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Model TR400-C
Programmable Process Ratemeter
Installation & Operation Manual

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Programmable Process Ratemeter
Installation & Operation Manual

Part Number: 990–000510

Revision E

Electro-Sensors®, Inc.
6111 Blue Circle Drive
Minnetonka, MN 55343-9108

Contact us at:

Local:	952-930-0100
National:	1-800-328-6170
Fax:	952-930-0130
Web:	www.electro-sensors.com
Sales:	sales@electro-sensors.com
Support:	sales@electro-sensors.com

Introduction to This Manual

What is in this manual?

This installation and operation manual provides detailed technical information about the TR400-C Programmable Process Ratemeter. It should serve as your technical resource to install, set up, operate, and test the TR400-C.

Who should use this manual *(audience)*

Keep in mind that the function of the TR400-C installed in a mechanical process is to monitor speed; therefore, it must be installed by qualified personnel only. This manual is designed for persons who have the primary responsibility to install, set up, operate, and test the TR400-C.

The secondary audience would be those persons seeking technical information about the electrical concepts and operation of the TR400-C.

Knowledge level

Persons installing, setting up, and operating the TR400-C should have good knowledge and understanding of electrical and mechanical concepts and principles pertaining to Programmable Process Ratemeters. Again, the TR400-C should be installed by qualified personnel only.

Notices

- Installing Electro-Sensors, Inc., products is the responsibility of the purchaser, and is in no way guaranteed by Electro-Sensors, Inc.
- While the information in this manual has been carefully reviewed, Electro-Sensors, Inc., assumes no liability for any errors or omissions in this manual. Additionally, Electro-Sensors, Inc., reserves the right to make changes to any part of the information in this manual or the product described herein without further notices.
- No part of this manual may be photocopied, reproduced, or translated to another language without the prior written consent of Electro-Sensors, Inc.

How this manual is organized

Manual navigation tools

This manual contains the following navigation tools:

- Table of contents
- Beginning section table of contents
- Index

Each is designed to help you find the information you need quickly.

Manual sections

This manual is divided into the following sections:

- Section 1: Warnings and Cautions, discusses personal injury possibilities and potential damage to equipment.
- Section 2: Installation, discusses installing the TR400-C into a panel and the Explosionproof sensor.
- Section 3: TR400-C, Explosion-Proof Sensor Wiring and DIP Switches, discusses recommended wiring practices, wiring, and configuring the DIP Switches.
- Section 4: TR400-C Setup, discusses the TR400-C parts and functions, and set up information.
- Section 5: TR400-C Programming, discusses programming the operational variables of the TR400-C.
- Section 6: TR400-C Diagnostics, discusses the diagnostics tests used to verify the operation and functions of the TR400-C.
- Appendix A: TR400-C and Explosion-Proof Sensor Specifications.

Table of Contents

Section 1

Warnings & Cautions

Introduction

This section discusses warnings and cautions to guard against the possibility of injury to persons and damage to equipment. Since the TR400-C monitors the speed of various mechanical systems, observe all warnings and cautions that pertain to the mechanical systems as well.

In this section These are the topics:

About warnings and cautions

Important notice

Read the warnings and cautions in this section before attempting to install, set up, or operate the TR400-C and its associated hardware. Warnings and cautions appear in this section and throughout this manual.

Definitions

Warnings are given when there is the possibility of injury to persons.

Cautions are given when there is the possibility of damage to equipment.

The warning label will appear as follows:

Warning

The caution label will appear as follows:

Caution

Continued on next page

Warnings

Warning

Always turn the power source OFF before wiring the TR400-C. Failure to observe this warning could result in an electrical shock or damage to the equipment.

Warning

During a Stop condition, any slight movement of the shaft or magnetic disc could activate the control relay and start the motor. To prevent starting the motor accidentally, always use proper LOCKOUT, TAG OUT procedures. Failure to observe this warning could result in an injury to persons or damage to equipment.

Warning

Do not touch the Pulser Disc while it is spinning. Failure to observe this warning could result in a hand injury.

Warning

Always wear protective eye goggles when using power tools. Failure to observe this warning could result in an eye injury or blindness.

Warning

Recommended wiring practices must be followed when wiring industrial equipment such as the TR400-C. Failure to follow recommended wiring practices could result in an injury to persons or damage to equipment.

Warning

The TR400-C is a programmable process ratemeter and must be installed by qualified personnel only. Failure to observe this warning could result in an injury to persons or damage to equipment.

Warning

Only qualified personnel should attempt to connect any wires to the TR400-C. Failure to observe this warning could result in an injury to persons.

Cautions

Caution

Power to sensors is provided at TB2–6 (+12 Vdc) and TB2–5 (common) on the TR400-C. Wiring to those inputs should be shielded cable with the shield tied to TB2–5 common only. Failure to observe this caution could result in improper sensor function.

Caution

Always turn the power source OFF before wiring the TR400-C. Failure to observe this caution could result in damage to the TR400-C.

Caution

Never use shielded cable with extra conductors. Extra conductors can act as antennas, picking up electrical noise. Failure to observe this caution could result in improper sensor operation.

Caution

The TR400-C standard uses 115 Vac, 6 VA @ 60/50 Hz, with 230 Vac as an option. Make sure you know the correct supply voltage before applying power to the TR400-C. Failure to observe this caution could result in damage to the TR400-C.

Caution

Do not touch the Pulser Disc while it is spinning. Failure to observe this caution could cause an interruption in pulse generation, resulting in a disruption in the mechanical process being monitored.

Caution

When the digital input function is programmed as a Reset input and the switch input remains closed, the relay will never turn OFF regardless of the operating condition. A momentary contact closure of the switch is advised. Failure to observe this caution could result in damage to the equipment.

Caution

Only qualified personnel should attempt to connect any wires to the TR400-C. Failure to observe this caution could result in damage to the equipment.

Section 2

TR400-C Installation

Introduction

This section discusses unpacking and installing the TR400-C into a panel.

In this section These are the topics:

Installation overview

Warning

The TR400-C is a programmable process ratemeter and must be installed by qualified personnel only. Failure to observe this warning could result in an injury to persons or damage to equipment.

Unpacking the TR400-C and Explosion-Proof sensor and disc

After unpacking the TR400-C, Explosion-Proof Sensor and Pulser Disc save the following items:

- Packing list
- All instructions and other documentation

Verify that all parts were shipped via the packing list.

Installing the TR400-C

Panel cutout

To install the TR400-C into an instrument panel, do the following:

Step	Action
1.	Cut a rectangular hole in the panel to the dimensions shown in Figure 1.
2.	Loosen the screws holding the mounting bracket to the TR400-C and remove it, as shown in Figure 1.
3.	Slide the TR400-C into the cutout.
4.	Replace the mounting bracket and tighten the screws—do not over tighten. See Figure 1.

Note: Allow a minimum of 1.5 inches of clearance on all sides of the TR400-C *(all dimensions are in inches).*

