+/-570 to 820mV	F	C,F,H,I
+/-750 to 970mV	C	C,G,H,I
+/-950 to 1500mV	C	C,H,E,I
+/-1.4 to 2.0V	C,D	C,G,H,I
+/-1.8 to 3.0V	C	C,F,H,I
+/-2.9 to 3.3V	B	C,G,H,I
+/-3.1 to 4.7V	B,C	C,F,H,I
+/-4.6 to 5.5V	B	C,E,G,I
+/-5.4 to 6.1V	B,D	C,F,H,I
+/-5.7 to 8.9V	D	C,F,G,I
+/-8.6 to 11.0V	A	C,H,I

If reversed polarity is required, change the shorting bar on location W3-I to location W3-J.
The two tables on this page assume no zero offset.

SELECTING AMMETER RANGES

A] Define the largest +/- input current.
B] Select the lowest range from the current range and shorting bar table where the largest input current falls between the lower and upper limits of the range. Place the shorting bars at the locations referred to in the table. This procedure will produce a display of +/-1999 or (+/-9999, UC) depending on the type of main board used.

CURRENT RANGES and SHORTING BAR LOCATIONS		
RANGE	**W1**	**W3**
+/-370 to 510uA	E,L	C,G,H,I
+/-510 to 750uA	E,L	C,F,H,I
+/-740 to 850uA	E,L	C,E,G,I
+/-860 to 1090uA	E,K	C,G,H,I
+/-1080 to 1500uA	E,K	C,G,I
+/-1.46 to 2.00mA	E,K	C,E,H,I
+/-1.85 to 2.60mA	E,J	C,G,H,I
+/-2.40 to 3.80mA	E,J	C,E,H,I
+/-3.60 to 4.50mA	E,J	C,F,H,I
+/-3.70 to 5.10mA	E,I	C,G,H,I
+/-4.80 to 7.50mA	E,I	C,E,H,I
+/-7.30 to 8.00mA	E,I	C,E,G,I
+/-7.90 to 10.2mA	E,I	C,F,H,I
+/-9.60 to 15.0mA	E,H	C,E,H,I
+/-14.8 to 18.8mA	E,H	C,E,G,H,I
+/-18.8 to 25.8mA	E,G	C,H,I
+/-22.8 to 38.0mA	E,G	C,G,I
+/-32.0 to 52.0mA	E,G	C,F,G,I

SELECTING RANGES FOR A VOLTAGE RECEIVER

A voltage receiver is a voltmeter with a zero offset.

SELECTING THE ZERO OFFSET

A] Choose the lowest and highest display readings. Also select the lowest and highest input signals. Apply these values to the formula shown below.

Z = ((LR x HI - HR x LI) / (HI - LI))

Where:

LR = lowest display reading
HR = highest display reading
LI = lowest input signal
HI = highest input signal

B] Select the zero offset range where Z falls between the low and high limits of the range.
C] Place the shorting bar at the location indicated in the table.

ZERO CONTROL SPAN LIMITS			
Z	**UA,UB**	**UC**	**W3 SHORTING BAR LOCATION**
1	-1999**0** to -1600**0**	-9999 to -8000	A
2	-1999**0** to -500**0**	-9999 to -2500	B
3	-740**0** to 1100**0**	-3700 to 5500	C
4	782**0** to 1999**0**	3910 to 9999	D

SELECTING THE GAIN RANGE

A] Calculate the gain required by using the same figures as those used for calculating the zero offset and apply them to the following formula.

G = (HR-LR) / (HI-LI)

B] In the following voltage receiver range table, select the group block where the defined input voltage falls between the low and high limits in the column labeled INPUT RANGE.
C] Move to the column labeled DISPLAY COUNTS and select the range where G falls between the lower and upper limits. Be sure to use the correct column for the type of main board used.
D] Place the shorting bars in the locations indicated by the chart.
E] If the UC main board is used, be sure that a shorting bar is at location M2 on the main board.

VOLTAGE RECEIVER RANGE and SHORTING BAR LOCATION				
INPUT RANGE	**DISPLAY COUNTS UA, UB**	**DISPLAY COUNTS UC**	**W1**	**W3**
0 to .5V	80 to 2850	400 to 14250	E	E,F,I
0 to .5V	2840 to 5500	14200 to 27500	E	E,G,I
0 to .5V	5490 to 8170	27450 to 40850	E	F,H,I
0 to .5V	8160 to 10600	40800 to 53000	F	G,H,I
0 to 1.0V	40 to 1260	200 to 6300	F	E,F,I
0 to 1.0V	1255 to 2440	6275 to 12200	F	E,G,I
0 to 1.0V	2430 to 3605	12150 to 18025	F	F,H,I
0 to 1.0V	3595 to 4700	17975 to 23500	F	G,H,I
0 to 2.0V	20 to 750	100 to 3750	C	E,F,I
0 to 2.0V	745 to 1452	3725 to 7260	C	E,G,I
0 to 2.0V	1450 to 2157	7250 to 10785	C	F,H,I
0 to 2.0V	2155 to 2750	10775 to 13750	C	G,H,I
0 to 5.0V	8 to 231	40 to 115	B	E,F,I
0 to 5.0V	230 to 449	1150 to 2245	B	E,G,I
0 to 5.0V	448 to 667	2240 to 3335	B	F,H,I
0 to 5.0V	666 to 860	3330 to 4300	B	G,H,I
0 to 10.0V	4 to 114.5	20 to 572	D	E,F,I
0 to 10.0V	114 to 223	570 to 1115	D	E,G,I
0 to 10.0V	222 to 331	1117 to 1655	D	F,H,I
0 to 10.0V	330 to 428	1652 to 2140	D	G,H,I
0 to 20.0V	2 to 56	10 to 284	A	E,F,I
0 to 20.0V	56 to 110	282 to 551	A	E,G,I
0 to 20.0V	110 to 164	550 to 822	A	F,H,I
0 to 20.0V	164 to 220	821 to 1100	A	G,H,I

SELECTING RANGES FOR A CURRENT RECEIVER

A current receiver is an ammeter with a zero offset.

SELECTING THE ZERO OFFSET

A] Choose the lowest and highest display readings. Also select the lowest and highest input signals. Apply these values to the formula shown below.

Z = ((LR x HI - HR x LI) / (HI - LI))

Where:

LR = lowest display reading
HR = highest display reading
LI = lowest input signal
HI = highest input signal

B] Select the zero offset range where Z falls between the low and high limits of the range.
C] Place the shorting bar at the location indicated in the table.

ZERO CONTROL SPAN LIMITS			
Z	**UA,UB**	**UC**	**W3 SHORTING BAR LOCATION**
1	-1999**0** to -1600**0**	-9999 to -8000	A
2	-1999**0** to -500**0**	-9999 to -2500	B
3	-740**0** to 1100**0**	-3700 to 5500	C
4	782**0** to 1999**0**	3910 to 9999	D

SELECTING THE GAIN RANGE

A] Calculate the gain required by using the same figures as those used for calculating the zero offset but apply them to the following formula.

G = (HR-LR) / (HI-LI)

B] In the current receiver range table below, select the group block where the defined input current falls between the low and high limits in the column labeled INPUT RANGE.

