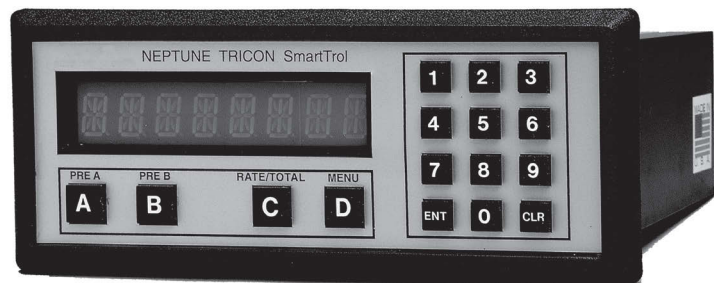




# TRICON<sup>®</sup> SmartTrol<sup>™</sup>



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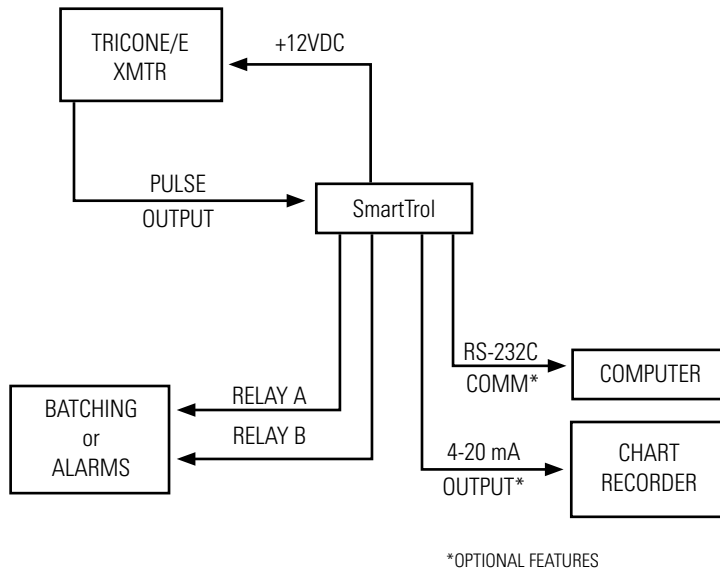
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## CHAPTER 1 INTRODUCTION

The Neptune SmartTrol™ is a versatile microprocessor-based controller for use with TRICON/E® electronic registers. The main function of the unit is to display rate and totalization values and control relays for batching or alarming. The SmartTrol allows two meter flows to be measured, separately scaled for both rate and total, then combined into one overall rate and one total. This dual input capability permits the SmartTrol to be used with TRU/FLO® and PROTECTUS® meters having two separate measuring elements to monitor flow.

**CHAPTER 2 TYPICAL APPLICATION**

In the illustration below, the SmartTrol is used to power a single TRICON/E transmitter which, in turn, provides digital pulses to the SmartTrol. The SmartTrol scales the pulse input to determine rate of flow and total quantity through the meter. The SmartTrol then uses the rate of flow or total values to operate two relays which may be used for single or two-stage batching, or under/over alarming. The SmartTrol may be ordered with optional RS-232C serial communications, or 4-20 mA analog output, or both.



### CHAPTER 3 OPERATING THE SMARTTROL

When power is initially applied, the SmartTrol is in the normal operating mode in which Total, Grand Total, and Rate are available for view.

To view Total, Grand Total, or Rate, apply power.

Press	Display	
	VER # . #	(Displayed 1 second)
	#####	(Current value of Total)

When power is applied to the SmartTrol, the current value of Total is displayed as indicated. Total remains on the display until another variable is selected. Total represents the volume of liquid through the meter since Total was last reset. The value of Total is preserved when power is removed from the SmartTrol and is restored when power is reapplied. Total is updated only while power is applied.

To display Grand Total,

Press	Display	
ENT	GR TOTAL	(Display 1 second)
	#####	(Current value of Grand Total blinks)

Grand Total also represents the volume of liquid through the meter since Grand Total was last reset. Like the value of Total, Grand Total is preserved when power is removed from the SmartTrol, and is restored when power is reapplied. Grand Total is updated only while power is applied.

To return the display to Total,

Press	Display	
ENT	#####	(Current value of Total)

To display Rate,

Press	Display	
C (Rate Total)	R #####	(Current value of Rate)

Notice when Rate is displayed, the first character position on the display is "R". Rate represents the volume of liquid passing through the meter in some unit of time such as gallons per minute.

To return the display to Total,

Press	Display	
C (Rate/Total)	#####	(Current value of Total)

Before using the SmartTrol you must program several setup values from the Setup Menu. Fill out the Worksheet (Page 18) using the instructions beginning on Page 19. Instructions for setting up the SmartTrol begin on Page 25. To enter the Menu from the normal operating mode, press the "D" (MENU) key.

## CHAPTER 4 GENERAL DESCRIPTION AND PRINCIPLES OF OPERATION

### 4.1 DISPLAY

The SmartTrol shows one of three different variables on its 8-digit, alphanumeric displays: Total, Grand Total, or Rate. Total is typically the volume through the meter in units such as gallons, cubic feet, or cubic meters. Grand Total is similar to Total but continues to count when Total is reset (very useful for many batching operations). Rate is the volume flowing through the meter per unit of time. Since Rate and Total values are scaled independently, different units may be used for each, e.g., Rate displayed in gallons/minute and Total in cubic feet.

### 4.2 RESETS

Resets return the value of Total or Grand Total to a predetermined point to begin counting up to or counting down from. Resets may be manually entered through the keypad by pressing the "CLR" key, remotely entered by applying 3 to 30 VDC pulse for a minimum of 5 seconds to Pin 5, or by a host computer via RS-232C communications. The SmartTrol may also be programmed to reset automatically when the endpoint is reached.

### 4.3 PRESETS

Presets are the values of Total or Grand Total the totalizer must reach, or the Rate of flow the ratemeter must register, to trigger relay operation. Total may be configured to count up from zero after a reset, or to count down from the preset value to zero after reset. Grand Total will only count up from zero to the preset value after a reset.

### 4.4 RELAYS

The SmartTrol may be used for monitoring or for control purposes, such as batching. There are two control relays in the SmartTrol whose operations are based on preset values of Rate, Total, or Grand Total. Each relay may be programmed to its own preset value. The presets can be programmed to allow two-stage stepping of a process providing precise control of a dispensing or blending application. For batching applications, an Auto Reset mode can be selected for continuous blending processes. When Total or Grand Total values are used, relay duration may be set from 1 to 99 seconds or minutes. NOTE: RELAY OPERATION IS DISABLED WHEN THE MENU FUNCTION IS ENTERED.

### 4.5 K FACTOR

The K Factor is divided into the input pulse to convert them into convenient units of measurement. Separate K Factors are entered into the rate and counter sections of the SmartTrol for each input, and K Factors may be mixed. Thus, you may batch (totalize) in gallons and display Rate in cubic feet per hour.

#### 4.6 RATEMETER

The ratemeter selection of the SmartTrol calculates Rate based on time between pulses from a maximum of two inputs. The resulting value of input pulses per second is then divided by the K Factor to display the Rate in units of volume per time.

#### 4.7 COUNTER

The counter section of the SmartTrol divides pulses from a maximum of two inputs by the Count K Factors to determine Total and Grand Total volumes through the meter in convenient units of volume.

#### 4.8 LOCKOUT

Once the SmartTrol is configured and operating, unauthorized changes can be prevented by use of a lock-out code that must be entered to allow modification of the configuration. The code may be modified periodically to maintain secure operations.

#### 4.9 RS-232C COMMUNICATIONS

The SmartTrol may be ordered with RS-232C computer communications. This option allows the SmartTrol to communicate with virtually any computer that has an RS-232C serial communications port. The data in the SmartTrol may be read or modified by computer to allow customization of the process. In addition, up to 15 SmartTrols may be tied to the same RS-232C port providing a path for future expansion.

