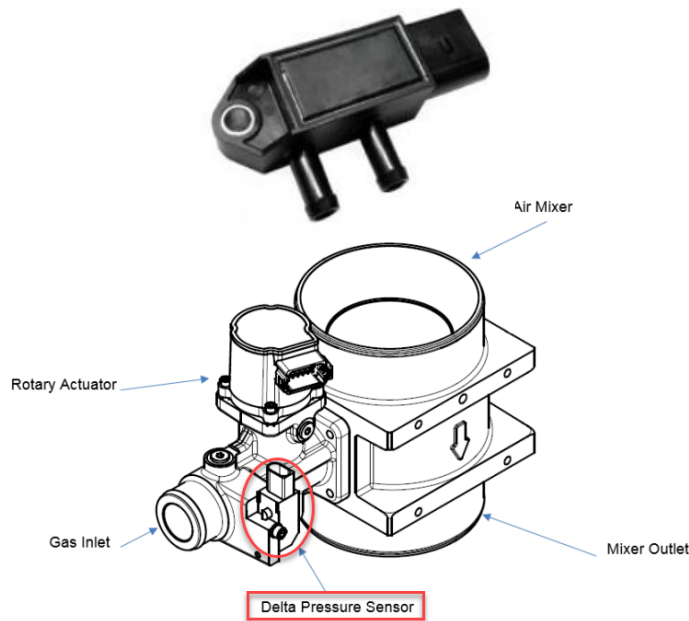


## **EFR, Differential Pressure Sensor Update**

# EFR, Differential Pressure Sensor Update

## PURPOSE

- The purpose of this Application Note is to inform all PG+ EFR product customers of a change of the differential pressure sensor change on our EFR product and required actions for existing installations..



## BACKGROUND

- The differential sensor used on the EFR was obsoleted by manufacturer Sensata.
- The only available replacement that fits the current geometry of the housing has a lower maximum dP (old 35 kPa, new 12 kPa). The old differential sensor has a range from -1.7kPa to 35kPa, the new sensor has a range of -2kPa to 12kPa. (Note: Max dP of EFR Product 5kPa, new sensor is better matched to product use.)
- All future EFR product will have the new delta-P sensor, current delta-P sensor assembled EFR products are not available and have been obsoleted.

## IMPACT

- All future production of EFR product will have new delta-P sensor and can be recognized by a new part number.
- This product requires updated sensor calibration for its application. WWD will provide updated EFR partial calibration for each new EFR product including a new sensor calibration update.

- Affected EFR part number and new item number are below.

Item	Description	Ext Desc	New item number
8407-801	VALVE	VALVE - PG+ 32MM-90-B EFR 110MM OPEN MIXER ASSY	8407-701
8407-802	VALVE	VALVE - PG+ 32MM-0-B EFR 110MM OPEN MIXER ASSY	8407-702
8407-803	VALVE	VALVE - PG+ 32MM-90-B EFR 150MM OPEN MIXER ASSY	8407-703
8407-804	VALVE	VALVE - PG+ 24MM-90-B EFR 70MM OPEN MIXER ASSY	8407-704
8407-805	VALVE	VALVE - PG+ 24MM-90-B EFR 70MM OPEN MIXER ASSY	8407-705
8407-807	VALVE	VALVE - PG+ 16MM-180-B EFR 70MM OPEN MIXER ASSY	8407-707
8407-809	VALVE	VALVE - PG+ 16MM-180-B EFR 70MM OPEN MIXER ASSY	8407-709
8407-810	VALVE	VALVE - PG+ 32MM-270-B EFR 150MM OPEN MIXER ASSY	8407-710
8407-813	VALVE	PG+ 24MM-0-B EFR 100MM OPEN MIXER ASSY	8407-713
8407-814	VALVE	VALVE - PG+ 24MM-90-B EFR 70MM OPEN MIXER ASSY	8407-714
8407-815	VALVE	VALVE - PG+ 24MM-90-B EFR 70MM OPEN MIXER ASSY	8407-715
8407-816	VALVE	ASSY VALVE - PG+ 24MM-0-B EFR 70MM FOR 1 CROSS TUBE MIXER	8407-716
8407-817	VALVE	PG+ 32MM-0-B EFR 110MM CROSS MIXER ASSY FOR F-SERIES THROTTLE	8407-717
8407-830	VALVE	VALVE - PG+ 24MM-0-B EFR 70MM OPEN MIXER ASSY	8407-730
8407-831	VALVE	VALVE - PG+ 24MM-0-B EFR 70MM OPEN MIXER ASSY	8407-731
8407-832	VALVE	ASSY VALVE - PG+ 24MM-0-B EFR 70MM FOR 1 X-TUBE MIXER, NPT INLET (1.250"-11.5)	8407-732
8407-833	VALVE	VALVE - PG+ 32MM-0-B EFR 150MM OPEN MIXER ASSY	8407-733

