

Sensor Solutions For Heavy Duty Applications



Sensata
Technologies

Sensor Solutions For Heavy Duty Applications



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WHAT’S IN A NAME?

A QUICK LOOK AT SENSATA AND ITS ORGANIZATION

The name Sensata comes from the Latin “sensata”, meaning “those gifted with sense”



Sensata manufactures over 16,000 different products and ships over 1 billion units a year under the familiar brand-names Klixon®, Airpax®, Wabash, Schrader, DeltaTech, Dimensions™, Qinex™ and Sensor-NITE. Our devices are used in automotive, appliance, aircraft, industrial, military, heavy vehicle, heating, air conditioning, data, telecommunications, recreational vehicle and marine applications.



THE SENSATA FAMILY OF BRANDS

AIRPAX

DIMENSIONS

DeltaTech
CONTROLS

Qinex™

SCHRADER
ELECTRONICS

KLIXON®

Wabash
TECHNOLOGIES

SENSOR
NITE

ABOUT SENSATA TECHNOLOGIES

Sensata Technologies is a world leader and early innovator in mission-critical sensors and controls



Sensata Technologies Holding N.V. (NYSE: ST), a global industrial technology company, is a leader in the development, manufacture and sale of sensors and controls.

Our high value-added solutions help satisfy the world's growing need for safety, energy efficiency, and a clean environment, positively affecting millions of people everyday.

AGRICULTURE VEHICLES & CONSTRUCTION – 50 or more sensors, switches and operator controls

AUTOMOBILES & TRUCKS – Up to 50 sensors and controls

COMMERCIAL JETS – Up to 1,500 circuit breakers and switches

HOMES – 30 or more sensors, switches and other safety devices

LARGE HVAC SYSTEMS – Dozens of sensors and switches

MOBILE PHONE SYSTEMS – 300 or more circuit breakers, sensors and switches

ON-ROAD COMMERCIAL VEHICLES – 50 or more sensors

PHOTOVOLTAIC SYSTEMS – 1 to 4 high voltage switches and fuses

RV'S & LARGE BOATS – Up to 60 power inverters, sensors and protection devices

A BRIEF COMPANY HISTORY

People and products that make a difference



HOW OUR BUSINESS IS ORGANIZED

Overall, we have two main global business units (Performance Sensing and Sensing Solutions) and worldwide global operations supported by business and product development centers and sales offices.

Performance Sensing Business Unit



Sensata's Performance Sensing business is a market leader in Heavy Vehicle & Off Road (HVOR) and automotive markets.

Our products include a full line of pressure sensors for cars, trucks and heavy off-road vehicles. They can be used for everything from improving performance and safety to helping the environment by reducing emissions. Our sensors and switches detect pressure, temperature, air flow, gas, humidity, speed, position and provide on/off controls used in automotive and heavy duty applications.

HVOR - Sensata is committed to the global market for Agriculture and Construction vehicles and equipment. In addition we have been serving the global Truck market for many years. The conditions under which HVOR equipment must operate are often extreme. We are proud to call many of the world's leading HVOR equipment manufacturers as long-standing clients. Our pressure and temperature sensors help control emissions and improve performance, our range of operator controls provides ergonomic man-machine interfaces in some of the most challenging off-road applications.

AUTOMOTIVE - Sensata has been the world leader in automotive pressure sensing since 2002. In vehicles, our components are found in air conditioning systems, power steering systems, engines, fuel emission and braking and suspension systems. A pressure switch manifold made by this business senses hydraulic pressure in automatic transmissions while our occupant classification sensors help keep airbags operating safely so they can do the job they're meant to do.

The Performance Sensing Business Unit designs and manufactures, among others:

- Acceleration sensors
- Transmission range sensors
- Occupant classification sensors
- Pressure sensors
- Joysticks and rockers
- Integrated armrests
- Gas sensors
- Magnetic speed and position sensors
- Temperature sensors

Sensing Solutions Business Unit



Our Sensing Solutions business is a major player in worldwide industrial sensing, electrical and power protection industries. Our products monitor pressure and temperature for energy efficiency and a clean environment and prevent damage from overheating and fires, protecting people from injury.

In the HVAC and industrial markets our pressure product portfolio serves many industrial applications – covering all sensing principles from absolute to relative and differential. Our pressure switches are designed to meet the needs in a variety of industrial applications requiring precise repeatable pressure control over a wide range of ambient conditions.

So, where might you find us?

- Where increased safety and performance are required.
- Where improved machine productivity and efficiency are needed.

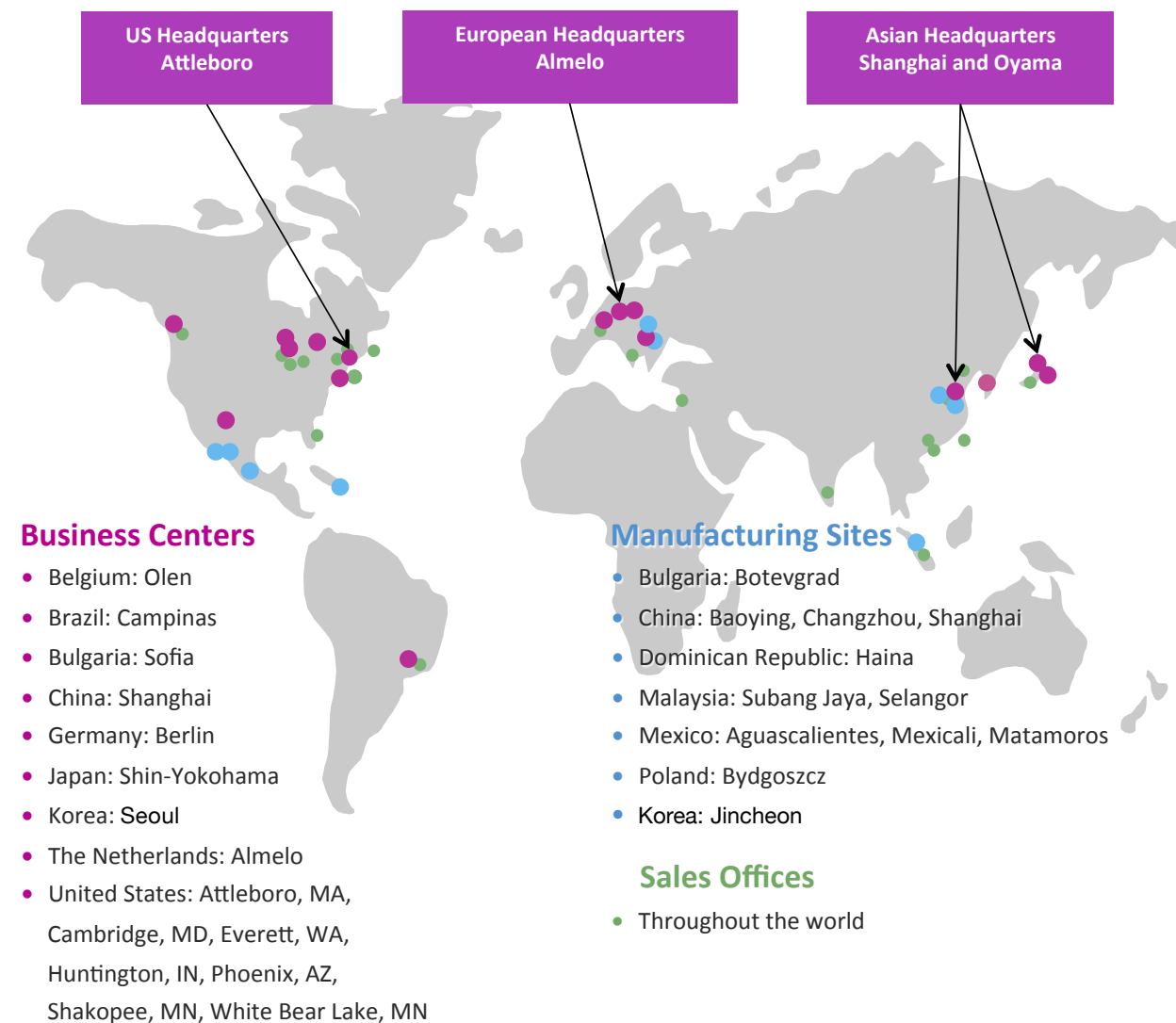
Our products are found in a wide range of applications including HVAC and refrigeration, heat pumps, heavy duty industrial pumps, compressors, material handling equipment, stationary equipment.

The Sensing Solutions business designs and manufactures:

- Pressure sensors
- Pressure switches
- Temperature sensors
- Controls
- Protectors
- Thermostats
- Circuit breakers
- Switches
- Test devices
- Battery disconnects

WHERE ARE WE LOCATED?

Business centers, Manufacturing sites,
and Sales offices



ENGINE SOLUTIONS

Diesel engines no longer have slow combustion from self-ignition in pre-chambers or are smoky due to unbalanced air-fuel mixtures. Because of their high torque, low fuel consumption and high engine-speed range they are the engine of choice for a wide range of heavy vehicles and off-road equipment while complying with ever stricter exhaust emission standards.

Since the late seventies, development of engines has no longer been solely focused on ignition, injection and combustion, but a great deal of development has gone into exhaust-gas after-treatment. Catalysts that clean up nitrogen oxides and other pollutants like particulates are now commonly used around the world. These systems are small chemical factories that contribute to cleaner exhaust gases and better health for human society.

ELECTRONICS ARE KEY

With the help of ever more sophisticated electronics, HVOR systems are optimally controlled under all operating conditions. In order to operate accurately, these electronics

rely on sensors to measure pressure, temperature as well as contents of gas and fluids and speed and position sensors to measure the actual position of moving parts.

Sensata has been developing sensors for the global automotive and HVOR industry for more than 25 years. Sensata's sensors and control devices are used in engine, transmission, AC, exhaust-gas after-treatment, brake, hydraulics and many other systems of all global OEM's and most of their system suppliers. Today's sensor capability of Sensata consists of pressure, temperature, acceleration, force, position, flow and gas sensors. In addition Sensata offers a range of operator control devices such as joysticks, pedals, throttle controls and other Man-Machine-Interface devices.

AVAILABLE SENSING TECHNOLOGIES

PRESSURE

Sensata Technologies' pressure-sensor line has been developed in such a way that all applications can be served, independent of pressure range, independent of principle and in all environments. The basis is a rich technology choice, from micro-electromechanical systems to capacitive ceramic and micro-fused strain gauges on metal membranes. Sensata's sensors can be found everywhere: from measuring 35 millibar differential highly corrosive exhaust-gas pressures on a Diesel Particulate Filter to 3000 bar diesel fuel in common-rail systems to operating inside a transmission in contact with hot fluid.

CERAMIC CAPACITIVE PRESSURE SENSORS

Ceramic transducers using a capacitive measurement principle have proven to be the automotive world's first choice for medium pressure ranges. Capacitive transducers are well known for their high sensitivity and low power consumption. The material is impervious to harsh media, and the transducer is very stable over a wide temperature range. Packaging is very simple, by clamping the ceramic transducer in a metal can and using an elastomer seal. This principle is commonly accepted as the most cost effective pressure sensing technology for pressure ranges between 1 and 100 bar.

MICRO-FUSED STRAIN GAUGE PRESSURE SENSORS

Steel membranes with piezo-resistive elements have been adopted as the common transducers for high pressures. Various concepts exist. All have in common the fact that the piezo-resistors are placed on a metal diaphragm, where stresses or strain from deflection under pressure induce the piezo-resistive effect.

MEMS-BASED PRESSURE SENSORS

Silicon is an ideal material for integrating piezo-resistive elements, which are often integrated with signal conditioning. The piezo resistive structures are formed in monolithic silicon using standard semiconductor manufacturing processes, also used for mass production of solid state integrated circuits. After processing of the resistive structures and metallization for interconnection, wet etching techniques are used to create a thin pressure diaphragm at the location of the stress sensitive piezo-resistive structures. MEMS-based pressure sensors are good solutions for lower pressures. Silicon or MEMS have a high sensitivity and are very small.

TEMPERATURE

Sensata's line of temperature sensors uses a technology known as Resistance Temperature Detectors (RTD's). They are used to measure temperature by correlating the resistance of the RTD element with temperature. The RTD element is made of platinum, because this material follows a very linear Resistance-Temperature (R-T) relationship and it follows the R-T relationship in a highly repeatable manner over a wide temperature range. Platinum is also chosen because of its chemical inertness. The RTD element is produced using thin film technology, where a very thin layer of platinum is deposited on a ceramic substrate. This film is then coated with an epoxy or glass that helps protect the deposited film and also acts as a strain relief for the external lead-wires. The RTD element is placed inside a sheathed probe to protect it. The sheath can be open (perforated) to achieve the highest response time or it can be closed to increase robustness against the medium. RTD can be tuned to various temperature ranges using either a Pt200 or Pt500 element. The RTD is one of the most accurate temperature sensors. Not only does it provide good accuracy, it also provides excellent stability and repeatability.

SPEED/POSITION

Sensata's line of speed and (rotary) position sensors features Hall Effect, Variable Reluctance (VR) and Resistive technologies to serve a wide range of applications.

HALL EFFECT

The Hall effect is the production of a voltage difference (the Hall voltage) across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current. Sensata uses this technology for both speed and position sensors.

VARIABLE RELUCTANCE

A variable reluctance sensor is used to measure position and speed of moving metal components. Although VR sensors are based on very mature technology, they still offer several significant advantages. Since VR sensors excel in

high-temperature applications, they are particularly suited for measuring engine camshaft and crankshaft position.

RESISTIVE SENSORS

The third technology uses potentiometers, which act as variable resistors to measure position of moving objects. As objects change position, a different input to the sensor causes it to change its resistance. Examples may be found in sensing throttle or pedal position or in EGR applications.

OPERATOR SENSING TECHNOLOGIES

Sensata's range of Operator Sensing Controls offers a variety of electromechanical devices that allow a precise translation of the operator's intentions to the moving parts of the equipment.

The mechanical portion of the system provides precise and intuitive feel to the operator, the electronics connect the feel to the machine.

Today's agriculture, construction and material handling equipment must have the ability to operate under diverse and often adverse conditions. Customers depend on reliability at all times, especially when it matters most.

Having been designed and thoroughly tested in the harshest of environments, the electromechanical solutions offered by Sensata's portfolio of rockers, switches, grips and joysticks offer reliable, premium haptics under all conditions. Ergonomic shape and operation make them ideal for mounting on hydraulic levers, electronic joysticks and more.

HVOR SENSORS TECHNOLOGY OVERVIEW

Providing a wide range of solutions for HVOR Applications

Pressure

Ceramic Capacitive



Micro-Fused Silicon Strain Gauge



MEMS



Cylinder Pressure



Temperature

Mid Temperature



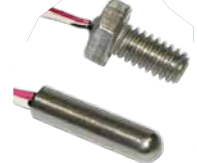
Mid Temperature



High Temperature



Probe



Speed / Position

Rotational speed



Position



Pedal Position



Rotary Position



Operator Sensing Technologies

Multifunction Grip



Joystick



Analog Rocker

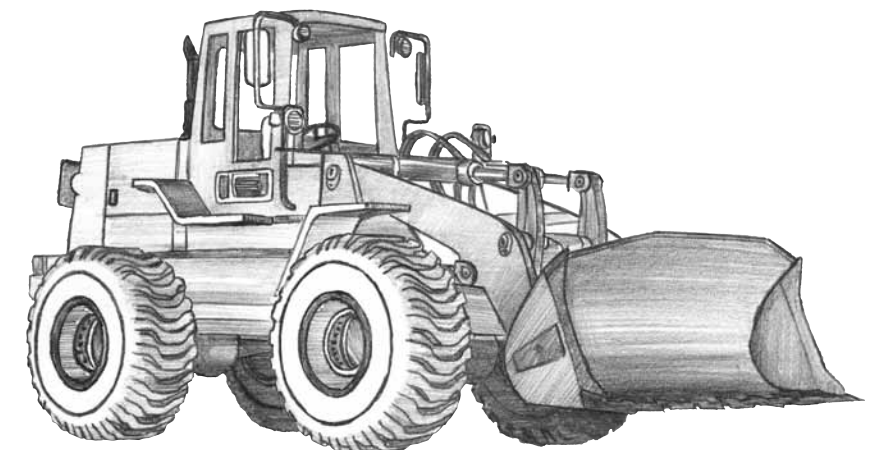
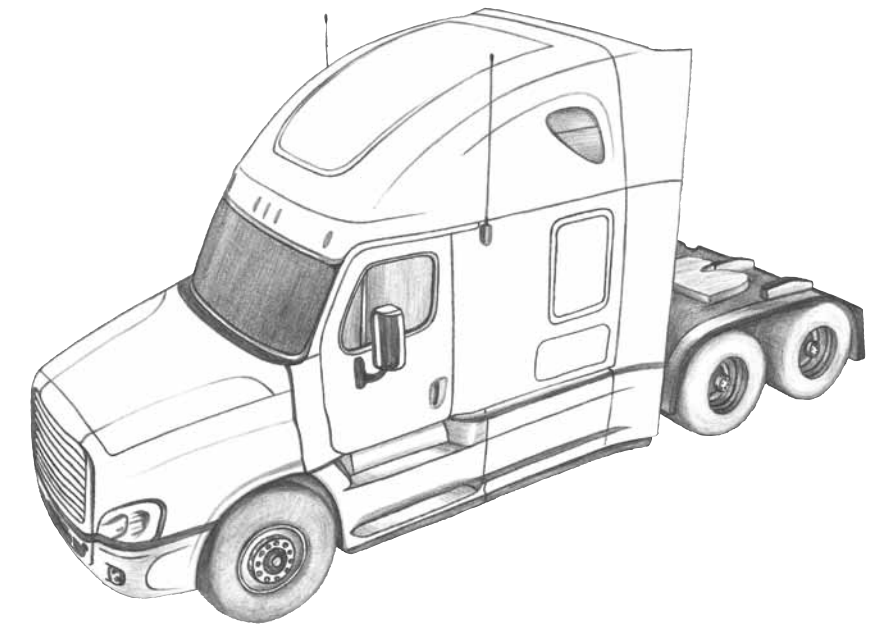
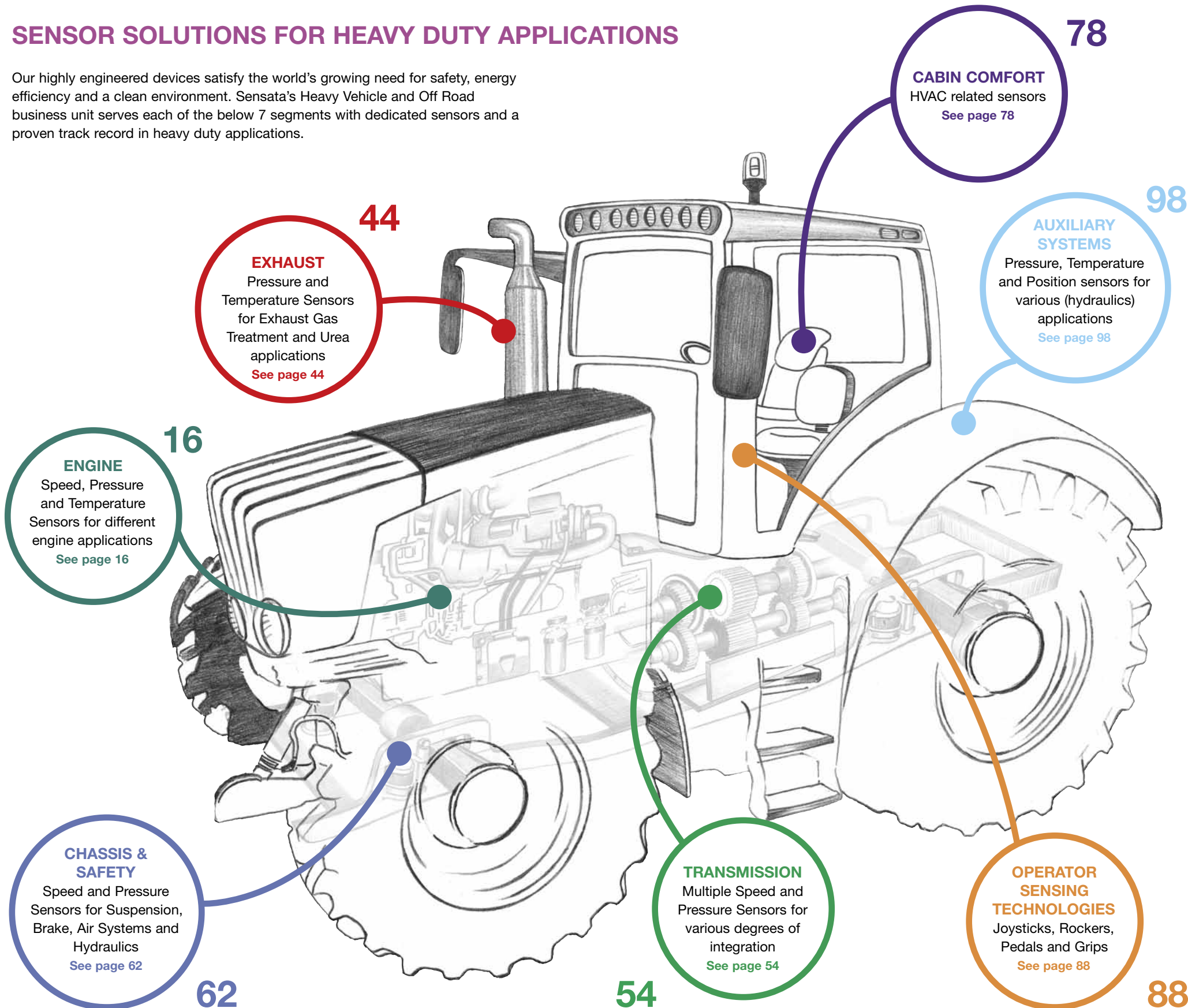


Foot Pedal



SENSOR SOLUTIONS FOR HEAVY DUTY APPLICATIONS

Our highly engineered devices satisfy the world's growing need for safety, energy efficiency and a clean environment. Sensata's Heavy Vehicle and Off Road business unit serves each of the below 7 segments with dedicated sensors and a proven track record in heavy duty applications.



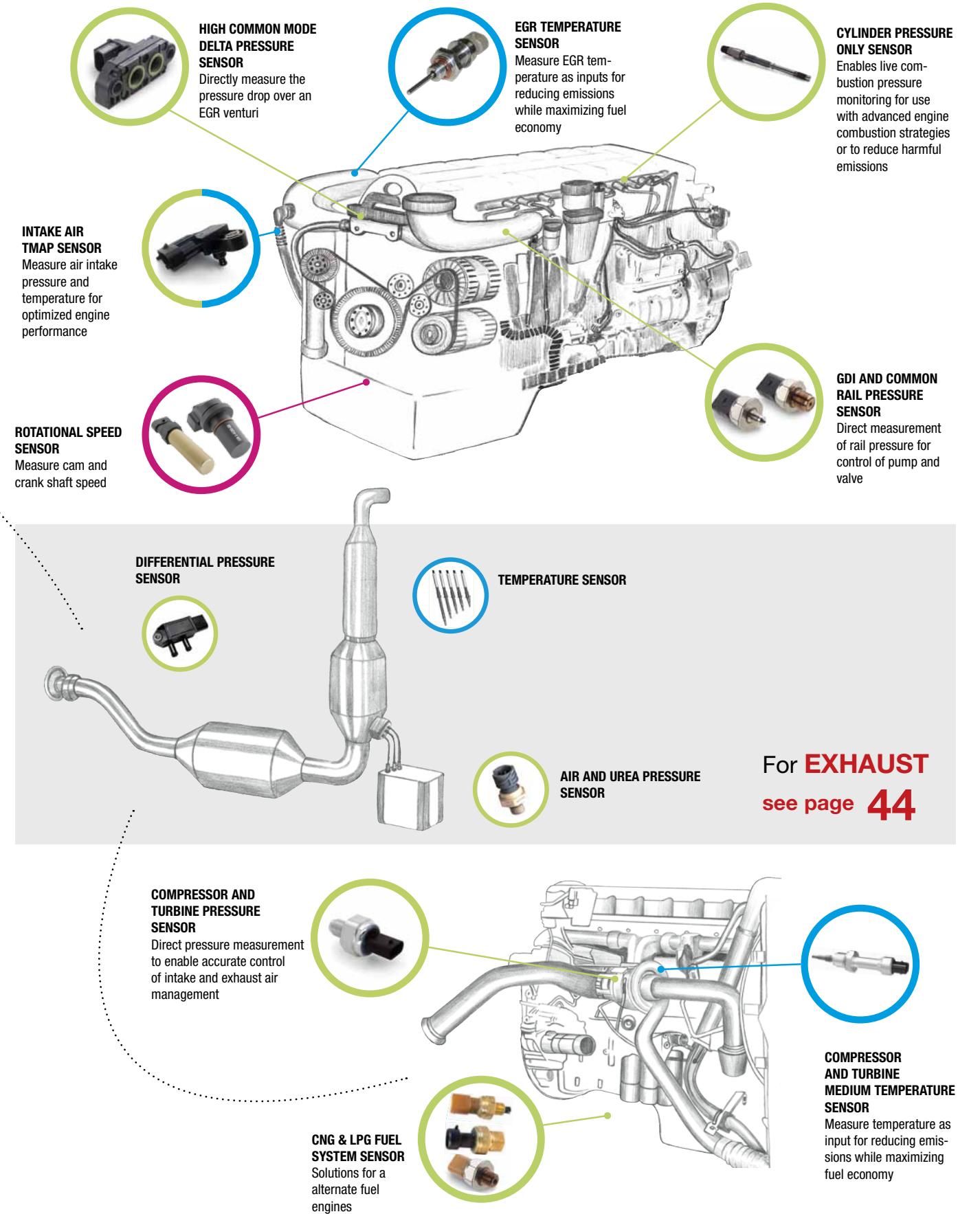
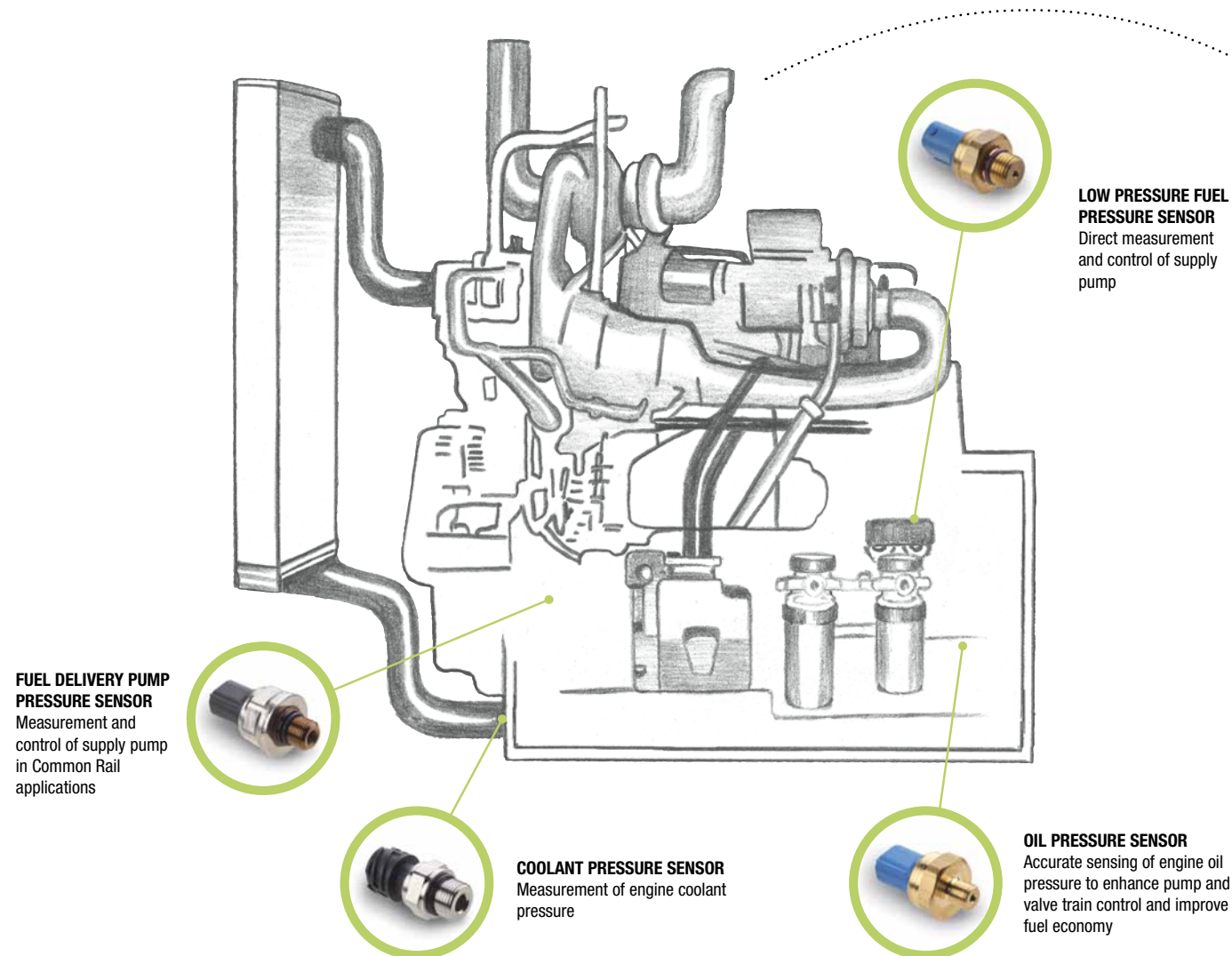
LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL

ENGINE SENSORS

In modern diesel engines electronics are key. With their help, systems can be controlled optimally under their operating conditions. Sensors measure and deliver the inputs needed for the electronic controls: physical parameters are measured, such as pressure, flow or gas temperature and converted into electronic signals. Sensata offers a range of sensors, specifically designed for use in powertrain applications.

Our portfolio consists of speed sensors, pressure sensors, combined pressure and temperature sensors and stand-alone temperature sensors.





INTAKE AIR TEMPERATURE MANIFOLD ABSOLUTE PRESSURE SENSOR

TMAP

Measures pressure and temperature of intake air for optimized engine performance.

