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Bulletin No. APLTC-I
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# MODEL APLTC - APOLLO THERMOCOUPLE INDICATOR

- *MICROPROCESSOR CONTROLLED, NO POTS OR DIP SWITCHES*
- *USER PROGRAMMABLE T/C TYPE (T, E, J, K, R, S or B)*
- *SELECTABLE °F OR °C DISPLAY*
- *FULL 4-DIGIT, 0.56" (14.2 mm) RED LED READOUT*
- *FAULT DETECTION FOR THERMOCOUPLE BURNOUT*
- *OPTIONAL ISOLATED ANALOG OUTPUT*
- *OPTIONAL ISOLATED SERIAL COMMUNICATIONS*
- *OPTIONAL ISOLATED TEMPERATURE ALARM OUTPUT*
- *NEMA 4/IP65 SEALED METAL FRONT BEZEL*


## DESCRIPTION

The Apollo Thermocouple Indicator is a high accuracy, microprocessor based instrument designed for low cost temperature measurement and control. The microprocessor automatically compensates for cold junction, NBS linearity, and the meter's zero and span. *(One model accepts all thermocouple types by simple programming.)* There is no need to recalibrate when changing input types. Isolated analog output, serial communications, and temperature alarms are available as low cost options.

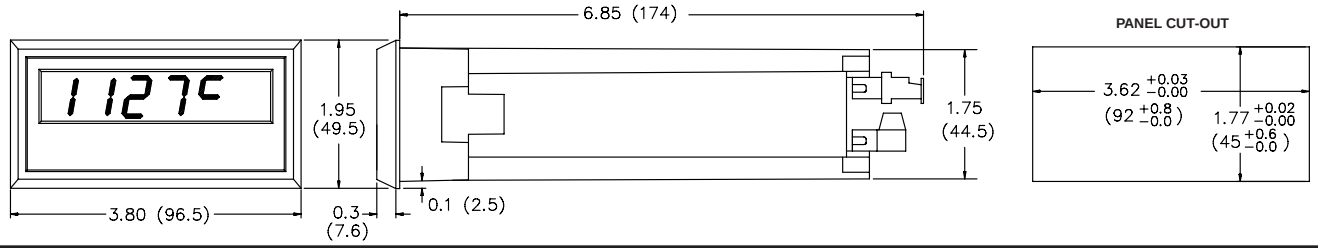
The NEMA 4/IP65 designed, die-cast metal bezel of the Apollo can be sealed in the front panel for use in wash-down and other tough industrial environments. The full 4-digit display features large 0.56" *(14.2 mm)* red LEDs for easy reading.

### SPECIFICATIONS

1. **DISPLAY:** 4-digit *(9999)*, 0.56" *(14.2 mm)* high LED, minus sign displayed when temperature is negative
2. **RESOLUTION:** 1 degree
3. **POWER:** Available in two voltage ranges 115 or 230 VAC, ±10%, 50/60 Hz, 8 VA
4. **THERMOCOUPLE TYPES:** T, E, J, K, R, S and B
5. **INPUT IMPEDANCE:** 10 MΩ *(protected from 115 VAC faults)*
6. **LEAD RESISTANCE EFFECT:** 20 µV/350 Ω
7. **OPEN THERMOCOUPLE INDICATION:**
   **Display**: *"OPEN"*
   **Analog Output**: -500 mV output
   **Serial Output**: *"OPEN"* in data field
8. **COLD JUNCTION COMPENSATION ERROR:** 0.02 degree/degree
9. **READING RATE:** 2.5 readings/second
10. **RESPONSE TIME:** 2 seconds for step change
11. **NORMAL MODE REJECTION:** 40 dB at 50/60 Hz
12. **COMMON MODE REJECTION:** 110 dB, DC OR 50/60 Hz
13. **TEMPERATURE EFFECTS:**
    **Operating Range**: 0° to +50°C
    **Storage Range**: -40° to +80°C
    **Relative Humidity**: Less than 85% R.H.
    **Span Temperature Coeff.**: ±60 ppm/°C
    **Zero Temperature Coeff.**: ±0.3 µV/°C
14. **SERIAL COMMUNICATIONS (optional):** 20 mA current loop
    **Data Format**: 10 Bit Frame, Odd Parity
    **Baud Rates**: 300, 600, 1200, 2400
15. **ALARMS (Optional):** *(2)* isolated *(output COMM. common with analog output COMM.)*, solid-state, current sinking NPN open collector transistors.
    **Resolution**: 1 degree
    **Hysteresis**: programmable, min. 1 degree
    **Imax**: 100 mA @ $V_{SAT}$ = 1 V
    **Vmax**: 30 VDC *(Zener protected)*
    **Connections**: 3-position, removable terminal block
16. **ANALOG OUTPUT (Optional):** 1 mV/degree, bipolar, 10 mA max. Isolated *(analog output COMM. common with alarm output COMM.)*
    **Accuracy**: ±6 mV
    **Adjustments**: zero and span pots
    **Connections**: 5-position, removable terminal block
17. **CONSTRUCTION:** Die-cast metal front bezel that meets NEMA 4/IP65 requirements for wash-down and/or dusty environments when properly installed. Case body is black high impact plastic (panel gasket and mounting clips included).
18. **CONNECTION:** 6-position terminal block
19. **WEIGHT:** 1.2 lbs. *(0.6 kg)*

