

SG1000D Damper-Valve Position Monitor

SG1000D general description

The SG1000D is a Damper-valve Monitor with a 4-20 mA output. The SG1000D is a rugged, medium cost encoder-based monitoring device that enables the end-user to very accurately monitor a damper-valve's position, allowing very accurate operations. The SG1000D has two modes: calibration mode, and normal operating mode. A simple calibration procedure teaches (programs) the SG1000D the fully-closed (0% open) and fully-open (100% open) valve positions. Once programmed, the SG1000D outputs a 4 mA DC signal when the valve is in the fully-closed position, and outputs a 20 mA DC signal when the valve is in the fully-open position. Any valve 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 SG1000D, showing the encoder-output-shaft.

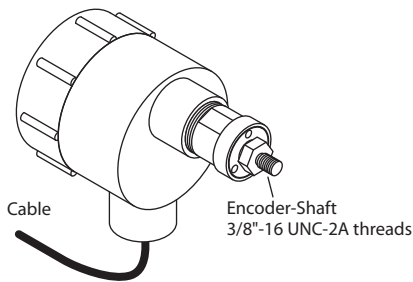


Figure 1:

The SG1000D attaches to the damper-valve's shaft, or similar rotating mechanical component, using an "end-of-shaft" mounting method. See Figure 2. The SG1000D'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.

Even though the SG1000D 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 SG1000D to "float" along with any wobble of the process's shaft while still preventing the SG1000D 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 SG1000D. The U-bolt's slack prevents it from rigidly clamping to the SG1000D's conduit port.

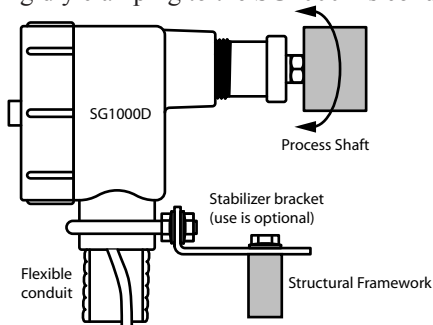


Figure 2:

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Electrical connections

The SG1000D's electrical cable has three wires, plus a shield-wire. Connect as follows: (See Figure 3):

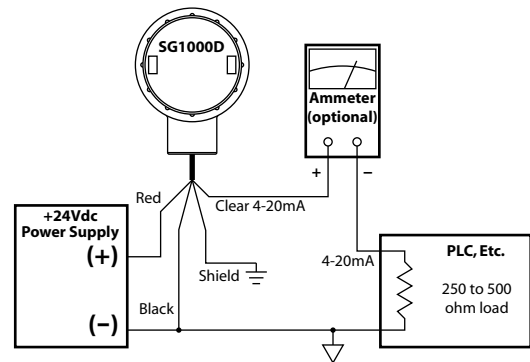


Figure 3:

- 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 SG1000D 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 SG1000D.

This provides access to the edge of the SG1000D'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.

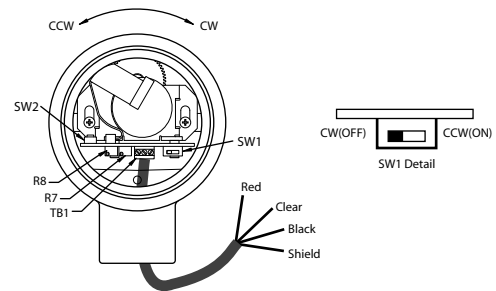


Figure 4:

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990-002430 Revision C

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 SG1000D. But if they do so, they must reconnect the 3-wire cable to the SG1000D as follows:

- Power supply (+24Vdc) terminal red wire to TB1-1.
- 4-20mA signal clear wire to TB1-2.
- Power supply (-) terminal black wire to TB1-3.

2) Before applying +24 Vdc power to the SG1000D, set the direction switch SW1 on the SG1000D's PC board to the proper position for the application.

SW1 tells the SG1000D the direction the encoder turns, CW or CCW, as the valve 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 valve 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 valve 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 during a calibration power-up (i.e., calibration switch SW2 pressed-in while applying +24 Vdc to the unit). After the unit powers-up and is in 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 the +24 Vdc power is applied to the unit in order for the calibration power-up to capture the desired setting of SW1.

3) Press-in the calibration switch SW2, then apply +24 Vdc power to the SG1000D.

(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 SG1000D outputs a constant 12 mA from its signal line, then release the button.

The SG1000D is now in the calibration mode.

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

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

Note: As the valve moves from fully-closed to fully-open, the SG1000D's encoder shaft must turn at least 15°, but not more than a 359° turn. Hence, if the shaft turns more than 359°, or less than 15°, then the SG1000D will **not** work properly for the application.

7) Press the calibration switch SW2.

- This captures the present encoder count. This value is then used for the fully-open position (100% open).
- **The SG1000D 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 valve, then the output signal is 20 mA. (Because the valve 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 SG1000D accepted the valve's two calibration positions.

8) Replace the back-end-cover onto the SG1000D.

This ends the calibration procedure.

Valid Calibration (Normal Operating Behavior)

Assuming the user followed the calibration process **correctly**, the SG1000D behaves as follows:

- When the valve is at the fully-closed position (0% open), the output signal is 4 mA.
- When the valve is at the fully-open position (100% open), the output signal is 20 mA.
- Any valve position between 0% open and 100% open is represented by the output signal being proportionally between 4 mA and 20 mA.
- If the valve 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 valve 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 SG1000D, the direction of calibration (CW or CCW), and the encoder values for the fully-closed and fully-open valve positions are all stored in the SG1000D’s EEPROM memory.