C] Move to the column labeled DISPLAY COUNTS and select the range where G falls between the lower and upper limits. Be sure to use the correct column for the type of main board used.

D] Place the shorting bars in the locations indicated by the chart.

E] If the UC main board is used, be sure that a shorting bar is at location M2 on the main board.

CURRENT RECEIVER RANGE and SHORTING BAR LOCATION				
INPUT RANGE	**DISPLAY COUNTS UA, UB**	**DISPLAY COUNTS UC**	**W1**	**W3**
0.2 to 1.0mA	50 to 1405	250 to 7025	E,L	E,F,I
0.2 to 1.0mA	1400 to 2730	7000 to 13650	E,L	E,G,I
0.2 to 1.0mA	2725 to 4055	13625 to 20275	E,L	F,H,I
0.2 to 1.0mA	4050 to 5264	20250 to 26320	E,L	G,H,I
0.4 to 2.0mA	25 to 702	125 to 3510	E,K	E,F,I
0.4 to 2.0mA	700 to 1365	3500 to 6825	E,K	E,G,I
0.4 to 2.0mA	1363 to 2027	6815 to 10135	E,K	F,H,I
0.4 to 2.0mA	2025 to 2632	10125 to 13160	E,K	G,H,I
1.0 to 5.0mA	10 to 282	50 to 1412	E,J	E,F,I
1.0 to 5.0mA	281 to 550	1407 to 2750	E,J	E,G,I
1.0 to 5.0mA	548 to 816	2740 to 4080	E,J	F,H,I
1.0 to 5.0mA	815 to 1059	4075 to 5295	E,J	G,H,I
2.0 to 10.0mA	5 to 141	25 to 705	E,I	E,F,I
2.0 to 10.0mA	140 to 274	702 to 1372	E,I	E,G,I
2.0 to 10.0mA	274 to 407	1370 to 2037	E,I	F,H,I
2.0 to 10.0mA	407 to 529	2035 to 2645	E,I	G,H,I
4.0 to 20.0mA	2.5 to 70	125 to 352	E,H	E,F,I
4.0 to 20.0mA	70 to 137	352 to 685	E,H	E,G,I
4.0 to 20.0mA	137 to 203	683 to 1017	E,H	F,H,I
4.0 to 20.0mA	203 to 264	1015 to 1320	E,H	G,H,I
10.0 to 50.0mA	1 to 28	5 to 141	E,F	E,F,I
10.0 to 50.0mA	28 to 55	141 to 275	E,G	E,G,I
10.0 to 50.0mA	54 to 81	274 to 408	E,G	F,H,I
10.0 to 50.0mA	81 to 106	407 to 530	E,G	G,H,I

SELECTING THE EXCITATION VOLTAGE (E Version only)

There are two choices of excitation voltage, 10 or 15Vdc. To configure the excitation, see the following table.

EXCITATION CONFIGURATION		
VOLTAGE	**W2**	**CURRENT AVAILABLE**
10 Vdc 15 Vdc	A None	50mA* 25mA*

*The total available current for analog output and excitation options.

SELECTING THE POLARITY

The output signal coming from the input board may be inverted if necessary. Select the polarity from the OUTPUT POLARITY table shown below and install the shorting bar at the location listed.

OUTPUT POLARITY	
POLARITY	**W3**
Standard Inverted	I J

CALIBRATION

VOLTMETER and AMMETER

A] Short the input terminals and adjust the zero control for a display reading of 000, (UC 0000).
B] Apply the input signal and adjust the span control until the display shows the required reading.

VOLTAGE or CURRENT RECEIVER

A] Short the input terminals and adjust the zero control until the display shows the offset reading for which the calculations were made.
B] Apply the input signal to the input terminals which is the equivalent to the signal used in the calculations. Adjust the span control until the display shows the required reading.

STRAIN GAUGE INPUT MODULE

DESCRIPTION

The S module has been designed to accept dc signals from balanced or unbalanced strain gauge bridges such as are used in load cells and pressure transducers.

An adjustable 1 to 10Vdc excitation supply is part of the input module assembly. The excitation voltage is roughly symmetrical around zero to maintain a low common mode voltage over all settings. A maximum load current of 30mA can be supplied for all output voltages within the 1 to 10 volt range. The excitation voltage must be specified at time of ordering.

Provisions have been incorporated to allow 4 wire connection to the bridge while also providing for excitation voltage sensing at the bridge when long cable lengths are required.

There are eight gain ranges selectable by push-on shorting bars. Fine span and zero adjustments on all ranges are accessible by removing the window.

The table on the following page illustrates the ranges available and the input signal values which will produce a full scale display of +/-1999 (UA), +/-10000 (UB) or +/-9999 (UC) counts depending on the type of main module used.

UA (+/-1999), UB (+/-19990) DISPLAYED COUNTS					
RANGE	**1**	**2**	**3**	**4**	**5**
Gain	4.02 to 9.9	8 to19.8	16.1 to 39.8	31 to 78.9	64.5 to 159.3
uV / Count	100 to 259	50.5 to 125	25.1 to 62	12.6 to 31.3	6.25 to 15.5
mV Input	201 to 497	101 to 250	50.2 to 124	25.3 to 62.6	12.5 to 31
RANGE	**6**	**7**			
Gain	127.8 to 315.7	258 to 638			
uV / Count	3.15 to 7.8	1.55 to 3.9			
mV Input	6.3 to 15.6	3.1 to 7.7			

UC (+/-9999) DISPLAYED COUNTS					
RANGE	**1**	**2**	**3**	**4**	**5**
Gain	4.02 to 9.9	8 to19.8	16.1 to 39.8	31 to 78.9	64.5 to 159.3
uV / Count	20 to 49.7	10.1 to 25	5.02 to 12.4	2.53 to 6.26	1.25 to 3.10
mV Input	201 to 497	101 to 250	50.2 to 124	25.3 to 62.6	12.5 to 31
RANGE	**6**	**7**			
Gain	127.8 to 315.7	258 to 638			
uV / Count	.63 to 3.10	.31 to .77			
mV Input	6.3 to 15.6	3.1 to 7.7			

SPECIFICATIONS

Input
Type ..... Differential, bipolar, ratiometric

Accuracy (at 25°C)
UA,UB ..... +/-0.05% rdg. +/-1 count
UC ..... +/-0.05% rdg. +/-2 counts
Warmup to rated accuracy ..... 20 minutes

Temperature Coef. (0 to 60°C)
Span ..... +/-0.01% rdg. / °C
Zero ..... +/-0.3uv / °C
Offset ..... +/-0.01% offset,+/-0.01% full scale

Common mode (Analog to signal low)
Common mode rejection (dc to 60Hz) 120dB
Common mode voltage (dc to 60Hz) ..... +/-1.5Volts

(Analog to ac power ground)
Common mode rejection (dc to 60Hz) 120dB
Common mode voltage (dc to 60Hz) ..... +/-1500Vp

Fine zero
Span ..... +/-200uV/V (of the excitation voltage)

Excitation supply (constant voltage)
Voltage range ..... Adjustable 1 to 10 Vdc
Load current 30mA
Temperature coef. ..... 250ppm / °C max.

When using excitation sensing at the sensor location, +sense is connected to J1-18 or V while -sense is connected to J1-14 or R. Also removal of the push-on jumpers at locations W1-A and W1-C on the input module is necessary.

