SG1000RA SlideGate Monitor

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

The SG1000RA is a SlideGate Monitor with 2 Relay outputs which act as a replacement for end-point limit switches.

The SG1000RA is a rugged, encoder-based monitoring device that enables the end-user to very accurately monitor for a slide-gate's fully-open and fully-closed end-point 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) end-point positions. Once programmed, any gate position between the fully-closed end-point and fully-open end-point, is indicated by both relays being energized. As a signal, the SG1000RA de-energizes Relay 1 when the gate is at the fully-closed end-point position, and de-energizes Relay 2 when the gate is at the fully-open end-point position. This provides information so the user can turn off their gate-drive when either end-point is reached.

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).

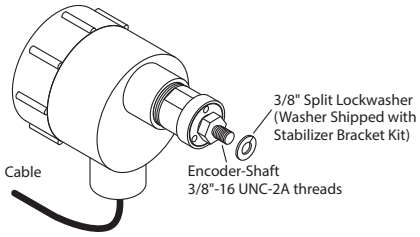

Figure 1:

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.) (Install the 3/8" split lockwasher, apply thread locker compound, and torque to 8ft-lbs.)

Note: If a torque wrench is not available, then still apply thread locker compound, then gently tighten encoder-shaft to application until you feel the split lock washer has fully compressed, then go 1/16th turn more.

Even though the SG1000RA is mounted to the process shaft via the "end-of-shaft" mounting method, installation of flexible conduit and the 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.

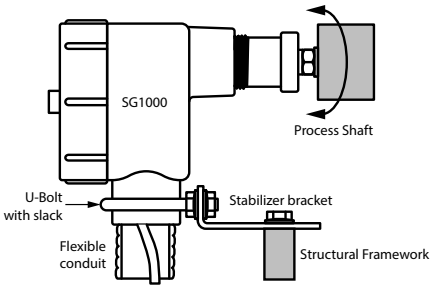

Figure 2:

Electrical connections

1) Remove (twist CCW) the back cover from the SG1000RA's red enclosure, to reveal the User Interface Board (see Figure 3).

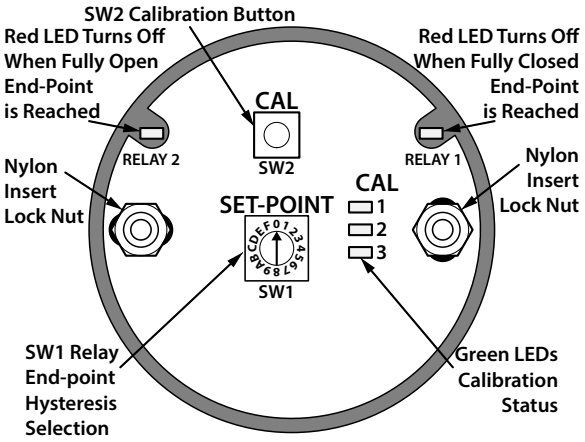

Figure 3: User Interface Board

2) Remove the nylon insert lock nuts that hold the User Interface Board in place, to reveal the terminal block TB1 (see Figure 4).

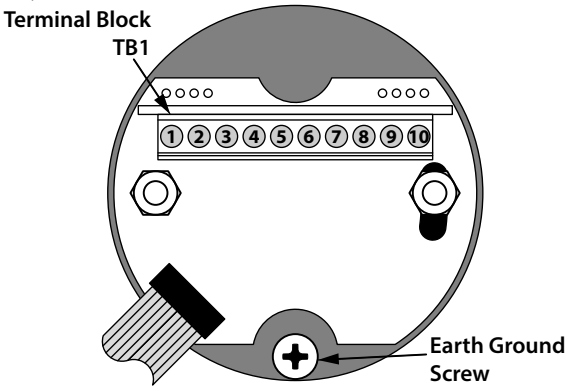

Figure 4: Terminal Block View

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The SG1000RA's electrical connections are as follows:

TB1	Description	
1	Relay 2 N.C.	De-energizes when Gate at Fully Open End-Point Position
2	Relay 2 N.O.	
3	Relay 2 COM	
4	VAC HOT Line 1 Jumper to Relay 2 COM (Optional)	
5	VAC 115V or 230V HOT Line 1	
6	VAC 115V Neutral or 230V Hot Line 2	
7	Relay 1 N.C.	De-energizes when Gate at Fully Closed End-Point Position
8	Relay 1 N.O.	
9	Relay 1 COM	
10	VAC HOT Line 1 Jumper to Relay 1 COM (Optional)	

3) Connect wiring to the terminal strip.

- 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.

- Optional: If using the SG1000RA's relays <u>with Vac power,</u> if desired you can power each of the two relay's COMMON pins via the Vac that is already powering the SG1000RA.
  - Connect ***24AWG or larger*** gauge jumper wire between terminal TB1-10 (VAC HOT Line 1 jumper tie) and terminal TB1-9 (Relay1 Common).
  - Connect ***24AWG or larger*** gauge jumper wire between terminal TB1-4 (VAC HOT Line 1 jumper tie) and terminal TB1-3 (Relay2 Common).

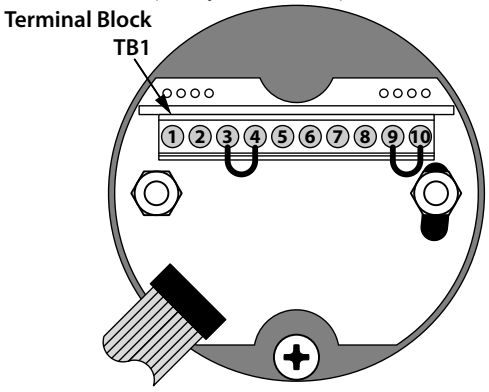

Figure 5: VAC Jumper Tie Installation

- If using the SG1000RA's relays <u>with Vdc power</u>, then do <u>NOT</u> connect jumpers from TB1-10 to TB1-9, <u>NOR</u> 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 = De-energizes at Fully-Closed end-point 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 = De-energizes at Fully-Open end-point 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 Figures 5, 7, 8, 9, and 10 for wiring configurations.

4) Reinstall User Iterface board with nylon insert lock nuts.

How to Calibrate the SG1000RA

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

<u>1) Remove (twist CCW) the SG1000RA's back cover</u>.
This provides access to the SG1000RA's User Interface Board, namely the calibration switch SW2 (the push-button switch), and the relay end-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 Fully-Closed to Fully-Open, so there is NO need for a 'Direction-Selection" switch in the SG1000Rx line of products

<u>2) How to enter Calibration Mode</u>.
While the SG1000RA remains powered, press-in and hold the calibration switch SW2, for a constant 5 to 6 seconds. When LED 1 and LED 2 are slowly flashing on the User Interface Board then the SG1000RA is in Calibration Mode, then release the SW2 button.

The SG1000RA is now in Calibration Mode.

Note: When in Calibration mode both the relays are de-energized.

<u>3) Move the gate to the fully-closed position.</u>

<u>4) Momentarily press the calibration switch SW2</u>.

- This captures the present encoder count. This value is then used for the fully-closed end-point position.
- LED 1 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.

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 end-point position.
- **The unit 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: LED 1 and 2 are now solid ON (to indicate both calibration points have been calibrated). If the user does not immediately move the gate, then the Fully-Closed Relay1 energizes, and the Fully-Open Relay2 de-energizes assuming the conditions of the SW1 end-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: LED 1 and 2 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 end-point hysteresis.

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

SW1 sets the "number of encoder positions" inboard from the fully-closed or fully-open calibration end-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.