#### 4.10 4-20 mA OUTPUT

The 4-20 mA option produces an analog output that is scaled based on Rate as calculated by the SmartTrol. You may select the upper and lower limits of Rate corresponding to the 4-20 mA range appropriate for the application.

#### 4.11 ENTERING DECIMAL POINTS

To include a decimal point as part of the number entered through the keypad, press the "D" button after the digit that you would like to place the decimal point. The decimal point will appear to the right of that digit.



**CHAPTER 5 SPECIFICATIONS**

- HOUSING: High-impact plastic case with NEMA 4X front panel.
- DIMENSIONS: Reference 6.2, Page 12.
- DISPLAY: 8-character, 0.55" high, 15 segment, red-orange LED.
- INPUT POWER: 110 VAC +/- 15% or 12 to 27 VDC.
- CURRENT: 5.3 VA at rated AC voltage or maximum 280 mA DC.
- OUTPUT POWER: (On AC power units only) +12 VDC at 100 mA  
Separate isolated 12 VDC at 100 mA to allow +/- 12 VDC or +24 VDC, regulated +/- 5% worst case.
- TEMPERATURE: Operating: +32° F (0° C) to +130° F (+54° C).  
Storage: -40° F (-40° C) to +200° F (+93° C).
- MEMORY: EEPROM stores all programming, display mode, and count data for a minimum of 10 years if power is lost.
- RESET: Front panel push button – “CLR” resets displayed number and control output.  
  
Remote input (Terminal 5) – Open or 0 to 1 VDC (low), 3 to 30 VDC (high), 10K ohm input impedance to ground. Minimum pulse on/off time 5 msec.
- PULSE INPUT: High impedance pulse input. Open or 0 to 1 VDC (low), 3 to 30 VDC (high), 10K ohm input impedance.  
  
1KHz maximum speed (minimum on/off 25 usec).
- ANALOG OUTPUT: 4-20 mA sinking output, 3-24 VDC +/- 100 uA worst case.
- RELAY CONTACTS: 10 amp, 120/240 VAC or 28 VDC.

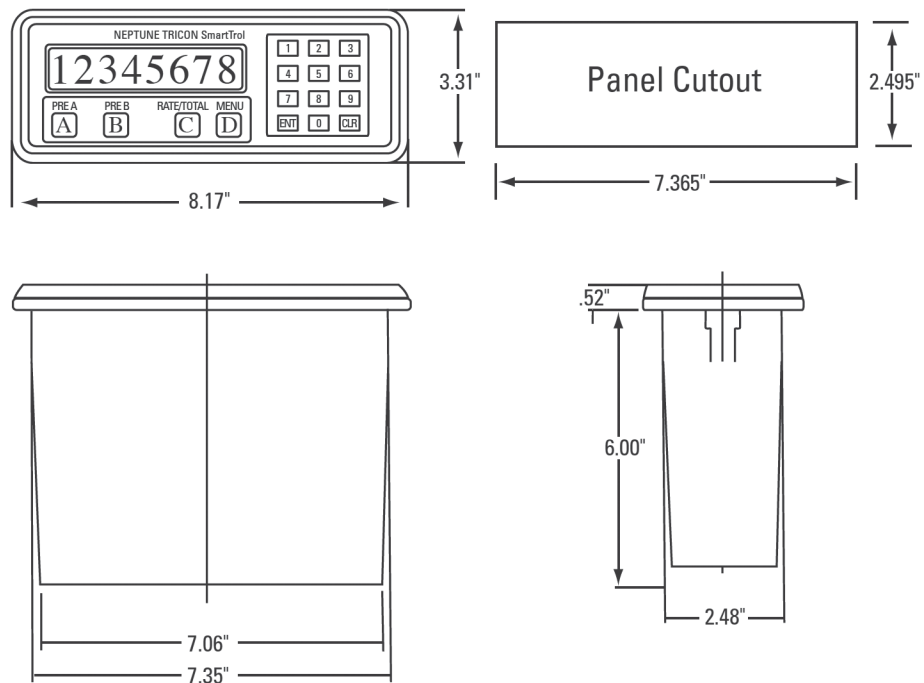
## CHAPTER 6 MOUNTING AND INSTALLATION

### 6.1 PANEL MOUNTING

The SmartTrol can be mounted in any panel with a thickness between .047" (1.2 mm) and .187" (4.7mm). It is shipped with two side mounting brackets and screws as well as a panel gasket. The gasket fits between the SmartTrol bezel and the front panel to form a NEMA 4 splash-proof assembly when properly panel-mounted.

To install the SmartTrol into a panel, slip the gasket over the case of the SmartTrol and set the gasket against the SmartTrol bezel. Insert the unit through the front of the panel until it engages the panel. Install the self-tapping screws provided in the mounting brackets and insert the brackets into the side slots of the unit. Tighten the screws firmly to attach the SmartTrol bezel to the panel.

### 6.2 DIMENSIONS



## CHAPTER 7 CONNECTIONS TO THE SMARTTROL

### 7.1 POWER CONNECTION FOR ALTERNATING CURRENT (AC)

(Refer to 7.5.1, Page 12)

Be certain all power is removed from the wire before connecting the power wiring to the SmartTrol. Also be sure that the power is 120 VAC to prevent damage due to application of incorrect voltage. Connect the AC power across terminals 17 and 18 on the large terminal block. Double-check all wiring before applying power to the SmartTrol.

### 7.2 POWER CONNECTION FOR DIRECT CURRENT (DC)

(Refer to 7.5.5, Page 15)

You may choose to power the SmartTrol with DC. Be certain that all power is removed from the wire before connecting the power wiring to the SmartTrol. Also be sure that the power is 12 to 27 VDC at .5 amp. Connect +DC to terminal 14 and ground to terminal 12 on the large terminal block. Double-check all wiring before applying power to the SmartTrol. If the SmartTrol is powered by DC, it cannot be used to provide DC power for TRICON/E operation. Use the same DC source to power both the SmartTrol and associated TRICON/E transmitters.

### 7.3 RELAY OUTPUT CONNECTION

(Refer to 7.5.1, Page 12 and 7.5.5, Page 15)

Be certain that all power wiring is de-energized before connecting relay outputs to controlled devices. The relay contacts are located on the six-pin terminal block. The relay associated with Preset A uses terminals 1 (normally open contact), 2 (normally closed contact), and 3 (common contact). The relay associated with Preset B uses terminals 4 (normally open contact), 5 (normally closed contact), and 6 (common contact).

### 7.4 4-20 mA OPTION

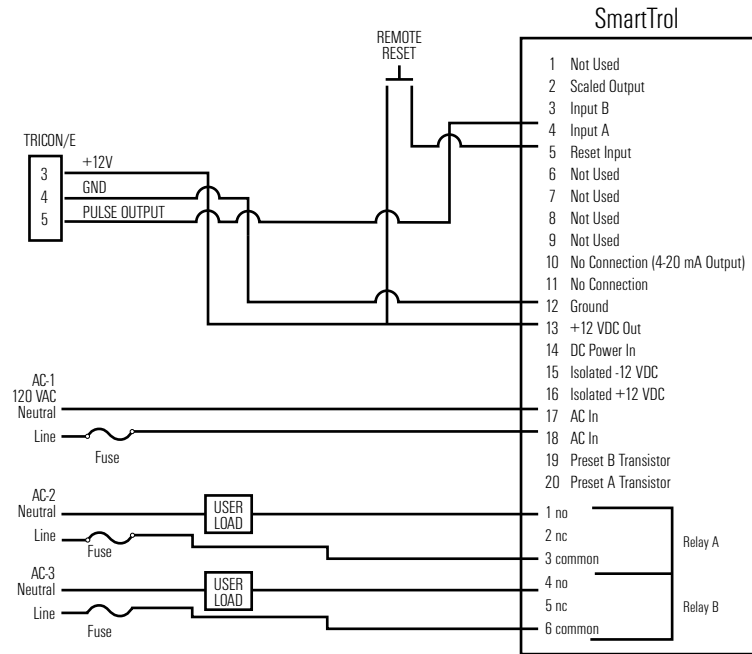
(Refer to 7.5.4, Page 14)

The 4-20 mA output option is connected to terminal 10 of the large terminal block. The output sinks current from a voltage source. The receiving instrument (Ammeter) must NOT be ground-referenced in order to be compatible with this output.

