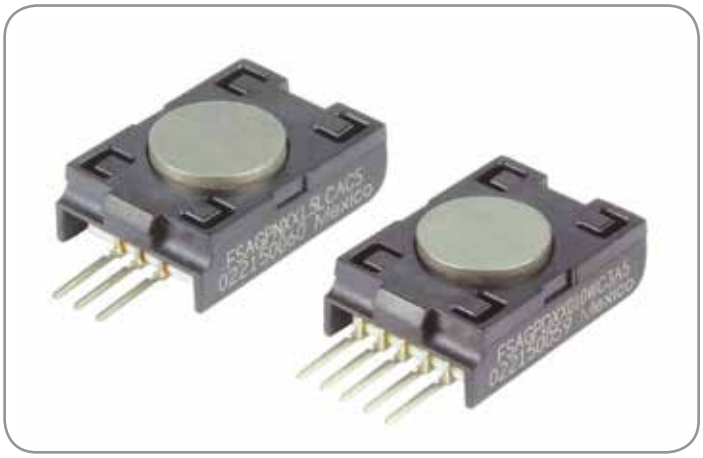
Honeywell

Force Sensors
FSA Series, Compensated/Amplified

32311096
Issue B

Datasheet



DESCRIPTION
The FSA Series are piezoresistive-based force sensors offering a ratiometric analog or digital output for reading force over the specified full scale force span and temperature range. They are fully calibrated and temperature compensated for sensor offset, sensitivity, temperature effects, and nonlinearity using an on-board Application Specific Integrated Circuit (ASIC). Direct mechanical coupling allows for easy interface with the sensor, coupling with tubing, membrane or a plunger, providing repeatable performance and a reliable mechanical interface to the application. The package also provides excellent corrosion resistance and isolation to external package stress. All products are designed and manufactured according to ISO 9001 standards.

VALUE TO CUSTOMERS
The FSA Series are designed to meet the customers' need for a compensated, amplified force sensor that provides analog and digital outputs, a variety of force sensing ranges, and enhanced durability and accuracy. Their flexible design provides multiple standard configurations over a wide operating temperature range.

DIFFERENTIATION
- Multiple force ranges allow the customer to choose the force range to maximize sensitivity and improve system resolution/performance
- Overforce provides enhanced durability in applications where overforce may exist
- Enhanced accuracy includes all errors due to force non-linearity, force hysteresis, and non-repeatability
- Total Error Band enhances system performance
- Digital output enhances performance through reduced conversion requirements and the convenience of direct interface to microprocessors
- Diagnostics functions allow the user to determine if the sensor is working correctly by detecting if the electrical paths are broken or shorted inside the sensor
- Supply voltage provides customers flexibility of design within the application

FEATURES
- Wide variety of force ranges
  - Newton (N): 5, 7.5, 10, 15, 20, 25
  - pound (lb): 1, 1.5, 2, 3, 5
  - gram (g): 500, 750
  - kilogram (kg): 1, 2
- Total Error Band: ±5 %FSS
- Accuracy: ±3 %FSS
- Ratiometric analog or SPI- or I²C-compatible digital output
- Fully calibrated and temperature compensated over a temperature range of 5°C to 50°C [41°F to 122°F]
- Overforce: 6804 g [15 lb]
- Supply voltage: 3.3 Vdc typ. or 5.0 Vdc typ.
- Low power consumption: 13 mW (analog) or 20 mW (digital)
- Excellent part-to-part repeatability
- Enhanced reliability
- Stable interface plunger
- Internal diagnostic functions available
- REACH and RoHS compliant

POTENTIAL APPLICATIONS
Medical:
- Ambulatory non-invasive pump pressure
- Infusion pumps
- Kidney dialysis machines
- Occlusion detection

Industrial:
- Load and compression sensing

PORTFOLIO
The FSA Series joins the FSG Series, FSS Series, FSS-SMT Series, TBF Series, and 1865 Series.