BENEFITS

- Optimizes engine performance for emissions control, fuel economy and engine performance
- Allows for airflow measurement

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|---------------------------|------------------------------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 10 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Pressure Response Time | <10 ms |
| Temperature Response Time | <10 s (T_{63} with air v=6 m/s) |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 VdC |
| EMC (10 MHz-1GHz) | >50 V/m Class A |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|--------------------|---------------------|
| Pressure Range | 50-400kPa abs. |
| Proof Pressure | 600 kPa |
| Temperature range | -40 to +130°C |
| Minimum Cycle Life | >2M Pressure Cycles |
| Vibration | >15g sine |

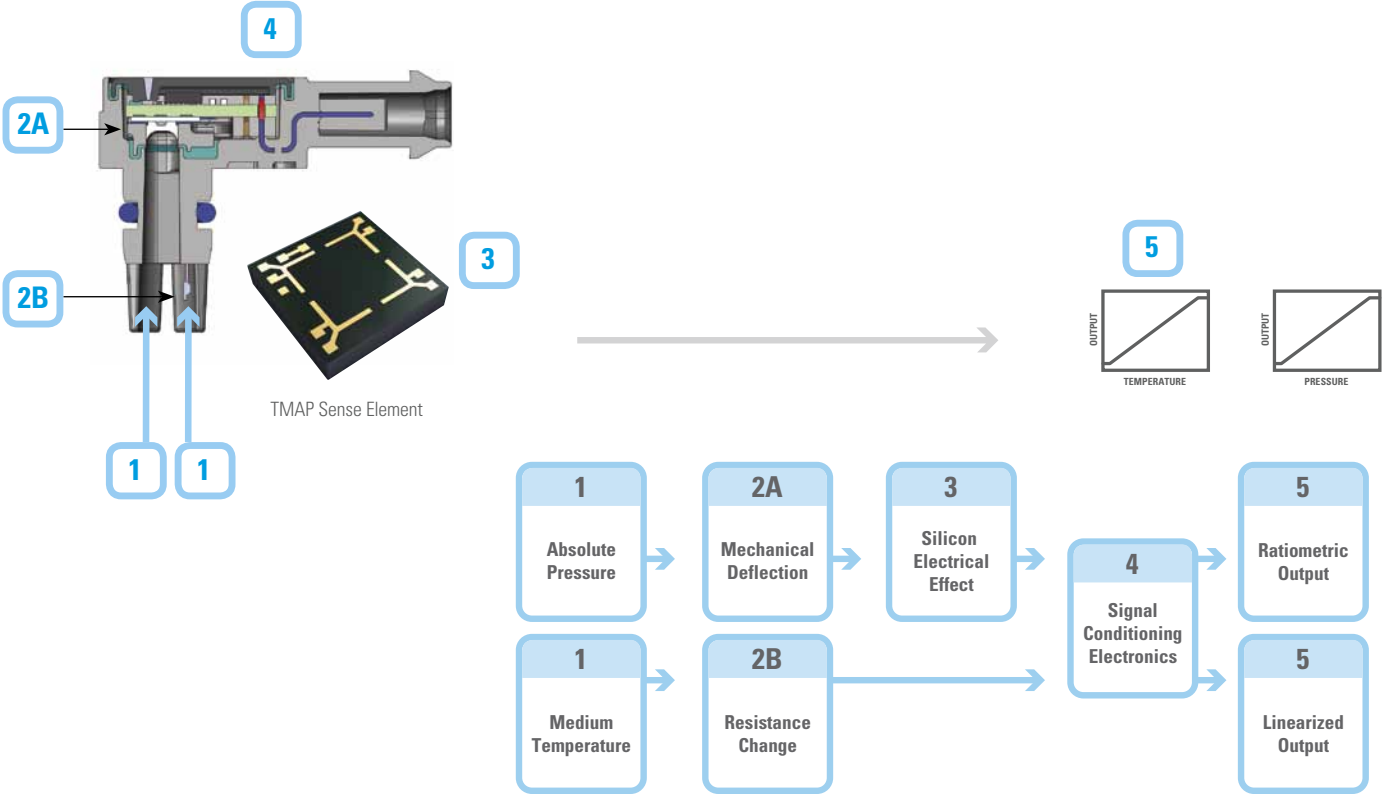
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +130°C |
| Storage Temp | -40 to +130°C |

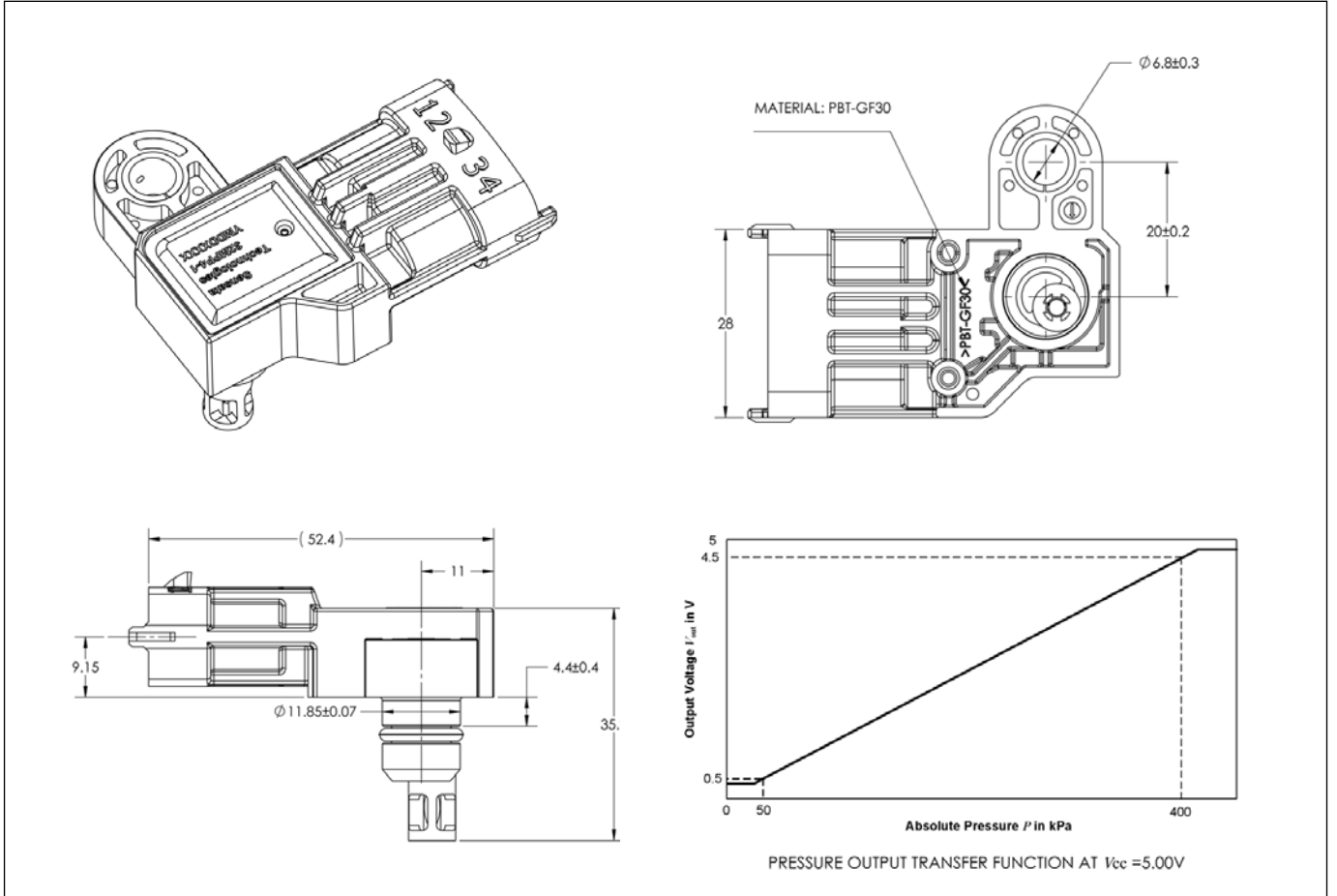
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 1.2% FS |
| -40 to +130°C | \pm 2.0% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE

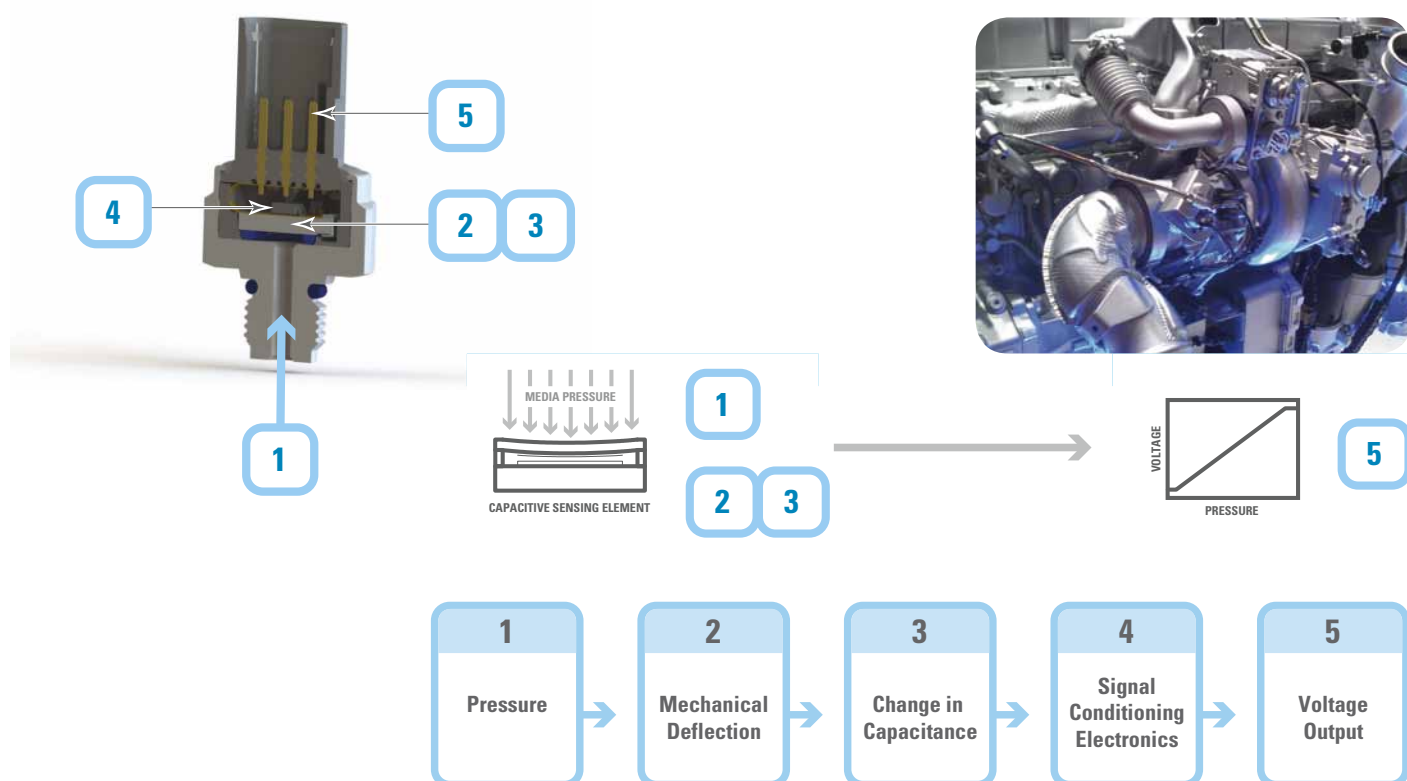


APT

BENEFITS

- Robust design
- Suitable for the hot, humid and possibly soot containing application environment
- Specialized design to prevent fluid induced shifts

HOW IT WORKS



TYPICAL SPECIFICATIONS

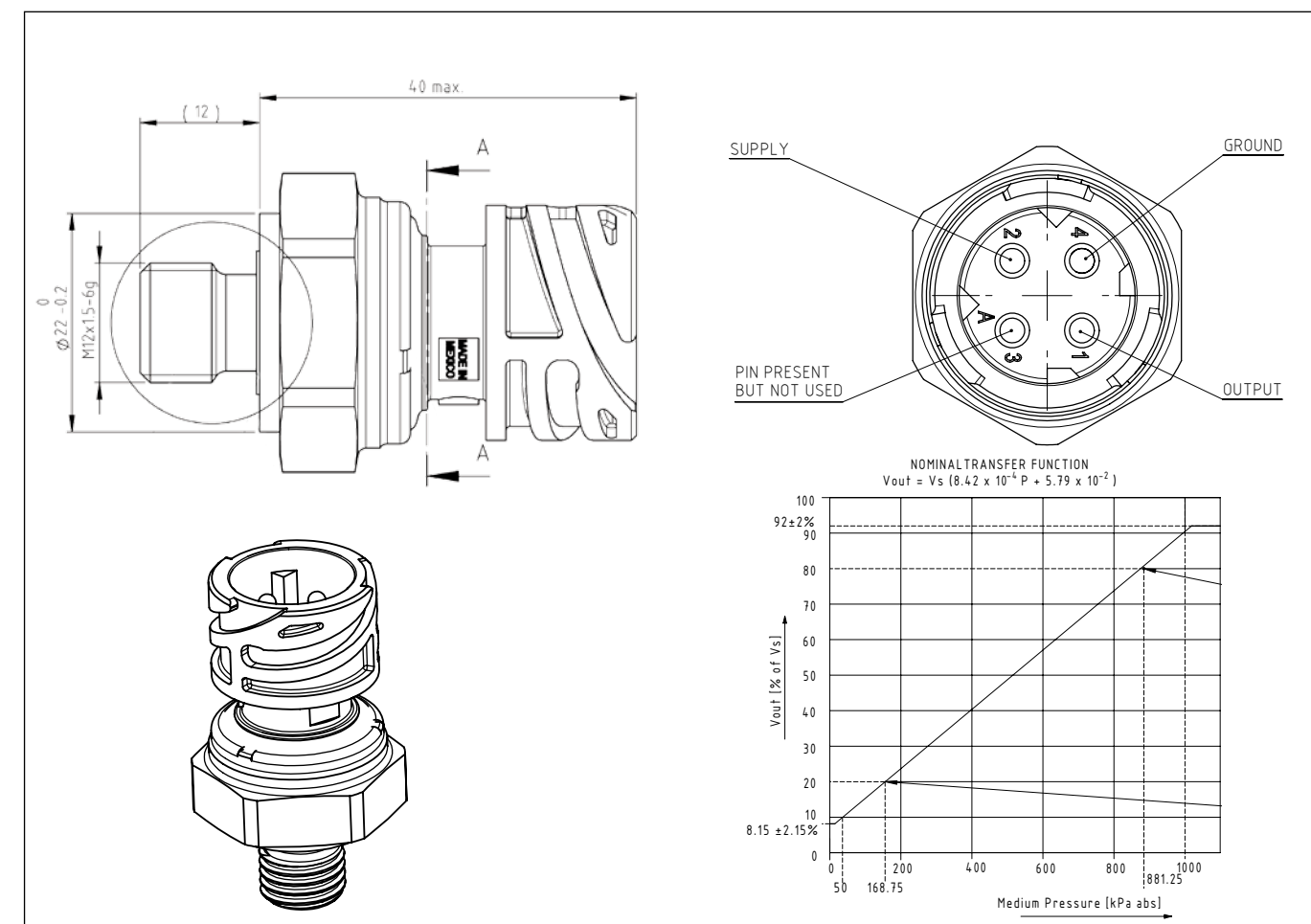
| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >50 V/m |

| | |
|-----------------------------|---------------|
| Operating Pressure | up to 10bar |
| Proof Pressure | >2x FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12g |

| | |
|-----------------------|---------------|
| Operating Temperature | -40 to +145°C |
| Peak Temperature | -40 to +150°C |

| | |
|---------------|-----------|
| 0 to +100°C | ± 1.5% FS |
| -40 to +145°C | ± 2.5% FS |

DIMENSIONAL DRAWINGS & TRANSFER CURVE





LOW PRESSURE FUEL PRESSURE SENSOR

APT

Allows direct measurement and control of supply pump. Measure the fuel back pressure on the fuel filter to determine filter service interval.

BENEFITS

- Robust against specific fuels due to sealed package
- Accurate pressure measurement

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 VdC |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|----------------------------------|
| Operating Pressure | 50 -300kPa, variants up to 20bar |
| Proof Pressure | >2x FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

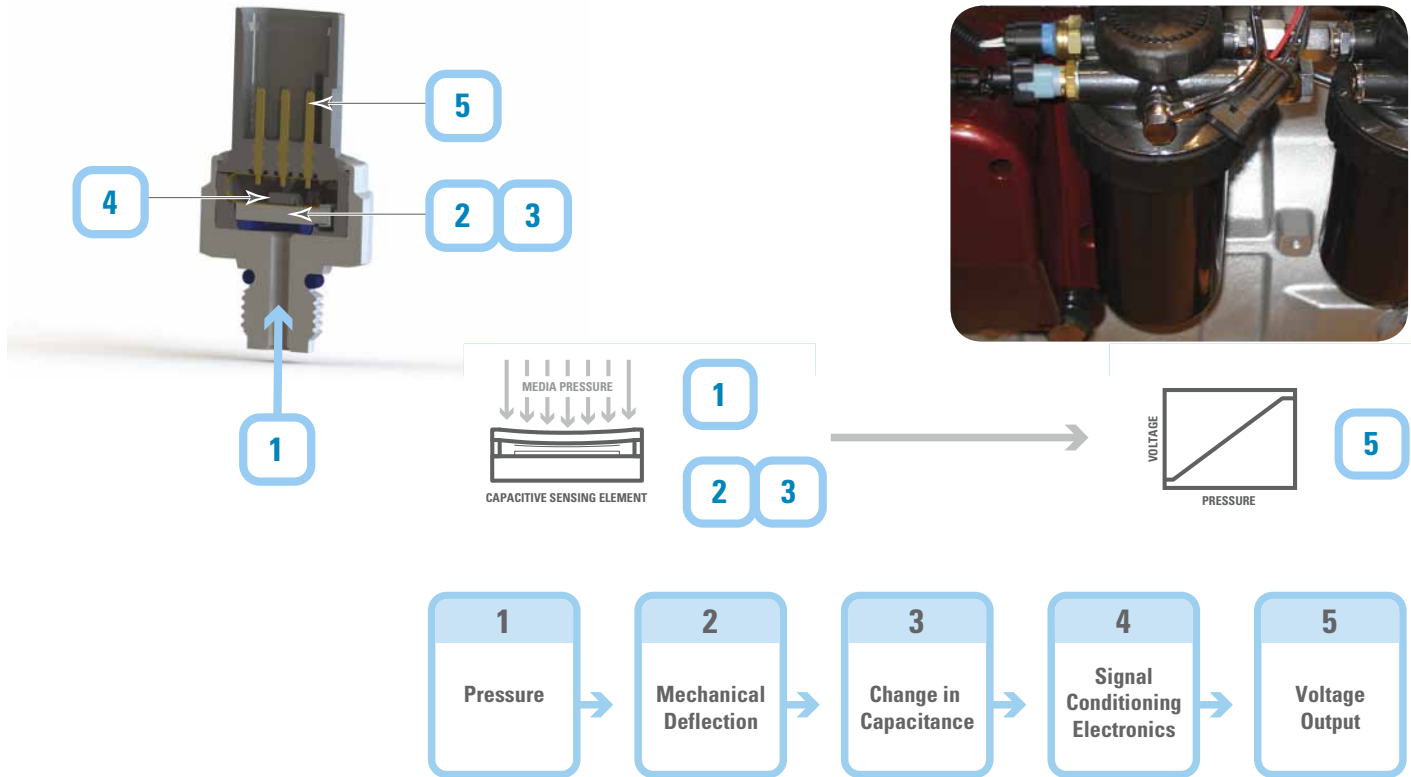
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

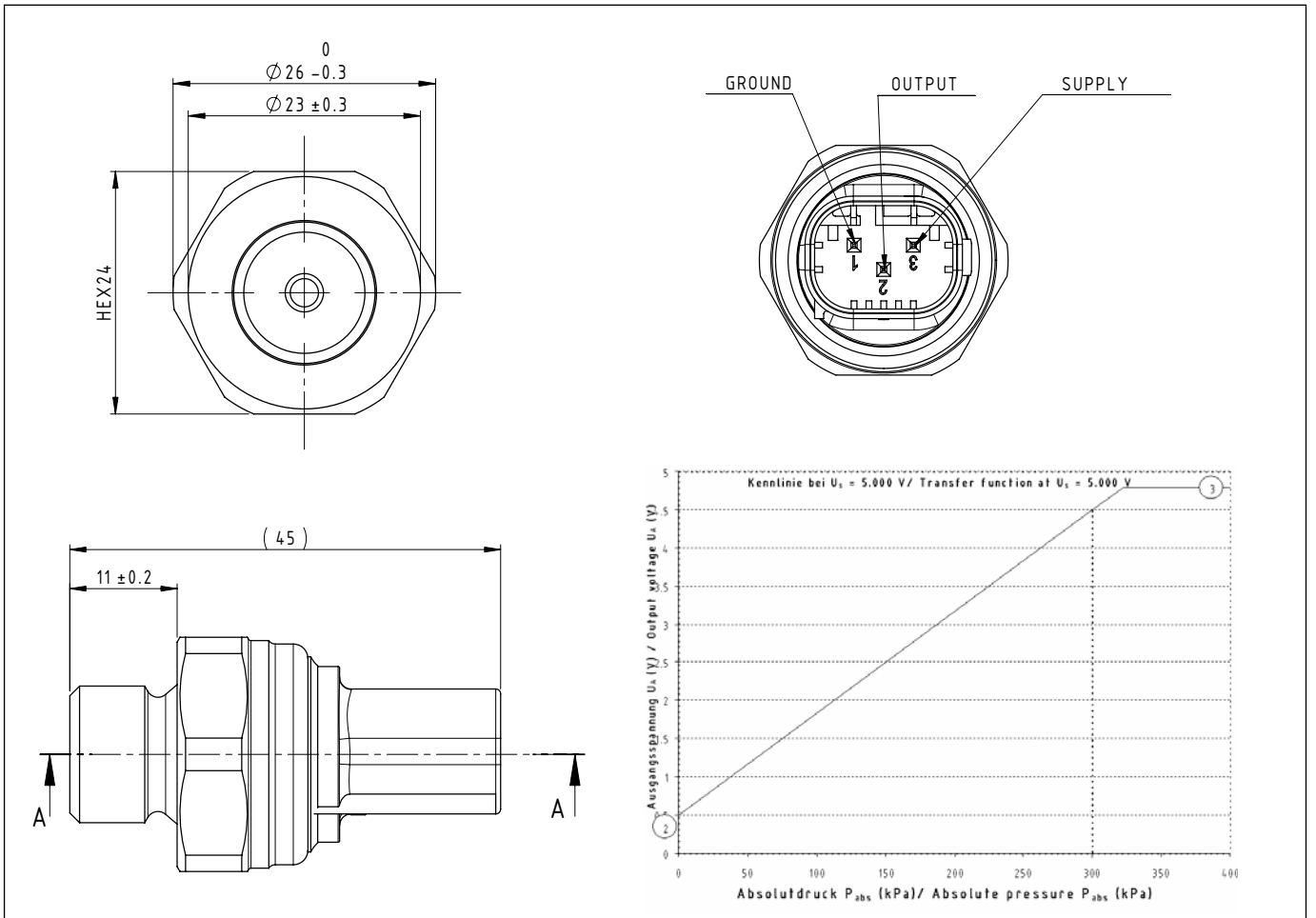
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +135°C | \pm 3.0% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





FUEL DELIVERY PUMP PRESSURE SENSOR MSG

Allows direct measurement and control of supply pump used in Common Rail applications.

BENEFITS

- Hermetic design
- Robust and simple solution for aggressive media
- UN ECE certified for LPG (R67) and CNG (R110)
- State-of-the-art signal processing with self-diagnostics and high accuracy

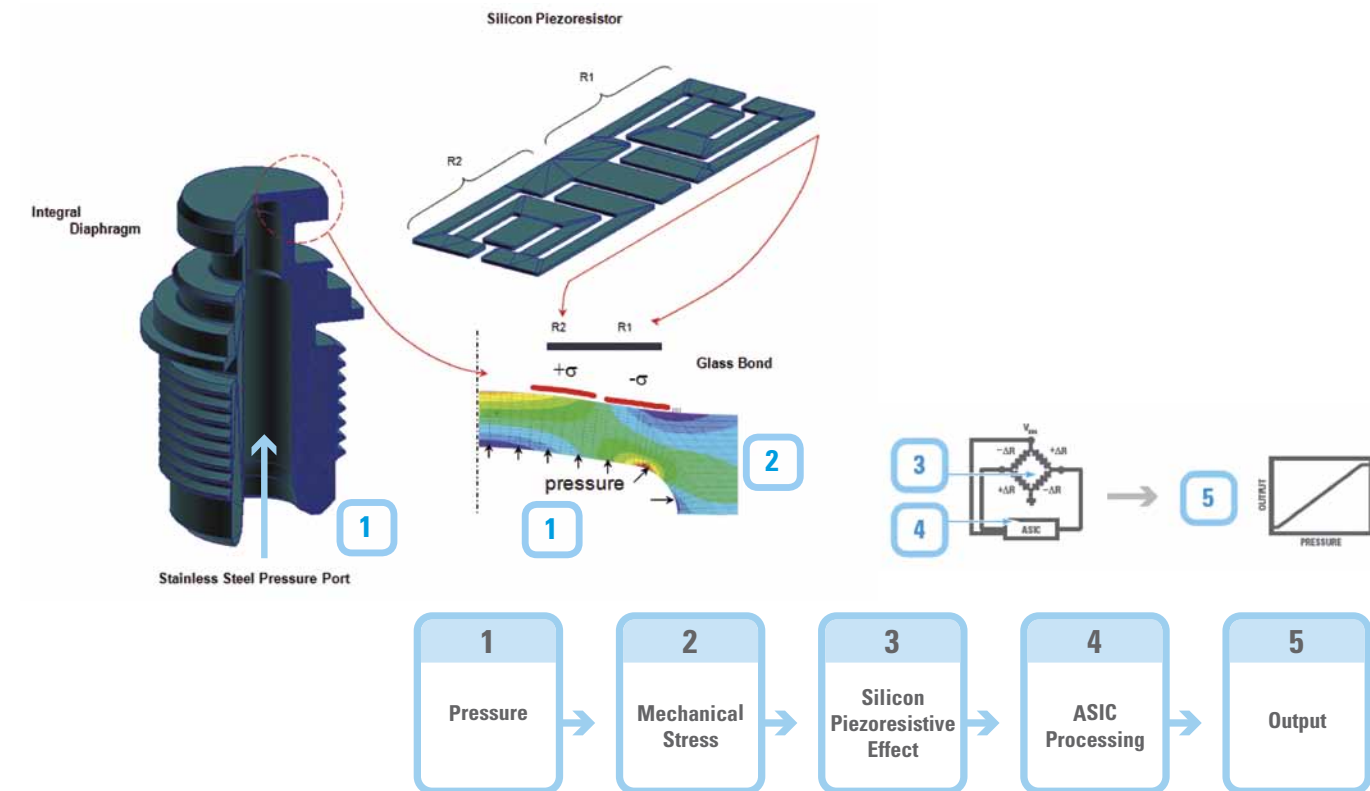
TYPICAL SPECIFICATIONS

| ELECTRICAL | | PHYSICAL | |
|-------------------------|-----------------|------------------------|--------------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% | Operating Pressure | 0-100 bar relative |
| Supply Current | 15 mA max | Proof Pressure | 1.1 x FS |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vdc | Burst Pressure | 1.8 x FS |
| Response Time | 2 ms max | Minimum Cycle Life | >10M FS Cycles |
| Overvoltage Protection | 16 Vdc | Vibration (50-2000 Hz) | up to 40g sine |
| Reverse Voltage Protect | 14 Vdc | | |
| EMC (1 MHz-4GHz) | >100 V/m | ENVIRONMENTAL | |
| ESD (ISO 10605) | >8 kV | Operating Temp | -40 to +140°C |
| | | Storage Temp | -40 to +145°C |

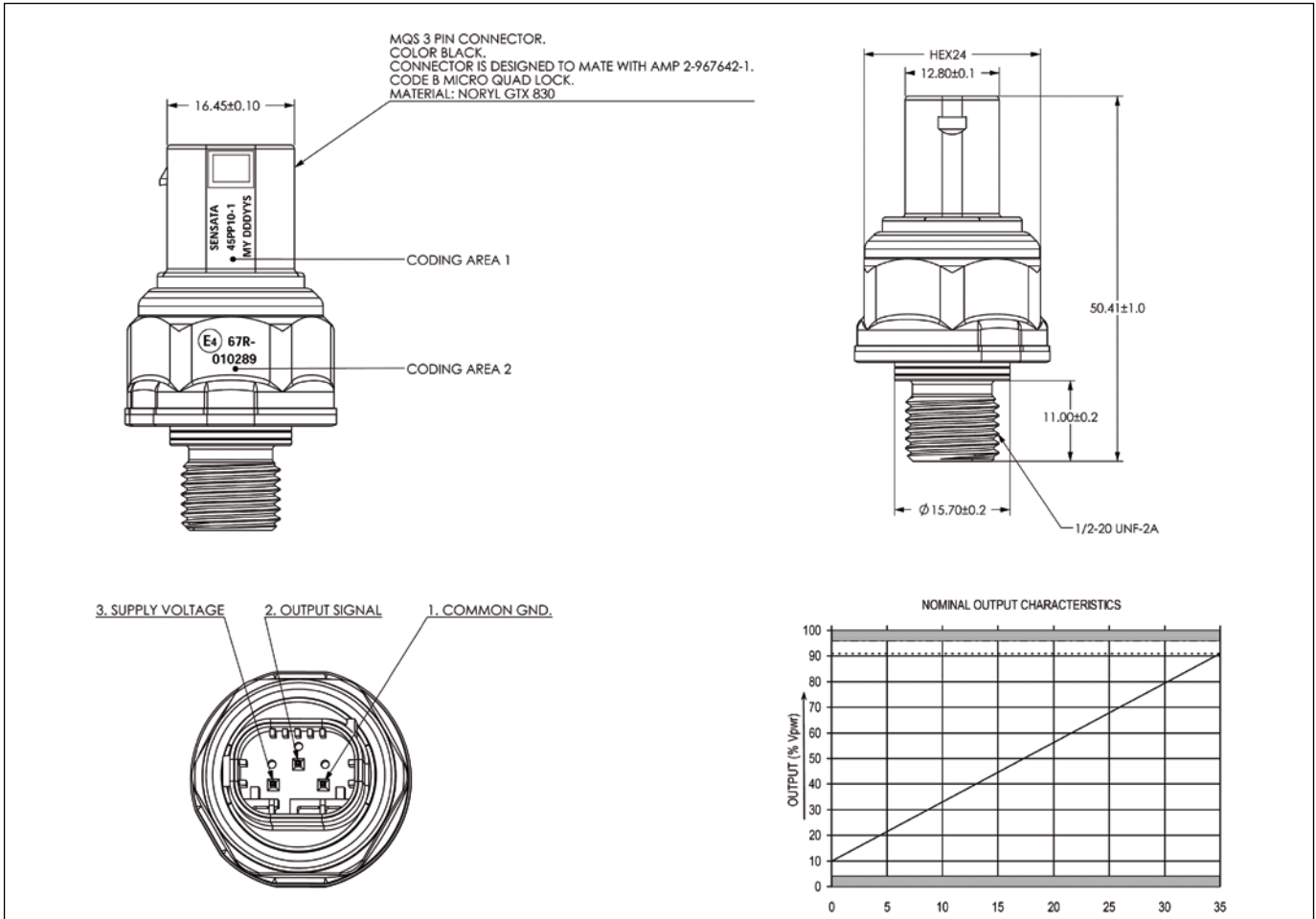
PERFORMANCE - AFTER LIFE ACCURACY (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2% FS |
| -40 to +140°C | \pm 2.5% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





GDI AND COMMON RAIL PRESSURE SENSORS MSG

Accurate fuel rail pressure sensing is crucial for fuel system management, fuel economy, emissions and OBDII.

