TR400SGA User's Manual

TR400SGA User's Manual

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Introduction to This Manual

What is in this manual?

This installation and operation manual provides detailed technical information about the TR400SGA Programmable Process Ratemeter. It should serve as your technical resource to install, set up, operate, and test the TR400SGA.

Who should use this manual *(audience)*

Keep in mind that the function of the TR400SGA installed in a mechanical process is to monitor position, capacity, speed, etc; 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 TR400SGA.
The secondary audience would be those persons seeking technical information about the electrical concepts and operation of the TR400SGA.

Knowledge level

Persons installing, setting up, and operating the TR400SGA should have good knowledge and understanding of electrical and mechanical concepts and principles pertaining to Programmable Process Ratemeters. Again, the TR400SGA should be installed by qualified personnel only.

Notices

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Introduction to This Product

The TR400SGA is a stand-alone display device that accepts a 4–20 mA DC analog input signal.

- The TR400SGA display has four 7-segment LED digits with decimal points.
- The TR400SGA displays ‘0’ user units when the input signal is 4 mA DC.
- The TR400SGA can be programmed to display any value of user units from ‘0.001’ to ‘9999’ when the input signal is 20 mA DC.
- The TR400SGA has two SPST NO relay outputs with programmable functions (HI, LO, and UNUSED alarms), and programmable trip points.
- The TR400SGA has a 4 to 20 mA output signal, which is isolated from the 4 to 20 mA input signal.
- The TR400SGA display has 5 status LED’s to indicate relay output status, as well as for indicating when the TR400SGA is in the programming, security, or diagnostics modes.
- The TR400SGA has an unregulated +24 Vdc output that can supply 40 mA maximum. (This supply can be used to power sensors, etc.).

The User Interface

The user interface consists of a keypad, the four character display, five discrete LEDs, several user variables, and three menus—the user variable menu, the security menu, and the diagnostic menu. The three menus are each accessed by a menu key; the VAR key accesses the user variable menu, the DECIMAL POINT key accesses the security menu, and the DIAG key accesses the diagnostic menu. In each of these menus there is an intermediate level (level 2) enabling you to select a menu item and a final level (level 3) enabling you to change or edit the selected menu item.

The method for selecting which menu item to edit depends on what menu you are in. In the VAR menu use the up, down, left, and right arrow keys to edit the two digits of the user variable number. In the security menu and in the DIAG menu use the up and down arrow keys to scroll through menu item prompts. Once a menu item has been chosen, press the ENTER key to move to the final level (level 3) to edit the variable value or perform the diagnostic action.

To edit a user variable value, use the left and right arrow keys to move the cursor (the flashing digit) to the digit whose value you want to change, then use the up and down arrow keys to change the value of the digit. Press the ENTER key to accept the value or press the 'abort' key to throw away the changes that you have made. (The 'abort' key depends on which menu you are in, i.e. the VAR key enters the user variable menu and the VAR key aborts the user variable menu.)

For example, to change a user variable value, press the VAR key to go to level 2—select user variable number. While in level 2, edit the display so that it shows the user variable number whose value that you want to change. Then, press the ENTER key to accept the user variable number and go to level 3—change user variable value. While in level 3, edit the display so that it shows the new user variable value. Then, press the ENTER key to accept that value and return to level 1—the user units display level. When the user accepts a value the TR400SGA will test it and will not allow an out-of-range or illegal value. If at any time you don't like the changes that you have made while you are in a particular level, press the abort key to discard the changes and go back to level 1—the user units display level.

The SECR menu works in a similar way to allow you to change the security variable values. The diagnostic menu will allow you to perform a diagnostic test, to perform calibration actions, or to observe the state of the system, thereby enabling you to set up your system or to troubleshoot your system installation.

The front panel LEDs are used to indicate which menu you are in or to indicate status information about the TR400SGA. There are five LEDs: SECR, PROG, OUT1, OUT2, and KEY ERR. When a menu key is pressed the LED associated with that menu turns on to indicate which menu you are in.

Key	LED	Menu
Decimal Point key	SECR LED on	Change Security Variable
VAR key	PROG LED on	Change User Variable
DIAG key	Both SECR and PROG LED on	Perform Diagnostic Action

Table 1; Associations Between Keys, LEDs, and Menus

The OUT1 LED is associated with relay output 1. The OUT2 LED is associated with relay output 2. A relay LED is 'ON' when the respective relay function is active (HI or LO alarm trip point surpassed), and is 'OFF' when the respective relay function is non-active (HI or LO alarm trip point not surpassed).

The KEY ERR LED is used to indicate an invalid key press, an invalid user variable number, or an invalid user variable value. It shuts off after a timeout period of 500 ms.

Neither the SECR LED nor the PROG LED is 'ON' when the display is showing a real-time value selected by the display function variable, Var04. This normal real-time display mode is indicated via both the SECR LED and PROG LED being 'OFF'.

Reading the User Interface Tables

The following tables provide a detailed guide to each of the three main menus. The tables break down each of the menus into levels. The rows of the tables indicate which menu activities are available at each level. The columns indicate what the display value is, what tasks can be performed, and which task key is used for each task. You can work your way through the menu activities by selecting from the tasks available at your current level and then pressing the appropriate task key. Items in quotes (" ") are the display items and X's are used to indicate unknown values.

The User Interface Tables

(SECR Menu) How to Change the Security Settings

Level	Level Description	Display Value	Task	Task Key
1	**User Units Display**	User units–"XXXX".	Select the security menu and go to level 2.	Decimal point key.
2	**Select Security Variable**	Security variables: Edit input password–"PIn ". Change password definition–"PdEF". Define security lockout–"SdEF".	Select the security variable.	Up and down arrow keys.
			Accept the security variable and go to level 3.	ENTER key.
			Abort selecting the security variable and go back to level 1.	Decimal point key.
3	**Change Security Variable**	Security variable value–"XXXX".[1]	Edit the display	Arrow keys.
			Accept the security value and go to level 1	ENTER key.
			Abort the changes and go to level 1	Decimal point key.

[1] If the user enters an incorrect password into the password input variable 'PIn', then the password definition variable 'PdEF' will not allow the user to see the current password (it will only display "HIdn"). See the section "*The Security Variables*," for information on the security lockout feature.