CALIBRATION PROCEDURE

A] Connect the strain gauge transducer to the input terminals T1-4 through T1-7.
B] Apply a zero signal and adjust the zero control until the display reads zero.
C] Apply a full scale input signal and adjust the span control until the display shows the desired reading.

SELECTING THE CONFIGURATION

In order to select the proper locations for the shorting bars, it is necessary to determine the following information.

LOAD CELL INFORMATION	
Resistance in ohms	= R
Capacity in pounds	= C
Output voltage in mV/V	= V
OTHER INFORMATION	
Excitation voltage	=Ve
Tare weight in pounds	=T
Max. load in pounds	=L
Full scale counts	=FS
4 wire connection	=FW
6 wire connection	=SW

GAIN SELECTION

To select the gain range, use these known parameters along with the following formulas. Select the correct formula depending on the main board type used.

UA, UB	**UC**
Gain = (FS x C) / (V x Ve X L)	Gain = ((FS x C) / (V x Ve x L)) / 5

Observe the gain range table below and select the range where the calculated gain falls between the lower and upper limits listed.

GAIN RANGES & SHORTING BARS	
RANGE LIMITS	**SHORTING BAR LOCATIONS**
4.02 to 9.9	W2-None
8.0 to 19.8	W2-A
16.1 to 39.8	W2-B
31.9 to 78.9	W2-C
64.5 to 159.3	W2-D
127.8 to 315.7	W2-E
258 to 638	W2-F
503 to 1000	W2-G

Install a shorting bar at the location indicated by the range selected.

When using the meter as a millivolt indicator, choose the gain range by using the following formula.

UA, UB	**UC**
Gain = D / I	Gain = (D / I) / 5

Where D = display value
I = maximum signal input in millivolts
Observe the gain range table and select the range where the calculated gain falls between the lower and upper limits listed. Install a shorting bar at the location indicated by the range selected.

TARE RESISTOR VALUE SELECTION

The tare weight is the weight on the system caused by the empty hopper or other container. To display the true weight of the material in question, the tare weight must be eliminated, thereby allowing the meter to read zero. Use the following formula to calculate the value of the tare resistor, TR.

TR (Ohms) = (R x C) / (4 x V x T)

The resistor value calculated, TR, is installed between pins 5 and 7 of the T1 connector. If desired this resistor may be installed on the input board at location R3 instead of connector T1. The resistor specifications must be 1%, 25ppm/°C.

PUSH BUTTON CALIBRATION

If the push button calibration feature is used, a resistor value must be calculated and installed at location R2 on the input module. To do this, use the following formula to calculate the resistor value.

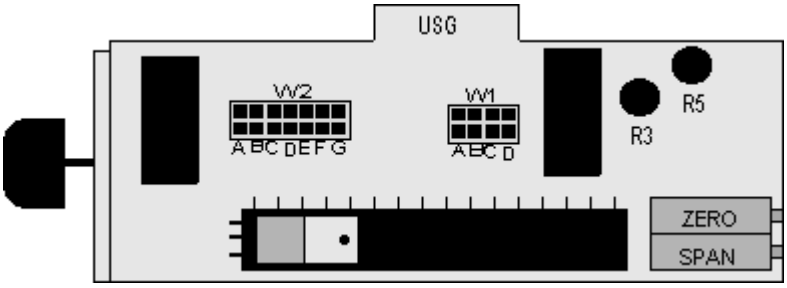
PC (Ohms) = (R x C) / (4 x V x L)

Resistor PC must also have the same specification as previously mensioned. The push button switch should be mounted external to the meter with its two leads connected at location SW1 on the input module.

UNBALANCED BRIDGE OPERATION

The use of an unbalanced bridge is possible by installing shorting bars at locations W1-D and W1-B on the input module. An unbalance ratio of up to 10:1 may be accommodated.

If the UC main board is used, install a shorting bar at location M2 on the main board.



EXCITATION SENSING	
FUNCTION	**SHORTING BARS**
Internal Remote	W1-C, A None
BRIDGE TYPE	
TYPE	**SHORTING BARS**
Balanced Unbalanced	None W1-D, B

THERMOCOUPLE TEMPERATURE INPUT MODULES

DESCRIPTION

Three temperature modules are available which will condition and linearize the voltages produced by thermocouple types J, K, or T. This linearized voltage is then processed further and displayed in °C or °F. Converting the scaling to °C or °F is accomplished by moving shorting bars to various positions on the module control header.

Ice point compensation is provided to cancel error voltages at the input terminals caused by ambient temperature fluctuations. The following table illustrates the three temperature modules.

MODULE RANGES

		TEMPERATURE RANGE	
MODULE	**T.C. TYPE**	**UA**	**UC**
UTJ1	J	-40 to 760 °C	-40.0 to 760.0 °C
UTJ2	J	-40 to 1400 °F	-40.0 to 999.9 °F
UTK1	K	-40 to 1260 °C	-40.0 to 999.9 °C
UTK2	K	-40 to 1999 °F	-40.0 to 999.9 °F
UTT1	T	-184 to 371 °C	-184.0 to 371.0 °C
UTT2	T	-300 to 700 °F	-300.0 to 700.0 °F

SPECIFICATIONS

ACCURACY UA,UB = +/-0.5 counts, UC = +/-2 counts

MODULE	ACCURACY	
UTJ1-2 (UA, UB, UC)	0 to 277°C = +/-1.2 °C 278 to 760 °C = +/-0.5% rdg. -40 to 0 °C See following table	°C
	32 to 530 °F = +/-2.4 °F 531 to 1400 oF = +/-0.5% rdg. -40 to 32 °F See following table	°F
UTK1-2 (UA, UB, UC)	0 to 277 °C = +/-1.8 °C 278 to 1260 °C = +/-0.5% rdg. -40 to 0 °C See following table	°C
	32 to 530 °F = +/-3.0 °F 531 to 1999 °F = +/-0.6% rdg. -40 to 32 °F See following table	°F
UTT1-2 (UA, UB, UC)	-184 to -59 °C = +/-1.5% rdg. -58 to 93 °C = +/-1 °C 94 to 371 °C = +/-0.6% rdg.	°C
	-300 to -75 °F+/-1.5% rdg. -74 to 200 °F = +/-1.5 °F 200 to 700 °F = +/-0.5% rdg.	°F

Accuracy formulas for types J and K thermocouples in the temperature range -40 to 0 °C (-40 to 32 °F).