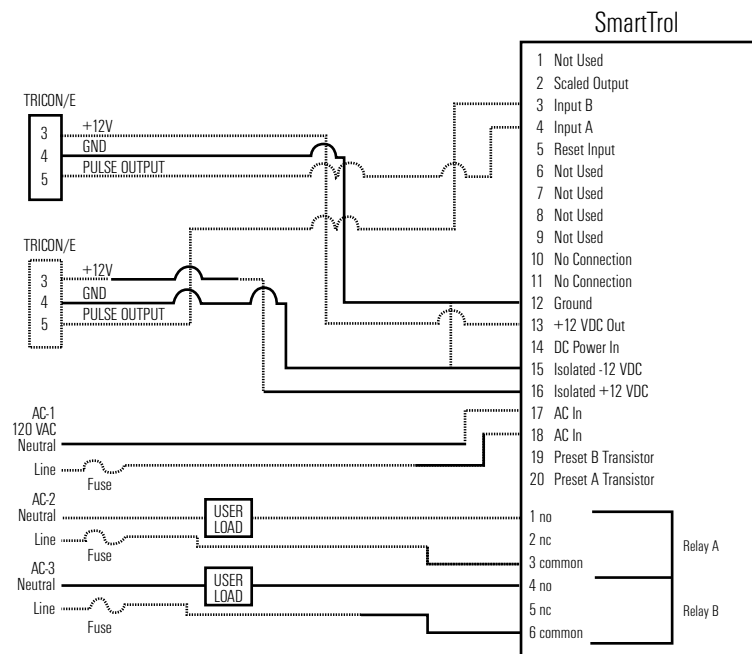
### 7.5 SCHEMATICS

The following pages illustrate the SmartTrol in various configurations and wiring for each. Your specific application may not be represented, but it may be a composite of several of the illustrations provided.

### 7.5.1 SmartTrol and Single TRICON/E Transmitter with Pulse Output and Remote Reset

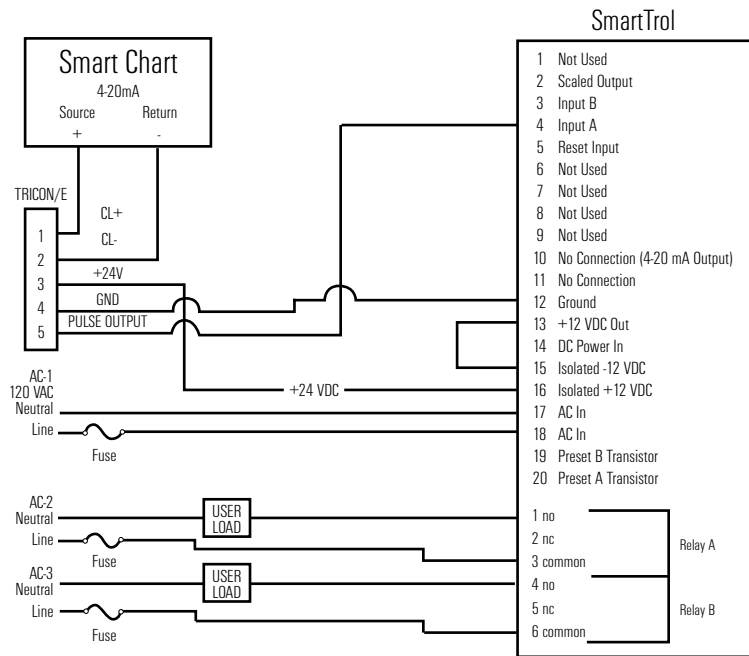


### 7.5.2 SmartTrol and Two TRICON/E Transmitters with Pulse Output and Remote Reset

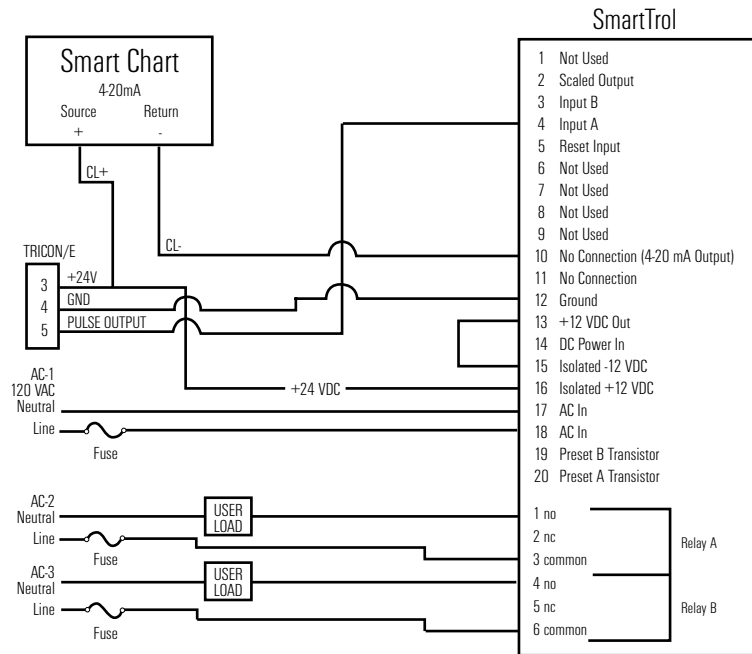


### 7.5.3 SmartTrol and 4-20 mA TRICON/E and SmartChart

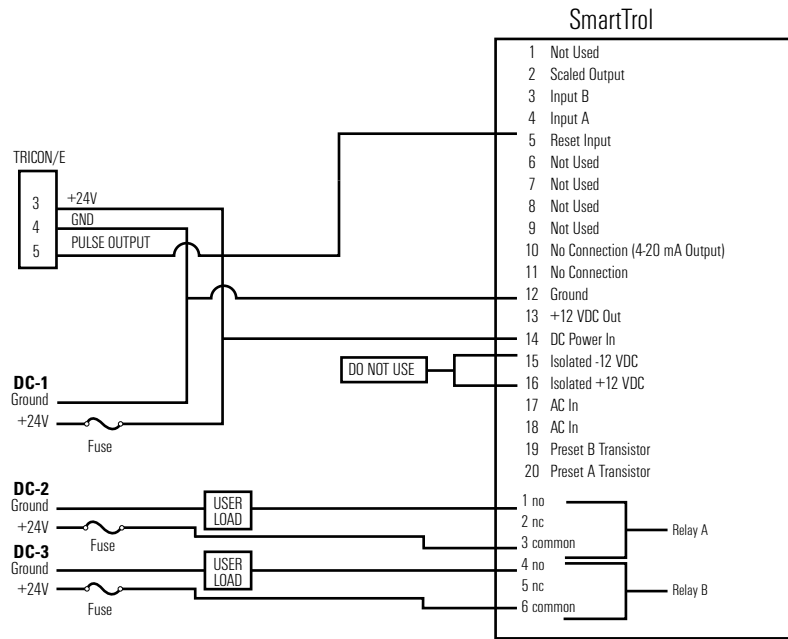
4-20 mA TRICON/E must be powered by 24 VDC. The SmartTrol is able to produce 24 VDC by “stacking” two independent 12 VDC power supplies. Configure the SmartTrol to provide +24 VDC by tying the +12 VDC (PIN 15). This jumper causes +24 VDC to appear across PIN 16 referenced to ground (PIN 12).