(VAR Menu) How to Change a User Variable

Level	Level Description	Display Value	Task	Task Key
1	**User Units Display**	User units–“XXXX”.	Select the user variable menu and go to level 2.	VAR key.
2	**Select User Variable Number**	User variable number–“PrXX”.	Edit the display.	Arrow keys.
			Accept the user variable number and go to level 3.	ENTER key.
			Abort the changes to the user variable number and go back to level 1.	VAR key.
3	**Change User Variable Value**	User variable value–“XXXX”.	Edit the display.	Arrow keys and the decimal point.[2]
			Accept the user variable value and go to level 1.	ENTER key.
			Abort the changes to the user variable value and go back to level 1.	VAR key.

Note: Access to the VAR menu is denied during a simulated LRC error (triggered by the “LrC.d” Diagnostic test).
Access to the VAR menu is still permitted during a real-life LRC error in the TR400SGA’s non-volatile memory.

[2] Not all variables accept a decimal point. Some of the variables that allow a decimal point are restricted to having decimal points that match those in a related variable. For more information see “*Appendix D—Variable Value Logs*”, for information on which variables accept a decimal point.

(DIAG Menu) How to Perform the Diagnostic Functions

Level	Level Description	Display Value	Task	Task Key
1	**User Units Display**	User units–"XXXX".	Select the diagnostic menu and go to level 2.	DIAG key.
2	**Select Diagnostic Function**	Diagnostic functions–"dIAg". Analog output calibration–"Anou". Standard I/O test–" SIo". Simulated LRC error–" LrC.d". Keypad test–"HEyP". Firmware version–" UEr". Reset–"rESE". **Note:** The "LrC.d" diagnostic cannot be accessed during a real-life LRC non-volatile memory error.	Select diagnostic function.	Up and down arrow keys.
			Accept the diagnostic, and go to level 3.	ENTER key.
			Abort selecting the diagnostic, go back to level 1.	DIAG key.
3	**Perform Diagnostic Function** Analog Output Calibration	Output percent "XX%".	Change the analog output percent.	Up and down arrow keys.
			Go to level 1.	DIAG key.[3]
3	**Perform Diagnostic Function** Standard I/O Test	Relay states. Relay one–digit one. Relay two–digit two. "00XX"	Pull relay 1 in.	Right arrow key.
			Pull relay 2 in.	Left arrow key.
			Drop both relays out.	ENTER key.
			Go to Level 1.	DIAG key.
3	**Perform Diagnostic Function** Simulated LRC Error	"0000"–disable simulated LRC error. "0001"–enable simulated LRC error.	Disable / enable simulated LRC.	Up and down arrow keys.
			Accept selection, auto exit DIAG, auto power-down, auto power-up, auto test LRC, auto go to level 1.	ENTER key.
			Abort diagnostic, go back to level 1.	DIAG key.
3	**Perform Diagnostic Function** Keypad Test	VAR key–"1111.". Up arrow key–"222.2". REV key–"33.33". Left arrow key–"4.444". ENTER key–"5555.". Right arrow key–"666.6". Decimal point key–"77.77". Down arrow key–"8.888".	Show the key test value.	All keys except the DIAG key.
			Go to level 1.	DIAG key.
3	**Perform Diagnostic Function** Firmware Version	Firmware version–"XX.XX".	Go to Level 1.	DIAG key.
3	**Perform Diagnostic Function** Factory Default User Variables Reset	"dOnE"	Go to Level 1.	DIAG key.

[3] The user cannot exit the analog output calibration menu until the output percent has been reduced to zero.

(SECR Menu) The Security Variables

The SECURITY menu is accessed by pressing the DECIMAL POINT key.

See the *"Security Variable Log"* in the "*Appendix D—Variable Value Logs"* for more information on the three security variables and for their default values.
Also, see the section *"(SECR Menu) How to Change the Security Settings*" for information on editing the security variables.

In the security menu the user has access to three variables. The input password variable (PIn), the password definition variable (PdEF), and the security definition variable (SdEF).

The security features defined by the security definition variable 'SdEF' are enabled anytime the input password 'PIn' is different from the password definition 'PdEF'.
In other words, in order to access locked-out functions the user has to enter an input password that matches the password definition (PIn = PdEF).
In order to lock out unauthorized changes to user variables the user must enter a password definition that is unknown to unauthorized users (PIn ≠ PdEF). Any attempt to access the password definition by an unauthorized user will result in a display of "HIdn" (hidden).

The following table indicates how menu access is controlled by the digits of the security definition variable.

<table>
<tr><th>Display Digits</th><th>Digit Function</th><th>Function Codes</th></tr>
<tr><td>Digit 1</td><td>VAR Menu

When this menu is locked the user variables can be viewed but not changed.</td><td rowspan="4">0–Menu Unlocked
1–Menu Locked</td></tr>
<tr><td>Digit 2</td><td>Not used</td></tr>
<tr><td>Digit 3</td><td>Not used</td></tr>
<tr><td>Digit 4</td><td>DIAG Menu

When this menu is locked, access to the diagnostic functions are denied.</td></tr>
</table>

Table 2; Security Variable "SdEF", Security Definition

(VAR Menu) Programming the User Variables

The VAR menu is accessed by pressing the VAR key.

See the *"User Variable Log"* in the "*Appendix D—Variable Value Logs"* for more information on the eight user variables and for their default values.
Also, see the section *"(VAR Menu) How to Change a User Variable*" for information on editing the user variables.

(Var01) Analog Input Maximum Rate in User Units

User Variable 01—Analog Input Maximum Rate in User Units (at 20 mA input).
This variable (a.k.a. "Maximum Rate in User Units") is used to scale a 20 mA signal into a displayed maximum value in user units.
The value entered into Var01 is the number of user defined units (position, capacity, speed, etc,) processed by the system when the analog input signal is 20 mA.

Notes:

1. The analog input may need to be calibrated to ensure the display reads the desired Var01 maximum rate when the analog input is 20 mA.
   See the section "*Calibrating the Analog Input*" for more information.
2. There is no corresponding user variable for "Minimum Rate in User Units (at 4 mA input)". The TR400SGA assumes when the analog input signal is 4 mA the system is stopped and the process rate is '0' user units.
3. A common use for the TR400SGA is as a "percentage" meter. In this case, the value entered into Var01 is 100.

