THE APOLLO INTELLIGENT METER SERIES

MODEL IMT INSTRUCTION MANUAL

INTRODUCTION

The Intelligent Meter for Thermocouple Inputs (IMT) is another unit in our multi-purpose series of industrial control products that are field-programmable to solve multiple applications. This series of products is built around the concept that the end user has the capability to program different personalities and functions into the unit in order to adapt to different indication and control requirements.

The Intelligent Thermocouple Meter which you have purchased has the same high quality workmanship and advanced technological capabilities that have made Red Lion Controls the leader in today's industrial market.

Red Lion Controls has a complete line of industrial indication and control equipment, and we look forward to being of service to you now and in the future.

CE

CAUTION: Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

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SAFETY INFORMATION

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.

DEFINITION OF TERMS

INSTALLATION CATEGORY (overvoltage category) **I**:
Signal level, special equipment or parts of equipment, telecommunication, electronic, etc. with smaller transient overvoltages than Installation Category (overvoltage category) **II**.

INSTALLATION CATEGORY (overvoltage category) **II**:
Local level, appliances, portable equipment, etc. with smaller transient overvoltages than Installation Category (overvoltage category) **III**.

GENERAL DESCRIPTION

The Apollo Intelligent Thermocouple Meter accepts inputs from standard thermocouples and precisely linearizes them. A full 6-digit display accommodates a wide range of temperature inputs and holds large totalization values. State-of-the-art digital circuitry virtually eliminates errors due to drift. The unit automatically compensates for cold junction, NBS linearity and the meter's zero and span. A full complement of option packages is available to fulfill many process applications.

The indicator features a readout choice of either Fahrenheit or Celsius with 0.1 or 1 degree of resolution. English Style display prompts aid the operator through set-up and operation. With a few simple steps the unit can be engaged as a millivolt meter by programming *"mV"* for thermocouple type *(enter 8 in "Pro 1")*. This mode is useful in monitoring and displaying the actual voltage produced at the thermocouple probe junction as an aid in troubleshooting for a possible faulty thermocouple probe. A front panel lock-out menu protects set-up data and operation modes from unauthorized personnel. Programmable digital filtering enhances the stability of the reading. The programmable remote input *"E1-CON" pin can be utilized to control a variety of functions, such as totalizing, alarm control, peak/valley readings, display hold, or temperature offset operations. All set-up data is stored in* E^2*PROM, which will hold data for a minimum of 10 years without power.*

An optional integrator *(totalizer)* can be used to totalize or integrate temperatures up to a maximum display value of 999,999. It features independent scaling, decimal point selection and a low temperature cut-out to suit a wide variety of temperature integration applications. The programmable remote input *"E2-CON"* pin is included with this option and can be utilized to control a variety of functions, such as totalizing, alarm control, peak/valley readings, display hold or temperature offset operations, simultaneously with *"E1-CON"* pin. Peak/valley *(max/min)* reading memory, display hold and programmable temperature offset functions are included with this option and they are easily recalled and controlled by either the front panel or a remote input. All readings are retained at power-down.

Optional dual relays with parallel solid state outputs are fully programmable to operate in a wide variety of modes to suit many control or alarm applications.

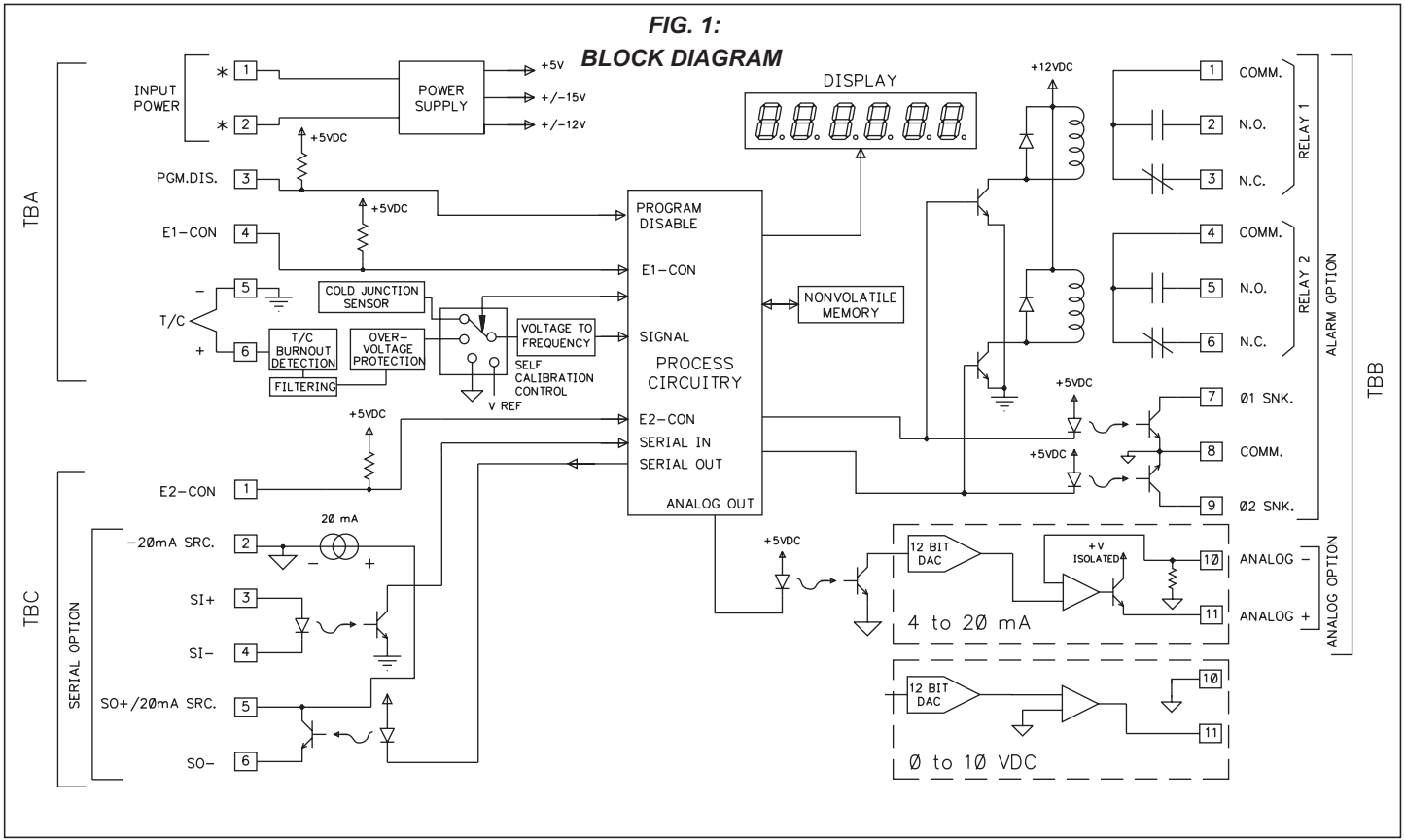
Optional 20 mA loop, bi-directional serial communications provides computer and printer interfacing to extend the capabilities of the indicator. More than one unit can be connected in the loop with other RLC products which have serial communications capabilities.

An optional 4 to 20 mA or 0 to 10 VDC re-transmitted analog output can be scaled by the user to interface with a host of recorders, indicators and controllers. The type of analog output is determined by the model ordered. (See Ordering Information for available models.) The indicator has several built-in diagnostic functions to alert operators of most malfunctions. Extensive testing of noise interference mechanisms and full burn-in make the indicator extremely reliable in industrial environments. The die-cast front bezel meets NEMA 4/IP65 requirements for washdown applications.

THEORY OF OPERATION

The IMT employs a microprocessor to perform the A/D conversion on the input signal via a voltage-to-frequency converter. It digitally scales the result, corrects for meter drift which may be present and then displays the result in a 6-digit display *(4 for temperature, 6 for totalizer)*. The inputs are filtered to enhance the stability of the display. A non-volatile E^2PROM memory device provides permanent data retention for operating variables. The display consists of drivers and 6-digit solid-state LEDs. The alarm option employs opto-isolators to isolate the open collector devices from meter common. Operating in parallel, the relays are type Form-C and are rated at 5-amps. The serial communication option features a built-in 20 mA current source and complete opto-isolation. The analog option features a 12-bit DAC and provides an output signal that is digitally scaled. The re-transmitted output is isolated from meter common.

FIG. 1:
BLOCK DIAGRAM



Note: Analog, Serial, and SNK output options are isolated from signal common at a working voltage of 50 V. The commons should NOT be tied together.

PROGRAMMING & OPERATING THE IMT

PROGRAMMING THE IMT

Although the unit has been programmed at the factory, the set-ups will generally have to be changed to suit the application. Basic set-up is complete after unit of temperature scale selection, thermocouple type selection, decimal point selection, and digital filtering level selection have been made.

Before actually trying to program the indicator, it is advisable to organize all the data for the programming steps to avoid any possible confusion and to read the programming procedure entirely before proceeding.

To set-up the indicator, connect AC power and signal wires as outlined in the connections section *(Appendix "A")*. Remove the jumper wire *(if installed)* from TBA #3 *(PGM. DIS.)*. This will allow the operator to enter and modify all of the indicator's parameters. Press the front panel button labeled *"P"*, momentarily. Briefly, the display will show *"Pro"* alternately flashing with *"0"*. This is the indicator's programming mode. The programming mode is divided into sections, numbered 0-9, each of which can be individually accessed. The front panel *"UP"* and *"DOWN"* arrow buttons can be used to select one of these numbers and the *"P"* button can be used to enter the selected programming module. In all of the programming modules, *"UP"* and *"DOWN"* are used to either select from a list of choices or enter a value. The *"P"* button is used to save the new value and progress to the next step within a module *(Note: the new value takes effect when "P" is pressed)*. Upon completion of a module, the indicator returns to the *"Pro"* < > "0" stage. Pressing the *"P"* button at this point causes the indicator to display *"End"* after which the indicator returns to the normal display mode. The following table explains the basic function of each step.

Note: < >This indicates that the display will alternate between the English prompt and the actual data.

DISPLAY ***RESULT OF "P" BUTTON***

"Pro" < > "0" - Causes the indicator to return to normal display mode. Any changes to set-up data are permanently stored in the E^2PROM.

"Pro" < > "1" - Entry into this module allows the user to select the thermocouple type, temperature scale *(Fahrenheit "F" or Celsius "C")*, and display decimal point position. User keys in 0 or 0.0 degree resolution.

"Pro" < >"2" - Entry into this module allows the user to select non-standard display slope and display offset values. This enables the meter to be *"scaled"* to a calibrated temperature thermocouple. *(This scaling is NOT required for most applications.)*

"Pro" < > "3" - Module #3 allows the user to program what can be accessed from the front panel when the PGM. DIS. *(Program Disable, TBA #3)* pin is connected to common. This feature protects critical set-up data from accidental modification while allowing access to setpoints and other functions. The front panel lock-out menu *(quick programming)* includes setpoint modification, integrator/totalizer resetting, peak/valley resetting and display offset modification.

Note: The term "Quick Programming" is used to refer to the ability to change the information that can be accessed from the front panel when the "PGM. DIS." terminal is connected to "COMM.".

DISPLAY ***RESULT OF "P" BUTTON***

"Pro" < > "4" - Module #4 programs the digital filtering level and the function of the remote input *"E1-CON"* pin *(TBA #4)* and if the totalizer option is installed the remote input *"E2-CON"* pin *(TBC #1)*. The functions of the remote E1 and E2 pins are the same and include display hold, peak/valley modes, totalizer reset, alarm reset, temperature offset, reading synchronization or print request.

"Pro" < > "5" - This module sets the decimal point, time base, scale factor and low temperature disable function for the optional integrator/totalizer.

"Pro" < > "6" - This module allows programming for the basic configuration of the alarm option. The programming includes HI/ LO acting, tracking, alarm display, latched or auto-reset, assignment to either the input or the integrator/totalizer, and alarm and hysteresis values.

"Pro" < >"7" - Module #7 is the serial communication parameter program-ming. Baud rate, unit address, print request function and condensed prints are all programmable.

"Pro" < > "8" - This module allows digital scaling of the retransmitted analog output. Display values that correspond to 4 mA or 0 VDC and 20 mA or 10 VDC are keyed-in to scale the output and it may be assigned to either the input or the integrator/totalizer.

"Pro" < > "9" - This module is the service operations calibration sequence and is not normally accessed by the user. This step re-calibrates the basic input and the cold junction temperature and is used to compensate for long-term drift. Execution of this module should be done by technicians with the proper equipment in accordance with a maintenance plan of yearly recalibrations. A code number entry step is used to protect from inadvertent entries. Also, there is a number of other access codes, which provide test and set-up changes as an aid in troubleshooting.

MODULE #1 - PROGRAM THERMOCOUPLE TYPE, SCALE AND RESOLUTION

SELECT THERMOCOUPLE TYPE

Select the desired thermocouple type. *(see appendix "B" for additional information on thermocouple types and ranges)*

"tYPE" < > "0" - Type T
"1" - Type E
"2" - Type J
"3" - Type K
"4" - Type R
"5" - Type S
"6" - Type B
"7" - Type N
"8" - Engages millivolt mode
(not cold junction compensated)

SELECT TEMPERATURE SCALE

Select the desired temperature scale by pressing the *"UP"* or *"DOWN"* button.

"SCALE" < > "F"
"C"

SELECT DECIMAL POINT POSITION

Select the appropriate decimal point position.

