SG1000RA SlideGate Monitor

SG1000RA general description ('R' is for 'relays')

The SG1000RA is a SlideGate Monitor with a 2-Relay output. The SG1000RA is a rugged, medium cost encoder-based monitoring device that enables the end-user to very accurately monitor a slide-gate's fully-open and fully-closed positions. The SG1000RA has two modes: Calibration Mode, and Normal Operating Mode. A simple calibration procedure teaches (programs) the SG1000RA the fully-closed (0% open) and fully-open (100% open) gate positions. Once programmed, the SG1000RA de-energizes one relay when the gate is in the fully-closed position, and de-energizes the other relay when the gate is in the fully-open position. Any gate position between fully-closed and fully-open, is represented by both relays being energized.

Physical Appearance and Installation Overview

Figure 1 is the front-view of the SG1000RA, showing the encoder-output-shaft (with the most common shaft end-thread type shown).

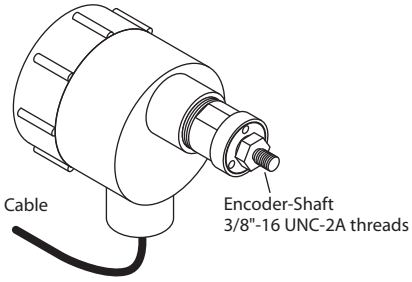

Figure 1:

The SG1000RA attaches to the slide-gate's 'rack and pinion' shaft, or similar rotating mechanical component, using an "end-of-shaft" mounting method. See Figure 2. In the most common application, the SG1000RA's encoder-shaft-end screws into a single 3/8-inch diameter hole, to a depth of 0.625 inch, having 3/8" – 16 UNC-2B threads. (Other encoder-shaft end-thread types are optional.)

Even though the SG1000RA is mounted to the process shaft via the "end-of-shaft" mounting method, installation of flexible conduit and of the optional stabilizer bracket is recommended, which allows the SG1000RA to "float" along with any wobble of the process's shaft while still preventing the SG1000RA itself from rotating along with that shaft (see Fig. 2).

Note: The stabilizer bracket's U-bolt is slightly oversized to provide about 1/8" of slack between it and the SG1000RA. The U-bolt's slack prevents it from rigidly clamping to the SG1000RA's conduit port.

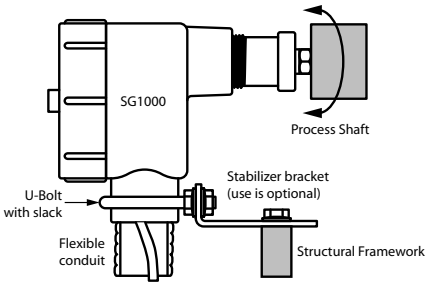

Figure 2:

Electrical connections

First, remove (twist CCW) the back-end-cover from the SG1000RA's red enclosure, to reveal the User Interface Board (see Figure 3).

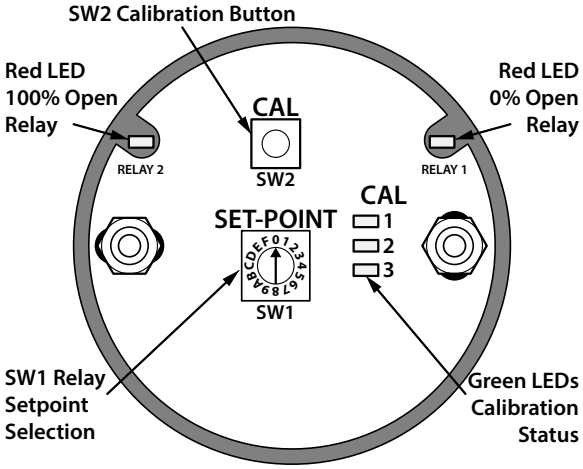

Figure 3: User Interface Board

Second, remove the nylon-retained metal nuts that hold the User Interface Board in place, to reveal the terminal block TB1 (see Figure 4)