UTJ	
RANGE	**FORMULA**
-40 to 0 °C -40 to 32 °F	0.95 °C - 0.83 t +/-(1.2 °C + 0.11T) 0.5 °F - 0.083 (T - 32 °F) +/-1.9 °F

UTK	
RANGE	**FORMULA**
-40 to 0 °C -40 to 32 °F	0.35 °C - 0.075T +/-(1.35 °C + 0.1T) 1.65 °F - 0.091T +/-(1.9 °F + 0.012T)

T = A specific temperature between -40 and 0 °C (-40 to 32 °F)

TEMPERATURE SENSOR DESCRIPTION

TYPE	MATERIAL	CALIBRATION	MAX. LEAD RESISTANCE	LEAD COLOR
J	Iron-Constantan	NBS, IPTS68	500 Ohms	White
K	Chrome-Alumel	NBS, IPTS68	395 Ohms	Yellow
T	Copper-Constantan	NBS, IPTS68	200 Ohms	Blue

Linearization
Six break points

Temperature Coefficient (+10 to 40 °C)
Reference junction ..... +/-0.06 deg. / deg.
Span ..... +/-0.01% rdg. / °C

Input circuitry
Configuration ..... Bipolar, single ended
Zero adjustment ..... +/-5 °C (+/-10 °F)
Max. input protection ..... 120Vrms continuous,
..... 230Vrms (10s)
Polarity ..... Automatic

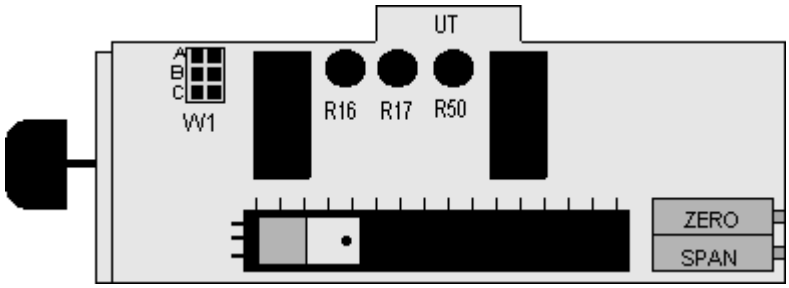
Normal mode rejection (50 to 60 Hz)
UA, UB 70dB
UC 125dB

Common mode (Analog to power grounds)
CMR (dc to 60Hz) 120dB
CMV (dc to 60 Hz) ..... +/-1500Vp

Open sensor indication
UA, UB 1BBB
UC ..... FFFF

B = Blank digits, F = Flashing digits.

CONFIGURING the THERMOCOUPLE BOARD



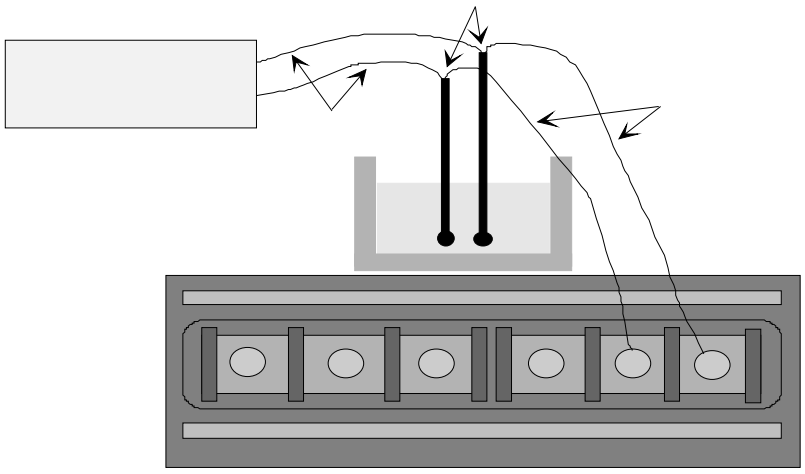
A] Select the module and thermocouple type that match one another.
B] Select °C or °F scaling from the table below and install a shorting bar at the locations indicated on the control header W1.
C] If using the UC main board, remove any shorting bar at M2 on the main board.

CONFIGURATION TABLE	
UTJ, UTK, UTT	
SCALING	**W1**
°C °F	A B,C

CHECKING CALIBRATION

A complete calibration requires that internal jumpers be removed and pots be adjusted. Calibration should be checked by using a precision thermocouple simulator, however if a calibrator is not available you may perform the following procedure.

A] Connect a precision voltage source, thermocouples and ice bath as illustrated in the drawing below.
B] Install the shorting bar(s) at the locations listed in the configuration table for °C or °F.
C] It is important that the ice bath be continuously stirred to maintain a temperature of 0 °C during this procedure.
D] When calibrating any of the modules in °F, perform the calibration in °C first.
E] Refer to the following calibration table and select the one with the module, main board and scaling required. Apply the signal value listed and adjust the stated control for the display value in the table.



DEGREES C CALIBRATION			
MODULES UTJ, UTK, UTT - UA or UB MAIN BOARDS			
TC TYPE	**INPUT**	**ADJUST**	**FOR DISPLAY RDG.**
J	0mV	R14	000**0**
K	0mV	R14	000**0**
T	0mV	R14	000**0**
J	41.01mV	R51	730**0**
K	48.83mV	R51	1200**0**
T	19.09mV	R51	371**0**
T	-5.32mV	R17	-182**0**
DEGREES F CALIBRATION **Perform degree C calibration first**			
J	0mV	R14	032**0**
K	0mV	R14	032**0**
T	-0.66mV	R14	000**0**
J	41.01mV	R50	1346**0**
K	38.83mV	R50	1720**0**
T	19.06mV	R50	700**0**

BOLD zeros = UB main board assemblies.

DEGREES C CALIBRATION			
MODULES UTJ, UTK, UTT - UC MAIN BOARDS			
TC TYPE	**INPUT**	**ADJUST**	**FOR DISPLAY RDG.**
J	0mV	R14	0000
K	0mV	R14	0000
T	-0.02mV	R14	0000
J	41.01mV	R51	7300
K	48.83mV	R51	2000
T	19.09mV	R51	3710
T	-5.32mV	R17	-1820
DEGREES F CALIBRATION **Perform degree C calibration first**			
J	0mV	R14	0320
K	0mV	R14	0320
T	-0.66mV	R14	0000
J	41.01mV	R50	Flashing 3460
K	38.83mV	R50	Flashing 7200
T	19.06mV	R50	7000

SINGLE and DUAL SETPOINT CONTROL BOARDS

DESCRIPTION

The single or dual setpoint board assemblies are designed to be used with all three main board assemblies UA, UB and UC. The boards are as a control media for external equipment through the use of one or two electromechanical relays. These relays can be set to activate at any point between negative and positive full scale.

The setpoint control(s) are located on the right side, (X version), left and right side, (R version), of the board. They are accessible from the front of the meter and are adjustable with a small screwdriver.

Immediately below each control is a push button switch which, when depressed, will cause the value of the set point to display.

Red LED lamp(s) are positioned beside each setpoint control to indicate when the relay(s) are energized, (UA & UB only).

Hysteresis for each relay may be adjusted by individual controls, accessible from inside the meter. The range of hysteresis control is from 0 to 10mV.

A variety of control formats may be configured by applying shorting bars at appropriate locations on the board.

Four external control inputs are provided and are accessible from the rear of the instrument. They activate the four functions listed below and control the operation of the relays.

A] Latch
B] Sample and hold
C] Reset
D] Hysteresis (R version only)

LATCH: A low level place on this pin will latch the relay(s) whenever the signal reaches the setpoint values. The relays will remain latched until the latch pin is momentarily disconnected or driven to a high level. Latching may also be disabled by placing a low level on the reset pin, or by depressing both of the setpoint select buttons simultaneously.

If the low relay latch has been disabled by the internal shorting bar, it will not latch when energized.

SAMPLE & HOLD: Applying a low level to the sample and hold pin will cause the relay(s) to remain in their present state regardless of the amplitude or polarity of the input signal.