### DIMENSIONS In inches (mm)

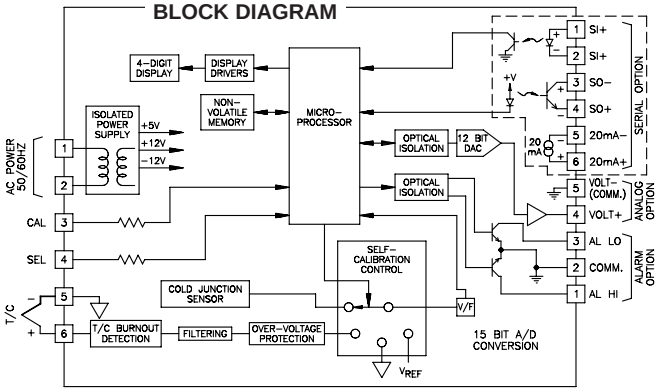
Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.5" (140) W.



## THERMOCOUPLE ACCURACY TABLE

*(All errors include NBS conformity, cold junction effect and A/D conversion errors at 25°C after 10 minutes warm-up.)*

| TC TYPE | RANGE | ACCURACY (ALL +/- 4 LSD) | WIRE COLOR |
|---|---|---|---|
| T | -200 to +400°C<br>-328 to +752°F | 1.0°C<br>1.8°F | blue |
| E | -200 to +1000°C<br>-328 to +1832°F | 1.0°C<br>1.8°F | purple |
| J | -200 to +760°C<br>-328 to +1400°F | 1.0°C<br>1.8°F | white |
| K | -200 to +1250°C<br>-328 to +2282°F | 1.0°C<br>1.8°F | yellow |
| R | 0 to +1768°C<br>+32 to +3214°F | 2.3°C<br>4.1°F | black |
| S | 0 to +1768°C<br>+32 to +3214°F | 2.3°C<br>4.1°F | black |
| B | +150 to +1820°C<br>+302 to +3308°F | 2.5°C<br>4.5°F | grey |




## CONNECTIONS

### POWER CONNECTIONS

Primary AC power is connected to Terminal 1 and 2 *(Marked VAC 50/60 Hz, located on the left-hand side of the terminal block).* For best results, the AC power should be relatively "clean" and within the specified ±10% variation limit. Drawing power from heavily loaded circuits or from circuits that also power loads that cycle on and off, should be avoided.

### INPUT CONNECTIONS

Remove power and connect the negative thermocouple lead *(always red)* to TC- and the positive lead to TC+. Be certain that connections are clean and tight.

When connecting and installing the input wires, the following guidelines should be observed. *(This is especially true in "electrically noisy" environments.)*

A) Never run thermocouple wires in the same conduit or raceways with conductors feeding motors, solenoids, SCR controls, heaters, etc. Ideally, signal wires should be run by themselves in a separate conduit.

B) Thermocouple wires within electrical enclosures should be routed as far from contactors, motor starters, control relays, transformers, and other components as possible.

C) When shielded wire is used, connect the shield to the TC- terminal of the indicator and leave the other end of the shield unconnected and insulated from machine ground.

D) The Input Common may be connected to machine ground *(earth)* only at one point, preferably a single, direct connection between a known good, earth ground and the Input Common Terminal.

In order to maintain rated temperature accuracy of the indicator, the rear of the unit must not be exposed to heat sources *(either radiated or convected)* or excessive air currents which cycle in temperature frequently. Special consideration should be given when the unit is installed adjacent to ovens, furnaces, etc., to preclude such a situation.

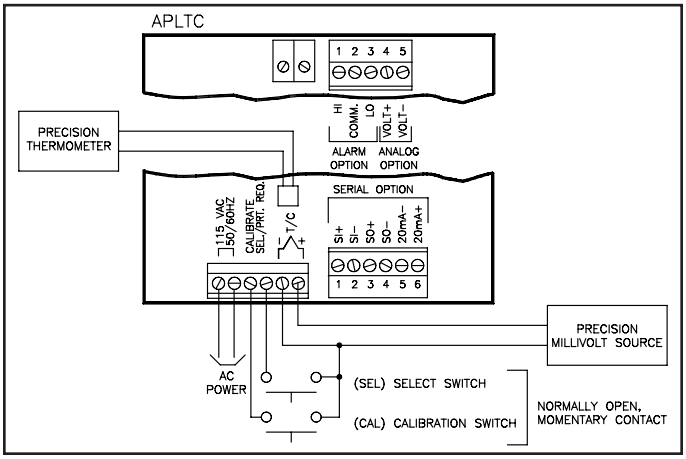
## OPERATION

The Apollo indicator employs a microprocessor to automatically compensate for zero, span and cold junction effects. A high accuracy voltage-to-frequency converter is used to convert the thermocouple voltage into digital words for precise linearization and digital display.