BENEFITS

- Accurate and robust
- Allows fast and direct measurement of rail pressure for control of pump, valve and determining injected fuel pressure
- Adaptable for different pressures

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|---------------|
| Supply Voltage (Vs) | 5 V \pm 10% |
| Supply Current | 15 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Response Time | 20 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-4GHz) | >100 V/m |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|------------------------|-------------------------------|
| Operating Pressure | 0-35 bar to 3500 bar relative |
| Proof Pressure | 1.1 x FS min |
| Burst Pressure | 1.8 x FS min |
| Minimum Cycle Life | >10M FS Cycles |
| Vibration (50-2000 Hz) | up to 60g sine |

ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +140°C |
| Storage Temp | -40 to +145°C |

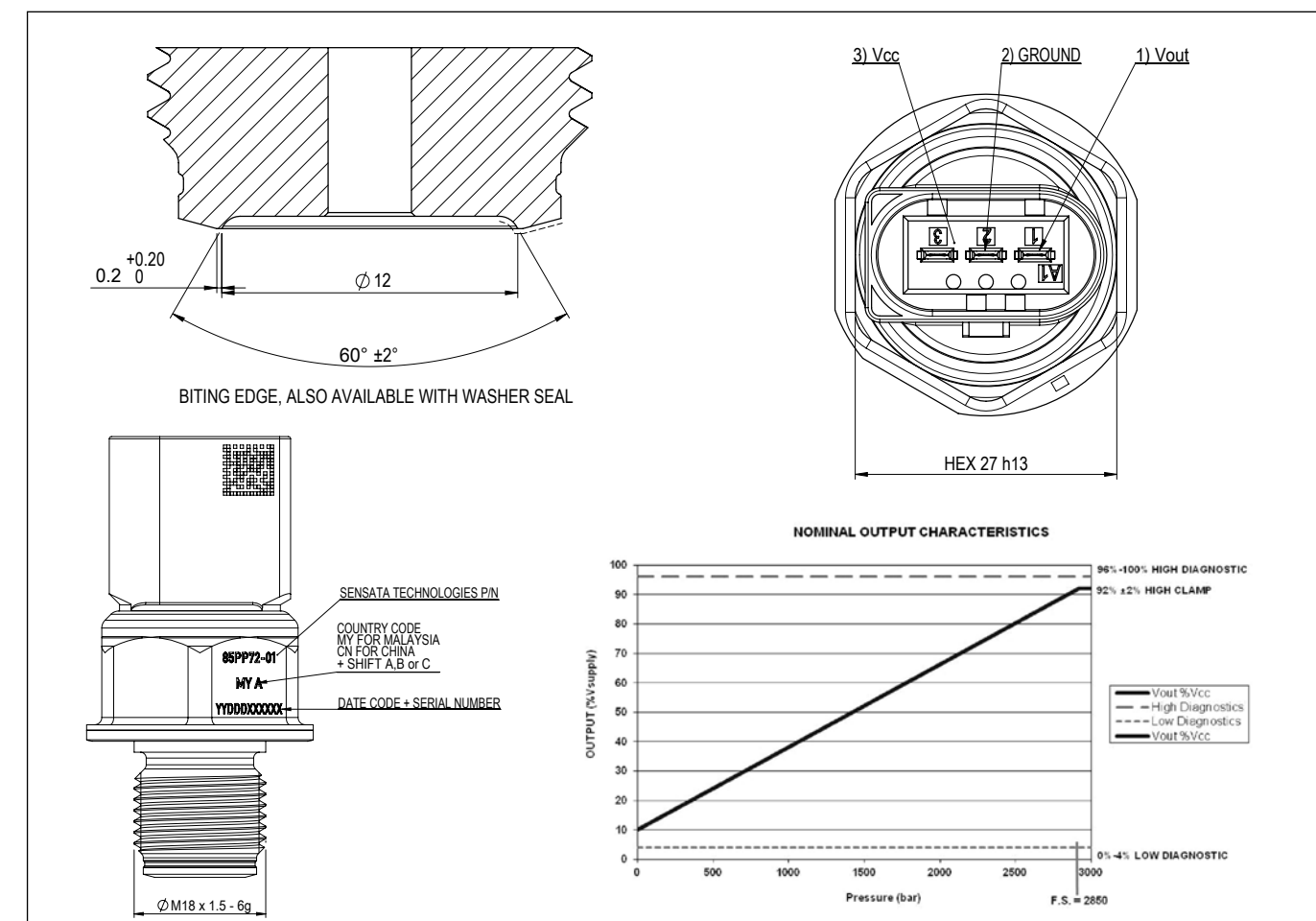
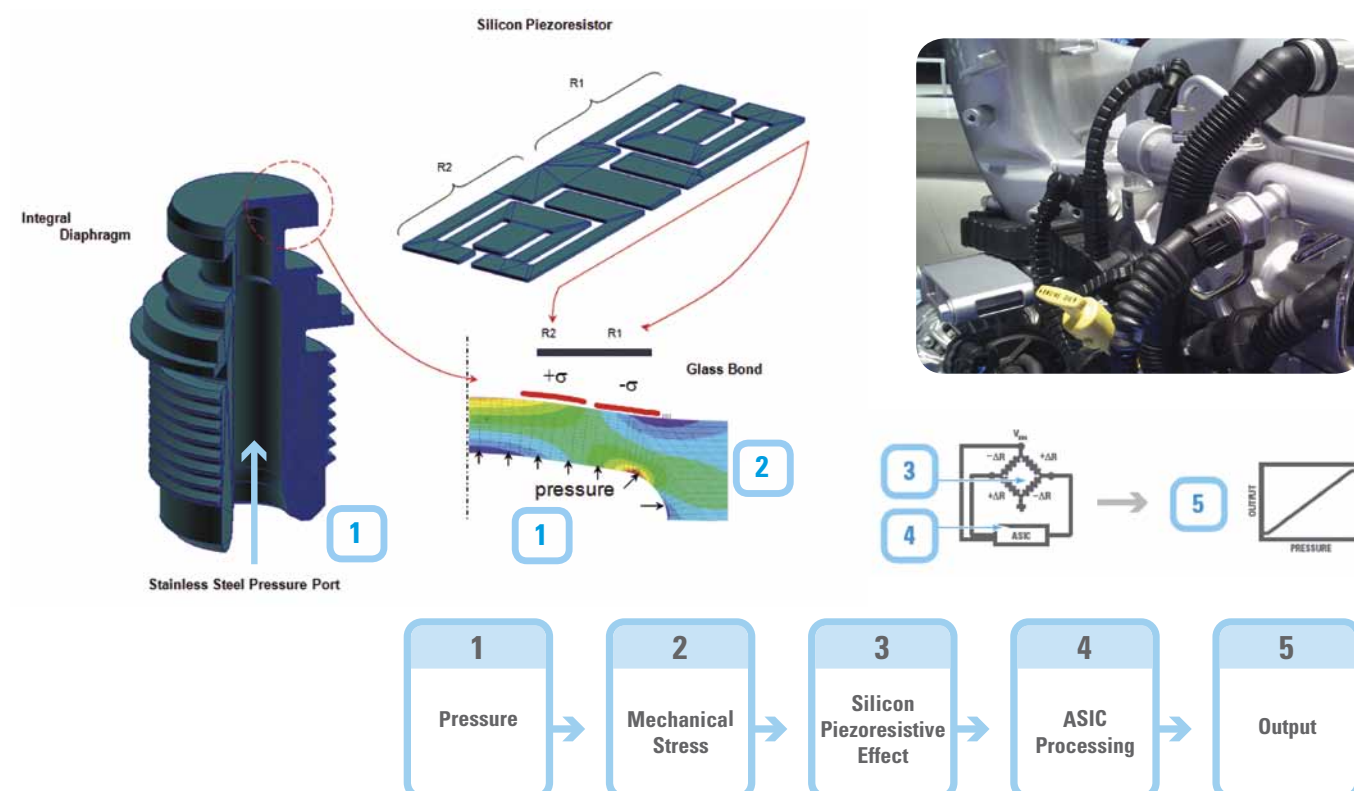
PERFORMANCE - AFTER ACCURACY

(See page 110 for explanation)

| | |
|---------------|----------------------|
| 0 to +100°C | \pm 1.1 to 1.5% FS |
| -40 to +140°C | \pm 2.5% FS |

DIMENSIONAL DRAWINGS & TRANSFER CURVE

HOW IT WORKS





ROTATIONAL SPEED SENSOR GPSS / GTSS

Designed for rugged, reliable speed sensing requirements where durability and dependability are required, its proven, field tested design conforms to SAE standards, while offering customers flexibility in variations and features.

BENEFITS

- Proven robust design
- Dependable performance
- Single and dual outputs available

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|---|---|
| Resistance for single output | 1600 ohm \pm 10% |
| Resistance for dual output | Coil A-B: 1600 ohm \pm 10%; Coil C-D: 2200 ohm \pm 10% |
| Inductance for single output (1000 Hz 3" leads) | 1.17 \pm 0.10mh @ 1000 Hz |
| Inductance for dual output (1000 Hz 3" leads) | Coil A-B: 1.17 \pm 0.10mh @ 1000 Hz; Coil C-D: 1.21 \pm 0.10mh @ 1000 Hz |

All measurements made at free ambient air at +25° (\pm 5°)A - B = Inner Coil; C - D = External Coil

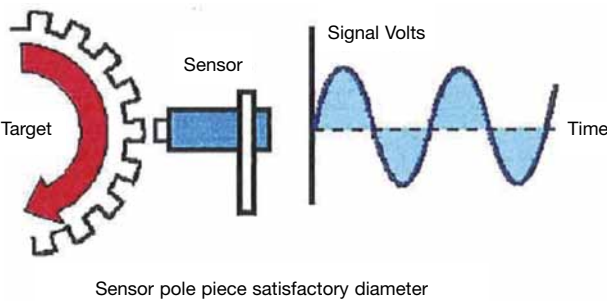
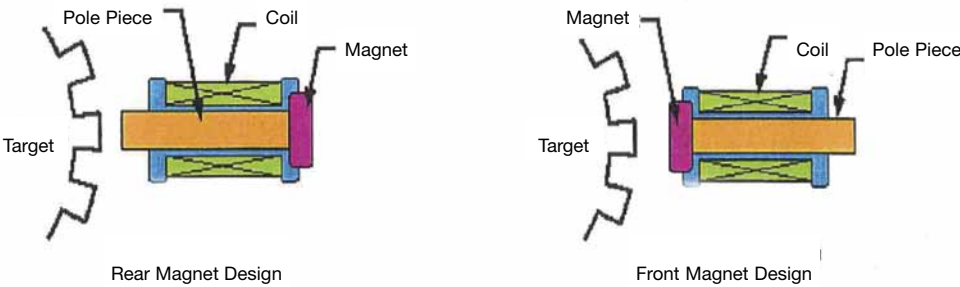
OUTPUT

Standard 4" diameter tone wheel (single tooth) is used for testing. Measurements are done with a 10K-ohm load in parallel with a 470pf capacitor across the coil. Actual result will vary based on target wheel, tooth configuration, controller impedance, etc.

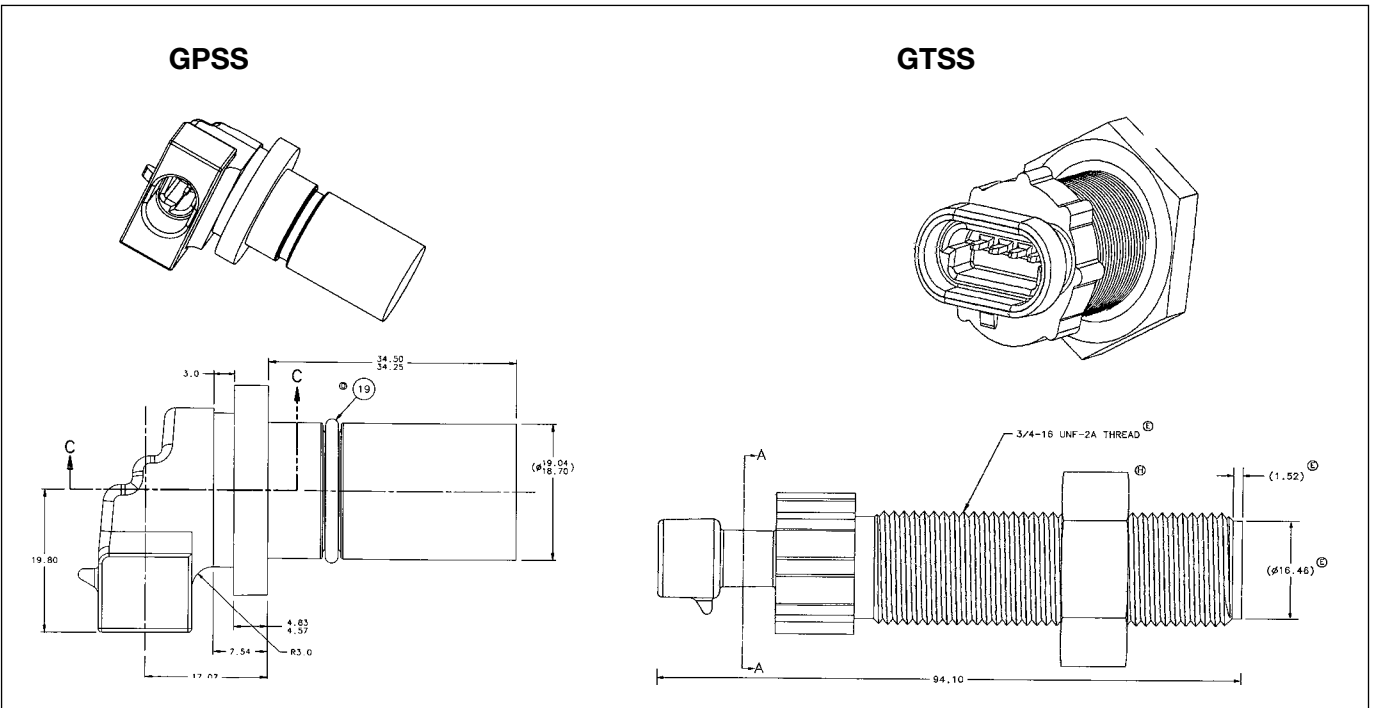
Coil output Specifications (Minimum: P-P volts)

| | 143 RPM | | 3500 RPM | |
|----------------------------|------------------|------------------|------------------|------------------|
| | Air Gap = 0.50mm | Air Gap = 1.27mm | Air Gap = 0.50mm | Air Gap = 1.27mm |
| 1.27mm | | | | |
| Single output | 4,91 | 2,70 | 49,63 | 28,75 |
| Dual output, inner coil | 4,64 | 2,57 | 48,95 | 28,39 |
| Dual output, external coil | 4,82 | 2,63 | 48,93 | 28,03 |

HOW IT WORKS



DIMENSIONAL DRAWINGS





OIL PRESSURE SENSOR APT

Accurate sensing of engine oil pressure can enhance pump and valvetrain control and improve fuel economy.

BENEFITS

- Better control of variable flow pumps
- Expand use of VVT, VVL or Cylinder de-activation
- Detects low oil pressure
- Offers feedback for OBD system

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >100 V/m |

PHYSICAL

| | |
|-----------------------------|---------------|
| Operating Pressure | up to 11 bar |
| Proof Pressure | >2x FS |
| Burst Pressure | >3x FS |
| Minimum Pressyre Cycle Life | >2M FS cycles |
| Sine Vibration(50-2000 Hz) | >12 g |

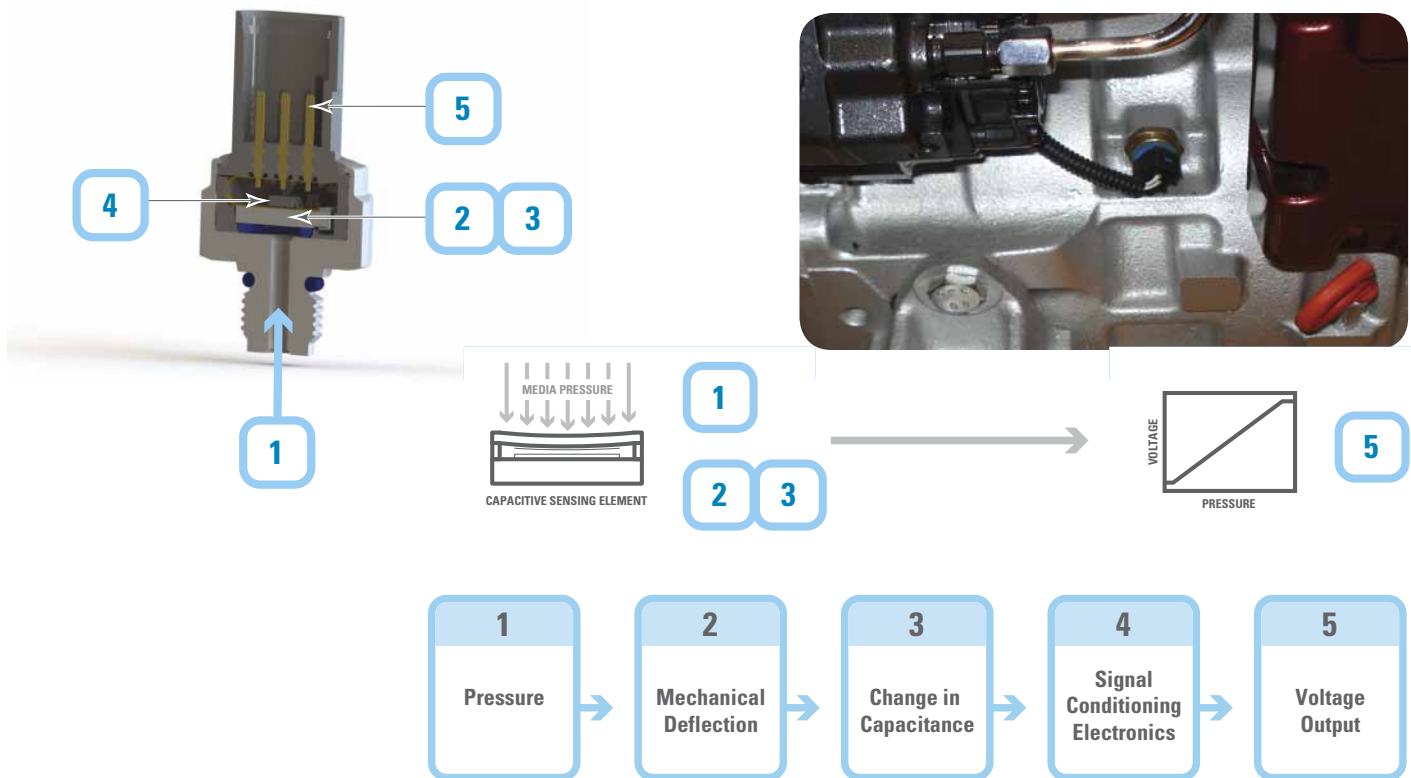
ENVIRONMENTAL

| | |
|-----------------------|---------------|
| Operating Temperature | -40 to +135°C |
| Peak Temperature | -40 to +145°C |

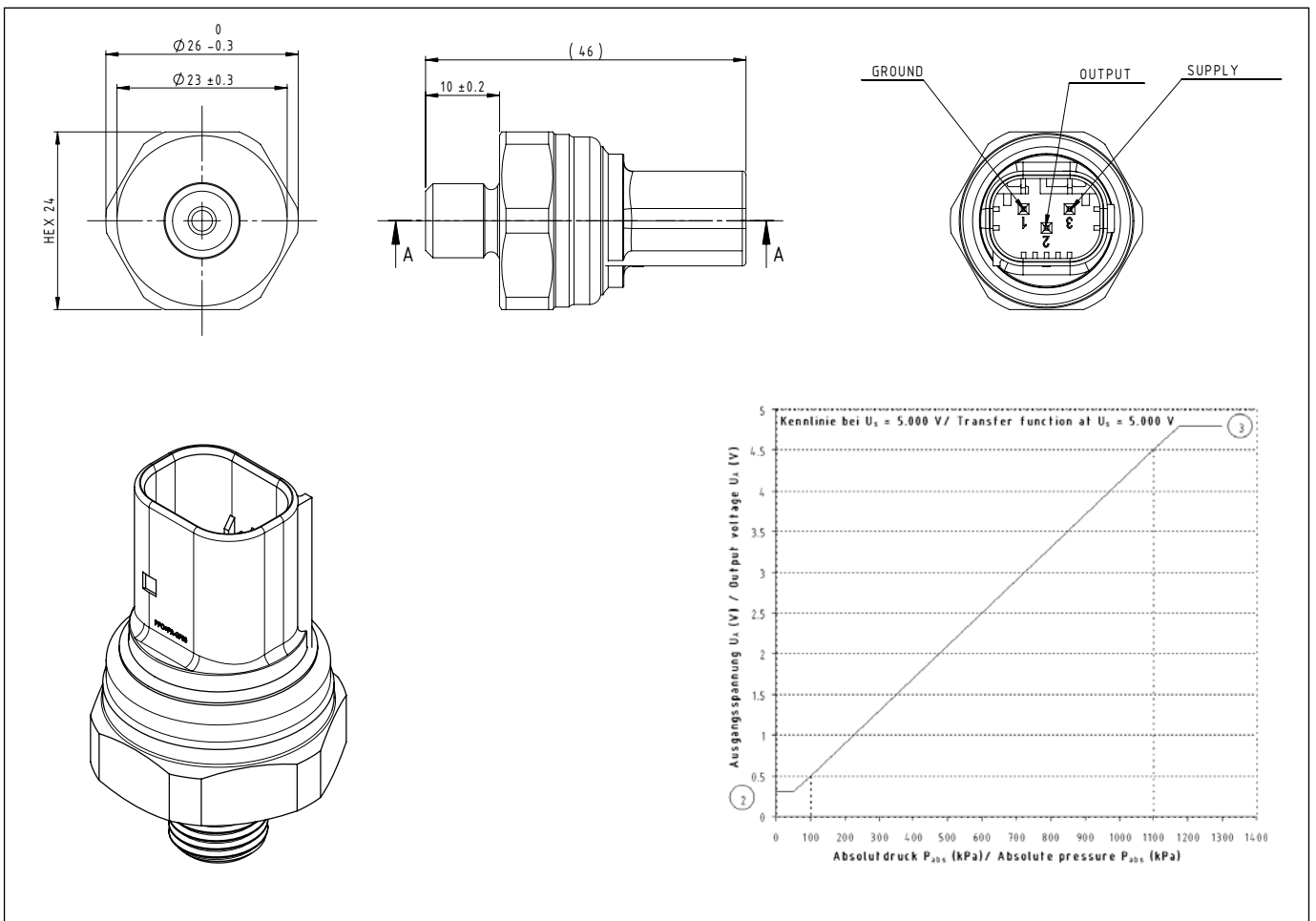
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





COOLANT PRESSURE SENSOR APT

Accurate sensing of coolant pressure.

BENEFITS

- Proven and reliable design
- Low risk, >30M sensors deployed since 2002
- Flexible, many port material and connector options available
- Suitable for marine applications

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|--------------------|
| Operating Pressure | up to 3 bar |
| Proof Pressure | >2x FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Random Vibration | >11 g (50-2000 Hz) |

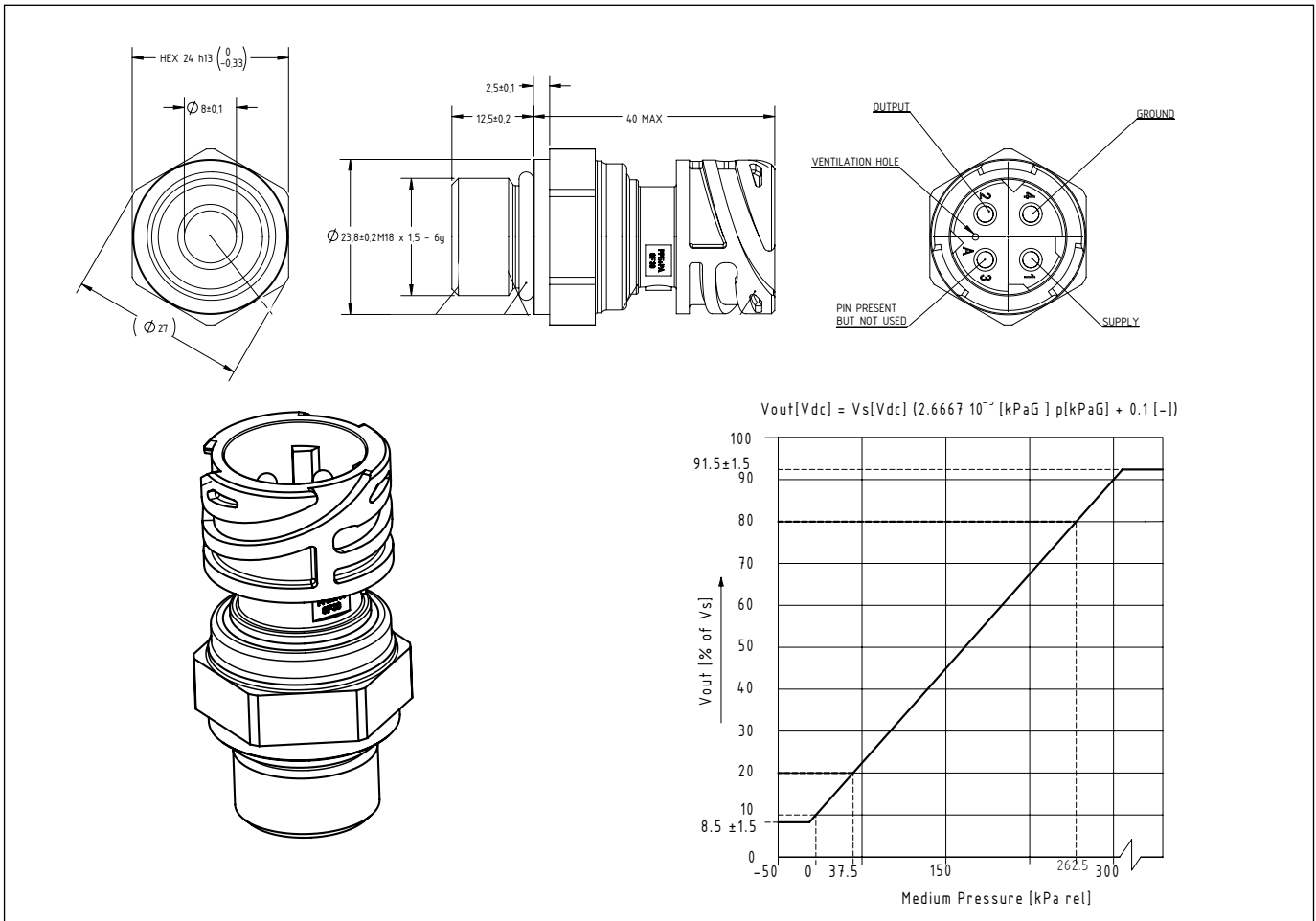
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 3.0% Span |
| -40 to +135°C | \pm 4.0% Span |

DIMENSIONAL DRAWINGS & TRANSFER CURVE

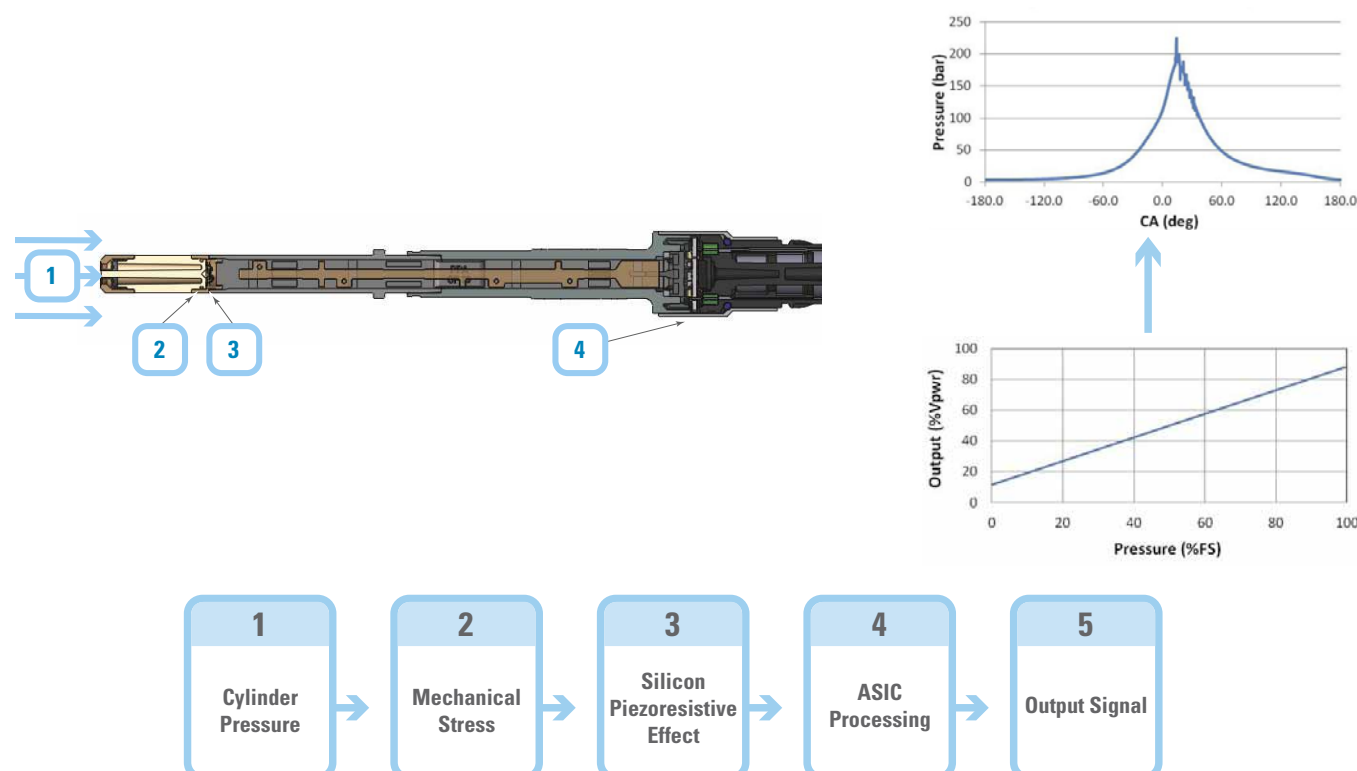


BENEFITS

- Enables closed loop engine combustion
- Reduced emissions of CO₂, NO_x and soot
- Improved fuel economy
- Reduced engine cost through power and size optimization
- Realtime monitoring and engine diagnostics

Sensata's CPoS enables closed loop control of engine combustion, developed to support regulations requiring drastic reduction of greenhouse gas and particulate emissions for gas and diesel vehicles.

HOW IT WORKS



TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|----------------------------|-------------------------------------|
| Supply Voltage | 5.0 ± 5% VDC (customer specific) |
| Supply Current | Max 10mA |
| Load Resistor | 4.7kOhm pull up |
| Nominal Output Voltage | 11.5%Vs to 91.5%Vs |
| Output Noise RMS | < 0.2% of Vs |
| Overvoltage Protection | 24V |
| Reverse Voltage Protection | -13.5V |
| Signal Resolution | <50m bar (analog) |
| Bandwidth | 15kHz |

PHYSICAL

| | |
|--------------------------------|----------------|
| Proof Pressure | 250 bar |
| Burst Pressure | 300 bar |
| Response Time For Signal Delay | < 200 us total |

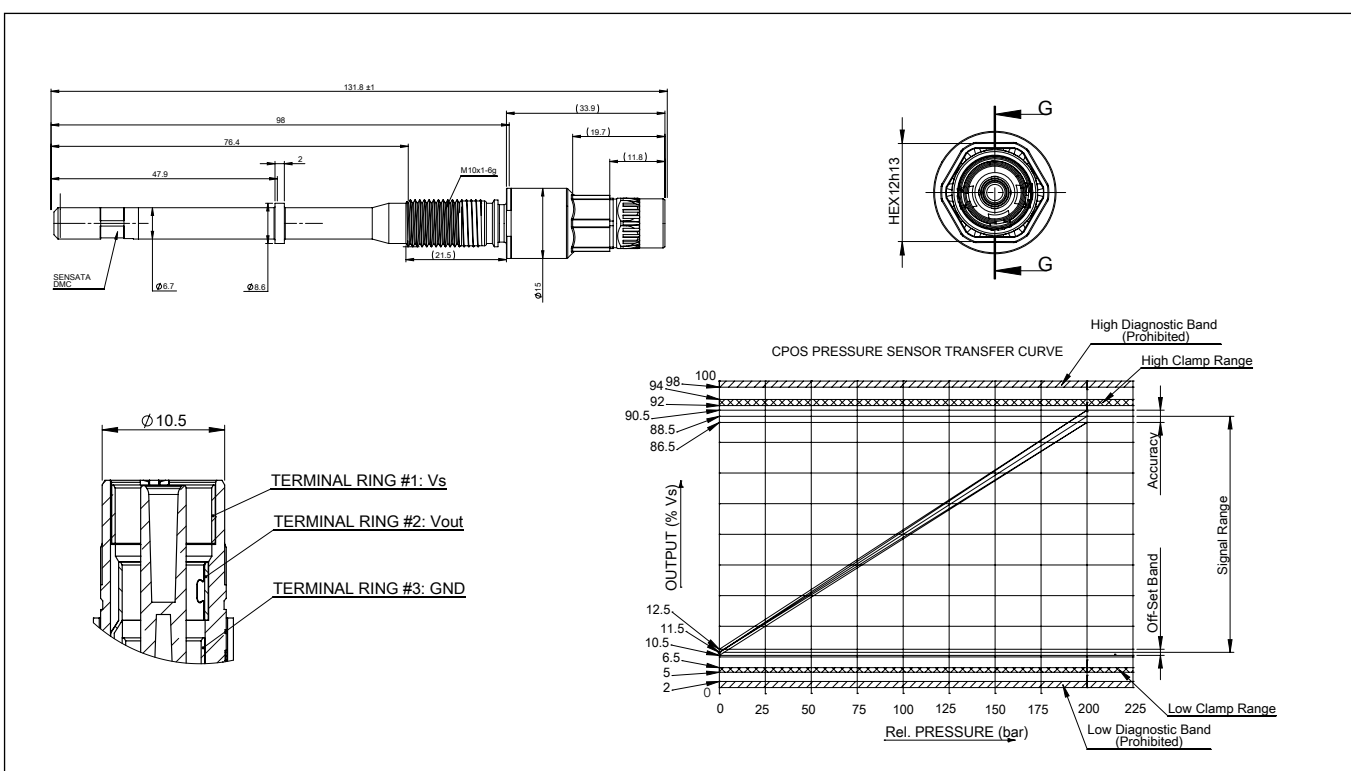
ENVIRONMENTAL

| | |
|-----------------------|--------------------------------------|
| Operating Temperature | -40°C to +140°C (tip up to 300°C) |
| Operating Pressure | 0 to 150 / 250 bar |

PERFORMANCE - ACCURACY AFTER LIFE

| | |
|------------------|--|
| Stable Output | ± 2% after lifetime |
| Gain Accuracy | ± 2% of Vs after life |
| Non linearity | <± 1% of Vs after life |
| Hysteresis | <± 1% of Vs after life |
| Offset Variation | ± 1% of Vs after life |
| Accuracy | 0-5 bar low pressure: ± 0.4% of Vs (10°C to +140°C) ± 0.6% of Vs (-40°C to +10°C) |

DIMENSIONAL DRAWINGS & TRANSFER CURVE





HIGH COMMON MODE DELTA PRESSURE SENSOR HCM

High Common Mode delta pressure sensor allows customer to measure the pressure drop across an EGR Venturi. The HCM is specially designed to withstand the harsh conditions of the Exhaust Gas Recirculation (EGR) stream.

