Honeywell

MICRO SWITCH Force Sensors

Force Sensor

FS Series

FEATURES

- Robust performance characteristics
- Precision force sensing
- Adaptable product design
- Highly reliable
- Signal conditioning available
- Electrically ratiometric output
- Extremely low deflection (30 microns typical @ Full Scale)
- Low repeatability errors (± 0.2% Span)
- Low linearity errors (± 0.5% Span)
- Low off-center loading errors
- Resolution to 1.0 gram force
- Fast response time
- Low power consumption
- High ESD resistance - 10 KV

TYPICAL APPLICATIONS

- Medical infusion pumps
- Kidney dialysis machines
- Robotic end-effectors
- Variable tension control
- Load and compression sensing
- Contact sensing

The FS Series Force Sensor provides precise, reliable force sensing performance in a compact commercial grade package. The sensor features a proven sensing technology that utilizes a specialized piezoresistive micro-machined silicon sensing element. The low power, unamplified, non-compensated Wheatstone bridge circuit design provides inherently stable mV outputs over the 1,500 gram force range.

The force sensor operates on the principle that the resistance of silicon implanted piezoresistors will increase when the resistors flex under an applied force The sensor concentrates force from the application through the stainless steel plunger 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.

The sensor package design incorporates a patented modular construction. The use of innovative elastomeric technology and engineered molded plastics results in load capacities of 5.5 Kg over-force. The stainless steel plunger provides excellent mechanical stability and is adaptable to a variety of applications. Various electrical interconnects can accept pre-wired connectors, printed circuit board mounting, and surface mounting. The unique sensor design also provides a variety of mounting options including mounting brackets, as well as application-specific mounting requirements.

MICRO SWITCH Force Sensors

Force Sensor

FS Series

PERFORMANCE CHARACTERISTICS @ 10 ± 0.01 VDC, 25°C

Preliminary, based on limited test data

Parameter	Min.	Typ.	Max.	Units
Excitation*	—	10	12	VDC
Null shift, 25 to 0°, 25 to 50°C	—	± 0.5	—	mV
Null offset	-30	0	+30	mV
Linearity (BFSL)	—	± 0.5	—	% Span
Sensitivity	—	0.24	—	mV/grf
Sensitivity shift 25 to 0°, 25 to 50°C	—	± 5.0	—	% Span
Repeatability	—	± 0.2	—	% Span
Response time	—	—	1.0	msec
Input resistance	—	5.0 K	—	ohms
Output resistance	—	5.0 K	—	ohms
Plunger deflection	—	30	—	microns
Weight	—	2.0	—	grams
ESD (direct contact - terminals and plunger)	10	—	—	kVolts

* Non-compensated force sensors, excited by constant current (1.5 mA) instead of voltage, exhibit partial temperature compensation of Span.

ENVIRONMENTAL SPECIFICATIONS

Operating temperature	-40 to +85°C (-40 to +185°F)
Storage temperature	-55 to +105°C (-67 to +221°F)
Shock	Qualification tested to 150 g
Vibration	Qualification tested to 0 to 2 kHz, 20 g sine

Note: All force related specifications are established using dead weight or compliant force.

ORDER GUIDE

Catalog Listing	Force Range (grams)	Span, mV			Overforce grams
		Min.	Typ.	Max.	Max.
FSG-15N1A	1,500	290	360	430	5,500

MOUNTING

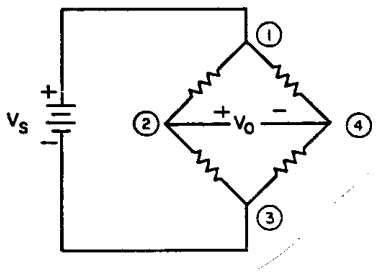
The sensor output characteristics do not change with respect to mounting orientation. Care should be taken not to obstruct the vent hole in the bottom of the sensor housing. Improper venting may result in unstable output.

Mounting bracket mounting torque: 2-5 in. lb. (,21-,56 Nm).

APPLYING FORCE

Evaluation of the sensor is to be performed using dead-weight or compliant force. Application of a rigid, immobile force will result in output drift (decrease) as elastomeric seals relax. Off-center plunger loading has minimal effect on sensor performance and maintains operation within design specifications.

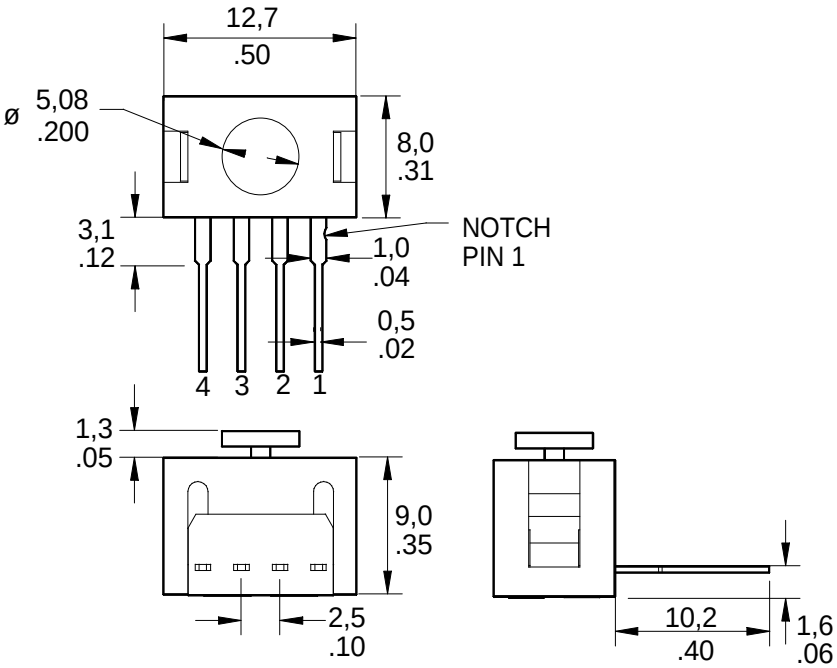
EXCITATION SCHEMATIC



FS SERIES CIRCUIT

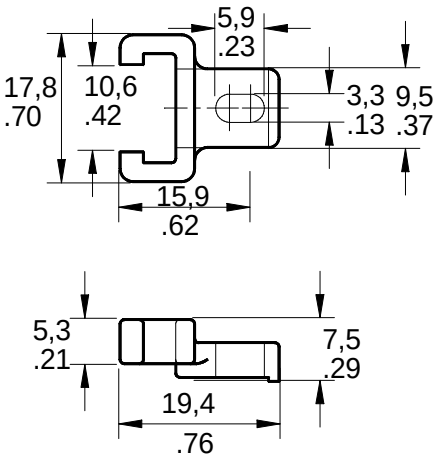
1. Circled numbers refer to sensor terminals (pins). Pin 1 is designated with a notch.
   Pin 1 = Supply V_S (+)
   Pin 2 = Output, (+)
   Pin 3 = Ground, (-)
   Pin 4 = Output, (-)
2. The force sensor may be powered by voltage or current. Maximum supply voltage is not to exceed 12 volts. Maximum supply current is not to exceed 1.6 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 ($V_O = V_2 - V_4$). 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.