Table 1. Operating Specifications

Characteristic	Analog			Digital			Unit
	Min.	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
Supply voltage (V_{supply}):[1, 2, 3] 3.3 Vdc 5.0 Vdc	 3.0 4.75	 3.3 5.0	 3.6 5.25	 3.0 4.75	 3.3 5.0	 3.6 5.25	Vdc
Supply current: 3.3 Vdc 5.0 Vdc	 — —	 2.0 2.6	 — —	 — —	 2.8 3.9	 3.9 4.6	mA
Power input		13			20		mW
Operating temperature range[4]	0 [32]	—	70 [158]	0 [32]	—	70 [158]	°C [°F]
Compensated temperature range[5]	5 [41]	—	50 [122]	5 [41]	—	50 [122]	°C [°F]
Storage temperature range	-40 [-40]	—	85 [185]	-40 [-40]	—	85 [185]	°C [°F]
Startup time (power up to data ready)	—	—	5	—	—	3	ms
Response time	—	1	—	—	0.42	0.84	ms
Clipping limit: upper lower	 — 2.5	 — —	 97.5 —	 — —	 — —	 — —	$\%V_{supply}$
SPI/I²C voltage level: low high	 — —	 — —	 — —	 — 80	 — —	 20 —	$\%V_{supply}$
Pull up on SDA/MISO, SCL/SCLK, SS	—	—	—	1	—	—	kOhm
Accuracy[6]	—	—	±3	—	—	±3	%FSS[7] BFSL
Total Error Band[8]	—	—	±5	—	—	±5	%FSS
Output resolution	—	—	—	12	—	—	bits
Long term stability[9]	—	±1.3	—	—	±1.3	—	%FSS

[1]Sensors are either 3.3 Vdc or 5.0 Vdc based on the catalog listing selected.

[2]Ratiometricity of the sensor (the ability of the device output to scale to the supply voltage) is achieved within the specified operating voltage.

[3]The sensor is not reverse polarity protected. Incorrect application of supply voltage or ground to the wrong pin may cause electrical failure.

[4]Operating temperature range: The temperature range over which the sensor will produce an output proportional to force.

[5]Compensated temperature range: The temperature range over which the sensor will produce an output proportional to force within the specified performance limits.

[6]Accuracy: The maximum deviation in output from a Best Fit Straight Line (BFSL) fitted to the output measured over the force range at 25°C [77°F]. Includes all errors due to force non-linearity, force hysteresis, and non-repeatability.

[7]Full Scale Span (FSS): The algebraic difference between the output voltage at full scale force and the output at zero force.

[8]Total Error Band (TEB): Combined error from calibration, accuracy and temperature effects over the compensated temperature range at 5.0 V from 15 %FSS to 95 %FSS.

[9]Long-term stability after 1000 hr of operation at 25°C [77°F].

Table 2. Environmental Specifications

Characteristic	Parameter
Humidity	0% to 95% RH, non-condensing
Vibration	MIL-STD-202, Method 214, Condition 1E (16.9 G)
Shock	MIL-STD-202, Method 213, Condition F (1500 G)
Life[1]	1 million full scale force cycles minimum

[1]Life may vary depending on specific application in which the sensor is utilized.

Table 3. Materials[1]

Component	Material
Covers	high temperature polyamide
Plunger	stainless steel 316
Substrate	alumina, ceramic
Adhesives	epoxy, silicone
Electronic components	ceramic silicon, glass, solder

[1]Contact Honeywell customer service for detailed material information.

Table 4. Absolute Maximum Specifications

Characteristic	Min.	Max.	Unit
Supply voltage	-0.3	6.0	Vdc
Voltage on any pin	-0.3	V_{supply} + 0.3	V
Digital interface clock frequency: SPI I^2C	 50 100	 800 400	kHz
ESD susceptibility (human body model)	2	—	kV
Storage temperature range	-40 [-40]	85 [185]	°C [°F]
Overforce limit	—	6804 [15]	g [lb]
Minimum operating voltage	2.8 Vdc		
Lead soldering time and temperature	4 s max. at 220°C [428°F]		

Force Sensors, FSA Series Compensated/Amplified

Figure 1. Nomenclature and Order Guide

For example, **FSAGPNXX001LCAA3** defines an FSA Series Force Sensor, gel coupling, plunger contact element, no diagnostics, 2 lb force range, force unit in pounds, compression force type, analog output, 10% to 90% transfer function, 3.3 Vdc supply voltage

FSA G P N XX 001 L C A A 3

Series

FSA	Force Sensor Compensated/Amplified

Coupling

G	Gel

Contact Element

P	Plunger

Diagnostics Option

N	No diagnostics
D	Diagnostics, sensor short and open

Future Use

XX

Force Range[1]

Newton (N)		pound (lb)		gram (g)		kilogram (kg)	
005	5 N	**001**	1 lb	**500**	500 g	**001**	1 kg
7.5	7.5 N	**1.5**	1.5 lb	**750**	750 g	**002**	2 kg
010	10 N	**002**	2 lb				
015	15 N	**003**	3 lb				
020	20 N	**005**	5 lb				
025	25 N						

Supply Voltage

3	3.3 Vdc ±10%
5	5 Vdc ±10%

Transfer Function[3]

A	10% to 90%
B	5% to 95%
C	20% to 80%

Output

A	Analog
S	SPI
2	I²C, Address 0x28
3	I²C, Address 0x38
4	I²C, Address 0x48
5	I²C, Address 0x58
6	I²C, Address 0x68