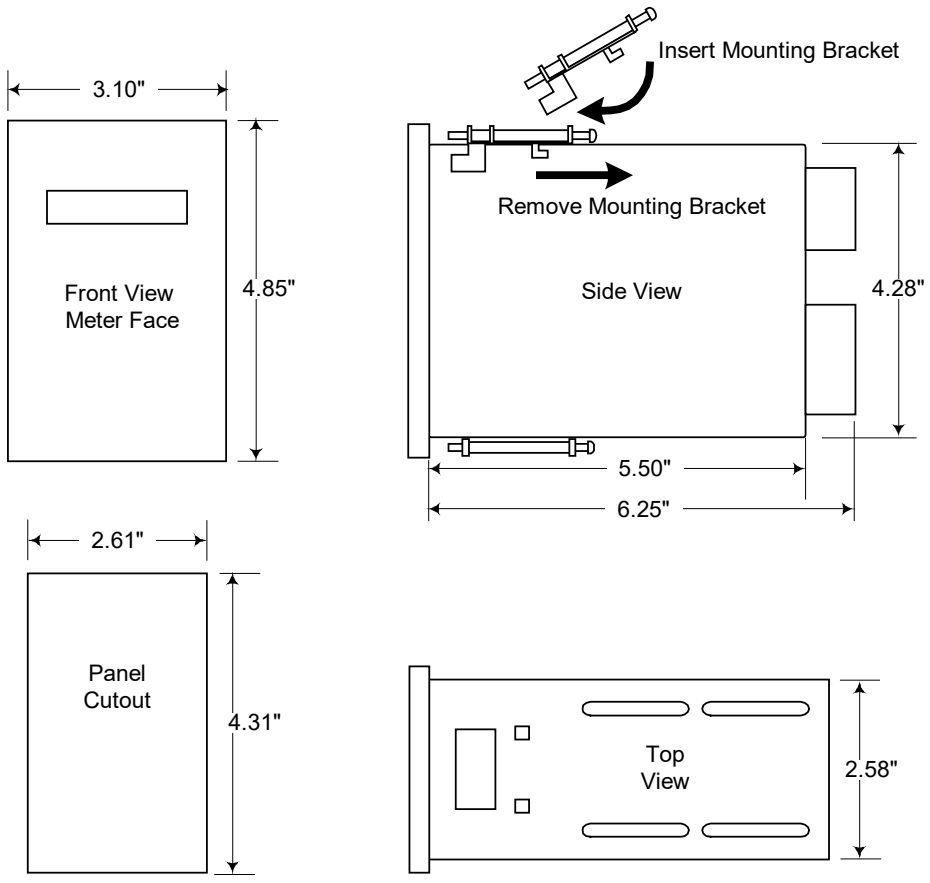

Figure 1: TR400-C and Panel Cutout Dimensions

About the model 907 Hall-Effect Explosion-Proof sensor

Sensor description

The model 907 Hall-Effect Explosion-Proof sensor* has an XLB–3 enclosure that is C.S.A. approved and UL rated for Class I Group D; Class II Group E, F, G; and Class III. It has a 1-inch NPT conduit opening, and it comes with a mounting bracket. See Figure 2.

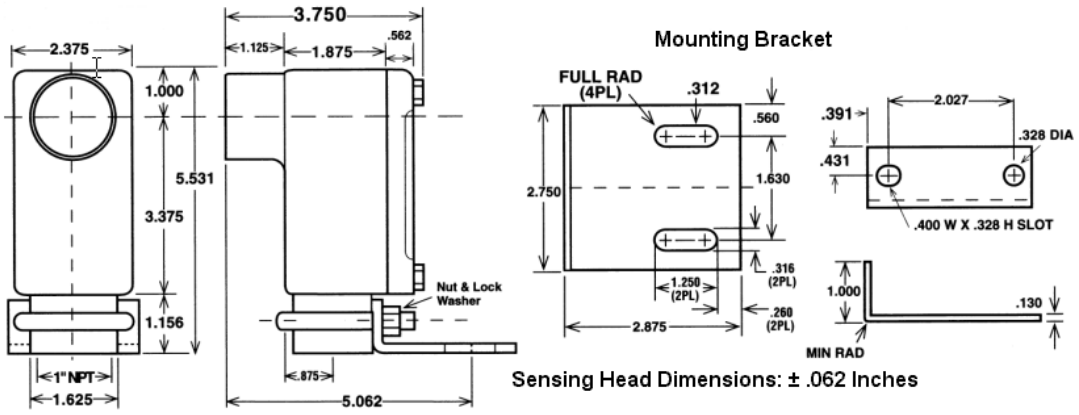

Figure 2: Explosion-Proof Sensor Dimensional Drawing *(all dimensions in inches)*

Sensor function

The Explosion-Proof sensor produces digital pulse signals for use with speed switches, tachometers, counters, and signal conditioners; or as a direct-pulse input into programmable controllers. As the pulser disc mounted onto the end of the monitored shaft rotates, the target magnets pass in front of the sensor causing the sensor to switch from high to low, due to the alternating polarity of the disc's magnets. This switching action produces one pulse for every two magnets.

The sensor tolerates a gap distance of 3/8 ± 1/8 inch between the surface of the sensor and the target magnets. The gap flexibility makes the sensors tolerant of vibration, slight shaft run-out, and minor misalignment.

Mounting distance and power

The sensors can be mounted up to 1500 feet from the control unit—speed switch, tachometer, etc. The sensors are powered by 5–24 Vdc and provide an NPN Open Collector output. See page 18 for details.

* *Specifications for the 907 Explosion-Proof Sensor are in Appendix A.*

Installing the Explosion-Proof sensor

Installation

The Explosion-Proof sensor is supplied with a slotted mounting bracket. Sensors should be installed so that the centerline of the magnets pass in front of the centerline of the sensor as the disc rotates. The centerline on the magnetized area of the disc should be 1¾ inch from the center of the disc—dimension B, shown in Figure 3.

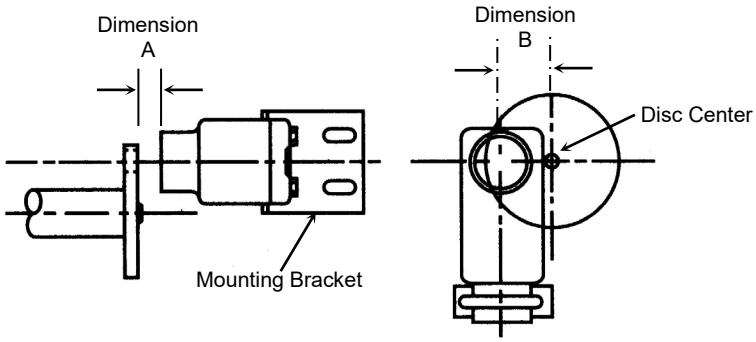

Figure 3: Explosion-Proof Sensor and Pulser Disc Positioning

Gap distance

The sensor allows a gap distance of 3/8 ± 1/8 inch between the surface of the sensor and the target magnets—Dimension A, shown in Figure 3. To achieve the proper gap distance, adjust the position of the sensor, using the slots on the mounting bracket.

About the Pulser Disc

Pulser disc description

The heavy-duty pulser disc is nylon. The disc is designed with magnets of alternating polarity (N-S-N-S) imbedded in the face of the disc on the outside edge or outside circumference. See Figure 4. The disc is mounted onto the end of the shaft where the magnets serve as targets for the 907 sensors, which switches because of exposure to the changing magnetic poles.

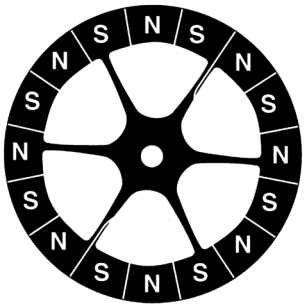

Figure 4: Face Read Nylon Pulser Disc

Pulser disc specifications

The following are pulser disc specifications:

- Material — Nylon®12
- Maximum speed — 10,000 rpm at ambient temperature
- Operating temperature — -40ºC to +60ºC

Continued on next page

Installing the pulser disc

Installation To install the pulser disc, do the following:

Step	Action
1.	All pulser discs have a center hole dimension of 0.196 inch. To mount the disc to the shaft, use a #21 drill bit to drill a center hole in the shaft's end to a depth of 0.5 inch. **Note:** The maximum bore for the number 255-nylon pulser disc is 0.5 inch.
2.	Tap the center hole for a 10/32 UNF screw *(screw provided by Electro-Sensors)*.
3.	After drilling and tapping the shaft, apply Loctite® or a similar adhesive to the screw threads and mount the disc securely onto the end of the shaft. See Figure 5.

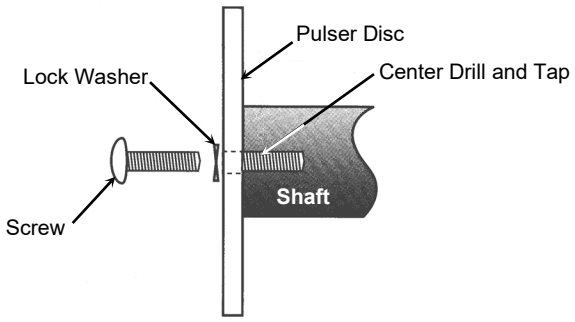

Figure 5: Pulser Disc and Shaft Assembly

Step	Action
4.	Torque the mounting screw to 8-10 foot pounds maximum.

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Section 3

TR400-C Wiring & DIP Switches

Introduction

This section discusses electrical information concerning the TR400-C, including wiring practices, wiring schematics, and DIP Switch settings.

In this section These are the topics:

Recommended wiring practices

Warning

Recommended wiring practices must be followed when wiring industrial equipment such as the TR400-C. Failure to follow the recommended wiring practices listed below could result in an injury to persons or damage to equipment.

Wiring practices

The following is a list of recommended wiring practices for installing industrial equipment. It is critically important that you observe and follow these wiring practices when wiring the TR400-C.

