Hays Cleveland
Division of UniControl Inc.

SERIES D-06120-0
THERMOCOUPLE METER

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1.0 INTRODUCTION

1.1 Application

The **Series D-06120 Solid State Microprocessor Thermocouple Meter** offers accurate measurement and display of boiler exit, oven, dryer, or other process temperatures. The **LED** display indicates the temperature variable. The **thermocouple sensor and cable assembly** is available in a range of lengths (see nomenclature in Section 1.2, below). **Modbus communications**, for interface with a supervisory control and data acquisition system (SCADA) or other controls, is a standard feature.The meter is available in either panel-mounting or surface-mounting configurations.

Although the **D-06120 Thermocouple Meter** may be used to measure any process gas temperature within the limits of its specifications, its most common application is the measurement of boiler exit gas temperature. Accordingly, **the mounting and installation instructions provided in this manual reflect this application.** Please adapt as required to suit your application, or consult the factory.

The thermocouple/cable assembly consists of a ***Type J*** thermocouple threaded through a 2.5–18" rod with mounting flange for insertion into the process, and an insulated iron constantan cable of required length to connect the sensor to the display unit. When the thermocouple is exposed to the process media, it generates a millivolt electrical current in direct proportion to the process temperature. The millivolt output is transmitted through the cable to the electronics assembly, where it is converted to a displayed temperature reading.

The electronics portion of the meter includes dual fail-safe SPDT contacts (10-amp rated) for remote alarm or indication. A 4-20 mA DC“retransmit” output is provided for remote data acquisition, recording, etc. Two alarms are offered: alarm #2 has the option of manual reset. The alarm set points are viewed and adjusted from the display panel. Display and output are convertible between degrees Celsius and degrees Fahrenheit units.

Thermocouple failure results in a “fail-safe” response: the over range reading is displayed on the meter, and the meter and retransmit outputs immediately go to *maximum*.

The output of the **D-06120 Thermocouple Meter** is ice-point compensated with automatic external resistance compensation.

D - 0 6 1 2 0 - * 0 - __ - __ - __ - __

A B C D

1.2 Nomenclature

The basic catalog number for the **Hays Cleveland Model D-06120 Thermocouple Meter** is shown below. Use this table to select the complete model nomenclature to suit mounting and cable length requirements.

6120-A*0-ABCD

A = Package

1 Semi-Flush for Panel Mounting
2 Surface Mount

B = Thermocouple Options:

0 Customer supply.
1 Type J, 2.5" insertion (P/N 31138-025)
2 Type J, 4.5" insertion (P/N 31138-045)
3 Type J, 12" insertion (P/N 31138-120)
4 Type J, Flue Gas Temperature, variable insertion, 6 - 18" (P/N 31138-618)

C = Alarm #2 Setup (Factory Set, Field Adjustable)

1 Local Manual Reset of Alarm #2 included.
2 Remote Manual Reset of Alarm #2 included.
3 Auto Reset of Alarm #2 included.

D = Thermocouple Cable for Code B, above:

0 Customer Supply-N/A
1 50' length (P/N 31139-050)
2 100' length (P/N 31139-100)
3 Special length exceeding 100' (specify with order)

*Current Model Designation =**A**

1.3 Specifications

Thermocouple Specification:

Type J, Iron and Constantan is standard: linear range 32 to 999F or 0 to 537C. Suitable for use in oxidizing or reducing environments. If other material is required (for instance, because of a nonstandard temperature range), please contact **Hays Cleveland**. Probe insertion 2.5–18" (see **1.2 Nomenclature** for choices).

Indication:

• LED Display, 0.43" Height.
• Visual Display Indicators for Alarm 1 and Alarm 2.
• **"Open Thermocouple"** Indication: In the event of thermocouple failure, the over range reading is displayed on the meter.
• Temperature Units: operator set for ºF or ºC.

Display range settings:

• 32 - 999F.
• 0 - 537C.

Alarm Settings:

2 alarms, independently adjustable, 32 to 999F or 0 to 537C. Contact rating: 10 amps, 12 v. AC SPDT, non-inductive.

Retransmit Output:

4-20 mADC, directly proportional to thermocouple temperature, where **32F = 4 mADC and 999F = 20 mADC.** 750 Ω maximum.(Output is grounded but not isolated.)

Alarm Contact Rating:

10 amps, 120 V AC SPDT, non-inductive.

Accuracy:

±4 °F (±2.2 °C) over entire operating range.

Power Requirements:

120 V AC ± 10%, 50/60 Hz.

Ambient Temperature Limits for Meter Housing:

32 to 130F. 0 to 60C.
Fuse: One, @ 1 amp.

Relative Humidity:

0-90% non-condensing.

Mounting:

Panel or surface-mountable housings available.

Shipping Dimensions

Determined at order entry.

Shipping Weight:

Determined at order entry.

Construction Material:

Durable plastic construction.

Approvals:

UL and CUL pending.

SPECIFICATIONS ARE SUBJECT TO CHANGE.