" dECPNt" < > "0"
"0.0"

MODULE #2 - PROGRAM TEMPERATURE DISPLAY OFFSET AND SLOPE

If a totalizer option is installed, the offset and slope can be programmed for various temperature probe differences. Reference offset and slope display temperature section for more details

To Program:

Select the desired temperature display slope value by pressing the "UP" or the "DOWN" button.

"SLOPE" < > "0.0001" to "9.9999" (ex. 1.0309)

Select the desired temperature display offset value by pressing the "UP" or the "DOWN" button.

"OFFSEt" < > "-999" to "9999" (ex. -17.5)

MODULE #3 - PROGRAM FUNCTIONS ACCESSIBLE W/ FRONT PANEL LOCKOUT

This programming module programs what is accessible through the front panel when the PGM. DIS. pin is connected to common *(COMM.)*.

Note: The term "Quick Programming" is used to refer to the ability to change the information that can be accessed from the front panel when the "PGM. DIS." terminal is connected to "COMM.".

DISPLAY ALARM VALUES

If the alarm option is installed, this selects whether the alarm values will or will not be displayed.

"dSP AL" < > "yES" or "NO"

ENTER ALARM VALUES †

If *"YES"* was selected for display alarm values, this will select if alarm values may be modified from the front panel. *(If "NO" was selected for display alarm values, then this step will default to "NO" and will not be displayed for selection.)*

"ENt AL" < > "yES" or "NO"

DISPLAY HYSTERESIS VALUES

If the alarm option is installed, this selects whether the hysteresis values will or will not be displayed.

"dSPHYS" < > "yES" or "NO"

ENTER HYSTERESIS VALUES †

If *"YES"* was selected for display hysteresis values, this selects whether hysteresis values may be modified from the front panel. *(If "NO" was selected for display hysteresis value, then this step will default to "NO" and will not be displayed for selection.)*

"ENtHYS" < > "yES" or "NO"

RESET LATCHED ALARMS

If the alarm option is installed and if either alarm is programmed to latch, this will select if a latched alarm*(s)* can be reset from the front panel.

"rSt AL" < > "yES" or "NO"

DISPLAY PEAK/VALLEY MEMORY BUFFER

If the integrator/totalizer option is installed, this selects whether peak and valley buffers will be displayed.

"dSPbUF" < > "yES" or "NO"

RESET PEAK/VALLEY MEMORY BUFFER †

If *"YES"* was selected for the previous step, this selects whether the peak and valley buffers may be reset from the front panel. *(If "NO" was selected, then this step defaults to "NO" and will not be displayed for selection.)*

"rStbUF" < > "yES" or "NO"

*SELECT DISPLAY**

If the integrator/totalizer option is installed, this selects whether the display can be switched from input display to total display and from total display to input display.

Note: When "NO" is selected, whatever display (Input or total) is shown, will be the only display accessible.

"SELdSP" < > "yES" or "NO"

*RESET TOTAL**

If the Integrator/Totalizer option is installed, this selects whether the total can be reset from the front panel.

"rSttOt" < > "yES" or "NO"

TEMPERATURE OFFSET VALUE †

If the Integrator/Totalizer/Peak/Valley/Temperature Offset option is installed, this selects whether the programmed offset value will be displayed.

"dsPOFF" < > "yES" or "NO"

ENTER OFFSET VALUE †

If "YES" was selected for the previous step, this selects whether the offset value can be entered from the panel. *(If "NO" was selected, then this step defaults to "NO" and will not be displayed for selection.)*

"ENtOFF" < > "yES" or "NO"

Depending on functions selected under Pro 3 and Pro 6, alarms, hysteresis, peak, valley and offset values can be monitored and/or changed when PGM. DIS. is tied to COMM. This provides a *"QUICK PROGRAMMING"* method for *"day to day"* process changes. *(See QUICK PROGRAMMING SECTION for more details.)*

† *Note: This sequence may be locked-out due to other programmed sequences.*

* *This function operates independent of the state of the "PGM. DIS." pin.*

MODULE #4 - PROGRAM DIGITAL FILTER AND REMOTE INPUT

PROGRAM DIGITAL FILTERING

If the displayed process signal is difficult to read due to small process variations or noise, increased levels of filtering will help to stabilize the display. This programming step may be used in conjunction with display rounding programming (PRO 1 & 2) to help minimize this effect. The digital filter used is an *"adaptive"* filter. That is, the filter coefficients change dynamically according to the nature of the input signal. This feature simultaneously allows the filter to settle quickly for large input changes while providing a stable display reading for normal process variations. Because of the adaptive nature of the filter, it cannot be characterized in terms of a time constant. The following table lists the maximum settling time for a step input to within 99% of the final value.

Filter Value			Settling Time (99%)
"FILtEr" < >	"0"	- no digital filtering	1.5 sec.
	"1"	- normal filtering	2 sec.
	"2"	- increased filtering	6 sec.
	"3"	- maximum filtering	13 sec.

PROGRAM FUNCTION OF E1-CON AND OPTIONAL E2-CON PIN

The function of the remote input *"E1-CON"* pin *(TBA #4)* and, if the totalizer option is installed, the remote input *"E2-CON"* pin *(TBC #1)* are the same. Functions are activated, as described in the appropriate function, when connected to signal common *(TBA #5)*. Whether a function is edge or level activated it must be held low for a minimum of 20 msec in order for the function to occur. The remote input pins can be used simultaneously and with any combination of functions. When pins are tied together and activated, E1-CON function is generally performed first.

"E1-CON"< > "0" - If the Integrator/Totalizer/Peak/Valley/Display Offset option is installed, a negative going edge offsets the displayed temperature to zero. (*At this time the E-Pin is activated, the value of the actual temperature being displayed is placed in the location of the display offset value. To bring the unit back into the normal temperature display mode, reset the offset value to zero via the front panel.)*

"1" - If the Integrator/Totalizer option is installed, a negative going edge resets the contents of the Integrator/Totalizer to zero. Integration/Totalization commences regardless of the state of the input.

"2" - If the Integrator/Totalizer option is installed, a negative going edge resets the contents of the Integrator/Totalizer to zero and allows Integration/Totalization as long as input is low. If the input goes high, Integration/Totalization is stopped and the contents are saved. This acts as a Integration/Totalization enable control from time T1 to T2.

"3" - A low level allows Integration/Totalization as long as the input is low. If the input goes high, totalization is stopped and the contents are saved. This acts as a totalization enable control from time T1 to T2.

"4" - A low level holds the display *(display hold)*. While this input is low, the indicator continues to process the input signal and drive the alarms, Integrator/Totalizer, etc. with the actual signal. The contents of the Integrator/Totalizer are stored at the same time the input display is held.
Note: If display hold is activated, and input value is requested via serial, the value on the display will be sent instead of the actual input value at that time.

"5" - If the Integrator/Totalizer option is installed, a negative going edge resets both peak and valley buffers.
Note: If P/V is called up, a change will not appear on the display until the next time the P/V is called up.

"6" - If the Integrator/Totalizer option is installed, a negative going edge resets only the peak buffer and the indicator enters a peak reading display mode as long as the input is low. If the input goes high, peak detection and indication are stopped and the last peak reading is retained.

"7" - If the Integrator/Totalizer option is installed, a negative going edge resets only the valley buffer and the indicator enters a valley reading display mode as long as the input is low. If the input goes high, valley detection and indication are stopped and the last valley reading is retained.

"8" - If the alarm option is installed, a negative going edge resets the latched alarm*(s)*.

"9" - If the alarm option is installed, a low level resets a latched or unlatched alarm into its inactive state. This provides manual override of alarms for system start-up and other unusual events such as system testing.

"10" - A negative going edge toggles the display between *"input"* and *"total" (from input to total, or vice versa)*. No action is taken on the positive going edge.

"11" - A negative going edge zeros *(tares)* the input signal and adds the value that was in the input display to the totalizer value, every time this operation is performed. The time-base, scale factor and low cut-out in *"Module #5"* are in affect disabled, when this function is selected.

"12" - Display hold with offset. A negative going edge offsets *(zeros)* the input signal. Prior to the offset operation, the input signal is saved and held *(display hold)* as long as the remote input pin is low. On the positive edge, the input display will show zero. If there is an increase to the input signal while the remote input is low, the display will reflect (show) the increase at the positive edge.

"13" - Instrument reading synchronization. A low level disables all meter operations (alarms, total, analog out, etc.). A positive edge resets the start of the A/D conversion, to allow synchronization with external processes and controls. While in this function, the other E-CON pin is operational.

"14" - Print request. Transmits data according to the print options that have been selected in Program Module #7. If the low time exceeds 800 msec, a second print-out may occur.

"E2-CON" < > If the totalizer option is installed, E2-CON has the same programmable functions as E1-CON.

MODULE #5 - PROGRAM INTEGRATOR/TOTALIZER

Programming for the integrator/totalizer consists of four programming steps: totalizer decimal point position, time base, scale factor and low temperature disable. Note that the decimal point position of the totalizer can be set independent of the decimal point position of the scaled input signal. The integrator/totalizer will roll over and flash when the total exceeds, 999999 or -99999, indicating an overflow condition. Reverse signal input will cause the totalizer value to count in the opposite direction and eventually no longer be in an overflow condition.

PROGRAM DECIMAL POINT POSITION

Enter the decimal point position for the integrator/totalizer.

"dECPNt" < > "0"
"0.0"
"0.00"
"0.000"
"0.0000"

PROGRAM INTEGRATOR/TOTALIZER TIME BASE

The time base determines the rate at which readings increase. The integrator/totalizer display is updated 2 times per second regardless of time base selected, but longer time bases decrease the magnitude of each increase. The three time bases are per second, per minute and per hour. A constant input temperature of 100°, for example, would integrate/totalize to 100° in one second *(with a TB of 1 sec.)*, 100° in one minute *(with a TB of 1 min.)*, and 100° in one hour *(with a TB of 1 hr.)*. *(Note: Input changes cannot be made synchronous to the display by programming E1 or optional E2-CON pin for function 13, instrument reading synchronization.)* A multiplying scale factor may be used to span the standard time ranges *(or divide if scale factor 1)*. The following equation expresses the integration/totalization process.

$$S.F. = \frac{D.T.}{T.D.} \times \frac{T.B.}{TIME} \times \frac{D.T.D.P.}{T.D.D.P.}$$

S.F. = Programmable Scale Factor
D.T. = Desired Totalizer value for a fixed time duration
T.B. = Programmable Time Base

TB = If Program Select Number Chosen Is:	Enter in Formula
"0" for sec.	1
"1" for min.	60
"2" for hr.	3600

T.D. = Temperature Display Value
TIME = Actual Time period in seconds

D.T.D.P. = Desired Totalizer Value Decimal Point	Enter in Formula
0	1
0.0	10
0.00	100
0.000	1000
0.0000	10000

T.D.D.P. = Temperature Display Value Decimal Point	Enter in Formula
0	1
0.0	10

"tbASE" < > "0" - per second
"1" - per minute
"2" - per hour

PROGRAM THE INTEGRATOR/TOTALIZER SCALE FACTOR

As explained in the previous programming step, a multiplying scale factor can be used to scale the update rate as required. This may be used to span the standard ranges. A scale factor of *"1.000"* has no effect on the standard ranges.

"SCLFAC" < > "0.001" to "100.000"

PROGRAM THE LOW-END CUTOUT (low temperature level disable)

In order to prevent false integration/totalization in situations where integration/totalization is undesirable, a programmable setpoint can be used to disable integration/totalization when the input temperature falls below this low-end cutout level.

"Lo-cut" < > "-999" to "9999"

MODULE #6 - PROGRAM ALARM/SETPOINT

If the alarm option is installed, this module is used to configure the operation of the alarms to a variety of combinations. The programmable options are HI/LO acting, auto/manual reset *(latching)*, tracking, assignment to input or integrator/totalizer, display alarms, alarm values and hysteresis *(deadband)* values.

ALARM TRACKING

With alarm tracking, whenever alarm #2 is changed, alarm #1 will also change so that the offset between alarm #2 and alarm #1 remains the same. This is useful for hierarchical setpoints *(pre-alarm and alarm)* when one change applies to both alarm values. When programming from the front panel, tracking only occurs when PGM. DIS. is low *(front panel lock-out mode, alarm #1 will not appear)*. Tracking will always occur if alarm #2 is modified via serial communications independent of PGM.DIS.

"trAc" < > "yES" or "NO"

DISPLAY ALARMS

If display alarm is desired, a message will flash on the display every 5-10 secs when an alarm activates. For alarm 1, the message will flash "AL1 on" and alarm 2 will flash "AL2 on", this warns an operator of an alarm condition. The message will stop when the unit is no longer in an alarm condition.

"dISP" < > "yES" or "NO"

AUTO OR MANUAL RESET FOR ALARM #1

The reset action of alarm #1 may be programmed to reset automatically *(unlatched)* or be programmed to require a manual reset *(latched)* through either a remote input *(E1-CON or optional E2-CON)* or through the front panel. Latched alarms are usually used when an operator is required to take some action for the alarm condition.

"LAtC-1" < > "yES" or "NO"

ALARM #1 ASSIGNMENT TO INPUT OR INTEGRATOR/TOTALIZER

Alarm #1 may be programmed to activate on either the input or the integrator/totalizer value. If the integrator/totalizer option is not installed, this step defaults to the input.

"ASN-1" < > "INPUt" or "totAL"

PROGRAM VALUE FOR ALARM #1

The range of the alarm value is -999 to 9,999 if the alarm "assignment" is programmed for "INPUt". If "assignment" is set for "totAL", then the range is -99,999 to 999,999.