MOUNTING DIMENSIONS (for reference only)



ACCESSORY

Catalog Listing	Description
PC15132	Plastic mounting bracket



MICRO SWITCH Force Sensors

Force Sensor

FS Series

SALES AND SERVICE

Honeywell's MICRO SWITCH Division serves its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact a nearby sales office. Or call:

1-800-537-6945 USA
1-416-293-8111 Canada
1-815-235-6847 International

INTERNET

http://www.sensing.honeywell.com
info@micro.honeywell.com

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this printing. However, we assume no responsibility for its use.

While we provide application assistance, personally and through our literature, it is up to the customer to determine the suitability of the product in the application.

Honeywell

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Freeport, Illinois 61032

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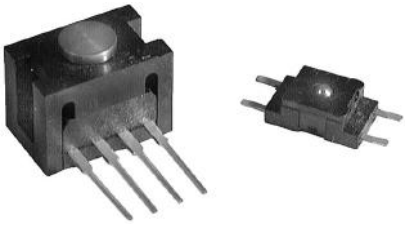
Helping You Control Your World

Force Sensors
FSG and FSL Series

NEW



FEATURES
- Compact commercial grade package
- Robust performance characteristics
- Adaptable product design
- Precision force sensing
- Electrically ratiometric output
- Extremely low deflection (30 microns typ. @ Full Scale)
- High ESD resistance 10 KV
- Available signal conditioning
- Optional terminal configurations

The FS Series Force Sensors provide precise, reliable force sensing performance in a compact commercial grade package. The sensor features a proven sensing technology that utilizes a specialized piezoresistive micro-machined silicon sensing element. The low power, unamplified, noncompensated 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 plunger, 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.

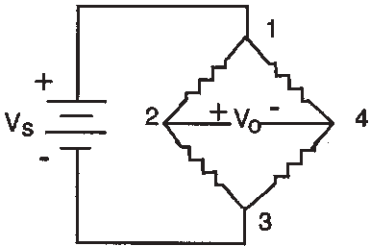
The sensor package design incorporates a patented modular construction. The use of innovative elastomeric technology and engineered molded plastics results in load capacities of 4.5 Kg over-force. The stainless steel plunger provides excellent mechanical stability and is adaptable to a variety of applications. Various electrical interconnects can accept prewired connectors, printed circuit board mounting, and surface mounting. The unique sensor design also provides a variety of mounting options including mounting brackets, as well as application specific mounting requirements.

MOUNTING
Sensor output characteristics do not change with respect to mounting orientation. Care should be taken not to obstruct the vent hole in the bottom of the housing. Improper venting may result in unstable output.

APPLYING FORCE
Evaluation of the sensor is to be performed using deadweight or compliant force. Application of a rigid, immobile force will result in output drift (decrease) as elastomeric seals relax. Off-center plunger loading has minimal effect on sensor performance and maintains operation within design specifications.

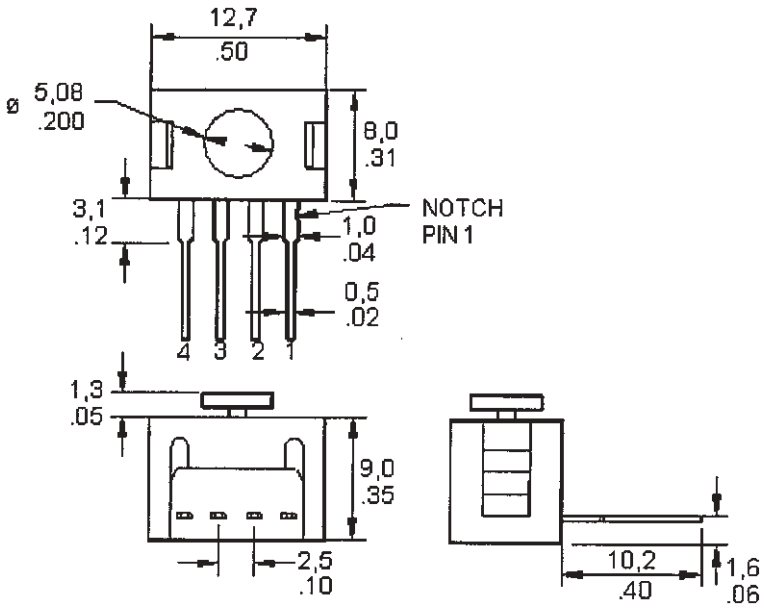
TYPICAL APPLICATIONS
1. Medical infusion pumps
2. Kidney dialysis machines
3. Load and compression sensing
4. Variable tension control
5. Robotic end-effectors
6. Wire bonder equipment

ELECTRICAL CONNECTIONS

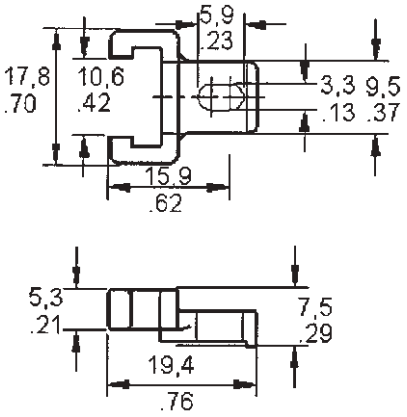


FS SERIES CIRCUIT NOTES
1. Circled numbers refer to Sensor Terminals (interface pins).
   Pin 1 = V_s (+)
   Pin 2 = Output, (+)
   Pin 3 = Ground, (−)
   Pin 4 = Output, (−)
2. The force sensor may be powered by voltage or current.
   Maximum supply voltage is not to exceed 12 volts.
   Maximum supply current is not to exceed 1.6 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 ($V_o = V_2 - V_4$). 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.

MOUNTING DIMENSIONS (for reference only)
FSG15N1A



ACCESSORY (FSG Sensor only)
PC-15132 Plastic Mounting Bracket



PERFORMANCE CHARACTERISTICS @ 10.0 ±0.01 VDC, 25°C

Parameter	Min.	Typ.	Max.	Units
Excitation*	—	10.0	12.0	VDC
Null offset	−30	0	30	mV
Operating Force	0	—	1500	grams
Sensitivity	0.20	0.24	0.28	mV/gram
Linearity (B.F.S.L.)**	—	±22.5	45	grams
Null Shift				
+25°C to 0°C, +25°C to +50°C	—	±1.0	—	mV
Sensitivity Shift				
+25°C to 0°C	—	0.012	—	mV/gram
+25°C to +50°C	—	−0.012	—	mV/gram
Hysteresis	—	45	180	grams
Repeatability (@ 1500 grams)	—	30	120	grams
Input Resistance	4.0 K	5.0 K	6.0 K	Ohms
Output Resistance	4.0 K	5.0 K	6.0 K	Ohms
Overforce	—	—	4,500	grams

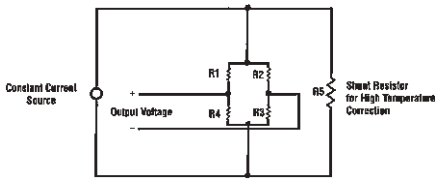
ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	−40° to 85°C (−40° to +185°F)
Storage Temperature	−55° to +105°C (−131° to +221°F)
Vibration	Qualification tested to 10 Hz to 2 kHz, 20 g sine
Shock	Qualification tested to 150 g, 6 ms, half-sine
Solderability	5 sec at 315°C per lead
Output ratiometric	Within Supply Range

**B.F.S.L.—Best Fit Straight Line
Note: All force related specifications established using dead weight or compliant force.

Constant Current Excitation Schematic
*Non-compensated force sensors, excited by constant current instead of voltage, exhibit temperature compensation of Span. Application Note #1 briefly discusses current excitation.