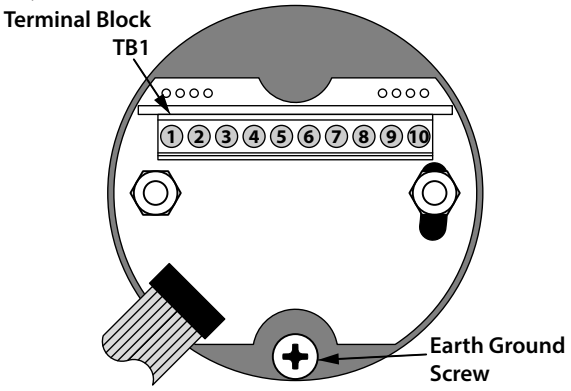

Figure 4: Terminal Block View

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The SG1000RA's electrical connections are as follows:

Terminal	Description
1	Relay 2 N.C.
2	Relay 2 N.O.
3	Relay 2 COM
4	AP2 (Alternate Power, Same as L1)
5	L1 (VAC Hot)
6	L2 (VAC Neutral/Hot)
7	Relay 1 N.C.
8	Relay 1 N.O.
9	Relay 1 COM
10	AP1 (Alternate Power, Same as L1)

- Connect the Vac's earth ground wire to the ground screw inside the SG1000RA housing (see Fig 4 for location of ground screw).
- For 115 Vac, connect Vac's HOT to terminal TB1-5.
- For 115 Vac, connect Vac's NUETRAL to terminal TB1-6.
- For 230 Vac, connect Vac's L1-HOT to terminal TB1-5.
- For 230 Vac, connect Vac's L2-HOT to terminal TB1-6.

- If using the SG1000RA's relays to switch Vac power, if desired you can power each of the two relay's COMMON pins via the Vac that is already powering the SG1000RA.
  - Connect ***appropriate*** gauge jumper wire between terminal TB1-10 (AP1: Alternate-Power1) and terminal TB1-9 (Relay1 Common).
  - Connect ***appropriate*** gauge jumper wire between terminal TB1-4 (AP2: Alternate-Power2) and terminal TB1-3 (Relay2 Common).

  Note: In this case **"appropriate"** means a jumper wire capable of carrying up to 0.5A at 125Vac, or 0.25A at 250Vac, this assuming the relays will be running at their maximum rated power in the application.

- If using the SG1000RA's relays to switch Vdc power, then do NOT connect jumpers from TB1-10 to TB1-9, NOR from TB1-4 to TB1-3. Instead, connect your separately supplied DC power to each of the two relay's COMMON pins, at terminal TB1-9 (Relay1 Common), and at terminal TB1-3 (Relay2 Common).

- Relay1 = Gate at 0%-open position.
  - Relay1 COMMON pin is at terminal TB1-9.
  - Relay1 NORMALLY OPEN pin is at terminal TB1-8.
  - Relay1 NORMALLY CLOSED pin is at terminal TB1-7.

- Relay2 = Gate at 100%-open position.
  - Relay2 COMMON pin is at terminal TB1-3.
  - Relay2 NORMALLY OPEN pin is at terminal TB1-2.
  - Relay2 NORMALLY CLOSED pin is at terminal TB1-1.

- See Figure 4 for related information.

Calibration Procedure

Calibration consists of teaching the SG1000RA the encoder values for the fully-closed (0% open) and fully-open (100% open) positions. The **eight** calibration steps are as follows (once the user is familiar with the calibration procedure they need only follow the **underlined** portions as a quick calibration guide):

1) Remove (twist CCW) the back-end-cover from the SG1000RA.

This provides access to the SG1000RA's User Interface Board, namely the calibration switch SW2 (the push-button switch), and the relay set-point/hysteresis selection 16-position rotary switch (SW1). See Figure 3 for locations of these switches.

Note: The SG1000RA has "Auto-Direction-Detection" software to detect the direction the slide-gate's shaft is turning, CW or CCW, as it runs from 0%-open to 100%-open, so there is NO need for a 'Direction-Selection" switch in the SG1000Rx line of products

2) There are two ways to enter Calibration Mode.