"AL-1" < > "-99999" to "999999"

PROGRAM HYSTERESIS VALUE FOR ALARM #1 *(Cannot be programmed if alarm latch is programmed)*

The hysteresis *(deadband)* value for alarm #1 may be programmed from 1 to 9,999 if the alarm "assignment" is programmed for "INPUt". If "assignment" is set for "totAL", then the range is 1 to 999,999. The value is either added to or subtracted from the alarm value depending on whether the alarm is high or low acting. *(See "alarm" section for operation.)*

"HYS-1" < > "1" to "999999"

ALARM #1 HIGH OR LOW ACTING

The action of alarm #1 may be programmed to activate either when the signal goes above the alarm value *(high acting)* or goes below it *(low acting)*.

"Act-1" < > "HI" or "LO"

MODULE #6 - PROGRAM ALARM / SETPOINT (Cont'd)

AUTO OR MANUAL RESET FOR ALARM #2

The reset action of alarm #2 may be programmed to reset automatically *(unlatched)* or be programmed to require a manual reset *(latched)* through either a remote input *(E1-CON or optional E2-CON)* or through the front panel. Latched alarms are usually used when an operator is required to take some action for the alarm condition.

"LAtC-2" < > "yES" or "NO"

ALARM #2 ASSIGNMENT TO INPUT OR INTEGRATOR/TOTALIZER

Alarm #2 may be programmed to activate on either the input or the Integrator/Totalizer value. If the Integrator/Totalizer option is not installed, this step defaults to the input.

"ASN-2" < > "INPUt" or "totAL"

PROGRAM VALUE FOR ALARM #2

The range of the alarm value is -999 to 9,999 if the alarm "assignment" is programmed for "INPUt". If "assignment" is set for "totAL", then the range is -99,999 to 999,999.

"AL-2" < > "-99999" to "999999"

PROGRAM HYSTERESIS VALUE FOR ALARM #2 (Cannot be programmed if alarm latch is programmed)

The hysteresis *(deadband)* value for alarm #2 may be programmed from 1 to 9,999 if the alarm "assignment" is programmed for "INPUt". If "assignment" is set for "totAL", then the range is 1 to 999,999. The value is either added to or subtracted from the alarm value depending on whether the alarm is high or low acting. *(See "alarm" section for operation.)*

"HYS-2" < > "1" to "999999"

ALARM #2 HIGH OR LOW ACTING

The action of alarm #2 may be programmed to activate either when the signal goes above the alarm value *(high acting)* or goes below it *(low acting)*.

"Act-2" < > "HI" or "LO"

Note: Depending on options selected under Pro 3 and Pro 6, alarms, hysteresis, peak, and valley values can be monitored and/or changed when PGM. DIS. is tied to COMM. This provides a "QUICK PROGRAMMING" method for "day to day" process changes. (See QUICK PROGRAMMING SECTION for more details.)

MODULE #7 - PROGRAM SERIAL COMMUNICATIONS

Several programmable parameters must be programmed before serial communication can occur.

BAUD RATE

Select one of the baud rates from the list to match the baud rate of the printer, computer, controller, etc.

"bAud" < > "300"	-	300 baud
"600"	-	600 baud
"1200"	-	1200 baud
"2400"	-	2400 baud

UNIT ADDRESS NUMBER

To allow multiple units to communicate on the 20 mA loop, different address numbers must be assigned to each unit. If only one unit is on the loop, an address of *"0"* may be given, eliminating the need for the address command.

"AddrES" < > "0" to "99"

PRINT REQUEST FUNCTION

A selection of print operations can be programmed. A print operation occurs when a print request is activated via E1-CON *(TBA #4)* or optional E2-CON *(TBC #1)* pin, or a *"P"* command is sent from a terminal via the serial communications option. If the option to which a particular print code applies is not installed, then that parameter will not be printed.

If the totalizer is overfowed an asterisk (*) will precede the digits that are printed *(ex. *000127 positive overflow, -*00127 negative overflow)*. If the temperature exceeds the positive range of the unit, the print-out will show "OLOLOL". An open sensor will print out "OPEN". If the temperature exceeds the negative range, the print-out will show "ULULUL". A shorted sensor will print out "SHOrt".

"Print" < > "0" - temperature input signal
"1" - temperature input signal, peak, valley and offset
"2" - temperature input signal, alarm 1, and alarm 2
"3" - temperature input signal, alarm 1, alarm 2, hysteresis 1, hysteresis 2, peak, valley, and offset
"4" - totalizer
"5" - temperature input signal and totalizer
"6" - temperature input signal, totalizer, peak, valley, and offset
"7" - totalizer, alarm 1, and alarm 2
"8" - temperature input signal, totalizer, alarm 1, alarm 2
"9" - temperature input signal, totalizer, alarm 1, alarm 2, hysteresis 1, hysteresis 2, peak, valley, and offset

FULL OR ABBREVIATED TRANSMISSION

When transmitting data, the IMT can be programmed to suppress the address number, mnemonics and some spaces, if desired by selecting "NO". A selection of "NO" results in faster transmission. This feature may be helpful when interfacing with a computer. When interfacing to a printer, a *"yES"* response is usually desirable.

"FULL" < > "yES" or "NO"

An example of full and abbreviated transmission is shown below:

2 TC -125.7F <CR> <LF> Full transmission
-125.7 <CR> <LF> Abbreviated transmission

MODULE #8 - PROGRAM RE-TRANSMITTED ANALOG OUTPUT

This programming module allows digital scaling of the 4 to 20 mA or 0 to 10 VDC analog output. The type of analog output is determined by the model ordered. (See Ordering Information for available models.) The display value at which 4 mA or 0 VDC and the display value at which 20 mA or 10 VDC are transmitted are keyed-in. The indicator automatically calculates slope and intercept values to complete the scaling. The analog output then follows the calculated display value and as such will update every measurement cycle. The output may also be programmed to proportionally re-transmit the contents of the integrator instead of the input. Reverse acting output can be achieved by programming the *"high"* display value for the *"AN-Lo"* programming step and the *"low"* display value for the *"AN-HI"* step.

Note: DO NOT ADJUST THE ANALOG OUTPUT POTS ON THE BACK OF THE UNIT. Fine offset and span adjustment pots are externally accessible to compensate for small drifts in the output. These pots have been set at the factory and do not normally require adjustment.

ANALOG OUTPUT SOURCE

Program whether the input or the integrator/totalizer will serve as the basis for the analog output signal. If the integrator/totalizer option is not installed, then this step defaults to *"INPUt"*.

"ASIN" < > "INPUt" or "totAL"

ANALOG OUTPUT LO DISPLAY VALUE

Program the display value at which the analog output transmits 4 mA or 0 VDC. If "INPUt" was selected for "ASIN", the range is -999 to 9999. If "totAL" was selected, then the range is -99,999 to 999,999.

"AN-Lo" < > "-99999" to "999999"

ANALOG OUTPUT HI DISPLAY VALUE

Program the display value at which the analog output transmits 20 mA or 10 VDC. If "INPUt" was selected for "ASIN", the range is -999 to 9999. If "totAL" was selected, then the range is -99,999 to 999,999.

"AN-HI" < > "-99999" to "999999"

MODULE #9 - SERVICE OPERATIONS

The indicator has been fully calibrated at the factory. If the unit appears to be indicating incorrectly or inaccurately, refer to the troubleshooting section before attempting this procedure.

When re-calibration is required *(generally every 2 years)*, this procedure should only be performed by qualified technicians using appropriate equipment. A precision thermometer (RTD, thermistor or similar type (accuracy of ± 0.3° C) and an accurate voltage source (0.01%) are required.

The procedure consists of setting the cold junction temperature and applying accurate voltages to the indicator in a series of three steps. Allow a 30 minute warm-up before starting this procedure.

Note: Once the access code has been entered, there is no exiting the program module without completing the calibration procedure. Removing power to the meter cancels the procedure.

MODULE #9 - SERVICE OPERATIONS (Cont'd)

COLD JUNCTION TEMPERATURE CALIBRATION

1. 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. The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the IMT thermocouple probe may be placed in a calibration bath of known temperature.)
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 (0.6° C)
4. If cold junction re-calibration is necessary (temperature out of tolerance), enter Module #9, code 48. At the "CJC" display, key-in the new cold junction temperature according to the formula:

New Cold Junction Reading = Old Cold Junction Reading + Difference

Difference = Reference Thermometer Temperature - Meter Display Temp.

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

VOLTAGE CALIBRATION

1. Enter Module #9, code 48.
2. Step through "CJC" until CAL <> yes/no appears. Select yes.

ENTER 1st CALIBRATION VOLTAGE

Apply 0.000 mV to the input by shorting the signal wires. Allow to stabilize for 20 seconds before pressing *"P"*.

"StEP 1" (Press "P")

ENTER 2nd CALIBRATION VOLTAGE

Apply 30.000 mV to the input. Allow to stabilize for 20 seconds before pressing *"P"*.

"StEP 2" (Press "P")

ENTER 3rd CALIBRATION VOLTAGE

Apply 60.000 mV to the input. Allow to stabilize for 20 seconds before pressing *"P"*.

"StEP 3" (Press "P")

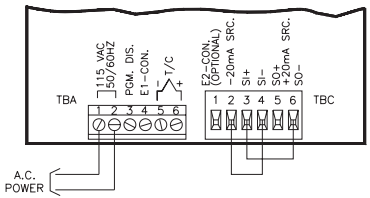
Indicator calibration is complete. It is recommended that calibration be checked by selecting mV indication mode, and verifying unit accuracy at various points over the range of the unit (-10 to +80 mV).

SERIAL HARDWARE (loop-back) DIAGNOSTICS

The internal serial communications hardware in the IMT can be tested to verify proper operation. The procedure consists of connecting the Serial Input *(SI)*, Serial Output *(SO)*, and 20 mA Source into a simple loop, and then entering an access code.

Connect the IMT as shown below. Enter *"Pro 9"*, key-in *"Code 39"*, and then press *"P"*. If the serial communication hardware is OK, "PASS" will be displayed. Conversely, if there is an internal problem, *"FAIL"* will be displayed. After the diagnostic test is complete, press *"P"* to return to *"Pro 0"*.

"COdE" < > "39"



RESTORING ALL PROGRAMMING PARAMETERS BACK TO FACTORY CONFIGURATION

All of the programming in Modules #1 through #8 can be restored back to the factory configuration by entering a specific access code *(refer to the "Factory Configuration" section for the data that will be entered)*. The procedure consists of entering *"Pro 9", keying-in "Code 66"*, and then pressing *"P"*. The IMT responds by displaying *"INItAL"* for several seconds, and then returns to *"Pro 0"*.

Note: When this procedure is performed, all parameters that were programmed into the IMT will be overwritten.

"COdE" < > "66"

OPERATING THE IMT

After completing all set-up operations, the unit is ready to install and operate. After power is applied, a display test consisting of illuminating all segments for 2 seconds is performed. Afterward, the input or total will appear, depending upon the display mode prior to the last power-down. To switch the display to input, press *"DOWN" (indicated by "arrows" on the front panel)* and to switch it to total, press *"UP"*. If the integrator/totalizer option is not installed, then display switching to total is inoperative. A minus sign *"-"* will precede numbers that are negative.

QUICK PROGRAMMING

To limit access to the set-up parameters, connect a key-switch or wire from PGM. DIS. *(TBA #3)* to COMM. *(TBA #5)*. With this pin connected to common, only a predetermined amount of data can be viewed or altered, as programmed by programming module #3. If *"NO"* was programmed for all of the available steps in module #3, then pressing *"P"* will cause the unit to display "Loc". However, if *"yES"* was programmed in one or more of the steps, then *"P"* will invoke entry into a series of commonly modified parameters while protecting the crucial set-up information. This is referred to as the *"quick programming"* mode. When *"quick programming"* mode is entered, the alarms, hysteresis and offset values can be modified in the same manner as in the regular programming mode. The new alarm, hysteresis and offset values will take effect when *"P"* is pressed. The other operations in the *"quick programming"* mode require special key sequences as shown:

To reset latched alarm, scroll through steps in *"quick programming"* mode using the *"P"* button until *"LAtCH1"* or *"LAtCH2"* appears in the display. If they do not appear, they are not latched.

To reset: While *"LAtCH1"* or *"LAtCH2"* is being displayed, press and hold *"DOWN"* and press *"P"*. Pressing *"P"* alone causes a step to the next item with no action taken on the alarm.

To reset peak and valley buffers, scroll through steps in *"quick programming"* mode using the *"P"* button until *"PEA"* or *"VAL"* appears in the display.

To reset: While *"PEA"* or *"VAL"* is being displayed, press and hold *"DOWN"* and press *"P"*. Pressing *"P"* alone causes a step to next item with no action taken on the buffer.

The front panel buttons are not only used to input data during the programming and *"quick programming"* mode, but control a number of other functions *(if enabled in Pro "3")* as well. In the normal meter mode, these functions are available:

To switch to display of input: Press *"DOWN"* button.
To switch to display of integrator: Press *"UP"* button.
To reset integrator to zero: Press and hold *"UP"* and press *"P"*.
To enter programming or *"quick programming"*: Press *"P"*.

After each operation, a message will appear briefly to acknowledge the action.