### 7.5.4 SmartTrol with 4-20 mA Output Option and SmartChart and Single TRICON/E Transmitter with Pulse Output

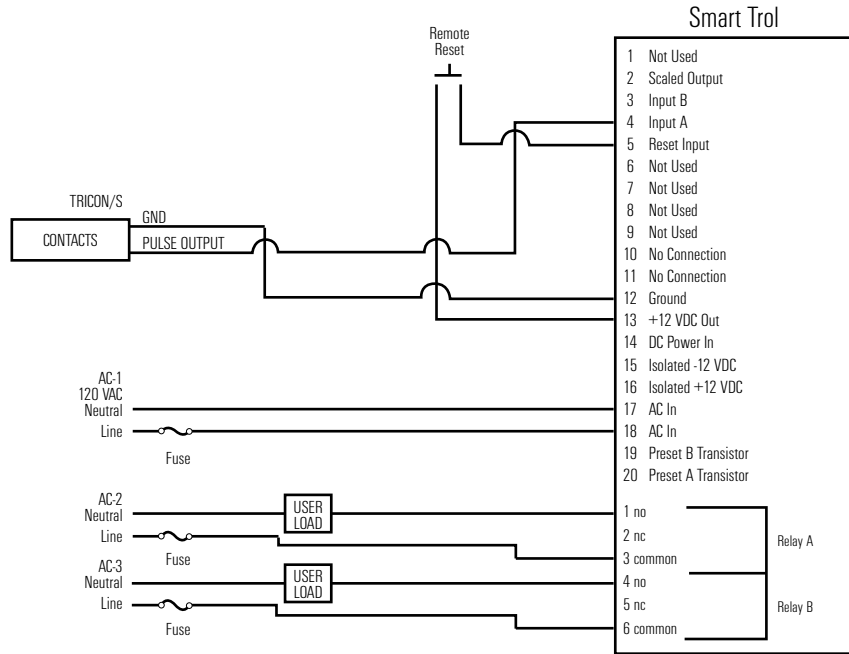


### 7.5.5 SmartTrol Powered by +24 VDC, Relays Controlling +24 VDC, and Single TRICON/E Transmitter with Pulse Output



The SmartTrol may be powered by an external DC power supply. The supply must provide 12-27 VDC and at least 250 mA of current. The positive side (+DC) of the supply should be connected to terminal 14 and the negative (or ground) side to terminal 12. Units Powered by DC voltage do not have an isolated voltage on terminals 15 and 16.

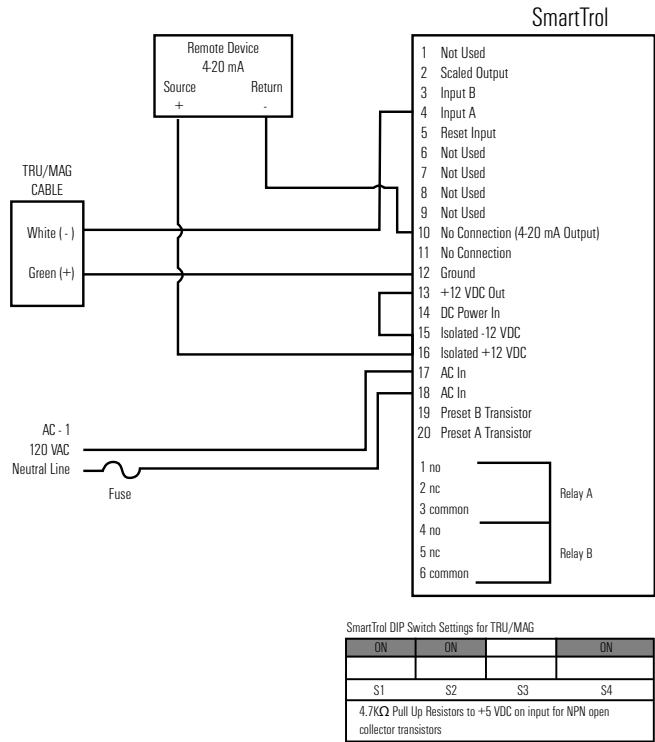
### 7.5.6 SmartTrol and Single TRICON/S Transmitter with Pulse Output and Remote Reset



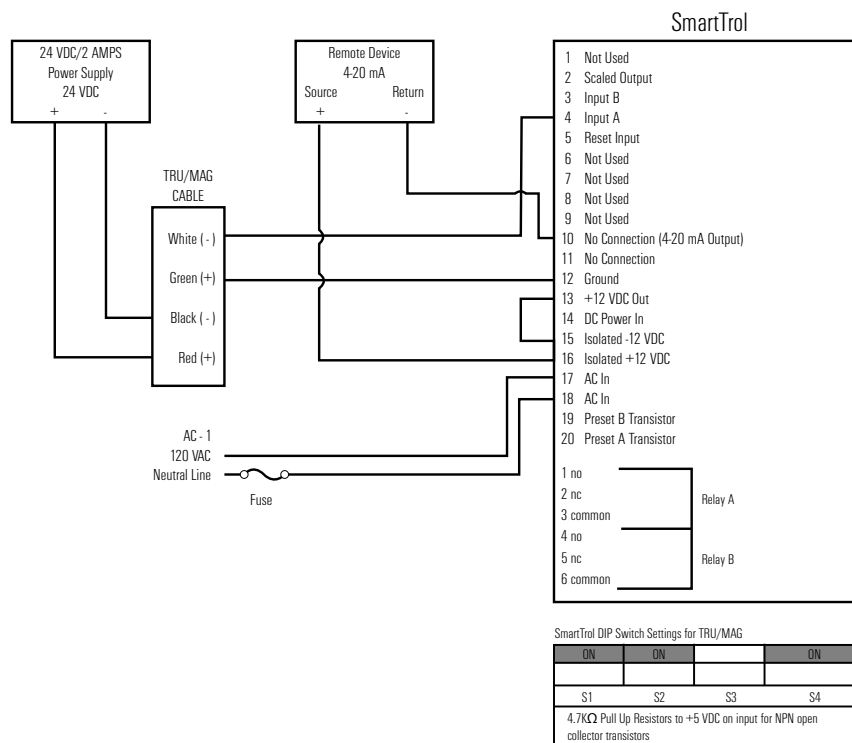
NOTE: The SmartTrol must be ordered from the factory configured for use with the TRICON/S.



### 7.5.7 SmartTrol with 4-20 mA Output Option and Remote Device and Battery-Powered TRU/MAG™



### 7.5.8 SmartTrol with 4-20 mA Output Option and Remote Device and DC-Powered TRU/MAG



**CHAPTER 8 PROGRAMMING WORKSHEET**

CONFIGURED BY: \_\_\_\_\_ DATE: \_\_\_\_/\_\_\_\_/\_\_\_\_  
 MODEL NUMBER: \_\_\_\_\_ APPLICATION: \_\_\_\_\_  
 CALCULATION AREA \_\_\_\_\_

**COUNTER**

K FACTOR A \_\_\_\_\_  
 K FACTOR B \_\_\_\_\_  
 RESET TO 0 \_\_\_\_\_ RESET TO PRESET \_\_\_\_\_  
 AUTOMATIC RESET \_\_\_\_\_ MANUAL RESET \_\_\_\_\_  
 DECIMAL LOCATION # # # # # # # # # #  
 8 7 6 5 4 3 2 1

**RATEMETER**

K FACTOR A \_\_\_\_\_  
 K FACTOR B \_\_\_\_\_  
 WEIGHT \_\_\_\_\_  
 WINDOW \_\_\_\_\_  
 SIG. FIG. \_\_\_\_\_  
 LOCK OUT CODE \_\_\_\_\_  
 RS-232C COMMUNICATIONS (SKIP IF UNIT DOES NOT HAVE OPTION)  
 UNIT NUMBER \_\_\_\_\_

**BAUDRATE**

300 \_\_\_\_ 600 \_\_\_\_ 1200 \_\_\_\_ 2400 \_\_\_\_ 4800 \_\_\_\_ 9600 \_\_\_\_

PARITY BIT

EVEN \_\_\_\_ ODD \_\_\_\_ SPACE \_\_\_\_ MARK \_\_\_\_

4-20 mA OUTPUT (SKIP IF UNIT DOES NOT HAVE OPTION)

LOW LIMIT RATE VALUE \_\_\_\_\_

HIGH LIMIT RATE VALUE \_\_\_\_\_

RELAY OPERATION

DURATION IN SEC. \_\_\_\_\_ MIN. \_\_\_\_\_

RELAY A COMPARISON TO:

RATE \_\_\_\_\_ TOTAL \_\_\_\_\_ GRAND TOTAL \_\_\_\_\_

OUTPUT DURATION \_\_\_\_\_

RELAY B COMPARISON TO:

RATE \_\_\_\_\_ TOTAL \_\_\_\_\_ GRAND TOTAL \_\_\_\_\_

OUTPUT DURATION \_\_\_\_\_

PRESET A \_\_\_\_\_

PRESET B \_\_\_\_\_

## CHAPTER 9 USING THE WORKSHEET

The worksheet is an aid to help in setting the operating configuration of the SmartTrol. By filling out the worksheet first, all the data needed to program the unit is in front of you during programming. This makes programming the unit as simple as selecting items from a menu. The following function definitions will aid in the proper selection of setup values for the application. Refer to the TRICON/E specification sheet (Page 33) as necessary for pulse output constants.