RESET: A low level at the reset pin will reset the relay(s) to their deenergized state.
HYSTERESIS: Applying a low level to the hysteresis pin causes the relay(s) to operate in the differential mode. The high relay will energize at the high setpoint value and become deenergized at the low setpoint value. The low relay will energize at the low setpoint value and become deenergized at the high setpoint value.

SPECIFICATIONS

Relay Control

Contact type and rating ..... Form C (each relay)
10A @ 240 Vrms or
10A @ 30Vdc
(resistive load)
Isolation ..... 1500Vp (contacts to power ground
dc to 60 Hz

Setpoint characteristics

Settability ..... +/-3 counts
Resolution ..... +/-1 count
Range ..... -full scale to + full scale

High setpoint slaved to low setpoint (R version)
Low setpoint range ..... -full scale to + full scale
High setpoint range ..... Low setpoint to + full scale

Temperature Coef.	+/-0.01% full scale +/-10uV / °C
Setpoint selection	One or two momentary push buttons
Annunciators	One or two LED's behind window
Hysteresis	Internal pot adjustment, 0 to 10mV

Available ranges

Ranges:

- Zero to positive full scale
- Zero to positive half scale
- Zero to negative half scale
- Negative full scale to positive full scale
- Negative 1/4 scale to positive 1/4 scale

SELECTING the SETPOINT CONFIGURATION

The setpoint board is shipped set for the following configuration.

Setpoint range	-2 to 2V
Relay configuration	Alarm ON below the low setpoint and above the high setpoint.
Latch	Low relay latch enabled.

To change this configuration, perform the following.

Single setpoint board (X version)

A] Observe the option table and select the required setpoint adjustment range under the ADJUSTMENT RANGE column. Place the shorting bars indicated at the locations for W4 and W6.

B] Select the relay configuration by the description under the RELAY CONFIGURATION column. Place the shorting bars indicated at the locations for W7.

C] Determine whether the low relay is to be disabled or enabled from the LOW LATCH STATE column. Place the shorting bars indicated at the locations for W1.

Dual setpoint board (R version)

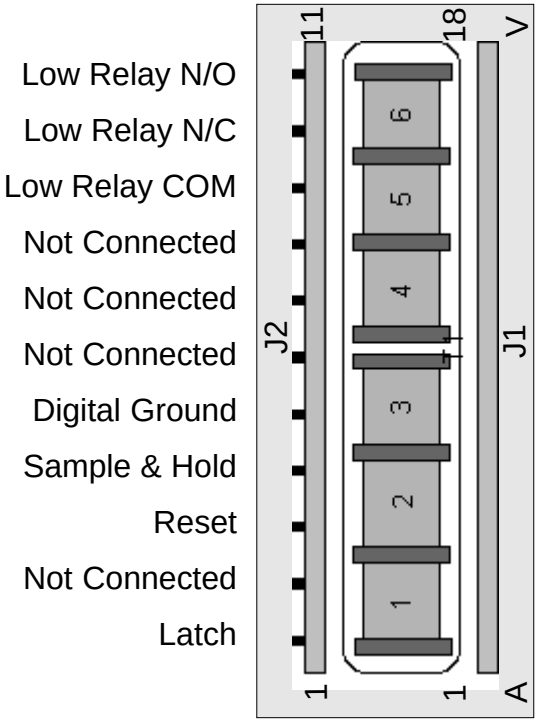
A] Observe the option table and select the required setpoint adjustment range under the ADJUSTMENT RANGE column. Place the shorting bars indicated at the locations for W3, W4, W5 and W6.

B] Select the relay configuration by the description under the RELAY CONFIGURATION column. Place the shorting bars indicated at the locations for W7.

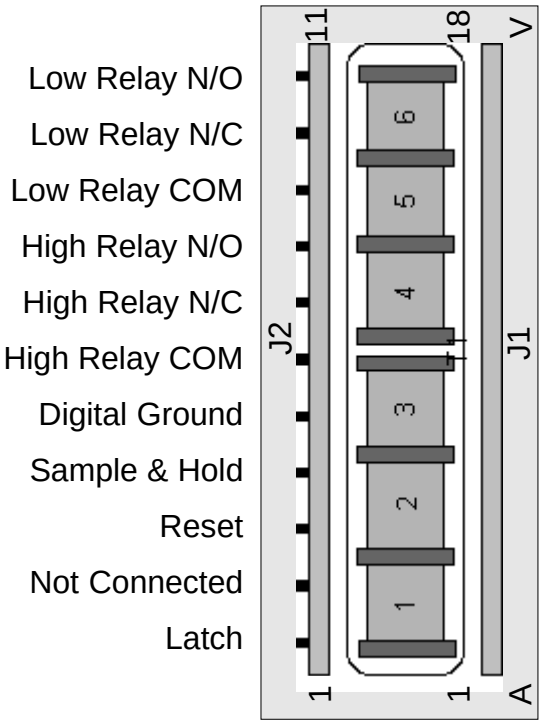
C] Determine whether the low relay is to be disabled or enabled from the LOW LATCH STATE column. Place the shorting bars indicated at the locations for W1.

D] To slave the high setpoint control to the low setpoint control, move the shorting bar on W3 to W2.

Single setpoint (X version)



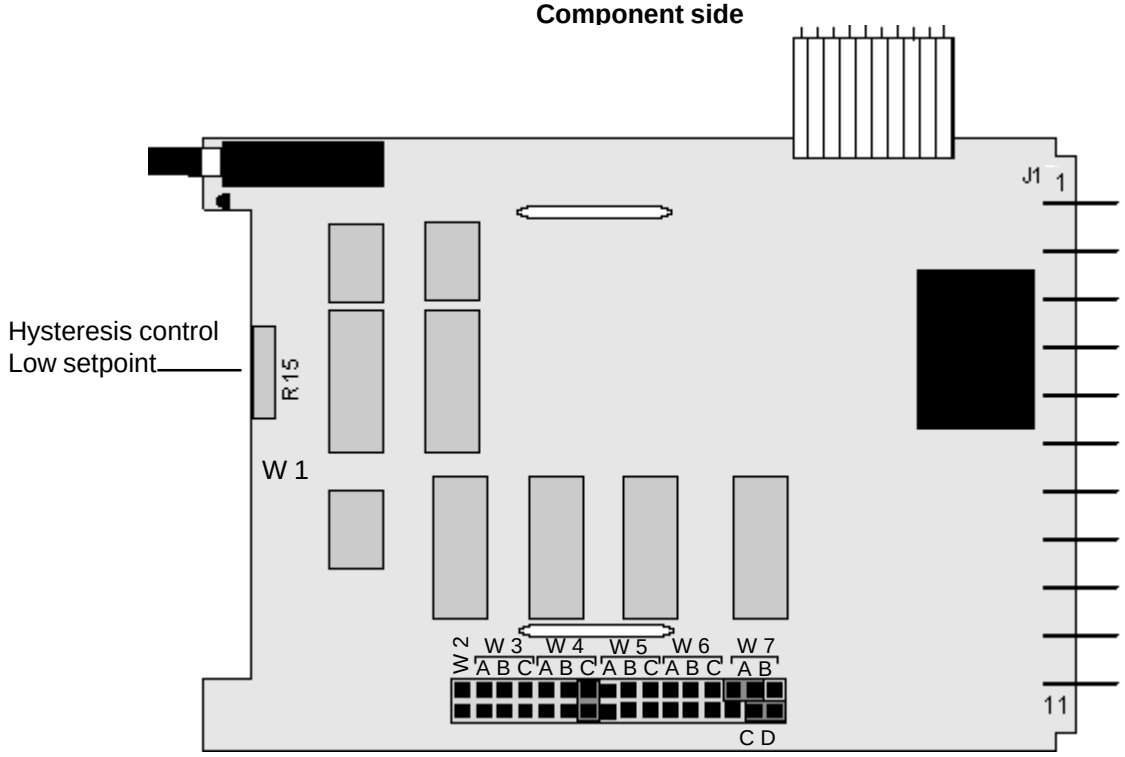
Dual setpoint (R version)