- All control signals must be shielded cable. The shield must be tied to common or earth ground at the receiving end only. In some environments, earth ground may contain excessive electrical noise. If you encounter problems using earth ground as a shield-tie point, switch the shields to signal common. All connections to the controller are considered signal unless they carry AC voltage.
- Never use a shielded cable with unused conductors. The unused conductors act as antennas. Attempting to tie the unused conductors to ground or other signal-carrying wires will create different antenna configurations. In many cases, an unshielded wire could be less susceptible to electrical noise. Always make sure that a shielded cable with the correct number of conductors is pulled.
- All control signals must be separated from power wires. Power wiring includes any AC or DC wires carrying voltages with a current potential of greater than one (1) amp or a voltage greater than 24 volts. This includes, but is not limited to, 115 Vac, 230 Vac, and 460 Vac.
- Do not bundle shielded cables and power wires together.
- Do not run signal cables along high magnetic or electrostatic generators. This includes, but is not limited to motors, fans, contactors, igniters, etc. Aluminum shielded cable does not stop magnetically induced noise; braided shielded cable only partially reduces magnetically induced noise.
- An earth ground wire must be installed on microprocessor-based equipment when required. Do not rely on the enclosure's contact with the panel for earth ground. Earth ground is often used in noise-rejection circuitry as well as for safety.
- Contactors, solenoids, and relay coils connected to the same AC power source, or in the same enclosure panel as the controller, must be suppressed with a capacitor-resistor filter across the coil. These can be made with a 1 kV capacitor and a ¼-watt resistor in series, or they can be purchased in a pre-made package. Use a capacitance value of 0.1 microfarad or larger and a resistor value of 500 ohms or less.
- When AC voltage is stepped down for use with equipment, a capacitor-resistor network or a filter should be placed across the secondary.

TR400-C wiring schematics

Warning

Only qualified personnel should attempt to connect any wires to the TR400-C. Failure to observe this warning could result in an injury to persons.

Caution

Do not wire the TR400-C to 230 Vac unless it has been specially built for that voltage. The standard voltage setting is 115 Vac. Failure to observe this caution could result in damage to the TR400-C.

Wiring schematic

Figure 6 shows the various wiring schemes for the TR400-C.

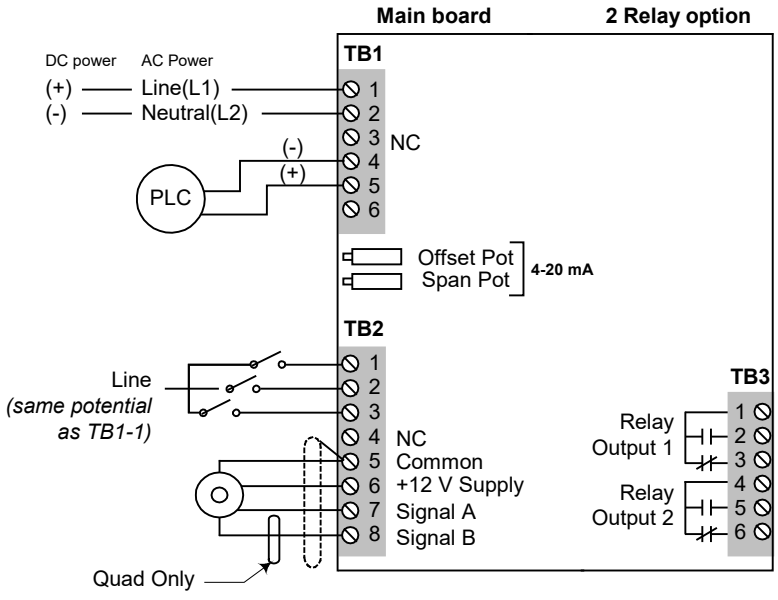

Figure 6: TR400-C Wiring

Continued on next page

TR400-C wiring schematics, continued

Warning

During a Stop condition, any slight movement of the shaft or magnetic disc could activate the control relay and start the motor if the Motor Auxiliary, Normally Open Contact (MS Aux n.o.) is not wired in series. To prevent starting the motor accidentally, always use the proper LOCKOUT TAG OUT procedures. Failure to observe this warning could result in an injury to persons or damage to equipment.

Slowdown control wiring

Figures 7a and 7b are typical slowdown PLC control wiring schematics.

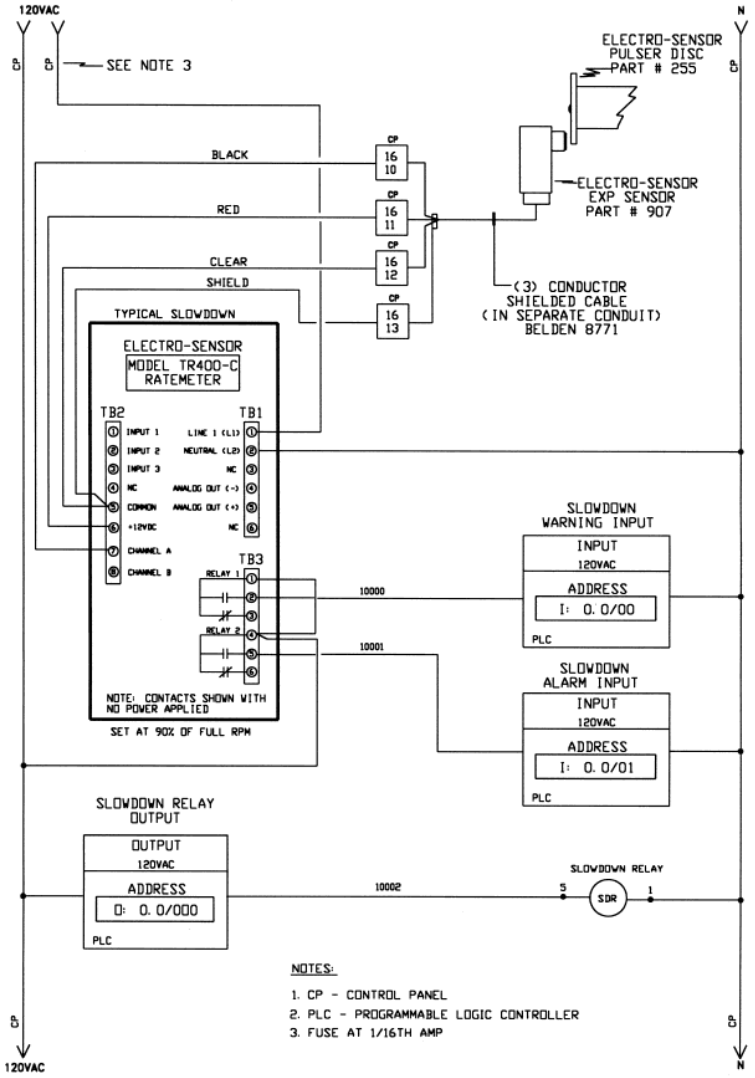

Figure 7a: Slowdown PLC Wiring Schematic *(Warning, Alarm, and Relay Output)*

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TR400-C wiring schematics, continued