The thermocouple inputs are protected from overvoltage faults and are filtered for noise rejection. A non-volatile $E^2$PROM memory device provides permanent data retention for microprocessor variables. The display consists of 5 solid state LEDs for temperature and units readout. The serial communication option is isolated from the meter and features a 20 mA source and bidirectional operation. The analog option employs optical isolation, a 12-bit DAC and externally-accessible zero and span adjustments. The alarm option is also isolated and has open collector transistors capable of driving relays. Isolation eliminates errors due to groundloops and provides a good measure of noise immunity.

## SET-UP AND CALIBRATION

Connect a *"Calibration"* and *"Select"* switch, as indicated in the figure below, to facilitate programming. If instrument calibration is to be undertaken, an appropriate calibrator and thermometer should be connected as shown.




Pressing and holding the *"CAL"* button for 10 seconds will cause the Apollo to enter the programming mode. This will be indicated by a display of CAL 0. Pressing the *"SEL"* button will cause the menu number to increment from 0 through 5. Refer to the main menu below to select the desired programming section. Programming in the desired section is initiated by pressing the *"CAL"* button while the desired menu number is displayed.

*Note: Serial communications should not be active when doing any programming operations.*

| MAIN MENU | |
|---|---|
| CAL 0 | Starting and exiting point for set-up and calibration programming. Pressing and holding the CAL button until CAL 0 appears (approximately 10 seconds) enters the programming mode. The programming mode can be exited at any time CAL 0 is displayed by pressing the CAL button. |
| CAL 1 | Initial set-up programming. |
| CAL 2 | Alarm programming. |
| CAL 3 | Serial communication programming. |
| *Caution: Programming beyond this point will affect the basic factory calibration and should only be attempted by qualified technical personnel utilizing appropriate equipment. If the "CAL" button is inadvertently pressed while in CAL 4, allow a time out of 20 seconds for the unit to return to CAL 0. If the "CAL" button is inadvertently pressed while in CAL 5, press the "CAL" button again to return to CAL 0.* | |
| CAL 4 | Zero and Span Calibration. |
| CAL 5 | Cold Junction Compensation Entry. |

## FACTORY CONFIGURATION

The following chart lists the programming of the unit when shipped from the factory.

"Cal 1" - "F or C" - F
"tYPE" - 2 (J)
"Cal 2" - "AL-H" - -50
"AL-L" - -400
"HYS" - 1
"Cal 3" - "bAud" - 3 (1200)
"Addr" - 0
"PSEL" - 1 (Print TC Temp.)

## INITIAL SET UP

Before installing the indicator, it must be configured to the thermocouple type and temperature scale *(F or C)* desired. Following the procedure outlined in SET-UP and CALIBRATION, press the buttons indicated in the following chart and observe the indicated display.

| CAL 1 INITIAL SET-UP PROGRAMMING | | | |
|---|---|---|---|
| **STEP** | **CAL. BUTTON** | **SEL. BUTTON** | **DISPLAY** |
| A | X 10 secs. | | CAL $^{0}$ |
| B | | X | CAL $^{1}$ |
| C | X | | F or C$^{X}$ (Current Scale) |
| D | | X | F or C$^{X}$ (Desired Scale) |
| E | X | | tYPE$^{X}$ (Current Type) |
| F | | X | tYPE$^{X}$ (Desired Type) |
| | | | TYPE CODE |
| | | | 0 - T, 1 - E, 2 - J |
| | | | 3 - K, 4 - R, 5 - S, 6 - B |
| G | X | | CAL $^{0}$ |
| H | X | | 888.8$^{8}$ Then TC Disp.* |

* *It is not necessary to exit to the thermocouple display if further set-up or calibration are required, just press the "SEL" button. While in CAL $^{0}$, select the desired CAL #.*

## ALARM OPTION

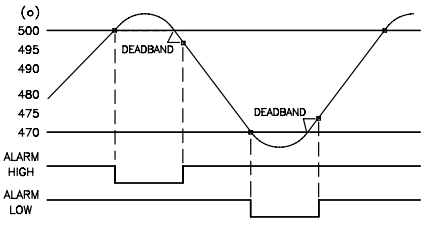
The Apollo Thermocouple Indicator alarm option has isolated open collector outputs for the control of temperature baths, environmental ovens, furnaces and other industrial processes where operation within a temperature range must be maintained. Independently programmable high and low alarm values with programmable hysteresis *(deadband)* can be adapted to any requirement. With the serial communication option, the alarm values may be remotely set or interrogated by a programmable logic controller or computer. The graph depicts how the alarms activate with hysteresis.

The Apollo display will, if selected, indicate when an alarm output is ON. If the Alarm Display is programmed to be ON *(d ON)*, the Apollo's display will alternate between the T/C temperature and *"LO on"* or *"HI on"* during the time that the respective output is ON *(the temperature is displayed for 4 seconds and then "XX on" is displayed for 1 second)*. If the Alarm Display is programmed to be OFF *(d OFF)*, the Apollo display will not indicate alarms.