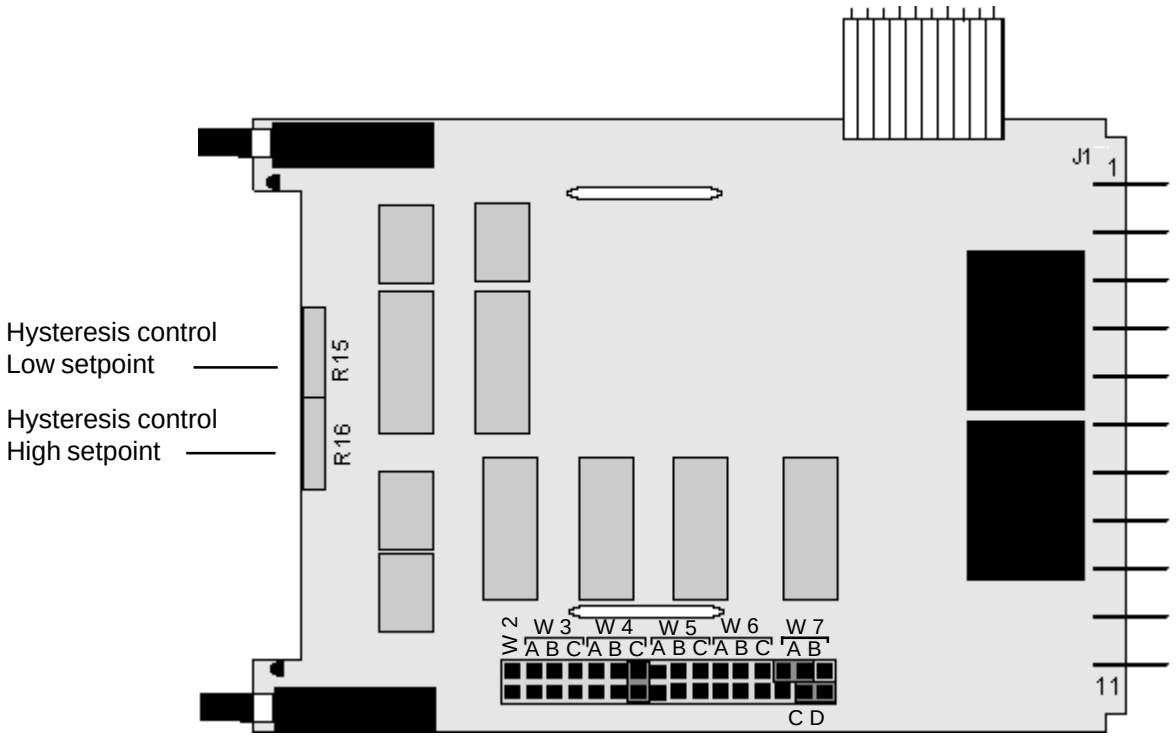
OPTION TABLE				
ADJUSTMENT RANGE	**W3**	**W4**	**W5**	**W6**
0 to 2V	B	B	C	A
0 to 1V	B	B	A	C
0 to -2V	C	C	B	B
0 to -1V	A	A	B	B
-2 to 2V	C	C	C	A
-0.5 to 0.5V	A	A	A	C
ALARM ON	**W7**	**W7**		
Below low setpoint	B	B		
Above low setpoint	A	A		
Below high setpoint	C			
Above high setpoint	D			
LOW LATCH STATE	**W1**	**W1**		
Low latch enabled	A	A		
Low latch disabled	B	B		

Shaded areas of chart apply to single setpoint board.
All areas of chart apply to dual setpoint board.

Single setpoint board (X version)
Component side



Dual setpoint board (R version)
Component side



ANALOG OUTPUT MODULE OPTIONS

The analog output module is compatible with all input modules and all main boards. Installing the analog output module will have no adverse effect on any other module.

Span and zero controls are located at the front of the meter to the right of the display board. The controls are accessible when the window is removed from the meter.

The analog output module will provide various analog outputs and may be configured for sinking or sourcing current by configuring the internal module shorting bars.

Output configurations

H No analog output module installed. Standard output of 1mV / count (UA,UB) or 0.2mV / count (UC) is included.
J 0-5Vdc with a maximum 2mA load and 12Vdc compliance voltage.
K 0-10Vdc with a maximum 2mA load and 12Vdc compliance voltage.
L 0-1mAdc proportional to the input signal (sink or source) and 12Vdc compliance voltage.
M 4/20mAdc proportional to the input signal (sink or source) and 12Vdc compliance voltage.
Y 4/20mAdc driven from an external power supply (sink only) and 40Vdc (max.) compliance voltage.
N 0-1mAdc driven from an external power supply (sink only) and 40Vdc (max.) compliance voltage.

SPECIFICATIONS

Range

Output voltage range	0 to 10Vdc
Output current range	0 to 1, 0/20 & 4/20mA
Zero offset range	-2.0 to -.94Vdc
	-.93 to .1Vdc
	-.09 to .97Vdc
	.94 to 2.0Vdc

Temperature Coefficient

Span	0.007% / °C
Zero	325nA or 100uV / °C

Available output current

The maximum output current available for excitation and analog output current is 50mA. If an analog output module is installed, the excitation output specifications are reduced. Refer to the excitation specifications for the input module installed.

CONFIGURATION PROCEDURE

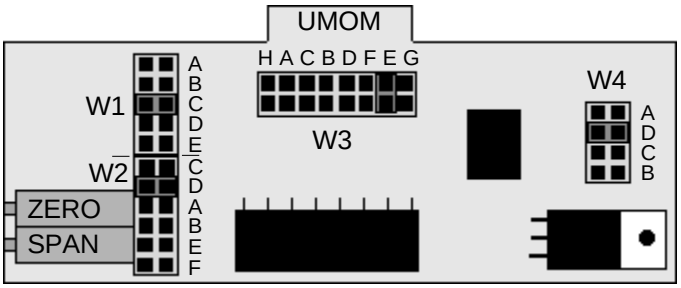
When configuring the multipurpose output module, first decide if a standard voltage or current range will fulfill your application requirements. The standard ranges will provide the stated output voltage or current for a display reading of 1999 when using the UA board, 19990 for the UB, or 9999 for the UC.

Selecting a standard voltage or current range

The table below shows the standard voltage and current ranges and their shorting bar locations.

