



FSS Series

Low Profile Force Sensor

DESCRIPTION

The FSS Series Force Sensor provides precise, reliable force sensing performance in a compact, commercial-grade package at a cost effective price. The sensor features a proven sensing technology that uses a specialized piezoresistive, micromachined silicon sensing element. The low power, unamplified, uncompensated Wheatstone bridge circuit design provides inherently stable mV outputs over the force range.

Force sensors operate on the principle that the resistance of silicon-implanted piezoresistors will increase when the resistors flex under any applied force. The sensor concentrates force from the application, through the stainless steel ball, directly to the silicon-sensing element. The amount of resistance changes in proportion to the amount of force being applied. This change in circuit resistance results in a corresponding mV output level change.

FEATURES AND BENEFITS

- RoHS-compliant materials meet Directive 2002/95/EC allows use in industries requiring regulation compliance
- Low deflection (approx. 30 μm typical at full scale) helps reduce measurement error
- Direct mechanical coupling of the actuation ball to the sense element reduces coupling errors and keeps mechanical hysteresis to a minimum
- Product rating of 20 million MCTF at 25 °C [77 °F], subject to application variation, provides for consistent output over time and reduces repairs or replacements
- Small size minimizes space on the printed circuit board (PCB)
- Provides enhanced sensitivity without compromising signal integrity, resulting in low system noise and reducing measurement errors
- Electrically ratiometric output accommodates supply voltage variations, leading to low ratiometricity error
- Low voltage supply allows for use in many battery powered applications
- High resistance to electrostatic discharge (ESD) meets ESD Sensitivity Classification Level 3B (8 KV), reducing special handling during assembly
- Sensor output has low sensitivity to many mounting stresses

The sensor package design incorporates patented modular construction. The use of innovative elastomeric technology and engineered molded plastics results in overforce capacities of up to three times the rated force. The stainless steel ball provides excellent mechanical stability and is adaptable to a variety of applications.

The FSS Series Sensor delivered 20 million operations in Mean Cycles to Failure (MCTF) reliability testing at 50°C [122°F]. This test determines the number of possible sensor operations at full scale until failure.

POTENTIAL APPLICATIONS

Medical

- Infusion pumps
- Ambulatory non-invasive pumps
- Occlusion detection
- Kidney dialysis machines
- Enteral pumps

Industrial

- Load and compression sensing
- Variable tension control
- Robotic end-effectors
- Wire bonding equipment

FSS Series

Table 1. Performance Characteristics (At 10 ±0.01 Vdc, 25 °C [77 °F].)¹

| Characteristic | Unit | FSS005WNSX | | | FSS010WNSX | | | FSS015WNSX | | | FSS020WNSX | | |
|---|--------|------------|------|------|------------|------|------|------------|------|------|------------|------|------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. |
| Force sensing range | N | 0 to 5 | | | 0 to 10 | | | 0 to 15 | | | 0 to 20 | | |
| Excitation ² | Vdc | 3.3 | 10 | 12.5 | 3.3 | 10 | 12.5 | 3.3 | 10 | 12.5 | 3.3 | 10 | 12.5 |
| Null offset ³ | mV | -30 | 0 | +30 | -30 | 0 | +30 | -30 | 0 | +30 | -30 | 0 | +30 |
| Null shift ⁴ (25 to 0°, 25 to 50° C) | mV | - | ±0.5 | - | - | ±0.5 | - | - | ±0.5 | - | - | ±0.5 | - |
| Span ⁵ | mV | 330 | 360 | 390 | 330 | 360 | 390 | 330 | 360 | 390 | 330 | 360 | 390 |
| Linearity (BFSL) ⁶ | % span | - | ±0.5 | - | - | ±0.5 | - | - | ±0.5 | - | - | ±0.5 | - |
| Sensitivity ⁷ | mV/V/N | 6.6 | 7.2 | 7.8 | 3.3 | 3.6 | 3.9 | 2.2 | 2.4 | 2.6 | 1.65 | 1.8 | 1.95 |
| Sensitivity shift ⁸ (25 °C to 0°, 25 °C to 50 °C) | % span | - | ±5.0 | - | - | ±5.0 | - | - | ±5.0 | - | - | ±5.0 | - |
| Repeatability ⁹ | % span | - | ±0.2 | - | - | ±0.2 | - | - | ±0.2 | - | - | ±0.2 | - |
| Response time (10 %FS to 90 %FS) | ms | - | 0.1 | 0.5 | - | 0.1 | 0.5 | - | 0.1 | 0.5 | - | 0.1 | 0.5 |
| Input resistance | kΩ | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 |
| Output resistance | kΩ | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 | 4.0 | 5.0 | 6.0 |
| Plunger deflection | µm | - | 26 | - | - | 28 | - | - | 33 | - | - | 39 | - |
| Overforce ¹⁰ | N | - | - | 15 | - | - | 30 | - | - | 45 | - | - | 60 |

Notes:

- All force-related specifications are established using dead weight or compliant force.
- The range of voltage excitation which can be supplied to the product to produce an output which is proportional to force but due to ratiometricity errors may not remain within the specified performance limits. Non-compensated force sensors, excited by constant current (1.5 mA) instead of voltage, exhibit partial temperature compensation of span.
- The output signal obtained when the zero force is applied to the sensor. Also known as "null" or "zero".
- The change in the null resulting from a change in temperature. It is not a predictable error as it can shift up and down from unit to unit. Change in temperature causes the entire output curve to shift up or down along the voltage axis.
- The algebraic difference between output signals measured at the upper and lower limits of the operating force range. Also known as "full scale output" or simply "span".
- The maximum deviation of product output from a straight line fitted to output measured over the operating force range. The straight line through a set of points which minimizes the sum of the square of the deviations of each of the points from the straight line.
- The ratio of output signal change to the corresponding input force change. Sensitivity is determined by computing the ratio of span to the specified operating force range multiplied by the supply voltage being used.
- The maximum deviation in sensitivity due to changes in temperature over the operating temperature range, relative to sensitivity measured at 25 °C.
- The maximum difference between output readings when the same force is applied consecutively, under the same operating conditions, with force approaching from the same direction within the operating force range.
- The maximum force which may safely be applied to the product for it to remain in specification once force is returned to the operating force range. Exposure to higher forces may cause permanent damage to the product. Unless otherwise specified, this applies to all temperatures within the operating temperature range.

CAUTION
EXCEEDING
PRODUCT
OVERFORCE RATING

- Ensure the overforce ratings given in Table 1 are not exceeded during any phase of sensor assembly to the board, as well as during the use of the sensor in the application.

Failure to comply with these instructions may result in product damage.

Table 2. Environmental Specifications

| Characteristic | Parameter |
|--|---|
| Operating temperature ¹ | -40 °C to 85 °C [-40 °F to 185 °F] |
| Shock | qualification tested to 150 g |
| Vibration | qualification tested to 0 to 2 kHz, 20 g sine |
| MCTF (Mean Cycles To Failure) ² | 20 million at 25 °C [77 °F] |
| Output ratiometric | within supply range |

Notes:

- The temperature range over which the product may safely be exposed without excitation or force applied. Under these conditions the product will remain in specification after excursion to any temperatures in this range. Exposure to temperatures beyond this range may cause permanent damage to the product.
- MCTF is a basic measure of reliability for a non-repairable device. It is the mean number of cycles to maximum operating force over which a sensor can be expected to operate until failure. The mean value is determined statistically from a probability distribution for failures based upon test data. MCTF may vary depending on the specific application in which a sensor is utilized.

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Table 3. Absolute Maximum Ratings¹

| Characteristic | Parameter |
|----------------------------------|---|
| Storage temperature ² | -40 °C to 100 °C [-40 °F to 212 °F] |
| Solderability ³ | 10 s at 260 °C [500 °F] |
| ESD | Meets ESD Sensitivity Classification Level 3B |

Notes:

1. Absolute maximum ratings are the extreme limits that the product can withstand without damage to the product.
2. The temperature range over which the product may safely be exposed without excitation or force applied. Under these conditions, the product will remain in the specification after excursions to any temperature in this range. Exposure to temperatures beyond this range may cause permanent damage to the product.
3. The maximum temperature and time to which the product may be exposed for processing of solder electrical connections.

Figure 1. Excitation Schematic (Excitation 5 Vdc Typ., 6 Vdc max.)

1. Circled numbers refer to sensor terminals (pins).
Pin 1 = Supply Vs (+), Pin 2 = Output Vo (+), Pin 3 = Ground Vg (-), Pin 4 = Output Vo (-)
2. The force sensor may be powered by voltage or current. Maximum supply voltage is not to exceed 6 V. Maximum supply current is not to exceed 1.2 mA. Power is applied across Pin 1 and Pin 3.
3. The sensor output should be measured as a differential voltage across Pin 2 and Pin 4 (Vo = Vo(+)-Vo(-)). The output is ratiometric to the supply voltage. Shifts in supply voltage will cause shifts in output. Neither Pin 2 nor Pin 4 should be tied to ground or voltage supply.

Figure 2. Sensor Mounting Dimensions (For reference only: mm/[in.])

FSS005WNSX, FSS010WNSX, FSS015WNSX, FSS020WNSX

| Force Sensing Range | Ball (Actuator) Height |
|---------------------|--|
| 0 N to 5 N | 0.375 ±0.10 mm [0.0148 ±0.0039 in] |
| 0 N to 10 N | 0.452 ±0.10 mm [0.0178 ±0.0039 in] |
| 0 N to 15 N | 0.504 ±0.10 mm [0.01984 ±0.0039 in] |
| 0 N to 20 N | 0.562 ±0.10 mm [0.0221 ±0.0039 in] |

Figure 3. Packaging Dimensions (For reference only.)

Short Tube: 43,9 mm [1.73 in] long, 5 units/tube
Standard Tube: 584 mm [22.99 in] long, 100 units/tube

Tape and Reel (mm)

SECTION A - A
 .35 ±.05
 R 0.3 MAX
 12.00
 2.00 ±.10
 4.00
 15.7
 4.8
 9.20
 11.5 ±.1
 24.0 ±0.3/-0.1
 1.75 ±.10
 φ 1.50 MIN
 φ 1.50 ±0.1/-0.0
 R 0.5 TYP.
 2.3
 Ao = 6.10 ±K1
 Bo = 14.70
 Ko = 4.55
 K1 = 4.20

1. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
2. 10 sprocket hole pitch cumulative tolerance is ±0.2 mm.
 - Camber is in compliance with EIA 481.
 - Ao and Bo are calculated on a plane at a distance "R" above the bottom of the pocket.