(Var02) Analog Input 20 mA Gain

User Variable 02—Analog Input 20 mA Gain.
Var02 is used to calibrate the 20mA-end of the TR400SGA's internal analog-to-digital converter. This ensures that the full 0 to 4095 ADC bit range of the 12-bit A/D converter is utilized. This improves accuracy of the TR400SGA.

With the analog input signal at 20 mA, the user can adjust Var02's value to make the display read the desired Var01 "Maximum Rate in User Units" value. Var02 has a valid range from 3900 to 4020.
See the section "*Calibrating the Analog Input*" for information on how to tweak Var02.

(Var03) Analog Input Averaging

User Variable 03—Analog Input Averaging.
Var03 contains a boolean value to indicate when averaging is enabled/disabled for the 4/20 mA analog input signal.
With averaging disabled, the TR400SGA samples the analog input every 20 ms.
With averaging enabled, the analog input signal is still sampled every 20ms, however the TR400SGA then uses a running average of the last eight analog values.

Var03 selections are:

- "0000" disables averaging.
- "0001" enables averaging.

The default is for averaging to be 'disabled'.

(Var04) Display Function Select

User Variable 04—Display Function Select.
Var04 controls which real-time value is displayed by the user interface. The default function code is 0 (display in User Units). Function codes 1, 3, 5, and 6 are not used. The following table gives the display function codes and a description of their meanings. Display function code 7 is interpreted by Table 4.

Function Code	Function Description	Display Units
0	Process position, capacity, speed, etc.	User Units[4]
2	Process position, capacity, speed, etc.	Hz, 0 to 4095
4	Analog Output Value	DAC Bits, 0 to 4095
7	Relay Output Status	Boolean State (0 or 1)
8	Analog Input ADC Value	ADC bits, 0 to 4095

Table 3; Var04, Display Function Codes

Display Digits	Digit Function	Status Code
Digit 1	Relay Output 1	0–Dropped Out 1–Pulled In
Digit 2	Relay Output 2	
Digit 3	Unused	None
Digit 4	Unused	

Table 4; Var04, Display Function Code 7, Relay Output Status

[4] Var01 "Maximum Rate in User Units" scales the 4/20 mA analog input signal into user units for display function 0.

(Var05, Var06, Var07) Relay Output Variables

User Variable 05—Relay Output Function Select.
Var05 allows the user to select the relay output function(s). The user can choose from three function codes (one unused). The following table gives the relay output function codes and shows which Var05 digit corresponds to which relay output.

Display Digits	Digit Function	Function Codes
Digit 1	Relay Output 1	0–Unused 1–High Alarm 2–Low Alarm
Digit 2	Relay Output 2	
Digit 3	Unused	None
Digit 4	Unused	

Table 5; Var05, Relay Output Function Codes

The **unused** function keeps the respective relay permanently dropped-out.

The **high alarm** function pulls-in the relay when the 4/20 mA input signal rises to the trip point level, and drops-out the relay when the 4/20 mA input signal falls below the trip point level by 2.5%.

The **low alarm** function pulls-in the relay when the 4/20 mA input signal falls to the trip point level, and drops-out the relay when the 4/20 mA input signal rises above the trip-point level by 2.5%.

When a relay is pulled-in, the corresponding OUT1 or OUT2 LED is 'ON'.
When a relay is dropped-out, the corresponding OUT1 or OUT2 LED is 'OFF'.
Note: The relay hysteresis is fixed at 2.5% of the Var01 "Maximum Rate in User Units" value.

User Variable 06—This variable contains the trip point level for relay 1.
User Variable 07—This variable contains the trip point level for relay 2.
Note: The Var06 and Var07 trip points are in the same user units as the Var01 "Maximum Rate in User Units" value. Also, the decimal point locations for the Var06 and Var07 relay trip points are fixed in the same place as the decimal point location in the Var01 value.

(Var08) Analog Output Maximum Rate in User Units

User Variable 08—Analog Output Maximum Rate in User Units (at 20 mA output).
Var08 sets-up the maximum value of the 4/20 mA analog output. To properly "pass the 4/20 mA signal down the line" to another device, the TR400SGA needs to know the maximum value of the 4/20 mA analog ***output*** (in User Units), that corresponds to the analog ***input*** at 20 mA.

Var08 is typically set identical to the Var01 "Maximum Rate in User Units" value. However, Var08 can be tweaked, ± around the Var01 value in order to achieve the desired maximum 4/20 mA analog output level. See the section "*Calibrating the Analog Output"* for the procedure on how to tweak Var08.

Note: Enable the 4/20 mA analog output via doing both these back-panel terminal wiring connections:
- connect terminal TB2-1 (Analog Output Enable 0) to terminal TB1-1 (line AC).
- connect terminal TB2-2 (Analog Output Enable 1) to terminal TB1-1 (line AC).

Calibrating the Analog Input

This procedure calibrates the analog input (via calibrating the A/D converter's low and high end-points).

- The 4 mA low-end is initially factory calibrated via the "Analog Input 1" potentiometer, and should only need a minor adjustment, if any. (The 4mA low-end calibration is mainly steps 2 through 5).
- Since the 20 mA high-end calibration is user variable dependent, the high-end is not calibrated at the factory. The user must follow this procedure to calibrate the high-end (tweak Var02) to make the display read the desired Var01 "Maximum Rate in User Units" value.

Note: The 20 mA high-end may need recalibration after a "reset-to-factory-defaults" is performed.

The following procedure is used to calibrate the 4/20 mA analog input.

1. Set Var01 to the desired 20 mA "Maximum Rate in User Units" value.
2. Set the Analog Input 1 DIP switch to the 4-20 mA position (see Figure 1 below for DIP switch location).
   Note: Analog Input DIP Switches 2 and 3 are not used; their positions are irrelevant.
   Note: The "Analog Input 2 Pot" is not used; its setting is irrelevant.

3. Set Var04 to 8 (real-time display of analog input ADC bits).
4. Apply a 4 mA signal to the analog input back-panel terminals, TB4-7 (+) and TB4-9 (–).
5. Calibrate the analog input's 4 mA low-end by adjusting the "Analog Input 1 Pot" until the display reads 0, (0 bits). (See Figure 1 below for the "Analog Input 1 Pot" location).
   Note: Since the 4 mA low-end is initially calibrated at the factory, Step 5 may not be necessary.