BENEFITS

- Used in combination with APT and Temperature sensor to calculate EGR mass flow
- Durable
- HCM enables control of the EGR valve

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-------------------------|
| Supply Voltage (Vs) | 5 V \pm 10% |
| Supply Current | 15 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Response Time | 80-140 ms or 0.5-5.5 ms |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-2 GHz) | >50V/m Class A |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|-----------------------------|------------------------|
| Differential Pressure Range | 0-35 kPa (or 0-100kPa) |
| Differential Proof Pressure | 100 kPa |
| Differential Burst Pressure | 150 kPa |
| Common Mode Pressure Range | 70 to 600kPa abs. |
| Common Mode Proof Pressure | 1000kPa abs. |
| Common Mode Burst Pressure | 1500kPa abs. |
| Minimum Cycle Life | >2M Pressure Cycles |
| Vibration (100-450 Hz) | 15-25g sine |

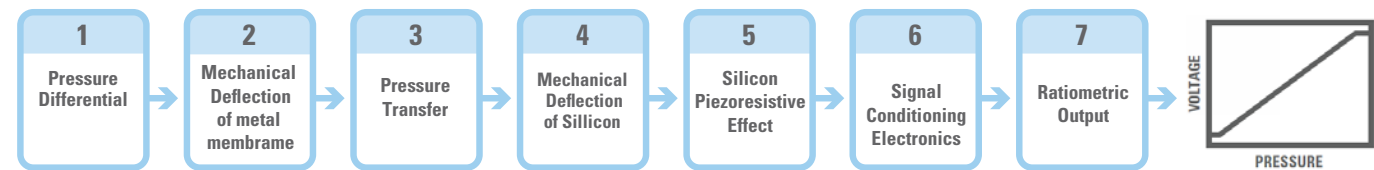
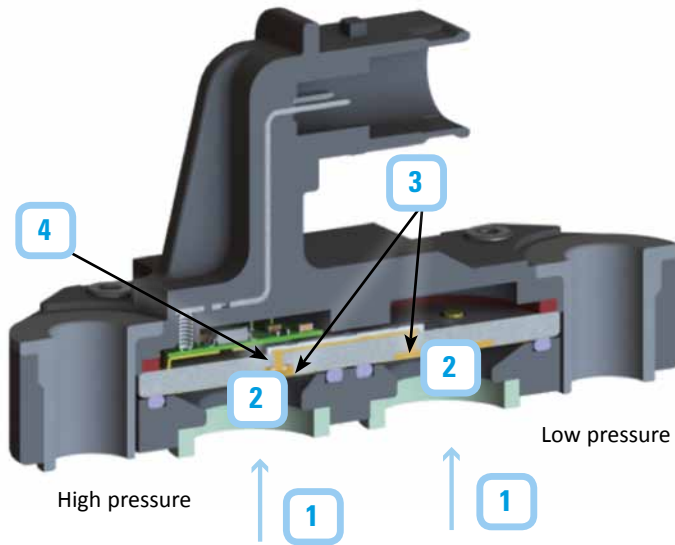
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +125°C |
| Storage Temp | 0 to +130°C |

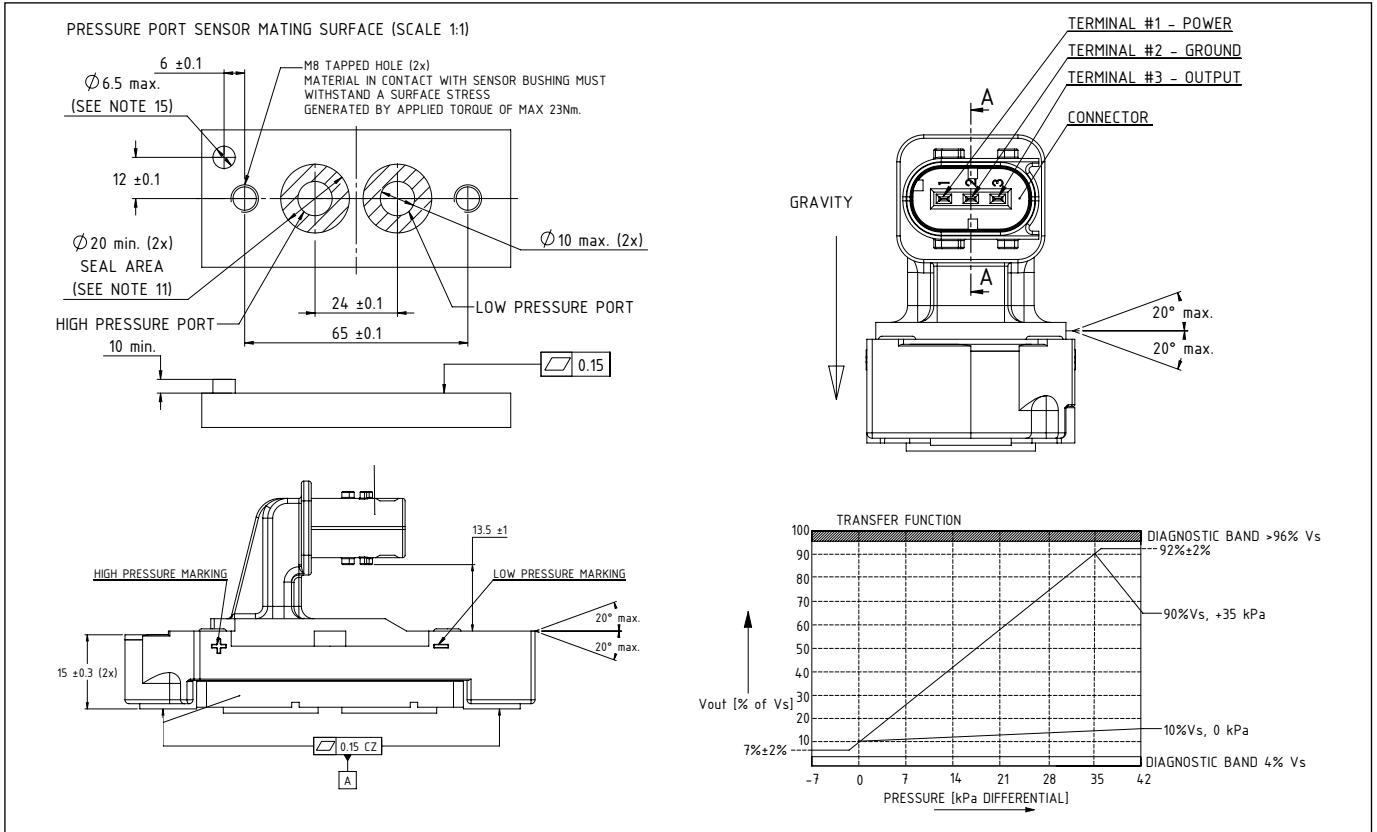
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +130°C | \pm 2.5% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





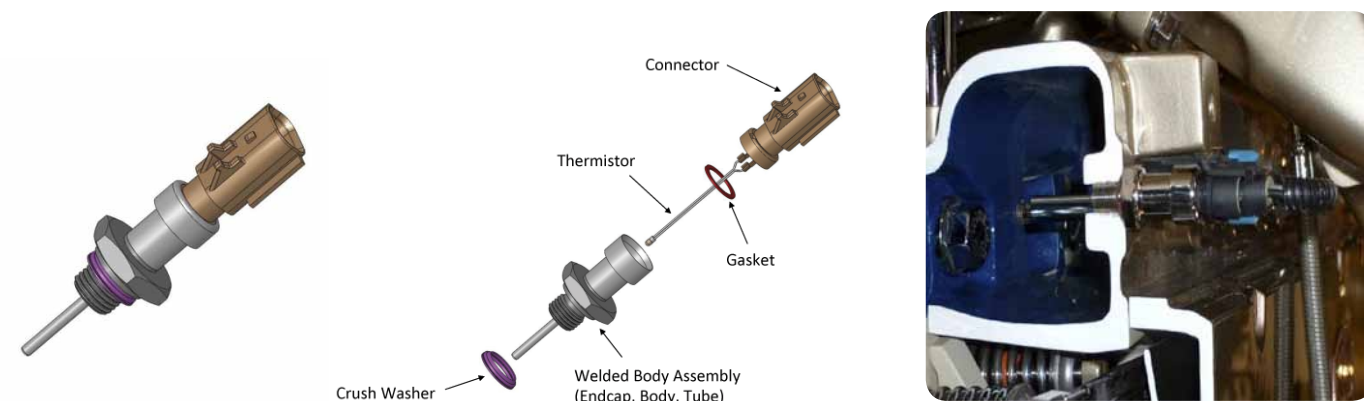
TEMPERATURE SENSOR 5024 EGR SERIES

5024 EGR temperature sensors provide up to 300°C temperature sensing capability in fast response stainless steel packages.

BENEFITS

- High temperature sensing NTC thermistor technology
- Fast response stainless steel packages in various thread sizes
- Lead wire or integral connector terminal options
- Available in 150°C or 300°C constructions

HOW IT WORKS

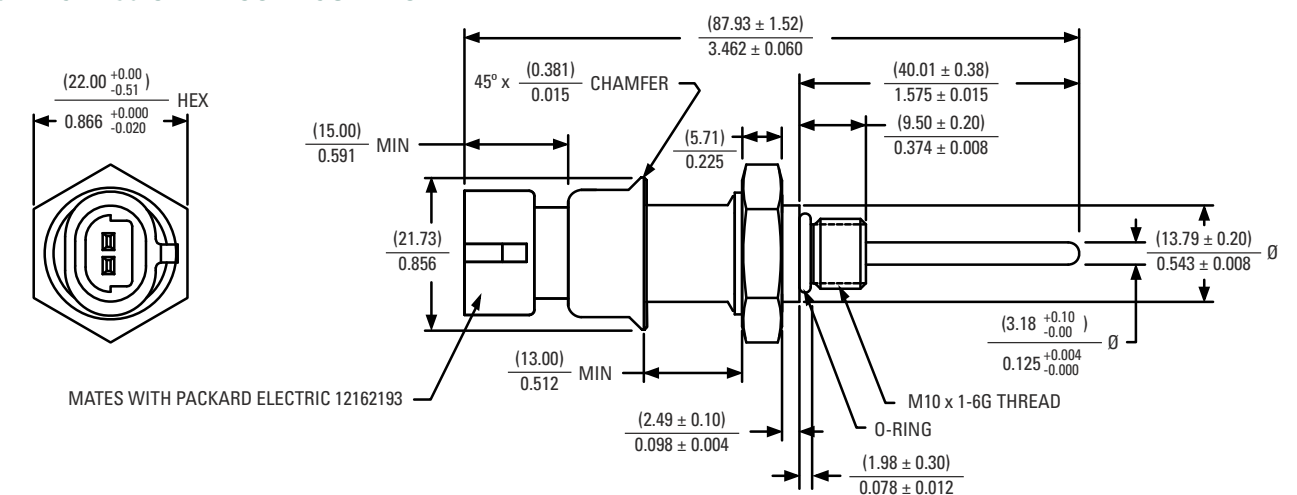


TYPICAL SPECIFICATIONS

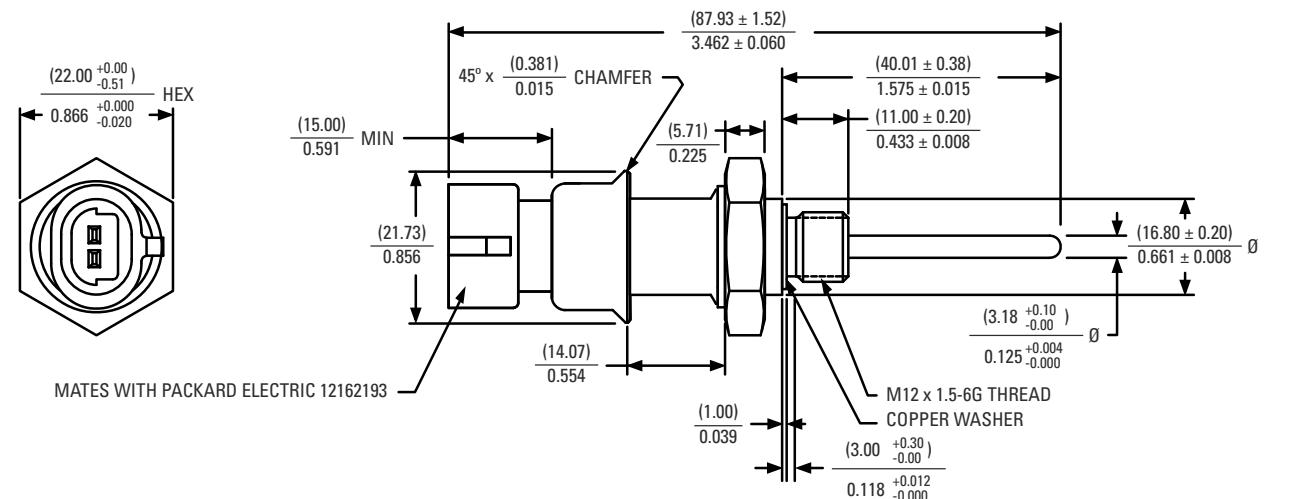
| | |
|---------------------------|--|
| Max operating temperature | -55°C to +300°C |
| Temperature tolerance | 150°C max version: 25°C ± 0.4 ±, 150°C ± 0.8°C 300°C max version: 25°C ± 0.8°C, 300°C ± 3.7°C |
| Body material | 304 Stainless Steel |
| Sensor type | 150°C max version: 3.000 ohms @ 25C, NTC 300°C max version: 49,120 ohms @ 25C, NTC |
| Mating Connector | 150°C max version: Packard Electric 12162193 300°C max version: Packard Electric 12162197 |

DIMENSIONAL DRAWINGS

5024 EGR 150°C MAX CONFIGURATION



5024 EGR 300°C MAX CONFIGURATION





CNG & LPG FUEL SYSTEM SENSOR APT / MSG

BENEFITS

- ISO 15500 and UN ECE R110 approved
- Pressure-only and pressure + temperature versions available
- Proven designs

INTRODUCTION

Alternative fuels are playing a bigger role in engine design and create a number of unique challenges for engine control systems. Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) engines and their infrastructure are steadily gaining position around the world. They offer improved fuel diversity and emissions benefits - not to mention tax and mobility incentives in some areas.

Sensata Technologies has experience in implementing sensor solutions for CNG and LPG powered cars, trucks, buses and forklifts. Whether low pressure for the fuel rail, high pressure for tank pressure, or even combined pressure + temperature solutions, Sensata has a wide and proven portfolio. Our CNG and LPG products meet regulations set by the International Organization for Standardization (ISO) as well as by the United Nations Economic Commission for Europe (UN ECE). More than 65 countries worldwide have adopted ISO 15500 and UN ECE R110 for CNG and R67 for LPG.

Sensata Technologies' products are developed to the highest performance requirements and made to the highest quality standards.

APPLICATIONS

The Fuel Rail sensor measures the absolute pressure of the fuel at the inlet of the injectors to optimize fuel metering and to control combustion for improved emissions and engine performance. Whether CNG or LPG, it is possible to measure both pressure and temperature, using the CP+T package, which combines both readings in one convenient robust package.

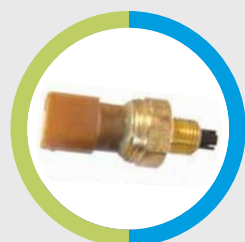
The pressure measurement from the Regulator or Tank Valve application is used to calculate the amount of fuel in the tank for dashboard fuel gauge indication. It replaces more traditional electro-mechanical devices and its accuracy can also help to detect possible leakage in high-pressure CNG systems.

SOLUTIONS

The following three product families are available to serve the requirements of CNG and LPG systems:

| Sensor Family | Parameter (Technology) | Typical Application | Typical Specifications |
|---------------|--|------------------------------------|---|
| CP | Pressure (Capactive Ceramic) | CNG/LPG Fuel rail LPG Regulator | 0-100kPa to 0-10Pa abs or rel 5V in / 0.5-4.5V out Accuracy (*) $\pm 0.75\%$ to $\pm 1.2\%$ FS EMC 100V/m Overvoltage & Reverse polarity protection |
| CP+T | Pressure + Temperature (Capactive Ceramic with NTC thermistor) | CNG/LPG Fuel rail LPG Regulator | 50-450kPa to 100-4000Pa abs 5V in / 0.5-4.5V out Accuracy (*) $\pm 0.75\%$ to $\pm 1.2\%$ FS EMC 100V/m Overvoltage & Reverse polarity protection 10k Ω at 25°C NTC |
| PP | Pressure (Piezo Resistive) | CNG Regulator/ Tank Valve | 0-3500kPa to 0-220MPa rel 5V in / 0.5-4.5V out Accuracy (*) $\pm 1.1\%$ to $\pm 1.3\%$ FS EMC 200V/m Overvoltage & Reverse polarity protection |

* Static error band at 25°C including linearity, hysteresis and repeatability



Capacity Ceramic
Pressure



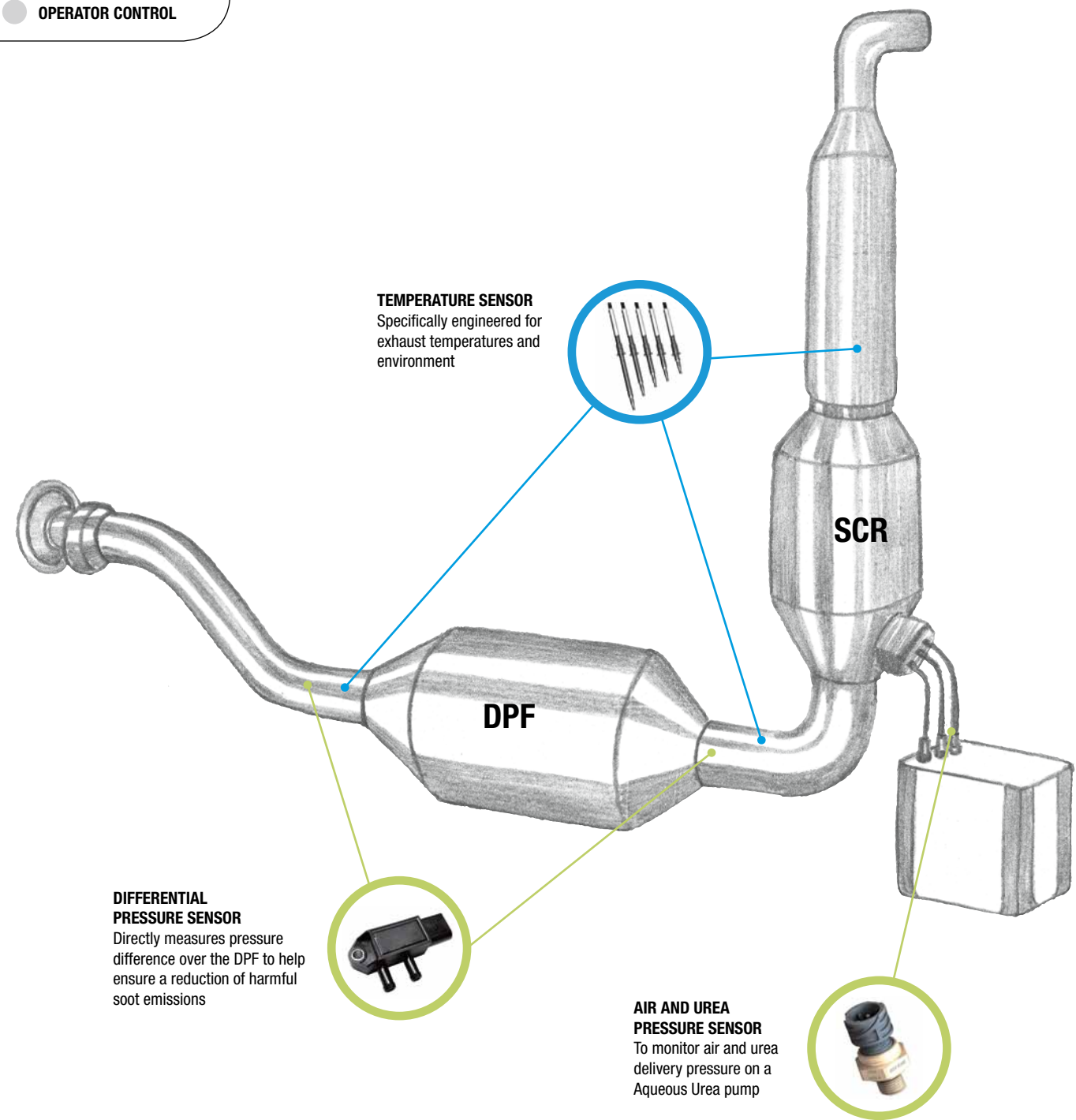
Capacitive Ceramic
Pressure + Temperature



Piezo Resistive
Pressure

LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL



EXHAUST SENSOR SOLUTIONS

Since the late seventies of the previous century engine development has expanded to exhaust-gas after-treatment. Since the late nineties, catalysts to clean up nitrogen oxides such as hydrocarbons or incompletely burned gases and other pollutants like particulates, are becoming more common. These systems are small chemical factories that contribute to cleaner exhaust gases and better health for human society.

The performance of these systems highly depends on sensors and controls. Sensata offers dedicated pressure and temperature sensors to provide maximum performance of exhaust treatment systems.

DIFFERENTIAL PRESSURE SENSORS (DPS)

Directly measuring the pressure difference over the DPF, Sensata's DPS allows accurate operation of the DPF and thus helps ensure a reduction of harmful soot emissions. Sensata has developed a MEMS-based DPS, capable of surviving in exhaust gases that helps OEMs to improve regeneration strategies for particle filters and to prevent blockage of the filter.

TEMPERATURE SENSORS

Sensata offers a full range of temperature sensors for accurate measurement of temperature at different levels. Fast response times are ensured, even at high gas velocities. Sensors are available in many different packages, allowing easy integration in a wide range of customer applications.

EXHAUST-GAS BACK-PRESSURE SENSORS (EBP)

EBP sensors are used in exhausts for emission purposes to control the back-pressure in systems with or without a Diesel-Particle Filter (DPF). Their task is not only to protect the engine against damage from overpressure, but also to provide diagnostics for regeneration of the DPF. Sensata has been producing Exhaust-gas Pressure Sensors for over ten years. The capacitive ceramic technology used is well suited for the application because it is impervious to acids, humidity and soot in the exhaust gas. The latest improvements in electronics deliver reliable and accurate pressure measurement, throughout the life of the sensor. (See ENGINE section)

AIR AND UREA PRESSURE SENSORS

Dosing Urea mixed with water into exhaust streams has rapidly become the industry standard for use with Selective Catalytic Reduction (SCR) of NOx systems. Sensata's sensors are used in both Airless and Air-assisted dosing system for either the urea pressure and / or the air pressure. Our sensors are designed to survive basic freezing cycles.



DIFFERENTIAL PRESSURE SENSOR DPS

Measures changes in pressure to help ensure a reduction of harmful soot emissions and compliance with emissions standards in support of a clean environment.

BENEFITS

- Improves engine life
- Signals when an engine's diesel particulate filter needs to be regenerated for efficient emissions reductions
- Offers increased accuracy and robustness in harsh exhaust gas environments
- Helps detect cracks or other issues with the diesel particulate filter

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|--|-------------------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 15 mA max. |
| Output Voltage @ 5 Vs (see example below) | 0.5 - 4.5 Vs or digital |
| Response Time T ₉₀ | <10 ms |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-2GHz) | >50V/m Class A |
| ESD (ISO 10605) | >8 kV |
| Available with analog and digital output | |

PHYSICAL

| | |
|-----------------------------|------------------------|
| Differential Pressure Range | 0-35 kPa (or 0-100kPa) |
| Differential Proof Pressure | 200 kPa |
| Differential Burst Pressure | 300 kPa |
| Minimum Cycle Life | >2M Pressure Cycles |
| Vibration (100-450 Hz) | 15-25g sine |
| Sine Vibration (50-2000 Hz) | >12 g |

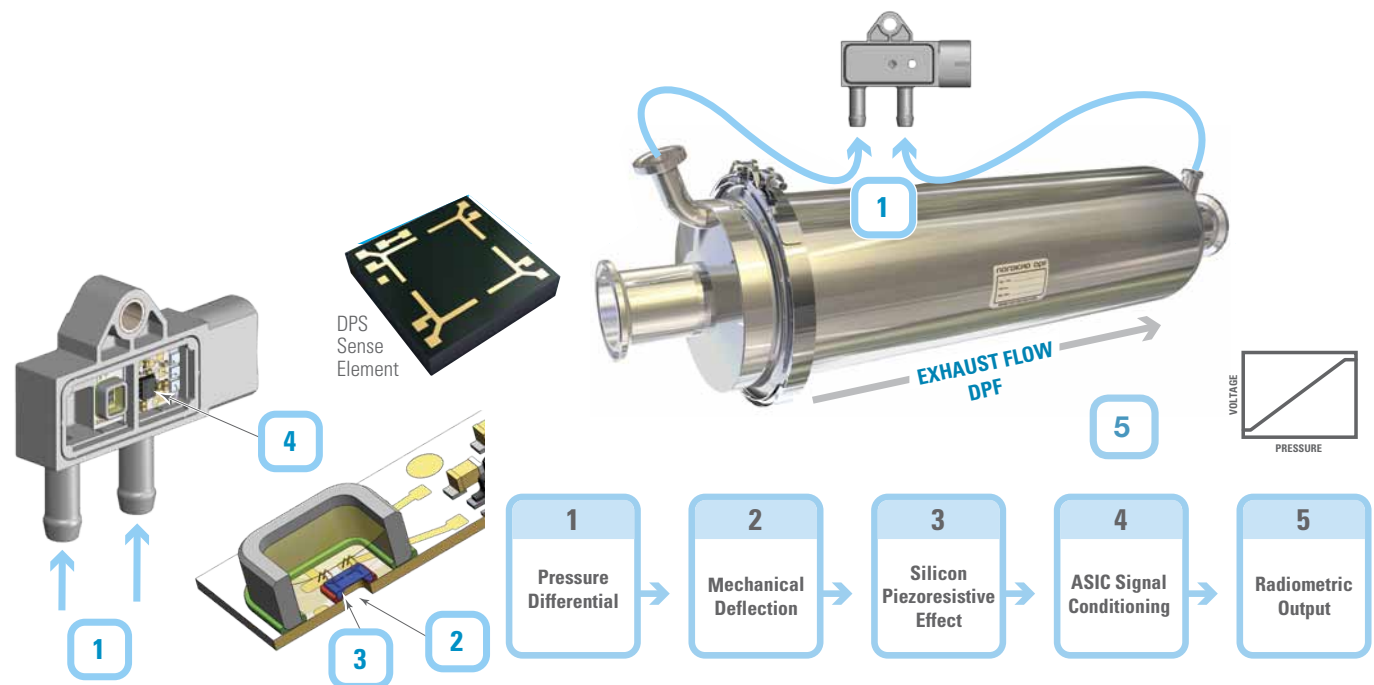
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +125°C |
| Storage Temp | -40 to +130°C |

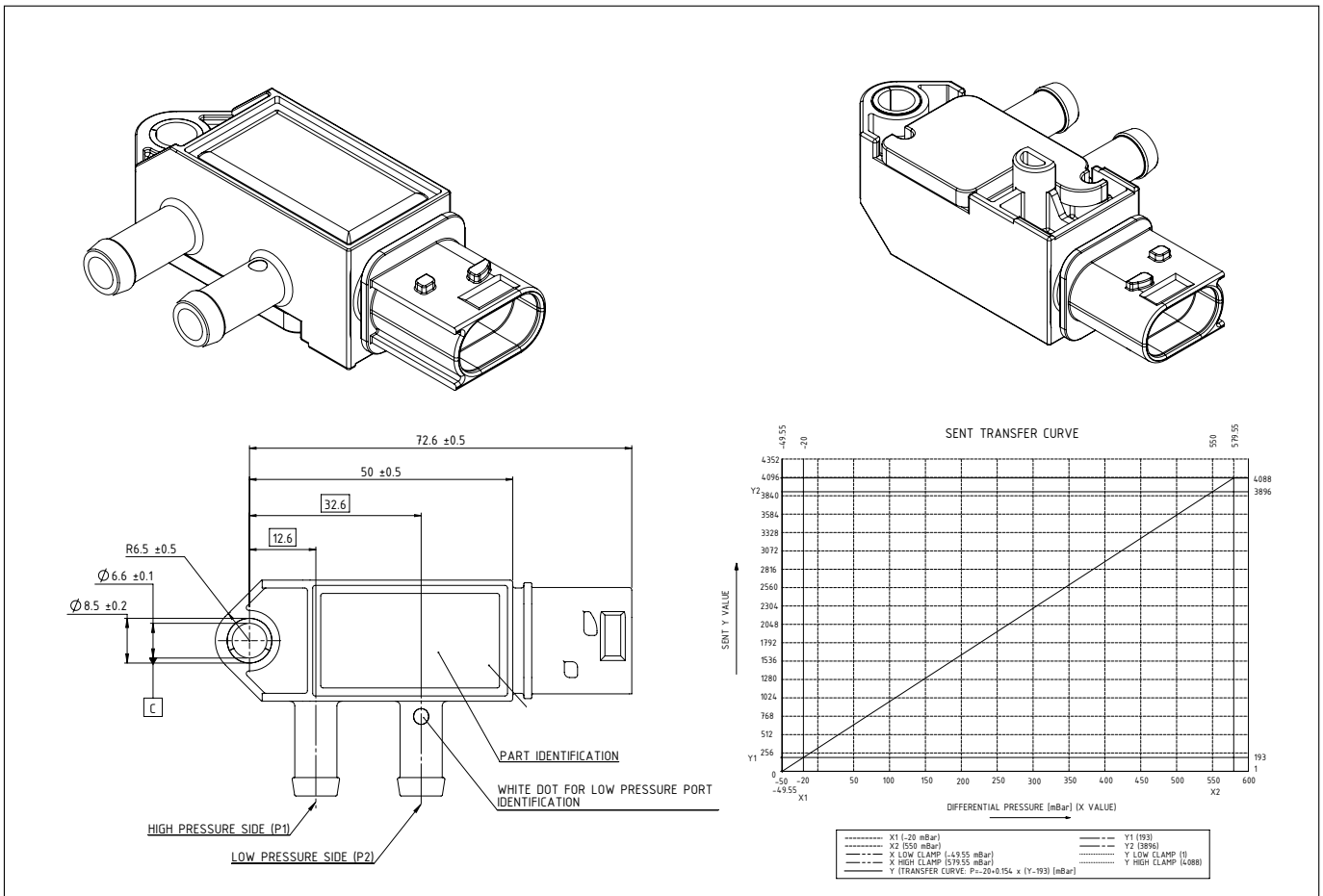
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

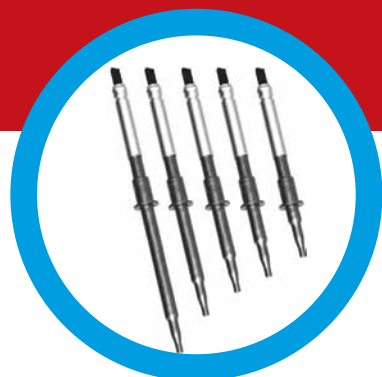
| | |
|---------------|---------------|
| 0 to +100°C | \pm 1.5% FS |
| -40 to +130°C | \pm 2.0% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





HIGH TEMPERATURE SENSOR DARTS200

High temperature sensors monitor vehicle exhaust gas temperature in after-treatment applications for control, monitoring, and diagnostics; used in conjunction with DPS, CPS, and HCM sensors.