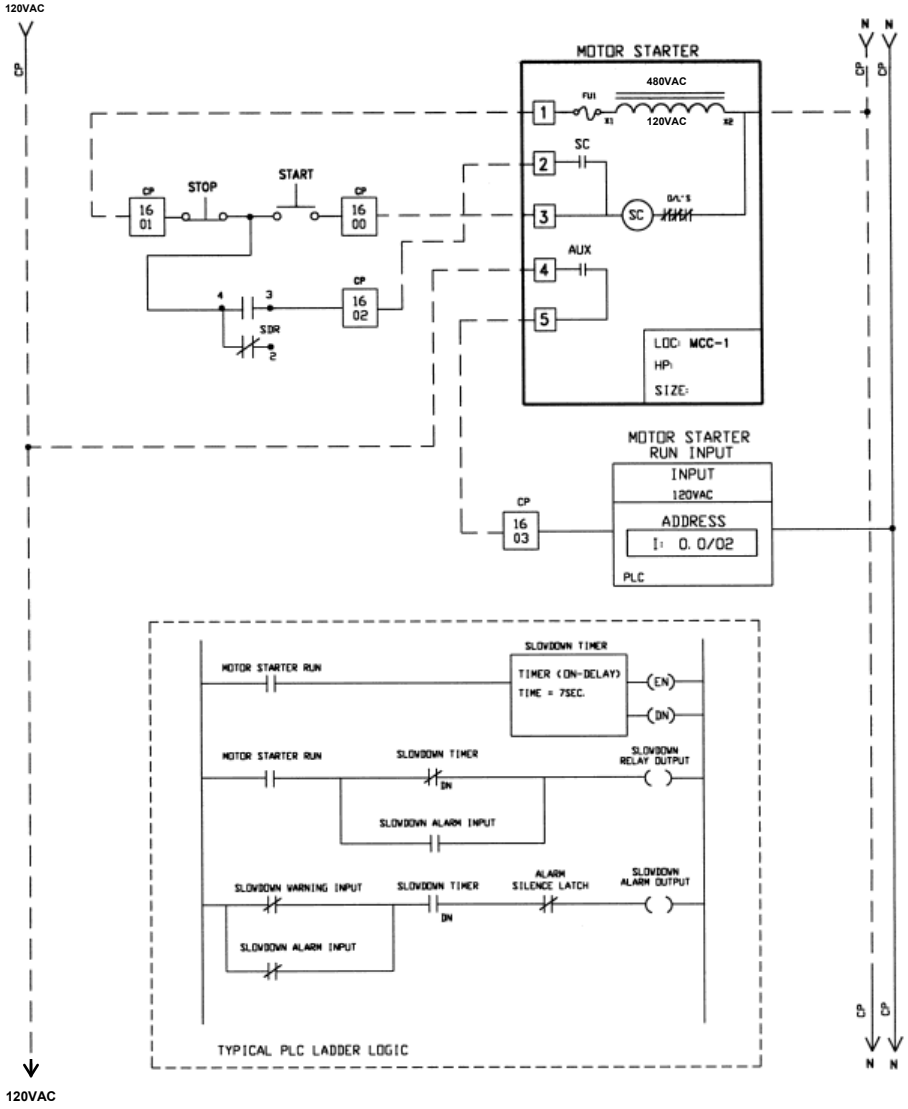

Figure 7b: Slowdown PLC Wiring Schematic *(Motor Starter and Timer)*

AC power and Channel A input signal power

AC power wiring

The TR400-C standard comes set-up for 115 Vac, 6VA at 50/60 Hz. An external 1/16 amp slow-blow fuse must be provided by the customer. AC power will tie to TB1–1, Line, and TB1–2, Neutral. A 1/32 amp slow-blow fuse for 230 Vac.

Channel A input signal

Channel A input signal – Rate information is provided by a single pulse generator connected to Channel A, input terminal, TB2–7. See Figure 8. This input requires a frequency input relative to speed. Devices such as Hall-effect sensors, encoders, or magnetic pickups can be used.

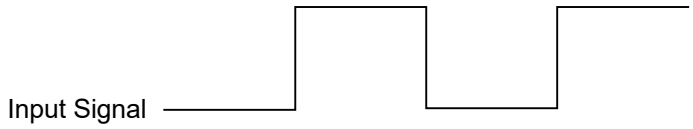

Figure 8: Channel A Input Signal

Sensor Supply

Voltage to these sensors is from TB2–6 (+12 Vdc) and TB2–5 (common). The maximum current draw available is 100 mA @ 12 Vdc, unregulated. Wiring should be shielded cable with the shield tied to TB2–5 common only.

4-20mA / 0-10Vdc analog output wiring

4-20 mA/0-10 VDC analog output

The 4-20mA/*0-10 Vdc analog output supports a maximum load resistance of 500 ohms. The analog output plus (+) signal is at TB1–5, and the negative (-) signal is at TB1–4, as shown in Figure 9.

See the Diagnostics section for additional information about the analog outputs.

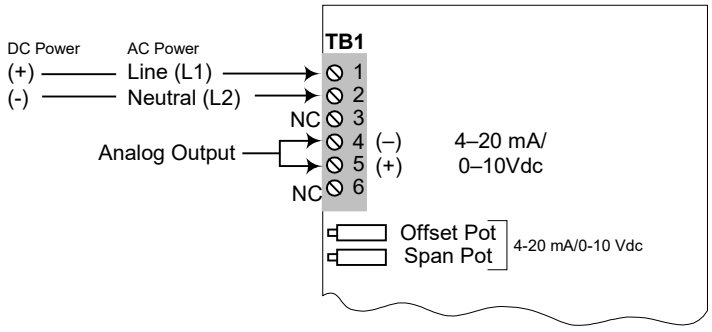

Figure 9: Wiring for Analog Outputs 4-20 mA/*0-10 Vdc

The 0-10 Vdc analog output is optional.

Channel A input signal sensor wiring

Caution

Never use shielded cable with extra conductors. Extra conductors can act as antennas, picking up electrical noise. Failure to observe this caution could result in improper sensor operation.

Channel A input signal wiring

Wiring to these inputs should be shielded cable, with the shield tied to TB2–5 common only. TB2–7 is the input signal, and TB2–6 is +12 Vdc. See Figure 10.

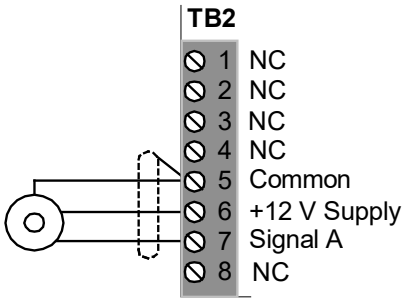

Figure 10: Input Signal Wiring

Caution

Do not short signal to supply. Failure to observe this caution will result in damage to the sensor or ratemeter.

Sensor wiring

The sensor must be wired according to Table 1.

Table 1: Sensor Wiring

TR400 Terminal, description	ESI 907 Color Code	ESI 907 Old Color Code
TB2–5, Common	Blue & Shield	White & Shield
TB2–6, +12 VDC Supply	Brown	Red
TB2–7, Signal	Black	Black

TR400-C DIP switches

Sensor DIP switches

The sensor DIP Switches are located on the bottom of the TR400-C, as shown in Figure 11. Sensor input and switch information is shown in Table 2.

Table 2: Sensor Input Configuration DIP Switches

Input	Channel A TB2–7			
Input Type	**NPN**	PNP	Mag. 2 Wire	Logic Level
Switch ON	**5**	6	4	None
Switch OFF	**4, 6**	4, 5	5, 6	4, 5, 6

Note: The model 907 Electro-Sensor is NPN open collector.

TR400-C DIP switch settings

Since all sensing devices produced by Electro-Sensors, Inc., are NPN open collector, the standard DIP Switch settings are 2 and 5, set to ON, and all others set to OFF, as shown in Figure 11.

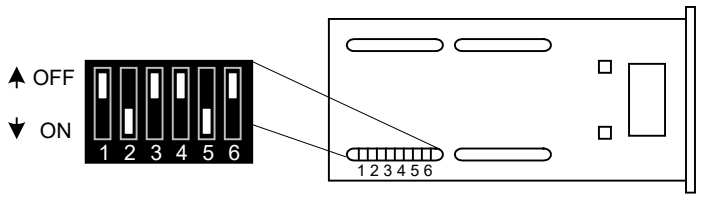

Figure 11: TR400-C Sensor Switch Settings

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Section 4

TR400-C Set-Up Parameters

Introduction

This section discusses information about the TR400-C operations panel and set-up parameters.

In this section These are the topics:

TR400-C parts and functions

Overview

The TR400-C* face contains five (5) status LEDs, a four-digit display, and a keypad containing nine (9) keys. See Figures 12a and 12b. The letters in Figures 12a and 12b represent each part on the front panel of the TR400-C. The Parts and Functions table 3 describes the function of each of the parts.

Sensor DIP switches, located on the bottom of the TR400-C, are not discussed in this section; see "TR400-C DIP Switches" in Section 3.

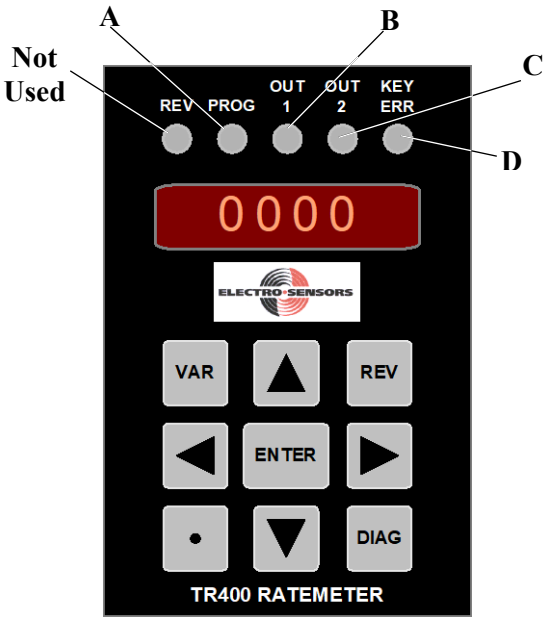

Figure 12a: TR400-C Front Panel Description

Table 3: TR400-C Panel Parts and Functions

Part	Function
A	The PROG LED will light when the VAR key is pressed, indicating Program Mode. It also turns on when the DIAG key is pressed, entering Diagnostic Mode.
B	The OUT 1 LED will light when relay "1" is activated. Relay "1" is enabled by variable 13, and its set point value is entered in variable 07.
C	The OUT 2 LED will light when relay "2" is activated. Relay "2" is enabled by variable 13, and its set point value is entered in variable 10.
D	The KEY ERR LED will light when the wrong key is pressed.