The alarm option terminal block is located at the rear of the unit in the upper right-hand corner. Terminals 1, 2, and 3 are used for the outputs of the alarm option. Terminal 1 is used for the high *(HI)* alarm output. Terminal 2 is used for the COMM. *{Note: The Alarm COMM. terminal is NOT isolated from the Analog output VOLT- (COMM.) terminal}* Terminal 3 is the low *(LO)* alarm output.

**EXAMPLE**

Alarm High Value = 500° Hysteresis Value = 4° (effectively 5°)
Alarm Low Value = 470°




### ALARM PROGRAMMING

Following the procedure outlined in SET-UP and CALIBRATION, press the buttons indicated in the following chart and observe the indicated display.

In steps C, E and G, the display will first indicate what the display is and then alternate, at a 1 second rate, between the current value and what the display is.

In steps D, F and H, when the Select button is pressed, the display will increment first slowly and then more rapidly. The button can be released and pressed again to increment slowly when the desired value is approached.

| CAL 2 INITIAL ALARM PROGRAMMING | | | |
|---|---|---|---|
| **STEP** | **CAL. BUTTON** | **SEL. BUTTON** | **DISPLAY** |
| A | X 10 secs. | | CAL $^{0}$ |
| B | | X | CAL $^{2}$ |
| C | X | | AL-H$^{X}$ (Alarm High) Alternating With xxxx (Current Value) |
| D | | X Hold | Starts at -400 and increments to desired value. |
| E | X | | AL-L$^{X}$ (Alarm Low) Alternating With xxxx (Current Value) |
| F | | X Hold | Starts at -400 and increments to desired value. |
| G | X | | HYS $^{X}$ (Hysteresis) Alternating With xxxx (Current Value) |
| H | | X Hold | Starts at 1 and increments to desired value. |
| I | X | | dxxx (Current Alarm display - ON or OFF). |
| J | | X | dxxx (Desired Alarm display - ON or OFF). |
| K | X | | CAL $^{0}$ |
| L | X | | 888.8$^{8}$ Then TC Disp.* |

* *It is not necessary to exit to the thermocouple display if further set-up or calibration are required, just press the "SEL" button. While in CAL $^{0}$, select the desired CAL #.*

## SERIAL COMMUNICATIONS OPTION

### DESCRIPTION

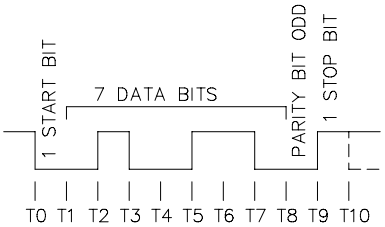
The Apollo Thermocouple Indicator Serial Communication option allows half-duplex *(two-way)* communication links to a variety of printers, controllers, computers and terminals in order to monitor or control a temperature process. Interrogation of thermocouple temperature, reference *(cold)* junction temperature, and the two alarm values along with the modification of the two alarm values provide complete remote operation. Two loops can be established; one for sending commands to the Apollo and one for receiving data from it. Additionally, multiple Apollos can be serially looped and assigned address numbers. The implementation of the interface is a 20 mA loop and it is isolated from instrument ground. This provides a high degree of noise immunity and prevents ground loops.

An optional 20 mA to RS232C converter *(GCM232)* can be used to convert the 20 mA loop to RS232C voltage levels.

### FORMAT

Data is sent by switching current on and off in the loop and is received by monitoring the switching action and interpreting the codes that are transmitted. In order for data to be correctly interpreted, there must be identical formats and baud rates. The only format available with the Apollo is 1 start bit, 7 data bits, 1 odd parity bit and 1 stop bit. The selectable baud rates are 300, 600, 1200, and 2400. These values are programmed into the Apollo. *(see programming)*.

**FIG. 1: DATA FORMAT-10 BIT FRAME [300, 600, 1200, 2400 Baud]**



## SERIAL PROGRAMMING

Before communication can take place, the Apollo must be programmed to the same baud rate as the connected equipment. In addition, a loop address and print options, if the print request terminal is to be used, may be programmed. If only one Apollo is being used, an address of zero may be used. If more than one Apollo is being used, assignment of unique addresses, other than zero, for each Apollo is recommended. Valid addresses of 0 to 9 may be assigned, however, the Apollo's internal current source is capable of driving only 7 units on the loop. Additional drive capability may be afforded by an external current source with a higher voltage compliance *(ie. >15 VDC)*.

Following the procedure outlined in SET-UP and CALIBRATION, press the buttons indicated in the following chart and observe the indicated display.

| CAL 3 SERIAL COMMUNICATION PROGRAMMING | | | |
|---|---|---|---|
| **STEP** | **CAL. BUTTON** | **SEL. BUTTON** | **DISPLAY** |
| A | X 10 secs. | | CAL 0 |
| B | | X | CAL 3 |
| C | X | | bAud$^{X}$ (Current Rate) |
| D | | X | bAud$^{X}$ (Desired Rate) |
| | | | BAUD RATE CODE |
| | | | 0 - Disable Comm. |
| | | | 1 - 300, 2 - 600 |
| | | | 3 - 1200, 4 - 2400 |
| E | X | | Addr$^{X}$ (Current Addr.) |
| F | | X | Addr$^{X}$ (desired Addr.0 thru 9) |
| G | X | | PSEL$^{X}$ (Current PCode) |
| H | | X | PSEL$^{X}$ (Desired PCode) |
| | | | 0 - No Print |
| | | | 1 - Print TC Temp. |
| | | | 2 - Print Cold Junction Temp. |
| | | | 3 - Print Alarm Values |
| | | | 4 - Print TC Temp., Cold Junction Temp. & Alarm Values |
| | | | 5 - Print TC Temp., and Alarm Values |
| | | | 6 - Print TC Temp., Alarm Values, & Hysteresis |
| I | X | | CAL 0 |
| J | X | | 888.8$^{8}$ Then TC Disp.* |