### 9.1 COUNTER

The counter takes up to two pulse inputs, A and B, scales each using separate K Factors, and sums the resulting scaled counts into a single Total. (If only one input is active, then only the counts from that input are used.) The scaled counts are then used to update the Total and Grand Total values in the SmartTrol. The counter is set up by entering selections for five parameters.

#### 9.1.1 K Factor A and K Factor B (Counter)

These factors are divided into the associated incoming pulses to develop the overall Total in the desired units of volume. The K Factor is the number of TRICON/E output pulses per unit of volume. The SmartTrol uses the K Factor for the following calculation:

$$\frac{\text{Input pulses}}{\text{K Factor}} = \frac{\text{Input pulses}}{\text{Pulses per unit of volume}} = \text{Total and Grand Total displayed in units of volume}$$

Using the 4" Trident Turbine as an example, the TRICON/E produces a pulse output for each 1.6 gallons through the meter (reference the TRICON/E specification sheet). Using 1.6 as the K Factor, Total, and Grand Total values would then be displayed as gallons.

$$\frac{\text{Input pulses}}{1.6 \text{ pulses/gallons}} = \text{Total and Grand Total displayed in gallons}$$

##### 9.1.1.1 Fractional Units of Volume

You may want to display Total and Grand Total in fractional quantities such as tenths or hundredths of gallons. To change the display, divide the K Factor by 10 or 100 respectively and enter the new value (including the new decimal point). (The physical location of the display decimal point is set in a later step, 9.1.4, Page 21.) In the previous example, suppose you wanted Total Grand Total to be displayed in tenths of gallons.

$$\frac{\text{K Factor}}{10} = \frac{1.6}{10} = 1.6$$

Notice the decimal point to the left. Total and Grand Total will be displayed in tenths of gallons.

### 9.1.1.2 Changing Units of Volume

The K Factor also may be modified so that the displayed values of Total or Grand Total are in units of measurement instead of gallons. To change the display from gallons to cubic feet, multiply the K Factor by 7.4805, which is the number of gallons per cubic foot. To change the display from gallons to cubic meters, multiply the K Factor by 264.172, the number of gallons per cubic meter.

In the previous example of the 4" Trident Turbine, to display Total or Grand Total in cubic feet, the K Factor of 1.6 pulses per gallon is multiplied by 7.4805. So:

$$1.6 \text{ pulses/gallon} \times 7.4805 \text{ gallons/cubic foot} = 11.9688 \text{ pulses/cubic foot}$$

Setting the K Factor to 11.9688 would then display Total and Grand Total in cubic feet for the 4" Trident Turbine.

### 9.1.1.3 "DataLost"

If the value of the K Factor is less than .0001, or the factored counts exceed 30,000 per second, the counter will be unable to keep up with the counts and "DATA LOST" will appear on the display during operation of the SmartTrol. If this message appears, the appropriate K Factor must be increased in value.

## 9.1.2 Reset to Zero or Set to Preset

The selection of the counter operation depends on the application. For simple monitoring of volume through the meter, the selection would be "Reset to Zero". This mode is normal for volume measurement where the Total would be reset to zero, then increase, as water passes through the meter.

For some batching applications, it is preferable to inject a fixed amount of water into some process. It may be easier to track the process if, upon reset, the Total is set to the batch volume and decremented as the water is injected. The end point of the batch, zero, would be the same no matter the injected volume. This mode is chosen by selecting "Set to Preset" for the counter operation.

## 9.1.3 Automatic or Manual Reset

This function determines what happens to the Total upon reaching the end point (preset value for counting up, zero for counting down). If "Manual" mode is selected, the Total will continue to be updated after reaching the end point. The reset, either from panel or external input, would have to be active to reset the counter. In the Automatic mode, the counter is automatically reset upon reaching the endpoint (reset to zero if counting up, reset to the preset value if counting down).

### 9.1.4 Decimal Location

In a previous example (9.1.1), the K Factor was divided by ten to display Total and Grand Total in tenths of gallons. The decimal point for the display must be set so that the value displayed using the decimal point will be the total in gallons, and the value displayed not using the decimal point will be the total in tenths of gallons. To make this adjustment, the decimal location must be moved between the lowest and second lowest digits of the display. Selecting a decimal location of "2" will properly set the decimal point so that Total and Grand Total in gallons will be the "#####.#" value and tenths of gallons will be the "#####" value.

## 9.2 RATEMETER

The Ratemeter calculates the rate of flow through the meter. It converts the output pulse from up to two TRICON/E registers into convenient units of measurement by using two separate scaling factors. The two input rates are scaled and combined into one rate that is the Total Rate from both inputs. To program the Ratemeter portion of the SmartTrol, there are five parameters that must be entered.

### 9.2.1 K Factor A and K Factor B (Rate)

These scaling factors are used to convert the input pulses into units of volume per unit of time, such as Gallons per Minute. K Factor A is the scaling factor associated with input A while K Factor B is associated with Input B. The SmartTrol first converts input pulses into pulses per second and then divides the input pulses per second by the K Factor, producing Rate which is displayed. The K Factor for Rate to be displayed in units per minute may be determined by the following formula:

$$\frac{\text{Pulse per unit of volume}}{\text{seconds/minute}} = \frac{\text{Pulse per unit of volume}}{\text{volume per minute}} = \text{Rate K Factor}$$

For example, a TRICON/E for a 4" Trident Turbine outputs 1.6 pulses per gallon (reference the TRICON/E specification sheet).

Thus:

$$\frac{1.6 \text{ pulses per gallon}}{60 \text{ seconds per minute}} = 0.02667 = \text{Rate K Factor}$$

Entering a K Factor of 0.02667 will display the Rate in gallons per minute.

#### 9.2.1.1 Changing Units of Time

You may choose to display the Rate of flow in another quantity of time such as hours. To determine the proper K Factor, divide pulses per gallon by the flow rate in gallons per hour, the calculation would be:

$$\frac{1.6 \text{ pulses per gallon}}{3600 \text{ seconds/hour}} = 0.000444 = \text{K Factor}$$

Entering a K Factor of 0.000444 will display the Rate in gallons per hour.

### 9.2.1.2 Changing Units of Volume

You may choose to display the Rate of flow in other units of volume such as cubic feet. Just multiply the gallons K Factor by the appropriate value. In the example determining the K Factor for the 4" Trident Turbine Rate in gallons per minute, the K Factor was 0.02667. To display Rate in cubic feet per minute, multiply by 7.4805, the number of gallons per cubic foot. The calculation would be:

$$\text{Gallons/minute K Factor} \times 7.4805 = 0.02667 \times 7.4805 = .1995$$

With the K Factor set to .1995, Rate will be displayed in cubic feet per minute for the 4" Trident Turbine.

### 9.2.2 Weight

This value represents how much the value of Rate will change as the SmartTrol re-samples the input pulses to upgrade the Rate being displayed. The value can range from 0.0 to 9.9 as the weighting factor is increased. It is best to adjust this value to suit the application. Initially, set this value to 0.0. If the display rate changes too often (jitters), then the value of Weight can be increased in .1 increments.

