CAUTION!

1.) Disconnect power to the sensor before performing any of the procedures described in this document.

2.) The electronic modules provided with each sensor are designed for a specific stroke length range:

Length Ranges:
- *1 - 12 in.*
- *12.1 - 36 in.*
- *36.1 - 120 in.*

Ensure that electronics modules used have the correct length configuration for the sensors in which they are installed.

This document contains information pertaining only to Temposonics L Series sensors with pulse-width modulated (PWM) output.

Use the information contained in this document only if you need to modify the...

- Resolution

- Update Time (sensors w/internal interrogation only)

- Interrogation Mode

...of your L Series position sensor with PWM output.

TOOLS REQUIRED:

Torque wrench (capable of 8 in./lbs) with Torx T9 and 9/64 bits

Small (jewelers) flathead screwdriver or equivalent

Note: *Locktite® 242 is also needed*

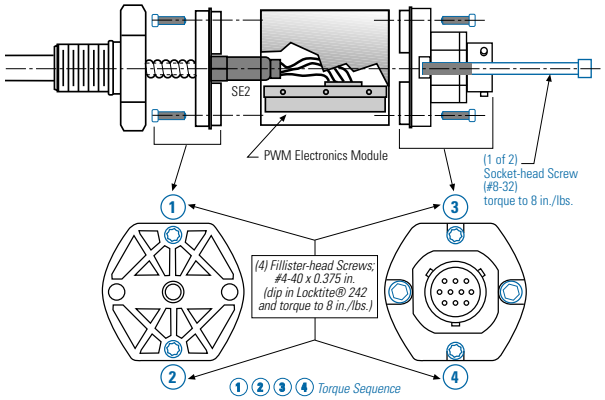

Figure 1 - Screws, Torque Sequence

Figure 2 - L Series Sensor

Figure 3a - PWM Module

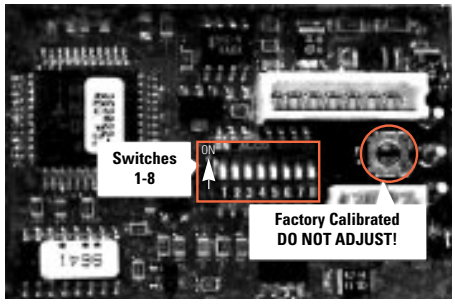

Figure 3b - PWM Electronics Board

ACCESSING DIP SWITCHES FOR MODIFICATION:

To access the PWM electronics module and the adjustable dip switches, follow the steps below:

1.) Remove the six screws (4 fillister head #4-40 x 0.375 in. screws and 2 socket head #8-32 screws) shown in Figure 1.

2.) Slide the PWM electronics module, along with its clear plastic isolation sleeve, from the housing (see Figure 2).

3.) Disconnect the two electrical connections to the module (one from the connector module, the other from the sensing element; see Figure 2).

4.) Remove the copper cover from the module (see Figure 3a).

5.) Locate the dip switches (1-8) on the PWM board (see Figure 3b) and adjust them to the desired settings. Refer to Tables 1 and 2 for proper switch settings for desired circulation count.

(After setting the switches per the instructions below, reassemble the sensor per the "Reassembly Instructions" on the following page)

SETTING THE PROGRAMMING SWITCHES (SWITCHES 1-8)

Tables 1 and 2 show how to set switches 1-8 to configure L Series sensors with PWM outputs with desired circulation count. The tables are described below:

- **Table 1:**
  Lists switch settings for selecting desired circulation count for L Series sensors with PWM output and ***external*** interrogation.

- **Table 2:**
  Lists switch settings for selecting desired circulation count for L Series sensors with PWM output and ***internal*** interrogation.

Table 1:
Switch Settings - PWM Output & *External* Interrogation

SWITCH SETTINGS (1-8) *(All switches are **OFF** unless noted below)*	
CIRCULATION COUNT	***ON SWITCHES Stroke Length: 1 - 120 in. (25 - 3048 mm)***
1	4, 8
2	5, 8
3	4, 5, 8
4	6, 8
5	4, 6 , 8
6	5, 6, 8
7	4, 5, 6, 8
8	7, 8
9	4, 7, 8
10	5, 7, 8
11	4, 5, 7, 8
12	6, 7, 8
13	4, 6, 7, 8
14	5, 6, 7, 8
15	4, 5, 6, 7, 8