6. Keep Var04 at 8 (real-time display of analog input ADC bits).
7. Apply a 20 mA signal to the analog input back-panel terminals.
8. Calibrate the analog input's 20 mA high-end by tweaking Var02's value until the real-time display reads between 4092 and 4095 ADC bits. (Var02 itself can only range from 3900 to 4020).
   Note: If the 20 mA high-end is calibrated firmly at 4095 bits, then it is difficult to determine if it is saturated at 4095. Hence, it is better if the high-end is calibrated just below 4095 to prevent ADC saturation (i.e., set Var02 so the "Var04 selection 8" real-time display reads between 4092 and 4095 bits).

9. Set Var04 to 0 (real-time display in User Units).
10. Display should read Var01 "Maximum Rate in User Units" value when the analog input is 20 mA.
11. Display should read 0 User Units, when the analog input is 4 mA.
12. Done.

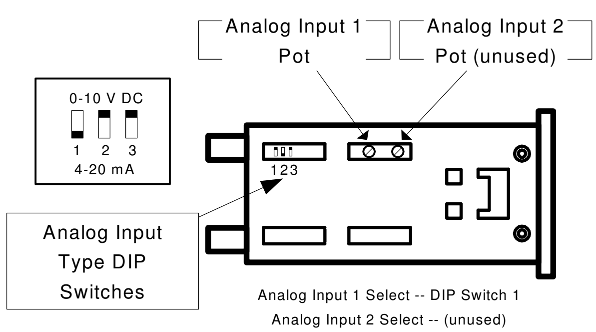


Figure 1; Analog Input Type DIP Switches and Calibration Pots

Calibrating the Analog Output

Proper calibration ensures that the analog ***output*** follows the analog ***input*** as close as possible. The following procedure is used to calibrate the 4/20 mA analog output.

1. First make sure the analog ***input*** is properly calibrated, before calibrating the analog ***output***.
   See the section *"Calibrating the Analog Input"* for more information.
2. Make sure Var08 is set to the same value as Var01.

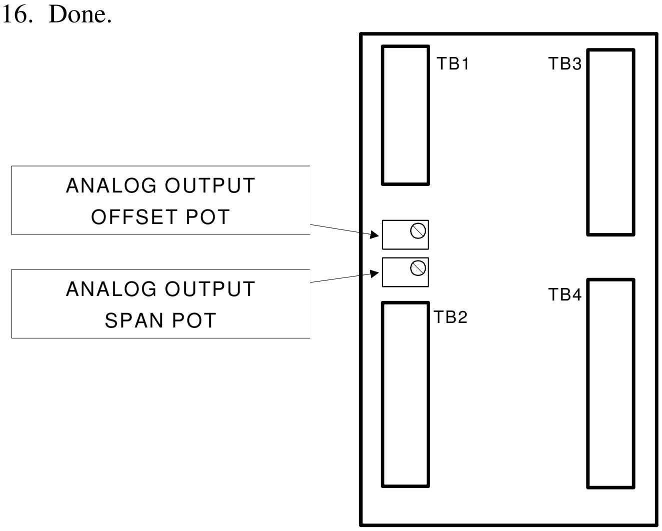
3. Install a resistive load, no larger than 500 ohm, along with an ammeter in series between the TR400SGA's analog output back-panel terminals TB1-5 (+) and TB1-4 (–).
4. Select "Anou" from the diagnostics menu. The display reads in percent, it should be 00%.
   See the section **"***(DIAG Menu) The Diagnostic Functions"* for more information about the Diagnostics Menu, and also on restrictions to accessing the Diagnostics Menu.
5. With the output at 00%, adjust the OFFSET pot until the ammeter (connected between TB1-5 and TB1-4) reads 4.00 mA. (See Figure below for OFFSET pot location).
6. Use the up and down arrows to scroll the analog output signal until it can go no higher than 99%.
7. Adjust the SPAN pot until the ammeter reads 20.00 mA. (See Figure below for SPAN pot location).
8. Scroll the output signal down to 00%.
9. Press the DIAG key to exit the calibration mode and Diagnostics Menu.

10. Enable the 4/20 mA analog output via doing both these back-panel terminal wiring connections:
    - connect terminal TB2-1 (Analog Output Enable 0) to terminal TB1-1 (line AC).
    - connect terminal TB2-2 (Analog Output Enable 1) to terminal TB1-1 (line AC).

11. Apply a 4 mA signal to the analog ***input*** back-panel terminals, TB4-7 (+) and TB4-9 (–).
12. Verify that the analog ***output*** is 4.00 mA (ammeter reads 4.00 mA).
    Note: If the analog ***output*** is not 4.00 mA, then go back and repeat step 5.

13. Apply a 20 mA signal to the analog ***input*** back-panel terminals.
14. **Tweak** Var08 (if needed) until the analog ***output*** is 20.00 mA (ammeter reads 20.00 mA).
    Note: If the analog ***output*** cannot achieve 20.00 mA, then go back and repeat starting at step 1.

15. Remove the resistive load and ammeter if not further needed by the application.
16. Done.



Figure; Rear-View of TR400SGA; Analog Output Calibration Pots

The LRC non-volatile memory check feature

The LRC feature is a self-check the TR400SGA performs on its non-volatile memory upon power-up. User variables Var01 through Var08, and the "LrC.d" diagnostic variable, are stored in the non-volatile memory.

After either of the following:

- a "Factory-Default-Reset-Power-up" (press-in 'DIAG' key while applying AC power to unit),
- or a "Diagnostic Menu \ rESE" (Reset the User Variables to Their Factory Default Values),

the values of Var01 through Var08, and the "LrC.d" diagnostic test variable, are all initially summed together and their LRC sum is also stored in the non-volatile memory.
The TR400SGA keeps track of changes to the LRC sum. Assuming no LRC error, if the user changes any variables or the "LrC.d" diagnostic test variable, then the LRC sum is updated in the non-volatile memory.

If upon a power-up, the new LRC sum matches the previous LRC sum from the non-volatile memory, then the LRC self-check passes. But, if the new LRC sum does <u>not</u> match the previous LRC sum, then the LRC self-check flags an error. An LRC error means the values of Var01 through Var08 have been corrupted in the non-volatile memory (i.e., they don't contain all the user's previous values).