RANGES	SHORTING BAR LOCATIONS			
	W1	**W2**	**W3**	**W4**
0 to 5Vdc	D	A,C,E,F	A,C,F,G,H	A,C
1 to 5Vdc	E	B,D,E,F	A,C,F,G,H	A,C
0 to 10Vdc	C	A,C,E,F	A,C,F,G,H	A,C
0.1 to 1.0mAdc Sinking	E	B,D,E	A,F,H	C
4/20mAdc Sinking	D	B,D,E,F	A,F,H	C,D
0.1 to 1.0mAdc Sourcing	E	B,D,E	B,E,H	C
4/20mAdc sourcing	D	B,D,E,F	B,E,H	C,D

NONE-STANDARD VOLTAGE AND CURRENT RANGES



To configure the output module for a nonstandard range, it is necessary to know the following five parameters.

1] For a current output, is the current sinking or sourcing.
2] The minimum and maximum display readings.
3] The minimum and maximum output signals from the output module.

CONFIGURING THE OUTPUT MODE

The first step is to select the output mode. There are three output modes available which are shown, along with their shorting bar locations in the following table.

OUTPUT MODES and SHORTING BAR LOCATIONS	
MODE	**W3**
Voltage output	A,F
Current output (sinking)	A,F
Current mode (sourcing)	B,E

CALCULATING and CONFIGURING the ZERO OFFSET RANGES

Step 2 is to calculate the required zero offset. This calculation will be made after determining the following four parameters.

1] LR = Lowest display reading.
2] HR = Highest display reading.
3] LO = lowest output in volts or mA.
4] HO = Highest output in volts or mA.

Calculate the zero offset range by solving the following formula.

Z = ((LR x HO) / (HO - LO))

The available zero offset ranges and their shorting bar locations are shown in the following table.

ZERO OFFSET RANGES and SHORTING BAR LOCATIONS				
	ZERO SPAN CONTROL			SHORTING BAR LOCATIONS
Z	**UA, UB**	**UC / R1**	**UC / R2**	**W2**
1	-2000 to -940	-20000 to -9400	-10000 to -3200	F,D,B
2	-937 to 100	-9370 to 1000	-4685 to 500	E,D,B
3	-90 to 970	-900 to 9700	-450 to 4850	E,A,C
4	940 to 2000	9400 to 20000	4700 to 10000	F,A,C

Observe that when using the UC board, the columns labeled UC/R1 and UC/R2 have differing ranges. These ranges are determined by the application of either a 1 or 2 volt reference voltage to the analog to digital converter on the main board. To apply a 1 volt reference, remove the shorting bar at location M2 on the main board. For a 2 volt reference, install the shorting bar on M2. Determination of R1 or R2 mode is made depending on the input module used.

Note the main board type and whether or not a shorting bar is at location M2. Select the corresponding column and range where the resultant Z, calculated in the above formula falls between the range lower and upper limits. Place the indicate shorting bars on W2 of the output module.

CALCULATING NONSTANDARD VOLTAGE or CURRENT RANGES

The process for calculating the nonstandard voltage and current ranges is the same as above with the exception that different tables are used for determining the range limits.

Using the same parameters as were used for calculating the zero offset, find the gain require by using the following formula.

GAIN = (HR - LR) / (HO - LO)

Where:

LR = Lowest display reading.
HR = Highest display reading.
LO = lowest output in volts or mA.
HO = Highest output in volts or mA.

While observing the main board type, select the voltage or current range from the tables below where the resultant GAIN falls between the lower and upper range limits.

VOLTAGE GAIN RANGES and SHORTING BAR LOCATIONS						
RANGE LIMITS (10V)			SHORTING BAR LOCATIONS			
UA, UB	UC/R1	UC/R2	W1	W2	W3	W4
18.7 to 37.3	187 to 373	93 to 186	none	E	C,G,H	A,C
34.7 to 68.7	347 to 687	173 to 343	A	E	C,G,H	A,C
66.0 to 129	660 to 129	330 to 645	B	E	C,G,H	A,C
124 to 230	1240 to 2360	620 to 1190	C	E	C,G,H	A,C
229 to 444	2290 to 4440	1145 to 2220	D	E	C,G,H	A,C
454 to 909	4540 to 9890	2270 to 4945	E	E	C,G,H	A,C

CURRENT GAIN RANGES and SHORTING BAR LOCATIONS					
RANGE LIMITS (1mA)			SHORTING BAR LOCATIONS		
UA, UB	UC/R1	UC/R2	W1	W2	W4
174 to 348	1740 to 3480	870 to 1740	none	E	C
332 to 641	3320 to 6410	1660 to 3205	A	E	C
613 to 1234	6130 to 12340	3065 to 6170	B	E	C
1136 to 2272	11360 to 22720	5680 to 11360	C	E	C
2174 to 4348	21730 to 43480	10865 to 21740	D	E	C
4166 to 7692	41660 to 76920	20830 to 38460	E	E	C
RANGE GAIN LIMITS (20mA)			SHORTING BAR LOCATIONS		
UA, UB	UC/R1	UC/R2	W1	W3	W4
7.9 to 15.7	79 to 157	39 to 785	none	H	C,D
14.6 to 29.2	146 to 292	73 to 146	A	H	C,D
27.7 to 55.2	277 to 552	138 to 276	B	H	C,D
51.5 to 103	515 to 1030	257 to 515	C	H	C,D
100 to 200	1000 to 2000	500 to 1000	D	H	C,D
196 to 384	1960 to 3840	980 to 1920	E	H	C,D

SELECTING EXTERNALLY DRIVEN CURRENT RANGES

In order to use the current output and provide a high compliance voltage greater than 12 volts, an external voltages source not greater than 40Vdc is required. Go to the section titled CALCULATING and CONFIGURING ZERO OFFSET RANGES in this section and perform the zero offset calculations.

GAIN SELECTION

Using the same parameters as were used for calculating the zero offset, find the gain require by using the following formula.

GAIN = (HR - LR) / (HO - LO)

Where:

LR = Lowest display reading.
HR = Highest display reading.
LO = lowest output in volts or mA.
HO = Highest output in volts or mA.

While observing the main board type, select the voltage or current range from the tables below where the resultant GAIN falls between the lower and upper range limits.

20mA OUTPUT RANGE (externally driven)

CURRENT GAIN RANGES and SHORTING BAR LOCATIONS					
RANGE LIMITS (20mA)			SHORTING BAR LOCATIONS		
UA, UB	**UC/R1**	**UC/R2**	**W1**	**W3**	**W4**
9.38 to 18.9	94 to 189	47 to 946	none	A,C,F,G	B
17.6 to 34.4	176 to 344	88 to 142	A	A,C,F,G	B
32.5 to 65.4	325 to 654	162 to 327	B	A,C,F,G	B
60.9 to 120	609 to 1200	304 to 600	C	A,C,F,G	B
112 to 226	1120 to 2260	560 to 1130	D	A,C,F,G	B
222 to 458	2220 to 4580	110 to 2290	E	A,C,F,G	B

Observe that when using the UC board, the columns labeled UC/R1 and UC/R2 have differing ranges. These ranges are determined by the application of either a 1 or 2 volt reference voltage to the analog to digital converter on the main board. To apply a 1 volt reference, remove the shorting bar at location M2 on the main board. For a 2 volt reference, install the shorting bar on M2. Determination of R1 or R2 mode is made depending on the input module used.