BENEFITS

- Helps reduce emissions
- Enables engine controller to appropriately regulate exhaust gas aftertreatment systems
- Maximizes fuel economy
- Protection against overheating

TYPICAL SPECIFICATIONS

TYPICAL 5V MEASUREMENT CIRCUIT

| | |
|------------------------|-------------------------------|
| Pull-Up Voltage | $U = +5V \pm 0.1\%$ |
| Pull-Up Resistance | $R_p = 1k\ \Omega \pm 0.1\%$ |
| A/D Converter Accuracy | 10 bit |
| Polarity | Signal: Grey Ground: White |
| Operational current | Between 2.7mA and 4.2mA |

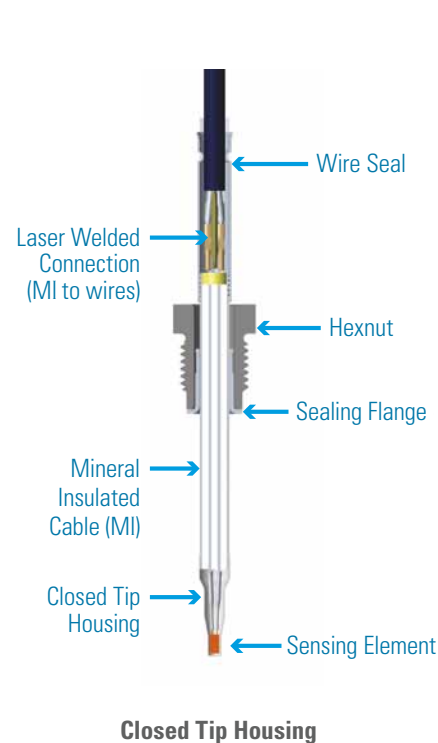
(Same methodology applies for other voltage systems (e.g. 3.3V), but operational current must be lower than 5mA)

FUNCTIONAL CHARACTERISTICS

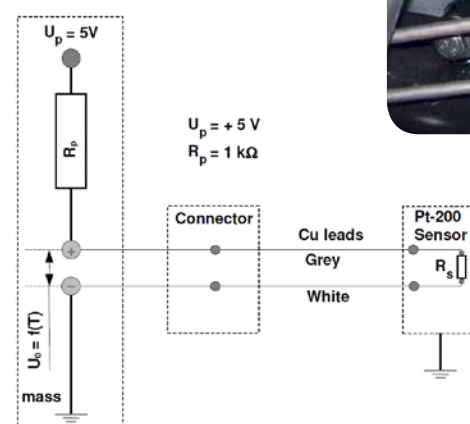
(See page 110 for explanation)

| | |
|------------------------|--|
| Sensor Element | PT-200 platinum resistor |
| Measurement principle | PT-200 The resistance of the PT-200 element increases with temperature based on the positive temperature coefficient of platinum electrical resistance |
| Nominal Resistance | $200\ \Omega$ at 0°C |
| Temperature Range | Continuous: -40°C to 850°C Peak: 900°C |
| Accuracy | $\pm 2.5^\circ\text{C}$ from -40°C to 280°C |
| Response Time t_{63} | $\pm 0.9\%$ from 280°C to 850°C (including 500 hours ageing at 850°C) |
| Insulation Resistance | <11 seconds at 300°C , gas velocity of 11m/s <5 seconds at 300°C , gas velocity of 70m/s $>1\text{m}\ \Omega$ at 20°C , VDC 500 Volt |

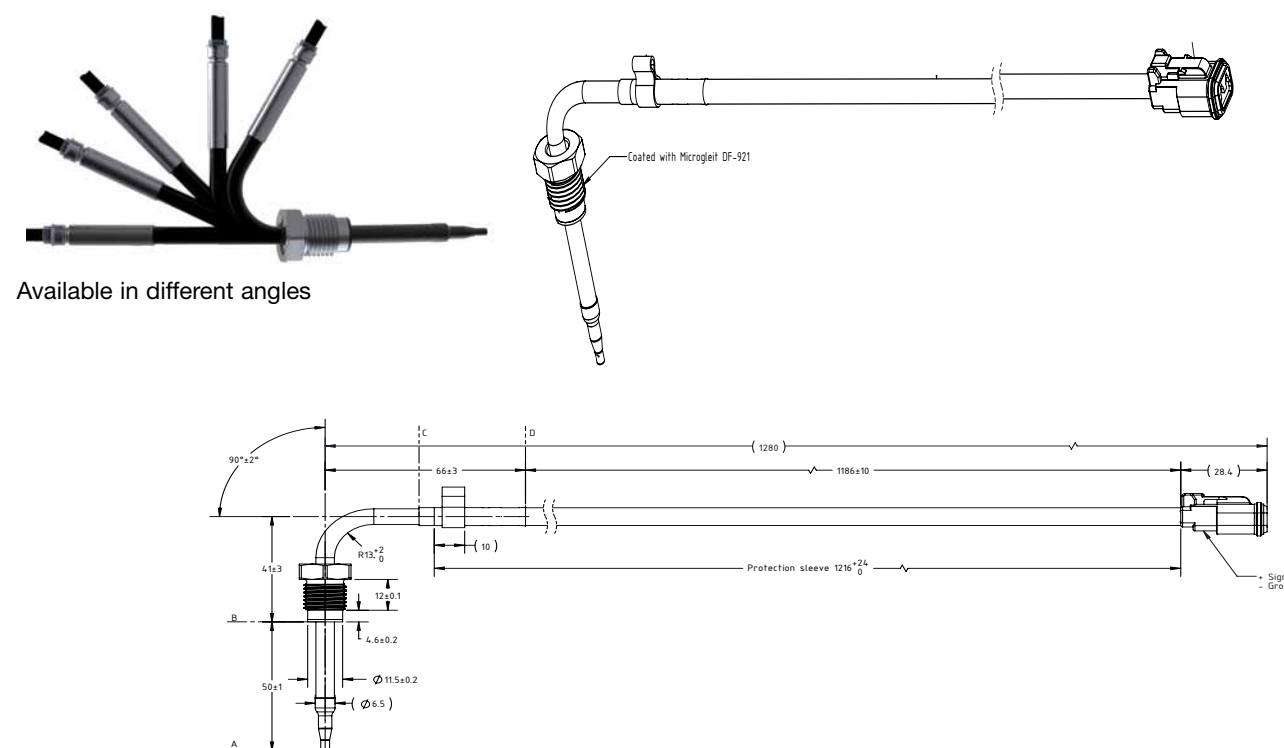
HOW IT WORKS



RTD circuit to MCU



DIMENSIONAL DRAWINGS





UREA PRESSURE SENSOR APT

Measure the Urea injection pressure in SCR systems.

BENEFITS

- High accuracy
- Robust design
- Withstands highly corrosive media
- Remains functional even if the Urea has crystallized inside the chamber

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 VdC |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|---|
| Operating Pressure | 0-3bar (variants available for up to 13bar) |
| Proof Pressure | >2 FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

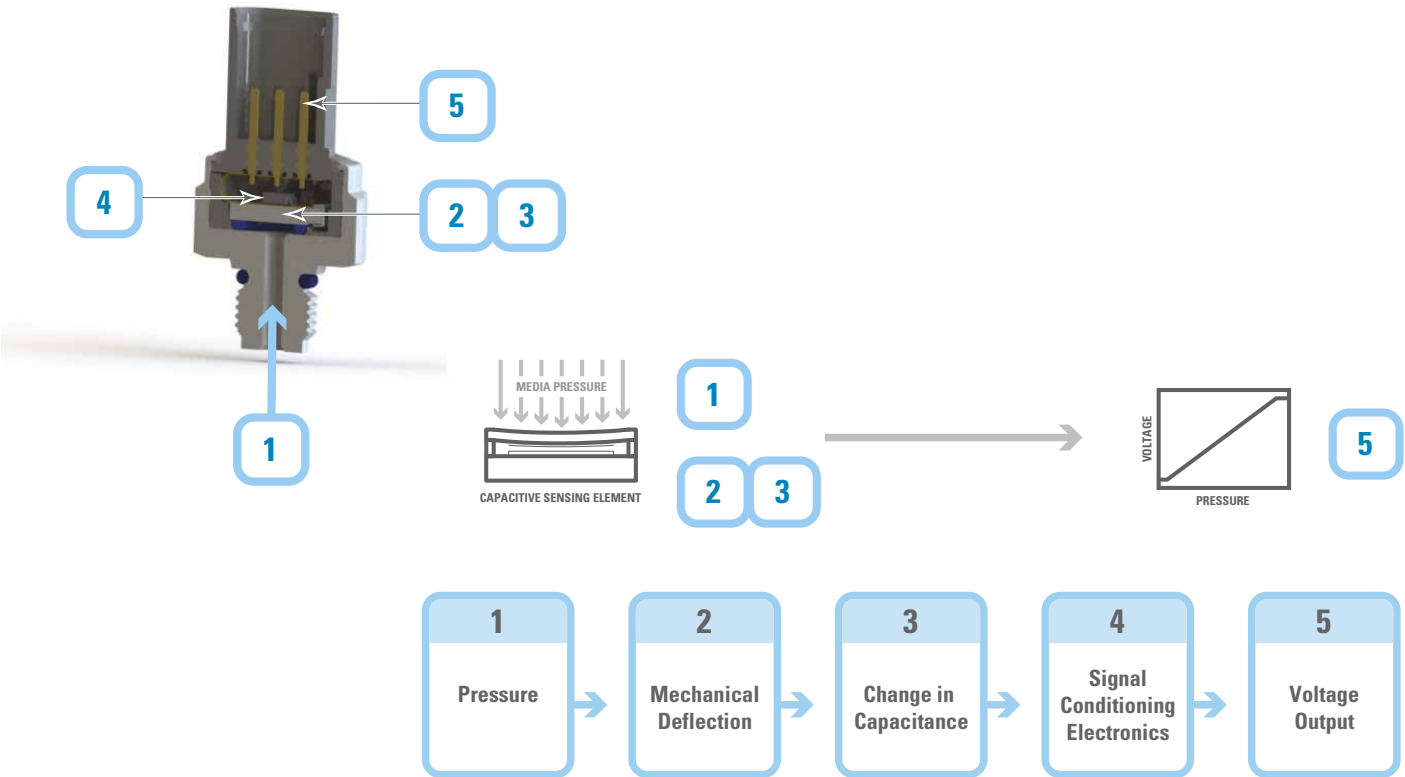
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

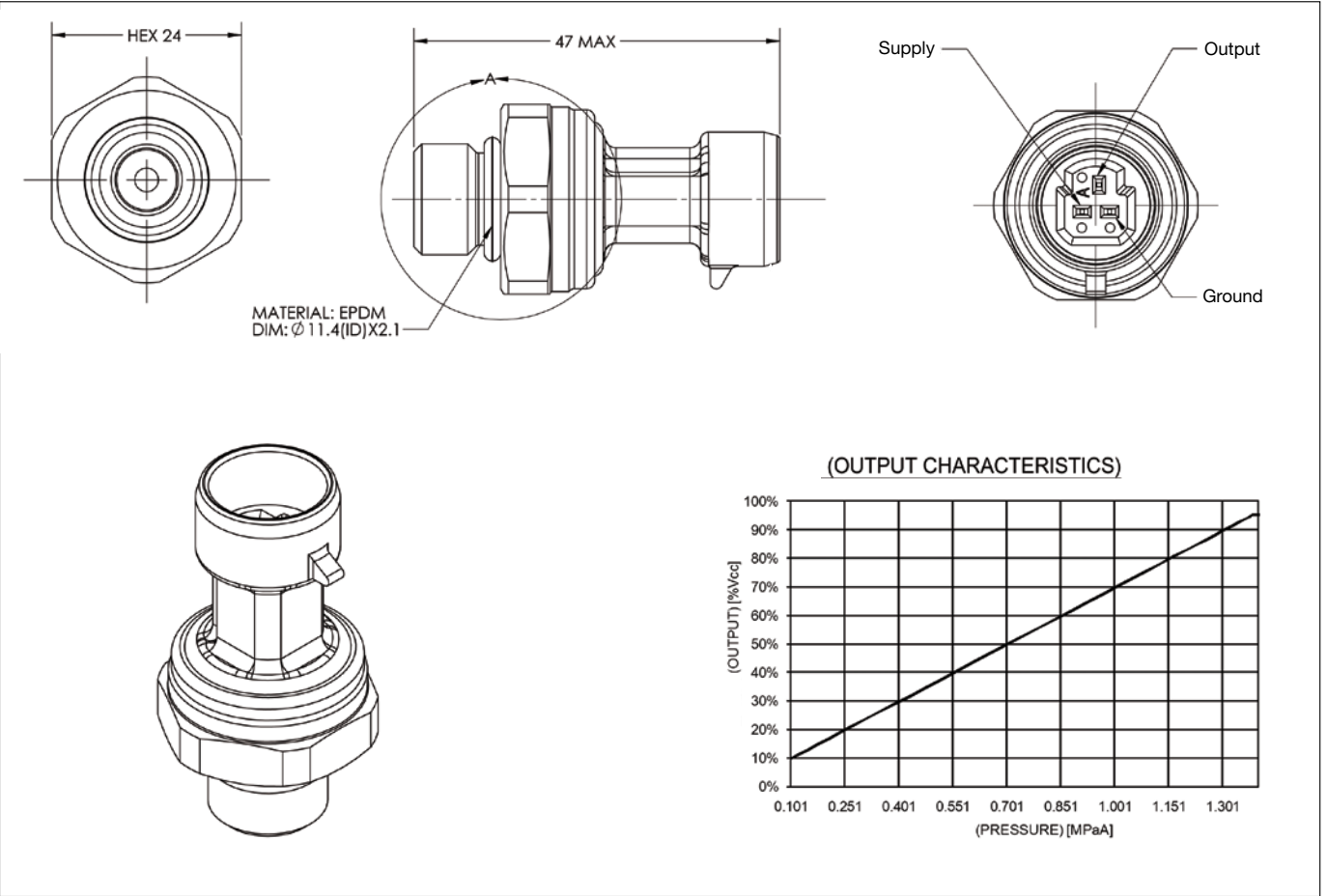
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





AIR PRESSURE SENSOR APT

Sense the air pressure
in air assisted Urea
dosing systems.

BENEFITS

- Enables accurate droplet size distributions in combination with input from a Urea pressure sensor
- Enables accurate pump control and helps with air driven purge cycles

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 VdC |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|---|
| Operating Pressure | 0-3bar (variants available for up to 16bar) |
| Proof Pressure | >2 FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

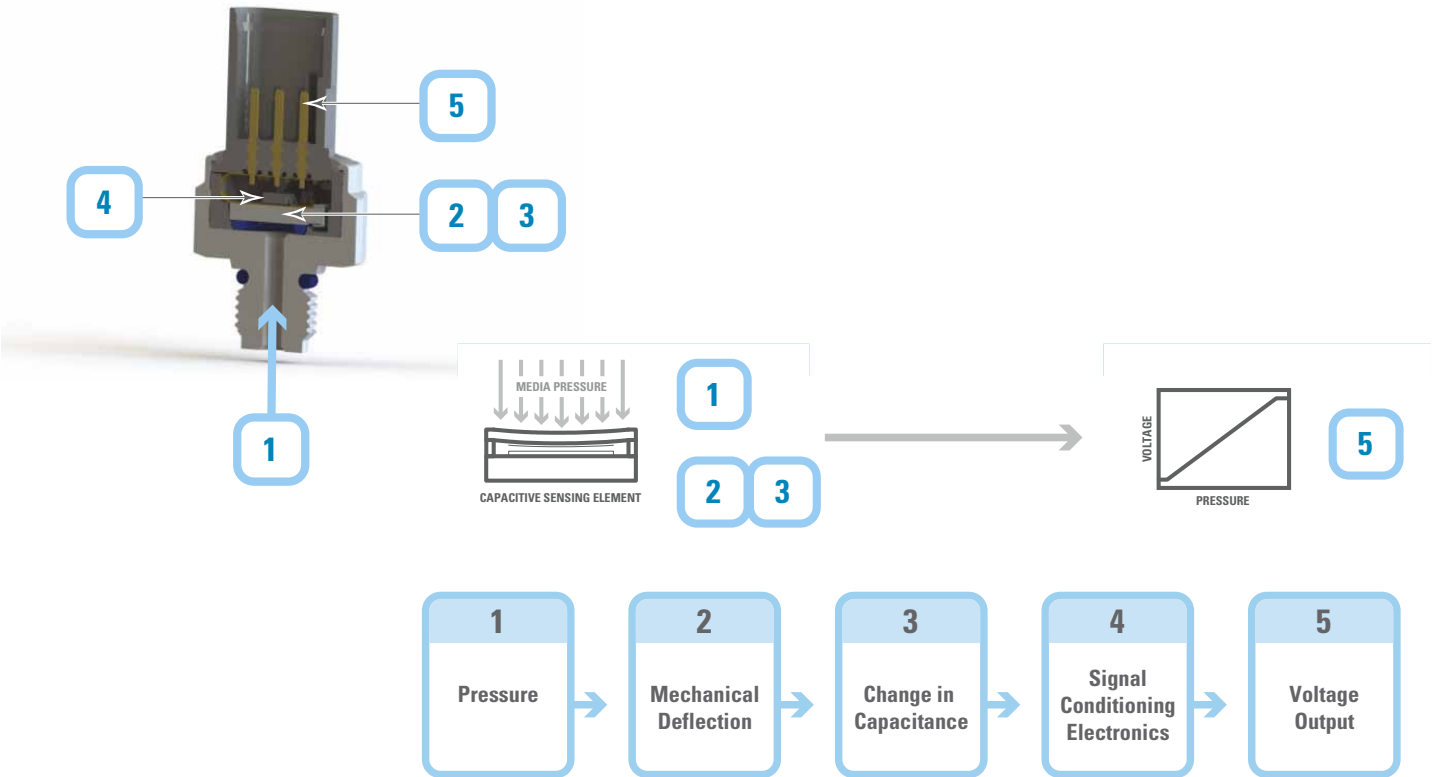
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

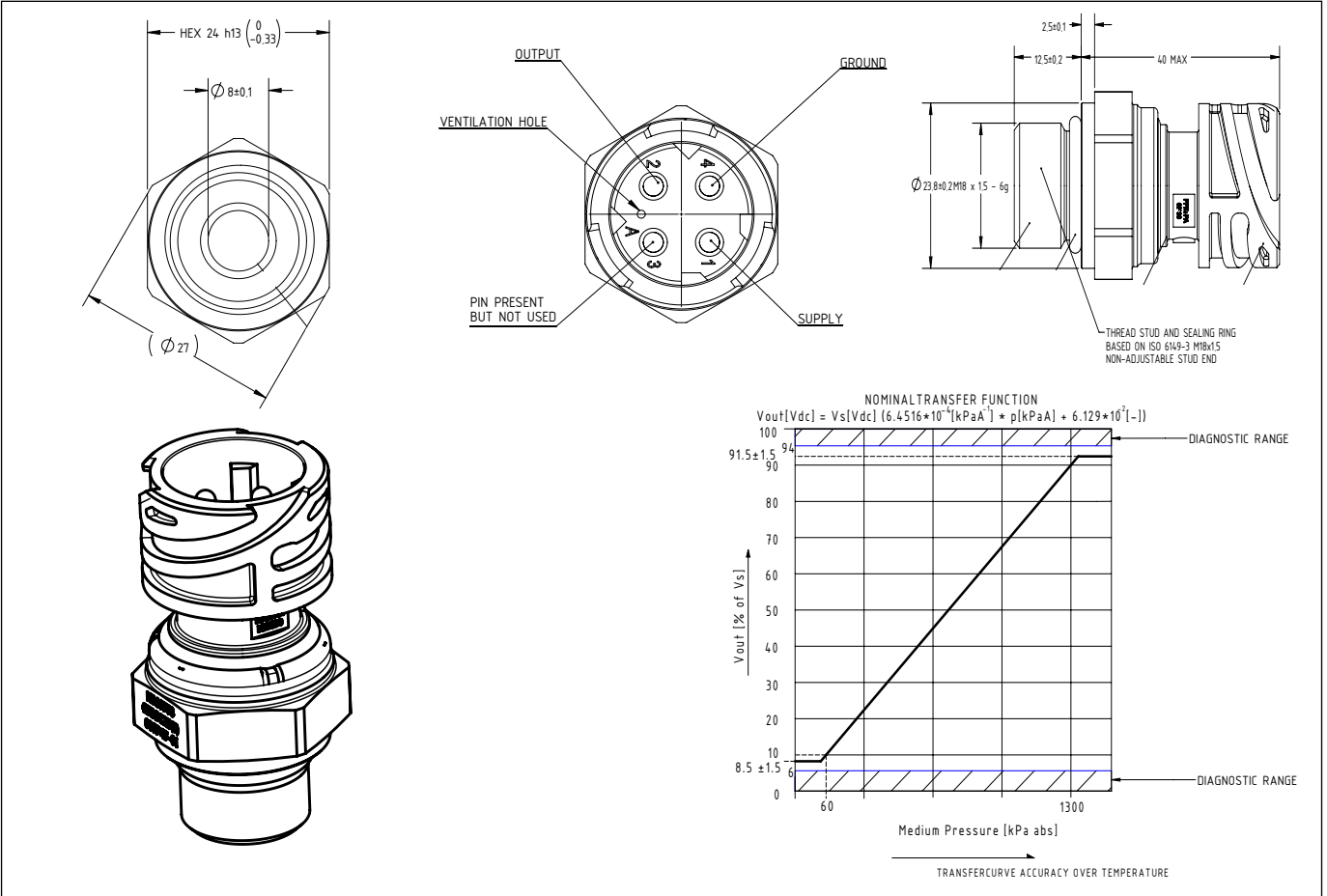
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS

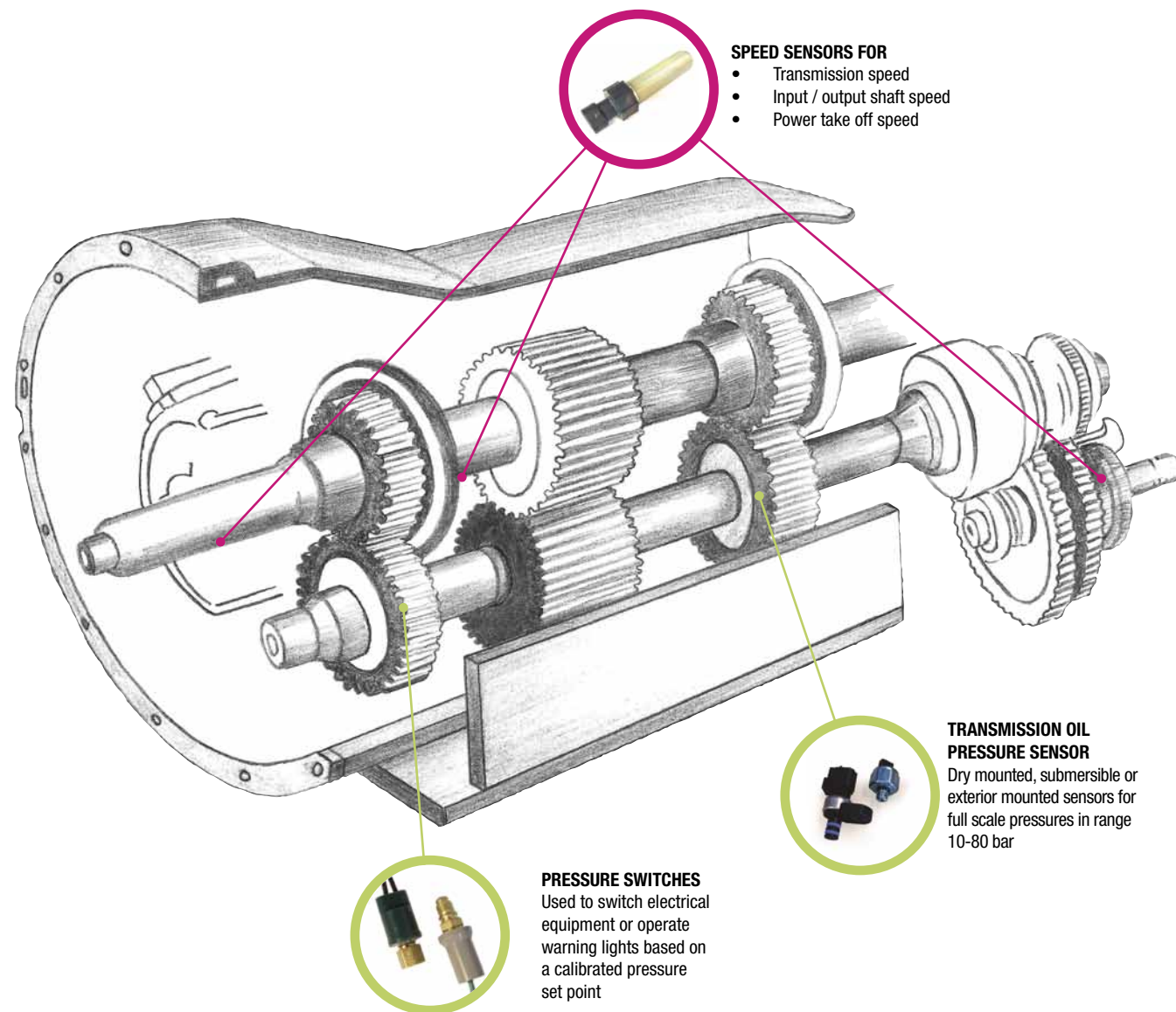


DIMENSIONAL DRAWINGS & TRANSFER CURVE



LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL



TRANSMISSION APPLICATIONS

Whether automatic, manual or even CVT and DCT transmission systems are deployed, Sensata's range of transmission sensors deliver accuracy, repeatability and robustness against fluids and application extremes. Sensata's sensor range offers improved fuel efficiency, lower emissions and smoother ride.

PRESSURE SENSING

Sensata has developed three kinds of pressure sensors and switches to suit every client application:

EXTERNAL-MOUNT (Automatic and Manual Transmission) – Externally mounted sensors are robust enough to withstand under-hood environments. Sensata offers a wide range of connectors, such as AMP, Packard, Yazaki etc.

SUBMERSIBLE (CVT, DCT and Automatic Transmissions) – For customers who choose to locate the pressure sensor outside the TCU (Transmission Control Unit), Sensata offers submersible solutions. These sensors are able to withstand the harsh environments of transmission fluids.

DRY TCU INTEGRATED (CVT and DCT) – This sensor focuses on sensor integration and the TCU assembly process. It serves operating pressures between 20 and 70 bars.

SPEED AND POSITION SENSING

Sensata offers Hall-effect position sensors to provide an accurate neutral gear position signal as one of the essential parts of the Manual Transmission start/stop system.

Target wheel speed detection for automatic transmission systems is provided by the Sensata Transmission Speed sensor. It comes in both passive (electromagnetic induction) and active (Hall) variants and various cable lengths and connectors are available for easy system integration design.

Accurate Cam and Crank shaft speed sensing is provided by the Push-in (GP) or Threaded (GT) Speed Sensors.



TRANSMISSION PRESSURE SENSOR APT

Located on or in the transmission to measure various pressures in for example automatic (AT), dual clutch (DCT) and continuously variable transmissions (CVT). This sensor is also available in MSG and MEMS Technologies.