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* *Specifications for the TR400-C are shown in Appendix A.*

TR400-C parts and functions, continued

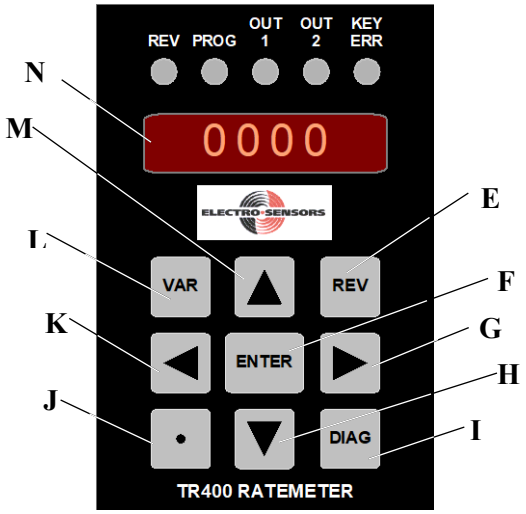


Figure 12b: TR400-C Front Panel Description

Table 3: TR400-C Panel Parts and Functions (continued)

Part	Function
E	The REV key is used as a keypad test key in Diagnostics Mode only.
F	The ENTER key is used in Program Mode to set the value of a variable after it has been changed
G	The RIGHT ARROW key selects the next digit to the right, when pressed in Program Mode.
H	The DOWN ARROW key decrements the active digit position on the display down by one (1), when pressed in Program Mode.
I	The DIAG key enters Diagnostics Mode when pressed. Press this key a second time exits Diagnostics Mode.
J	The DECIMAL POINT key moves the decimal point to the left one place, when pressed in Program Mode. Also, pressing the DECIMAL POINT key for four (4) seconds will shutoff the relay outputs.
K	The LEFT ARROW key selects the next digit to the left, when pressed in Program Mode.
L	The VAR key enters Program Mode when pressed.
M	The UP ARROW key increments the active digit position on the display up by one (1), when pressed in Program Mode.
N	The Four-digit display.

TR400-C set-up parameters

Set-up parameters

The TR400-C comes from the factory set for NPN open-collector operation. In most applications, when using a standard hall effect sensor with the model 255-pulser disc, you only need to program a few variables. For example, RPM *(Revolutions Per Minute)* and PPR *(Pulses Per Revolution):*

- If your operation involves relays requiring the reading of RPM, variable 01, Max RPM and variable 03, Display Units should be set to the same value *(default is 200 RPM fixed).*
- If you are using a 255-pulser disc, variable 02 should be the default value of 8 PPR.

A typical shaft-monitoring scenario for the TR400-C is shown in Figure 13.

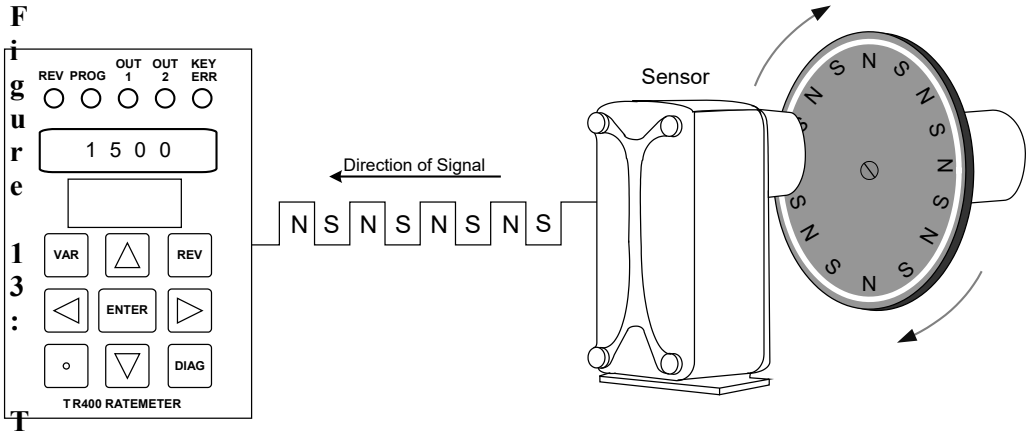


Figure 13: TR400-C Monitoring Shaft Speed

Set point and relay output values

In some applications, the set point will be 90 to 95 percent of full operating speed for safety reasons. Consider the following variables when setting relay outputs:

Set points, delay and on-times, and output function selection; for example:

- Variables 07 and 10: outputs 1 and 2 respectively, hold the set point value.
- Variables 08, 09, 11, and 12: delay and on-time values are fixed, *(non-adjustable)*.
- Variable 13: output function selection for relays 1 and 2, which are fixed in Underspeed Mode.

Section 5

TR400-C Programming

Introduction

This section discusses information about programming the TR400-C.

In this section These are the topics:

Programmable variables

Variables Table 4 describes the programmable variables for the TR400-C.

Table 4: TR400-C Programmable Variables

Var #	Variable Name	Description	See Page
02	PPR	Pulses Per Revolution.	34
06	Start Delay	Time relay is held energized at startup regardless of setpoint status	35
07	Output 1 Value	Holds the set point value for output “1” in display units.	35
08	Relay output 1 delay time	The amount of time that the set-point condition must exist before the output will deactivate	36
09	Relay output 1 on time	The minimum time the output will stay inactive when a set-point condition occurs.	36
10	Output 2 Value	Holds the set point value for output “2” in display units.	35
11	Relay output 2 delay time	The amount of time that the set-point condition must exist before the output will deactivate	36
12	Relay output 2 on time	The minimum time the output will stay inactive when a set-point condition occurs.	36
15	Display value at 4 ma or 0 Vdc	The rate display value to be represented at 4 mA or 0 Vdc	37
16	Display value at 20 mA or 10 Vdc	The rate display value to be represented at 20 mA or 10 Vdc	37
23	Pulses to average	number of pulses to average	34
24	Averaging window	This is a window, expressed in percent, in which pulse averaging will used	34
26	Display features	Leading Zero blanking and bright/dim display	38

How to select a variable and view its data

Overview

Each programmable variable can be selected and its data viewed within a few key presses—the results will appear on the display. The following procedure shows how to enter Program Mode and view the data for variable 07, output 1 value.

Selecting the variable

To select variable 07, do the following three steps:

Step	Action
1	Press the VAR key; the PROG LED will light and the display will show Pr (Program Mode) and a variable with the 1's digit position flashing. See Figure 14 for an illustration of this step.

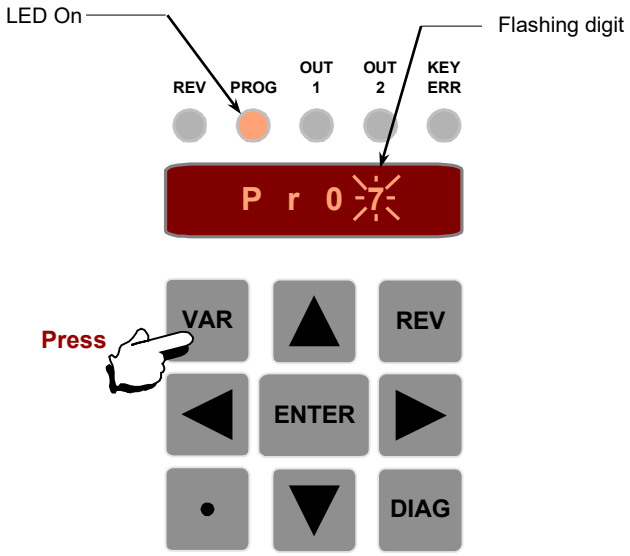


Figure 14: TR400-C Placed in Program Mode Displaying Variable 07

Note: The TR400-C will remember the last variable selected and changed until the TR400-C is powered Down. After powering up the TR400-C, the display will show Pr01 the first time you enter Program Mode.

Continued on next page

How to select a variable and view its data, continued

Viewing variable data

To view the data for variable 07, do the following:

Step	Action
2	Press the ENTER key to go to the data-entry level; the display will show 0150, which is the default value for variable 07, output 1, with the 1's digit position flashing. See Figure 15 for an illustration of this step.