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

SW1 Setting	Relay de-energizes inboard of calibrated end-point (distance 'X' in Fig. 6)	Relay re-energizes further inboard of the de-energize point (distance 'Y' in Fig. 6)
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

*Note: Factory default setting of SW1 Rotary Switch

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 Fully-Closed end-point at encoder position 200, and places the gate's Fully-Open end-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 hysteresis selection at a setting of **'9'**, then that means:

- the Fully-Closed 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 Fully-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**.

Note: See Figure 6 near end of this User Manual for a graph of this example.

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 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 calibrated end-point.

Likewise, the re-energize 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 calibrated end-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:

- LED 1 and 2 are solid ON.
- When the gate is at the fully-closed position, then the Fully-Closed Relay1 de-energizes, and the Fully-Open Relay2 remains energized. This behavior modifies slightly when accounting for any effect of the SW1 end-point hysteresis selection.
- When the gate is at the fully-open position, then the Fully-Open Relay2 de-energizes, and the Fully-Closed Relay1 remains energized. (Again, allow for any effect of the SW1 selection).
- Any gate position between Fully-Closed and Fully-Open is represented by 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 case with the Fully-Open Relay2 de-energized, and the Fully-Closed 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 case with the Fully-Closed Relay1 de-energized, and the Fully-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 end-point limit 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:

- LED 1 and 2 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.
- Or the user "double-pressed" SW2 during during entry into Calibration Mode or while teaching the SG1000RA the fully-closed position.
- Or the user had multiple encoder rollovers between their Fully-Closed and Fully-Open calibration points, most likely due to moving forward over the 0/1023 encoder rollover point and then reversing over the same rollover point. (See **Troubleshooting Hint #2** for details).

To clear the Invalid Calibration Error, either press-in the calibration button SW2 for 5 to 6 seconds, or simply cycle power. Either way returns the SG1000RA to the Calibration Mode.

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.

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 end-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 end-point limit positions.
2) As a troubleshooting aid, the green LED 3 lights up when the encoder is near it's 0/1023 rollover point.

How to clear-out the existing calibration, and reprogram the SG1000RA

While the SG1000RA remains powered, press-in and hold the calibration switch SW2, for a constant 5 to 6 seconds. When LED 1 and LED 2 are slowly flashing on the User Interface Board, then the SG1000RA is in Calibration Mode so release the SW2 button. During Calibration Mode 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 normal operation power on/off does not affect calibration end-points.

See the "**How to Calibrate**" 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, via the VAC-out jumper ties, then allow for a maximum of 0.5 A @115Vac, or 0.25 A @ 230 Vac, **for each of the two relays**)

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

Input Signal	**Parameters**
Type	Rotating shaft connected to internal 10 bit, 0 to 1023 count, absolute position 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 end-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 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, 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 unit 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.)
Mounting Torque	8ft-lbs, with threadlocker compound.
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

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 end-point positions, and select Relay end-point 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