### 9.2.3 Window

This quantity is the number of seconds the ratemeter will sample input pulses before making an update to the value of Rate being displayed. The 2- to 24-second "WINDOW" selected at setup is the maximum time the SmartTrol will wait for sufficient pulses to make an accurate calculation before it displays a Rate of "0". This function is used in some applications with low flow rates to prevent zero flow from being displayed instead of the low value of the actual flow. For most applications, the Window value should be set to 5.0.

### 9.2.4 Significant Figures

This function selects the number of significant figures (digits) displayed for the Rate value. This number may be set from one to six. For example, if the number of significant figures is set at three, a rate of 24737.89 will be displayed as 24700, and a rate of 0.739216 will be displayed as 0.739. Note that trailing zeros will be inserted only if necessary. Digits beyond the significant figure value are truncated and zeros are inserted as needed. No rounding is done. Use this function to select the number of digits needed for the application. Usually only four digits are needed to display the Rate properly.

### 9.3 LOCK OUT

This feature prevents unauthorized access of the SmartTrol. The 4-digit numeric code entered is used to lock out access to the Menu during operation. When the lock out feature is active, no values can be cleared or changed by keyboard entry. Simply entering the code while Total, Grand Total, or Rate is displayed will change the lock condition. Care must be taken in documenting the code to prevent being those authorized from being “locked out”.

The lock-out code is used during normal operating of the SmartTrol. Upon entering the lock-out code, the display should flash “LOCK ON” for one second. To disable the lock-out condition, enter the code one more time. The display will flash “LOCK OFF” for one second, and open access is established.

The SmartTrol is shipped with lock-out disabled and default code of “1000”.

### 9.4 OUTPUT CARD

For SmartTrols with the RS-232C option, the serial port configuration must be set to allow the SmartTrol to talk the same “language” as the host computer. The SmartTrol uses 7-bit ASCII code with start, stop, and parity bits included. In addition, the following parameters must be set.

#### 9.4.1 Unit Number

The unit number is used to identify which SmartTrol receives the communication. The unit number must be 1 to 15. Up to 15 SmartTrols may be connected to one RS-232C and communicate with the host computer.

#### 9.4.2 Serial or Parallel

This selection is always serial for the RS-232C option.

#### 9.4.3 Baud Rate

The Baud Rate is the communication rate in bits/second. It must be selected to match the host computer Baud Rate. The rate can be set to any of the following values: 300, 600, 1200, 2400, 4800, or 9600 baud.

#### 9.4.4 Parity

Parity is a form of error checking in the data transmission. The parity (even, odd, mark, space) should match the host computer.

### 9.5 ANALOG OUTPUT

For SmartTrols with the analog output option, this function allows setting of the output scale. The SmartTrol produces the 4-20 mA output based upon the display Rate and uses low and high limits to set the range of the output. For a Trident Turbine, the low limit could be “0” (corresponding to the zero flow) and the high limit could be set to “1000” (corresponding to 1000 GPM flow rate at maximum continuous flow). These values would set the output to 4 mA when zero flow occurred and 20 mA when the flow rate went to 1000 GPM.

The low and high limits may be customized to the application to provide higher resolution of the flow rate if the full range of flow rates is not used. If the flow rate was never less than 20 GPM and never more than 600 GPM, these values could be set to correspond to the 4 and 20 mA output levels respectively. For flow values in between the low and high setpoints, the output current is offset and proportionately scaled.

### 9.6 RELAY OPERATION

This function sets all parameters associated with relay operations with the exception of the actual preset values which will trigger the relays. Relay durations may be set in seconds or minutes. Relay A may be set to use the displayed value of Rate, Total, or Grand Total in comparison to the Preset A value. Relay B is independently set to use the display value of Rate, Total, or Grand Total in comparison to the Preset B value.

For each relay, if the comparison is selected as Total or Grand Total, then a duration value must be set ranging from 0 to 99. If 0 is selected as the duration value, then the relay will be latched on upon reaching the endpoint. For each relay, if the comparison is selected as Rate, then the relay will close whenever the Rate exceeds the preset value and open when the Rate falls below the preset value. Since the normally closed as well as the normally open contacts of the relay are available, this feature can be used for both over and under Rate alarming.

### 9.7 PRESETS

The value entered for Preset A and Preset B are the values used for comparison with Rate, Total, or Grand Total to actuate the respective relay. (Note: The same decimal location selected in the counter setup is also displayed in Preset A or B if the comparison is made with either Total or Grand Total values.)



## CHAPTER 10 SETTING UP THE SMARTTROL

The SmartTrol is configured by using the keyboard on the front panel of the unit. The Set Up Mode is entered by depressing the “D” key. In all cases, when “v” appears in the last position of the display, additional choices can be found by depressing the “D” key. Depressing the “ENT” key will select the choice being displayed. (Refer to the Worksheet.)

### 10.1 SETTING UP THE COUNTER

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
ENT	RTv CNTv
D	K FACT A (Displays 1 second) ##### (Current value blinks)
CLR	0 (Blinks) Key in new Counter K Factor A from worksheet
ENT	K FACT B (Displays 1 second) ##### (Current value blinks)
CLR	0 (Blinks) Key in new Counter K Factor B from worksheet
ENT	ROv SPv Press B for Reset to 0, press D for SET to Preset
ENT	ATv MANv Press B for Automatic Reset, press D for Manual Reset
ENT	DEC LOC Key in number for the appropriate decimal point location; Decimal point will appear at the designated spot on the display
ENT	SmartTrol returns to normal operating mode

### 10.2 SETTING UP THE RATEMETER

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
ENT	RTv CNTv
B	K Fact A (Display 1 second) ##### (Current value blinks)
CLR	0 (Blinks) Key in new Rate K Factor A from worksheet
ENT	K Fact B (Displays 1 second) ##### (Current value blinks)
CLR	0 (Blinks) Key in new Rate K Factor B from worksheet
ENT	WEIGHT#.# (Current value)
CLR	Key in new Weight value from worksheet
ENT	WINDOW## (Current value)
CLR	Key in new Window value from worksheet
ENT	SIGFIG## (Current value)
CLR	Key in new significant value from worksheet
ENT	SmartTrol returns to normal operating mode

### 10.3 SETTING UP THE LOCK OUT CODE

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
D	LOCKOUTv
ENT	CODE (Displays 1 second) ### (Current value blinks)
CLR	0 (Blinks) Key in new Code value from worksheet
ENT	SmartTrol returns to normal operating mode

### 10.4 SETTING UP THE OUTCARD FOR RS-232 COMMUNICATIONS

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
D	LOCKOUTv
D	OUTCARDv
ENT	UNIT ## (Current Unit #)
CLR	UNIT 00 Key in new Unit Number from worksheet
ENT	PLv SERV Press D for Serial communications
ENT	BAUDRATE (Displays 1 second) ####v (Current Baud Rate) Press D until Baud Rate value from worksheet is displayed
ENT	PARITY (Displays 1 second) ####v (Current Parity) Press D until Parity Bit from worksheet is displayed
ENT	SmartTrol returns to normal operating mode

### 10.5 SETTING UP THE 4-20 mA OUTPUT

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
D	LOCKOUTv
D	OUTCARDv
D	ALG OUTv
ENT	SET LOW (Displays 1 second) ##### (Current value blinks)
CLR	Key in new Rate Low Limit from worksheet for 4 mA output
ENT	SET HIGH (Displays 1 second) ##### (Current value blinks)
CLR	Key in new Rate High Limit from worksheet for 20 mA output
ENT	SmartTrol returns to normal operating mode