2.0 INSTALLATION

2.1 Mechanical (Refer to Figures 1, 2, 3 and 4).

Mount the meter with other controls and instruments in a panel or cabinet where temperatures are within the housing limits as shown in the specifications (0 - 60 C or 32 - 130 F). Preferably, the meter should be readable from a position in front of the boiler.
Install the thermocouple assembly in the boiler exit above and as near as possible to the point where the gases leave the last pass of tubes or baffles. If the thermocouple assembly must be installed near the outlet damper, make sure that the damper blade does not strike the thermocouple or rod when it is turned. If a barometric damper is used, the thermocouple must be installed between this damper and the boiler.

Mount the thermocouple flange by drilling two 1/8" holes in the side of the breeching and using #10 sheet metal screws to fasten it to the breeching surface. Drill a 5/8" clearance hole for the thermocouple rod. Use the flange itself as a template for locating the hole positions.

For bulkhead mount, thread the 1/2” NPT mounting adaptor into the existing or new bulkhead fitting.

Insert the thermocouple rod to a depth that reaches as close to the center of the passage as possible. In large breechings, the thermocouple rod should be inserted to its maximum depth. Tighten the set screw securely.

Run the cable from the thermocouple to the meter. Do not allow the cable to touch the hot surfaces of the breeching.

Wiring Tips

- **Wire** with extreme caution!
- 120 V AC wiring must be 14 AWG minimum. Do not run in conduit with low voltage signal wiring!
- All wiring must conform to the **National Electrical Code** and to local code regulations. Verify all electrical ratings on equipment.
- Connecting **high** voltage to the **low** voltage circuits will damage the circuitry!
- Mount the **display** unit in such a manner that the wiring cable from the main electronics does not touch or approach any **high magnetic source**. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

2.2 Wiring (Refer to Figure 5).

Power, output, thermocouple input and alarm contacts are located on the back of the meter. 120 V AC is applied to terminals H (hot) and N (neutral). Terminal G is ground.

120 V AC wiring must be 14 AWG minimum. Do not run in conduit with low voltage signal wiring!

The electrical transmission in the thermocouple output cable is so slight that no codes stipulate wiring specifications. However, for appearance and protection, we recommend shielded cable for the output wiring: it **must** be used if the output wiring is not being run in a separate conduit. Ground the shield at one end only, preferably the receiving end. Do not run the output wires near heavy electrical equipment or with power wiring exceeding 120 VAC.

Terminals 1,2, and 3 are associated with alarm 1. Normally Open (2), Normally Closed (1), and Common (3) are provided. These are fail-safe so that the relay contacts change state on power up. Please note this when wiring.

Terminals 4,5, and 6 are associated with alarm 2. Normally Open (5), Normally Closed (4), and Common (6) are provided. These are fail-safe so that the relay contacts change state on power up. Please note this when wiring.

Terminals 7 and 8 (ALM1 RST) come jumpered from the factory. Do not modify these terminals or jumper.

Terminals 9 and 10 (ALM2 RST) are used for remote reset. An external switch (NO) is wired to these terminals. If automatic reset is required, a jumper is placed between these two terminals . If manual reset from the front display panel is required, do not install a jumper between these two terminals.

Terminals 11(+), 12(–), and 13(SHD) provide for Modbus communication.

Terminals 14(+) and 15(–) provide the retransmitted signal which is directly proportional to the flue gas temperature where 32F = 0C = 4 mA DC and 999F = 536C = 20 mA DC.

Terminal 16 is the ground for the shield associated with terminals 14 and 15.

Terminals 17, 18, and 19 are the termination for the Type J Thermocouple wires. Note that the red wire (non-magnetic) of the thermocouple is placed on Terminal 17, the white wire (magnetic) is placed on Terminal 18 and Terminal 19 is the shield.

DC wiring (for transmitted temperature signals) is at voltage levels of 24 V DC or less. Unless otherwise specified, all signals are 4-20 mA DC. Each signal requires a shielded 2-wire pair, 16 AWG minimum.

RS-485 Modbus wiring: a plus terminal is provided for plus signals, a minus terminal for minus signals, and a shield (shd) for shield wires**.** Generally, Belden 9841™ shielded cable or equivalent is suggested for RS-485 communications.

Thermocouple wiring: The Type J thermocouple assembly is available in several lengths (see section **1.2 Nomenclature**). Select a cable length as long or longer than needed: the cable may be shortened if necessary, but cannot be spliced.

Thermocouple cable tuning: The meter is calibrated at the factory for use with the selected length 20 gauge, type J thermocouple cable. Type J thermocouple cable must be used in order for the indicator/transmitter to operate properly. **Alternate gauge** type J thermocouple **may** be used in place of the recommended 20-gauge size. However the Thermocouple Meter **must be tuned** to operate with any cable other than the 20 gauge, using the following procedure. **(Note: high voltage is present when the printed circuit board is exposed. Use caution while performing the following procedure!)**

- Wire the thermocouple to the thermocouple meter. Make sure that the thermocouple is at a stable temperature.
- Pull the **H1** jumper off the printed circuit board, and then note the temperature on the display.
- Replace the jumper to the **H1** position. This is a necessary part of the open thermocouple protection circuitry.
- Adjust R12 (T/C zero) to the value that was noted in the third step above.
- Put unit into operation.