Force Type

C	Compression

Force Unit

W	Newton (N)
L	pound (lb)
F	gram (g)
R	kilogram (kg)

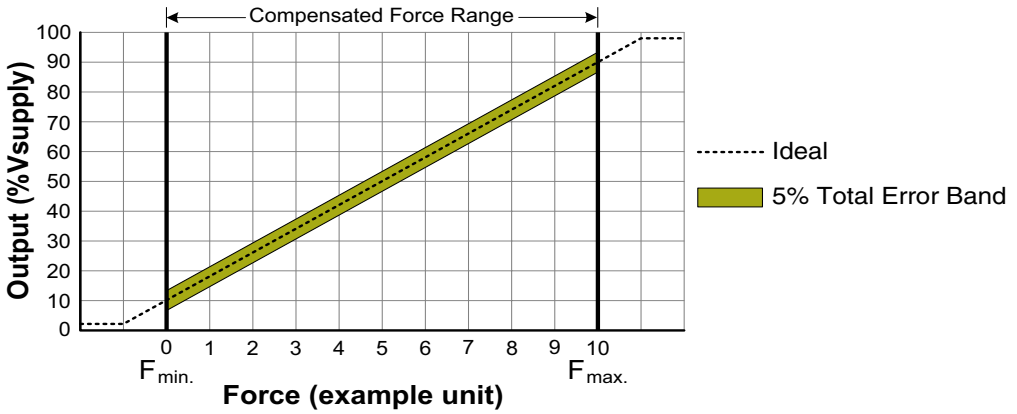
[1]Custom designations available upon request.
[2]Consult with factory.
[3]For other available transfer functions, contact Honeywell customer service.

COMMON CATALOG LISTINGS

FSAGPDXX010WCAA5
FSAGPDXX001RCAB5
FSAGPNXX1.5LCAC5
FSAGPNXX003LCAC5
FSAGPNXX010WC2C3
FSAGPNXX001RC4C5
FSAGPDXX005LCSB5
FSAGPDXX1.5LC5B5

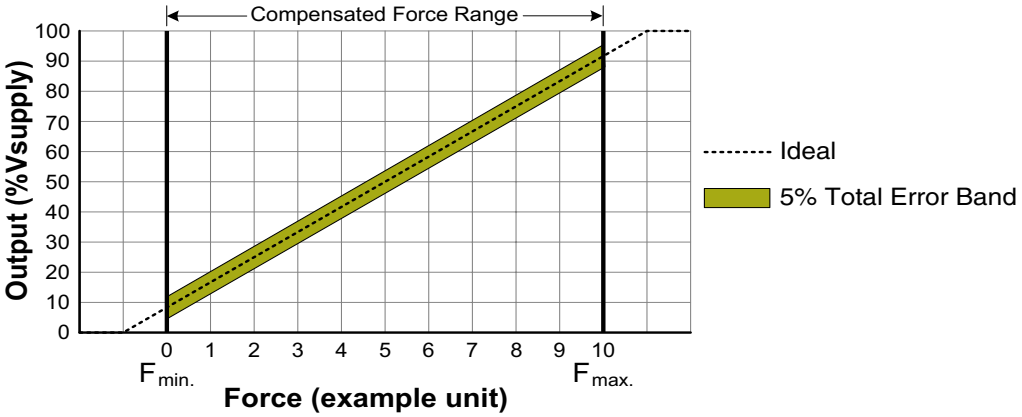
Figure 2. Transfer Function Limits[1]

Analog Version



$$\text{Output (V)} = \frac{0.8 \times V_{supply}}{\text{Force}_{range}} \times (\text{Force}_{applied}) + 0.10 \times V_{supply}$$