FACTORY CONFIGURATION

The following chart lists the programming of the unit when shipped from the factory. *(In Program Module #9, Code 66 will restore the unit to these values.)*

"Pro 1".....	"tYPE"	-	"2"
	"SCALE"	-	"F"
	"dECPNt"	-	"0.0F"
"Pro 2".....	"SLOPE"	-	"1.0000"
	"OFFSEt"	-	"0.0"
"Pro 3".....	"dSP AL"	-	"yES"
	"ENt AL"	-	"yES"
	"dSPHYS"	-	"yES"
	"ENtHYS"	-	"yES"
	"rSt AL"	-	"yES"
	"dSPbUF"	-	"yES"
	"rStbUF"	-	"yES"
	"SELdSP"	-	"yES"
	"rSttOt"	-	"yES"
	"dSPOFF"	-	"yES"
	"ENtOFF"	-	"yES"
"Pro 4".....	"FILtEr"	-	"1"
	"E1-CON"	-	"4" (Display Hold)
	"E2-CON"	-	"4" (Display Hold)
"Pro 5".....	"dECPNt"	-	"0"
	"tbASE"	-	"0"
	"SCLFAC"	-	"1.000"
	"Lo-cut"	-	"0.0 F"
"Pro 6".....	"trAc"	-	"NO"
	"dISP"	-	"NO"
	"LAtC-1"	-	"NO"
	"ASN-1"	-	"INPUt"
	"AL-1"	-	"0.0 F"
	"HYS-1"	-	"0.1 F"
	"Act-1"	-	"HI"
	"LAtC-2"	-	"NO"
	"ASN -2"	-	"INPUt"
	"AL-2"	-	"0.0 F"
	"HYS-2"	-	"0.1 F"
	"Act-2"	-	"HI"
"Pro 7".....	"bAud"	-	"1200"
	"AddrES"	-	"0"
	"Print"	-	"0"
	"FULL"	-	"yES"
"Pro 8".....	"ASIN"	-	"INPUt"
	"AN-Lo"	-	"0.0 F"
	"AN-HI"	-	"100.0 F"

PROGRAMMING EXAMPLE

As an example of a programming sequence, the following values, gained from a temperature monitoring application *(using a type J thermocouple)* are programmed into the indicator.

DISPLAY: Display the actual temperature of a liquid chemical solution in °F. Activate alarm #1 output when temperature falls below 150° F, activate display alarm. Peak and valley *(max/min)* readings for each cycle to be recorded.

TOTALIZER: When total exceeds 1,000.0 degree-hours, then alarm #2 latches, which stops the process and activates a signal to indicate that the process is complete. Reset alarm #2 by remote input. Disable Integration when temperature falls below 150° F. Reset and switch the display to/from temperature and total by the front panel buttons.

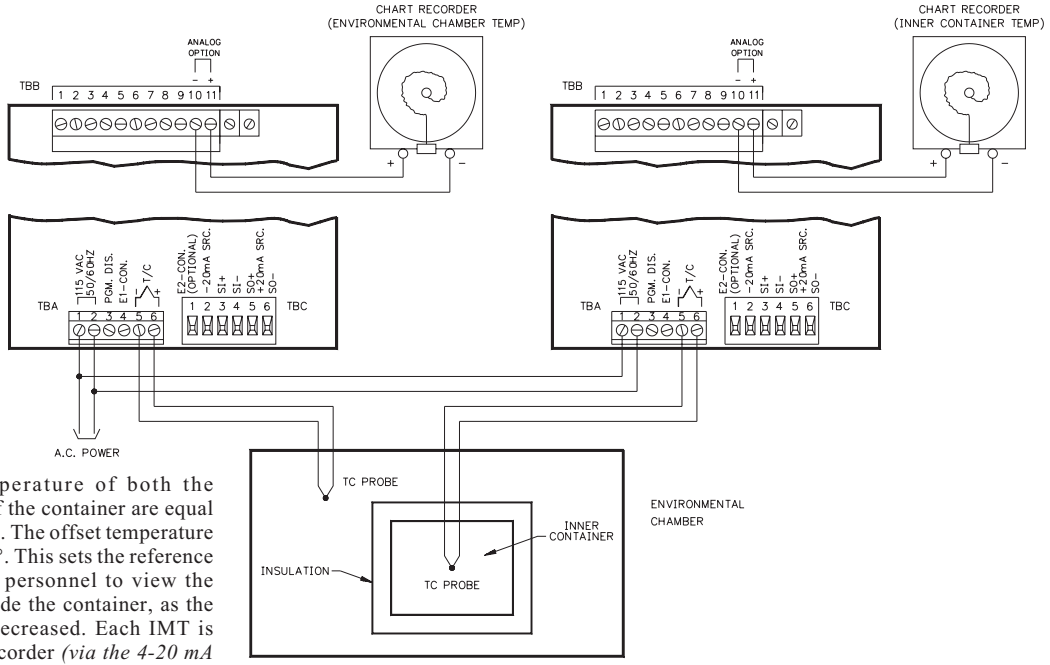
SERIAL: Provide hard copy printout of total, input and peak/valley when operator actuates E2-CON. Baud rate 300.

ANALOG RE-TRANSMISSION: Record temperature profile. 4 mA at 100° F and 20 mA at 400° F.

"Pro 1".....	"tYPE"	-	Enter 2 (type J)
	"SCALE"	-	Enter F
	"dECPNt"	-	Enter 0
"Pro 2".....	"SLOPE"	-	Enter 1.0000
	"OFFSEt"	-	Enter 0
"Pro 3".....	"dSP AL"	-	Enter yES
	"ENt AL"	-	Enter yES
	"dSPHYS"	-	Enter NO
	"rSt AL"	-	Enter NO
	"dSPbUF"	-	Enter yES
	"rStbUF"	-	Enter yES
	"SELdSP"	-	Enter yES
	"rSttOt"	-	Enter yES
	"dSPOFF"	-	Enter NO
"Pro 4".....	"FILtEr"	-	Enter 1
	"E1-CON"	-	Enter 8 (reset alarm #2)
	"E2-CON"	-	Enter 14 (print request)
"Pro 5".....	"dECPNt"	-	Enter 0.0
	"tbASE"	-	Enter 2
	"SCLFAC"	-	Enter 10.000
	"Lo-cut"	-	Enter 150
"Pro 6".....	"trAc"	-	Enter NO
	"dISP"	-	Enter yES
	"LAtC-1"	-	Enter NO
	"ASN-1"	-	Enter INPUt
	"AL-1"	-	Enter 150
	"HYS-1"	-	Enter 1
	"Act-1"	-	Enter LO
	"LAtC-2"	-	Enter yES
	"ASN-2"	-	Enter tOtAL
	"AL-2"	-	Enter 1,000.0
	"HYS-2"	-	Enter .1
	"Act-2"	-	Enter HI
"Pro 7".....	"bAud"	-	Enter 300
	"AddrEs"	-	Enter 0
	"Print"	-	Enter 6
	"FULL"	-	Enter yES
"Pro 8".....	"ASIN"	-	Enter INPUt
	"AN-Lo"	-	Enter 100
	"AN-HI"	-	Enter 400

TEMPERATURE MONITORING/OFFSET EXAMPLE

Two IMTs are used for research and testing by a large insulation manufacturer. One such test involves the use of an environmental chamber, along with the IMTs. A container completely surrounded by the insulation under test is placed inside the chamber. Both IMTs are purchased with integrator/ totalizer/ peak/valley/slope/offset and re-transmitted 4 to 20 mA analog output options. One IMT is used to monitor, display and re-transmit the temperature inside the container, while the outside temperature is drastically increased and decreased. The purpose of the test is to compare the change in temperature inside the insulated container, with the outside temperature changes. The second IMT is used to monitor the temperature inside the environmental chamber.

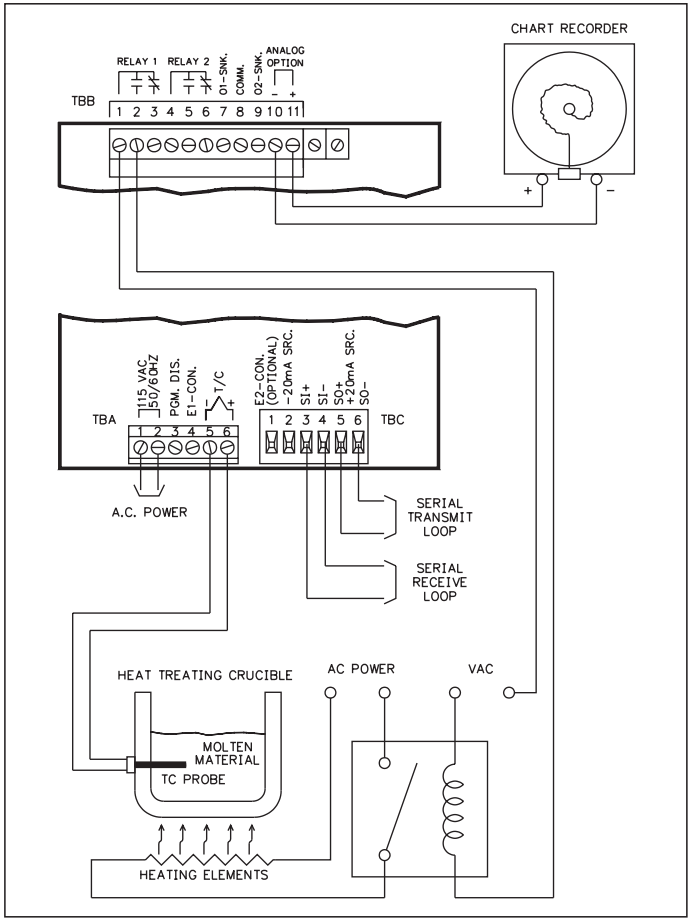


At the start of the test, the temperature of both the environmental chamber and the inside of the container are equal *(75° F)*. This is the reference temperature. The offset temperature of both the IMTs are programmed to +75°. This sets the reference temperature to 0° F, allowing the test personnel to view the degrees of change *(+/- 0 reference)* inside the container, as the outside temperature is increased and decreased. Each IMT is programmed to drive a separate chart recorder *(via the 4-20 mA re-transmitted analog output option)* to provide a hard copy of temperature profiles for comparisons at a later time.

PROCESS CONTROL EXAMPLE

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. Additionally, a temperature versus time plot of each process is needed for verification purposes. An IMT with dual alarm, analog output and serial communication options is used to satisfy this application. A computer is connected to the serial transmit/receive of the unit, and a program is written which sets the alarm values for the IMT to control the temperature of the annealing crucible. The computer also provides the proper timing for temperature soak and ramp. The IMT's relay alarm outputs are used to drive relays which switch AC power to the crucible's electric heating elements. The IMT's 4-20 mA analog output is digitally scaled to drive a chart recorder to provide a permanent record of the heat treating process. Soak temperatures, duration and temperature ramps are specific for each alloy and will change often.

As an example, to anneal one type of alloy, it must be brought to 1000° F and left to soak for 2 hours after which it must cool at the rate of 200°/ hour until it reaches 600° F where it must stay for 2 hours and then allowed to air cool. To achieve a mean temperature of 1000° F, alarm #1 is programmed to be low acting and one-half of the systems dead-band hysteresis is subtracted from this value *(990° F)*, to achieve an average temperature of 1000° F. For this example, the hysteresis is 20° F to avoid unnecessary relay cycling. After the initial soak period, the alarm is reprogrammed in a succession of steps to obtain the gradual 200°/hour cool off to 600°. After a two hour time period at 600°, the crucible is allowed to air cool. The chart recorder provides a graph of the entire process.



INTEGRATOR / TOTALIZER / PEAK / VALLEY / SLOPE / OFFSET (Optional)

INTEGRATOR/TOTALIZER

The integrator/totalizer option simply adds input readings together using a programmable time base and scaling coefficient. The decimal point position of the integrator/totalizer is independent of the temperature *(input)* decimal point position. The integrator/totalizer may be reset through a remote input, by the front panel or through the serial communications option. Alarms may be programmed to trigger from integrator/totalizer values; for example, to integrate temperature for an indication of *"degree minutes"* for batching operations. The programmable time bases are *"per second"*, *"per minute"* and *"per hour"*, meaning the integrator/totalizer will accumulate at a fixed rate of 2.5 times per second and be equal to a fixed input level over the selected time period. For example, if the input is a constant 100° and the *"per minute"* time base is selected, the integrator/totalizer will accumulate at the rate of 100° per minute. The totalizer is updated at this rate every 400 msec. As a result, the input is accumulated in "batches" of 6.6 counts every 400 msec. Therefore, the totalizer start and stop sequencing, as well as alarm values set to trigger at specific totalizer values, are accurate only to the 400 msec totalizer update rate. The preceding example requires a scale factor of 1.000 to yield exact time bases, but any scale factor can be used to span between the ranges. *(See section on integrator/totalizer programming for detailed information.)* A programmable low temperature level disable feature completes the integrator/totalizer features *(this will stop accumulation when the input drops below this programmed value, "low cut")*. At loss of power to the indicator, the contents of the integrator/totalizer are saved. This will allow integrating/totalizing of interrupted processes. The total can accumulate to 999,999. If the low-end cutout value is programmed negative *(ex. - 100, reference Program Module #5)*, and the input signal is between zero and the low-end cutout value, the totalizer value will decrement. If the input signal goes above zero, the total will increment. If the signal goes below *(more negative than)* the low-end cutout value, totalization will stop.