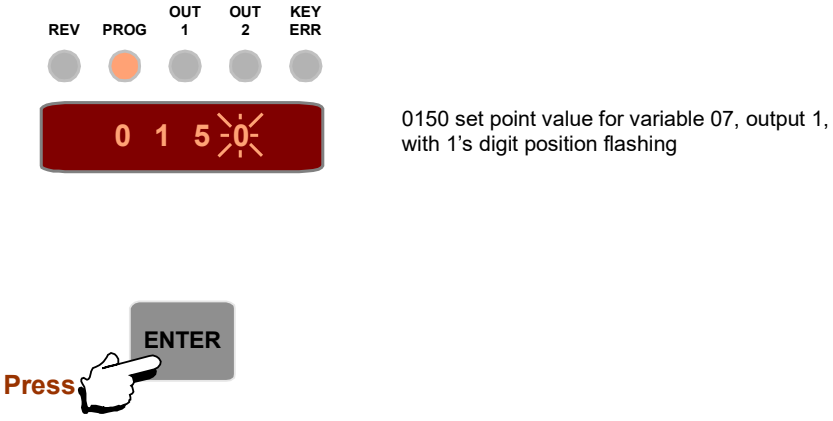


Figure 15: Data for Variable 07

Exiting

To exit the variable without changing its value, do the following:

Step	Action
3	Press the VAR key to exit Program Mode. See Figure 16 for an illustration of this step.

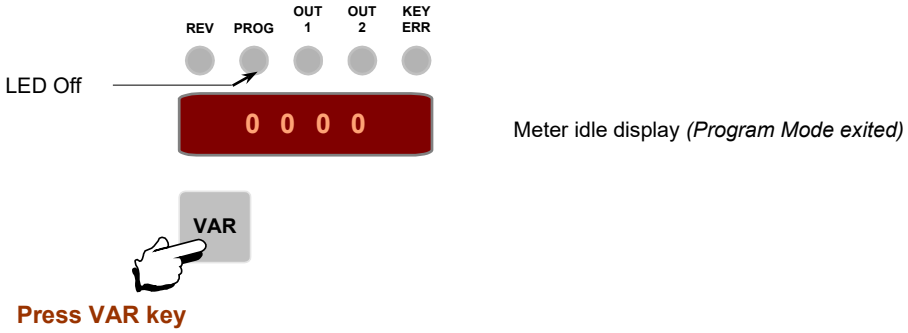


Figure 16: Exit Program Mode Without Changing the Variable's Value

Keypad keys used to access and program variables

Overview

You can access and program the variables by using the VAR, LEFT ARROW, RIGHT ARROW, UP ARROW, DOWN ARROW, DECIMAL, and ENTER keypad keys. The REV and DIAG keys are inactive when the TR400-C is in Program Mode.

Figure 17 shows only the keys used to program the variables. Table 5 describes the keys and their functions.

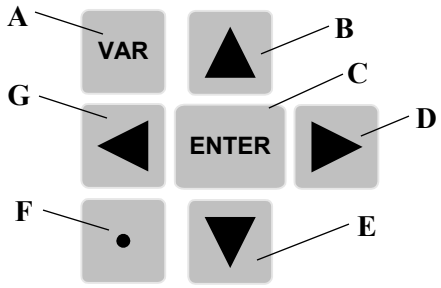


Figure 17: Keypad Keys Used to Program Variables

Table 5: TR400-C Keys and Functions for Programming Variables

Key	Function
A	• Press the VAR key to enter Program Mode; the display will show Pr *(Program Mode)* and the last selected programmable variable, 01 thru 19. • Press the VAR key again to exit Program Mode.
B	Press the UP ARROW key to increment the flashing digit by one (1) on the display.
C	• Press the ENTER key to go to the data-entry level to program the variables. • Press the ENTER key to accept the new numerical value and exit Program Mode.
D	Press the Right ARROW key to select a digit position from left to right on the display.
E	Press the DOWN ARROW key to decrement the flashing digit by one (1) on the display.
F	Press the DECIMAL key to position the decimal point at each digit position from right to left on the display.
G	Press the LEFT ARROW key to select a digit position from right to left on the display.

How to select and change a variable's numerical value

Exercise

The following 7-step procedure shows:

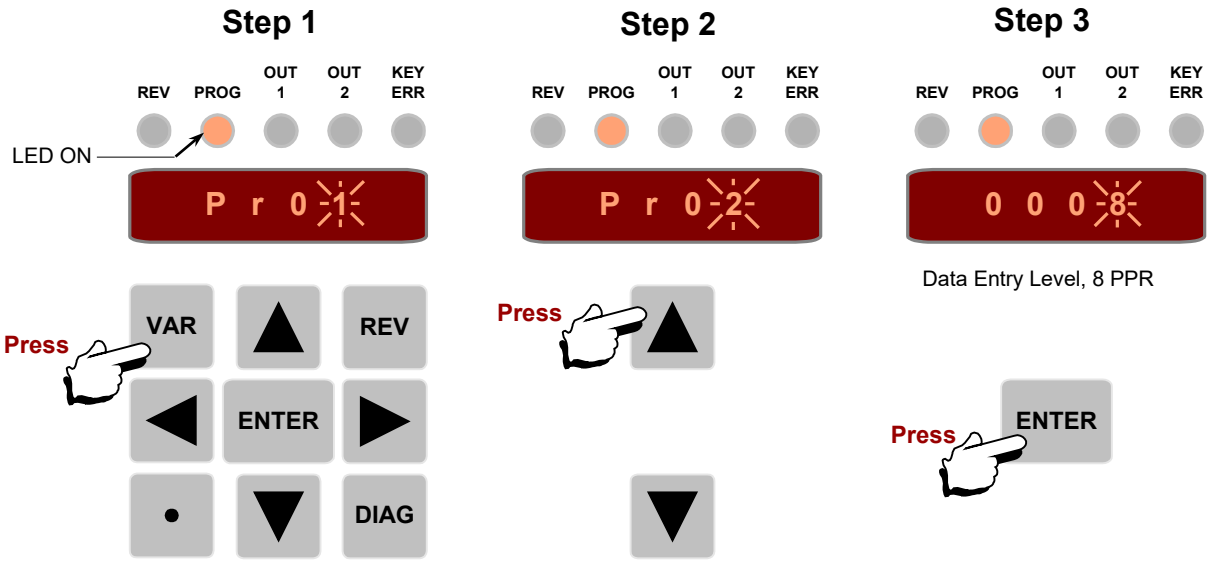
- How to enter Program Mode
- How to select variable 02 *(PPR)*
- How to change the value of variable 02 from 8 PPR to 16 PPR
- How to save the change, and exit Program Mode

Note: You can use the following 7-step procedure to select any variable, change its value, and save the results.

Note: You can select a variable and change its value when the TR400-C is actively monitoring or when it is idle.

Selecting and displaying variable data

To select variable 02 and display its data, press the key sequence shown in the three (3) steps below, while viewing the results on the display.