Note: Since a properly calibrated SG1000D 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 SG1000D the calibration results are protected from the user inadvertently changing the SW1 position, or by pressing SW2 (during normal operating mode). If re-calibration is needed, see the section below titled **“How to clear-out the existing calibration and reprogram the SG1000D.”**

Invalid Calibration (Error condition behavior)

Assuming the user followed the calibration process **incorrectly**, the SG1000D 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 valve (or moved it but less than a 15° turn of the encoder shaft) between teaching the SG1000D 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 SG1000D the fully-closed position.

Power-ups; calibration vs. normal operating mode

- An SG1000D 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 SG1000D powers-up in the normal operating mode, when power is applied.

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 SG1000D outputs a 4 mA to 20 mA signal, but not at the valve 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) before applying power to the SG1000D.

- B) As your valve moves from fully-closed to fully-open, does the SG1000D’s encoder shaft turn more than 359°, or less than a 15° turn? If so, then the SG1000D will not work in your application.
- C) Is your SG1000D terminal TB1 wiring correct?
 - Power supply (+24Vdc) terminal red wire is TB1-1.
 - 4-20mA signal clear wire is TB1-2.
 - Power supply (-) terminal black wire is TB1-3.
- D) Assuming conditions (A), (B), and (C) are proper, and your SG1000D 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 SG1000D 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 SG1000D for the fully-closed and fully-open valve positions).

- A) During normal operating mode, move the valve to your fully-closed calibrated position. Adjust R7 until 4 mA is output from the signal line.
- B) During normal operating mode, move the valve to the fully-open calibrated position. Adjust R8 until 20 mA is output from the signal line.
- 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 (press-in SW2, then apply power). 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 valve’s fully-closed and fully-open positions.

How to clear-out the existing calibration, and reprogram the SG1000D

First remove +24Vdc power, then press and hold-in the SW2 button while re-applying the +24Vdc power to the SG1000D. Continue to keep the SW2 button pressed-in for a few seconds until the SG1000D outputs 12 mA, then release the SW2 button. The old calibration has now been cleared-out, and the SG1000D is in calibration mode awaiting new calibration. See the “Calibration Procedure” section for complete details.

Specifications

Performance

- The SG1000D’s built-in 9-bit absolute encoder measures damper-valve position (internal readings are 0 up to 511 counts).
- The SG1000D uses a 1:1 gear-ratio between the output-shaft and the encoder.
- The maximum calibrate-able valve-span is just less than 1 complete turn of the output shaft. (i.e. max of 359°)
- The minimum calibrate-able valve-span is 1/24th turn (or 15°) of the output shaft.
- The SG1000D’s 4-20 mA output signal can resolve down to one encoder count out of its calibrated span. Hence, the final resolution obtained by the user depends on the number of encoder counts in the calibration span between their fully-closed and fully-open positions.

With this dependence, the SG1000D’s 4-20 mA output signal resolution varies linearly:

- From a best of 0.2% of the span. (This occurs when calibrated at the maximum span of 511 encoder counts, which is a 359° turn of the output shaft. That is, 1 count out of 511 counts is about 0.002, or 0.2 %).
- To a worst of 5.0% of the span. (This occurs when calibrated at the minimum span of 21 encoder counts, which is a 15° 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.

Note: The SG1000D is commonly used in damper-valve applications where the SG1000D’s output shaft makes a 90° turn (or swing). When the SG1000D is calibrated for a 90° swing the encoder uses 128 positions (or counts), i.e., 512 counts / (360°/90°) = 128 counts.

- Thus the 90° swing is resolved into 128 counts. This is about one encoder count every 0.70°.
- Likewise, the 4-20 mA output signal’s 16 mA span is resolved into 128 increments. This is an output resolution of 0.125 mA per increment.

- In the event of power failure or shutdown, the EEPROM retains the valve calibration direction (CW, CCW), and valve calibration positions (fully-closed, and fully-open).

Mechanical packaging

- Mounts on “end-of-shaft” via single 3/8-inch diameter hole, to a depth of 0.625 inch, and 3/8 “– 16 UNC threads.
- Cylindrical aluminum housing / cover. Outside diameter of 3-11/16th inch. Maximum length of 7-5/8th inch (length includes cover and encoder shaft).

Environmental considerations



Class I, Div 1, Groups C, D
Class II, Div 1, Groups E, F, G
UL File: E249019



- NEMA4X Cast Aluminum Housing
- Temperature range of -40°C to +65°C (-40°F to +149°F).
- Humidity range of 0% to 90% non-condensing.

Operator interface

- One pushbutton: (*enter calibration mode upon power-up, calibrate for fully-closed / fully-open valve positions*).
- One slide switch: (*select calibration direction CW/CCW*).

Operation modes

- Normal Operating Mode: (*output 4 mA to 20 mA signal corresponding to valve position*).
- Calibration Mode: (*select calibration direction, calibrate for fully-closed / fully-open valve positions*).

I/O requirements

- Input: External power supply of +24 Vdc (± 10%). The SG1000D’s current draw is 40 mA DC or less
- Output: 12 mA DC output signal for an un-calibrated system (when running in Calibration Mode, or in Normal Operating Mode with improper calibration).
- Output: 4 mA DC to 20 mA DC output signal proportional to valve position, for a properly calibrated system running in Normal Operating Mode.

Additional Information

To get additional information about the SG1000D, visit our website at: www.electro-sensors.com

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