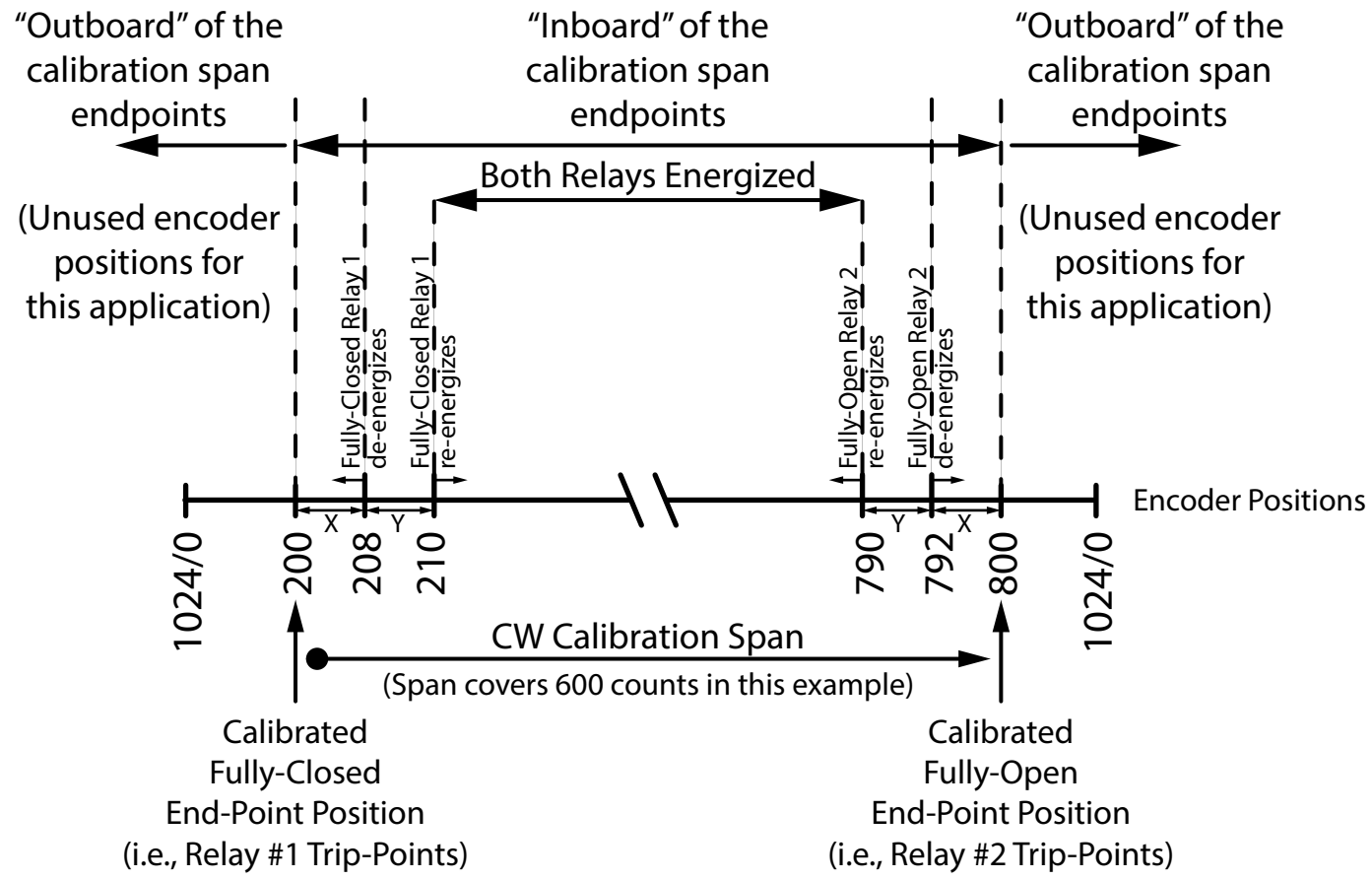

Figure 6: Calibration Span Example

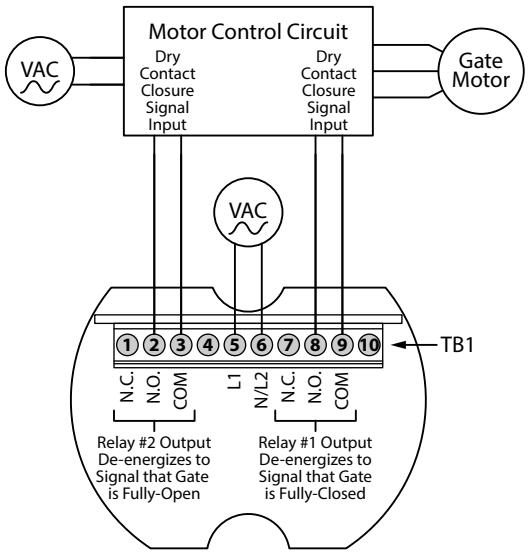

Figure 7: SG1000RA Relay Outputs with Dry Contact Closure Wiring Configuration

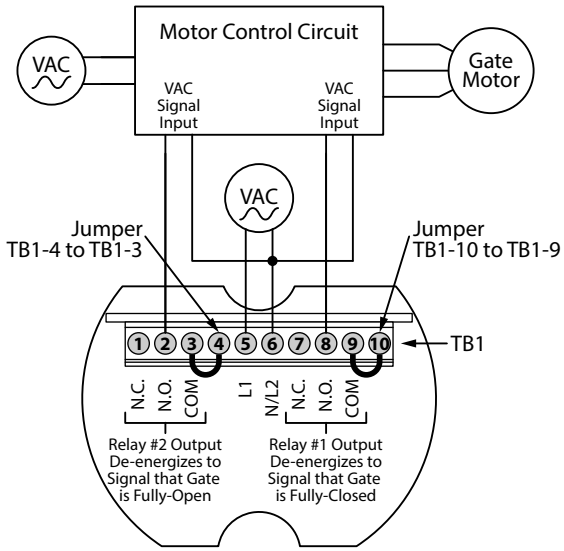

