SG1000A SlideGate Monitor

SG1000A general description

The SG1000A is a SlideGate Monitor with a 4-20 mA output. The SG1000A is a rugged, medium cost encoder-based monitoring device that enables the end-user to very accurately monitor a slide-gate's position, allowing very accurate blending operations. The SG1000A has two modes: calibration mode, and normal operating mode. A simple calibration procedure teaches (programs) the SG1000A the fully-closed (0% open) and fully-open (100% open) gate positions. Once programmed, the SG1000A outputs a 4 mA DC signal when the gate is in the fully-closed position, and outputs a 20 mA DC signal when the gate is in the fully-open position. Any gate position between fully-closed and fully-open, is represented by the output signal being proportionally between 4 and 20 mA.

Physical Appearance and Installation Overview

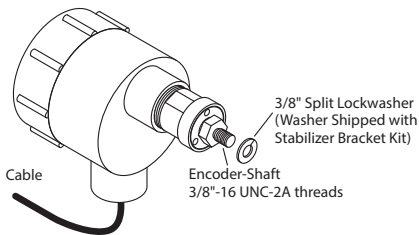Figure 1 is the front-view of the SG1000A, showing the encoder-output-shaft.

Figure 1:

The SG1000A 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. The SG1000A'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. (Install the 3/8" Split Lockwasher, apply thread locker compound, and tighten to 8ft-lbs torque).

Even though the SG1000A 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 SG1000A to "float" along with any wobble of the process' shaft while still preventing the SG1000A 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 SG1000A. The U-bolt's slack prevents it from rigidly clamping to the SG1000A's conduit port.
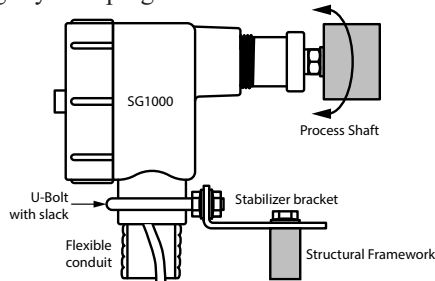

Figure 2:

Electrical connections

The SG1000A's electrical cable has three wires, plus a shield-wire. Connect as follows: (See Figure 3):
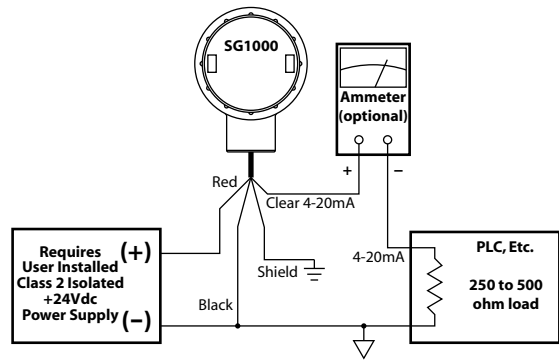

Figure 3:

- Connect the shield wire to the earth ground.
- Connect the black wire to the power-supply (-) terminal.
- Connect the red wire to the power-supply (+24 Vdc) terminal.
- Connect the clear wire to a resistive load of 250 Ω to 500 Ω, (usually this load is internal to a PLC, etc.).
  Note: The clear wire is the 4-20 mA DC output line. The other side of the 250 Ω to 500 Ω load must be connected to the power-supply (-) terminal.
- See Figure 4 below for related information.

Calibration Procedure

Calibration consists of teaching the SG1000A 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 SG1000A.**
   This provides access to the edge of the SG1000A's printed circuit board, namely the direction switch SW1 (the slide switch), and the calibration switch SW2 (the push-button switch). See Figure 4 for locations of these switches.
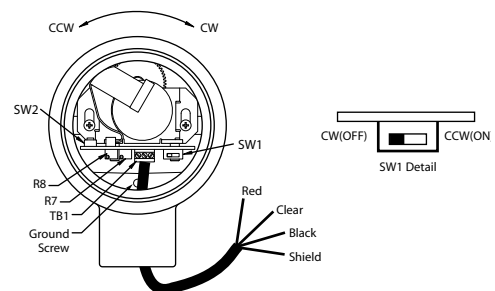

Figure 4:

Note: Also on the edge of the PC board are two adjustment potentiometers, R7 and R8, and a 3-pin terminal TB1. Pot R7 is for tweaking the 4 mA output level. Pot R8 is for tweaking the 20 mA output level. These two pots are factory-adjusted, and the user normally should not have to adjust them. It is best to leave these two pots alone. The user normally should not have to disconnect the 3-wire cable from the SG1000A. But if they do so, they must reconnect the 3-wire cable to the SG1000A as follows:
- +24Vdc red wire to TB1-1.
- 4-20mA signal clear wire to TB1-2.
- Power supply ground black wire to TB1-3.