**10.6 SETTING UP THE RELAY OPERATION**

<b>PRESS</b>	<b>DISPLAY</b>
D	MENU (Displays 1 second) DEV TYP v
D	LOCKOUTv
D	OUTCARDv
D	ALG OUTv
D	RELAY v
ENT	SCV MINV Press B for Seconds, press D for Minutes
ENT	A #####v (Current Relay A comparison mode) Press D until Comparison mode from worksheet is displayed
ENT	DUR A ## (Duration of Relay A if Comparison mode is Total or Grand Total)
CLR	Key in new Output Duration from worksheet for Relay A, or if Comparison mode for Relay A is Rate
ENT	B #####v (Current Relay B comparison mode) Press D until Comparison mode from worksheet is displayed
ENT	DUR B ## (Duration of Relay B if Comparison mode is Total or Grand Total)
CLR	Key in new Output Duration from worksheet for Relay A, or if Comparison mode for Relay B is Rate
ENT	SmartTrol returns to normal operating mode

**10.7 SETTING UP PRESET A**

<b>PRESS</b>	<b>DISPLAY</b>
A	PRESET A (Displays 1 second) ##### (Current value blinks)
CLR	Key in new Preset A value from worksheet
ENT	SmartTrol returns to normal operating mode

**10.8 SETTING UP PRESET B**

<b>PRESS</b>	<b>DISPLAY</b>
B	PRESET B (Displays 1 second) ##### (Current value blinks)
CLR	Key in new Preset B value from worksheet
ENT	SmartTrol returns to normal operating mode

## CHAPTER 11 RS-232C SERIAL COMMUNICATION OPERATIONS

The RS-232C communications port provides the capability of obtaining information from the SmartTrol by a host computer. RS-232 is an EIA (ELECTRICAL INDUSTRY ASSOCIATION) specification for the electrical characteristics and signal assignments for a serial communication format. The SmartTrol expects the connection to the host computer to comply with the electrical characteristics for RS-232C. The SmartTrol is operated as Data Communications Equipment (DCE) and has connection pin assignments as follows:

### PIN ASSIGNMENTS

CONNECTOR PIN #	SIGNAL NAME	DESCRIPTION
2	RD	RECEIVED DATA (FROM HOST)
3	TD	TRANSMITTED DATA (TO HOST)
4	RTS	REQUEST TO SEND (FROM HOST)
5	CTS	CLEAR TO SEND (FROM SmartTrol)
6	DSR	DATA SET READY (FROM SmartTrol)
7	GND	SIGNAL GROUND
8	RSLD	RECEIVED SIGNAL DETECT
20	DTR	DATA TERMINAL READY (FROM HOST)

The SmartTrol only requires the TD, RD, and GND pins for normal operation. No control signals are controlled by the normal operation. No control signals are controlled by the SmartTrol for access control (handshaking). To enable most host devices to operate with the SmartTrol, the RTS and CTS lines are tied together in the SmartTrol. Also, DSR is internally connected to DTR and RSLD to give proper signal levels to the host computer.

Communication between the SmartTrol and the host computer has to be seven-bit ASCII code. The code is embedded in a serial word that has a parity bit, start bit, and stop bit. (Having eight data bits with no parity bit would be the same as seven data bits with parity selected to be a space). The total number of bits then is 10 bits per character.

The SmartTrol only communicates in response to commands from the host. To allow more than one SmartTrol to be connected onto the RS-232C port, each SmartTrol must have a unique number. This number is used to select the SmartTrol to which the command will be issued. To address a SmartTrol unit, the host must transmit a "D" (device) followed by the unit number (1 to 15) and a "Space". Once the SmartTrol receives the "Space", the SmartTrol selected becomes active and responds, "DEVICE#: n" (n is the unit number).

Once active, the SmartTrol operates in the full duplex mode and echos the commands from the host back to the host as they are received by the unit. Up to 80 command characters, including spaces, may be sent to the SmartTrol from the host in one transmission. The commands must be separated by spaces and the last character must be a "Carriage Return". The carriage return character causes the received command string to be processed. Once the command is received, the data is processed and the response is sent on a low priority basis. If the keyboard is used during the processing of the data, then the communication cycle is halted. If the SmartTrol is not busy, it should take no more than five mSec before the command is processed. The communications response time depends on this delay, the amount of data requested, and the operating baud rate. In practice, if transmission has not started within two seconds after data is requested, it can be assumed that there is a problem. The SmartTrol response contains a "Carriage Return" and "Line Feed" before each data value requested. The data will be returned in the order the command string was received from the host. After the unit has responded to the host command, it becomes inactive and must be activated again before the command can be processed ("D#" "Space").

**Command Code Definitions**

CODE	DESCRIPTION
DC	COMMAND TO TRANSMIT COUNT (TOTAL)
DR	COMMAND TO TRANSMIT RATE
DT	COMMAND TO TRANSMIT GRAND TOTAL
KA	COMMAND TO TRANSMIT COUNTER K Factor A
KA (S) XXX	COMMAND TO LOAD COUNTER K Factor A WITH XXX
KB	COMMAND TO TRANSMIT COUNTER K Factor B
KB (S) XXX	COMMAND TO LOAD COUNTER K Factor B WITH XXX
KC	COMMAND TO TRANSMIT RATE K Factor A
KC (S) XXX	COMMAND TO LOAD RATE K Factor A WITH XXX
KD	COMMAND TO TRANSMIT RATE K Factor B
KD (S)	COMMAND TO LOAD RATE K Factor B WITH XXX
PA	COMMAND TO TRANSMIT PRESET A
PA (S) XXX	COMMAND TO LOAD PRESET A WITH XXX
PB	COMMAND TO TRANSMIT PRESET B
PB (S) XXX	COMMAND TO LOAD PRESET B WITH XXX
RC	COMMAND TO RESET THE COUNTER (TOTAL) (SET TO PRESET IF IN THE COUNT DOWN MODE)
RC (S) XXX	COMMAND TO SET COUNTER (TOTAL) TO XXX
RT	COMMAND TO RESET GRAND TOTAL TO 0
RT (S) XXX	COMMAND TO SET GRAND TOTAL TO XXX

Note: (S) represents the ASCII "space" character.

Example: Unit Number 1

<b>Host Command</b>	<b>SmartTrol Response</b>
D1 (S)	Device # 1:
PA (S) 76546 (S) PA (S)	PA 76546 PA (Keystrokes echo)
KC (S) 1575 (S) KC (S)	KC 1575 KC (Keystrokes echo)
RC (Enter)	RC (Keystrokes echo, request processed)
	76546 (New Preset A value)
	1575 (New rate K Factor for Input A)

A sample communications program written in BASIC may be found in Appendix B, Page 38. Note the program has been printed using a word processor program, and character posting may not be the same as a printout using BASIC to drive the printer.

## CHAPTER 12 WARRANTY

Neptune Technology Group warrants the SmartTrol against defects in materials and workmanship for a period of one (1) year from the date of shipment to the Buyer. The Warranty is limited to repair or replacement of the defective unit at the option of Neptune. This warranty is void if the product has been altered, misused, dismantled, or otherwise abused.

All other warranties, expressed or implied, are excluded. Including but not limited to the implied warranties of merchantability and fitness for a particular purpose.



**APPENDIX A SPECIFICATIONS**

**TRICON/E Performance Data**

T-10						
Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Max Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Flow (CPS)	Flow for 20 mA Output (GPM)
5/8"	20	10	1/4	578.1	192.70	20
3/4"	30	15	1/2	322.6	161.30	30
1"	50	25	3/4	150.8	125.67	50
1 1/2"	100	50	1 1/2	67.57	112.62	100
2"	160	80	2	37.50	100.00	160
T-8						
Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Flow (CPS)	Flow for 20 mA Output (GPM)
5/8"	20	10	1/4	473.60	157.87	24.41
3/4"	30	15	1/2	329.14	164.57	29.40
1"	50	25	3/4	126.55	105.46	59.58
1 1/2"	100	50	1 1/2	47.86	79.77	141.18
2"	160	80	2	25.60	68.27	234.37

NOTE: Because the TRICON/E transmitter is manufactured specifically for the T-10 series of meters, the flow required to produce 20 mA output with the T-8 series is greater than the Max Flow listed for each meter size.