Constant current excitation has an additional benefit of temperature measurement. When driven by a constant current source, a silicon pressure sensor's terminal voltage will rise with increased temperature. The rise in voltage not only compensates the Span, but is also an indication of die temperature.



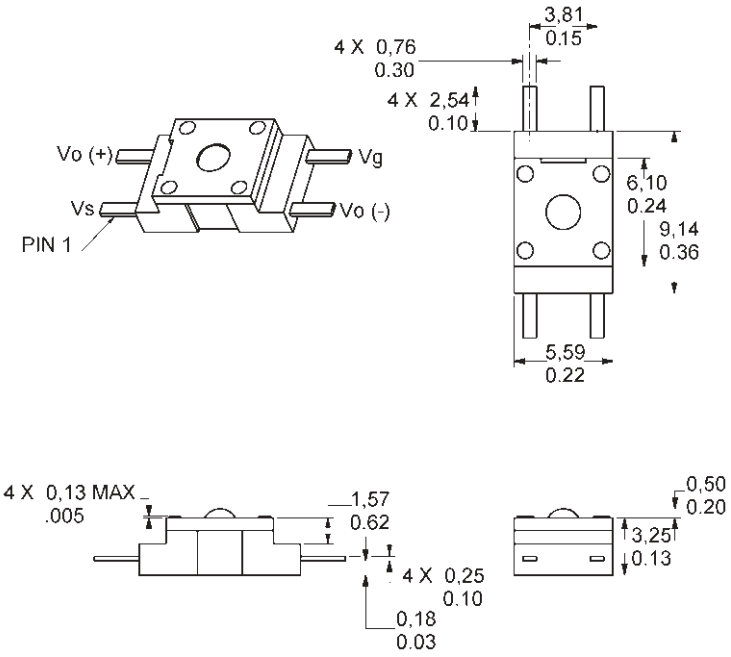
FS SERIES ORDER GUIDE

Catalog Listing	Force Range (grams)	Sensitivity mV/V/gram			Span mV	Over Force grams
		Min.	Typ.	Max.	Typ.	Max.
FSG15N1A	1,500	.02	.024	.028	360 (at 10 VDC)	4,500

Force Sensors
FSG and FSL Series

NEW

MOUNTING DIMENSIONS (for reference only)
FSL05N2C



PERFORMANCE CHARACTERISTICS @ 5.0 ±0.01 Excitation, 25°C

Parameter	Min.	Typ.	Max.	Units
Excitation*	—	5.0	12	VDC
Null offset	−15	0	15	mV
Operating Force	0	—	500	grams
Sensitivity	0.1	0.12	0.14	mV/gram
Linearity (B.F.S.L.)**	—	±10	—	grams
Repeatability @ 300 g	—	±10	—	grams
Null Shift				
+25°C to 2°C, +25°C to +40°C	—	±0.5	—	mV
Sensitivity Shift				
+25°C to 2°C	—	0.012	—	mV/gram
+25°C to +40°C	—	−0.012	—	mV/gram
Input Resistance	4.0 K	5.0 K	6.0 K	Ohms
Output Resistance	4.0 K	5.0 K	6.0 K	Ohms
Overforce	—	—	4,500	grams
ESD (Direct contact, terminals and plunger)	10	—	—	kVolts

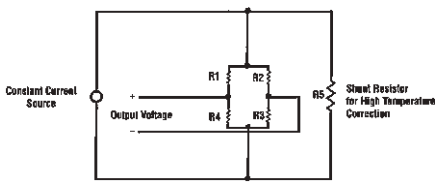
ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	+2°C to +40°C (+36°F to +104°F)
Storage Temperature	−40° to +70°C (−40° to +158°F)
Vibration	Qualification tested to 10 Hz to 2 kHz, 20 g sine
Shock	Qualification tested to 150 g, 6 ms, half-sine
MCTF	7 million
Solderability	5 sec at 315°C per lead
Output ratiometric	Within Supply Range

**B.F.S.L.—Best Fit Straight Line
Note: All force related specifications established using dead weight or compliant force.

Constant Current Excitation Schematic
* Non-compensated force sensors, excited by constant current instead of voltage, exhibit temperature compensation of Span. Application Note #1 briefly discusses current excitation.

Constant current excitation has an additional benefit of temperature measurement. When driven by a constant current source, a silicon pressure sensor's terminal voltage will rise with increased temperature. The rise in voltage not only compensates the Span, but is also an indication of die temperature.



FS SERIES ORDER GUIDE

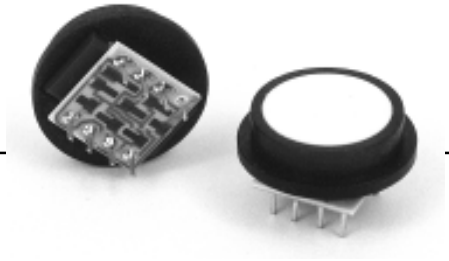
Catalog Listing	Force Range (grams)	Sensitivity mV/V/gram			Span mV	Over Force grams
		Min.	Typ.	Max.	Typ.	Max.
FSL05N2C	500	.02	.024	.028	60 (at 5 VDC)	4,500

Force

Honeywell

Model 1865 Series

Force/Pressure transducer



DESCRIPTION

The Model 1865 is a high-performance transducer specifically designed to address the needs of medical and specialized OEM applications. Offering laser-trimmed compensation, the Model 1865 may be specified to operate with either a constant current or voltage supply.

The Model 1865 employs a solid state piezoresistive pressure transducer mounted in a plastic package. For applications where force is applied by a flexible membrane to the sensor, such as found in infusion pumps, the Model 1865's precision height silicone diaphragm provides long life and is a reliable replacement for older force or load cell transducers. Utilizing a silicon rubber diaphragm, the 1865 is compatible with some liquid media applications.

The Model 1865 provides access to important safety features in critical care medical instrumentation, such as occlusion pressure or infiltration detection. The pressure data can provide medical personnel with useful diagnostic information regarding the condition of the patient's circulatory system. These force/pressure transducers can also be used with other medical dispensing devices, such as syringe pumps, to improve safety and accuracy.

May be operated in either current or voltage excitation, the Model 1865's output can be amplified or signal conditioned, as required. The semiconductor-based sensor offers high resolution using its Wheatstone Bridge strain gauge design. The height of the unit's patented, poured-in-place silicon rubber diaphragm is controlled to ensure sensitivity to low pressure. This diaphragm is bonded to a plastic header and transmits force applied through a special silicone gel to the diaphragm of a silicon peizoresistive die. The back of the die is exposed to atmospheric pressure, which results in a gauge pressure output.