Minimum Gauge for Thermocouple Cable Based Upon Length:	
0-50 feet	20 Gauge
50-100 feet	18 Gauge
100-200 feet	10 Gauge

Table 1: Thermocouple Cable Length

3.0 OPERATION & MAINTENANCE

3.1 Display Screen

When power is applied to the unit, the display lights. The display indicates the following parameters:

Display	Name	Function
Temp. °F/°C (Actual Number)	Process Variable	Displays actual temperature in selected temperature units.
AL1	Alarm 1	Flashes when temperature exceeds Alarm 1 limit.
AL2	Alarm 2	Flashes when temperature exceeds Alarm 2 limit.
°	Degree Symbol	Flashes to indicate that the microprocessor is running under normal conditions.
F/C	Fahrenheit/Celsius	Displays the units selected for the process variable.

Table 2: Display Screen

3.2 Field Configuration

Enter the scrolling display to change and set parameters. Press the ENTER button repeatedly to access the desired parameter. Press the INC button to increase the value. Press the DEC button to decrease the value. It is not necessary to press the ENTER button after setting a value: the new value is effective immediately. The RESET button is used for the manual reset option: press it to reset Alarm #2.*

* The manual and automatic reset can be changed by the use of the application jumper located on the printed circuit board terminal block. After the selection has been made, turn the power off and then on to reinitialize the microprocessor.

Parameter	Function
Process Variable	Displays the current temperature in °F or °C.
Software Revision	Displays the software version installed in unit.
F 9 U	Displays and prompts for the next display to select flue gas temperature units, °F or °C.
°F/°C	Displays and toggles units between °F or °C.
Al 1	Displays and prompts to change Alarm #1 trip point.
Al 2	Displays and prompts to change Alarm #2 trip point.
SCA	Displays and prompts to change the serial communications address (Modbus).
SCr	Displays and prompts to change the serial communications baud rate.

Table 3: Configuration screen.

3.3 Maintenance

The meter components of the **Series D-06120 Thermocouple Meter** require no routine maintenance, but the Type J thermocouple should be withdrawn approximately once a month for inspection and cleaning.
The boiler exit gas temperature indicates the degree to which the boiler is absorbing the heat generated by the firing equipment. The ideal exit gas temperature correlates to the steam temperature. Table 1 shows the relationship between the pressure and temperature of saturated steam. As a rule, exit gas temperature within 75-100ºF of the saturated steam temperature indicates excellent heat transfer efficiency. (Contact your boiler supplier for the design temperature differential.)

Another rule of thumb for exit gas temperature is that for every 40 degrees F above design temperature, fuel consumption increases 1%.

If meter readings are consistently too high, either one or both of the following conditions exist:

1. Soot or scale formations on the boiler passages are creating an insulating effect.

2. The heated gases are being drawn through the boiler passes so rapidly that they do not have time to transfer their useful heat.

To make corrections, make sure first that heat transfer surfaces are clean. Then make necessary adjustments or corrections on the rate of air flow through the boiler to bring temperatures within the permissible range.

4.0 MISCELLANEOUS

4.1 Retransmission of the Process Variable

Refer to the overall wiring diagram (Fig. 4 Terminal Designations). The terminals for the retransmission of the process variable are 14(+), 15(–), and 16(SHD). These terminals provide the retransmitted signal of the temperature. The signal is fixed (i.e.,cannotbe changed) at these parameters: 4ma DC = 32ºF and 20ma DC = 999ºF. 750 ohm maximum.

4.2 Modbus Communications

Refer to the overall wiring diagram (Fig. x). The terminals for Modbus communication are terminals 11(+), 12(–), and 13(SHD). These terminals provide the following information with the Modbus protocol using RS-485.

Table 4: Modbus addresses.

Modbus Series D-06120 Thermocouple Meter							
Modbus Address 40001	**Flue Gas Temperature**					**Signed Integer**	
Modbus Address 40002	**Status**						
MSB	not used	not used	not used	not used	not used	not used	not used
not used	1 = °F 0 = °C	not used	not used	not used	not used	ALM 2	ALM 1 LSB
Modbus Address 40003	**Alarm #1 Trip Point**					**Unsigned integer**	
Modbus Address 40004	**Alarm #2 Trip Point**					**Unsigned integer**	

4.3 Troubleshooting (LED's)

• Diagnostic LED: This is the "processor is running" LED that indicates the state of the microprocessor, by blinking at different rates, as shown in Table 2.

• Checksum Error: When the microprocessor values do not match the stored values im memory, "Err" is displayed and all logic functions are halted. To correct this error, turn the power off and then on again. If this procedure does not rectify the error, reenter all control parameters. If the problem persists, contact Customer Service at Hays Cleveland.

5.0 CUSTOMER SERVICE INFORMATION

5.1 Contacts

Hays Cleveland Customer Service Department

1111 Brookpark Road

Cleveland OH 44109

Telephone: 216.398.4414

Fax: 216.398.8556

email: **customerservice@unicontrolinc.com**

Visit us on the WEB!

http://www.hayscleveland.com

5.2 Repairs

Damaged or defective units may be returned to the factory for repair. However, factory authorization must be obtained before shipping whether warranty or non-warranty service is required, and all units must be shipped prepaid.

A letter of transmittal that includes the following information should accompany the returned instrument:

1. Location, type of service, and length of time in service of the unit.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the unit.
4. Indicate whether warranty or non-warranty service is requested.
5. Attach Purchase Order for all out-of-warranty repairs.
6. Complete shipping instructions for the return of the repaired instrument.
7. Original purchase order number and date of purchase.
8. Return Goods Authorization number provided by the factory when you called.