- One, remove the Vac power, press-in and hold the calibration switch SW2, then reapply the Vac power. When the two green LEDs are flashing on the User Interface Board then the SG1000RA is in Calibration Mode, then release the SW2 button. (This is referred to as "power-up" entry into Calibration Mode).
- Or two, while the SG1000RA remains powered, press-in and hold the calibration switch SW2, for a constant 5 to 6 seconds. When the two green LEDs are flashing on the User Interface Board then the SG1000RA is in Calibration Mode, then release the SW2 button. (This is referred to as "on-the-fly" entry into Calibration Mode).

The SG1000RA is now in Calibration Mode.

Note: For either Calibration Mode entry method, do not press SW2 multiple times or allow it to change state, just keep it pressed-in until the SG1000RA's two green LEDs are flashing, then release the button. Also when in Calibration Mode, both the relays are de-energized.

3) Move the gate to the fully-closed position (i.e., 0% open).

4) Momentarily press the calibration switch SW2.

- This captures the present encoder count. This value is then used for the fully-closed position (0% open).
- One of the green LEDs goes solid ON (to indicate the first calibration point has been calibrated), while the other green LED keeps flashing.
- Both relays remain de-energized.

5) Move the gate to the fully-open position (i.e., 100% open).

Note: As the gate moves from fully-closed to fully-open, the SG1000RA's encoder shaft must turn at least 1/4th-turn, but not more than 6-turns. Hence, if the shaft turns more than 6-turns, or less than 1/4th-turn,

then the SG1000RA will **not** work properly for the application.

6) Momentarily press the calibration switch SW2.

- This captures the present encoder count. This value is then used for the fully-open position (100% open).
- **The SG1000RA then automatically exits Calibration Mode**

Note: Calibration Mode is exited at this point for both valid and invalid calibrations.

- For a valid calibration the **Normal Operating Mode** is now entered: Both green LEDs are now solid ON (to indicate both calibration points have been calibrated). If the user does not immediately move the gate, then the 0%-open Relay1 energizes, and the 100%-open Relay2 de-energizes assuming the conditions of the SW1 set-point / hysteresis are met (this because the gate was left in the fully-open position from step 5).
- For an invalid calibration an "**Error**" condition is indicated: Both green LEDs are now in a rapid flash, and both relays remain de-energized. (The user must re-enter Calibration Mode and try again).

See the "**Valid Calibration**" and "**Invalid Calibration**" sections below for details regarding whether, or not, your SG1000RA accepted the gate's two calibration positions

7) Select the desired 0% and 100% set-point hysteresis.

How 'tight' or how 'loose' you want your relays to trigger on or around the Slidegate's fully-closed and fully-open positions can be controlled by selecting the amount of Relay set-point and hysteresis using the 16-position rotary switch (SW1) found on the User Interface Board.

The SW1 Rotary Switch has 16 different selections (0 thru F) and they are as follows:

SW1 Setting	Relay de-energize set-point inboard of calibration-pts	Relay re-energize set-point further inboard of the de-energize point
0	0 Encoder Positions	0 Encoder Positions
1	1 Encoder Position	1 Encoder Position
2	2 Encoder Positions	1 Encoder Position
3	4 Encoder Positions	1 Encoder Position
4	8 Encoder Positions	1 Encoder Position
5	12 Encoder Positions	1 Encoder Position
6	1 Encoder Position	2 Encoder Positions
7	2 Encoder Positions	2 Encoder Positions
8	4 Encoder Positions	2 Encoder Positions
9	8 Encoder Positions	2 Encoder Positions
A	12 Encoder Positions	2 Encoder Positions
B	1 Encoder Positions	4 Encoder Positions
C	2 Encoder Positions	4 Encoder Positions
D	4 Encoder Positions	4 Encoder Positions
E	8 Encoder Positions	4 Encoder Positions
F	12 Encoder Positions	4 Encoder Positions

SW1 sets the "number of encoder positions" inboard from the fully-closed or fully-open calibration points at which the relays de-energize, and then also sets the amount of hysteresis encoder positions that must be surpassed further inboard beyond the de-energized point before each relay gets re-energized again.