**Trident Turbine**

Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Max Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Flow (CPS)	Flow for 20 mA Output (GPM)
2"	250	200	3	4.608	15.36	200
3"	560	450	5	2.890	21.68	450
4"	1,250	1,000	10	1.590	26.50	1,000
6"	2,500	2,000	20	0.464	15.47	2,000
For 8" through S/N 31918014 and For 10" through S/N 31919282						
8"	4,500	3,500	35	0.2493	14.54	3,500
10"	7,000	5,500	50	0.1600	14.67	5,500
For 8" from S/N 31918274 and for 10" from S/N 31919300						
8"	4,500	3,500	35	0.2253	13.14	3,873
10"	7,000	5,500	50	0.1472	13.49	5,981

**HP Turbine**

Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Cont. Flow (CPS)	Flow for 20 mA Output (GPM)
1½"	200	160	4	6.095	16.25	160
2"	230	200	4	6.095	20.32	200
3"	560	450	5	11.20	84.00	450
4"	1,500	1,200	10	7.556	151.1	1,200
6"	3,750	3,000	20	.7273	36.36	3,000
8"	5,000	4,000	35	.7556	50.37	4,000
10"	8,000	6,500	50	.7556	81.86	6,500

**DISC Elements in Compound Meters**

Size and Type Compound Meter	Size and Type Disc Element
2" TRU/FLO	⅝" T-10
3" TRU/FLO	⅝" T-10
4" TRU/FLO	¾" T-10
4" PROTECTUS III	1" T-10
6" TRU/FLO	1" T-10
6" PROTECTUS III	1½" T-10
8" PROTECTUS III	2" T-10
10" PROTECTUS III	2" T-10

Refer to the appropriate chart for TRICON/E performance data.

**TRU/FLO COMPOUND (TURBINE SIDE)**

Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Cont. Flow (CPS)	Flow for 20 mA Output (GPM)
3"	560	450	5	2.890	21.68	450
4"	1,250	1,000	10	1.590	26.50	1,000
6"	2,500	2,000	20	0.464	15.47	2,000

**Trident® PROTECTUS (Turbine Side)**

Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Cont. Flow (CPS)	Flow for 20 mA Output (GPM)
4"	1,250	1,000	10	1.590	26.50	1,000
6"	2,500	2,000	20	.464	15.47	2,000
8"	4,500	3,500	35	.2493	14.54	3,500
For 10" through S/N 31919282						
10"	7,000	5,500	50	.1600	14.67	5,500
For 10" from S/N 31919300						
10"	7,000	5,500	50	0.1472	13.49	5,981

**HP TRU/FLO Compound (Turbine Side)**

Size	Max Flow (GPM)	Max Contributions Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Cont. Flow (CPS)	Flow for 20 mA Output (GPM)
2"	250	220	4	6.095	20.32	200

**HP PROTECTUS III (TURBINE SIDE)**

Size	Max Flow (GPM)	Max Continuous Flow (GPM)	Min Flow (GPM)	Pulses/Gallon	Pulse Output @ Max Cont. Flow (CPS)	Flow for 20 mA Output (GPM)
4"	1,500	1,200	10	7.556	151.1	1,200
6"	3,750	3,000	20	.7556	37.78	2,888
8"	5,000	4,000	35	.6095	40.63	4,959
10"	8,000	6,500	50	.5333	57.78	9,209

**TRU/MAG HIGH FREQUENCY OUTPUT/K FACTOR**

Meter Size	Pulses per Gallon	Pulses per Liter	Qmax* Gallons per Minute	Qmax* Liters per Minute
3"	25.228	6.665	600	2,271
4"	16.362	4.323	1000	3,780
6"	6.307	1.666	2,400	9,462
8"	3.344	0.883	4,400	16,656
10"	2.150	0.568	7,000	26,496

\* Flow rate at 150 Hz max pulse rate.

**TRU/MAG PULSE RATES**

Signal	TRU/MAG: Current sinking pulse, opto-isolated, co Vdc at 10 mA max				
	TRU/MAG: Pulse output available only with the addition of post-factory output cable				
Pulse Rates	10 units/pulse (default): 100 units/pulse: 1000 units/pulse: High Frequency				
High Frequency	3"	4"	6"	8"	10"
(pulse/gal)	25.228	16.362	6.307	3.344	2.150

**APPENDIX B TRICON®/S**

**Performance Data**

Available switch closure rates

	GAL., IMP. GAL., OR LITRES (*)/CONTACT				CU. FT./CONTACT					CU. METERS/CONTACT			
	1	10	100	1000	1	10	100	1000	0.1	1	10	100	1000
METER													
5/8"-1"T-10	Y	Y	Y		Y	Y	Y						
1½"-2"T-10		Y	Y	Y	Y	Y	Y	Y					
1½"-4"HPT		Y	Y	Y	Y	Y	Y	Y					
1½"-6"HPT									Y	Y	Y	Y	
6"-10"HPT			Y	Y		Y	Y	Y					
8"-10"HPT										Y	Y	Y	Y

\*Units of Litres per contact not available for 1½"-10" HPT.

## APPENDIX C REGISTER TRACKING

### Making The Total Agree With The Register

After programming the SmartTrol with the appropriate K Factor and operating parameters, you may set the SmartTrol so that the value of Total agrees with the current quantity indicated on the meter register. However, the meter must be static for the duration of the following procedure. Either stop the flow through the meter or remove the register from the meter until the procedure is complete. Note the current register reading.

#### Overview of Procedure:

- Set the SmartTrol to Set to Preset (count down mode)
- Set Preset A to register reading value
- Reset to Preset by depressing "CLR" key
- Reset the SmartTrol to Reset to Zero (count up mode)

#### Preparing the SmartTrol to accept the current register reading.

PRESS	DISPLAY
D	MENU (Displays 1 second) DEV TYPv
ENT	RTv CNTv
D	K FACT A (Displays 1 second) ##### (Current Value blinks)
ENT	K Fact B (Displays 1 second) ##### (Current value blinks)
ENT	ROv SPv Press D for Set to Preset
ENT	ATv MANv Press D for Manual Reset
ENT	DEC LOC
ENT	SmartTrol returns to normal operating mode

**Keying in the current register reading.**

<b>PRESS</b>	<b>DISPLAY</b>
A	PRESET A (Displays 1 second) ##### (Current value blinks)
<b>PRESS</b>	<b>DISPLAY</b>
CLR	Key in the current register reading
ENT	SmartTrol returns to normal operating mode
CLR	SmartTrol displays the current register reading, but still is in count down mode

**Setting the SmartTrol to increment Total keeping pace with the meter register.**

<b>PRESS</b>	<b>DISPLAY</b>
D	MENU (Displays 1 second) DEV TYPv
ENT	RTV CNTv
D	KFACT A (Displays 1 second) ##### (Current value blinks)
ENT	K FACT B (Displays 1 second) ##### (Current value blinks)
ENT	ROv SPv Press B, Reset to 0, and Total will now increase along with the register
ENT	ATv MANv
	Press D for Manual Reset
ENT	DEC LOC
ENT	SmartTrol returns to normal operating mode

Start the flow or reattach the register to the meter. As the register advances, so will Total as displayed on the SmartTrol.

This procedure may need to be performed periodically due to rounding errors in the K Factor. To improve the matching of the percentage difference between Total and the register, the K Factor may be adjusted by the percentage difference between Total and the register reading.

The adjustment is determined by the following formula:

$$\text{New K Factor} = \text{Old K Factor} \times \frac{\text{Current Total} - \text{previous Total}}{\text{Current Register} - \text{previous Reg.}}$$

**Example:**

10" Trident Turbine K Factor = .16  
 Start register reading = 106400  
 SmartTrol Total reading = 106400

**After some period of operation:**

Current register reading = 408000  
 Current SmartTrol Total = 408257

Applying the formula,

$$\text{New K Factor} = .16 \times \frac{408257 - 106400}{408000 - 106400} = .1601363$$

Use the value of .1601363 and reset the Counter K Factor using the procedures in Paragraph 10.1. Then repeat the preceding procedure to make Total agree with and track the register reading.

NOTE: After the SmartTrol has been set up with Total tracking the register reading, DO NOT touch CLR when Total is displayed. If you do, Total will return to "0" and start counting up.





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