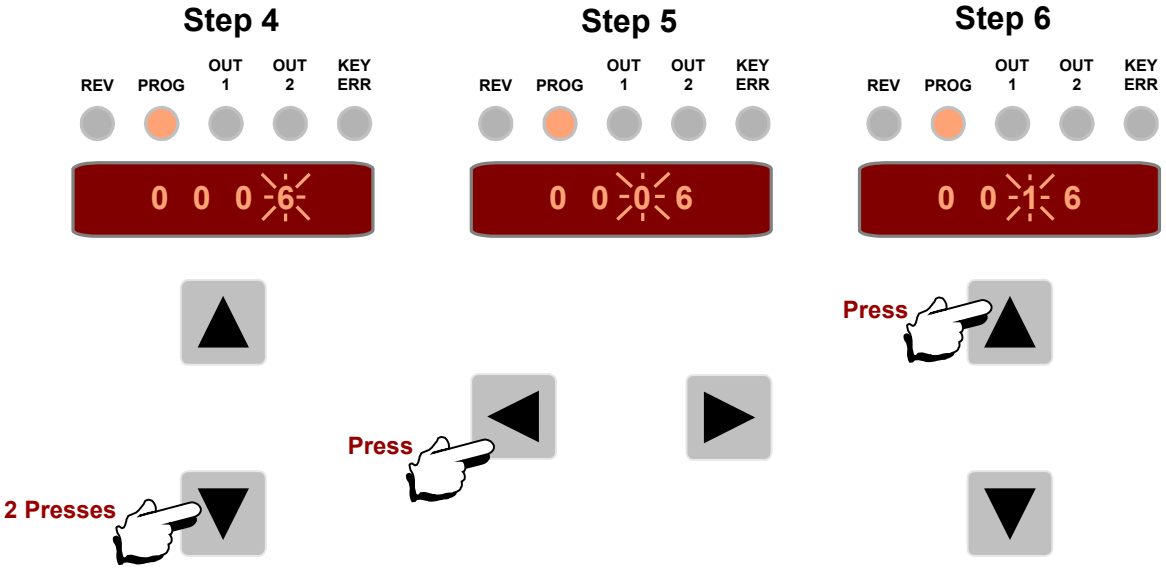


Continued on next page

How to select and change a variable's numerical value, continued

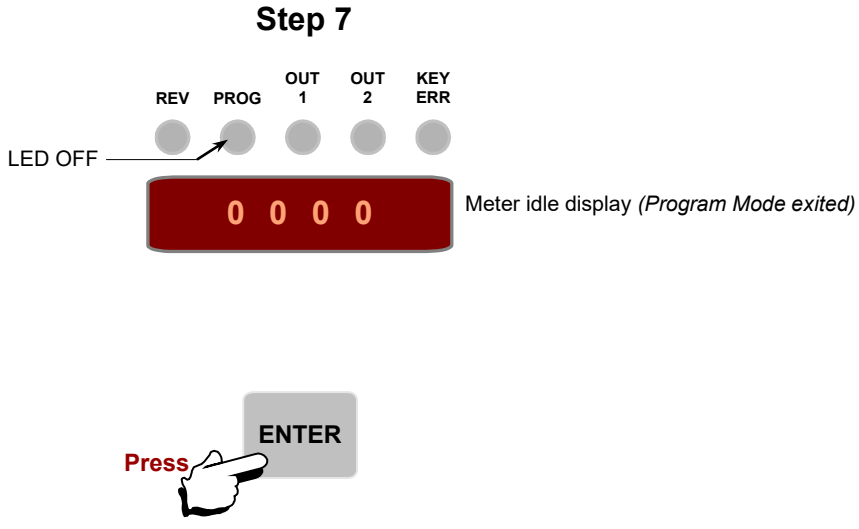
Changing the value

To change the PPR from 8 to 16 for variable 02, press each key the number of times shown in the three (3) steps below, while viewing the results on the display.



Saving the value and exiting

To save the new value and exit Program Mode, press the ENTER key as shown in Step 7 below, and view the result on the display—the PROG LED is OFF.



Rate and signal parameters

Overview

The TR400-C has the ability to display rates as “Speed”, using variables 01, 02, and 03. Variable 02 PPR is programmable; variables 01 and 02 are fixed.

Variables 01, RPM, and 02, PPR

The values for Maximum Revolution Per Minute (RPM) and Pulses Per Revolution (PPR):

- Variable 01, Maximum RPM is fixed at 200 RPM.
- Variable 02, PPR — Enter the actual Pulses Per Revolution for the sensor on the monitored shaft.

Note: Electro-Sensors Model 907 sensor with a Model 255 disc will provide eight (8) PPR.

Variable 03, display value /user units

Display Value/User Units value is fixed at 200.

The position of the decimal point will be fixed in Display Mode by its placement in variable 03.

Note: All TR400-C units readout in RPM only. (0-9999)

Variable 03, display value /user units

Display Value/User Units — Enter the value of the “user units” that will appear on the display when the monitored shaft is turning at the “speed” programmed in variable 01.

The position of the decimal point will be fixed in Display Mode by its placement in variable 03.

Variable 23, Pulses to Average

and

Variable 24

Averaging Window

- Variable 23, Pulses to Average — Enter the desired number of pulses to average. Valid values are 0 to 4 pulses.
- Variable 24, Averaging window — This is a window, expressed in percent, in which pulse averaging will be used. Deviations that are greater than the window will cause the TR400 to switch to pulse to pulse output. Ideally setting a window of about 2% greater than the actual measured is desired. Valid values are 0005 to 0025. The larger the window the slower the response is to a sudden change in speed. This is most noticeable at slower speeds.

Relay outputs and start time delay

Overview

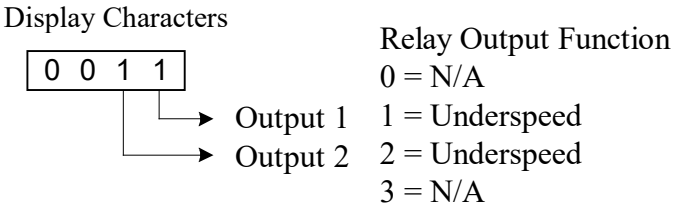
Variables 13, 10, and 07 establish the functional operating parameters for the relay outputs (fixed on Cargill units)

Variable 13, relay output function

The relay output Function sets the function of the relay outputs.

Each relay output has a set point value *(variables 07 and 10).* The set point value is compared to the value appearing on the display, and when they match, an action is performed.

The Relay outputs are fixed in Underspeed Mode, as shown below:



Variable 06, start delay time

Upon power-up or after an active Reset, both outputs are held ON until the Start Delay expires. The default is 2 seconds and is programmable up to five (5) seconds.

Output set points

The output set point value is compared to the value that appears on the display, and the outputs will deactivate if a set point condition occurs after the Start Delay times out.

Variables 07 and 10, relay output set point values

These variables are used to set the values at which the outputs will activate. There is a 1% hysteresis for the value used to activate the outputs; e.g., with an underspeed set point of 100 RPM, the output will activate at 0101 RPM, if the On Time has expired.

The default value for variable 07, output 1, is “0150.” The default value for variable 10, output 2, is “0100.”

Variables 08, & 11, relay output-delay times	Output Delay Times are used to set the amount of time the set-point condition must exist before the output will respond. The default value for these variables is one half second (0.5) second. The range is 0-1.0 seconds.
Variables 09, & 12, relay output- on times	Output On Times are used to set the minimum time that the output must be de-energized after a set point condition occurs and the relay has been de-energized. This value can be between 1 and 2 seconds. The default value for these variables is one (1) second.

Programming the analog output

Overview

The 4-20 mA or *0-10 Vdc range is specified with variables 15 and 16. The output is linear between the two specified values. Variable 19 is used to set the analog output response time. See Figure 18.

The REV key is used to change the direction associated with the value.

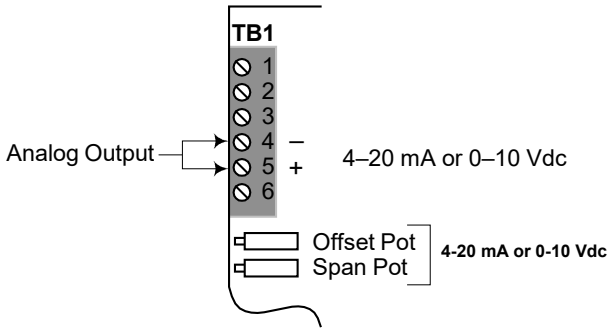


Figure 18: Analog Output

Variable 15, 4 mA display

This variable contains the display value at which the analog output is 4 mA. The default is “0.”

Variable 16, 20 mA display

This variable contains the display value at which the analog output is 20 mA. The default is “0200.”

Note: Variables 15 and 16 can be set up for reverse direction or as a window, as an example: 200–800 RPM.

Variable 19, analog output response time

The Analog Output Response Time sets the response time of the TR400's analog output from 0 to 100 percent. The TR400 will limit how much the analog output can change as the input frequency changes, which causes a filtering effect on the output. The minimum response time is “0.0,” which corresponds to approximately 50 msec from 0 to 100 percent. The maximum response time is ten (10) seconds. The default is “0.0.” (fixed on Cargill units)

**The 0-10 Vdc analog output is optional.*

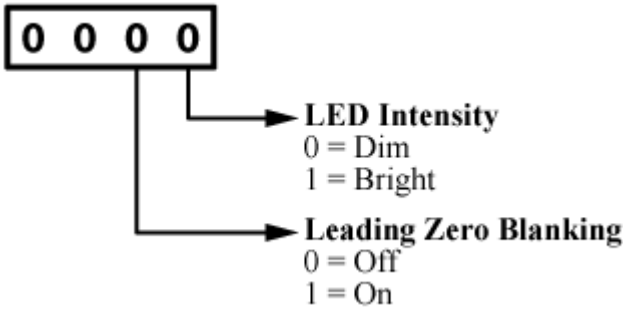
Programming the display features

Variable 26, Leading Zero Blanking and Segment intensity

This variable configures how the display appears.

The display appearance bit assignments are as shown below:

Display Characters



Leading Zero blanking — makes the leading zeros dark or not lit.

Intensity — makes the LED seven segments bright or dim to enhance the view ability based on ambient light.

Section 6

TR400-C Diagnostics

Introduction

Diagnostics are used to test the functionality of the TR400-C. When the DIAG key is pressed, the TR400-C will display “dIAg,” and all of the LEDs except the KEY ERR LED will light. The LEDs will remain on until you exit Diagnostics Mode.

In Diagnostics Mode you can do the following:

- Test the keypad and display
- Test the relay output
- Resetting the variables
- Test the Switch inputs
- Test the analog output
- Reset the variables

In this section These are the topics:

Keypad and display test

Overview

The keypad diagnostic tests the functionality of each key and bit position on the display.

Keypad and display test

To perform the keypad test, do the following:

Step	Action
1.	Press the DIAG key.
2.	Press the VAR key; the display will show 8888, the keypad diagnostic.
3.	Press each key from left to right and the display will appear as shown in Figure 19. Note the position of the decimal point after each key press.
4.	Press the DIAG key to exit the keypad diagnostic.