During an LRC error the TR400SGA goes into a 'fail-safe' mode. It does not show any real-time display selections per Var04, but rather shows the message "LrC". Also for an LRC error the relay outputs drop-out, the OUT1 and OUT2 LEDs stay 'OFF', and the 4/20 mA analog output holds at 4.00 mA.
Due to the corruption of the user variables, the TR400SGA's performance may no longer be what the user expects. To prevent the TR400SGA from performing abnormally, the TR400SGA essentially stops performing (because any inadvertent change to the user variables may have changed its performance). The user then obviously knows something is wrong with the TR400SGA's user variables.

> ***Note:*** *It is important the user fills in their application's values in the 'User Variable Log' near the back of this TR400SGA User Manual. Because if an LRC error does occur, then there will be a correct list of variable values to compare to, when attempting to fix a corrupted variable.*

An LRC error can be of two types. One is a 'real-life' LRC error, caused by some electrical disturbance as a power-line spike, sag, or surge, or a lightning strike, etc,. The other type is a 'simulated' LRC error, caused intentionally by the user via the "Diagnostic Menu \ LrC.d" test. Whatever the cause, it made changes in the non-volatile memory to at least one of the user variables, (or to the "LrC.d" diagnostic test variable). The two LRC errors can be distinguished by the following characteristics.

During a real-life LRC error:

- Access to the Diagnostic Menu is allowed, but access to the "LrC.d" diagnostic test is denied.
- Access and changes to the Security Menu are allowed (having no effect on the LRC error).
- Access and changes to the Var Menu are allowed (within the following restrictions):
  1. If the LRC error is from <u>only one</u> corrupted user variable, the user can view all the values (and compare to their custom values in the 'User Variable Log' at the back of this manual), then try to change (fix) the variable that is corrupted. Thus clearing the LRC error that way.
     - However, if the variable's new value does not clear the LRC error, then the variable is automatically restored to the previous (pre-changed) value and the LRC error remains. The user can then try changing other variables. If such correction attempts are unsuccessful, a "reset-to-factory-defaults" must be done to clear the LRC error.
  2. If the LRC error is from <u>more than one</u> corrupted user variable, the user can still view all the variable values, but won't be able to clear the LRC error by trying to fix a corrupted variable (since there is more than one corruption). In this case, a "reset-to-factory-defaults" is the only way to clear the LRC error.
  3. If the LRC error is from <u>no</u> corrupted user variables (all the user variables show correct values), then the LRC error is from corruption of the LRC sum in the non-volatile memory. In this case, a "reset-to-factory-defaults" is the only way to clear the LRC error.

Note: In (1), (2) or (3) above, after a "reset-to-factory-defaults", the user must enter Var Menu to set any default values back to custom values, and perhaps recalibrate the analog input's 20 mA high-end.

During a simulated LRC error:

- Access to the Diagnostic Menu is allowed (use the "LrC.d" Diagnostic test to clear the LRC error).
- Access and changes to the Security Menu are allowed (having no effect on the LRC error).
- Access to the Var Menu is denied (this is only a test; avoid confusion from new variable values).

Summary: If the TR400SGA display shows "LrC", here is a quick way to determine if this is a real-life LRC error or a simulated LRC error. Assuming the Security Menu lockout feature is not enabled (allowing access to the Var Menu and Diagnostic Menu), and the analog output is not enabled, do the following:

1. Press the VAR key. If access to the Var Menu is denied, then this is a simulated LRC error.
2. Press the DIAG key, then the UP arrow key until the display shows "LrC.d", then press the ENTER key. If access to the "LrC.d" diagnostic is denied, then this is a real-life LRC error.

(DIAG Menu) The Diagnostic Functions

The DIAGNOSTIC menu is accessed by pressing the DIAG key.
Also, see the section *"(DIAG Menu) How to Perform the Diagnostic Functions"* for more information on accessing the diagnostic functions.

Note: *The TR400SGA's analog output (if used) must be disabled before entering the Diagnostic Menu. This means any connection between back-panel terminals TB2-1 (Analog Output Enable 0) and TB1-1 (line AC), must be removed before the Diagnostic Menu can be accessed.*

Once inside the Diagnostics Menu, press the UP and DOWN arrow keys to scroll through the list of diagnostic functions. Each of the diagnostic functions is explained below.

(Anou) How to Calibrate the Analog Output

Proper calibration of the analog output ensures two things:
One, that the full range of the 12–bit output DAC is available.
And two, that the 4 to 20 mA analog ***output*** will track the 4 to 20 mA analog ***input*** as close as possible.

See the section *"Calibrating the Analog Output"* for the detailed calibration procedure.

(SIo) How to Test the Relay Outputs

Select " SIo" from the diagnostics menu. The display will show the status of the two relay outputs.

- The right arrow key pulls-in relay output 1, sets the corresponding digit of the display to a 1, and turns-on the OUT1 LED.
- The left arrow key pulls-in relay output 2, sets the corresponding digit of the display to a one, and turns-on the OUT2 LED.
- The ENTER key drops-out both relays, clears the corresponding digits of the display to 0, and turns-off the OUT1 and OUT2 LEDs.
- The DIAG key exits the "SIo" Relay Output test.

(LrC.d) How to Simulate an LRC Self-Check Non-Volatile Memory Error

Select “LrC.d” from the diagnostics menu.

1. Press the ENTER key.
   Note: If there is a real-life LRC error, pressing the ENTER key at this point only results in the KEY ERR led turning ‘ON’, with the display remaining to show “LrC.d”. During a real-life LRC error (as opposed to a simulated LRC error), access to this “LrC.d” diagnostic test is denied.
2. The display shows the “LrC.d” diagnostic test variable as:
   - “0000” if the simulated LRC error is disabled.
   - “0001” if the simulated LRC error is enabled.
3. Press the UP or DOWN arrow keys to change the selection from “0000” to “0001”, or vice versa.
4. Press the ENTER key to accept the disabled or enabled selection.
   - The TR400SGA automatically exits the DIAG menu,
   - Then it automatically powers-down,
   - Then it automatically powers-up,
   - The LRC self-check is performed on the power-up,
   - If the simulated LRC error is disabled, then the display shows the real-time display selection per Var04, after the power-up.
   - If the simulated LRC error is enabled, then the display does not show the real-time display selection per Var04, but rather the message “LrC”, after the power-up.