* *It is not necessary to exit to the thermocouple display if further set-up or calibration are required, just press the "SEL" button. While in CAL 0, select the desired CAL #.*

## SENDING COMMANDS TO THE APLTC

When sending commands to the Apollo, a command string must be constructed. The command string may consist of command codes, value identifiers and numerical data. Below is a table outlining the codes and identifiers the Apollo will recognize.

| COMMAND | FUNCTION |
|---|---|
| (T) | transmits the requested information specified by identifier |
| (V) | change the requested value specified by identifier (C, D, & E) |
| (N) | address a particular Apollo in a multiple unit loop |

| VALUE IDENTIFIER | FUNCTION |
|---|---|
| A | T/C temperature |
| B | Cold jct. temp. |
| C | Alarm high |
| D | Alarm low |
| E | Hysteresis |
| P | Print Select |

The command string is constructed by using the above commands and identifiers along with any data values that are required. The Apollo will accept + or - sign in front of the data value, however unsigned numbers are understood to be positive. Leading zeros can be eliminated and both upper and lower case characters are accepted. The address command is used to allow a command to be directed to a specific unit in the serial loop. Whenever the unit address is zero, transmission of the address command is not required. This is done for applications which require only one Apollo in the loop. For applications which require several units, it is necessary that each Apollo be given unique addresses so that each unit can be individually accessed.

The command string is constructed in a specific logical sequence. The Apollo will reject command strings that do not conform. Only one operation can be performed per command string. Below is a description of how to construct a command string.

1. If the Apollo has an address other than zero, the first two characters of the string must consist of the address command *(N)* and the address number of the unit.
2. The next two characters in the string are the actual command that the Apollo must perform and the identifier on which it operates.
3. If the change command *(V)* is being used, the next characters in the string, after the value identifier, are the numerical data.
4. All commands must be terminated by an asterisk*(*)*. Carriage return and line feed characters are not valid terminators and should be suppressed *(ie, in BASIC, use semicolon after print statement)*.

**EX. 1:** Have the Apollo with address of 3 transmit thermocouple temperature.

N3T*

**EX. 2:** Have the Apollo with address of 0 change the high alarm value to 800 degrees.

VC800* *(Note that degrees correspond to the current temperature scale.)*

**EX. 3:** Have the Apollo with address of 0 and a Print Select Options *(PSEL)* of 6, transmit the T.C. Temperature, Alarm Values & Hysteresis Values.

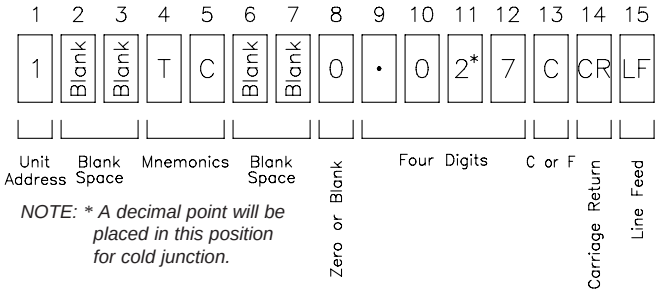
TP*

As shown, all commands must be terminated with a "command terminator"(*). The Apollo will not process the command until the terminator is sent. If illegal commands or characters are sent to the Apollo, they still would need to be terminated by an (*), so the unit could reset its receive buffer. When sending a command under BASIC, be sure to terminate the PRINT statement with a semicolon to suppress sending carriage return and linefeed characters (ex.PRINT "TA*";). The Apollo does not have a response for an illegal command.

Allow 800 msec for the Apollo to respond to either commands or hardware print requests before sending another command. If a command is sent during this period, the transmitted data may be invalid. Since the receive channel into the Apollo is monitored and used as (DTR), current must be flowing through it (mark condition) before transmission will commence.

## RECEIVING DATA FROM THE APLTC

Data is transmitted from the Apollo whenever a T *(transmit command)* is received or the hardware print request terminal is activated. The five possible responses and a typical transmission is shown below.