INTEGRATOR/TOTALIZER EXAMPLE

The indicator is employed to monitor and integrate the temperature of a kiln used for baking ceramics. The ceramic material is placed in the kiln for a total of 4 hours at a steady temperature of 700° C after which it is allowed to cool. The following programming steps are performed:

BASIC SET-UP

"Pro 1".....tYPE"	-	3 (type K)
"SCALE"	-	C
"dECPNt"	-	0

INTEGRATOR/TOTALIZER SET-UP

With an average temperature input which gives a display of 700 *(when viewing the contents of the integrator/totalizer)* after a 1 hour time period, the following formula applies:

$$S.F. = \frac{D.T.}{T.D.} \times \left(\frac{T.B.}{TIME}\right)^{*} \times \frac{D.T.D.P.}{T.D.D.P.}$$

S.F. = Programmable Scale Factor
D.T. = Desired Totalizer value for a fixed time duration
T.B. = Programmable Time Base

T.B. = If Program Select Number Chosen Is:	Enter in Formula
"0" for sec.	1
"1" for min.	60
"2" for hr.	3600

T.D. = Temperature Display Value
TIME = Actual Time period in seconds

D.T.D.P. = Desired Totalizer Value Decimal Point	Enter in Formula
0	1
0.0	10
0.00	100
0.000	1000
0.0000	10000

T.D.D.P. = Temperature Display Value Decimal Point	Enter in Formula
0	1
0.0	10

$$S.F. = \frac{700}{700} \times \left(\frac{3600\ **}{3600} \right)* \times \frac{1}{1}$$

S.F.= 1 x 1 x 1

S.F.= 1

"Pro 5".....“dECPNt” - 0

“tbASE” - 2

“SCLFAC” - 1.000

“Lo-cut ” - 650

After 4 hours the contents of the accumulator will equal 2800 *(700 per hour)*, indicating that the ceramic material has been properly baked. Totalization occurs only after the kiln has reached 650° C or above *(low-cut)*.

Alternatively, the scale factor may be programmed to have the indicator display the average temperature *(of the kiln)* at the end of the 4 hour baking process. This would be useful in assuring that the kiln is working properly and maintaining a steady temperature at the desired setting *(700° C in this case)*.

$$S.F. = \frac{700}{700} \times \left(\frac{3600\ **}{3600} \right)* \times \frac{1}{1}$$

S.F.= 1 x .25 x 1

S.F.= .25

“SCLFAC” - 0.250

At the end of 4 hours, the average temperature can be seen by viewing the contents of the integrator/totalizer. *(This value should show 700.)* Anytime during the shift, the average temperature can be calculated by the following formula:

$$Av = \frac{I.V.}{S.F. \times T.T.***}$$

I.V. = Integrator/Totalizer Value

S.F. = Programmable Scale Factor

T.T. = Total Time (From the beginning of the shift)

For example, 6 hours and 37 minutes into the shift the integrator/totalizer reads “1142”. To find the average temperature up to this point:

$$Av. = \frac{1142}{.25 \times 6.6166} = \frac{1142}{.827} \qquad Av. = 690$$

The average temperature over the last 6 hours and 37 minutes was 690° F.

**This value is normally 1, but can be used as a course scale factor of 60 or 3600.*

***Since the time period is in Hrs., the selected T.B. is 3600 (Program select value = 2) which equals per hour (3600 sec.).*

****Time is in hours. The number of minutes must be divided by 60 and then added to the hours.*

PEAK/VALLEY

Another feature of the integrator/totalizer option is peak and valley detection. The indicator will record the lowest reading *(valley)* and the highest reading *(peak)*, automatically, for later recall. This information is valuable in monitoring the limits of the process over any length of time since these values are stored at power-down to span over shifts, days, etc. An external input can be programmed to reset or engage the unit into a peak/valley reading indicator. Additionally, the peak and valley can be viewed and reset from the front panel, if so programmed, and viewed and reset from the serial communication option.

Note: The peak/valley measurement is not instantaneous and is based on a nominal 2 second response time.

OFFSET AND SLOPE DISPLAY TEMPERATURE

This feature allows the operator to manipulate the displayed temperature reading. The operator may utilize this feature for example, when switching thermocouple probes, to compensate for differences in thermocouple probe accuracy from one manufacturer to another or to offset the input reading to match a *"Reference"* temperature.

The displayed temperature can be offset either positive or negative to the actual measured temperature. Programming a positive number for the offset value increases the display value. Programming a negative number for the offset value decreases the display value. For example, if the displayed temperature is 10° less than the measured temperature, programming a +10 for the offset value will increase the displayed value by 10 throughout the entire range. If the displayed temperature is 10° higher than the measured temperature, programming a -10 for the offset value will decrease the display value by 10 throughout the entire range.

If a difference exists between the displayed temperature and a reference temperature point, the display may be offset for this effect. Similarly, a correcting *"slope"* may be programmed, with the offset, to allow for two point temperature correction.

For most applications, the slope and offset values are NOT changed. But if it is required to scale the display to match a calibrated probe, the following formula and example show the calculation of appropriate slope and offset values.

$$\text{Desired Display} = (\text{slope} \times \text{actual temp. display}) + \text{offset}$$

$$\text{slope} = \frac{\text{difference of two desired temperature points}}{\text{difference of two actual temperature points}}$$

$$\text{offset} = \text{one desired temperature point} - (\text{slope} \times \text{one corresponding actual temperature point})$$

EXAMPLE:

The meter is displaying 502 degrees and 696 degrees *(actual temperature)* when the calibrated temperature reference shows that 500 degrees and 700 degrees respectively should be displayed *(desired temperature)*.

First determine the new slope value using the sets of temperature points.

$$\text{slope} = \frac{700 - 500}{696 - 502} = \frac{200}{194} = 1.0309$$

Next, determine the new offset value by using either one of the temperature pairs.

$$\text{offset} = 700 - (696 \times 1.0309)$$
$$\text{offset} = -17.5$$

SET-UP:

"Pro 2" ..... "SLOPE" - 1.0309
"OFFSEt" - -17.5

ALARMS (Optional)

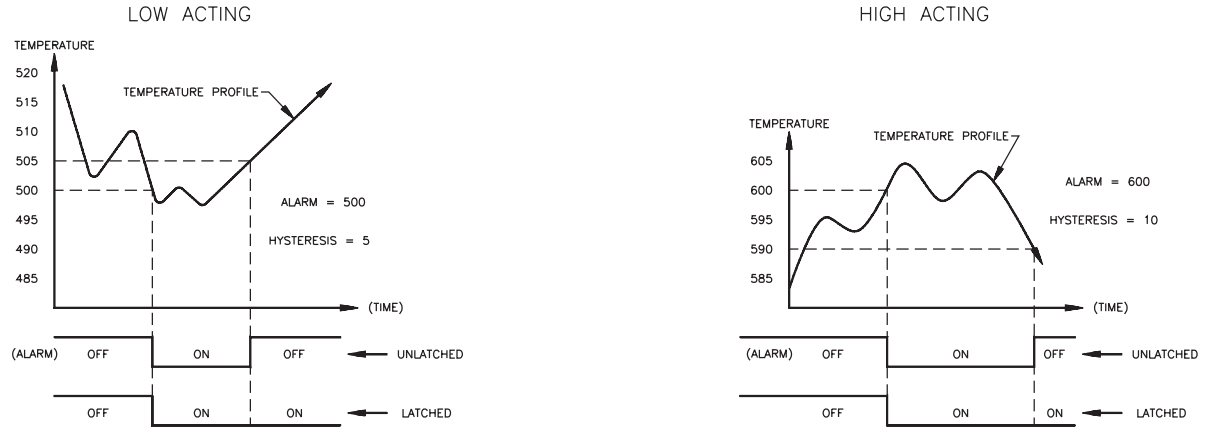
The alarm option consists of an additional printed circuit board with nine terminals. Six of these terminals are the two Form-C relays and the other three are the two open collector transistors, which act in parallel with the relays. The two alarms are completely independent with programmable values, hysteresis *(deadband)*, high or low acting, auto or manual reset, triggering from input or total, and tracking one another, if desired. If the alarms are programmed to latch *(manual reset)*, then they will have to be reset either by the front panel or remote input. The alarms can be made to trigger from the integrator/totalizer instead of the input, to activate external alarms, control valves, etc. Additionally, the alarms may be programmed to activate an alarm display to alert operators of the condition.

Alarm #1 can be made to track Alarm #2 by enabling alarm tracking. This is useful in alarm set-ups where a pre-warning control activates before a second alarm shuts off the process when tracking is programmed. Changing the shut-off trip value *(Alarm #2)* automatically changes Alarm #1 so that the offset between Alarm #2 and Alarm #1 remains the same. Alarm and hysteresis values can be modified through the optional serial communications to provide automatic control. The following diagrams depict how the alarms work with both *"HI"* and *"LO"* acting set-ups.

Programming of the alarms can be accomplished in the normal programming mode *"Pro 6"* or the unit can be programmed so that the values can only be changed in the *"quick programming"* mode. If the display should indicate an *"OPEN"* or *"SHort"* the alarms will de-energize, whether they are latched or unlatched.

Note: Alarm comm. TBB #8 must be kept isolated from Analog "-".

ALARM TIMING DIAGRAMS



20 mA CURRENT LOOP SERIAL COMMUNICATIONS (Optional)

GENERAL DESCRIPTION

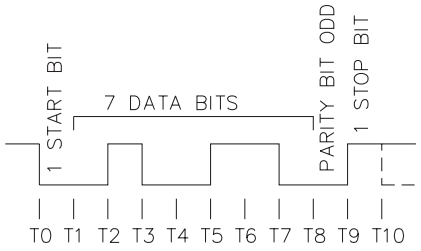
The serial communication option is a half-duplex, two-way, 20 mA loop that can connect to a variety of printers, computers, terminals and controllers to suit many data-polling or automatic operation applications. The indicator responds to a host of commands, including change alarm value, reset totalizer and transmit input value. Two loops are required for all hook-ups; a transmit *(out-going data)* loop and a receive *(in-coming data)* loop. Since the indicator monitors the receive loop for a busy signal *(current interrupted)* while transmitting, the receive loop must be connected even if the indicator is transmitting only, such as to a printer. A built-in 20 mA source can be used in the transmit loop *(only)* by connecting the current return wire to -20 mA SRC., instead of SO+. To bypass the built-in current source, make transmit loop connections to SO+ and SO-. Additionally, multiple units and other Red Lion Controls instruments can be serially addressed, up to a maximum of 99 units. *(The actual number in a single loop is limited by the serial hardware specifications.)* To eliminate problems with ground loops, the serial circuitry is isolated from both signal common and output common. Optional 20 mA to RS232C and 20 mA to RS422 converter modules expand the unit's flexibility.

Note: When operating the unit with a printer, the receive loop of the indicator must have current flowing into it before transmission can take place.

COMMUNICATION 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 among the communicating equipment. The only format available with this indicator is 1 start bit, 7 data bits, 1 odd parity bit and 1 stop bit. The baud rates are programmable and the choices are: 300, 600, 1200 and 2400.

DATA FORMAT-10 BIT FRAME [300, 600, 1200, 2400 Baud]



Before serial communication can take place, the indicator must be programmed to the same baud rate as the connected equipment. In addition, the loop address number, print options and full or abbreviated transmission must be programmed. If only one indicator is to be used, then a loop address number of "0" may by used, to eliminate the requirement for the address specifier when sending a command. If more than one indicator is on the loop, assignment of unique addresses, other than zero, for each indicator is recommended. Valid addresses of 0 to 99 may be assigned, but the built-in current source, if used, is capable of driving up to 7 units. Additional drive capability may be afforded by an external current source with a higher compliance voltage. Refer to programming section "Pro 7" to program the serial option.

SENDING COMMANDS TO THE IMT

When sending commands to the unit 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 the indicator will recognize.

COMMAND	FUNCTIONS
T	transmits the requested information specified by the identifier (A-I, K, & L)
V	change a value specified by the identifier (C-F, K, & L)
N	address a particular indicator in a multiple unit loop (0-99)
R	reset a value specified by the identifier (B-D, G, H, I, & J)
P	print per programmable print options (A-I)

VALUE	IDENTIFIERS	SERIAL MNEMONICS
A	temperature	TC
B	integrator/totalize	TOT
C	alarm #1	AL1
D	alarm #2	AL2
E	hysteresis #1	HS1
F	hysteresis #2	HS2
G	peak reading	PEK
H	valley reading	VAL
I	offset reading	OFS
J	tare input	--
K	analog low	ANL
L	analog high	ANH

Note: RJ - offset the input (re-zeros). When the input is offset (via front panel or "RJ") the amount is stored in the offset reading (I). Ex. When an offset is performed, the display reads "5.0", the offset value will be "-00005.0" (and the display will show 0.0).

A command string is constructed by using the above commands and identifiers along with any data values that are required. The indicator will accept *"+"* or *"-"* in front of the data value and numbers without *"+"* are understood to be positive. Leading zeros can be eliminated and both lower and upper case characters are accepted. The address command is used to allow a command to be directed to a specific unit on the loop. If the indicator is assigned an address of *"0"*, transmission of the address command is not required. This is done where only one indicator is in the loop.

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

1. If the indicator has an address other than zero, the first two characters of the string must consist of the address command *(N)* followed by the unit address number *(0-99)*. If the indicator has an address of 0, the address command is optional.
2. The next two characters in the string are the actual command the indicator must perform and the identifier on which it operates.
3. If the change value command is being used *(V)*, the next characters in the string after the value identifier, are the numerical data. When sending numerical data, such as change an alarm value, the correct number of digits to the right, must be included. As an example, to change an alarm value from 750.2 to 500.0. Sending 500 would cause the indicator to see 50.0 and change the alarm value accordingly.
4. All commands must be terminated by an asterisk*(*)*. The indicator will not respond to any other code. Carriage return and line feed are not valid terminators and should be suppressed with the character ";", if using a BASIC print statement (ex. Print "N9TA*";).