Clearly label the shipping container:

RETURN FOR REPAIR

Model _____

RG # _____

Ship prepaid to:

HAYS CLEVELAND

1111 Brookpark Road

Cleveland OH 44109-5869

216-398-4414

Please follow this procedure. It expedites handling of the returned item, and avoids unnecessary additional charges for inspection and testing to determine the problem before repairing it.

5.3 Service

A **Maintenance and Service Contract** can ensure trouble-free, economical operation of **Hays Cleveland** equipment for many years. One-time onsite service by a factory-trained service engineer can also be provided as needed. Contact Hays Cleveland for information on these service options.

5.4 Standard Terms and Conditions of Sale

TERMS OF SALE: 1% discount if paid in ten (10) days, net amount due and payable in thirty (30) days.

AGREEMENT OF SALE: Acceptance by Seller of any order placed for goods whether submitted on Buyer's purchase order form or on seller's Sales Order Acknowledgment form, shall be subject to Seller's Standard Terms and Conditions of Sale and is conditioned upon the Buyer's acceptance of these Standard Terms and Conditions.

TERMS OF CONTRACT: Any terms or conditions of the buyer's order which are inconsistent with these terms and conditions shall not be binding on the Seller and shall not be considered applicable to the sale or shipment of goods or materials. Unless buyer shall notify Seller in writing to the contrary within ten (10) days after the mailing of the Sales Contract by Seller, acceptance of the terms and conditions hereof by Buyer shall be indicated and, in the absence of such notification, the sale and shipment by Seller of the goods and materials covered hereby shall be conclusively deemed to be subject to the terms and conditions hereof.

PRICES: All prices and specifications and applicable discounts are subject to change without notice. Sales contracts which call for delivery in the future will be billed at prices in effect at the time of shipment. Shipping weights shown are approximate and subject to change without notice.

SHIPMENT AND PAYMENTS: All prices contained on the Sales Contract are F.O.B. factory in Cleveland, Ohio. No freight is allowed on any shipments. Shipments and deliveries shall at all times be subject to the approval of Seller's Credit Department, and at any time seller may require payment in advance or satisfactory security or guarantee that invoices will be promptly paid when due. If buyer fails to comply with any terms of payment, seller, in addition to its other rights and remedies, but not in limitation thereof, reserves the right to withhold further deliveries or terminate the Agreement, and any unpaid amount thereon shall become due immediately. Terms of payment shall be as set forth on the Sales Contract.

DELAYS AND DEFAULTS: Delays or defaults in delivery by Seller of the goods and materials covered by the Sales Contract shall be excused so far as the same is caused by fire, strikes, accident, governmental regulation, or any delays unavoidable or beyond reasonable control of Seller. In no event shall Seller be liable for any consequential, special, or contingent damages on account of any default or delay in delivery.

NON-CANCELLATION: Orders are not subject to suspension, reduction, or cancellation, except on terms that will indemnify Seller against loss.

SPECIFICATIONS: Seller relies on specifications and other data furnished by the Buyer, an architect, contractor, or consulting engineer in all phases of the work covered by the Sales Contract. Seller shall be responsible to check quantities only. Alterations to or changes in specifications, approval of samples, changes in delivery instructions and all other instructions must be submitted in writing to Seller.

In the event Seller performs design or engineering work at the request of Buyer, an architect, contractor, consulting engineer, or representative in any phase of the work covered by the Sales Contract, Seller shall not be responsible for any damages claimed by Buyer as a result of alleged errors or defects in such design or engineering work.

WARRANTY AND LIMITATION OF LIABILITY: Seller warrants that the goods supplied by it have been manufactured in accordance with its standard manufacturing practices and conform to the contract or catalog description set forth in the order. Seller further warrants that the goods supplied by it are fit for the ordinary purpose or purposes specified in its catalog for which such goods are used when installed in accordance with Seller's recommended installation procedures. Except as stated herein, Seller makes no express warranty with respect to goods supplied by it and Seller makes no warranty that the goods are fit for any particular purpose.

When the use of materials not manufactured by Seller is suggested by Seller's recommended installation procedures or otherwise, Seller makes no express warranty with respect to such materials nor that such materials are merchantable or fit for any particular purpose.

Seller will, at its sole option, credit, repair or replace, any goods supplied by it which its examination shall disclose to its satisfaction are defective in workmanship or material and are returned to it within one year from the date of shipment and any claim not made within this period shall conclusively be deemed waived by Buyer. Credit, repair or replacement will be preconditioned upon examination of the goods by Seller, and, if requested by Seller, return of the goods to Seller at its direction and expense. No goods are to be returned to Seller without its written consent. Seller shall not be liable for any expense incurred by Buyer in order to remedy any defect in its goods. Seller shall not be liable for any consequential, special, or contingent damage or expense, arising directly or indirectly from any defect in its goods or from the use of any defective goods. The remedies set forth herein shall constitute the exclusive remedies available to Buyer and are in lieu of all other remedies.

CLAIMS: Claims for shortage of goods or for mistakes or errors in billing must be presented within forty-five (45) days from the date of shipment of goods and must state the packing slip number and container number applicable to the claim. Any claim not so presented will be conclusively deemed waived.