Note: If the user does not want to go through with the “LrC.d” diagnostic test, then press the DIAG key instead of the ENTER key in step 4. This will abort any changes made to the “LrC.d” diagnostic test variable in step 3, and return the display back to the real-time ‘User Units Display’ (Level 1).

(HEyP) How to Verify That the Keypad is Working

Select “HEyP” from the diagnostics menu.
Each key corresponds to a unique display. Press each key to test its response.
The DIAG key exits the test.

(UEr) How to Find Out the Firmware Version Number

Select “ Uer” from the diagnostics menu. The firmware version and revision are displayed in “XX.XX” format.
The two digits before the decimal point reflect the version number.
The two digits after the decimal point reflect the revision number.
The DIAG key exits the test.

(rESE) How to Reset the User Variables to Their Factory Default Values

1. Select “rESE” from the diagnostics menu. Then press the ENTER key. This does not reset the processor, it only resets the user variables Var01 through Var08 in both the RAM memory and the non-volatile EEPROM memory. When the display shows “done”, press the DIAG key to exit.
2. Or, hold down the DIAG key on power-up. When the display shows “rESE” then release the DIAG key. This does everything the “rESE” diagnostic does, but also resets the processor.

Note: After doing a “reset-to-factory-defaults”, the analog input’s 20 mA high-end may need recalibration. See the section *“Calibrating the Analog Input”* for the necessary procedure.

Application Example

A plant engineer is using an Electro-Sensors, Inc. SG1000A SlideGate Monitor to sense the position of a slide gate controlling the amount of grain flowing out of a hopper storage bin.

The Electro-Sensors' SG1000A SlideGate Monitor is programmed to output a 4 mA DC signal when the gate is in the fully-closed position, and output a 20 mA DC signal when the gate is in the fully-open position. Any gate position between the fully-closed and fully-open positions, will be represented by the SG1000A output signal being proportionally between 4 mA and 20 mA.

Typically in such an application, the fully-closed slide gate position is referred to as being "0% open". Likewise, the fully-open slide gate position is referred to as being "100% open".

In this example, an Electro-Sensors' TR400SGA can be used to read the 4/20 mA signal coming from the SG1000A. The TR400SGA can be programmed to display the slide gate position as a percentage, from 0% open to 100% open. The user simply then has to view the TR400SGA displayed value to know the position of the slide gate at the bottom of the hopper storage bin.

In this example the TR400SGA's Var01 is set to 100 (to read 100% when the analog input is 20 mA). After following the TR400SGA User Manual instructions for calibrating the Analog Input, the plant engineer discovers he has to tweak Var02 from the default value of 3900 to 3950 to get the TR400SGA display to show 100% when the gate is fully-open.

The plant engineer also wants the TR400SGA to signal a LO alarm when the gate is in the 5% open position, and a HI alarm when the gate is in the 95% open position.
To accomplish this he programs the TR400SGA's Var05 to 0012 (Relay Output 1 as a LO alarm, Relay Output 2 as a HI alarm).
Then Var06 is programmed at 0005 (to trip at 5% display value), and Var07 is programmed at 0095 (to trip at 95% display value).

In this example, the plant engineer has no need for the TR400SGA to pass the 4/20 mA signal on to any other device, so he skips both the calibrating of the Analog Output and the tweaking of Var08.

The plant engineer tests the final system by closing the slide gate beneath the hopper bin, and verifies that the TR400SGA reads 0 (i.e., 0% for the 4 mA signal coming from the SG1000A).
When he runs the slide gate wide open, the TR400SGA shows 100 (i.e., 100% for the 20 mA signal coming from the SG1000A).

He notices that when the slide gate was fully-closed the OUT1 LED on the TR400SGA was 'ON', and remained so until the slide gate opened up to 5% (plus some hysteresis), then the OUT1 LED went 'OFF'. This is the LO position alarm he wanted.

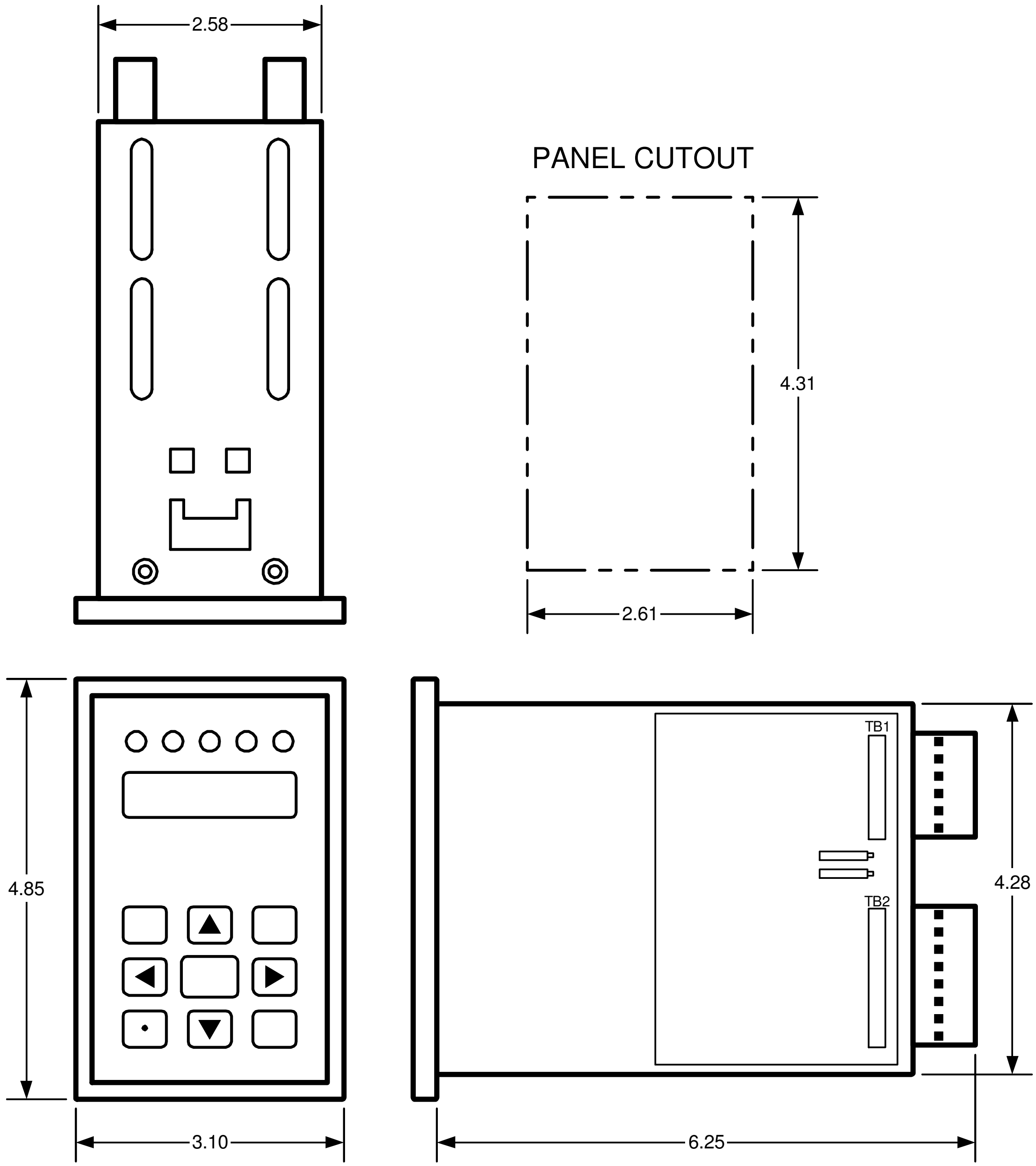
He also noticed that the TR400SGA's OUT2 LED was 'OFF' the entire time the slide gate was near the fully-closed position, and remained 'OFF' until the slide gate opened-up to the 95% open position, then the OUT2 LED came 'ON'.
This is the HI position alarm he wanted.