COMMAND STRING EXAMPLES

Indicator with address 3, transmit temperature reading.
N3TA*

Indicator with address 0, change alarm #1 to 1500.
VC1500*

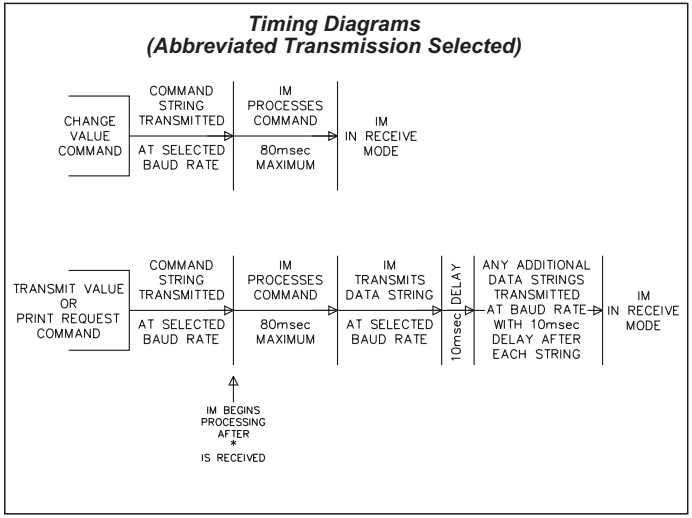
Indicator with address 1, reset totalizer.
N1RB*

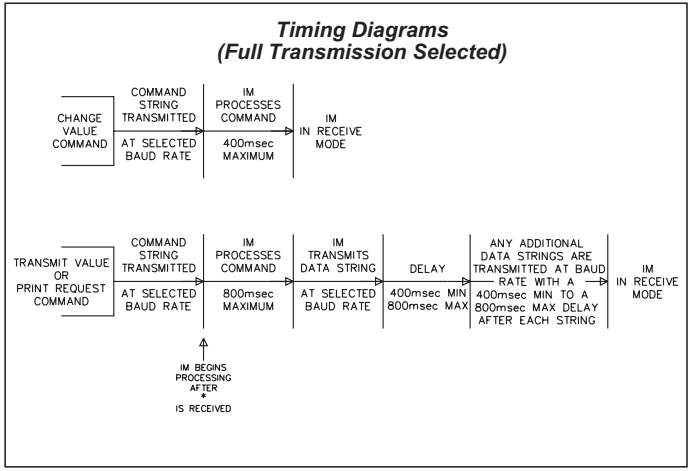
Indicator with address 99, print the print options.
N99P*

Indicator with address 0, zero the offset value.
RI*

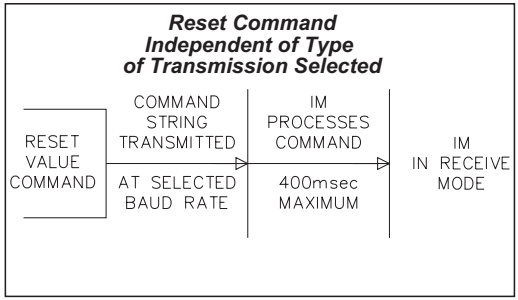
COMMAND STRING EXAMPLES (Cont'd)

If an illegal command or character is sent to the IM, an asterisk (*) must be transmitted to clear the input buffer. The IM will not respond to an illegal or incomplete transmission. The diagrams show the differences in the timing considerations for either Abbreviated or Full Character Transmission, or if a Reset Command is issued.



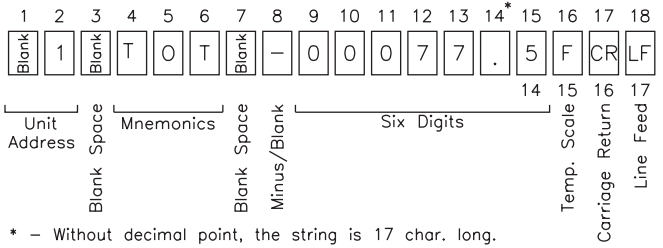


Note: If Full Transmission is selected and the front panel is being accessed at the time of transmission, the IM may take as long as 2 seconds to respond.



RECEIVING DATA FROM THE IMT

Data is transmitted from the indicator whenever a *"T"* or *"P"* command is received via serial communications or a remote input, E1-CON or optional E2-CON pin is programmed for print request, is activated. If the abbreviated transmission was programmed, just data will be transmitted with no built-in delay. *(If full transmission output is programmed, then there is a 400 msec min to 800 msec max delay built-in to the string.)* A data string transmission is shown below.



* – Without decimal point, the string is 17 char. long.

The first two characters transmitted are the unit address number, unless it is zero, in which case it is left blank. Then two blank spaces are sent. The next three characters are the abbreviation for the value, which is then followed by a blank. The actual data is transmitted next. The field is right justified with leading zeros. Negative numbers are indicated by a minus sign fixed next to the identifier. The temperature scale is now sent, followed by a carriage return and a line feed. For various reasons, *"extra"* characters are added onto the end of the above character string. *(These characters could be and are used for control or signaling purposes.)* These characters are:

< CR> sent after single line transmissions from IM unit.
< SP > < CR > < LF > sent after *"last line of a block"* transmission from IM unit.

For a "T" command or after each *"line of a block"* transmission, no additional characters are sent. If the abbreviated transmission is selected, the address, mnemonics, and any blanks *(first seven characters)* are not transmitted. If an open exists at the thermocouple input, then *"OPEN"* will be transmitted in the data field during serial transmission.

If the transmitted data is overrunning the peripheral's buffer, the receive channel to the indicator may be used for handshaking purposes. As a consequence of this, even if the indicator is to transmit only *(ex. to a printer)*, current must be flowing in the receive channel to allow transmission.

Examples of a transmission are as follows:

2 TOT-125.750 < CR> < LF> full transmission
-125.750 < CR> < LF> abbreviated transmission

CURRENT LOOP INSTALLATION

WIRING CONNECTIONS

When wiring the 20 mA current loop, remove the bottom terminal block *(TBC)*, located on the rear of the unit. Refer to the numbers listed with the terminal descriptions below or those located on the label. It is recommended that shielded (screened) cable be used for serial communications. This unit meets the EMC specifications using Alpha #2404 cable or equivalent. There are higher grades of shielded cable, such as four conductor twisted pair, that offer an even higher degree of noise immunity. Install each wire in its proper location on the terminal block. When all connections are made, replace the terminal block into its proper location.

SERIAL TERMINAL DESCRIPTIONS (TBC)

1. **PRINT REQ.** - The Print Request terminal is pulled low to activate the unit to transmit data according to the print function selected in Program Module #7 *(Reference Programming Module #7 for more details)*. In order for a print request function to occur, E1-CON *(TBA #4)* or optional E2-CON *(TBC #1)* pin must be programmed for print request.

Note: *In order to guarantee a printout, the programmed E-CON pin must be held low for at least 20 msec. If this time exceeds 800 msec, then a second printout may occur.*

2. **-20 mA SRC.** - 20 mA current source return path for the transmit loop. Current flows into this pin.
3. **SI+ (Serial In+)** -
4. **SI- (Serial In-)** -
   The unit receives commands on the SI terminals. They are connected in series with the transmit or output terminals of the device to be connected.
5. **SO+/+20 mA SRC. (Serial Out+)** - 20 mA current source for the transmit loop (internally connected).
6. **SO- (Serial Out-)** -
   The unit transmits the requested data on the SO terminals. They are connected in series to the receive input of the device to be connected.

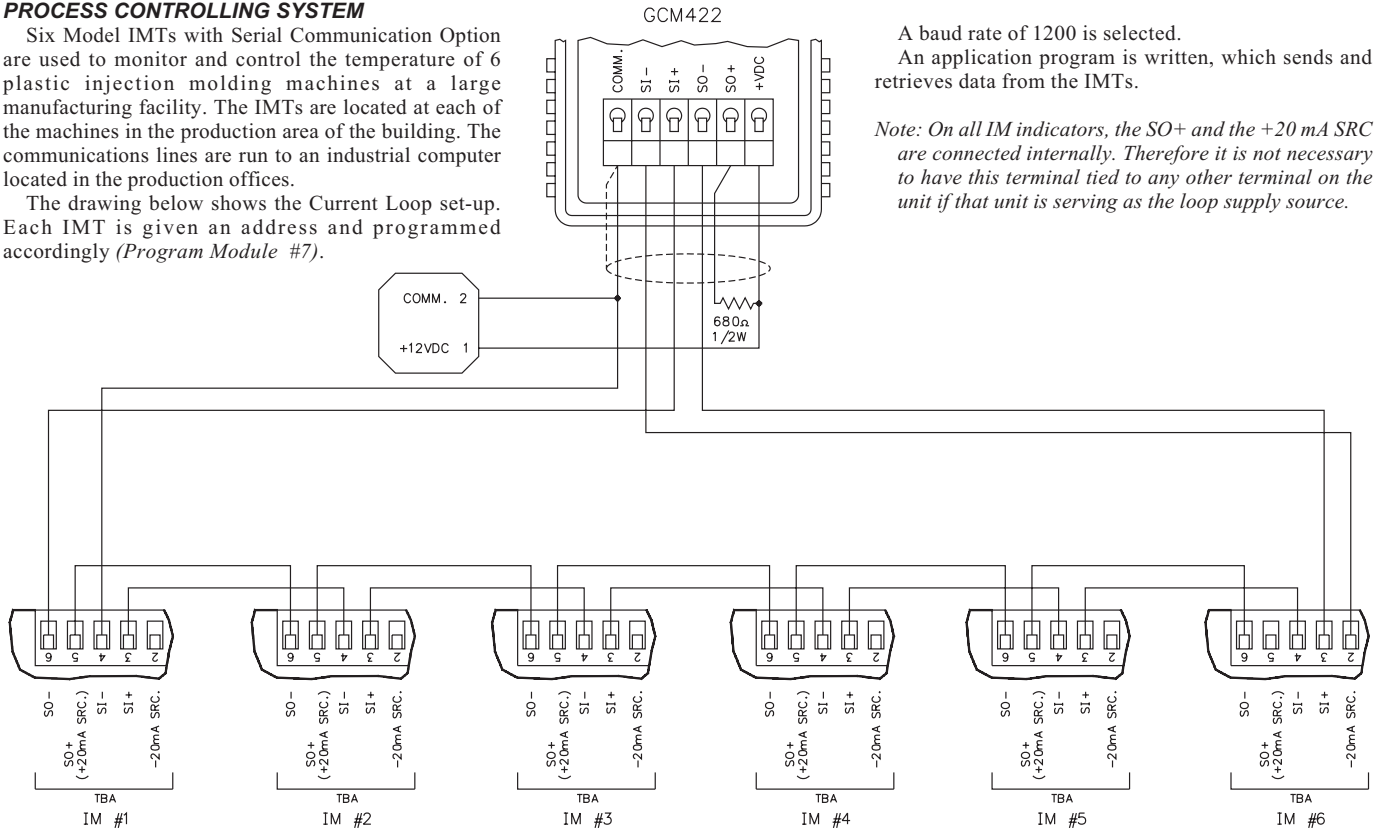
Note: *The Serial Input terminals must be held in the mark condition (current flowing) in order for the unit to respond to a Print Request terminal activation.*

SERIAL COMMUNICATIONS EXAMPLE

PROCESS CONTROLLING SYSTEM

Six Model IMTs with Serial Communication Option are used to monitor and control the temperature of 6 plastic injection molding machines at a large manufacturing facility. The IMTs are located at each of the machines in the production area of the building. The communications lines are run to an industrial computer located in the production offices.

The drawing below shows the Current Loop set-up. Each IMT is given an address and programmed accordingly *(Program Module #7)*.



A baud rate of 1200 is selected.

An application program is written, which sends and retrieves data from the IMTs.

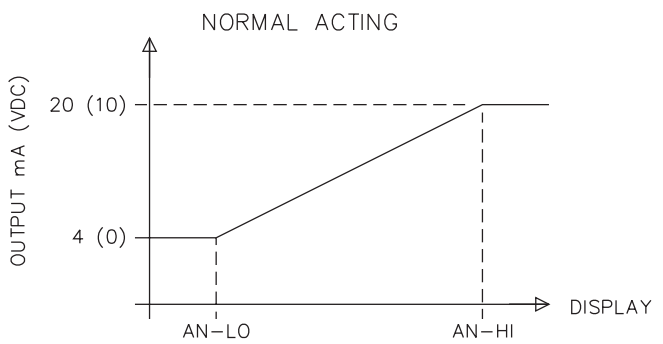
Note: On all IM indicators, the SO+ and the +20 mA SRC are connected internally. Therefore it is not necessary to have this terminal tied to any other terminal on the unit if that unit is serving as the loop supply source.