TAXES: Any federal taxes or other government charges on the sale, shipment, or installation of the goods or equipment covered by the Sales Contract shall be added to the price and paid by Buyer, or, in lieu thereof, the Buyer shall furnish the Seller with tax-exemption certificates acceptable to the taxing authority. The procedure also applies to duty and other similar charges on export sales. Seller is not responsible for sales and/or use tax in any state other than Ohio. The purchase made under this Sales Contract must be exempt or paid directly by Buyer. If Seller is required to pay any such tax, there shall be added to the prices quoted herein all such state and local taxes. Buyer agrees to reimburse and save Seller harmless from all such state and local taxes, including interest and penalties thereon, which may at any time be payable to any state or local government unit with respect to the sale of any goods or materials covered by the Sales Contract.

CORRECTIONS: Typographical or clerical errors contained in the Sales Contract, including prices, are subject to correction by the Seller.

FAIR LABOR STANDARDS: All goods covered by the Sales Contract have been produced in conformity with all applicable provisions of the Fair Labor Standards Act of 1938 as amended.

RENEGOTIATION: Unless advised by Buyer in writing, Seller assumes that Buyer's order and the Sales Contract are not renegotiable under the Renegotiation Act of 1951.

APPLICABLE LAW: All questions arising out of the Sales Contract, which shall be deemed an Ohio contract, shall be governed by the laws of the state of Ohio.

EXCLUSIVE TERMS: The Sales Contract shall constitute the complete contract between the parties, and no one has authority to depart from the terms and conditions set forth therein, nor to make any representations or arrangements other than those printed thereon whether in the execution or in the performance of the Sales Contract, unless the same are written on the face of the Sales Contract or are given in writing with it or in pursuance of it, and are fully approved in writing by an officer or authorized employee of the Seller.

LIMITATION FOR SUITS: Any controversy or claim arising out of or relating to this Sales Contract or the breach thereof, must be commenced within one (1) year after the cause of action accrued.

APPENDICES

°Celsius	°Fahrenheit	Type J Thermocouple Output MV)	°Celsius	°Fahrenheit	Type J Thermocouple Output MV)
0	32	0.000	240	464	12.998
10	50	0.507	260	500	14.108
20	68	1.019	280	536	15.217
25	77	1.277	300	572	16.325
30	86	1.536	320	608	17.432
40	104	2.058	340	644	18.537
50	122	2.585	360	680	19.640
60	140	3.115	380	716	20.743
80	176	4.186	400	752	21.846
100	212	5.268	420	788	22.949
120	248	6.359	440	824	24.054
140	284	7.457	460	860	25.161
160	320	8.560	480	896	26.272
180	356	9.667	500	932	27.388
200	392	10.777	520	968	28.511
220	428	11.887	540	1004	29.642

Table 5: Thermocouple Output Values Related to Temperature

Relationship between Saturated Steam Pressure and Temperature								
Steam Pressure (PSI)	0+	1	5	10	15	50	100	150
Steam Temperature (°F)	212	216	225	240	250	295	338	365
Note: For complete information, refer to the ASME Steam Tables, Table II.								

Table 6: Relationship between Saturated Steam Pressure and Temperature.