Note: The SG1000RA's internal encoder has 1024 positions, identified as 0 through 1023.

Note: The SW1 Rotary Switch selections can be done in either Calibration Mode or in Normal Operating Mode, but the effects are not seen until in Normal Operating Mode.

Example: Assume that out of the encoder's 1024 possible positions, a certain calibration span is in the CW direction, and places the gate's 0%-open point at encoder position 200, and places the gate's 100%-open point at encoder position 800. So then, 'inboard' means any encoder position inside the calibration span of 200 through 800, and 'outboard' would be any encoder reading 'outside' of the calibration span If the user set the SW1 selection at a setting of **'9'**, then that means:

- the 0%-open relay would de-energize at **8** counts inboard of 200 which is 200+8 = **208**, and re-energize at **2** counts inboard of the de-energize point which is 200+8+2= **210**.
- the 100%-open relay would de-energize at **8** counts inboard of 800 which is 800-8 = **792**, and re-energize at **2** counts inboard of the de-energize point which is 800-8-2= **790**.

Since the SG1000RA has a 6:1 internal gear-ratio between its output shaft and the internal encoder, this means that each internal encoder count (i.e., 1 out of 1024 counts) is 0.35° of rotation per count as seen at the encoder. But then, due to the 6:1 internal gear-ratio this translates into a 6 * 0.35° = 2.11° per encoder count as seen by the output shaft.

Hence in the example above, a SW1 setting of **'9'** provides de-energize set-points at **8** counts inboard of the fully-closed and fully-open positions, which translates out to be 2.11° per count * 8 positions = 16.88°, or about a 17°-turn of the output shaft inboard of each calibration point.

Likewise, the re-energize set-point in that example is 2.11° per count * **(8 + 2)** positions = 2.11° per count * **(10)** positions = 21.10°, or about 21°-turn of the output shaft inboard of each calibration point.

8) Replace the back-end-cover onto the SG1000RA.

This ends the calibration procedure.

Valid Calibration (Normal Operating Behavior)

Assuming the user followed the calibration process **correctly**,

the SG1000RA behaves as follows:

- Both green LEDs are solid ON.
- When the gate is at the fully-closed position (0% open), then the 0%-open Relay1 de-energizes, and the 100%-open Relay2 remains energized. This behavior modifies slightly when accounting for any effect of the SW1 set-point and hysteresis selection.
- When the gate is at the fully-open position (100% open), then the 100%-open Relay2 de-energizes, and the 0%-open Relay1 remains energized. (Again, allow for any effect of the SW1 selection).
- Any gate position between 0% open and 100% open is represented both relays being energized. (Again, allow for any effect of the SW1 selection).
- If the gate is moved to a position that is slightly beyond (outboard of) the fully-closed (0% open) calibrated position, then Relay1 remains de-energized. This is known as 0% 'run-out', and it holds to a certain point. If the encoder is turned far enough beyond the fully-closed calibrated position, then the encoder "wraps-around" and the relays flip-flop to the fully-open value of 100%-open Relay2 de-energized, and the 0%-open Relay1 energized.
- If the gate is moved to a position that is slightly beyond (outboard of) the fully-open (100% open) calibrated position, then Relay2 remains de-energized. This is known as 100% 'run-out', and it holds to a certain point. If the encoder is turned far enough beyond the fully-open calibrated position, then the encoder "wraps-around" and the relays flip-flop to the fully-closed value of 0%-open Relay1 de-energized, and the 100%-open Relay2 energized.
- For a properly calibrated SG1000RA, the direction of calibration (auto-detected CW or CCW), and the encoder values for the fully-closed and fully-open gate positions are all stored in the SG1000RA's EEPROM memory

Note: Since a properly calibrated SG1000RA can never enter Calibration Mode again by itself after Calibration Mode is exited, this means that for a properly calibrated SG1000RA running in Normal Operating Mode the calibration results are protected until the user wants to purposefully enter Calibration Mode again.
If re-calibration is needed, see the section below titled "**How to clear-out the existing calibration and reprogram the SG1000RA."**

Invalid Calibration (Error condition behavior)

Assuming the user followed the calibration process **incorrectly**, the SG1000RA behaves as follows:

- Both green LEDs are in a rapid flash.
- Both relays remain de-energized.