Customer specific item numbers are not listed in the table above.

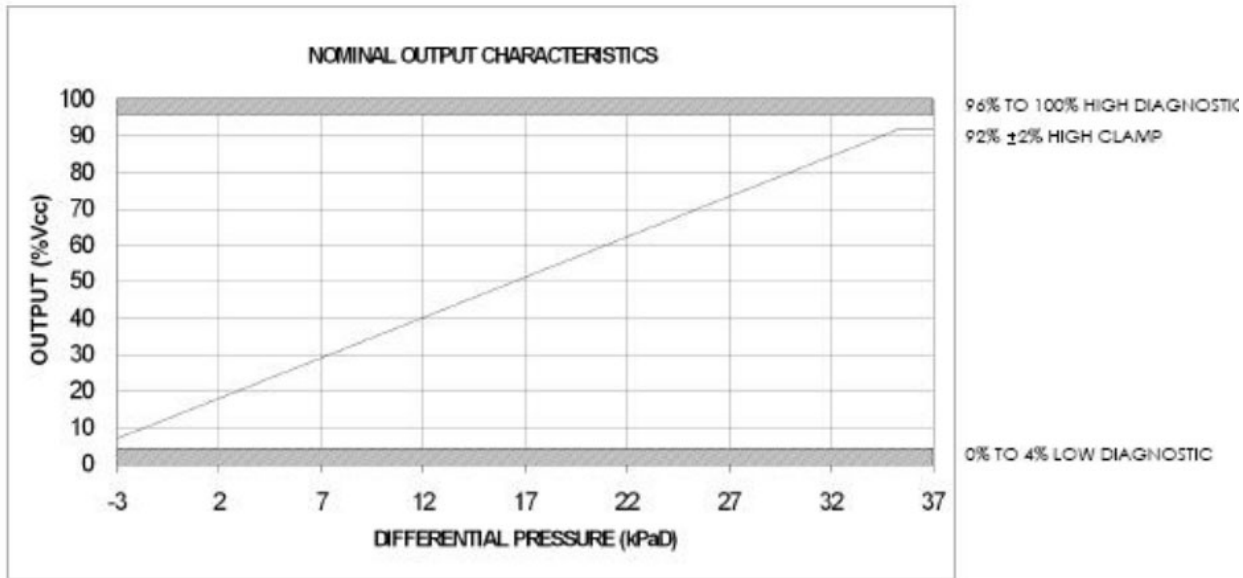
#### REFERENCE:

- There are no changes in mounting geometry or wiring connection for the sensor.
- Sensor calibration: **update required** (included in EFR partial calibration)

#### Sensor Characteristics

- Old differential pressure sensor (1689-1311)