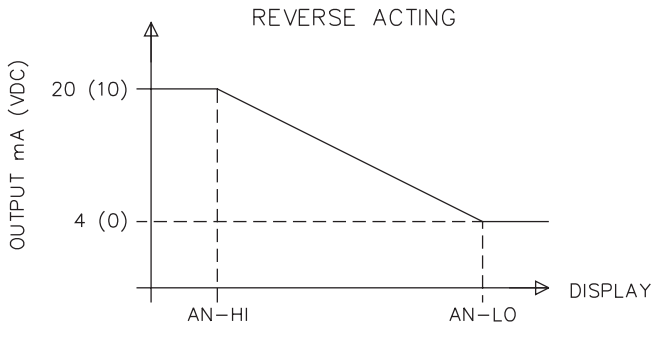
RE-TRANSMITTED ANALOG OUTPUT (Optional)

The re-transmitted analog output option transmits a digitally programmable 4 to 20 mA or 0 to 10 VDC signal to drive chart recorders, remote indicators and controllers. The option is contained on the upper PCB and has two outputs, *"ANALOG-" (TBB #10)* and *"ANALOG+" (TBB #11)* and is self-powered *(active)* with a compliance of 10VDC. The output is isolated from the input common analog *"-"*, eliminating problems from ground loops. Programming of the option is performed in *"Pro 8"* of the normal programming mode. Display values are simply keyed in to provide a 4 mA or 0 VDC output, *"AN-LO"*, and a 20 mA or 10 VDC output, *"AN-HI"*. The analog output then follows the assigned value and as such will update every measurement cycle. Nonstandard current or voltage ranges can be supported by calculating the slope and intercept of the display/output and calculating the required display values at 4 mA or 0 VDC and 20 mA or 10 VDC. Reverse action can be achieved by programming a *"high"* display value for *"AN-LO"* and a *"low"* display value for *"AN-HI"*. If the display should indicate an "OPEN" or "SHort" the analog output will go to 20 mA or 10 VDC for an open and 4 mA or 0 VDC for a short.

Note: Analog "-" must be kept isolated from alarm comm. (TBB #8).

ANALOG OUTPUT DIAGRAMS





ANALOG OUTPUT CALIBRATION

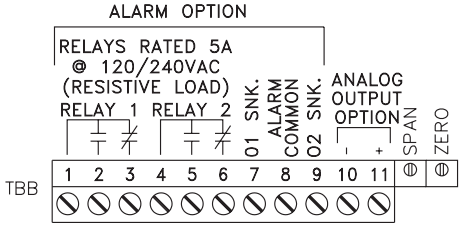
4 to 20 mA CALIBRATION

Although the analog output has been calibrated at the factory, zero and span adjustments are provided to compensate for small offsets and drifts. If excessive drift is noticed, the following calibration procedure may be performed.

Scale the analog output by entering an arbitrarily larger display value for *"AN-HI"* then for *"AN-LO"* in *"PRO 8"*.

Note: Set the analog output source assignment for input.

Exit the programming mode and apply a voltage to the input of the indicator so that the display reading is below that of the value entered for *"AN-LO"*. Adjust the zero potentiometer *(right side)* so that exactly 4.00 mA flows, as verified by an accurate ammeter. Next, apply a voltage to the indicator so that the display reading is above that of the value entered for *"AN-HI" (See Appendix "C" for maximum input voltage)*. Adjust the span potentiometer *(left side)* so that 20.00 mA is flowing. Repeat the zero and span adjustments until both are accurate. Analog output calibration is complete.



0 to 10 VDC CALIBRATION

Exit the programming mode and apply a (temperature)/(resistance) to the input of the indicator so that the display reading is below that of the value entered for *"AN-LO"*. Adjust the zero potentiometer *(right side)* so that exactly 0.00 VDC flows, as verified by an accurate voltmeter. Next, apply a (temperature)/(resistance) to the input of the indicator so that the display reading is above that of the value entered for *"AN-HI". (See Appendix "B" for max. input voltage.)* Adjust the span potentiometer *(left side)* so that 10.00 VDC is flowing. Repeat the zero and span adjustments until both are accurate. Analog output calibration is complete.

APPENDIX "A" - INSTALLATION & CONNECTIONS

INSTALLATION ENVIRONMENT

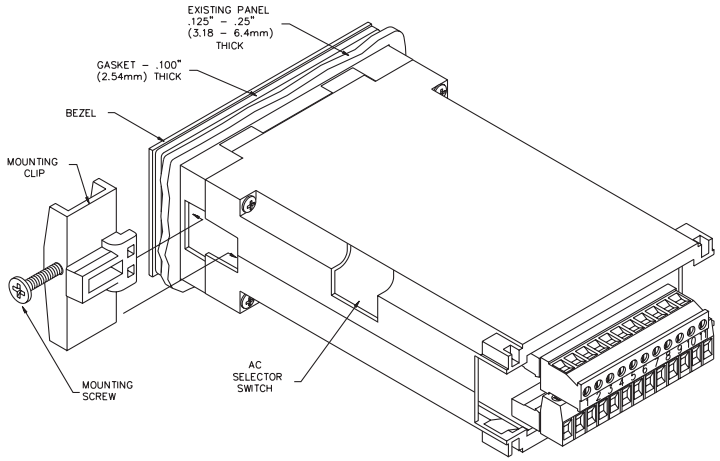
The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

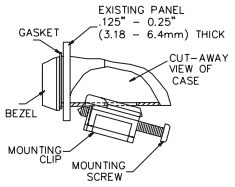
Before installing the IM into the panel, the user should first become familiar with the unit. It may also be desirable to program the unit for the application. When programming is complete, all parameters will be saved in non-volatile memory. The Program Disable (PGM.DIS.) terminal should be connected to COMM. to prevent accidental or unauthorized programming changes.

PANEL INSTALLATION



The unit meets NEMA 4/IP65 requirements for indoor use, when properly installed. The units are intended to be mounted into an enclosed panel, 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".)

After the panel cut-out has been completed and deburred, carefully apply the gasket to the panel. DO NOT APPLY THE ADHESIVE SIDE OF THE GASKET TO 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.

SELECT AC POWER (115/230 VAC)

The AC power to the unit must be selected for either 115 VAC or 230 VAC. The selector switch is located through an access slot on the side of the case (See figure above or label on case). The unit is shipped from the factory with the switch in the 230 VAC position.

Caution: Make sure the AC selector switch is set to the appropriate position before applying power to the unit. Damage to the unit may occur if the AC selector switch is set incorrectly.

EMC INSTALLATION GUIDELINES

Although this unit is designed with a high degree of immunity to ElectroMagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of electrical noise, source or coupling method into the unit may be different for various installations. In extremely high EMI environments, additional measures may be needed. The unit becomes more immune to EMI with fewer I/O connections. Cable length, routing and shield termination are very important and can mean the difference between a successful or a troublesome installation. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The unit should be mounted in a metal enclosure, which is properly connected to protective earth.
   a. If the bezel is exposed to high Electro-Static Discharge (ESD) levels, above 4 Kv, it should be connected to protective earth. This can be done by making sure the metal bezel makes proper contact to the panel cut-out or connecting the bezel screw with a spade terminal and wire to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 Mhz.
   c. Connect the shield to common of the unit and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are longand portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   Ferrite Suppression Cores for signal and control cables:
   Fair-Rite # 0443167251 (RLC #FCOR0000)
   TDK # ZCAT3035-1330A
   Steward #28B2029-0A0
   Line Filters for input power cables:
   Schaffner # FN610-1/07 (RLC #LFIL0000)
   Schaffner # FN670-1.8/07
   Corcom #1VR3

   Note: *Reference manufacturer's instructions when installing a line filter.*
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
   Snubbers:
   RLC #SNUB0000

POWER WIRING

Primary AC power is connected to TBA #1 and 2 *(marked VAC 50/60 Hz, located on the left hand side of the bottom terminal block, TBA)*. To reduce the chance of noise spikes entering the AC line and affecting the indicator, the AC power should be relatively *"clean"* and within the specified +/-10% variation limit. Drawing power from heavily loaded circuits or circuits which also power loads that cycle on and off, *(contactors, relays, motors, machinery, etc.)* should be avoided.

SIGNAL WIRING (TC SENSOR)

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. If the thermocouple probe is to be mounted away from the meter, thermocouple extension grade wire must be used *(copper wire will not work)*. Use the correct type and observe the correct polarity.

Always refer to the sensor manufacturer's instructions for probe wiring connections, if available. For multi-probe temperature averaging applications, two or more thermocouple probes may be connected at the indicator. *(Always use the same type.)*

In order to minimize the chances of coupling noise into the wires and subsequently causing bouncy and erroneous readings, certain guidelines for thermocouple wire routing must be followed.

USER INPUT WIRING

User inputs (PGM.DIS., E1-CON, and optional E2-CON) are digital inputs that are active when connected to TBA #5 Common. Any form of mechanical switch, sinking collector logic with less than 0.7 V saturation may be used. The use of shielded cable is recommended. Follow the Additional EMC Installation Guidelines for shield connection.

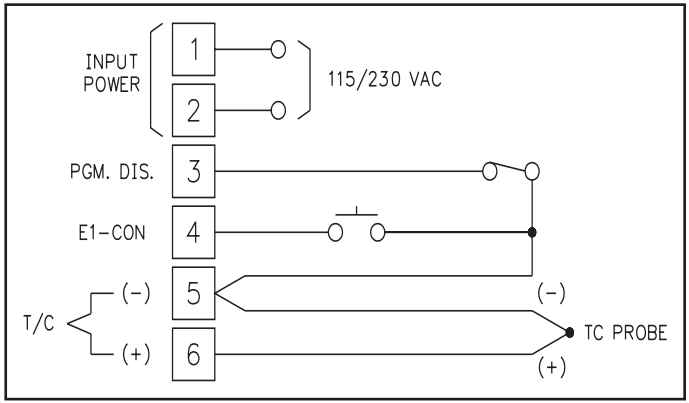
OUTPUT WIRING

Relay Connections

To prolong contact life and suppress electrical noise interference due to the switching of inductive loads, it is good installation practice to install a snubber across the contactor. Follow the manufacturer's instructions for installation.

Note: Snubber leakage current can cause some electro-mechanical devices to be held ON.

AC POWER BASIC CONNECTION



APPENDIX "B" - THERMOCOUPLE RANGE AND ACCURACY TABLE

(All errors include NBS conformity, cold junction effect and A/D conversion errors at 23° C after 10 minutes warm-up.)

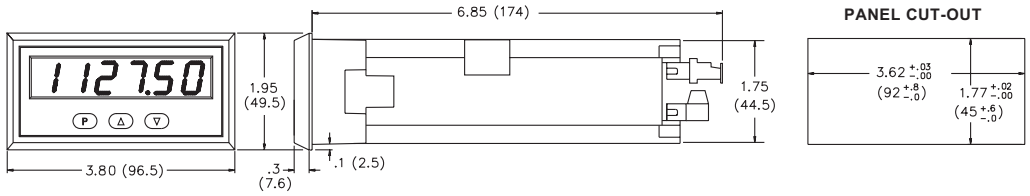
TC TYPE/ PRO 1 CODE	RANGE	ACCURACY	WIRE COLOR	
			(ANSI)	BS 1843
T/0	-200 to +400 °C -328 to +752 °F	0.8 °C 1.4 °F	blue (+) red (-)	white (+) blue (-)
E/1	-200 to +1000 °C -328 to +1832 °F	0.8 °C 1.4 °F	purple (+) red (-)	brown (+) blue (-)
J/2	-200 to +760 °C -328 to +1400 °F	0.8 °C 1.4 °F	white (+) red (-)	yellow(+) blue (-)
K/3	-200 to +1250 °C -328 to +2282 °F	0.8 °C 1.4 °F	yellow (+) red (-)	brown (+) blue (-)
R/4	0 to +1768 °C +32 to +3214 °F	2.1 °C 3.8 °F	black (+) red (-)	white (+) blue (-)
S/5	0 to +1768 °C +32 to +3214 °F	2.1 °C 3.8 °F	black (+) red (-)	white (+) blue (-)
B/6	+150 to +1820 °C +302 to +3308 °F	2.3 °C 4.1 °F	grey(+) red (-)	none (+) blue (-)
N/7	-200 to +1300 °C -328 to +2372 °F	0.8 °C 1.4 °F	orange (+) red (-)	orange(+) blue (-)
mV/8	-10.00 to +80.00 mV	0.01% of full scale	no standard	no standard

APPENDIX "C" - SPECIFICATIONS AND DIMENSIONS

1. **DISPLAY:** 4-digit with F/C indication, 0.56" *(14.2 mm)* high LED, minus sign displayed for negative temperatures. 6-digits for integrator/totalizer, *"Flashing"* display for totalizer overflow. "OLOLOL" displayed for input display out of positive range. "ULULUL" displayed for input display out of negative range.
2. **POWER:**
   A.C. Power: Switch selectable, 115/230 VAC, ± 10%, 50/60 Hz, 14 VA
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
   Working Voltage: 300 V max., CAT II
3. **CONTROLS:** Three front panel push buttons for modifying alarm values and indicator set-up. Two external inputs for disabling the front panel and controlling programmable functions.
4. **THERMOCOUPLE TYPES:** T, E, J, K, R, S, B, N or mV scale.
   Input Common potential with respect to earth Common: 50 V max., CAT I
5. **RESOLUTION:** 1°C/F all types, or 0.1° C/F for T, E, J, K and N only.
6. **INPUT IMPEDANCE:** 20 M Ω, all types.
7. **LEAD RESISTANCE EFFECT:** 20 uV/350 ohms.
   Max. Input Voltage Protection: 70 VDC Continuous.
8. **OPEN THERMOCOUPLE DETECTION:**
   Display - *"OPEN"*
   Setpoint Outputs - Disabled *(Deactivated)*
   Serial Output - *"OPEN"* in data field
   Analog output - 20 mA
   Integration/Totalization - Disabled
9. **COLD JUNCTION COMPENSATION:**
   Automatic, 0.02 degree/degree. Disabled for linear mV scale.
10. **READING RATE:** 2.5 readings/second.
11. **RESPONSE TIME:** 2 seconds to settle for step input *(increases with programmable digital filtering)*.
12. **NORMAL MODE REJECTION:** 45 dB at 50/60 Hz *(may be improved by programmable digital filtering)*.
13. **COMMON MODE REJECTION:** 120 dB, DC to 50/60 Hz.
14. **INTEGRATOR/TOTALIZER:** Front panel button for input/total display select. External integrator/totalizer reset/enable. Programmable time-base, scale factor (0.001-999.999) and low-temp cut-out. Maximum response time 0.2 sec.
15. **E1-CON & E2-CON:** External remote inputs which allow activation of various functions. (Reset total, peak indicator mode, trigger mode, etc.)
    V_{IL} = 0.8 V_{MAX}; V_{IH} = 2.0 V_{MIN}; Response Time = 0.2 sec maximum.
16. **ENVIRONMENTAL CONDITIONS:**
    Operating Range: 0 to 50° C.
    Storage Range: -40 to 80° C.
    Operating and Storage Humidity: 85% max.(non-condensing) from 0 to 50° C.
    Span Drift: 40 ppm/°C.
    Zero Drift: 0.1 uV/°C.
    Altitude: Up to 2000 meters
17. **SERIAL COMMUNICATIONS (Optional):**
    Isolation To Signal & User Input Commons: 500 Vrms for 1 min.
    Working Voltage: 50 V max., CAT I
    Not isolated from all other commons.
    Type: Bi-directional 20 mA current loop, 20 mA source provided on transmit loop. (Powers up to 7 units in a loop with internal current source).
    Baud Rate: programmable 300 to 2400
    Maximum address: 99 (Actual number in a single loop is limited by serial hardware specifications.)