*NOTE: * A decimal point will be placed in this position for cold junction.*

The first character transmitted is the unit address number; unless it is zero, in which case it will be left blank. Then two blank spaces. The next two characters are the abbreviation for the values, followed by three blanks *(two for cold junction)*. The actual data values are transmitted next. The field is right justified with leading zeros *(not blanks)* and negative values have a minus sign in position 9. A plus sign for positive values is not used and note that the field for cold junction has a decimal point. The message *"OPEN"* will appear in the data field of the thermocouple temperature transmission whenever the indicator senses a thermocouple break. After the data field, an F or C character is transmitted depending on the indicator's current units, followed by carriage return and line feed.

| PARAMETER | UNIT ADDRESS | MNEMONICS | DATA |
|---|---|---|---|
| Thermocouple temperature | 1 | TC | 0075F |
| Reference junction temp. | 1 | CJ | 023.9F |
| Alarm high value | 1 | SH | 0800F |
| Alarm low value | 1 | SL | -045F |
| Hysteresis | 1 | Hy | 0005F |

## SERIAL TERMINAL DESCRIPTION

*Note: The numbers in parentheses refer to the position numbers labeled on the terminal block.*

SI+ (1) - Serial In (+):
Current flows into the Apollo's receive channel.

SI- (2) - Serial In (-):
Current flows out of the Apollo's receive channel.

SO+ (3) - Serial Out (+):
Current flows into the Apollo's transmit channel.

SO- (4) - Serial Out (-):
Current flows out of the Apollo's transmit channel.

20 mA- (5) - 20 mA current source for either receive or transmit loop current. Current flows into this pin.

20 mA+(6) - 20 mA current source for either receive or transmit loop current. Current flows out of this pin.

When wiring the 20 mA Serial Loop, remove the 6-position terminal block on the right side of the bottom board. Strip 1/4" off each wire and connect each wire into the proper location of the terminal block. Re-install the connector and be sure that the wires are strain-relieved.

## *ANALOG OUTPUT OPTION*

The Apollo Thermocouple Indicator Analog Output Option provides an isolated 1mV/degree output to drive chart recorders, controllers, data loggers and slave displays. The output corresponds to the displayed temperature and increments in discrete steps. Although the option is calibrated at the factory, user accessible zero and span adjustments are provided for minor adjustments. These are located adjacent to the output connections. Recalibration is recommended after 1 year of use.

The analog output option terminal block is located at the rear of the unit in the upper right-hand corner. Terminal 4 is the VOLT+, and terminal 5 is the VOLT- *(COMM.) (Note:The alarm COMM. terminal and the analog output VOLT- terminal are internally connected.)*

To check for accuracy, connect a voltmeter to the output and the reading should be +1mV per degree of displayed reading *(+/- 6 degrees)*. If calibration should be necessary, connect the indicator as shown in the set-up and calibration section.

1. Apply an arbitrary voltage so that the indicator displays a negative temperature *(-100,-200, etc.)*. Adjust the zero potentiometer *(right side)* so that the readings from the voltmeter and the indicator correspond.
2. Apply an arbitrary voltage so that the indicator displays a large positive temperature *(+1500, +2000, etc.)*. Adjust the span potentiometer *(left side)* so that the reading from the voltmeter and the indicator correspond.
3. Repeat steps 1 and 2 until both points are correct. Calibration is complete.

## *TROUBLE SHOOTING*

A functional test can be performed by connecting a wire jumper between the thermocouple inputs. When power is applied, the display will briefly show "888.8[8]" to test the LEDs and then indicate the cold junction temperature at the rear of the unit. Verify that all display segments illuminate and the temperature indicated is near ambient temperature. The indicator has several special display modes which indicate faults within the meter or external connections. The table illustrates these and the most common causes.

| DISPLAY | PROBABLE CAUSES |
|---|---|
| "OPEN" | - broken or burned-out thermocouple<br>- excessive thermocouple voltage |
| "888.88"<br>Or<br>"- - - -" | - incorrect power up/down due to voltage spike |
| "EEEE" | - excessive negative thermocouple voltage (usually due to reversed T/C connections) defect in analog circuit |

## *CALIBRATION*

The Apollo thermocouple indicator has been calibrated at the factory using precision instruments and was designed not to require frequent recalibration.

However, as part of a regular maintenance program or after 1 year of use, recalibration by authorized personnel is recommended.

Recalibration consists of applying accurate voltages to the indicator and setting the cold junction temperature with an accurate thermometer. A precision thermometer (RTD, thermistor or similar type) (accuracy of ±0.3°C) and an accurate voltage source (0.01%) are required. **Do not use thermocouple wire when making connections.**

Allow 30 minutes warm-up time before calibration is attempted.

If long thermocouple runs are present in the application *(>300 ft.)*, significant offset errors may exist due to the input bias current of the indicator. To correct for this effect, insert a fixed resistance in series with the positive leg of the millivolt source which is equal to the thermocouple wire resistance and proceed with calibration as normal. In most thermocouple applications this error is insignificant and may be ignored.

Following the procedure outlined in SET-UP and CALIBRATION, press the buttons indicated in the following charts and observe the indicated display.

In steps D and E of CAL [4], a voltage applied that is not within the calibration range of the instrument will cause the calibration process to be aborted after 20 seconds and return the display to CAL [0]. Check the calibration set-up before attempting to recalibrate.

In step C, of CAL [5], the display will first indicate what the display is and after 2 seconds indicate the current value.