Appendix A—Panel Cutout Dimensions

To install the TR400SGA into an instrument panel:

- Remove the mounting brackets.
- Slide the TR400SGA into the panel cutout.
- Replace the mounting brackets and tighten the bracket screws (do not over tighten the bracket screws).

Allow a minimum of 1.5 inches clearance on all sides of the TR400SGA.



Appendix B—Wiring the TR400SGA

4/20 mA Analog Input (TB4-7, TB4-9)

A two conductor shielded cable should be used for this connection, with the shield tied at the receiving end (in this case the TR400SGA's end). The input can be calibrated (see the section "*Calibrating the Analog Input*" for details).

Note: TB4-7 is the analog input (+) terminal. TB4-9 is the analog common (–) terminal.

4/20 mA Analog Output (TB1-5, TB1-4)

A two conductor shielded cable should be used for this connection, with the shield tied at the receiving end (in this case not the TR400SGA's end). The output can be calibrated (see the section "*Calibrating the Analog Output*" for details).

This output is isolated to 1500 volts.

Note: TB1-5 (+) is the analog output terminal. TB1-4 (–) is the analog output common terminal. The TB1-4 analog output common is not internally connected to the TB4-9 analog common. The analog input and analog output are totally isolated from each other.

4/20 mA Analog Output Enable (TB2-1, TB2-2)

These switch inputs require that an AC voltage be applied to enable the 4/20 mA analog output. The applied AC voltage must be the same as that supplied to TB1-1, line input.

Enable the 4/20 mA analog output via doing both these back-panel terminal wiring connections:

- Connect terminal TB2-1 (Analog Output Enable 0) to terminal TB1-1 (line AC).
- Connect terminal TB2-2 (Analog Output Enable 1) to terminal TB1-1 (line AC).

AC or DC Input Power Supply (TB1-1, TB1-2)

The standard TR400SGA uses 115 VAC power. 230 VAC and 10-30 VDC power inputs are available as an option. External fusing must be provided by the customer. The recommended fuse size is 1/16 A Slo-Blo for 115 VAC, 1/32 A Slo-Blo for 230 VAC, and 2 A Slo-Blo for 10-30 VDC.

Note:

TB1-1 is the AC line terminal. TB1-2 is the AC neutral terminal.

TB1-1 is the DC + terminal. TB1-2 is the DC – terminal.

+24 VDC Voltage Output (TB4-8, TB4-9)

This is an unregulated +24 Vdc output that can supply 40 mA maximum. This supply can be used to power sensors, etc., such as an Electro-Sensors' SG1000A SlideGate Monitor.

Note: TB4-8 is the +24 Vdc analog power output terminal. TB4-9 is the analog common (–) terminal.

Relay Outputs (TB3-5, TB3-6, and TB3-7, TB3-8)

Each of the two relay outputs are rated as:

- 250 VAC, 5 A, Resistive Load.
- 30 VDC, 5 A, Resistive Load.

Note: TB3-5 and TB3-6 are Relay Output 1 terminals.

Note: TB3-7 and TB3-8 are Relay Output 2 terminals.