FEATURES

- Silicon pressure/force interface diaphragm
- Force measurement for infusion pump applications
- Pressure measurement for liquid media
- Medical-grade materials
- 8-pin DIP electrical connection
- Laser trimmed
- Choice of voltage or constant current excitation

TYPICAL APPLICATIONS

- Infusion pumps
- Anesthesia monitors
- Non-corrosive, nonpressurized media-level sensors
- Ventilation systems
- Blood pressure equipment
- Syringe pumps
- Drug delivery systems

Model 1865 Series

ELECTRICAL SPECIFICATIONS

	Ratings
Input impedance	
Current excitation	2.0 kOhm min. to 8.0 kOhm max.
Voltage excitation	8.0 kOhm min. to 40 kOhm max.
Output impedance	
Current excitation	3.5 kOhm min. to 6.0 kOhm max.
Voltage excitation	3.5 kOhm min. to 6.0 kOhm max.
Input excitation	
Current	< 2.0 mA
Voltage	< 15.0 Vdc
Effect of excitation change	Ratiometric
Response time (10% to 90%)	≤ 5 milliseconds
Insulation resistance	≥ 100 MOhm at 50 Vdc
Output common mode voltage	50 % of input typical

PHYSICAL SPECIFICATIONS

	Specification
Pressure over-range protection	3X span or 60 psi, whichever is least
Media/materials compatibility	
Top side	Room atmosphere, directly applied force, and liquids compatible with dimethyl silicon, polyetherimide (Ultem)
Bottom side	Non-corrosive dry gasses and fluids compatible with silicon, Pyrex, RTV silicone, and ceramic
Mass	3.0 g with laser-trim board

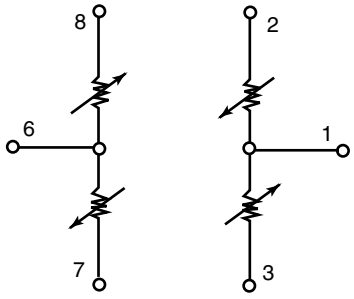
ENVIRONMENTAL CONDITIONS

	Specification
Position effect	≤ 0.05 % of zero or span shift for 90° tilt in any direction
Vibration effect	No change in performance at 10 Gs RMS, 20 Hz to 2,000 Hz
Shock	100 Gs for 11 milliseconds
Life	1 million cycles

PERFORMANCE SPECIFICATIONS

	Min.	Typ.	Max.	Unit
Temperature Compensated Performance				
Nonlinearity	-	0.10	0.25	% of Span, BFSL
Hysteresis	-	0.0125	0.015	% of Span, BFSL
Repeatability	-	0.0125	0.015	% of Span, BFSL
Output (laser trimmed normalized)				
Current excitation	98	100	102	mVdc
Voltage Excitation	38	40	42	mVdc
Zero pressure	-2	0	2	mVdc
Temperature Performance				
Compensated temperature range	-1 °C to 54 °C [30 °F to 129 °F]			
Operating temperature range	-28 °C to 54 °C [-19 °F to 129 °F]			
Maximum zero error			0.5	% of Span in reference to 27 °C [80.6 °F]
Maximum span error			0.5	% of Span in reference to 27 °C [80.6 °F]
Thermal hysteresis			0.2	% of Span, compensated temperature range
Long-term stability			± 0.3	% of Span per six months

FIGURE 1. SENSING ELEMENTS



Pin	Connection	Pin	Connection
1	+ Output	5	+ Input
2	NC	6	- Output
3	- Input	7	NC
4	NC	8	NC

REFERENCE CONDITIONS

	Specification
Media temperature	27 °C ± 1 °C [80 °F ± 2 °F]
Ambient temperature	27 °C ± 1 °C [80 °F ± 2 °F]
Vibration	0.1 G (1 m/s/s) max.
Humidity	50 % ± 10 %
Ambient pressure	12.8 psi to 16.5 psi [860 mBar to 1060 mBar]
Excitation source	1.5 mAdc ± 0.0015 mAdc or 10.0 Vdc ± 0.01 Vdc

FIGURE 2. MOUNTING DIMENSIONS IN MM (INCHES), FOR REFERENCE ONLY

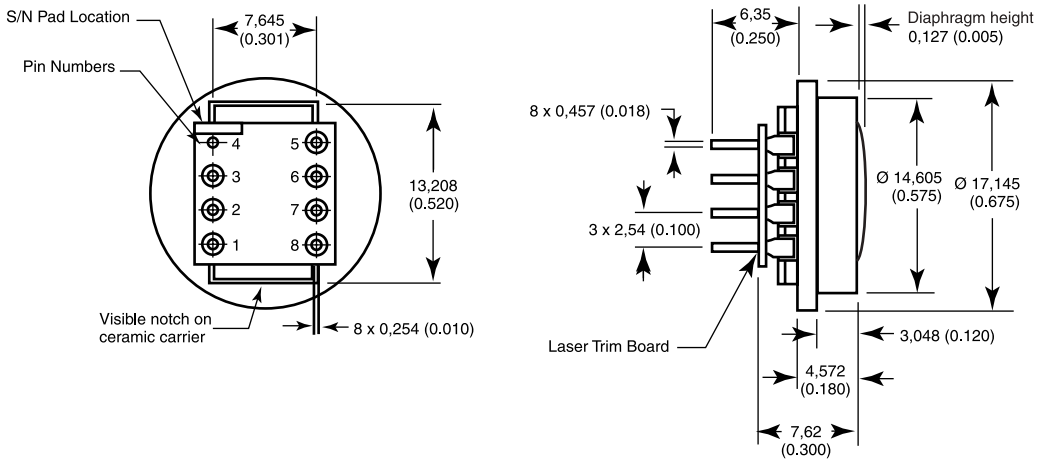


FIGURE 3. LASER TRIM BOARD

Current Excitation, Normalized Output

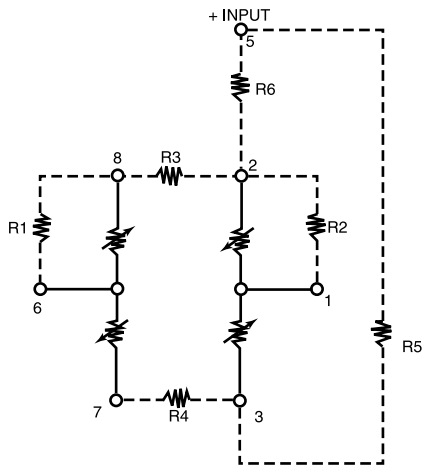
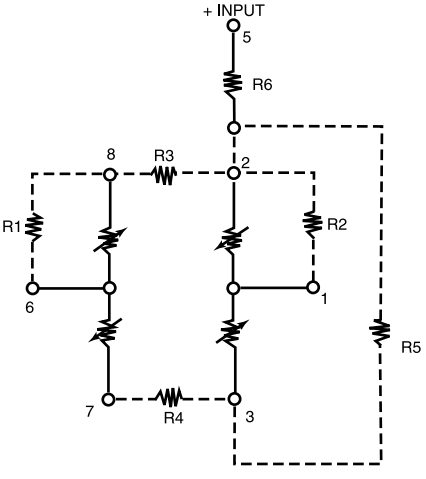
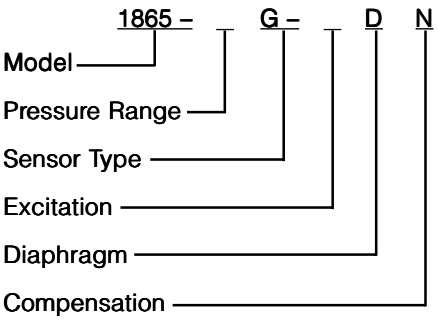


FIGURE 4. LASER TRIM BOARD

Voltage, Normalized Output



ORDER GUIDE



PRESSURE RANGE

01 = 0 psi to 5 psi
02 = 0 psi to 10 psi
03 = 0 psi to 15 psi
05 = 0 psi to 25 psi
07 = 0 psi to 30 psi

SENSOR TYPE

G = Gauge Pressure

EXCITATION

L = 1.5 mA
K = 10 Vdc

DIAPHRAGM TYPE

D = Dimethyl Silicone

COMPENSATION

N = Laser trimmed, normalized output

ACCURACY GRADE

Higher accuracy grades are available as specials.
Custom configurations are available on request.

WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items it finds defective. **The foregoing is buyer's sole remedy and is in lieu of all warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this printing. However, we assume no responsibility for its use.

⚠ WARNING

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. **Failure to comply with these instructions could result in death or serious injury.**

SALES AND SERVICE

Honeywell serves its customers through a worldwide network of sales offices, representatives and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact your local sales office or:

E-mail: info.sc@honeywell.com

Internet: www.honeywell.com/sensing

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Asia Pacific	+65 6355-2828
	+65 6445-3033 Fax
Europe	+44 (0) 1698 481481
	+44 (0) 1698 481676 Fax
Latin America	+1-305-805-8188
	+1-305-883-8257 Fax
USA/Canada	+1-800-537-6945
	+1-815-235-6847
	+1-815-235-6545 Fax

⚠ WARNING

MISUSE OF DOCUMENTATION

- The information presented in this product sheet is for reference only. Do not use this document as a product installation guide.
- Complete installation, operation, and maintenance information is provided in the instructions supplied with each product.

Failure to comply with these instructions could result in death or serious injury.

Automation and Control Solutions
Sensing and Control
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Freeport, Illinois 61032, USA
www.honeywell.com

Honeywell

008094-2-EN IL50 GLO
April 2005

Honeywell

Pressure Sensors

FS01/FS03 Force Sensors

FS Series

FEATURES

- 0 to 1.5 pounds and 0 to 3.0 pound ranges
- High-level output range
- Temperature compensated
- Calibrated zero and span
- Small size
- Low noise

TYPICAL APPLICATIONS

- Medical infusion pumps
- Ambulatory noninvasive pump pressure
- Occulsion detection
- Kidney dialysis machines
- Load and compression sensing
- Variable tensions control

The FS01/FS03 sensors are special low cost, peizoresistive-based force sensors. These high-level voltage output, calibrated, and temperature compensated sensors give an accurate and stable output over a 5 °C to 50 °C [41 °F to 122 °F] temperature range. They offer simple operation from a single 5.0 Vdc supply. Operation from any DC supply voltage, up to 12.0 Vdc, is acceptable.

The FS01/FS03 sensors feature an integrated circuit sensor element and laser trimmed think film ceramic in a small plastic housing. Their extremely small size enables the use of multiple sensors in limited available space. This package also provides excellent corrosion resistance and isolation to external package stress.

⚠ WARNING

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

⚠ WARNING

MISUSE OF DOCUMENTATION

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PRESSURE SENSOR SPECIFICATIONS

	Max. Ratings
Supply voltage, Vs	12.0 Vdc
Maximum over load	3.18 kg [7 lbs]
Lead temperature (soldering 2-4 seconds)	220 °C [428 °F]

ENVIRONMENTAL SPECIFICATIONS

Compensated temperature	5 °C to 50 °C [41 °F to 122 °F]
Operating temperature	0 °C to 70 °C [0 °F to 158 °F]
Storage temperature	-20 °C to 85 °C [13 °F to 185 °F]
Humidity limits	0% RH to 95% RH

STANDARD FORCE RANGES

			Full-Scale Span		
Part Number	Operating Force	Maximum Force	Min.	Typ.	Max.
FS01	0 lbs to 1.5 lbs [0 kg to 0.68 kg]	7 lbs	2.85 Vdc	3.0 Vdc	3.15 Vdc
FS03	0 lbs to 3.0 lbs [0 kg to 1.36 kg]	7 lbs	2.85 Vdc	3.0 Vdc	3.15 Vdc

PERFORMANCE SPECIFICATIONS

	Min.	Typ.	Max.	Unit
Zero force offset	0.95	1.0	1.05	Vdc
Full scale span [2]	2.85	3.0	3.15	Vdc
Linearity	–	± 1.0	± 3.0	%FSS
Hysteresis [3]	–	± 0.5	–	%FSS
Temp effect on Span (0 °C to 50 °C [0 °F to 122 °F]) [4]	–	± 1.0	± 2.5	%FSS
Temp. effect on Offset (0 °C to 50 °C [0 °F to 122 °F]) [4]	–	± 1.0	± 2.5	%FSS
Creep [5]	–	0.5	–	%FSS
Long-term stability of Offset and Span [6]	–	± 1.0	–	%FSS

Specification Notes:

Note 1: Reference conditions (unless otherwise noted): Supply voltage, Vs = 5 Vdc; T_A = 25 °C [77 °F]

Note 2: Full-scale Span is the algebraic difference between the output voltage at full-scale load and the output at zero load. Span is ratiometric to the supply voltage.

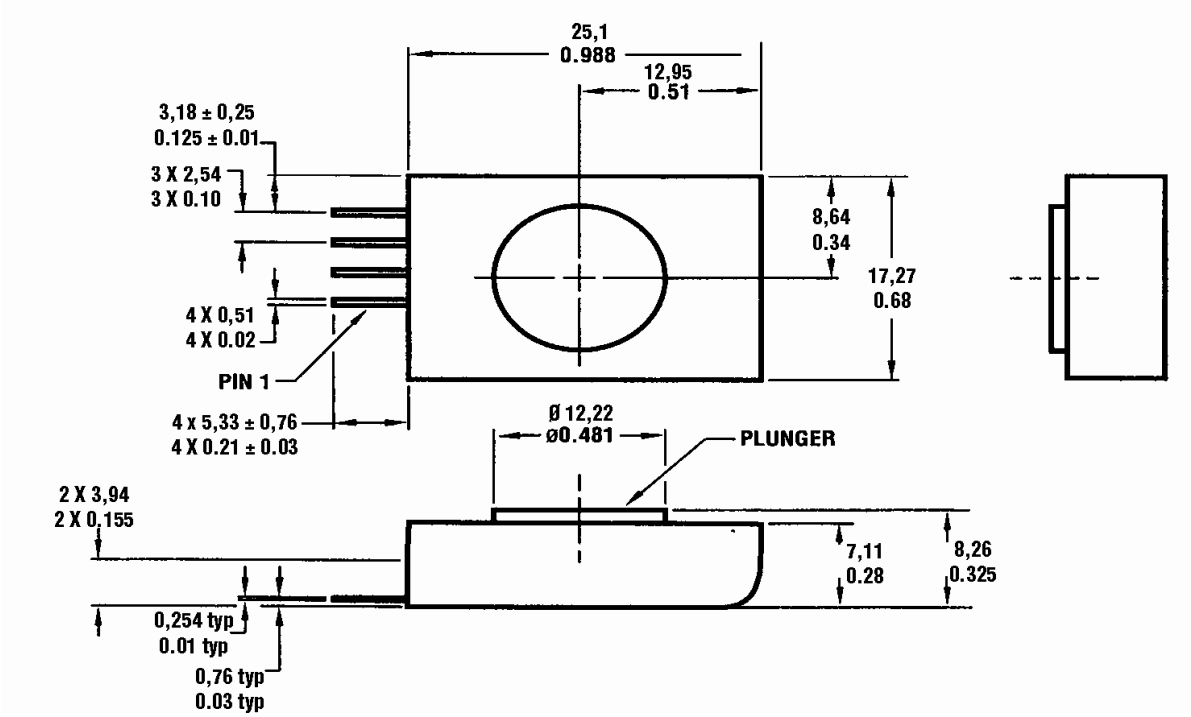
Note 3: Hysteresis is the maximum output difference at any point within the operating pressure range for increasing and decreasing load.