Figure 8: SG1000RA Relay Outputs withVac Wiring Configuration

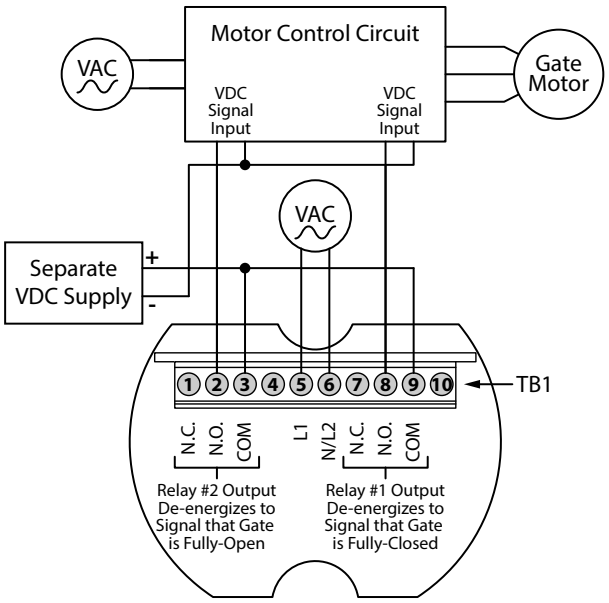

Figure 9: SG1000RA Relay Outputs with Vdc Wiring Configuration

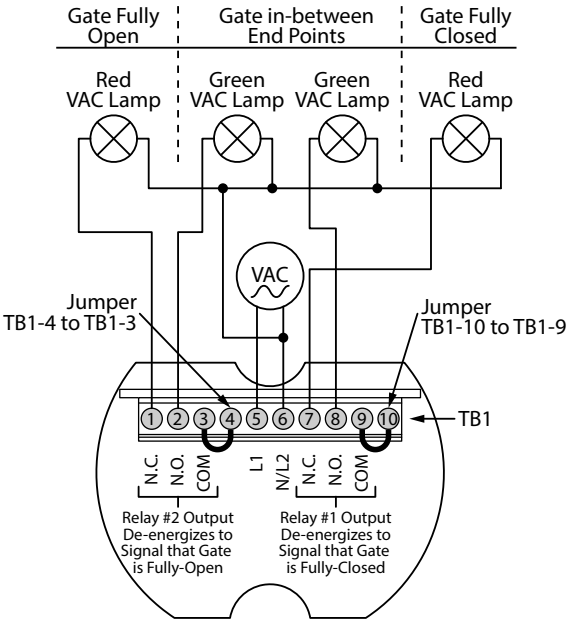

Figure10: SG1000RA Relay Outputs with Vac Wiring Configuration for Simple Indicator Lamps