In step D, of CAL [5], when the Select button is pressed, the display will increment first slowly and then more rapidly. The button can be released and pressed again to increment slowly when the desired value is approached.

| CAL 4 ZERO AND SPAN CALIBRATION | | | |
|---|---|---|---|
| STEP | CAL. BUTTON | SEL. BUTTON | DISPLAY |
| A | X 10 secs. | | CAL [0] |
| B | | X | CAL [4] |
| C | X | | In-0 Apply 0 millivolts +/-3 µV |
| D | X | X | In-5 Apply 50 millivolts +/-5 µV |
| E | X | X | CAL [0] |
| F | X | | 888.8[8] Then TC Disp.* |

** It is not necessary to exit to the thermocouple display if further set-up or calibration are required, just press the "SEL" button. While in CAL [0], select the desired CAL #.*

## COLD JUNCTION TEMPERATURE CALIBRATION

1. Set the panel meter to read in the Fahrenheit temperature scale. Connect a calibrated thermocouple (types T, E, J, K, or N only) to the panel meter. Select the thermocouple type used in programming.
2. Connect the reference thermometer to the measuring end of the thermocouple.
3. From the normal indicator display mode, compare the display temperature to that of the reference thermometer. Allow 10 minutes for the temperature to equalize. The meter and the reference thermometer should agree to within 1°F.
4. If cold junction re-calibration is necessary *(temperature out of tolerance)*, enter the new cold junction temperature according to the formula:

$$\text{New Cold Junction Reading} = \text{Old Cold Junction Reading} + \text{Difference}$$

$$\text{Difference} = \text{Reference Thermometer Temperature} - \text{Meter Display Temperature}$$

5. Check results by repeating steps 1, 2, and 3.

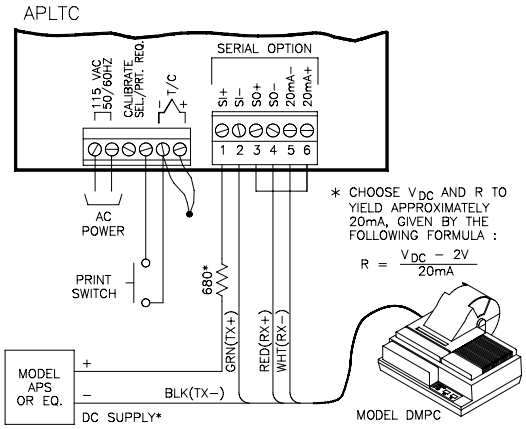
| CAL 5 COLD JUNCTION COMPENSATION ENTRY | | | |
|---|---|---|---|
| **STEP** | **CAL. BUTTON** | **SEL. BUTTON** | **DISPLAY** |
| A | X 10 secs. | | CAL 0 |
| B | | X | CAL 5 |
| C | X | | CJC X Then XXX.X X (Current Value) |
| D | | X Hold | Starts at 0 and increments to desired value. |
| E | X | | ——Then CAL 0 |
| F | X | | 888.8 8 Then TC Disp.* |

** It is not necessary to exit to the thermocouple display if further set-up or calibration are required, just press the "SEL" button. While in CAL 0, select the desired CAL #.*

# *APPLICATIONS*

## CONNECTING TO A PRINTER

The drawing shows the thermocouple indicator with the 20 mA serial communication option set-up with an RLC Model DMPC printer. An external current source is required to implement the printer's busy signal to the Apollo's receive loop, which prevents overruns. The *"Print Switch"* is a momentary-contact, pushbutton type connected between the print request terminal and the thermocouple negative input *(-)*. The print function must be programmed into the Apollo, along with baud rate.