Table 2:
Switch Settings - PWM Output & *Internal* Interrogation

	SWITCH SETTINGS (1-8) *(All switches are **OFF** unless noted below)*		
Circulations Count	***ON* Switches Stroke Length: 1 - 32 in. (25 - 814 mm)**	***ON* Switches Stroke Length: 32.1 - 60 in. (815 - 1524 mm)**	***ON* Switches Stroke Length: 60.1 - 120 in. (1525 - 3048 mm)**
1	3, 4	1, 3, 4	3, 4
2	3, 5	3, 5	1, 3, 5
3	3, 4, 5	3, 4, 5	2, 3, 4, 5
4	3, 6	3, 6	2, 3, 6
5	3, 4, 6	1, 3, 4, 6	1, 2, 3, 4, 6
6	3, 5, 6	1, 3, 5, 6	1, 2, 3, 5, 6
7	3, 4, 5, 6	1, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
8	3, 7	1, 3, 7	1, 2, 3, 7
9	3, 4, 7	1, 3, 4, 7	1, 2, 3, 4, 7
10	3, 5, 7	1, 3, 5, 7	1, 2, 3, 5, 7
11	3, 4, 5, 7	1, 3, 4, 5, 7	1, 2, 3, 4, 5, 7
12	3, 6, 7	1, 3, 6, 7	1, 2, 3, 6, 7
13	3, 4, 6, 7	1, 3, 4, 6, 7	1, 2, 3, 4, 6, 7
14	3, 5, 6, 7	1, 3, 5, 6, 7	1, 2, 3, 5, 6, 7
15	3, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7

IMPORTANT NOTE:
Maximum stroke per circulation count for PWM output w/internal interrogation

Maximum Stroke	*Circulation Count*
84 inches	15
96 inches	4
108 inches	2
120 inches	1

REASSEMBLY INSTRUCTIONS :

1.) Replace the copper cover to the electronics module.

2.) Reattach the two connectors to the electronics module.

3.) Slide the module (with isolation sleeve) back into the housing.

4.) Coat the threads of the 6 screws with Locktite® 242 and reinstall per the torquing sequence shown in Figure 1 (Caution: Tighten screws to 8 in./lbs. to ensure proper seal).

KEY TERMS

Circulation Count
This refers to the number of times that the sensor is interrogated to produce a position reading. By increasing the circulation/interrogation count and averaging the readings, the effective resolution of the position measurement is increased.

When using L Series sensors with PWM output, the "duty cycle" of the pulse duration is proportional to the circulation count (1 to 15).

Gradient or "Scale Factor"
The rate that a pulse signal propagates through the magnetostrictive waveguide (gradient ≈ 9 µs/inch or 2838 m/second); the gradient will vary slightly from sensor to sensor. Gradient values are indicated on the label attached to each sensor.

Resolution
The smallest incremental change in position along the stroke length that can be detected and indicated in an output. For digital systems, resolution is a discrete value normally stated in counts.

Update Time
The time period required to interrogate the sensor and obtain an output.

Resolution vs. Update Time Relationship
Because there is a propagation delay through the magnetostrictive waveguide, there is a delay between when the interrogation pulse is launched and when the return signal is generated. This delay varies based on the length of the waveguide. For every one inch of waveguide travel there is a propagation delay of approximately 9 microseconds. Hence, the update time for a l0 inch sensor is a minimum of 90 microseconds with one circulation. Other system parameters may increase this time period. If the sensor's interrogation signal is recirculated to provide an average reading and thus improving resolution, the waveguide travel time must be multiplied by the number of circulations (circulation count) to determine the minimum update time. In the same example, if the 10 inch sensor is circulated 4 times, the minimum update time is 360 microseconds.

For digital pulse systems (L Series sensor with PWM output), resolution is based on the crystal frequency of the counter that measures the time interval between the interrogation pulse and return signal. This counter resides in the controller and typically has a clock speed of 28 MHz, but may vary. With this clock speed and a single interrogation, output resolution of the sensor is 0.004 inches. Update time is approximately the waveguide travel time for 1 circulation (and varies according to sensor length). When the circulation count is increased and the reading is averaged, resolution is improved and update time increased. These parameters are defined by the formulas below:

Optimizing Update Time/Resolution:

Update Time (U) in microseconds:

U = (Stroke Length + Null + 4)(10)(Circulation Count)

Resolution (R) in inches:

R = 1 ÷ [(Gradient)(Controller Freq.)(Circulation Count)]

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Part Number: 01-98 550602 Revision A