BENEFITS

- Aids in shift control, shift feel, clutch control and improved fuel economy
- Submersible, externally mounted or dry integrated design available

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 VdC |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|---|
| Operating Pressure | 0 to 11 bar (variants up to 80 bar available) |
| Proof Pressure | >2x FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | 2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

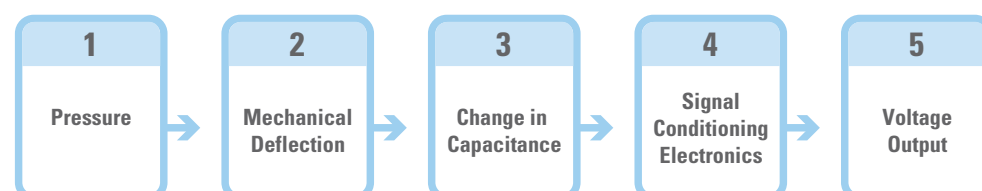
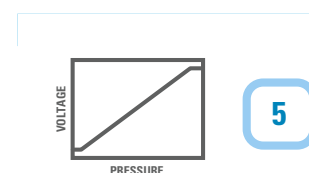
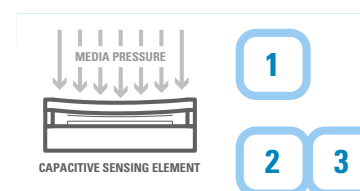
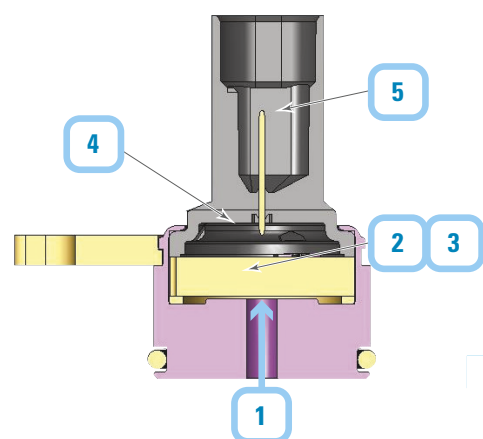
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

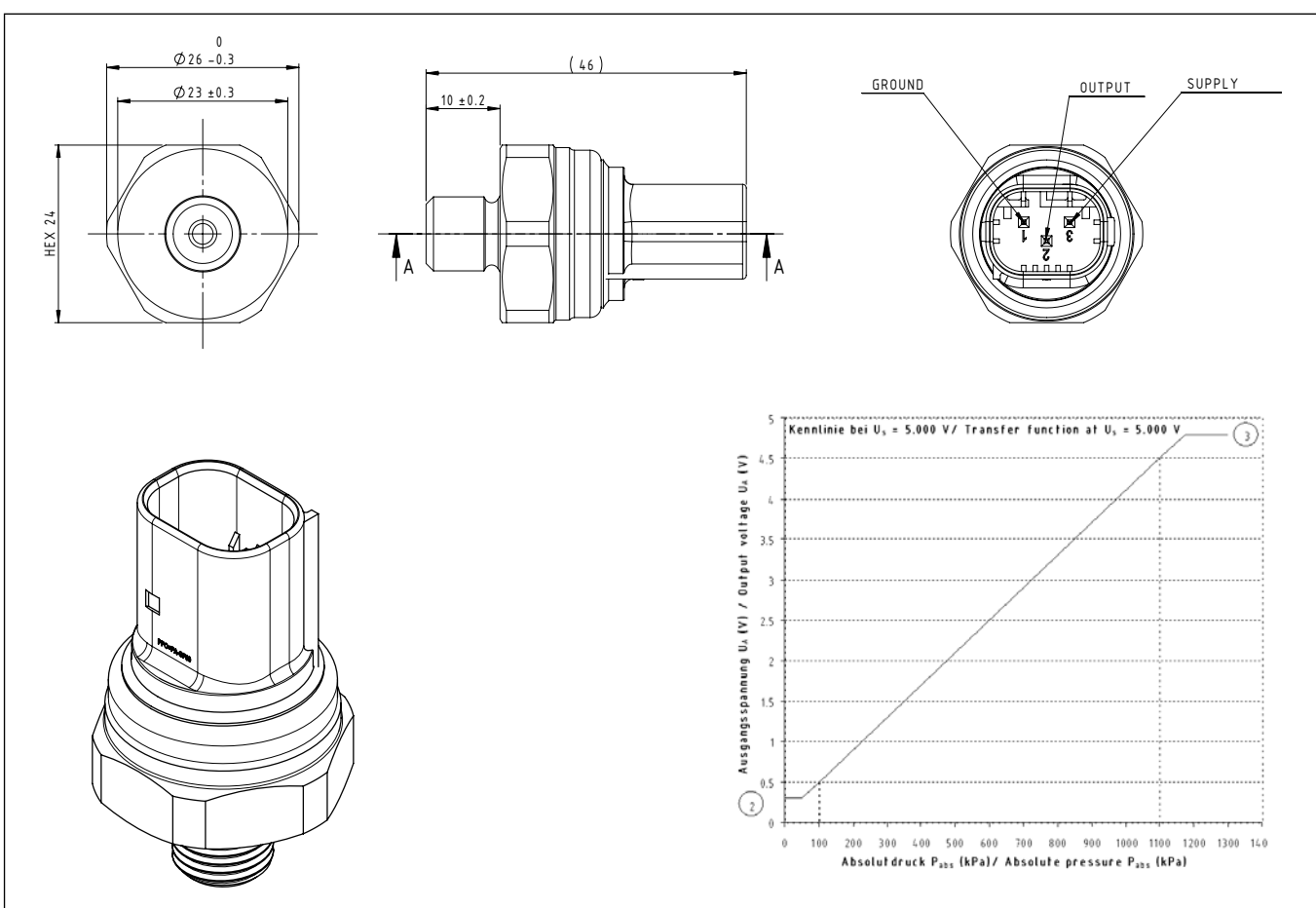
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

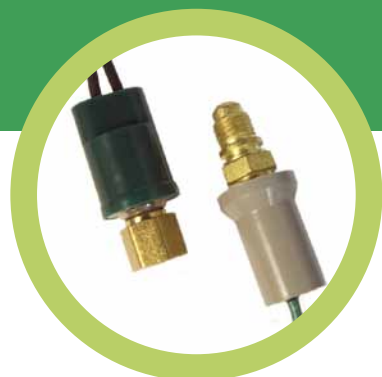
| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





PRESSURE SWITCH 20PS

The 20PS Family of Switch products (20PS, 39PS, 40PS and 41PS) was developed to meet the demanding needs of HVAC & industrial applications and has since become a staple of multiple mobile application segments. The reliable and durable construction allows the product to perform under severe environmental conditions and very high vibration levels.

BENEFITS

- Resets automatically
- Single-pole, single throw switch, normally open or normally closed
- Flexible: factory calibrated set points from vacuum to 50 bar
- Snap Klixon™ stainless steel, hermetically sealed

TYPICAL SPECIFICATIONS

PHYSICAL

| | |
|--|------------------|
| Operating Pressure | Vacuum to 50 bar |
| Set Point | Proof Pressure |
| <6 bar | 17 bar |
| 6-33 bar | 41 bar |
| >33 bar | 55 bar |
| Higher pressure available for certain applications | |
| Burst Pressure | 333 bar |

DIELECTRIC STRENGTH

750 Vrms Open Contacts
1550 Vrms Terminals to Fitting

LEAD WIRE MATERIAL / ELECTRICAL CONNECTION

18 or 16 AWG 600V 105°C PVC
Quick Connects .250" x .032" Male Str. Tab
Various AMP, Delphi & Deutsch Connectors

LIFE AT RATED CURRENT

100,000 cycles (All - UL Recognition)
250,000 cycles (All except 20PS)

AMBIENT TEMPERATURE

-29°C to +80°C (20PS)
-40°C to +120°C (40/41PS)

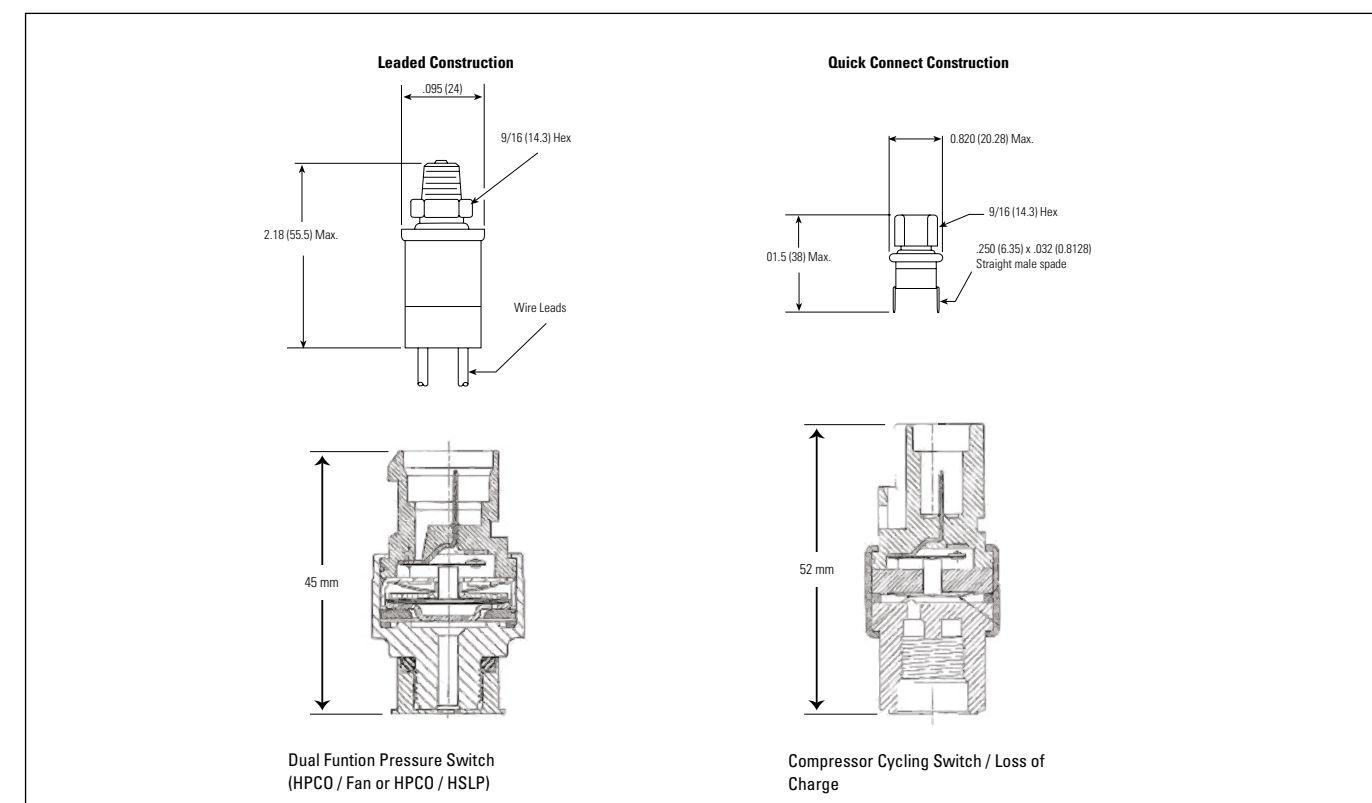
ELECTRICAL RATINGS

120 VAC - 5.8 FLA 34.8 LRA
240 VAC - 2.9 FLA 15.0 LRA
120/277 VAC -375 VA Pilot Duty
24 VAC - 125 VA Pilot Duty

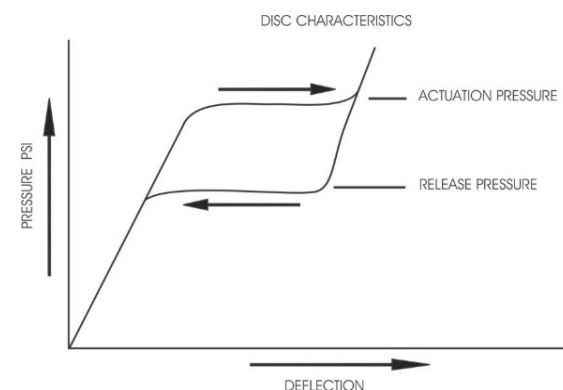
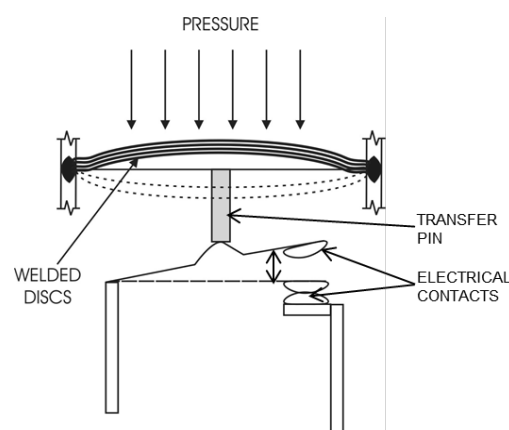
FLUID TEMPERATURE

-53.9°C to +135°C

DIMENSIONAL DRAWINGS



HOW IT WORKS





ROTATIONAL SPEED SENSOR GPSS / GTSS

Designed for rugged, reliable speed sensing requirements where durability and dependability are required, its proven, field tested design conforms to SAE standards, while offering customers flexibility in variations and features.

BENEFITS

- Proven robust design
- Dependable performance
- Single and dual output available

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|---|---|
| Resistance for single output | 1600 ohm \pm 10% |
| Resistance for dual output | Coil A-B: 1600 ohm \pm 10%; Coil C-D: 2200 ohm \pm 10% |
| Inductance for single output (1000 Hz 3" leads) | 1.17 \pm 0.10mh @ 1000 Hz |
| Inductance for dual output (1000 Hz 3" leads) | Coil A-B: 1.17 \pm 0.10mh @ 1000 Hz; Coil C-D: 1.21 \pm 0.10mh @ 1000 Hz |

All measurements made at free ambient air at +25° (\pm 5°) A - B = Inner Coil; C - D = External Coil

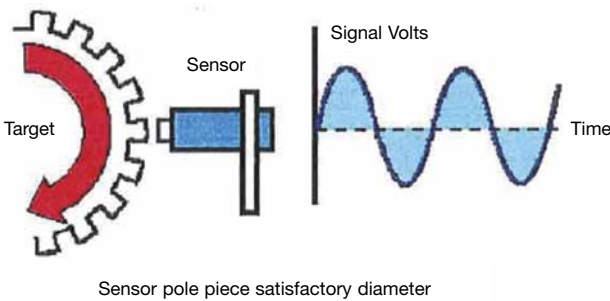
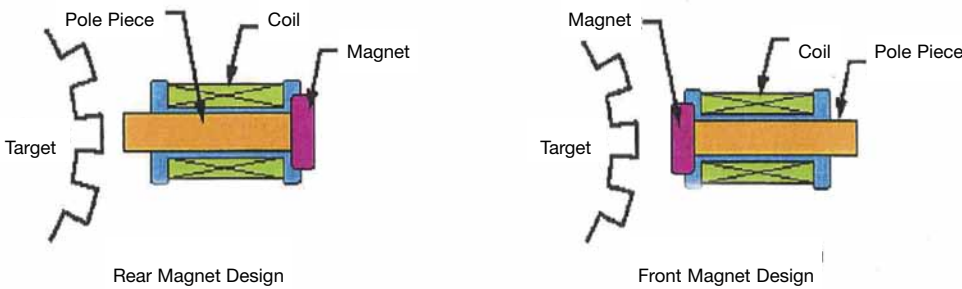
OUTPUT

Standard 4" diameter tone wheel (single tooth) is used for testing. Measurements are done with a 10K-ohm load in parallel with a 470pf capacitor across the coil. Actual result will vary based on target wheel, tooth configuration, controller impedance, etc.

Coil output Specifications (Minimum: P-P volts)

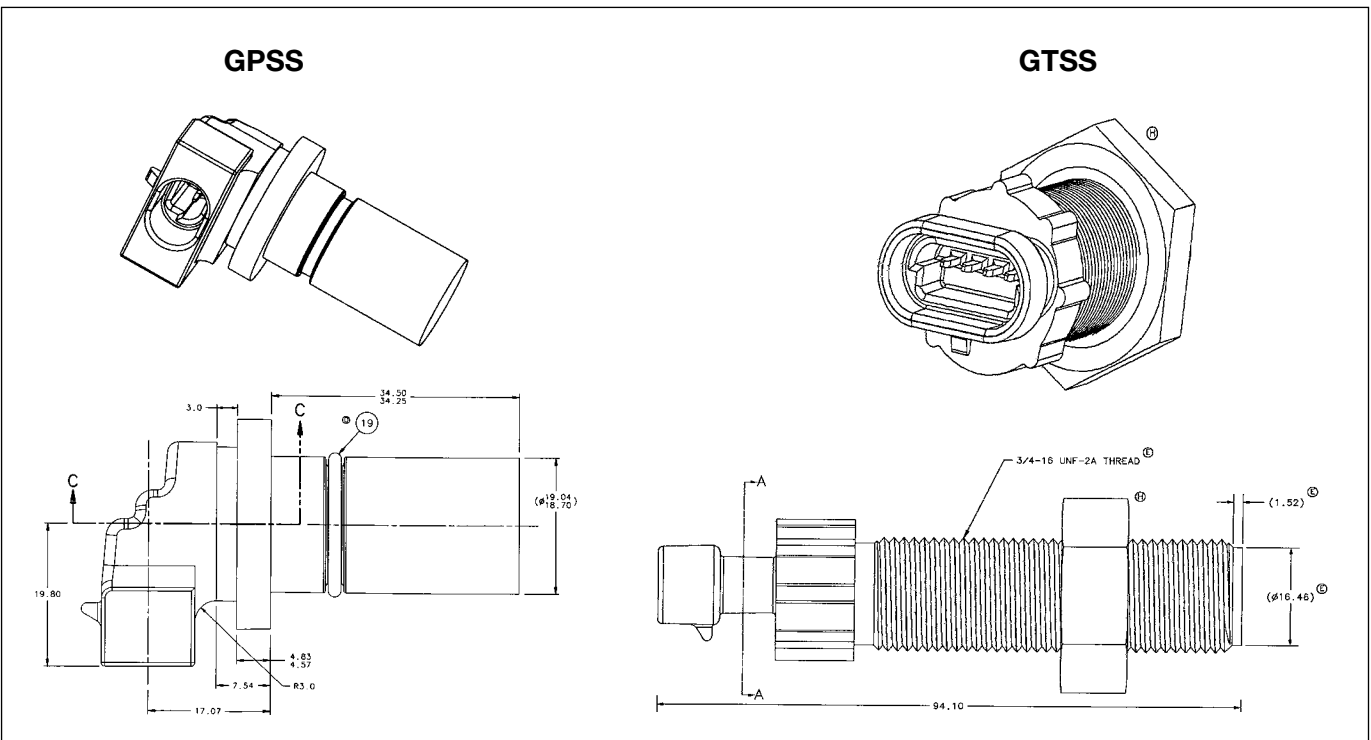
| | 143 RPM | | 3500 RPM | |
|----------------------------|------------------|------------------|------------------|------------------|
| | Air Gap = 0.50mm | Air Gap = 1.27mm | Air Gap = 0.50mm | Air Gap = 1.27mm |
| 1.27mm | | | | |
| Single output | 4,91 | 2,70 | 49,63 | 28,75 |
| Dual output, inner coil | 4,64 | 2,57 | 48,95 | 28,39 |
| Dual output, external coil | 4,82 | 2,63 | 48,93 | 28,03 |

HOW IT WORKS



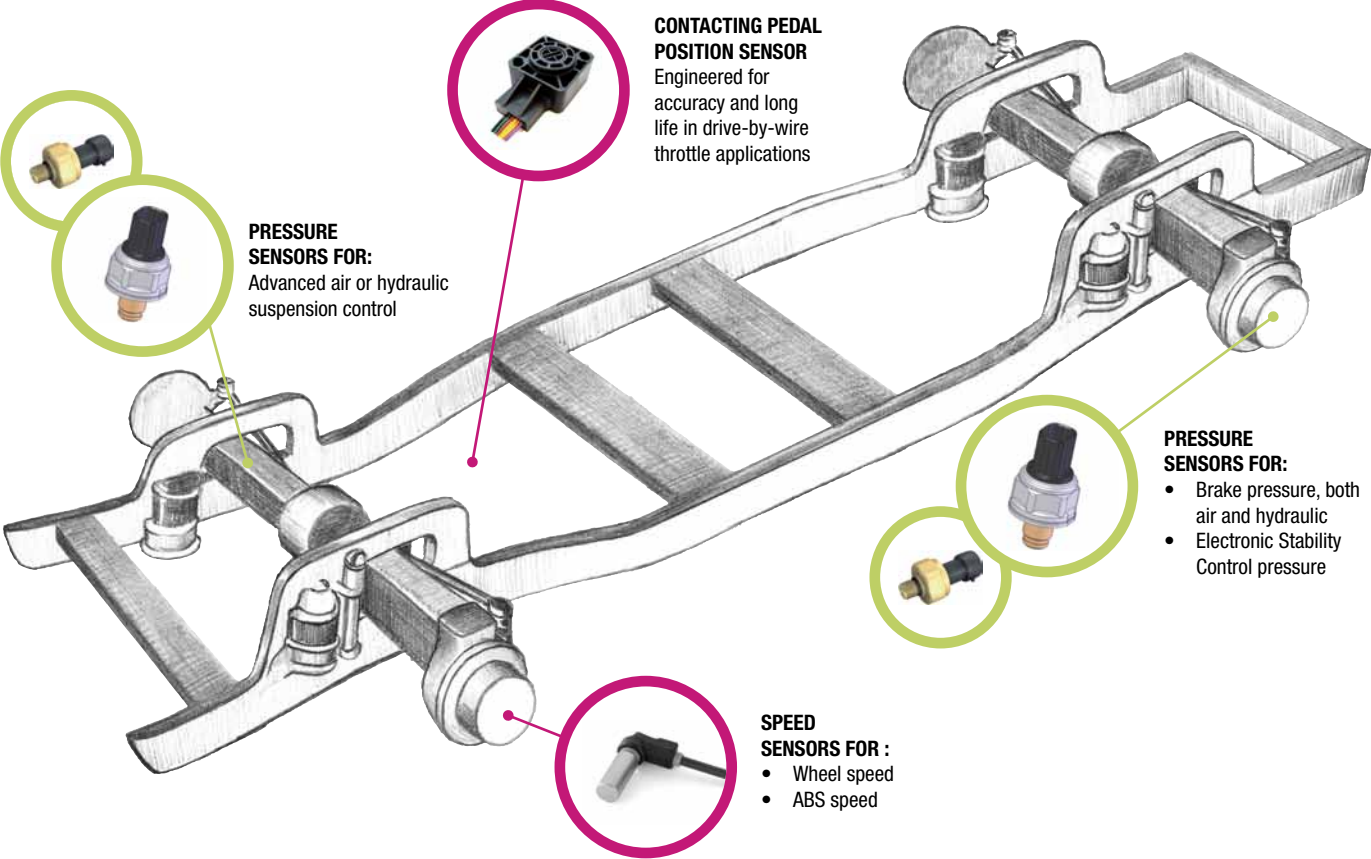
Sensor pole piece satisfactory diameter

DIMENSIONAL DRAWINGS



LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL



CHASSIS & SAFETY SENSOR CAPABILITIES

Following the homologation of seatbelts and airbags in the second half of the 20th century, the drive to further reduce road fatalities led to the development of Active Safety systems. This trend started with the Anti-lock braking system (ABS), preventing the loss of control of the car due to slipping wheels. In the late nineties ABS systems had evolved into Electronic Stability Control (ESC) systems, capable of recognizing hazardous situations, and correcting the trajectory of a car by braking individual wheels.

Sensata's high pressure sensors and wheel speed sensors are key components enabling the function and further enhancement of these systems.

ELECTRONIC STABILITY CONTROL PRESSURE - MSG

Since the beginning of Electronic Stability Control systems in the late nineties, various leading system suppliers have relied on Sensata pressure sensing technology. Deeply integrated in the hydraulic valve block, a Sensata Microfused Strain Gauge (MSG) senses pressures up to 250 bar in the hydraulic brake fluid. The main function of the sensor is to reliably and quickly measure how hard the driver pushes the brake pedal. This driver intent signal plays an important role in the system algorithm that decides whether the vehicle must intervene by autonomously braking one or more wheels. Besides this primary function, the sensor can be used to measure the brake pressure applied to individual wheels with the objective to improve brake performance. Alternatively, the sensors are used to measure the pressure generated by the hydraulic pump that is used by these systems, and the pressure reservoir used by some advanced systems.

VACUUM BRAKEBOOSTER PRESSURE - MEMS

Almost every vehicle in the world is too heavy for a human being to stop within a reasonable time and distance, with a reasonable amount of force. In order to help the driver, most cars are equipped with a vacuum brakebooster, a device that uses vacuum to help push the brake pedal rod into the hydraulic brake system by amplifying the drivers pedal force. Vacuumboosters use the engine vacuum to ensure the right amount of brake amplification is achieved. Proper functioning of these systems requires that the vacuum in the brakebooster is continuously monitored by pressure sensors. Sensata's MEMS-technology based vacuum brakebooster pressure sensor is increasingly adopted by large automotive OEMs to provide this function.

WHEELSPEED - POSITION

A key input for ABS and ESC systems is the accurate, fast and reliable measurement of the rotation speed of each

wheel. The vast majority of the vehicles produced is being equipped with wheelspeed sensors mounted on each wheel. The signal is transmitted to the ABS or ESC module, and used in the algorithm to detect wheel slippage and variations in speed between the individual wheels: a key input when determining whether a car is spinning out of control.

HYDRAULIC SUSPENSION - MSG

Most vehicles ensure the comfort of the occupants by using shock absorbers. Especially in off-road applications, advanced suspension systems are used: Some systems -referred to as adaptive or semi-active suspension systems- are capable of varying the shock absorber firmness to match changing road or dynamic conditions. Even more advanced are the fully active systems, which have actuators to adjust the shock absorber firmness. These instantaneous adjustments are done by using the inputs from various sensors in the vehicle. Most active suspension systems use hydraulic pressure for actuation. Sensata's MSG high pressure sensor technology is critical for controlling these complex dynamic systems.

AIR SUSPENSION - APT

Air suspension systems essentially replace a vehicle's coil springs with air springs. The air springs are simply tough rubber and plastic bags inflated to a certain pressure and height to mimic the coil springs. But the similarities end there. By adding in an on-board air compressor, sensors and electronic controls, today's air suspension systems provide several advantages over all-metal, conventional springs, including near-instant tuning, and the ability to adapt handling to different situations and vary load capability.



AIR BRAKE PRESSURE SENSOR APT

Sensata's air brake pressure sensor provides accurate pressure inputs for ABS and EBS system applications.

BENEFITS

- High sensitivity
- Proven technology
- Great endurance performance

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|---|
| Operating Pressure | 0 to 13 bar (variants up to 16 bar available) |
| Proof Pressure | >2 FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

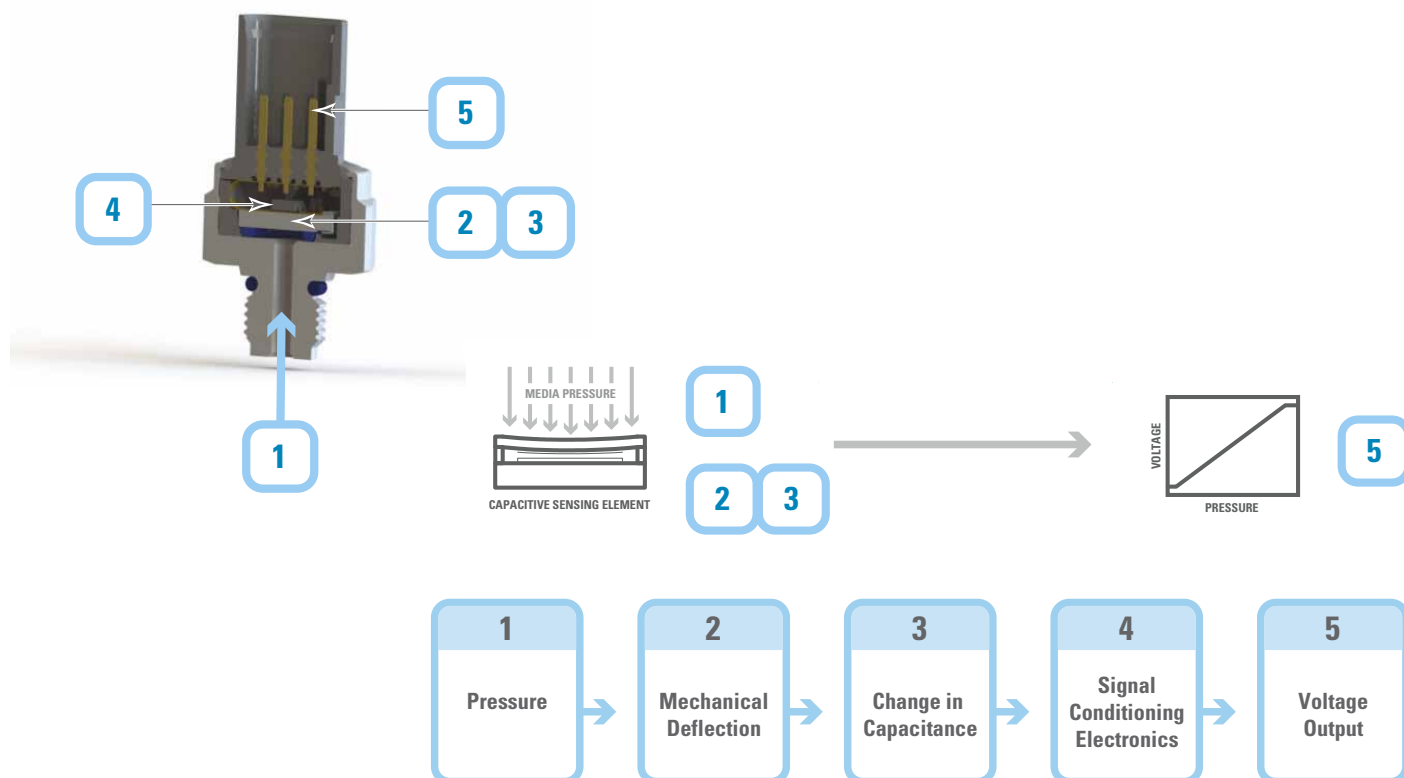
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

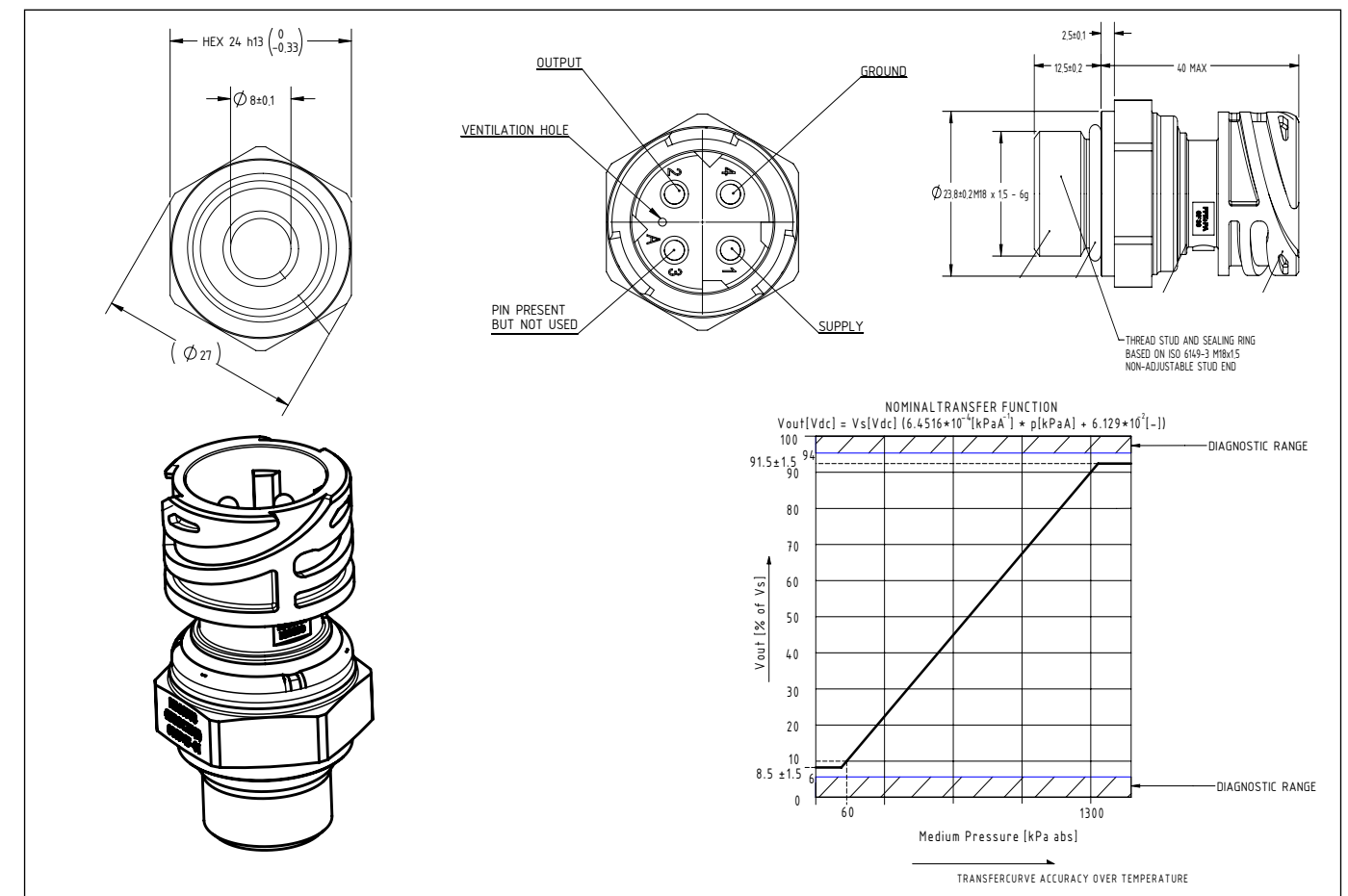
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





HYDRAULIC BRAKE PRESSURE SENSOR

MSG

Provides accurate pressure information to the hydraulic brake system.