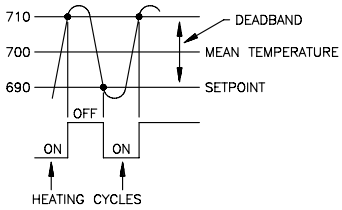


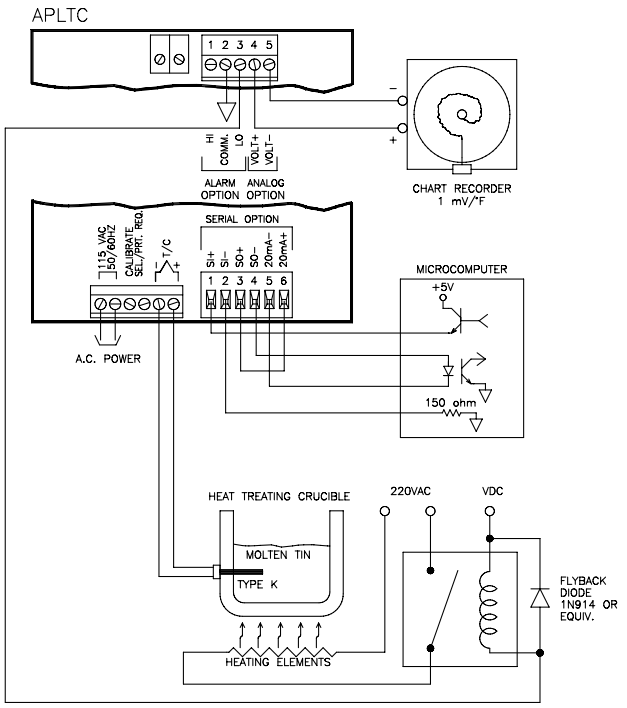

## ALARM, SERIAL, & ANALOG APPLICATION

A heat treating furnace is used to anneal alloys. In order to properly anneal all types of alloys, specific peak temperatures and cool off rates must be maintained. Also, a temperature versus time plot of each treatment is needed for verification purposes. An Apollo Thermocouple Indicator is used with analog output, serial communication and alarm output options to measure and control this process. Working through the serial communications, a microcomputer remotely sets the alarm values for the Apollo to control the temperature of the annealing crucible and the computer provides the proper timing for temperature soak and ramp. The Apollo's open collector alarm outputs are used to drive relays which switch 220 VAC power to the crucible's electric heating elements. The Apollo's analog output is used to drive a chart recorder for verification of conformity to customer's specifications. Soak temperatures, duration and temperature ramps are specific to the alloy and will change frequently. A *"K"* type thermocouple probe is selected due to its excellent high temperature characteristics.

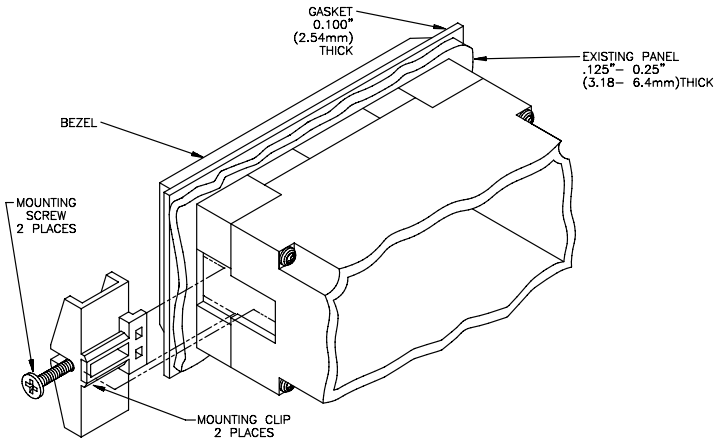
As an example, to anneal one type of alloy, it must be brought to 700°F and left to soak for 2 hours after which it must cool at the rate of 100°/hour until it reaches 500° where it must stay for 1 hour and then allowed to air cool. To achieve a mean temperature of 700°F, the systems bandwidth *(deadband)* is added to the low alarm set point value. In this case, the deadband is 20°F to avoid unnecessary relay operation.

The graph depicts the soak interval at 700°F. After the initial soak period, the setpoint alarm is reprogrammed in a succession of steps to obtain the gradual 100°/hr cool-off to 500°. After a one hour period at 500°, the crucible is then allowed to air cool. The chart recorder provides a graph of the entire process.



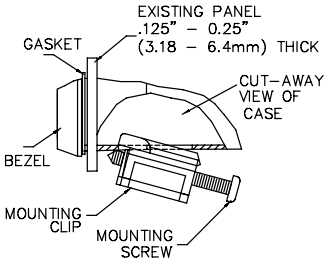



## PANEL INSTALLATION




The Apollo Indicators are designed to be panel-mounted with a gasket to provide a water-tight seal. Two mounting clips and screws are provided for easy installation. Consideration should be given to the thickness of the panel. A panel which is too thin may distort and not provide a water-tight seal. (Recommended minimum panel thickness is 1/8"{3.2 mm}.)

After the panel cut-out has been completed and deburred, carefully slide the panel gasket over the rear of the unit to the back of the bezel. Insert the unit into the panel. As depicted in the drawing, install the screws into the narrow end of the mounting clips. Thread the screws into the clips until the pointed end just protrudes through the other side. Install each of the mounting clips by inserting the wide lip of the clips into the wide end of the hole, located on either side of the case. Then snap the clip onto the case. Tighten the screws evenly to apply uniform compression, thus providing a water-tight seal.




*CAUTION: Only minimum pressure is required to seal panel. Do NOT overtighten screws.*

## ORDERING INFORMATION

| MODEL NO. | DESCRIPTION | OPTIONS | | | PART NUMBERS FOR AVAILABLE SUPPLY VOLTAGES | |
|---|---|---|---|---|---|---|
| | | W/ALARM | W/ANALOG OUTPUT | W/ SERIAL | 230 VAC | 115 VAC |
| APLTC | Apollo Thermocouple Indicator | NO | NO | NO | APLTC410 | APLTC400 |
| | | NO | NO | YES | APLTC411 | APLTC401 |
| | | YES | NO | NO | APLTC412 | APLTC402 |
| | | YES | NO | YES | APLTC413 | APLTC403 |
| | | YES | YES | NO | APLTC414 | APLTC404 |
| | | YES | YES | YES | APLTC415 | APLTC405 |
| GCM232 | Serial Converter Module | N/A | N/A | YES | GCM23201 | |
| For more information on Pricing, Enclosures & Panel Mount Kits refer to the RLC Catalog or contact your local RLC distributor. | | | | | | |

*Units are shipped calibrated and programmed to accept Type "J" thermocouple and indicate in degrees fahrenheit.*

## LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to one year from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.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