SPECIFICATIONS :	
SUPPLY VOLTAGE (V <sub>cc</sub> )	4.75 TO 5.25 VDC (5 VDC NOMINAL)
SUPPLY CURRENT	10mA MAX.
OPERATING TEMPERATURE RANGE	-40°C TO 135°C
INPUT PRESSURE RANGE	-1.7 TO 34.5 kPaD
DIFFERENTIAL PROOF PRESSURE	70 kPa
DIFFERENTIAL BURST PRESSURE	105 kPa
PROOF PRESSURE	300 kPa
BURST PRESSURE	450 kPa
LOAD RESISTOR	5K OHM PULL UP TO SUPPLY
HIGH CLAMP RAIL	92% ±2% V <sub>pwr</sub>
MOUNTING	MUST BE MOUNTED ON VEHICLE WITH PRESSURE PORTS DIRECTED VERTICALLY DOWNWARD ±20°C
INITIAL ACCURACY	±2% V <sub>cc</sub> FROM -40°C TO 135°C
AFTER AGING (PER SENSATA DOCUMENT 77284)	±3% V <sub>cc</sub> FROM -40°C TO 135°C



THE NOMINAL OUTPUT CURVE WILL BE EXPRESSED BY:

$$V_{out} = 2.21 \times DP + 13.81$$

$V_{out}$  = OUTPUT in %  $V_{supply}$

$V_{supply}$  = SUPPLY VOLTAGE IN VOLTS DC

DP = MEAN (FILTERED) DIFFERENTIAL PRESSURE

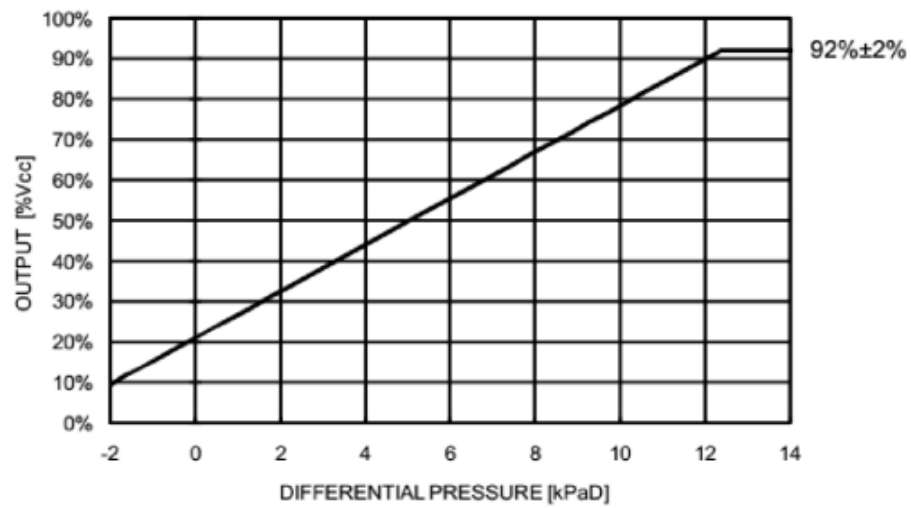
- Sensor gain/offset calibration (1689-1311\_sensata\_35kPa.wset)

Sensor Config	
deltaPGain	9.05 kPa/V
deltaPOfst	-6.2445 kPa

- **NEW differential pressure sensor (1689-2377)**

SPECIFICATION		
ITEMS	CODES	RATINGS
SUPPLY PRESSURE	-	:300kPa (gauge, common mode) : -20~70kPa (diff)
OPERATION PRESSURE	$P_{HI}-P_{LOW}$	-2~12kPa (diff)
OPERATION VOLTAGE	-	DC-0.2~6.0V Output voltage is Ratio metric to supply voltage. At $V_{cc} = 5V$ , Output voltage = 0.5 V at -2kPa and 4.5 V at 12kPa
SUPPLY VOLTAGE	$V_{cc}$	DC 5 $\pm$ 0.25V
STORAGE TEMPERATURE	$T_{stg}$	-40~140degC
OPERATION TEMPERATURE	$T_{opt}$	-40~130degC

TRANSFER CURVE



THE NOMINAL OUTPUT CURVE WILL BE EXPRESSED BY:

$$V_{out} = 5.7143 \times DP + 21.4286$$

$V_{out}$  = OUTPUT in %  $V_{supply}$

$V_{supply}$  = SUPPLY VOLTAGE IN VOLTS DC

DP = MEAN (FILTERED) DIFFERENTIAL PRESSURE

- Sensor gain/offset calibration (1689-2377\_sensata\_12kPa.wset)