Note 4: Maximum error band of the offset voltage and the effort band of span, relative to the 25 °C [77 °F] reading.

Note 5: Maximum difference in output at full-scale load in a 20 minute period.

Note 6: Maximum difference in output within any operating force after 1 million force cycles

DIMENSIONAL DRAWING
(FOR REFERENCE ONLY)

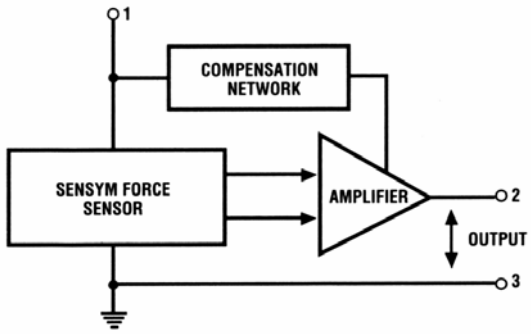


Tolerances, unless otherwise noted

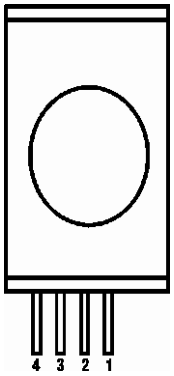
± 0.01 for two decimal places

± 0.005 for three decimal places

EQUIVALENT CIRCUIT



ELECTRICAL CONNECTION PINOUT



Pin 1 = + Supply
Pin 2 = + Output
Pin 3 = - Output/Ground
Pin 4 = N/C

Pressure Sensors

FS01/FS03 Force Sensors

FS Series

ORDER GUIDE

Part Number	Force Range
FS01	0 lbs to 1.5 lbs [0 kg to 0.68 kg]
FS03	0 lbs to 3.0 lbs [0 kg to 1.36 kg]

WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Contact your local sales office for warranty information. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace without charge those items it finds defective. **The foregoing is Buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose.**

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1-815-235-6847 International

FAX

1-815-235-6545 USA

INTERNET

www.honeywell.com/sensing

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Freeport, Illinois 61032

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Honeywell

Force Sensors

FSS Low Profile Force Sensors

FS Series

FEATURES

- True Surface Mount Technology
- Maximum peak reflow temperature of 260 °C [500 °F]
- Compact, commercial grade package
- Robust performance characteristics
- Adaptable package design
- Precision force sensing
- Reliability rated at 20 million MCTF at 25 °C [77 °F]
- Electrically ratiometric output
- Extremely low deflection (30 microns typ. @ Full Scale)
- High ESD resistance 8 kV
- Available signal conditioning
- Optional terminal configurations

TYPICAL APPLICATIONS

- Medical infusion pumps
- Ambulatory noninvasive pump pressure
- Occlusion detection
- Kidney dialysis machines
- Load and compression sensing
- Variable tensions control
- Robotic end-effectors
- Wire bonding equipment

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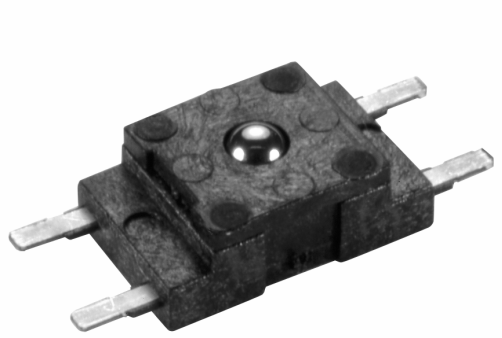

The FS Series sensors provide precise reliable force sensing performance in a compact commercial grade package at a cost effective price. The sensor features a proven sensing technology that uses a specialized piezoresistive micromachined silicon sensing element. The low power, unamplified, uncompensated 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 applications, 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.

The sensor package design incorporates patented modular construction. The use of innovative elastomeric technology and engineered molded plastics result in load excitation capacities of 4.5/5.5 kg over-force. The stainless steel ball provides excellent mechanical stability and is adaptable to a variety of applications. The FSS 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. Various electric interconnects can accept prewired connectors, printed circuit board mounting, and surface mountings. The unique sensor design also provides a variety of mounting options that include mounting brackets, as well as application specific mounting requirements.

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PERFORMANCE CHARACTERISTICS @ 5.0 ± 0.01 Vdc Excitation*, 25 °C [77 °F]

Parameter	Min.	Typical	Max.	Units
Null Offset	-15	0	+15	mV
Operating Force	0	–	1500	grams
Sensitivity.	0.1	0.12	14	mV/gram
Linearity (B.FS.L.)**	–	± 1.5	–	% span
Repeatability @ 300 g	–	± 10	–	grams
Null Shift				
25 °C to 2 °C [77 °F to 35.6 °F]	–	± 0.5	–	mV
25 °C to 40 °C [77 °F to 104 °F]	–	± 0.5	–	mV
Sensitivity Shift				
25 °C to 50 °C [77 °F to 122 °F]	–	5.5	–	% span
25 °C to 0 °C [77 °F to 32 °F]	–	5.5	–	% span
Input Resistance	4.0 K	5.0 K	6.0 K	Ohms
Output Resistance	4.0 K	5.0 K	6.0 K	Ohms
Overforce	–	–	4,500	grams
ESD (direct contact, terminals and plunger)	8	–	–	kV

* Non-compensated force sensors, excited by constant current (1.5 mA) instead of voltage, exhibit partial temperature compensation of Span.

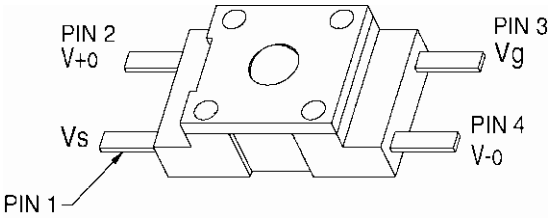
** BFSL: Best Fit Straight Line

ENVIRONMENTAL SPECIFICATIONS

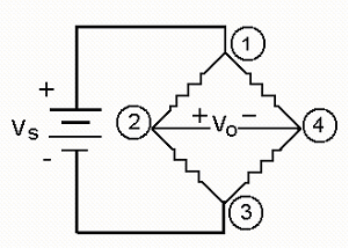
Operating temperature	-40 °C to 85 °C [-40 °F to 185 °F]
Storage temperature	-40 °C to 100 °C [-40°F to 212 °F]
Shock	Qualification tested to 150 g
Vibration	Qualification tested to 0 to 2 kHz, 20 g sine
MCTF	20 million at 25 °C [77 °F]
Solderability	5 sec at 315 °C [599 °F] per lead
Output ratiometric	Within supply range

Note: All force related specifications are established using dead weight or compliant force.