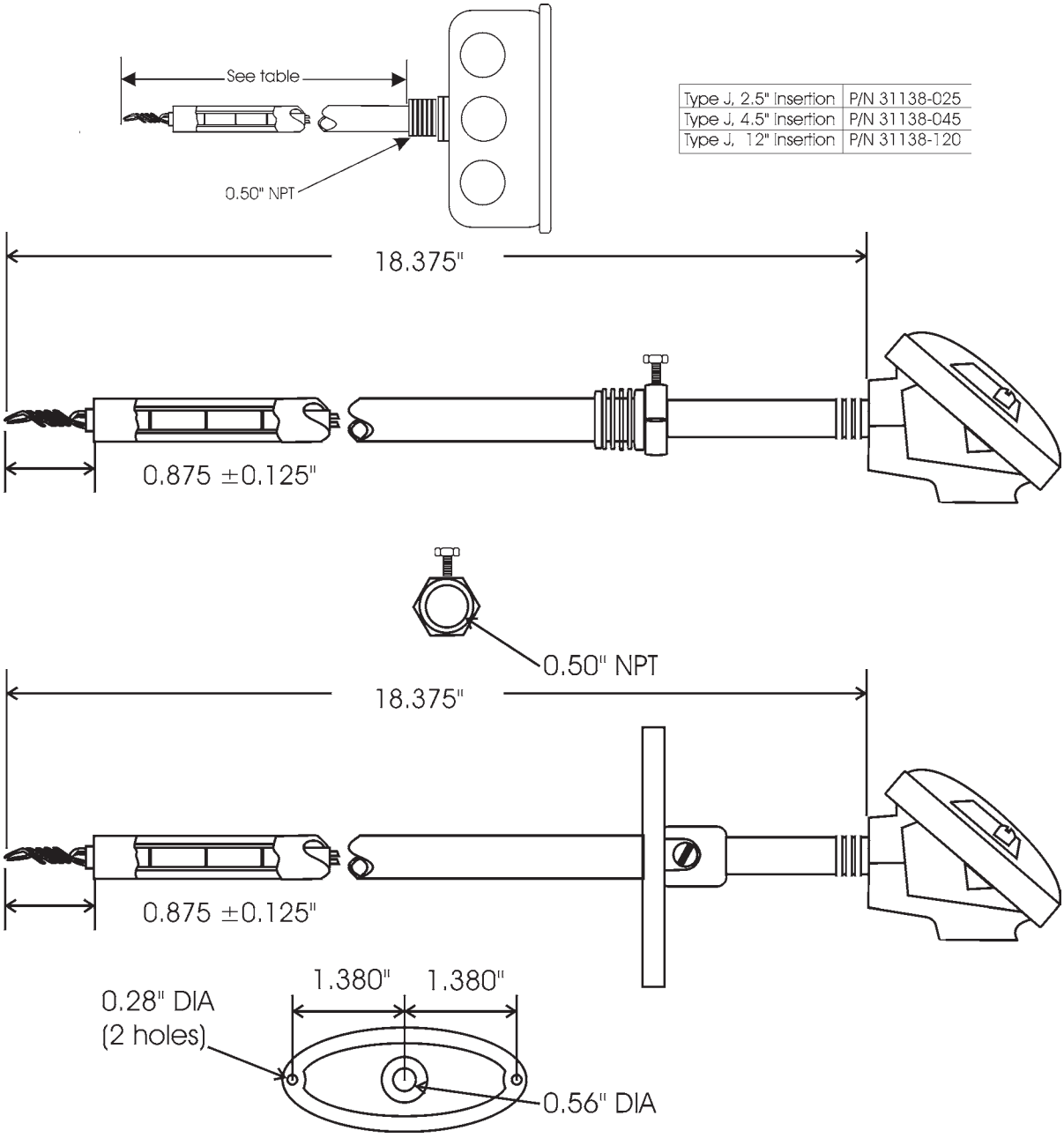

Figure 1: Thermocouple Assembly and Mounting Flange Options

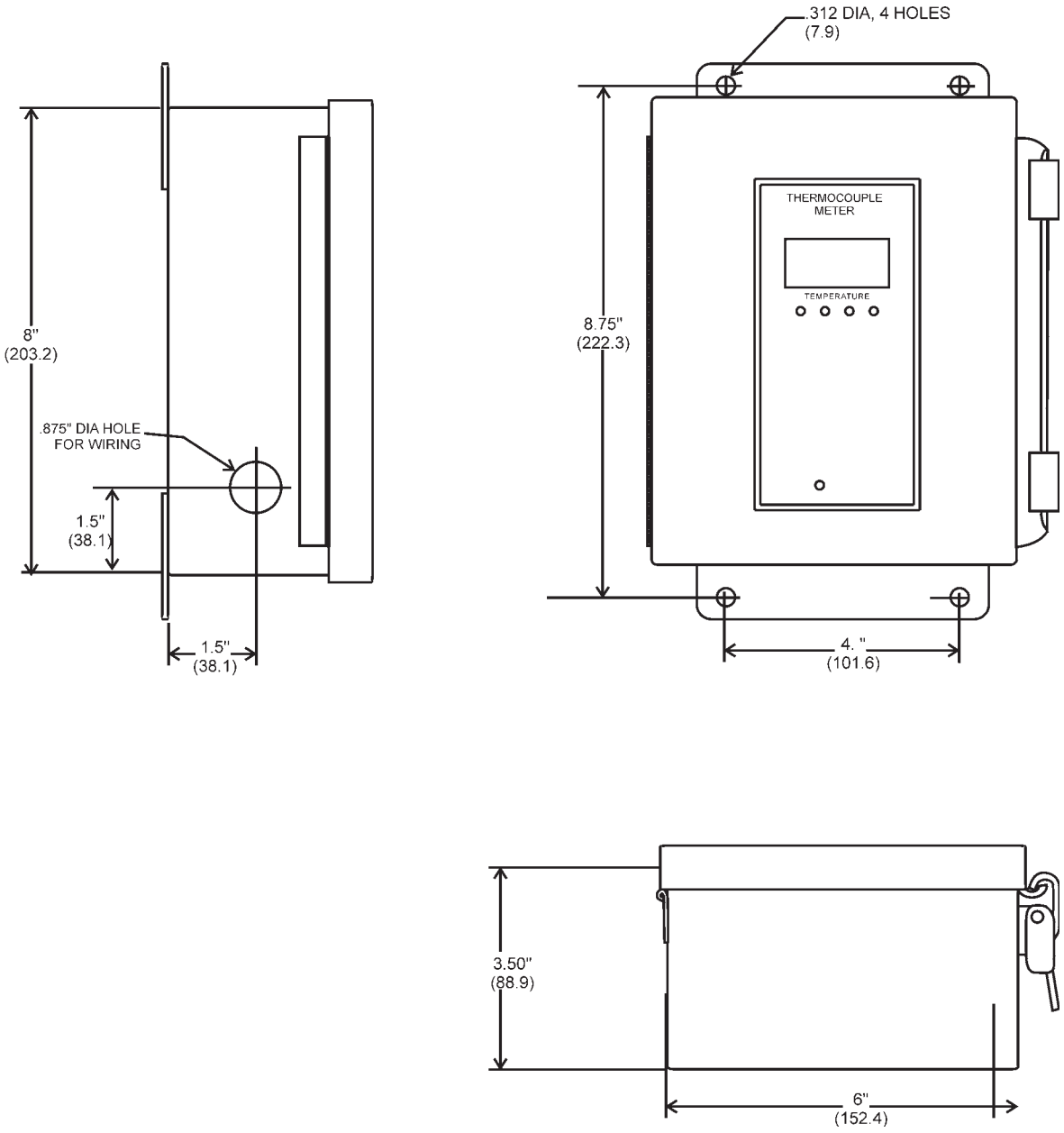

Figure 2: Electronics Panel Dimensions (surface-mounting configuration).