Digital Version

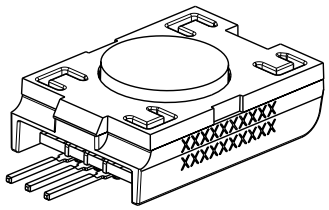


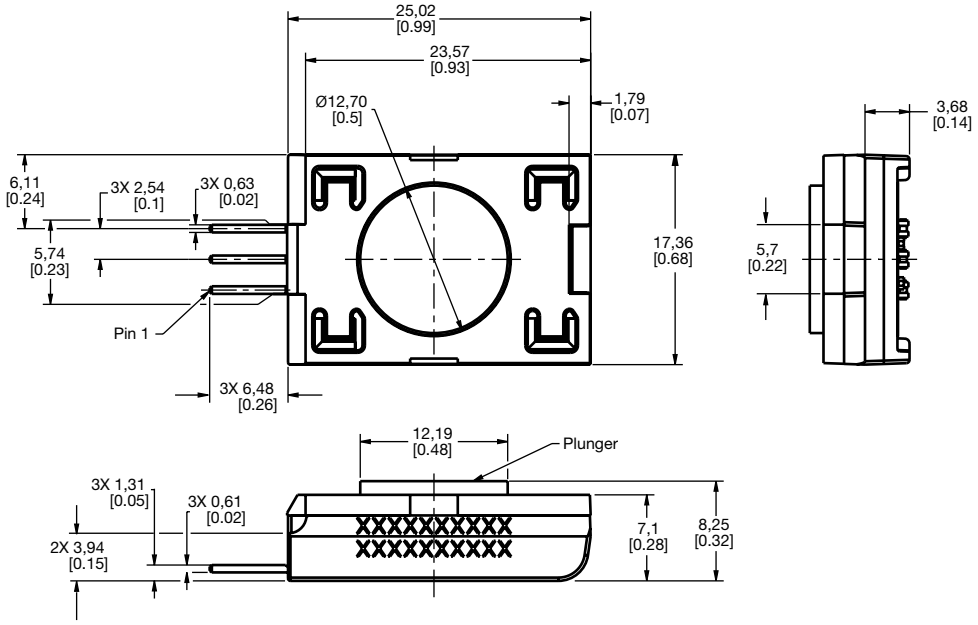
$$\text{Output (\% of } 2^{14} \text{ counts)} = \frac{80\%}{\text{Force}_{range}} \times (\text{Force}_{applied}) + 10\%$$

[1]Transfer Function "A" is shown. See Figure 1 for other available transfer function options.

Figure 3. Mounting Dimensions (For reference only: mm/in.)

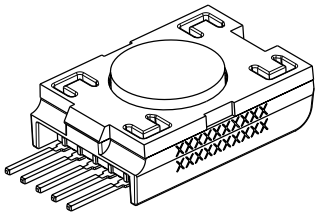
Analog version

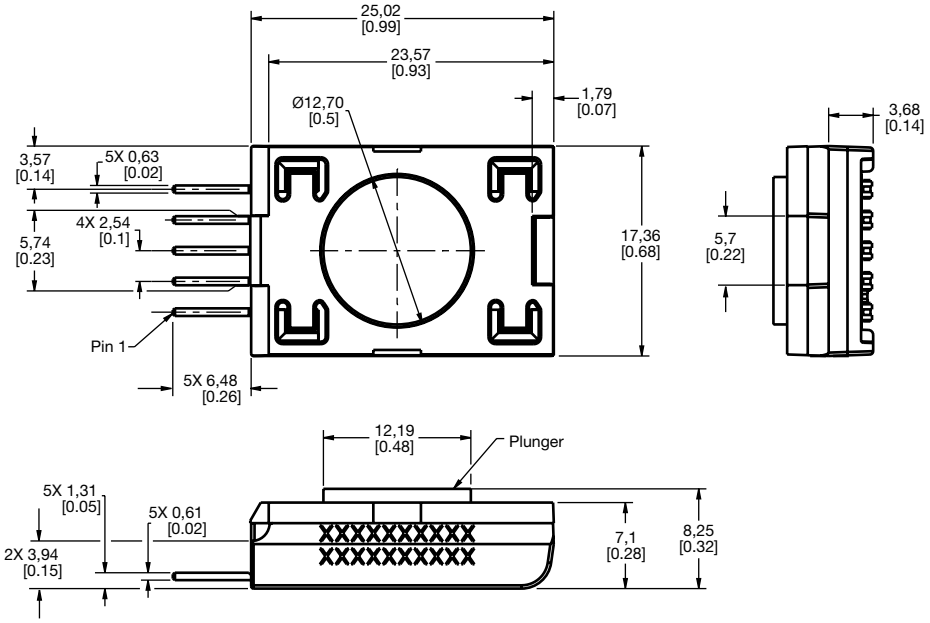




Function	Pin 1	Pin 2	Pin 3
analog	V_{supply}	Vout	GND

Digital version





Function	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5
SPI	GND	V_{supply}	SS	MISO	SCLK
I^2C	GND	V_{supply}	N/C	SDA	SCL

ADDITIONAL INFORMATION

The following associated literature is available on the Honeywell web site at sensing.honeywell.com:

- Product Range Guide
- Product Line Guide
- Product Installation Instructions
- Technical Information:
  - SPI Communications with Honeywell Digital Output Force Sensors
  - I^2C Communications with Honeywell Digital Output Force Sensors

⚠ 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

- The information presented in this datasheet 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.

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