SENSOR PINOUT



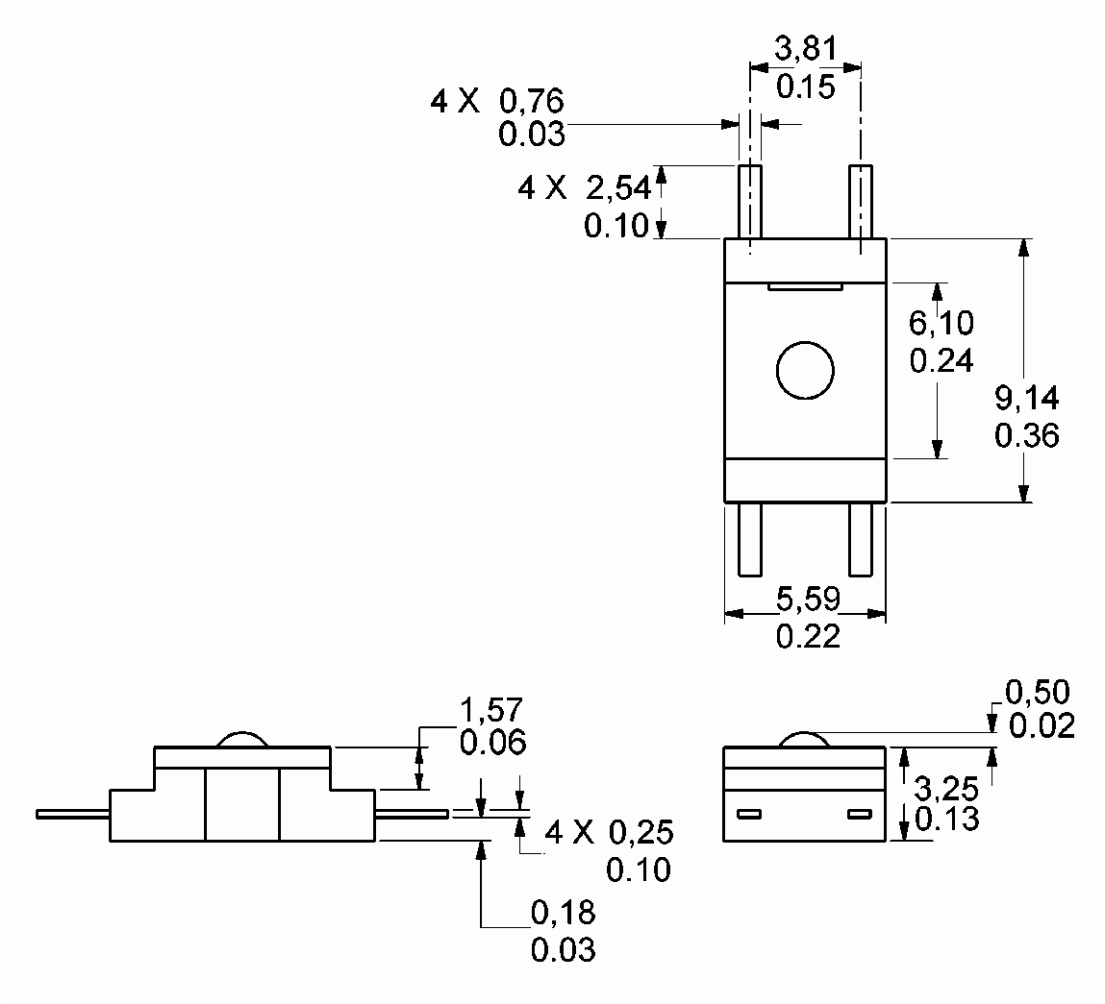
EXCITATION SCHEMATIC
Excitation 5 Vdc Typ., 12 Vdc Max.



FS SERIES CIRCUIT

1. Circled numbers refer to sensor terminals (pins).
   Pin 1 = Supply V_S (+)
   Pin 2 = Output Vo (+)
   Pin 3 = Ground V_g (-)
   Pin 4 = Output V_O (-)
2. The force sensor may be powered by voltage or current. Maximum supply voltage is not to exceed 12 volts. Maximum supply current is not to exceed 1.6 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 ($V_O = V_2 - V_4$). 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.

MOUNTING DIMENSIONS (for reference only) mm/in



DESCRIPTION

Catalog Listing	Packing Style
FSS1500NST	Tube
FSS1500NSB	Bubble Pack
FSS1500NSR	Tape and Reel

WARRANTY/REMEDY
Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Contact your local sales office for warranty information. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace without charge those items it finds defective. **The foregoing is Buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose.**
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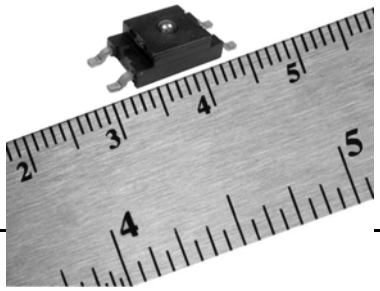
Honeywell

FSS-SMT Series

Low Profile Force Sensor



DESCRIPTION

Honeywell's FSS-SMT Series force sensors are designed to be one of the most reliable force sensors available as illustrated by 20 million Mean Cycles To Failure (MCTF) at 25 °C [77 °F] rating. This low profile Surface Mount Technology (SMT) sensor allows for automated assembly on a printed circuit board, often helping the customer to reduce assembly costs.

The FSS-SMT Series force sensor is designed to provide precise and reliable force sensing performance in a compact commercial-grade package. The sensor incorporates Honeywell sensing technology that uses a specialized piezoresistive micromachined silicon sensing element. The low power, unamplified, uncompensated Wheatstone bridge circuit design provides inherently stable millivolt output over the force range.

Force sensors operate on the principle that the resistance of silicon-implanted piezoresistors will change when the resistors flex under applied force. The sensor concentrates force from the applications, 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.

The sensor package design incorporates patented modular construction. The use of innovative elastomeric technology and engineered molded plastics results in load excitation capacities of 44 N over-force. The stainless steel ball provides excellent mechanical stability, and is suitable for a variety of potential medical and commercial applications.

FEATURES/BENEFITS

- Surface Mount Technology allows for automated assembly and may eliminate hand soldering
- RoHS-compliant materials meet Directive 2002/95/EC
- Low deflection (30 microns typical at full scale) help 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) (8 KV) meets ESD Sensitivity Classification Level 3, reducing special handling during assembly
- Sensor output has low sensitivity to many mounting stresses

FSS-SMT Series

POTENTIAL APPLICATIONS

Medical

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

Commercial

- Load and compression sensing
- Variable tension control
- Wire bonding equipment

Table 1. Absolute Maximum Ratings[1]

Parameter	Min.	Max.	Unit
Electro-Static Discharge (ESD)	-	8	kV
Storage temperature[2]	-40 [-40]	100 [212]	°C [°F]
Solderability[3]	-	260 [500] for 10 s	°C [°F]

Table 2. Operating Specifications (Performance characteristics at 5.0 ± 0.01 Vdc excitation, 25 °C [77 °F])

Parameter	Min.	Typical	Max.	Unit
Supply voltage[4]	3.0	5.0	6.0	V
Operating force	0	-	14.7	N
Operating temperature[5]	-40 [-40]	-	85 [185]	°C [°F]
Offset[6]	-15	0	15	mV
Span[7]	150	180	210	mV
Sensitivity[8]	10.2	12.2	14.3	mV/N
Force non-linearity (BFSL)[9]	-	±0.7	±1.5	%FSS
Repeatability at 2.9 N[10]	-	±1.5	-	mV
Mechanical hysteresis[11]		±0.5		%FSS
Thermal effect on offset[12] 25 °C to 0 °C [77 °F to 32 °F], 25 °C to 50 °C [77 °F to 122 °F]	-	±0.5	-	mV
Thermal effect on span[13] 25 °C to 0 °C [77 °F to 32 °F], 25 °C to 50 °C [77 °F to 122 °F]	-	±5.5	-	%FSS
Input resistance	4.0	5.0	6.0	kOhm
Output resistance	4.0	5.0	6.0	kOhm
Over force[14]	44	-	-	N