BENEFITS

- Proven technology
- Helps reduce engine load
- Best cost performance
- Meets functional safety standards

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|---------------|
| Supply Voltage (Vs) | 5 V \pm 10% |
| Supply Current | 15 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Response Time | 2 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-4GHz) | >100 V/m |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|------------------------|------------------------------|
| Operating Pressure | 0-35 bar to 500 bar relative |
| Proof Pressure | 1.1 x FS min |
| Burst Pressure | 1.8 x FS min |
| Minimum Cycle Life | >10M FS Cycles |
| Vibration (50-2000 Hz) | up to 40g sine |

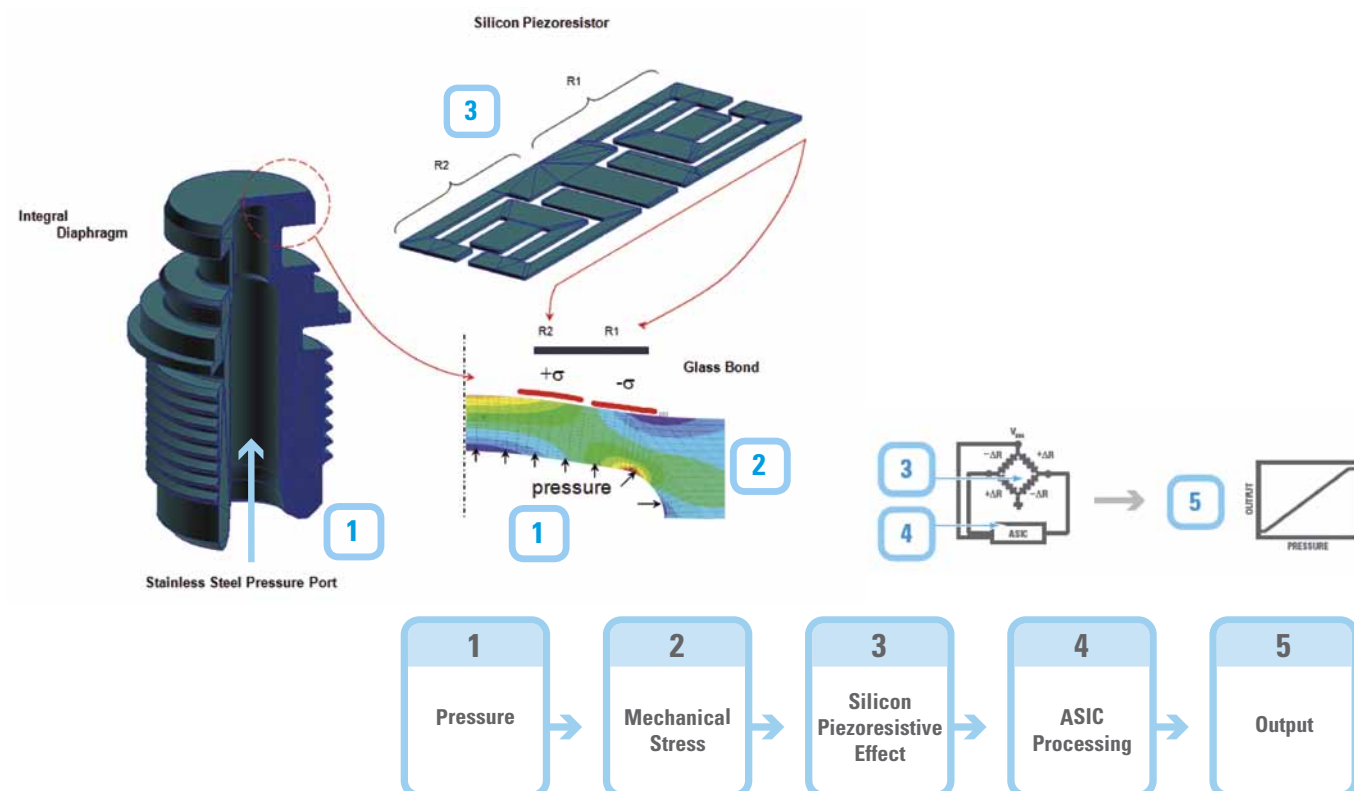
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +140°C |
| Storage Temp | -40 to +145°C |

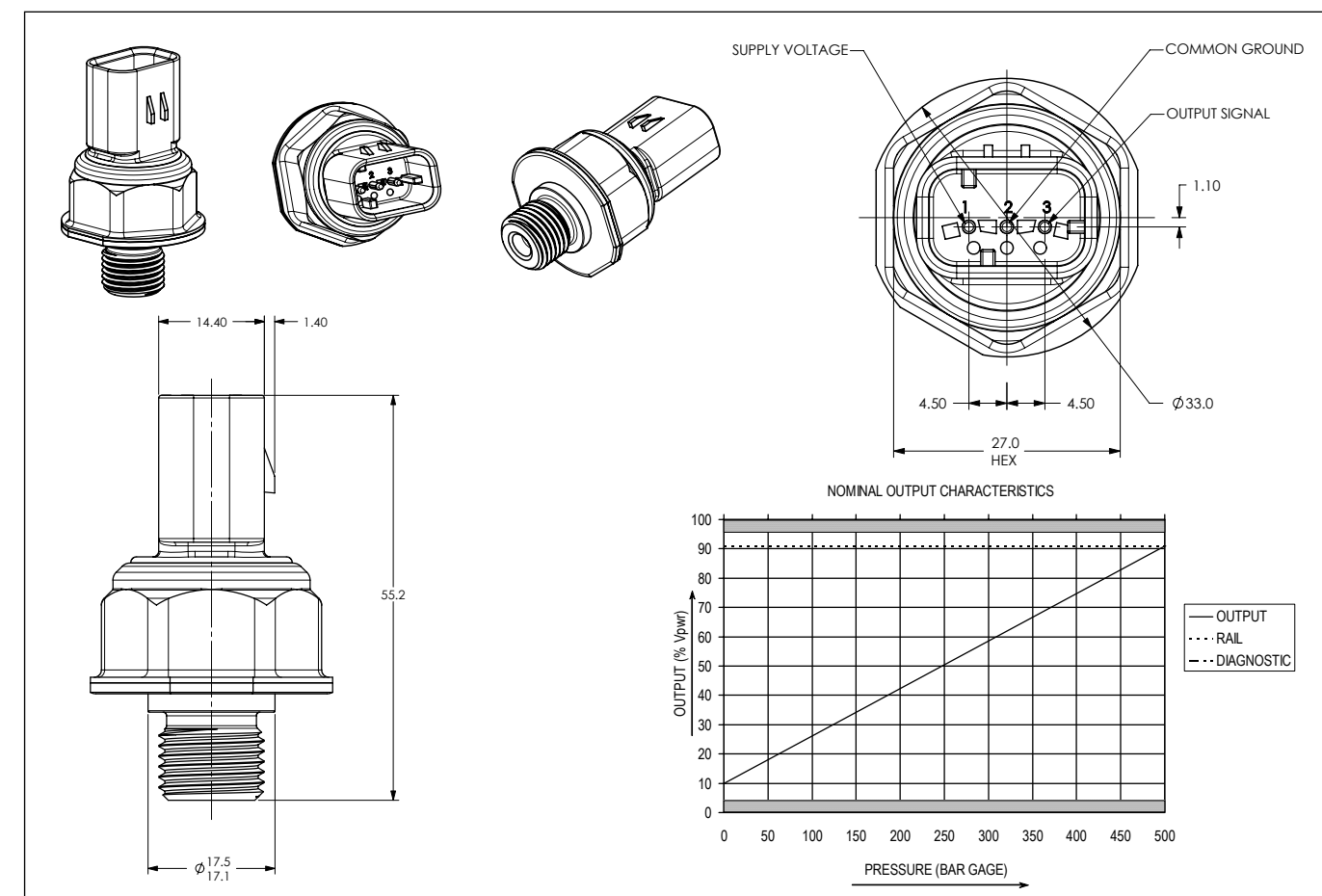
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +140°C | \pm 2.5% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





ELECTRONIC STABILITY CONTROL PRESSURE SENSOR MSG

Sensata's MSG, or Micro-fused Strain Gauge Technology is ideal for ESC applications. The integrated ASIC module provides a wide temperature working range and high accuracy signal output.

BENEFITS

- High accuracy signal output
- High reliability structure
- Multiple mounting methods available
- High medium compatibility

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|---------------|
| Supply Voltage (Vs) | 5 V \pm 10% |
| Supply Current | 15 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Response Time | 2 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-4GHz) | >100 V/m |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|------------------------|------------------------------|
| Operating Pressure | 0-35 bar to 500 bar relative |
| Proof Pressure | 1.1 x FS min |
| Burst Pressure | 1.8 x FS min |
| Minimum Cycle Life | >10M FS Cycles |
| Vibration (50-2000 Hz) | up to 40g sine |

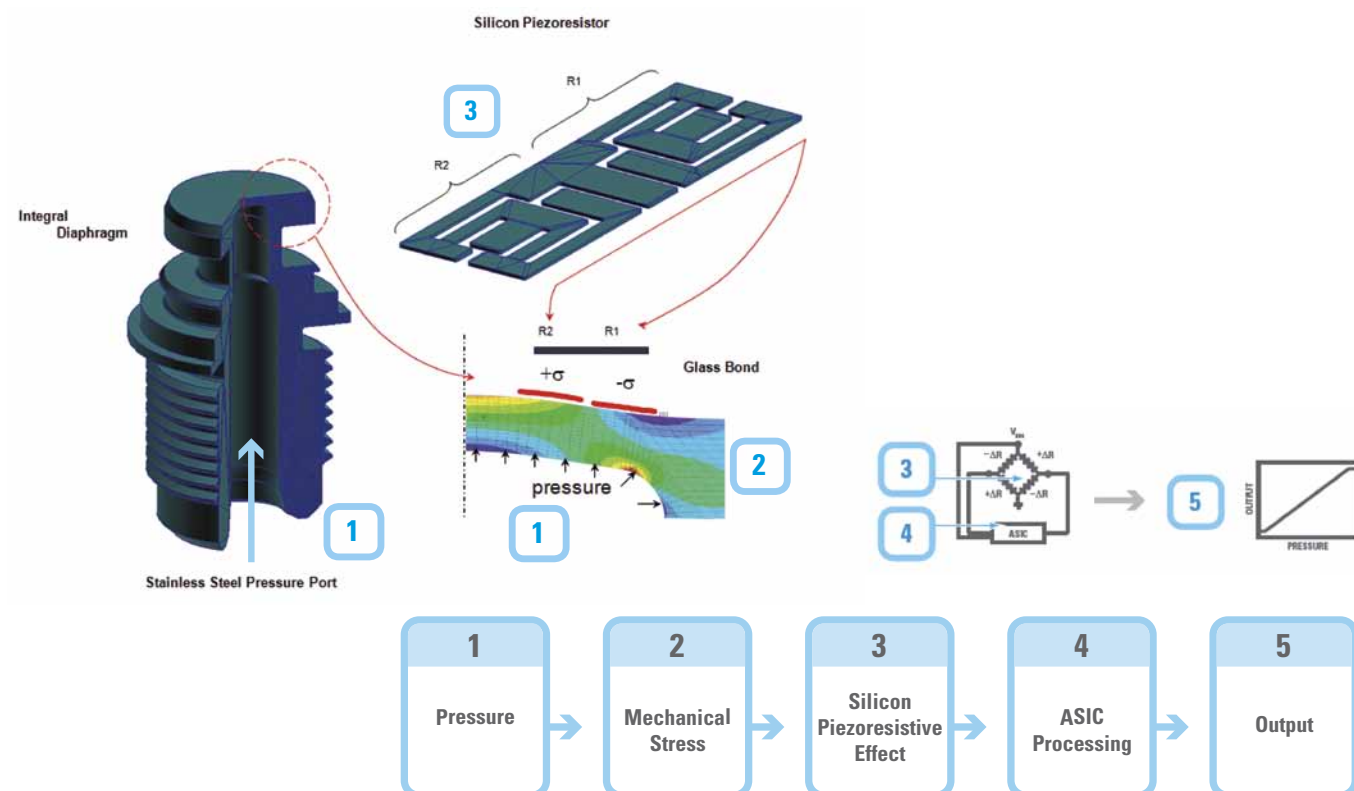
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +140°C |
| Storage Temp | -40 to +145°C |

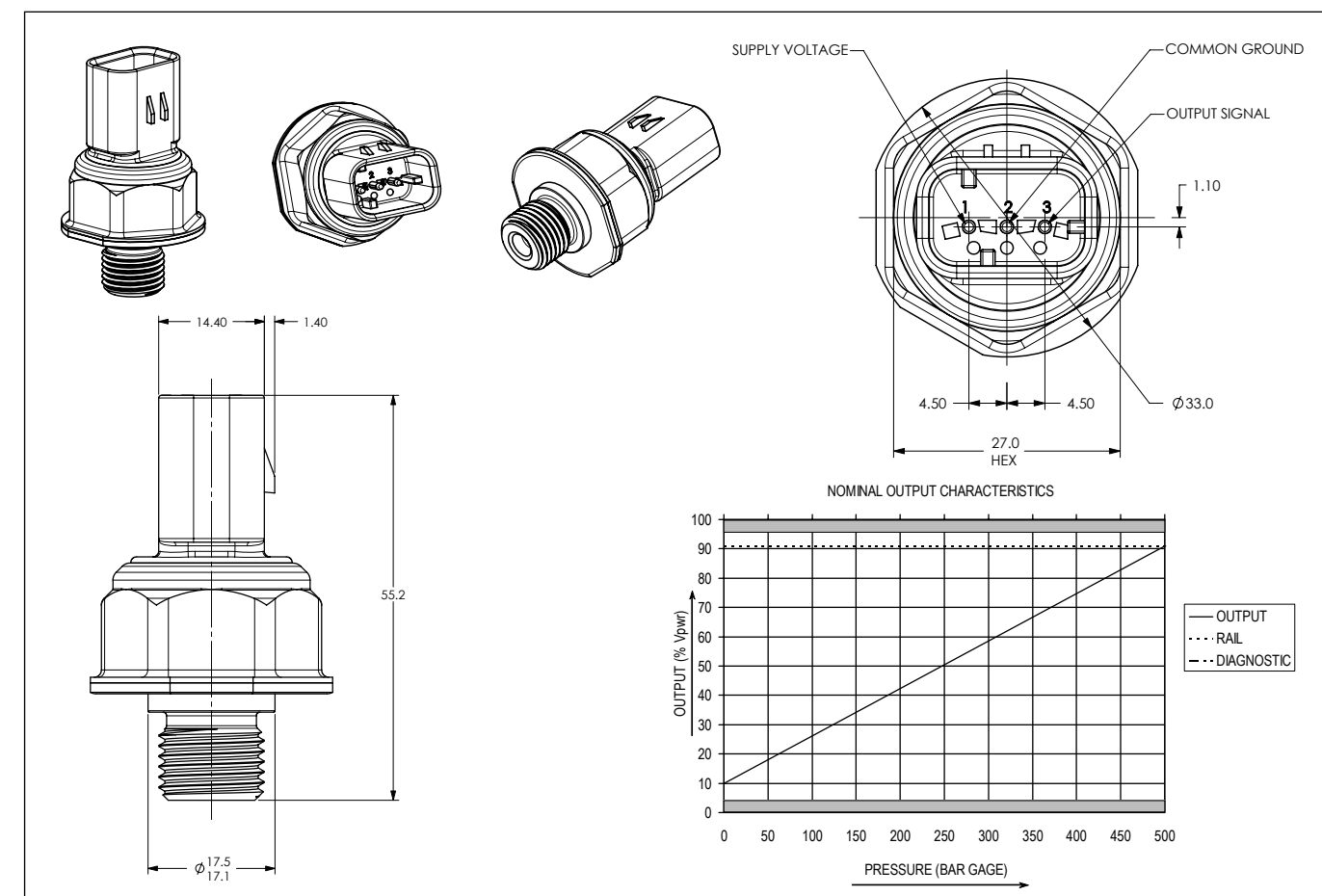
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +140°C | \pm 2.5% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





AIR SUSPENSION PRESSURE SENSOR APT

Sense the air pressure in an auxiliary air system.

BENEFITS

- Sensor designs available for in different pressure ranges
- Sensor designs available for use in humid air

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|--|
| Operating Pressure | 0-11 bar (variants up to 16 bar available) |
| Proof Pressure | >2 FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

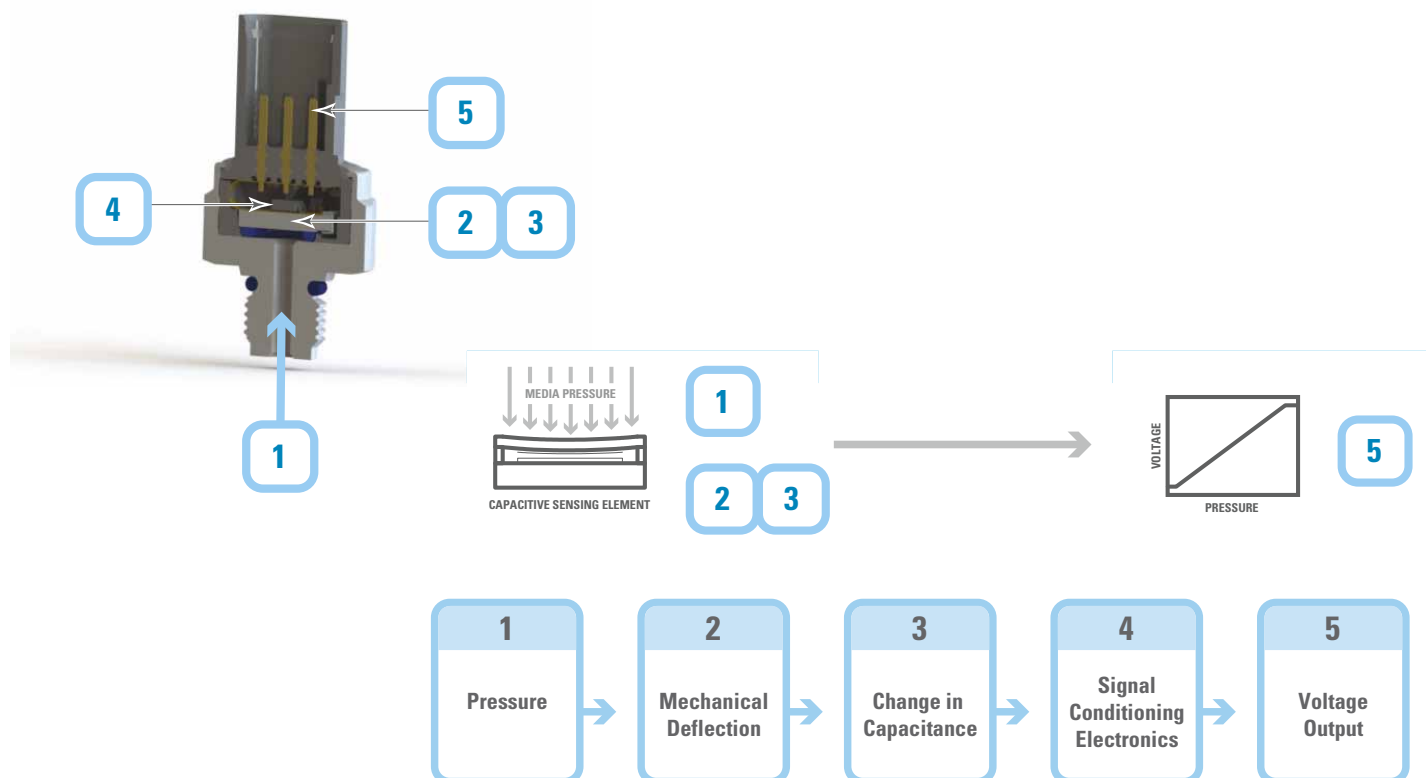
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

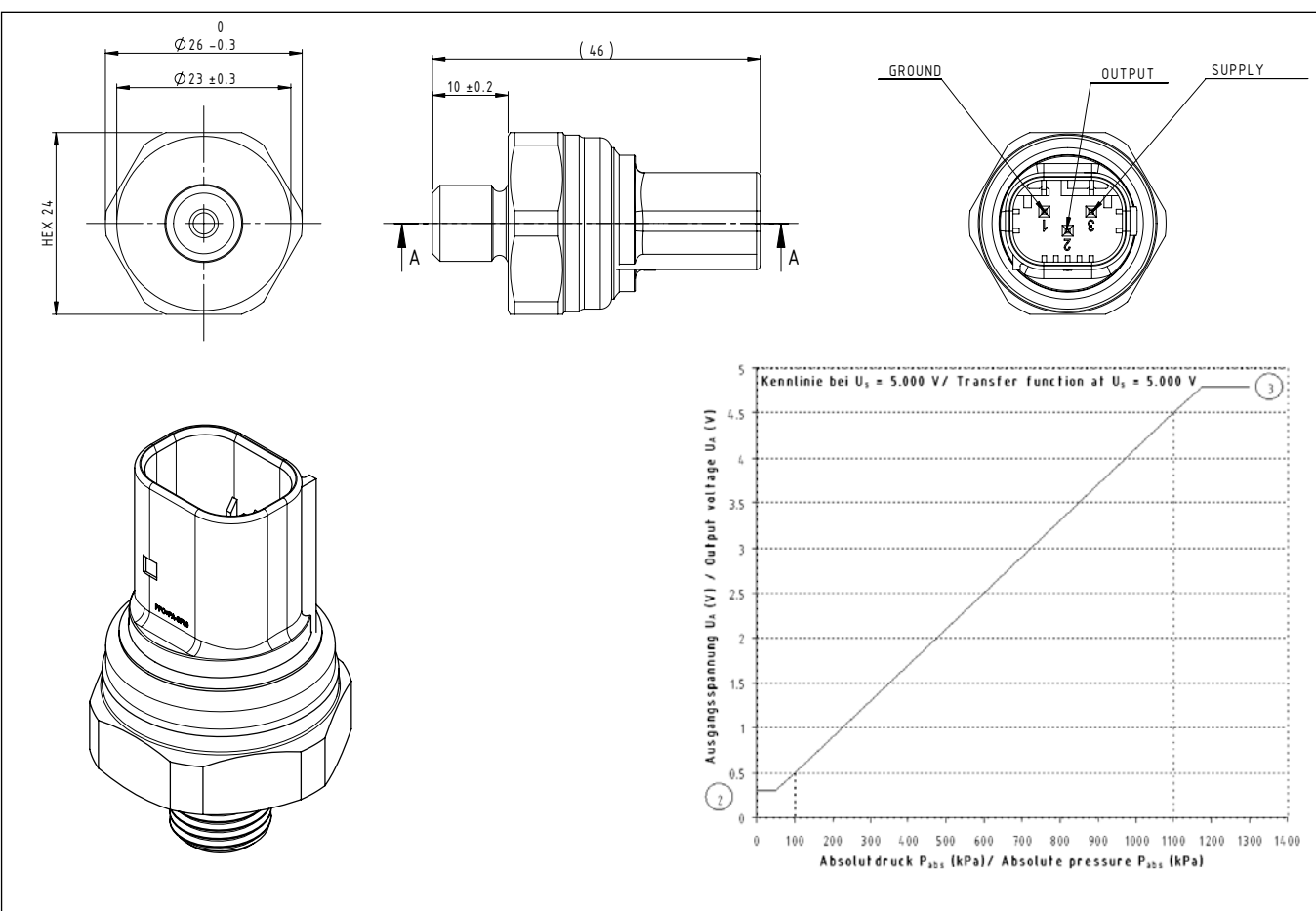
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 - to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





HYDRAULIC SUSPENSION PRESSURE SENSOR MSG

Measure the hydraulic pressure with a rugged design which survives over pressure spikes.

BENEFITS

- Allows direct measurement and control of hydraulics for modulating supply and saving energy consumption
- Measures pressure spikes used for safety and monitoring

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|---------------|
| Supply Voltage (Vs) | 5 V \pm 10% |
| Supply Current | 15 mA max |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vs |
| Response Time | 2 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (1 MHz-4GHz) | >100 V/m |
| ESD (ISO 10605) | >8 kV |

PHYSICAL

| | |
|------------------------|------------------------------|
| Operating Pressure | 0-35 bar to 500 bar relative |
| Proof Pressure | 1.1 x FS min |
| Burst Pressure | 1.8 x FS min |
| Minimum Cycle Life | >10M FS Cycles |
| Vibration (50-2000 Hz) | up to 40g sine |

ENVIRONMENTAL

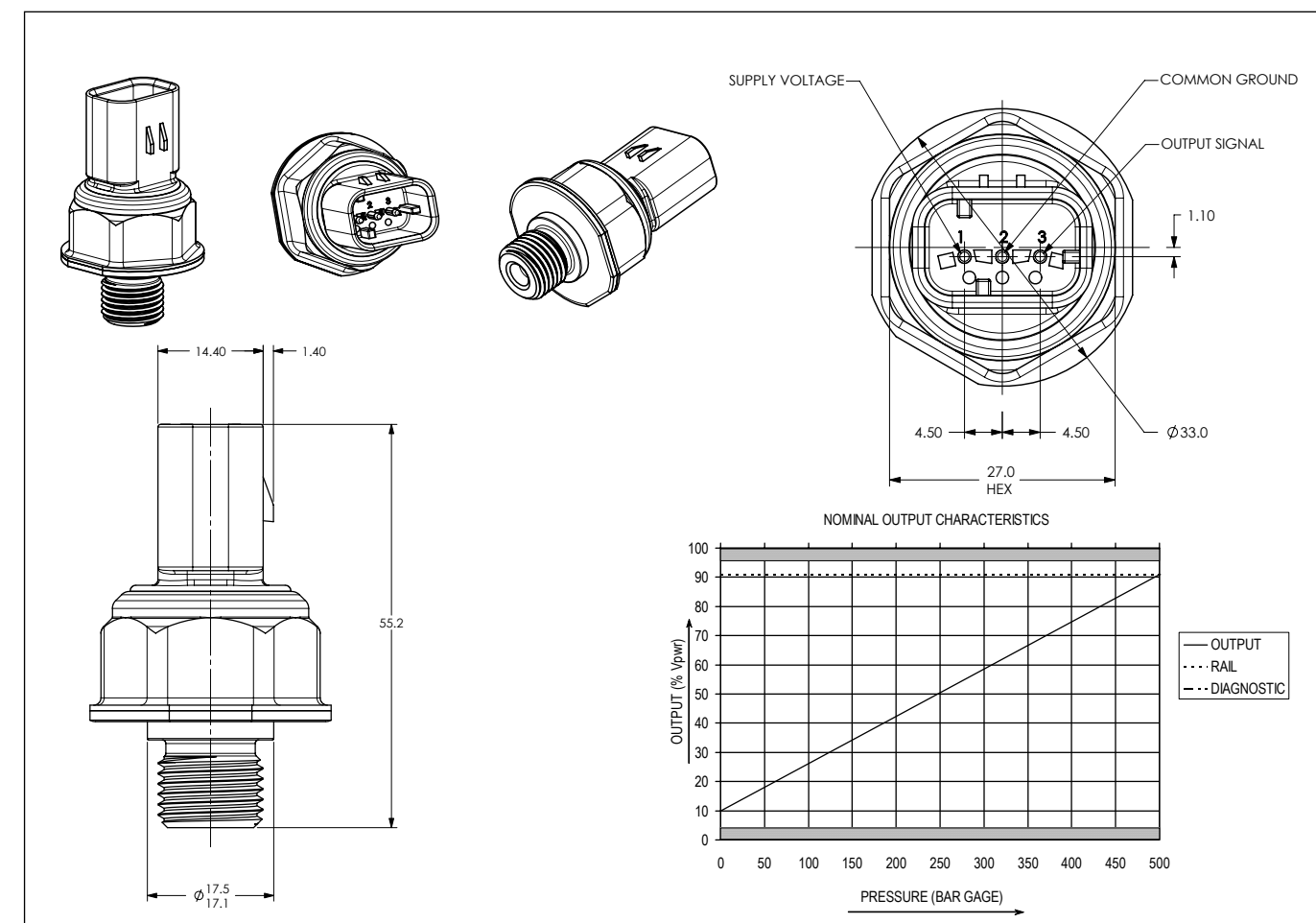
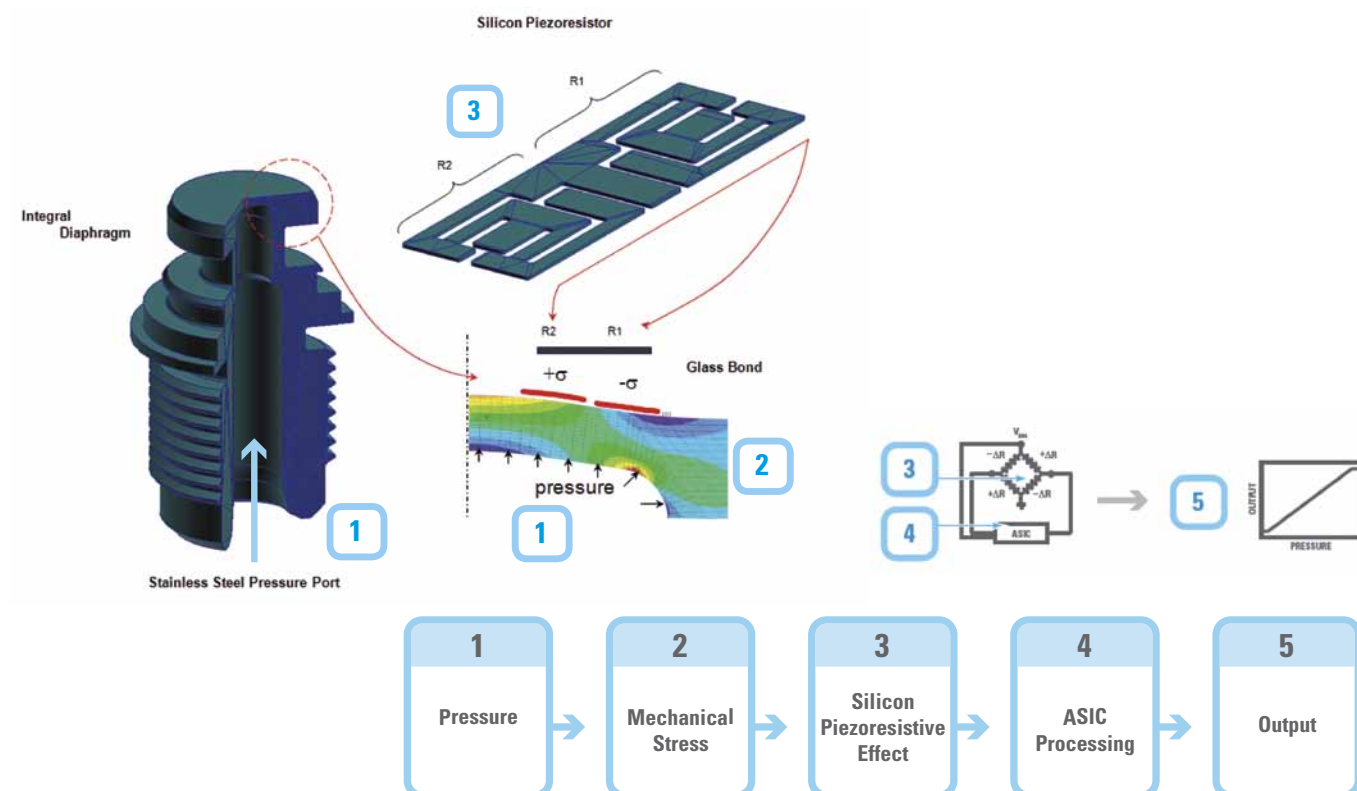
| | |
|----------------|---------------|
| Operating Temp | -40 to +140°C |
| Storage Temp | -40 to +145°C |

PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +140°C | \pm 2.5% FS |

DIMENSIONAL DRAWINGS & TRANSFER CURVE

HOW IT WORKS





WHEEL SPEED / ABS SPEED

9503

BENEFITS

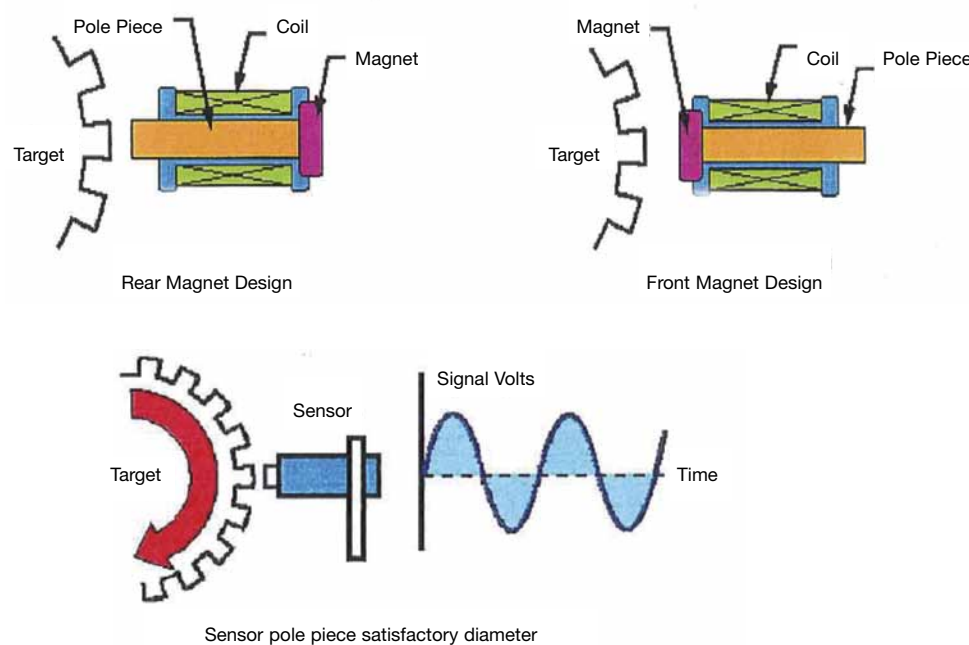
- Flexible design
- Proven in tough applications and environments
- Ideal for ABS applications