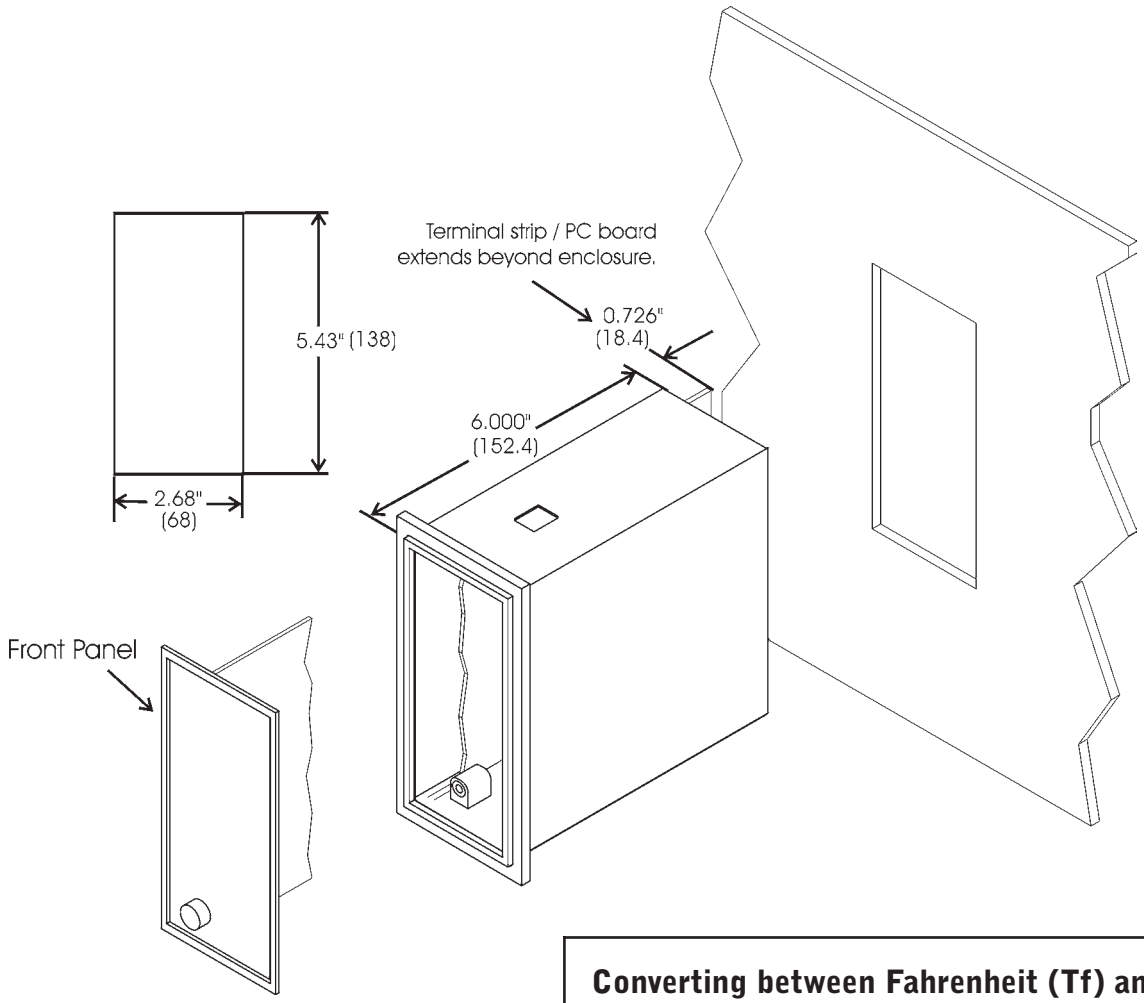

Figure 3: Electronics Panel Dimensions (panel-mounting configuration).

Converting between Fahrenheit (Tf) and Celsius (Tc) Temperature Scales
Tf = (9/5 X Tc) + 32
Tc = 5/9 X (Tf - 32)

Table 7: Relationship between Fahrenheit and Celsius Temperature Scales.