#### Sensor Config

deltaPGain	<input type="text" value="3.5"/> kPa/V
deltaPOfst	<input type="text" value="-3.75"/> kPa

**ANALYSIS:****Sensor – calibration mismatch case system analysis**

Sensor	Calibration	State	Actual fuel-P (kPa)	deltaP <sub>Raw</sub> V (v)	deltaP (kPa)	System detection	Fueling condition	Engine start result
35kPa sensor	35kPa sensor	Key on	0	0.69	0.00	normal		
		idle	2.5	0.93	2.33	normal		
35kPa sensor	12kPa sensor	Key on	0	0.69	-1.33	no fault detection		
		Crank	0.5 min	0.75	-1.13	Low Fuel Pressure	rich fueling	fail
		Crank	2.5 nominal	0.97	-0.36	Low Fuel Pressure	rich fueling	fail
		Crank	5 max	1.24	0.59	no detection	rich fueling	fail
12kPa sensor	35kPa sensor	Key on	0	1.07	0.00	normal		
		idle	2.5	1.70	2.24	normal		
12kPa sensor	35kPa sensor	Key on	0	1.07	3.40	Fuel Shutoff Stuck Open fault		
		Crank	0.5 Min	1.21	4.71	no detection	Lean fueling	fail
		Crank	2.5 Nominal	1.79	9.96	Fuel Pressure high Fault	Lean fueling	fail
		Crank	5 Max	2.50	16.38	Fuel Pressure high Fault	Lean fueling	fail

- If the 12 kPa differential sensor is used with the 35 kPa sensor calibration, the engine will not start
- If the 35 kPa differential sensor is used with the 12 kPa sensor calibration, the engine will not start

**Emission Related Component Considerations**

- The new sensor is solely for the replacement of an emissions-related element of design and is identical in design and function as the old sensor with the same fuel control.
- It restores that element of design to be identical in all emissions-related respects to the certified configuration of the engine with the correct calibration
- Customer applying for a determination of equivalence shall be responsible for collecting and verifying test data to demonstrate the equivalence of the alternative means of emission limitation.
  - Prime power stationary emissions certification engine validation test example, Emissions results comparing from each sensor; RMTIC cert lab testing D2 5-mode cycle

Brake Specific Emissions		CO <sub>2</sub>	CO	NO <sub>x</sub>	HC	NMHC	NMHC+NO <sub>x</sub>
8407-813 Old dP Sensor	g/kWh	986.43	2.50	0.22	0.83	0.04	0.26
8407-734 New dP Sensor	g/kWh	1004.27	1.91	0.12	0.79	0.03	0.15
Change	%	1.81%	-23.84%	-46.23%	-5.11%	-11.22%	-41.19%

- Customer is ultimately responsible for emissions that fully meet the standards

**ACTIONS:**

- **Woodward:** will provide a new EFR partial calibration for each new part number Update per process in EFR Manual (B35058)
  - 1689-1311\_sensata\_35kPa.wset
- **Customer:** required to update to the correct partial calibration per applied EFR product in their system
- If the existing EFR product delta-P sensor is replaced with new delta-P sensor (1689-2377) as service replacement for EFR product will then also require updating the sensor calibration. Please note that the sensor can be interchangeable as a service part, but require sensor calibration update.
- Acknowledgment of receipt: customer acknowledgment of this product change notice

**Additional Relevant Item Number Information:**

- Replacement sensor kit
  - 8923-2767



We appreciate your comments about the content of our publications.

Send comments to: [icinfo@woodward.com](mailto:icinfo@woodward.com)

Please reference publication **51633**.



B 5 1 6 3 3 : -



PO Box 1519, Fort Collins CO 80522-1519, USA  
1041 Woodward Way, Fort Collins CO 80524, USA  
Phone +1 (970) 482-5811

Email and Website—[www.woodward.com](http://www.woodward.com)

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.