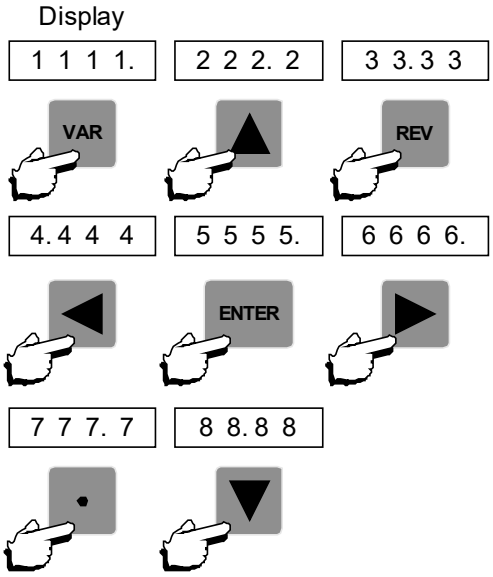


Figure 19: Keypad Test Showing the Display after Each Key Press

Relay output test

Overview

The relay output diagnostic tests the functionality of the relays.

Relay output test

To test the relay outputs using the built in diagnostic while not running, and when the TR400 is not locked, do the following:

Step	Action
1.	Press the DIAG key.
2.	Press the ► RIGHT ARROW key and the display will show the status of relay outputs 1 and 2. See Figure 20.

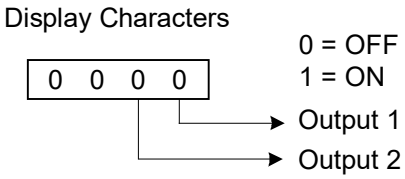


Figure 20: Relay output Test Display

Step	Action
3.	Use the ◄ LEFT ARROW key to turn ON output 2 and the ► RIGHT ARROW key to turn ON output 1.
4.	To turn OFF both outputs, press the ENTER key.

Switch input test

Overview

The Switch Input diagnostic tests the TR400's ability to recognize switch inputs tied to TB1–1. When a closed switch is tied to TB2, screw tap 1, 2, or 3, the corresponding bit position will toggle to "1."

Switch input test

To test the switch inputs, do the following:

Step	Action
1	Press the DIAG key.
2	Press the ▲ UP ARROW key and the display will show the status of the three (3) switch inputs. When a switch is activated at one of the inputs, the corresponding display character toggles to "1." When an input turns OFF, the corresponding display character toggles to "0." Figure 21 shows the bit positions associated with the three (3) switch inputs.

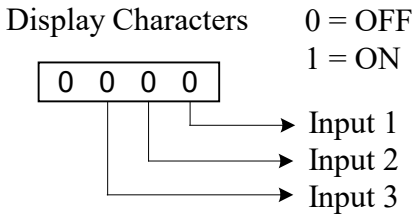


Figure 21: Display Bit Positions Associated with Switch Inputs

4-20mA / 0-10Vdc analog output test

Overview

The Analog Output diagnostic puts the TR400 into Pot Output Mode, which permits you to adjust the 4-20 mA 12-bit isolated, or the *0-10 Vdc outputs. The same hardware and procedure are used regardless of the option. There is a direct correlation between current/voltage and speed. See Figure 22.

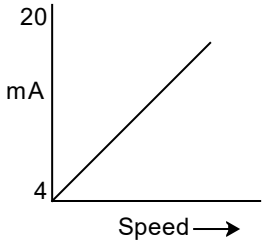


Figure 22: 4–20 mA 12 Bit Isolated Output Display

Note: 4-20 mA or 0-10 Vdc output is set up at the factory.

Adjusting the output

To adjust the 4-20 mA or 0-10 Vdc output, do the following:

Step	Action
1	Connect a milliammeter with a maximum load resistor of 500 ohms across TB1–4 and 5, or a voltmeter if using the 0-10 Vdc option.
2	Press the DIAG key.

Continued on next page

**The 0-10 Vdc analog output is optional.*

4-20mA / 0-10Vdc analog output test, continued

Step	Action
3	Press the ▼ DOWN ARROW key and the display will appear, as shown in Figure 23.

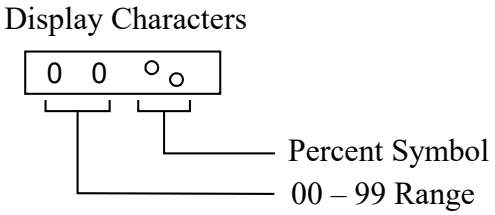


Figure 23: 4–20 mA or 0–10 Vdc Output Display in Percent

4	Turn the Offset Pot until the mA meter reads 4 mA or voltmeter reads 0 Vdc. Pots are located at the rear of the unit.
5	Press the ▲ UP ARROW key until the display reads 99%.
6	Adjust the Span Pot until the meter reads either 20 mA or 10 Vdc.
7	Press the DIAG key to exit the diagnostic.

System slowdown test

Overview

The system slowdown test, tests the functionality of the system as a whole.

System slowdown test

To run the slowdown test on the system you must have the system up and running. The system must be above both the shutdown and alarm setpoints. This test does not require the user to change the setpoints. Do the following:

Step	Action
1	Press the (.) decimal key and hold it down.
2	The displayed RPMs will start to decrement after 1.5 sec.
3	The relay output that has the alarm Setpoint will de-energize and the alarm should sound. This should occur (2-6 seconds) after starting the test depending on the operating speed. These times are based on the operating speeds of 50RPM to 200RPM. The test will work at all speeds but time will be greater or less than those shown.
4	The relay output that has the shutdown Setpoint will de-energize and the system should shut down. (3-8 seconds) after starting the test depending on the operating speed.
5	Test complete release the decimal key

Note: This test in this form is available on versions 001.C and later.

Reset the variables

Overview

When necessary, the TR400-C's variables can be reset to factory default, using the default function.

Resetting variables

To Reset the variables, do the following:

Step	Action
1.	Press the DIAG key.
2.	Press the REV key; the display will appear as shown in Figure 24, restoring the factory defaults.

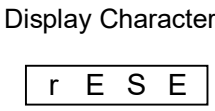


Figure 24: Reset Variables Display

Appendix A: Specifications

TR400-C Ratemeter

Power	Description
Input Power	• 115 Vac, 6VA @ 50/60 Hz, requires external fuse 1/16 amp slow-blow • 230 Vac, 6VA @ 50/60 Hz, requires external fuse 1/32 amp slow-blow
Sensor Input	Switch selectable
NPN Open Collector	2200 ohm pull-up to 12 Vdc, 2.5 volts trigger level
PNP Open Collector	2200 ohm pull-down, 2.5 volts trigger level
Logic Level	2.5 volts trigger level
Magnetic Pickup	150 mV peak-to-peak minimum signal, 50 mV trigger level
Maximum Frequency	Up to 4 KHz
Minimum Frequency	0.01 Hz

Optional External Control I/O	Description
Set point Outputs (*Relays)*	2 programmable-form C relays, rated 250 Vac 5 amp, 30 Vdc 5 amp resistive load
Analog output	1 programmable 4-20mA or 0-10Vdc, 12bit .1% linearity

Operational Values	Description
Accuracy	0.01 % +/- 1 digit for display and relays

Mechanical	Description
Enclosure	ABS Plastic 94V–0
Keypad	Polycarbonate Tactile switch pad, chemical resistant, splash proof
Display	4 digit .3 inch height, seven-segment display, 5 status LEDs
Operating Temperature	0º C to 50º C (+32º to + 122º F)
Humidity	0% to 90% non-condensing

Specifications are subject to change without notice.

Continued on next page

907 Hall-effect explosionproof sensor

Power	Description
Supply Requirements	5-24 Vdc @ 10 mA
Output Type	NPN Open Collector
Current Sink	25 mA Maximum
Maximum Frequency	20 kHz
Temperature Range	-40ºC to +60ºC
Gap Distance	3/8 ±1/8 inch
Maximum Dist. to Input Device	1500 feet
Material	Cast Aluminum, C.S.A. Approved Meets UL Class I Group D: Class II Groups E, F, G, and Glass III
Cable	3-Conductor Shielded
Mounting Bracket	Plated Steel U-Bolt Assembly, Included

Specifications are subject to change without notice.

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Electro-Sensors®, Inc.
6111 Blue Circle Drive
Minnetonka, MN 55343-9108

Contact us at:

Local:	952-930-0100
National:	1-800-328-6170
Fax:	952-930-0130
Web:	www.electro-sensors.com
Sales:	sales@electro-sensors.com
Support:	tech@electro-sensors.com