2) **Before entering Calibration Mode, set the direction switch SW1 on the SG1000A's PC board to the proper position for the application.**
SW1 tells the SG1000A the direction the encoder turns, CW or CCW, as the gate is moved from the fully-closed to the fully-open position. The CW or CCW direction is defined via the viewer looking at the back-cover-end of the enclosure, and not the encoder-shaft-end of the enclosure:

- If the encoder shaft turns in the CW direction as the gate is moved from the fully-closed to the fully-open position, then set SW1 to the OFF position (i.e., toward the center of the PC board). See Figure 4.

- If the encoder shaft turns in the CCW direction as the gate is moved from the fully-closed to the fully-open position, then set SW1 to the ON position (i.e., toward the edge of the PC board). See Figure 4.

Note: The direction switch SW1 is monitored only briefly as the SG1000 enters into Calibration Mode. But once inside Calibration Mode, SW1 is no longer relevant. Hence, changing SW1 at this point has no effect. Because of this, SW1 must be set to the desired position before Calibration Mode is entered in order to capture the desired setting of SW1.

3) **There are two ways to enter Calibration Mode:**
- One, remove the +24Vdc power, press-in and hold the calibration switch SW2, then reapply the +24Vdc power. (This is referred to as "power-up" entry into calibration mode).
- Or two, while the SG1000 remains powered, press-in and hold the calibration switch SW2, for a constant 5 to 6 seconds. (This is referred to as "on-the-fly" entry into calibration mode). (Do not press SW2 multiple times or allow it to change state, just keep it pressed-in). Continue to keep SW2 pressed-in for a few seconds until the SG1000 outputs a constant 12 mA from its signal line, then release the button. **The SG1000A is now in the calibration mode**.

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

5) **Momentarily press the calibration switch SW2.**
- This captures the present encoder count. This value is then used for the fully-closed position (0% open).
- The output signal remains at 12 mA.

6) **Move the gate to the fully-open position (i.e., 100% open).**
Note: As the gate moves from fully-closed to fully-open, the SG1000A'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 SG1000A will **not** work properly for the application.

7) **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 SG1000A then automatically exits the calibration mode and enters the normal operating mode.**
  Note: The calibration mode is exited at this point for both valid and invalid calibrations.
  For a valid calibration: If the user does not immediately move the gate, then the output signal is 20 mA. (Because the gate was left in the fully-open position from step 6, the output signal is at 100%, which is 20 mA).
  For an invalid calibration: The output signal remains at 12 mA.
  See the "**Valid Calibration**" and **"Invalid Calibration"** sections below for details regarding whether, or not, your SG1000A accepted the gate's two calibration positions.

8) **Replace the back-end-cover onto the SG1000A.**
This ends the calibration procedure.

Valid Calibration (Normal Operating Behavior)
Assuming the user followed the calibration process **correctly**, the SG1000A behaves as follows:
- When the gate is at the fully-closed position (0% open), the output signal is 4 mA.
- When the gate is at the fully-open position (100% open), the output signal is 20 mA.
- Any gate position between 0% open and 100% open is represented by the output signal being proportionally between 4 mA and 20 mA.
- If the gate is moved to a position that is slightly beyond (outside of) the fully-closed (0% open) calibrated position, then the output signal remains at 4 mA. 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 output signal jumps to the fully-open value of 20 mA.

Valid Calibration (cont.)

- If the gate is moved to a position that is slightly beyond (outside of) the fully-open (100% open) calibrated position, then the output signal remains at 20 mA. 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 output signal jumps to the fully-closed value of 4 mA.
- For a properly calibrated SG1000A, the direction of calibration (CW or CCW), and the encoder values for the fully-closed and fully-open gate positions are all stored in the SG1000A's EEPROM memory.

Note: Since a properly calibrated SG1000A can never enter the calibration mode again by itself after the calibration mode is exited, the direction switch SW1 and the calibration switch SW2 are ignored (during normal operating mode). This means that for a properly calibrated SG1000A 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 SG1000A."**

Invalid Calibration (Error condition behavior)

Assuming the user followed the calibration process **incorrectly**, the SG1000A behaves as follows:

- The output signal remains at a constant 12 mA after the calibration mode is automatically exited.
  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 of the encoder shaft) between teaching the SG1000A 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 power-up or while teaching the SG1000A the fully-closed position.

Power-ups; calibration vs. normal operating mode

- An SG1000A that is un-calibrated (or if the calibration attempt was invalid) automatically powers-up in the calibration mode, the next time power is applied.
- A properly calibrated SG1000A powers-up in the 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 +24Vdc 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

As an aid to troubleshooting, see figure 3 on how to connect an ammeter to directly measure the 4-20mA output signal.

1) If your SG1000A outputs a 4 mA to 20 mA signal, but not at the gate positions expected, then double-check the following:
   A) Before you performed the calibration procedure, did you set the direction switch SW1 to the proper position (CW or CCW) <u>before</u> entering calibration mode?
   B) As your gate moves from fully-closed to fully-open, does the SG1000A's encoder shaft turn more than 6 turns, or less than 1/4th turn? If so, then the SG1000A will not work in your application.
   C) Is your SG1000A terminal TB1 wiring correct?
      - +24Vdc red wire is TB1-1.
      - 4-20mA signal clear wire is TB1-2.
      - Power supply ground black wire is TB1-3.
   D) Assuming conditions (A), (B), and (C) are proper, and your SG1000A still seems to behave improperly, then try re-calibrating again, paying close attention to the eight calibration steps.