An "invalid calibration" is most likely due to one of the following errors:

- If the user did not move the gate (or moved it but less than 1/4th-turn, or more than 6-turns, of the encoder shaft) between teaching the SG1000RA the fully-closed and fully-open positions, then the closed and open positions have the same (or nearly the same) encoder count.
- The user "double-pressed" SW2 during during entry into Calibration Mode or while teaching the SG1000RA the fully-closed position.

Power-ups; Calibration vs. Normal Operating Mode

- An SG1000RA that is un-calibrated (or if the calibration attempt was invalid) automatically powers-up in Calibration Mode, the next time power is applied.
- A properly calibrated SG1000RA powers-up in Normal Operating Mode, when power is applied.
- If the user accesses Calibration Mode via the "power-up" method, then any previous calibration is immediately cleared.
- If the user accesses Calibration Mode via the "on-the-fly" method, then any previous calibration is retained until the new calibration points have been acquired. (This allows the user the option to bail out of Calibration Mode before completing the new calibration by simply removing the Vac power. In this case of intended power interruption, the EEPROM never gets called to save any new calibration, thus the old calibration is retained

Troubleshooting Hints

1) If your SG1000RA operates both relays, but not at the gate positions expected, then double-check the following:
   a) Do you have the Relay set-point/hysteresis selection 16-position rotary switch (SW1) set properly?
   b) As your gate moves from fully-closed to fully-open, does the SG1000RA's encoder-output-shaft turn less than 1/4th-turn, or more than 6-turns? If so, then the SG1000RA will not work in your application.
   c) Is your SG1000RA terminal TB1 wiring correct?
      - Do you have your relay wiring flip-flopped?
      - See the section "Electrical Connections" for proper terminal TB1 connections vs the internal Relay1 and Relay2 pin-outs.
   d) Assuming conditions (a) through (c) are proper, and your SG1000RA still seems to behave improperly, then try re-calibrating again, paying close attention to the eight calibration steps and your gate's fully-closed and fully-open positions.

How to clear-out the existing calibration, and reprogram the SG1000RA (Two methods)

One, remove the Vac power, press-in and hold the calibration switch SW2, then reapply the Vac power. When the two green LEDs are flashing on the User Interface Board then the SG1000RA is in Calibration Mode, then release the SW2 button. (This is referred to as "power-up" entry into Calibration Mode). The old calibration has now been cleared-out, and the SG1000RA is in Calibration Mode awaiting new calibration.

Or two, while the SG1000RA remains powered, press-in and hold the calibration switch SW2, for a constant 5 to 6 seconds. When the two green LEDs are flashing on the User Interface Board then the SG1000RA is in Calibration Mode, then release the SW2

button. (This is referred to as “on-the-fly” entry into Calibration Mode). (Technically, at this point for on-the-fly” entry into Calibration Mode, the old calibration does NOT get wiped-out until the new calibration points have been acquired).

See the “**Calibration Procedure**” section for complete details.

SG1000RA General Specifications:

Input Power	Input Current
115 - 230VAC ±10% 50/60Hz	60 mA for internal electronics (but if supplying Vac to the output relays then allow for a maximum of 0.5 A @115Vac, or 0.25 A @ 230 Vac, **for each of the two relays**)

Input Signal	Parameters
Type	Rotating shaft connected to internal 10 bit, 0 to 1023 count, absolute position magnetic-field encoder
Range of Operation	Continuous rotation with no physical end stops. Calibratable span of 1/4 to 6 turns of output shaft. Output shaft max RPM = 200.
Internal Gear Ratio	6:1