Table 3. Environmental Specifications

Parameter	Characteristics
Shock	Qualification tested to 150 G
Vibration	Qualification tested to 0 to 2 kHz, 20 G sine
Mean Cycles To Failure (MCTF)[15]	20 million at 25 ° C [77 ° F]

Notes:

1. Absolute maximum ratings are the extreme limits that the device can withstand without damage to the device.
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 specification after excursion to any temperatures in this range. Exposure to temperatures beyond this range may cause permanent damage to the product.
3. The maximum temperature and time for which the product can be exposed to for processing of solder electrical connections.
4. 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.
5. The temperature range over which the product will produce an output proportional to force but may not remain within the specified performance limits.
6. The output signal obtained when the zero force is applied to the sensor. Also known as "null" or "zero".
7. The algebraic difference between output signal measured at the upper and lower limits of the Operating Force Range. Also known as "full scale output" or simply "span".
8. 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.
9. Force Non-Linearity (Best Fit Straight Line): 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.
10. 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.
11. The maximum difference between output readings when the same force is applied consecutively, under the same operating conditions, with force approaching from opposite directions within the operating force range.
12. The maximum deviation in Offset due to changes in temperature over the Operating Temperature Range, relative to Offset measured at 25 °C.
13. The maximum deviation in Full Scale Span due to changes in temperature over the Operating Temperature Range, relative to Full Scale Span measured at 25 °C.
14. 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 temperature within the Operating Temperature Range.
15. 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.

Figure 1. Sensor Pinout

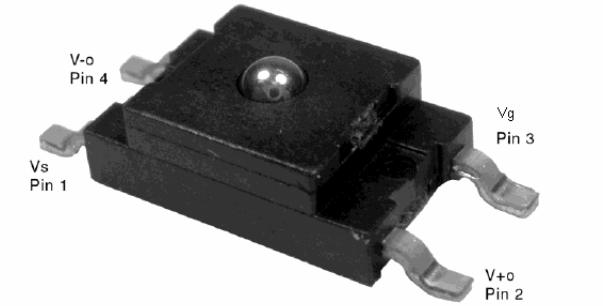
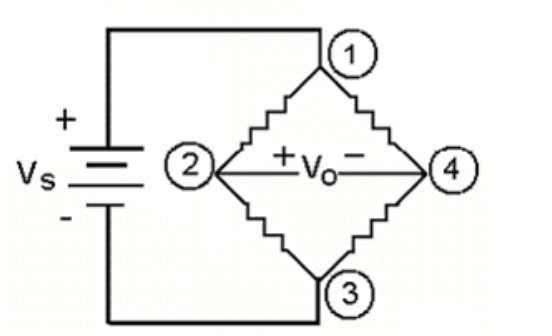


Figure 2. Excitation Schematics – Excitation 5 Vdc Typ., 6 Vdc max.



FS Series Circuit

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 3. Mounting Dimensions (for reference only) in mm

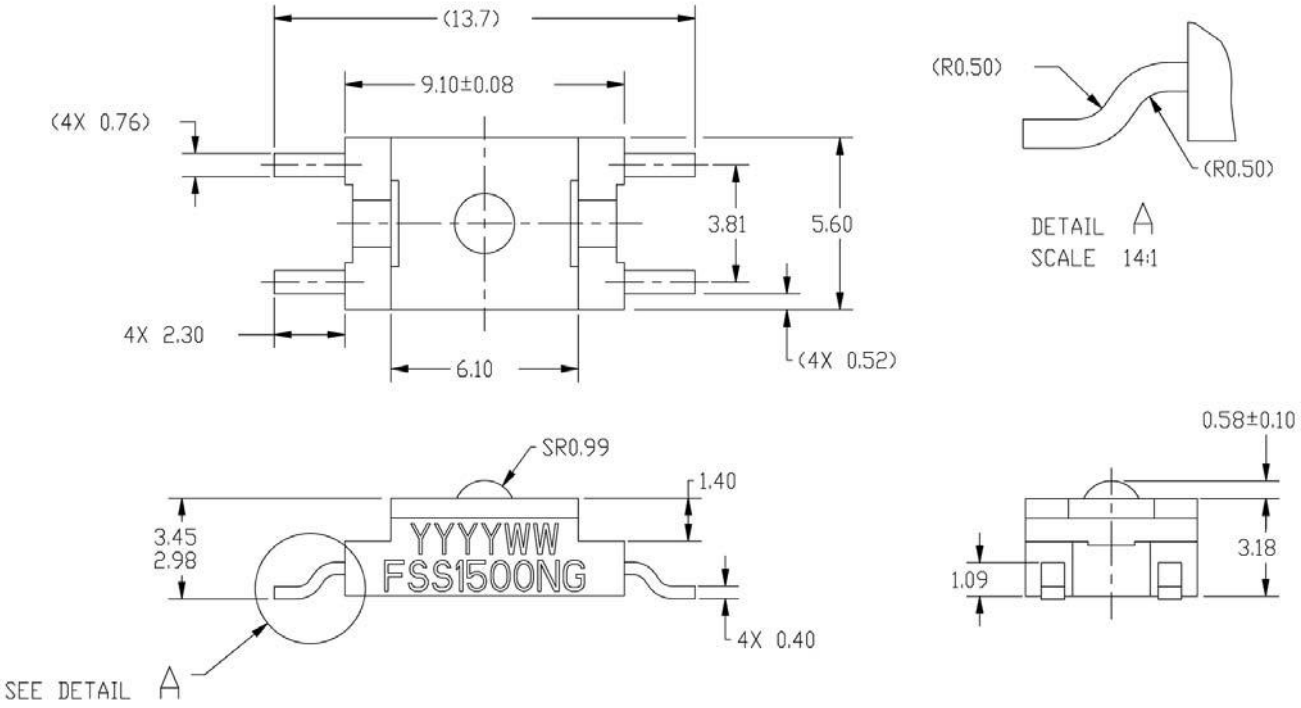


Figure 4. Suggested Land Pattern in mm

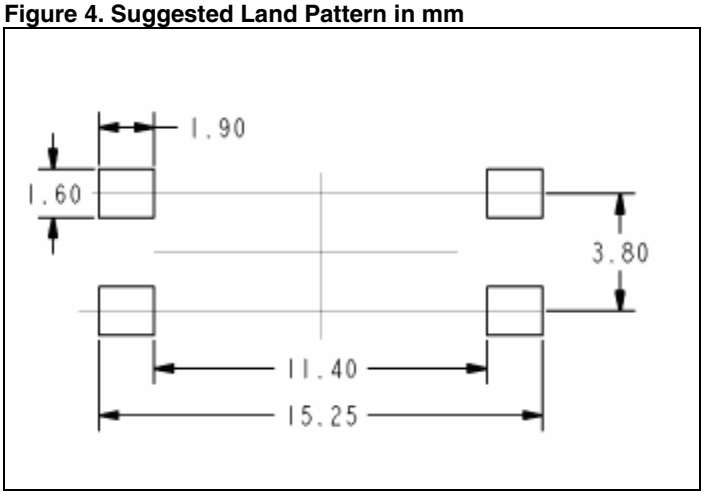


Table 4. Order Guide

Catalog Listing	Packaging*
FSS1500NGT	Tube
FSS1500NGR	Tape and reel (1,000 units)

* Tape and reel packaging in development

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SALES AND SERVICE

Honeywell serves its customers through a worldwide network of sales offices, representatives and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact your local sales office or:

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