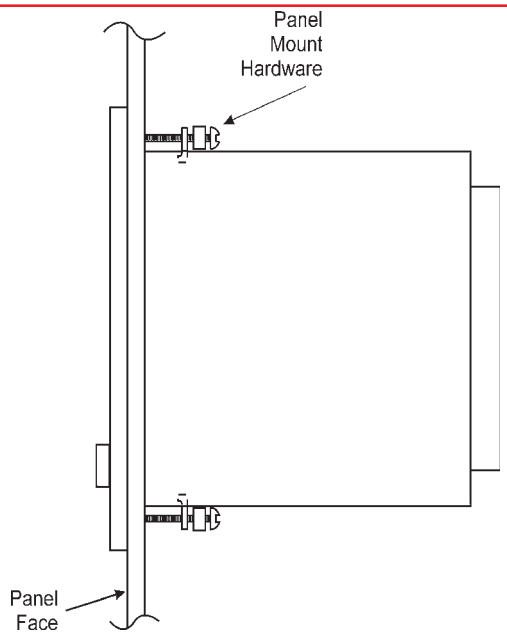

Figure 4: Electronics Panel Mounting Brackets

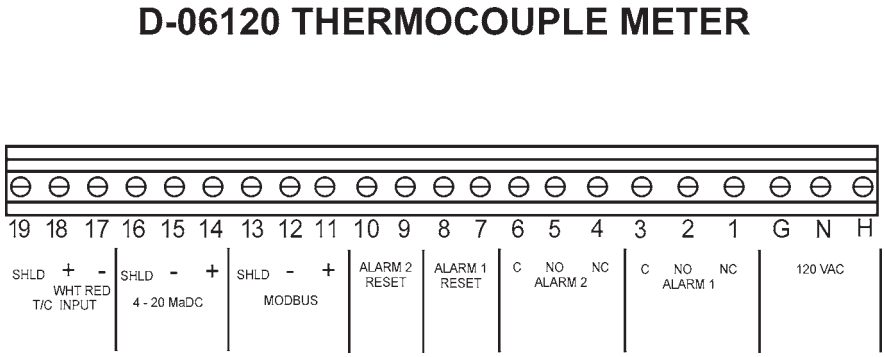

Figure 5: Terminal Designations

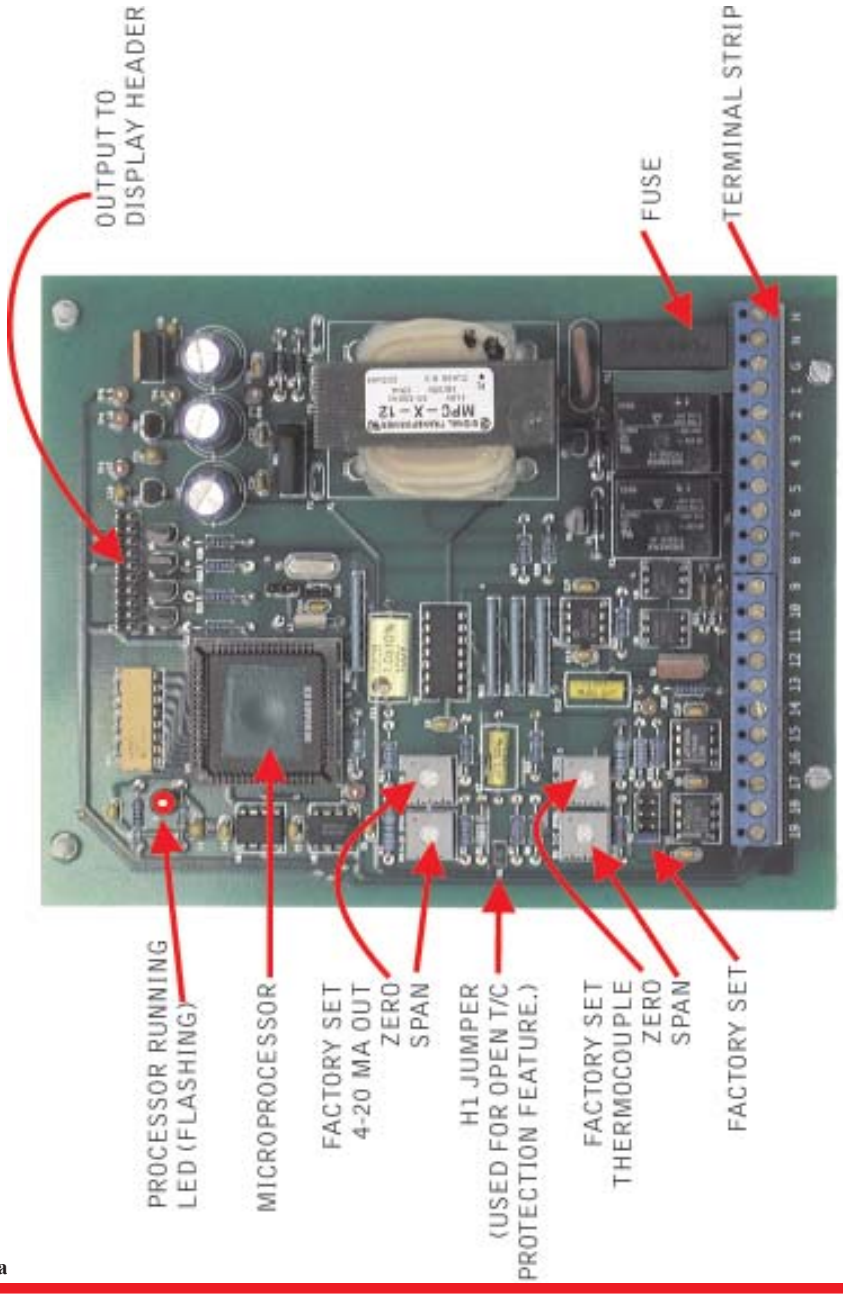

Figure 6: PC boa

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