WARNING:
Before the external 40Vdc supply is connector to the meter, care should be taken to determine that the shorting bars listed in the configuration tables are in the correct positions, otherwise damage to the output module will occur.

Connect the positive terminal of the external supply to J1-U and the negative terminal to J1-16. the load may be placed anywhere within the loop. The maximum load current is 20mA.

CALIBRATION PROCEDURES

Before calibration of the output module can be performed, one of the input modules must be installed and fully calibrated. See the manual section under the input module section for calibration instructions.

CALIBRATION PROCEDURE for STANDARD VOLTAGE RANGES

A] Connect a digital voltmeter, (DVM), between J1-U(+) and J1-T or 16(-).
B] Set the DVM range switch to a range >10Vdc.
C] Apply the low signal to the meter and adjust the zero control for a DVM reading of zero.

D] Apply an input signal sufficient to display 1990 on the meter display.
E] Observe the table below and adjust the span control in accordance with the listings in the table depending on the selected range.

SELECTED RANGE and VOLTAGE	DIGITAL VOLTMETER READING
0 to 5Vdc	4.975
1 to 5Vdc	4.975
0 to 10Vdc	9.950

F] Repeat steps C] through E] until the full scale DVM reading is within 10mV of those listed in the table.

STANDARD CURRENT RANGES

A] Connect a digital ammeter, (DA), between J1-U(+) and J1-T or 16(-).
B] Set the DA range switch to a range >20mAdc.
C] Apply the low signal to the meter and adjust the zero control for a DA reading of zero.
D] Apply an input signal sufficient to display 1990 on the meter display.
E] Observe the table below and adjust the span control in accordance with the listings in the table depending on the selected range.
F] Repeat steps C] through E] until the full scale DVM reading is within 10mV of those listed in the table.

SELECTED RANGE and CURRENT	DIGITAL AMMETER READING
0.1 to 1.0 mAdc Sinking	0.95mA +/-10uA
0.1 to 1.0 mAdc Sourcing	-0.95mA +/-10uA
4 to 20 mAdc Sinking	15.2 mA +/-80uA
4 to 20 mAdc Sourcing	-15.2 mA +/-80uA

G] On the 4 to 20 mA ranges apply the low input signal and adjust the zero control on the output module for a DA reading of 4mA.

SPECIAL VOLTAGE RANGES (THE 6 NONSTANDARD VOLTAGE RANGES)

A] Connect a digital voltmeter, (DVM), between J1-U(+) and J1-T or 16(-).
B] Set the DVM range switch to a range >10Vdc.
C] Apply the low signal necessary to generate to low display, (LR) reading and adjust the zero control on the output module until the DVM reads the lower voltage, (LO).
D] Apply an input signal necessary to generate the upper display, (HR), and adjust the span control on the output module until the DVM reads the upper voltage, (HO).
F] Repeat steps C] through D] until the full scale DVM readings are within 10mV of the readings required.

SPECIAL CURRENT RANGES (THE 6 NONSTANDARD CURRENT RANGES)

A] Connect a digital ammeter, (DA), between J1-U(+) and J1-T or 16(-).
B] Set the DA range switch to a range >20mAdc.
C] Apply the low signal necessary to generate to low display, (LR) reading and adjust the zero control on the output module until the DA reads the lower current, (LO).
D] Apply an input signal necessary to generate the upper display, (HR), and adjust the span control on the output module until the DA reads the upper current, (HO).
F] Repeat steps C] through D] until the full scale DA readings are within 10uA of the readings required.

SPECIFICATIONS (MAIN BOARDS and DISPLAYS)

	UA	**UB**	**UC**
ANALOG OUTPUT (Standard)	1mV/count	1mV/count	1mV/count
DISPLAY			
Range	+/-1999	+/-19990	+/-9999
Overrange indication (X = Blank)	1XXX /-1XXX	1XXX0 /-1XXX0	All blink
Type	Seven segment light emitting diode (LED)		
Size	0.56" (14.2 mm)		
Color	Red / Orange		
Lens	Red acrylic (silkscreened)		
POWER			
Input voltage	115 Vrms +/-15%, 47-400Hz		
	230 Vrms +/-15%, 47-400Hz		
	9-32Vdc (Isolated)		
Common mode voltage	1500Vp from pri. to sec. winding & signal ground		
Power cnsumption	5 Watts		
CONVERSION			
Signal integration	100 msec.		
Type	Dual slope, auto zero		
Reading rate	Approximately 3 readings / second		
ENVIRONMENT			
Operating temperature	-10 to 60°C		
Storage temperature	-40 to 85°C		
Relative humidity	95% to 40°C (non-condensing)		
PHYSICAL CHARACTERISTICS			
Termination	6 or 7 position, screw terminal		
Weight	16 oz.		
Case	DIN size, 94V-O UL-rated polycarbonate		
Panel cutout	1/8 DIN (45 X 92 mm)		

Electro-Numerics Inc. Products

Electro-Numerics family of Digital Panel Meters and Large Digit Indicators are high quality, accurate, solid state instruments designed for years of trouble free operation. Over 25 years of digital instrumentation experience has resulted in a series of displays recognized in the field as reliable, well designed instruments. From our compact sized DPM's with 0.6" LED digits to our Large Digit indicators with 1", 2 1/4", & 4" LED or 4", 6" & 9" tall electromagnetic digits, we cover most applications in process measurement and display.

Warranty (2 Years)

Electro-Numerics, Inc. warrants these products to be free in defects in workmanship and materials for two years from the date of shipment to the original customer. This warranty on workmanship and materials may be considered as unconditional provided that, in the opinion of Electro-Numerics, Inc., the equipment has not been mechanically, environmentally, or electrically abused and has been installed, maintained and operated within the limits of rated or normal usage.

Defective products must be sent, transportation charges prepaid with notice of the defect, to our plant in Temecula, CA.

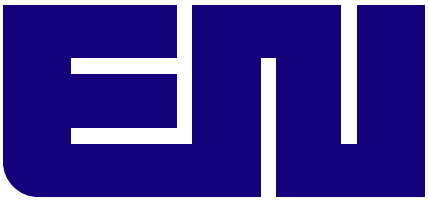
This warranty is limited, at the option of Electro-Numerics, Inc., to repair, replacement, or an appropriate credit adjustment not to exceed the original equipment sales price. All warranty freight charges are F.O.B. our plant, Temecula, CA.

Electro-Numerics, Inc. assumes no responsibility in connection with the sale of its products beyond that stated above and is not responsible for any incidental or consequential loss or damage which might result from a failure of any Electro-Numerics, Inc. product.

Repair Policy

Direct all warranty and out-of-warranty requests/inquiries to Electro-Numerics, Inc., Customer Service Repair Dept., telephone: (909) 699-2437, Fax: (909) 695-7246. Repair work will be handled at the factory or an authorized Electro-Numerics, Inc. repair service center.

All items sent in for service are subject to a minimum evaluation charge of $60.00 in the event that the product is found to be out-of-warranty or, if under warranty, not in need of additional service. Out-of-warranty service and repair charges will be quoted on a case by case basis. All repaired products will be shipped to you F.O.B., Temecula, CA.



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