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.3) H x 5.5" (140) W.



APPENDIX "C" - SPECIFICATIONS (Cont'd)

Data Format: 10 bit frame, Odd parity *(one start bit, 7 data bits, one odd parity bit, and one stop bit.)*

Serial Hardware Specifications:

SO - Output Transistor Rating:

V_{max} = 30 VDC, V_{SAT} = 1 V_{max} at 20 mA.

Note: This will allow up to 28 units max. in each loop.

SI - Input Diode Rating: $V_F = 1.25\ V_{TYP}$; 1.5 V_{max}

Note: The compliance voltage rating of the source must be greater than the sum of the voltage drops around the loop. (Typically, a 30 VDC powered source would be capable of operating between 18 and 22 units in a loop.)

18. **ALARMS (Optional):**

Solid State: Two, isolated, sinking open collector NPN transistors acting in parallel with relays. V_{SAT} = 1 V @ 100 mA max. V_{max} = 30 VDC.

Isolation To Signal & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V max., CAT I

Not isolated from all other commons.

Relays:

Isolation To Signal & User Input Commons: 2300 Vrms for 1 min.

Working Voltage: 300 V max., CAT I

Type: Form C (2)

Max. Rating: 5 Amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 hp @ 120 VAC *(inductive load)*.

Relay Life Expectancy: 100,000 cycles at max. rating. (As load level decreases, life expectancy increases.)

19. **ANALOG OUTPUT (Optional):** Digital scaling and offsetting.

Isolation To Signal & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V max., CAT I

Not isolated from all other commons.

4 to 20 mA:

Accuracy: 0.1% of full scale

Resolution: 12 bits

Compliance Voltage: 10 VDC *(500 ohms max. loop resistance)*

0 to 10 VDC:

Accuracy: ± (0.1% of reading +35 mV)

Resolution: 12 bits

Min. Load Resistance: 10 KΩ *(1 mA max.)*

20. **PEAK/VALLEY/SLOPE/OFFSET (Optional):**

Peak and Valley recording. Programmable temperature offset and slope.

21. **CERTIFICATIONS AND COMPLIANCES:**

SAFETY:

IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1.

IP65 Enclosure rating (Face only), IEC 529

Type 4 Enclosure rating (Face only), UL50

ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2		
Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact [1] Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [2] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz
Emissions to EN 50081-2		
RF interference	EN 55011	Enclosure class A Power mains class A

Notes:

1. Metal bezel of unit connected with ground lead from rear bezel screw to metal mounting panel.

2. Self-recoverable loss of performance during EMI disturbance at 10 V/m:

Process input and/or analog output signal may deviate during EMI disturbance.

For operation without loss of performance:

Unit is mounted in a metal enclosure (Buckeye SM7013-0 or equivalent)

I/O and power cables are routed in metal conduit connected to earth ground.

Refer to the EMC Installation Guidelines for additional information.

22. **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).This unit is rated for NEMA 4/IP65 indoor use. Pollution Degree 2

23. **CONNECTION:** Fixed and Removable terminal blocks.

24. **WEIGHT:** 1.2 lbs *(0.6 kg)*

APPENDIX "D" - TROUBLESHOOTING GUIDE

The majority of all problems with the indicator can be traced to improper connections or improper programming set-ups. Be sure all connections are clean and tight and check the programming set-ups for correct data.

For further technical assistance, contact technical support at the appropriate company numbers listed on the back cover of the instruction manual.

PROBLEM	POSSIBLE CAUSE	REMEDIES
NO DISPLAY	1. Power off, improperly connected, or brown-out.	1a. Check wiring. 1b. Verify power.
"PPPPPP" IN DISPLAY	1. Program data error.	1. Press "P" and Check data set-ups.
FLASHING DISPLAY	1. Integrator/Totalizer overflow.	1a. Reset integrator/totalizer.
"....." IN DISPLAY	1. Input display out of range. 2. Display overflow.	1. Check for electrical disturbance. 2a. Check data set-ups. 2b. Check for electrical disturbance. 2c. Disconnect and reconnect power.
DISPLAY WANDERS	1. Loss of data set-ups.	1a. Check data set-ups. 1b. Disconnect and reconnect power. 1c. Check for electrical disturbance.
JITTERY DISPLAY	1. Electrical "Noise" in process or sensor lines. 2. Process inherently unstable. 3. Corroded or dirty thermocouple wire connections.	1a. Increase digital filtering. 1b. Re-route sensor wires. 2. Dampen process to eliminate oscillations. 3. Clean and tighten connections.
"OPEN" IN DISPLAY	1. Probe unconnected. 2. Broken or burnout probe.	1. Connect probe. 2. Repair or obtain new probe.
"OLOLOL" IN DISPLAY	1. Excessive positive probe temperature.	1. Reduce temperature.
"ULULUL" IN DISPLAY	1. Excessive negative probe temperature.	1. Increase temperature.

APPENDIX "E" - PROGRAMMABLE FUNCTIONS

Programming of the indicator is divided into modular steps. Each module is a short sequence of data entries. The front panel buttons *"UP"* and *"DOWN" (shown as "arrows" on the front panel)* are used to change the data and set-ups, while the *"P"* button is used to *save* or *enter* data. After pressing *"P"*, which gains entry into the programming mode, the programming modules are identified by the message *"Pro"* and a number in the display. *"UP"* and *"DOWN"* are used to select the desired programming module and *"P"* is used to enter it. All of the subsequent programming steps follow the same procedure. The rear terminal labeled *"PGM. DIS."* must be ungrounded to gain access to programming.

The following table lists the programming steps.

"Pro 0" - RETURN TO MEASUREMENT MODE

"Pro 1" - PROGRAM THERMOCOUPLE TYPE, SCALE AND RESOLUTION

" tYPE"	-	Enter thermocouple type (T=0;E=1;J=2;K=3;R=4;S=5;B=6;N=7;mV=8)
"SCALE"	-	Enter temperature scale (F or C)
"dECPNt"	-	Enter resolution (0 or 0.0)

"Pro 2" - PROGRAM TEMPERATURE SLOPE AND OFFSET

"SLOPE"	-	Enter display slope (0.0001 to 9.9999)
"OFFSEt"	-	Enter offset (-999 to +9999)

"Pro 3" - PROGRAM FUNCTIONS ACCESSIBLE WITH FRONT PANEL LOCKOUT ENGAGED

"dSP AL"	-	Enable display alarms
"ENt AL"	-	Enable enter alarms †
"dSPHYS"	-	Enable display hysteresis
"ENtHYS"	-	Enable enter hysteresis †
"rSt AL"	-	Enable reset latched alarms
"dSPbUF"	-	Enable display of peak/valley readings
"rStbUF"	-	Enable reset of peak/valley readings †
"SELdSP"	-	Enable switching display between input and total
"rSttOt"	-	Enable reset total
"dSPOFF"	-	Enable display of offset value
"ENtOFF"	-	Enable enter offset value †

"Pro 4" - PROGRAM DIGITAL FILTERING AND REMOTE INPUT FUNCTION

"FILtEr"	-	Enter level of digital filtering
0	-	no digital filtering
1	-	normal filtering
2	-	increased filtering
3	-	maximum filtering
"E1-CON"	-	Enter function of remote input
0	-	re-zero input
1	-	reset total
2	-	reset and gate totalizer
3	-	gate totalizer
4	-	display hold
5	-	reset peak/valley
6	-	reset peak and start peak indicator
7	-	reset valley and start valley indicator
8	-	reset latched alarms
9	-	reset all alarms
10	-	toggle display between input and total
11	-	offset input to zero and totalize the offset values
12	-	display hold with tare
13	-	instrument reading with synchronization
14	-	print request
"E2-CON"	-	Same functions as E1-CON

"Pro 5" - PROGRAM TOTALIZER

"dECPNt"	-	Enter decimal point for totalizer
"tbASE"	-	Enter time base
0	-	second
1	-	minute
2	-	hour
"SCLFAC"	-	Enter multiplying scale factor
"Lo-cut"	-	Enter low-signal cut out

† - *This sequence may be subject to being locked-out due to other programmed sequences.*

APPENDIX "E" - PROGRAMMABLE FUNCTIONS (Cont'd)

"Pro 6" - PROGRAM ALARMS

"trAc"	-	Enable alarm value tracking
"dISP"	-	Enable display alarm annunciators
"LAtC-1"	-	Enable alarm #1 latching
"ASN-1"	-	Enter alarm #1 trigger source (temp. or integrator/totalizer)
"AL-1"	-	Enter alarm #1 value
"HYS-1"	-	Enter hysteresis value for alarm #1
"Act-1"	-	Enter alarm #1 action (high or low)
"LAtC-2"	-	Enable alarm #2 latching
"ASN-2"	-	Enter alarm #2 trigger source (temp. or integrator/totalizer)
"AL-2"	-	Enter alarm #2 value
"HYS-2"	-	Enter hysteresis value for alarm #2
"Act-2"	-	Enter alarm #2 action (high or low)

"Pro 7" - PROGRAM SERIAL COMMUNICATIONS

"bAud"	-	Enter baud rate
"AddrES"	-	Enter loop address number (0-99)
"Print"	-	Enter print function, or "P" command function through Serial Option
0	-	temp.
1	-	temp., peak/valley, and offset
2	-	temp. and alarms
3	-	temp., peak/valley, alarms, hysteresis, and offset
4	-	totalizer
5	-	temp., and totalizer
6	-	temp., totalizer, peak/valley, and offset
7	-	totalizer and alarms
8	-	temp., totalizer, and alarms
9	-	temp., totalizer, peak/valley, alarms, hysteresis, and offset
"FULL"	-	Enable complete or abbreviated printing

"Pro 8" - PROGRAM RE-TRANSMITTED ANALOG OUTPUT

"ASIN"	-	Select source of analog output (input or total)
"AN-Lo"	-	Enter 4 mA or 0 VDC display value
"AN-HI"	-	Enter 20 mA or 10 VDC display value

"Pro 9" - SERVICE OPERATIONS (Protected by access code)

"Code 39"	-	Serial hardware (loop-back) test
"Code 48"	-	Basic input and cold junction calibration
"Code 66"	-	Reset programming to factory configuration

APPENDIX "F" - ORDERING INFORMATION

MODEL NO.	DESCRIPTION	TOTALIZER/ PEAK/VALLEY/ SLOPE/OFFSET E2-CON	DUAL ALARM	SERIAL COMMUNICATIONS	ANALOG OUTPUT	PART NUMBERS FOR 115/230 VAC
IMT	Intelligent Meter for Thermocouple Inputs	NO	NO	NO	NO	IMT00060
		NO	YES	NO	NO	IMT00062
		YES	NO	NO	NO	IMT02060
		YES	NO	YES	NO	IMT02061
		YES	YES	NO	NO	IMT02062
		YES	NO	NO	4 to 20 mA	IMT02063
		YES	YES	YES	4 to 20 mA	IMT02067
		YES	YES	YES	0 to 10 VDC	IMT02069
For information on Pricing, Enclosures & Panel Mount Kits refer to the RLC catalog or contact your local RLC distributor.						

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 and relies on no other warranties or affirmations.

IMT/IM-K 3/05
DRAWING NO. LP0195

Red Lion Controls
20 Willow Springs Circle
York PA 17402
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839

Red Lion Controls BV
Basicweg 11b
NL - 3821 BR Amersfoort
Tel +31 (0) 334 723 225
Fax +31 (0) 334 893 793

Red Lion Controls AP
31, Kaki Bukit Road 3,
#06-04/05 TechLink
Singapore 417818
Tel +65 6744-6613
Fax +65 6743-3360