Output	Parameters
Relay Outputs	Two Form C Relays, w/programmable set-points: (Relay1 @ user’s fully-closed position). (Relay2 @ user’s fully-open position).
Relay Ratings (Resistive Loads Only)	125Vac @ 0.5A, 250Vac @ 0.25A, 30Vdc @ 0.5A, 110Vdc @ 0.3 A, and 220Vdc @ 0.27 A.
Accuracy	The internal magnetic-field encoder has a Nominal accuracy of +/- 0.7°-turn, and a Worst case accuracy of +/- 1.4°-turn, of its internal shaft. After going through the 6:1 gear-ratio inside of the SG1000RA, this results in a Nominal accuracy of +/- 4.2°-turn, and a Worst case accuracy of +/- 8.4°-turn, of the SG1000RA’s output shaft.
Encoder Resolution	The SG1000RA **resolves down to 2 encoder counts of the user’s calibrated span** (span from fully-closed to fully-open). This means the resolution varies linearly from best of 0.2% of span, to worst of 5.0% of span, depending on calibration (see details down below). **Note**: The internal encoder resolves down to 1 count of the user’s calibrated span. However the SG1000RA software uses a +/- 1 count anti-jitter-filter, resulting in more stable operation but at the expense of resolution, for a final resolution of 2 counts of the user’s calibrated span. **Note**: The SG1000RA software also monitors a long-term trend, so if no jitter is present then a resolution of 1 count of the user’s calibrated span may be achieved (but is not guaranteed).

Resolution details as per the calibrated span: A **0.2% resolution** occurs when the application can make full use of the 6-turn maximum capability of the SG1000RA, and in such a case calibration is done at the maximum span of 1024 encoder counts. That is, 1 count out of 1024 counts is about 0.001, or 0.1 %, but after running through the SG1000RA’s anti-jitter-filter becomes 2 counts out of 1024 counts, which is about 0.002 = 0.2%.
A **5.0% resolution** occurs when calibrated at the minimum span of 43 encoder counts, which is 1/4th-turn of the output shaft. Allowing for the +/- 1 count anti-jitter-filter, a 1 count out of 43 counts becomes 2 out of 43, which is about 0.05, or 5 %.
At temperatures -20F (-29C) and colder, the SG1000RA (relays specifically) may be unstable for a few seconds during a ‘cold-start’ power-up if the it has been sitting in the cold unpowered for awhile.

Mechanical	Parameters
Mounting	End of Shaft, single drilled and tapped hole.
Mounting Threads	3/8-16 UNC x 0.625 in. (Other options available.)
Housing Material	Cast Aluminum
Housing Dimensions	Cylindrical, with diameter of 3-11/16”, length of 7-5/8” (length includes housing & shaft)
Stabilizer Bracket	Mounted semi-rigidly to application’s framework using two user supplied 5/16” bolts.
Terminal Block Torque	0.35Nm to 0.4Nm 3.10in-lb to 3.54in-lb

Physical/Enviroment	Parameters
c UL us LISTED	Class I, Groups C, D Class II, Groups E, F, G UL File: E249019 For use in Pollution Degree 2 Environments. CE
Additional Rating	NEMA 4X, Gasket Provided
Temperature Range	-40ºC to +65ºC (-40ºF to +149ºF)
Humidity	0% to 90% non-condensing

Operator Interface	Parameters
One Pushbutton	Enter Calibration Mode, and calibrate for fully closed/fully open positions
One Rotary Switch	Select relay set-point hysteresis
Memory	EEPROM retains calibration during power failure or power shut down

Operation Modes
Normal Operating Mode: *(output relays per gate position)*. - Output: Energize/de-energize two relays as per gate position, for a properly calibrated SG1000R. - Output: Both relays remain de-energized for an uncalibrated or mis-calibrated SG1000R.
Calibration Mode: *(calibrate for fully-closed / fully-open gate positions, and select Relay set-point and hysteresis)*. - Output: Both relays remain de-energized in this mode.

Additional Information

To get additional information about the SG1000RA, visit our website at: www.electro-sensors.com

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