2) If you have gone through troubleshooting hints (1A), (1B), (1C), and (1D), and if your SG1000A seems to otherwise respond properly, from fully-closed to fully-open, with the only exception being that strange values other than 4 mA and 20 mA are output for the fully-closed/fully-open positions (e.g., 3 mA at one-end and 23 mA at the other-end), then possibly the R7 and R8 factory potentiometer settings have been tampered with. See Figure 4 for location of these pots.
   Evidence of R7 and R8 tampering is most easily seen when in the calibration mode. When R7 and R8 are at their factory-settings, the output signal is 12 mA during calibration mode. (Recall that the output signal remains at 12 mA until the calibration process is completed). If during calibration mode the output signal is not 12 mA, then most likely the R7 and R8 factory-settings have been tampered with.
   If you feel confident that you have followed the calibration procedure properly (perhaps have done it several times over), and followed the troubleshooting hints in (1A), (1B),(1C), and (1D), **AND** you still see strange values other than 4 mA at one end and 20 mA at the other, **then** you can attempt to restore R7 and R8 to the factory-settings by doing the following: (This assumes you have already calibrated your SG1000A for the fully-closed and fully-open gate positions).
   A) During normal operating mode, move the gate to your fully-closed calibrated position. Adjust R7 until 4 mA is output from the signal line.
   B) During normal operating mode, move the gate to the fully-open calibrated position. Adjust R8 until 20 mA is output from the signal line.

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Troubleshooting Hints (cont.)

C) You can now test and verify that your R7 and R8 are indeed set back to factory settings. Do this by re-entering the calibration procedure. If the 4 mA to 20 mA output signal is at 12 mA (or fairly close) when in the calibration mode, then you have properly restored R7 and R8 settings.

D) Continue and complete the calibration procedure for the gate's fully-closed and fully-open positions.

How to clear-out the existing calibration, and reprogram the SG1000A (Two methods)

One, remove +24Vdc power, then press and hold-in the SW2 button while re-applying the +24Vdc power to the SG1000A. Continue to keep the SW2 button pressed-in for a few seconds until the SG1000A outputs 12 mA, then release the SW2 button. The old calibration has now been cleared-out, and the SG1000A is in calibration mode awaiting new calibration.

Or two, while powered, press and hold-in the SW2 button for 5 to 6 seconds to enter calibration mode.

See the "**Calibration Procedure**" section for complete details.

SG1000A General Specifications:

Input Power	Input Current
REQUIRES USER INSTALLED CLASS 2 ISOLATED +24 VDC ±10% Power Supply	40mA max (when output signal is at 20mA)

Input Signal	Parameters
Type	Rotating shaft connected to internal 9 bit, 0 to 511 count, absolute position encoder
Range of Operation	Continuous rotation with no physical end stops. Calibratible span of 1/4 to 6 turns of output shaft.
Internal Gear Ratio	6:1

Analog Output Signal	Parameters
Type	4-20 mA DC, with programmable end-points: (4 mA @ user's fully closed position) (20 mA @ user's fully open position)
Accuracy	Resolve to 1 encoder count of calibrated span position (span from fully closed to fully open).
4-20 mA Resolution	Varies linearly from best of 0.2% of span, to worst of 5.0% of span depending on calibration
	0.2% resolution occurs when calibrated at the maximum span of 511 encoder counts, which is 6-turns of the output shaft. That is, 1 count out of 511 counts is about 0.002, or 0.2 %
	5.0% resolution occurs when calibrated at the minimum span of 21 encoder counts, which is 1/4th turn of the output shaft. That is, 1 count out of 21 counts is about 0.05, or 5 %
	Since the 4-20 mA output has a 16 mA span, a 0.2% resolution gives an incremental change of 0.032 mA, and a 5.0% resolution gives an incremental change of 0.800 mA.
Required impedance	4-20 mA output needs a 250 to 500 Ω load

Mechanical	Parameters
Mounting	End of Shaft, single drilled and tapped hole.
Mounting Threads	3/8-16 UNC x 0.625 in.
Mounting Torque	8ft-lbs, with threadlocker compound. 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.
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.

Physical/Enviroment	Parameters
	Class I, Groups C, D Class II, Groups E, F, G UL File: E249019 $C\epsilon$
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 Slide Switch	Select calibration direction CW/CCW
Memory	EEPROM retains calibration during power failure or power shut down

Operation Modes

Normal Operating Mode: *(output signal per gate position).*

- Output: 4 mA to 20 mA signal proportional to gate position, for a properly calibrated SG1000.

- Output: Constant 12 mA for an uncalibrated or miscalibrated SG1000.

Calibration Mode: *(select calibration direction, calibrate for fully-closed / fully-open gate positions).*

- Output: Holds at a constant 12 mA in this mode.

Additional Information

To get additional information about the SG1000A, visit our website at: www.electro-sensors.com