Wiring Diagram

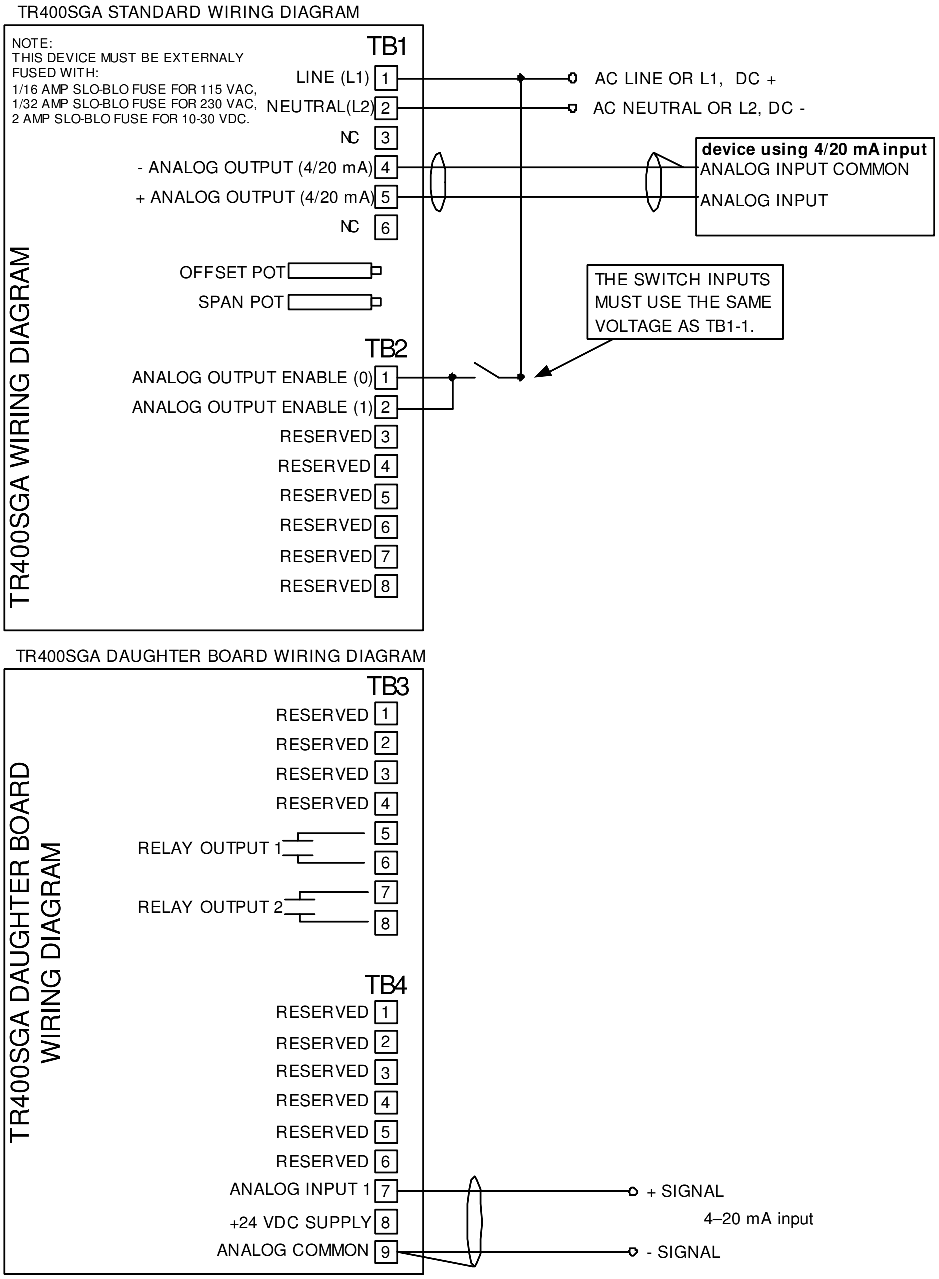


Figure 2; TR400SGA Wiring Diagram

Wiring Practices for Industrial Controllers

1. **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 have 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 power.

2. **Never use a shielded cable with unused conductors**. The unused conductors act as antennas. Attempting to tie the unused conductors to ground or other signals just creates different antenna configurations. In many cases unshielded wire would have received less electrical noise. Always insure that a shielded cable with the correct number of conductors is pulled.

3. **All control signals must be separated from power wiring**. Power wiring includes any AC or DC voltages with a current potential of greater that 1 A or a voltage greater than 24 V. This includes, but is not limited to, 115 VAC, 230 VAC, and 460 VAC. Do not bundle shielded cables and power wiring together.

4. **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.

5. **An earth ground wire must be installed on microprocessor based controllers when it is specified**. Do not rely on enclosure contact with the panel for earth ground. Earth ground is often used in noise rejection circuitry and is not just a safety factor.

6. Contactors, solenoids, and relay coils on the same AC power 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 µF or larger and a resistance value of 500 ohms or less.

7. When power is stepped down from a higher AC voltage for controllers, a capacitor-resistor network or other filter should be placed across the secondary.

Appendix C—TR400SGA Specifications

TR400SGA Power Supply Requirements

Input Voltage

Standard: 115 VAC 50/60 Hz, 9 VA
Optional: 230 VAC 50/60 Hz, 9 VA
Optional: 10-30 VDC, 6 Watts

Fuse—External Fuse Required

1/16 A Slo-Blo recommended for 115 VAC
1/32 A Slo-Blo recommended for 230 VAC
2 A Slo-Blo recommended for 10-30 VDC

Transducer Power Supply—Provided by the TR400SGA

+24 VDC unregulated, 40 mA maximum current draw. (Resettable fuse, recycle power to reset).

Control I/O

Standard Inputs:	2 AC switch inputs (for enabling the 4/20 mA analog output).
Standard Outputs:	2 Relays, programmable
	250 VAC, 5 A, Resistive Load
	30 VDC, 5 A, Resistive Load

Analog Input Signal

Standard: 4–20 mA DC, 12 bit ADC

Analog Output Signal

Standard: 4–20 mA DC, 1500 Volts Isolation , 12 bit DAC

Operational Specifications

Accuracy:	0.2%. (being within +/- 8 ADC bits out of 4095 ADC bits).
Response Time:	20 ms.
Display:	4 digit, 0.3”, seven-segment LED
	5 Status LEDs

Mechanical

Enclosure	ABS Plastic 94V-0
Keypad:	Polycarbonate Tactile Switch Pad, Chemical Resistant, Splash Proof
Operating Temperature:	0–50° C (32–122° F)
Humidity	0–90% Non-Condensing

Appendix D—Variable Value Logs

Security Variable Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	Decimal Point Locations	Page Reference
PdEF	Password Definition	0320		0001–9999	None	7, 10
PIn	Password Input	0320		0001–9999	None	7, 10
SdEF	Security Definition	1001		X00X (X is 0 or 1)	None	7, 10

User Variable Log

Variable Number	Variable Name	Default Value	User Value	Range of Values	Decimal Point Locations	Page Reference
01	Maximum Rate in User Units	0100		0.001–9999	All	11
02	Analog Input 20 mA Gain	3900		3900–4020	None	11
03	Analog Input Averaging Enable / Disable	0000		0000–0001	None	11
04	Display Function	0000		0000, 0002, 0004, 0007, or 0008	None	12
05	Relay Output Function	0012		0000–00XX (where X is 0, 1 or 2)	None	13
06	Relay 1 Trip Point	0005		0000–9999	Fixed[5]	13
07	Relay 2 Trip Point	0095		0000–9999	Fixed	13
08	Analog Output Maximum Rate in User Units	0100		0.000–9999	All	13

[5] The decimal point location for the relay trip points (Var06 and Var07) are fixed in the same place as the decimal point in the Var01 "Maximum Rate in User Units" value.

TR400SGA User's Manual Back Cover

Part Number: 990-002500 Rev B

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