The 9503 Universal Leaded Speed Sensor (ULSS) was specifically designed with the tough requirements of the Heavy Vehicle and Off Road market in mind. It is ideal for ABS sensor applications, while offering customers flexibility in variations and features. The proven speed sensor has gone through vigorous testing, both in the lab and in the field. Sensata

Technologies has designed the 9503 ULSS device to be flexible. This allows customers to utilize the same basic package, but also to have their custom inputs. Areas for modifications include:

- Electrical characteristics (Output, Resistance, Inductance)
- Lead lengths
- Connector orientations
- Lead wire diameter
- Conduit options

HOW IT WORKS



TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|------------|--|
| Resistance | 1800 Ohms |
| Inductance | (Measured in series @ 1,000 Hz): 1.17H |

PHYSICAL

Available in straight or 90° right angle
Connector choice of DIN, Deutsch, Packard
Variable lead length
Robust product (stainless steel housing)

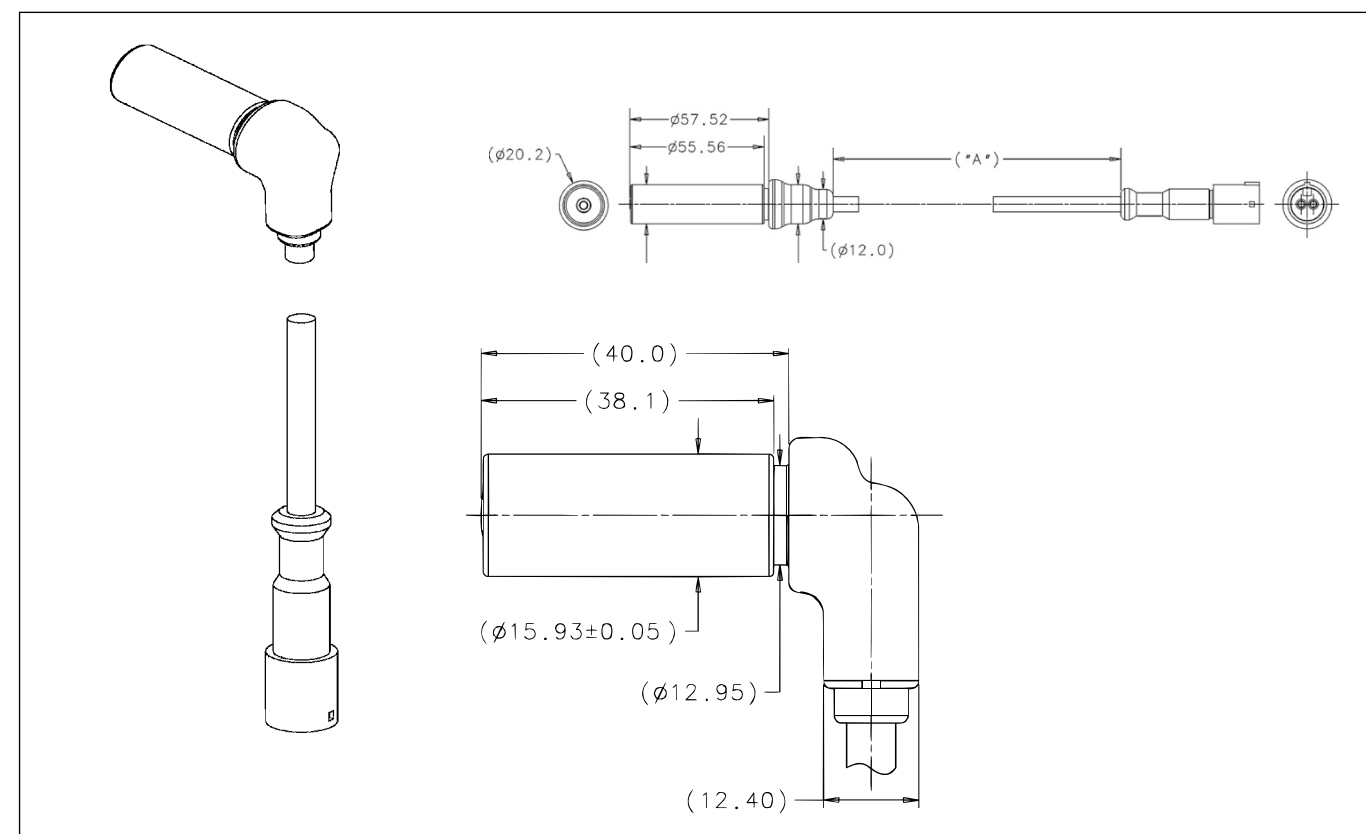
MECHANICAL TESTING

| | |
|-------------------------------------|--|
| Connector Retention Testing | 50N minimum |
| Pull Testing | Connector to cable - 250N minimum Sensor to cable - 445N minimum |
| Connector to Connector Mating Force | 100N maximum |

ENVIRONMENTAL TESTING

| | |
|--|---|
| Operating Temperature | -40°C to +160°C continuous; excursions to 180°C |
| Thermal Shock | -40°C to +150°C 200 cycles |
| Salt Spray | Per ASTM B117-94 200 hours |
| Humidity | 95% @ 55°C 28 days |
| Other testing includes Cyclic Corrosion, Chemical Resistance, High Pressure Spray, Hot and Cold Temperature Soak, Vibration and Bump Testing | |

DIMENSIONAL DRAWINGS



Bolt-on, dual output sensor that can be programmed to meet customer requirements within its 80 degrees travel range. The non-contacting 9631 Dual Output Position Sensor (DOPS) was designed for the tough requirements of the Heavy Vehicle and Off Road market. The sensor is RoHS compliant and operates with regulated 5V supplies. It features reverse voltage protection and is available in clockwise and counter-clockwise rotation versions. The fully sealed PCB construction meets IP standards.

- Customizable
- Small angle, dual output
- RoHS compliant
- Meets IP67 standards
- Long life
- Can be used in any application requiring redundancy

Diagram illustrating the Hall effect measurement setup and the resulting output voltage percentage based on the orientation of the magnetic field relative to the Hall plate.

The gauge shows the output voltage percentage, ranging from 10% to 90%.

Left Diagram: The magnetic field is parallel to the Hall plate. The output voltage is at 50% of the supply voltage.

Middle Diagram: As the component of magnetic field normal to the Hall plate increases, the voltage increases. The output voltage is approximately 65%.

Right Diagram: As the field rotates about the Hall plate in the opposite direction, the output decreases. The output voltage is approximately 40%.

| | |
|------------------------------|---|
| Supply Voltage (Vs) | 5.0V \pm 10% |
| Supply Current | 10mA Max |
| Reverse Voltage Protection | -14.0V Max. < 1 minute |
| Output | Programmable for slope and clamps |
| Independent Linearity | 45° travel \pm 1.5%Vs (All Conditions) 60° travel \pm 2.0% Vs (All Conditions) |
| Total Error | 45° travel \pm 3.0%Vs (All Conditions) 60° travel \pm 4.0% Vs (All Conditions) |
| Functional Electrical Range | 15° - 65° (Customer Specified) |
| Operational Electrical Range | 80° - Extended Specifications Apply |
| Output Modes | Analog, PWM and mix option available |

| | |
|-----------------|------------------------------|
| Rotational Life | >2M Cycles |
| Dither | >10M Cycles (2° Rotation) |

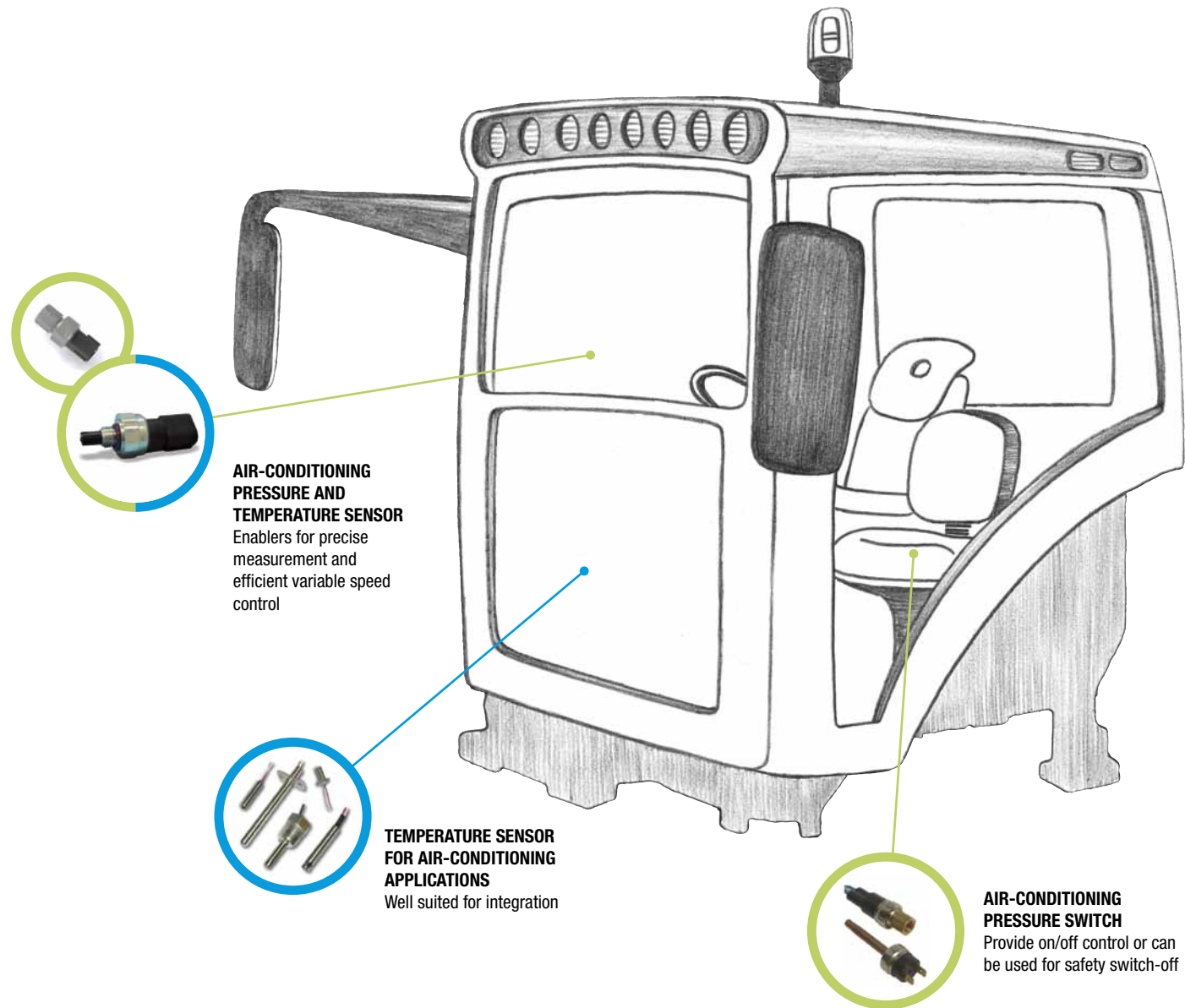
| | |
|-----------------------|-----------------|
| Operating Temperature | -40°C to +140°C |
| Storage Temperature | -40°C to +150°C |

| | |
|---------------------------|--------------------------------------|
| Mechanical Rotation Range | 83° End-Stop to End-Stop |
| Spring Torque | Minimum return 15 mNm |
| Fixing Torque | 3.5 Nm Maximum |
| Connector Type | Power & Signal (Metri Pack) 15397577 |

[illegible]

LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL



INTEGRATED CABIN COMFORT

Air-conditioning systems, being the single largest auxiliary load on the vehicle, increase fuel consumption.

Emission standards that are being implemented around the world provide the impetus for the HVAC industry to evaluate ever more efficient and cost-effective climate control concepts. Solutions for size reduction of the climate systems lie in developing advanced techniques for delivering heating and cooling to the occupants.

The sensor industry is driven by the need for fast response time and more sensitive sensors are required for monitoring the thermal comforts in the new designs of HVAC systems. Sensata offers a full range of pressure and temperature sensors and switches to optimize the control of the HVAC system.

AC PRESSURE SENSORS

Sensata is the world's leading supplier of pressure sensors for R134A AC applications. The pressure signal is used to support fan and compressor control. For applications that require in-stream temperature sensing at the same position of the pressure sensor, Sensata has developed an integrated P+T Sensor that offers unique integration opportunities.

Long-term reliability and accuracy are crucial in these applications and Sensata's range of sensors has proven to offer just that, especially in demanding AC applications.

AC PRESSURE SWITCHES

Whether providing reliable on/off control or offering an accurate safety switch function, Sensata's family of AC pressure switches meets the demanding needs of AC applications.

Originally developed for stationary HVAC and industrial applications, the 20PS family of switch products is a reliable choice for heavy equipment applications as well.

AC TEMPERATURE SENSORS

Stand-alone temperature sensing may be required at various locations within the AC system. Sensata offers a variety of temperature sensors capable of providing accurate and flexible control functions. Whether sensing temperatures of surfaces, liquids or ambient air, Sensata has the answer.



R134A AC PRESSURE SENSOR APT

The 2CP series is ideal for demanding AC applications where long-term reliability and accuracy is a must. It supports fan and compressor control by providing an accurate pressure signal. The patented ceramic sensing element and conditioning module provide high EMC performance.

BENEFITS

- Durable, compact, low-cost design
- Accurate performance over wide temperatures
- Overvoltage and short circuit protected
- Multiple thread parts provided
- Aluminium body weight less than 20 gram

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|----------------------------------|
| Electrical Connection | Nema 4X, IP65 |
| Supply Voltage | 4.5 to 5.5 VDC |
| Output Voltage | 0.5 to 4.5 VDC typical |
| Supply Current | 2.5 mA (max sunked or source) |
| Output Load | 10K ohms typical |
| Output Response Time | 10mS |
| Overvoltage Protection | 16 VDC |
| Reverse Voltage | -14 VDC |
| Short Circuit Protected | Yes |
| EMC (512MHz to 1 GHz) | 50 V/m |
| EMC (1 MHz to 512MHz) | 100 V/m |
| ESD (CDF-AEC-Q100-002) | 15 kV |

PHYSICAL

| | |
|------------------|--|
| Pressure Ranges | 0 to 1 bar, through 0 to 50 bar |
| Proof Pressure | -40°C to +150°C |
| Burst Pressure | 5X 1 to 5 bar, 3X 6 to 20 bar, 2X 33 bar |
| Cycle Life | 10M FS cycles |
| Random Vibration | 11g (50 to 2000 Hz) |
| Drop (any Axis) | 1.5m |

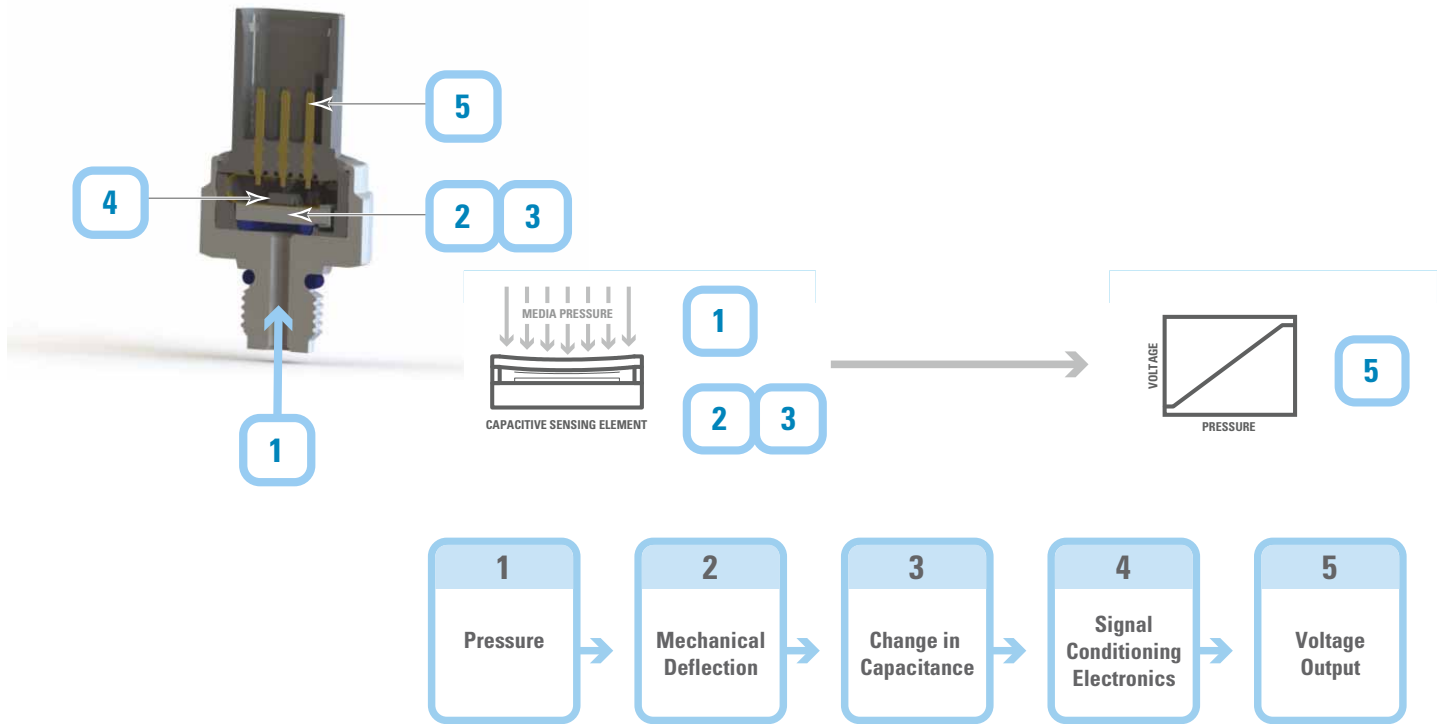
ENVIRONMENTAL

| | |
|-----------------------|--------------------------|
| Operating Temperature | ± 1.5% (-40°C to +125°C) |
| Storage Temperature | -40°C to +135°C |

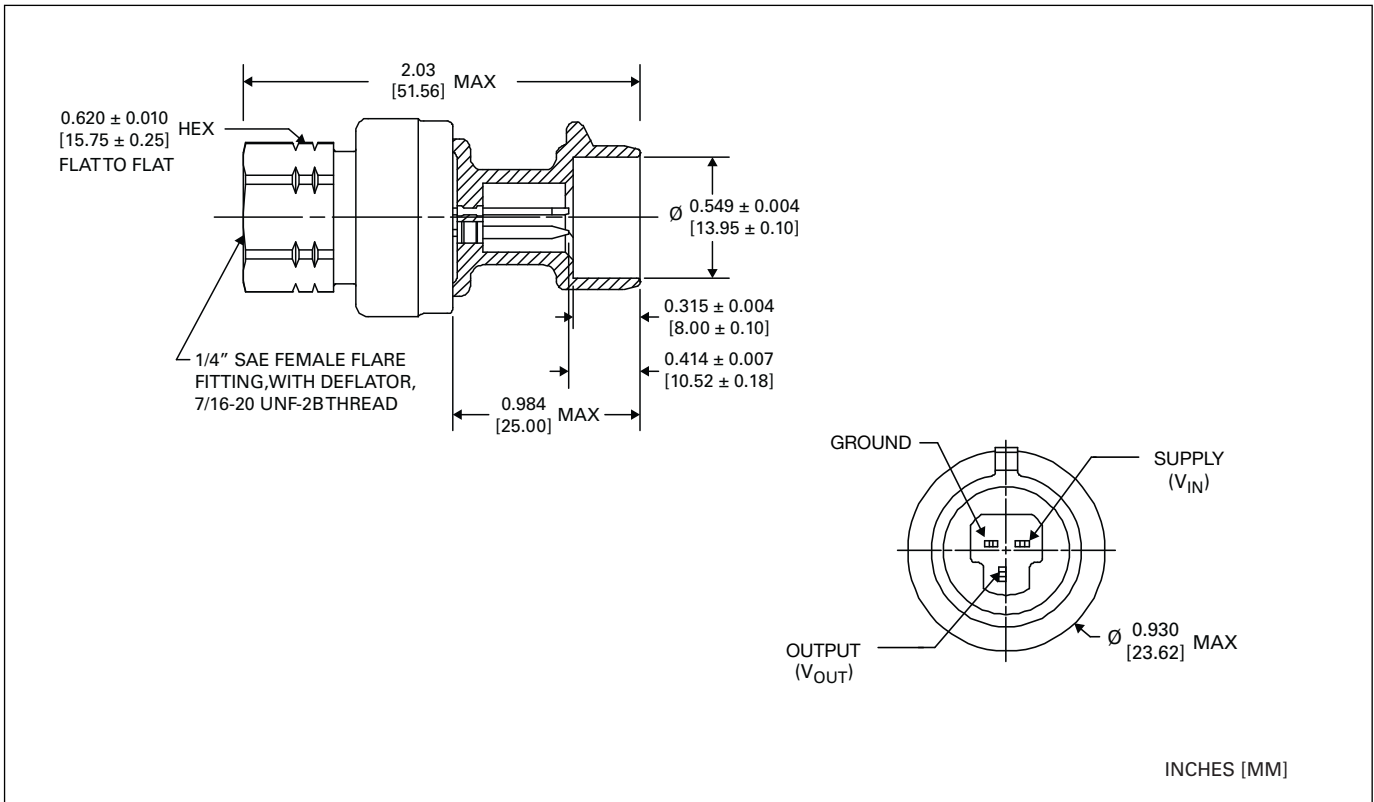
PERFORMANCE- ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|------------------|--|
| Accuracy | ± 0.8% FS Static error band @ 25°C, 5.0VDC |
| Total Error Band | ± 1.0% FS (-20°C to +80°C) |

HOW IT WORKS



DIMENSIONAL DRAWINGS





COMBINED PRESSURE & TEMPERATURE SENSOR **APT+T**

The 112CP series combined pressure and temperature sensors delivers the benefit of both pressure and in-stream temperature sensing in a single, robust integrated package.

BENEFITS

- Pressure and temperature measurement in one package
- Fast, in-stream temperature measurement
- Precise superheat measurement

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|----------------------------|-----------------|
| Resistance @ 25 C | 10K or 100 ohms |
| Supply Voltage (Vcc) | 4.5 to 5.5 VDC |
| Output Voltage | 0.5 to 4.5 VDC |
| Supply Current | 15.0 mA |
| Output Current | 8.0 mA |
| Output Load Range | 10K to 50K ohms |
| Overvoltage Protection | 16 VDC |
| Reverse Voltage Protection | -14 VDC |
| Output Response Time | 10mS |
| Electrical Connection | 4 pin AMP MQS |

PHYSICAL

| | |
|-----------------|----------------------------------|
| Pressure Ranges | 0 to 10 bar, through 0 to 45 bar |
| Proof Pressure | ≥2X |
| Burst Pressure | ≥3 X |
| Cycle Life | ≥1M cycles |
| Vibration | 5g |
| Drop (any Axis) | 1m |
| Weight | 1.5 oz max |

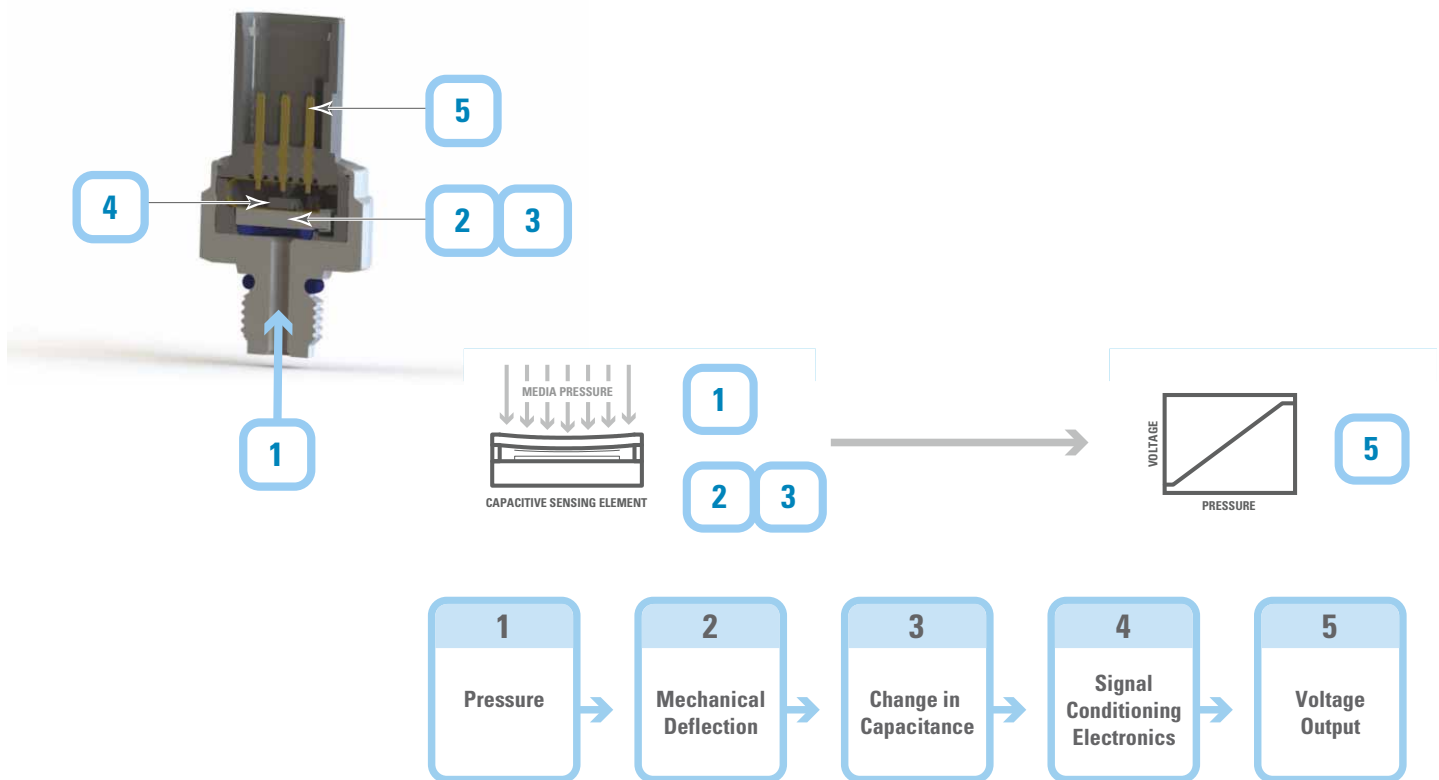
ENVIRONMENTAL

| | |
|-----------------------|-----------------|
| Operating Temperature | -40°C to +135°C |
|-----------------------|-----------------|

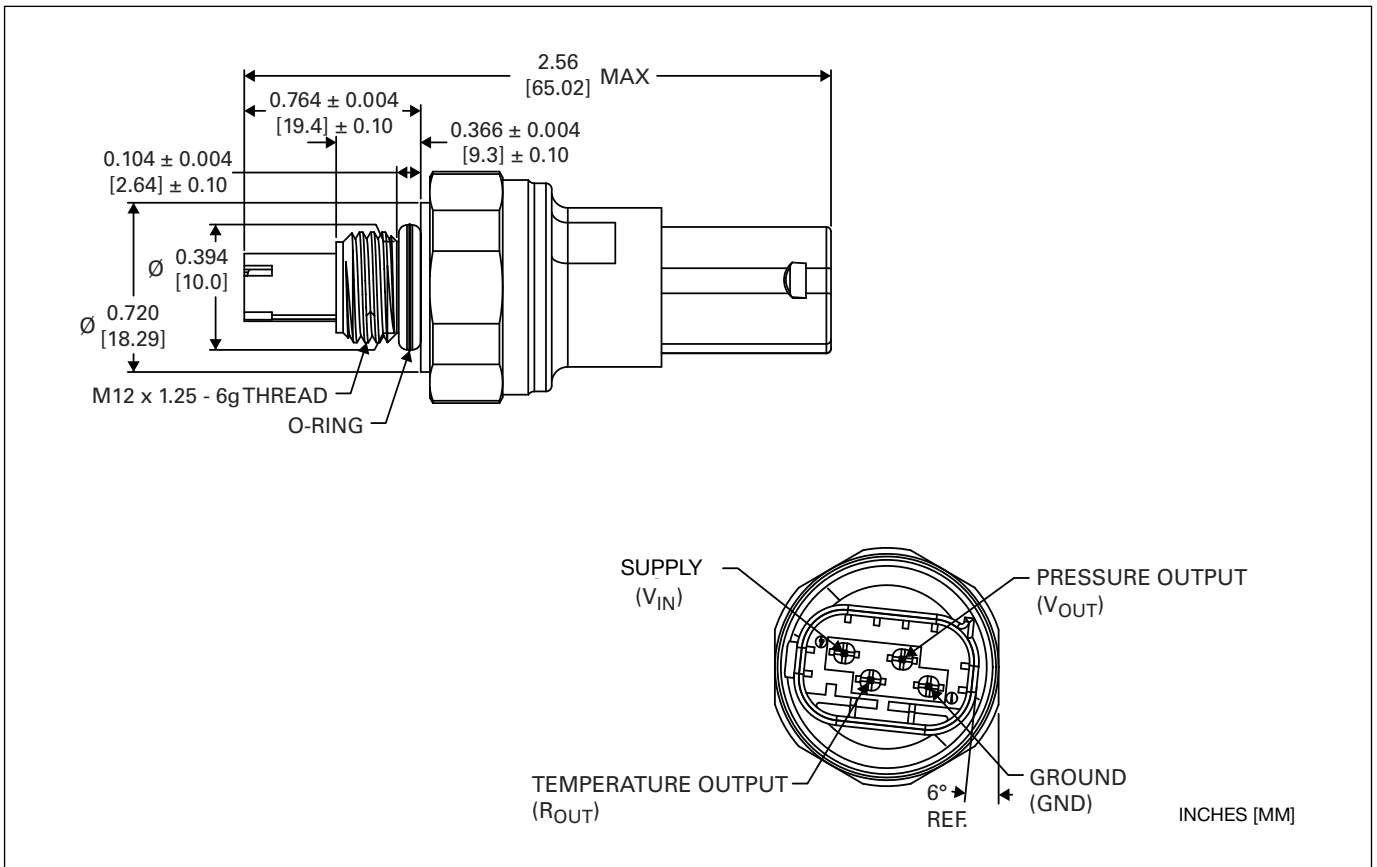
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|----------------------|--|
| Pressure Accuracy | ± 0.8% F.S. (Linearity, hysteresis, repeatability and calibration) |
| Total Error Band | ± 1.7% F.S. (0°C to +85°C) |
| Temperature Accuracy | ± 1%(delta R/R) |

HOW IT WORKS



DIMENSIONAL DRAWINGS





PRESSURE SWITCH 20PS

The 20PS Family of Switch products (20PS, 39PS, 40PS and 41PS) was developed to meet the demanding needs of HVAC & industrial applications. The reliable and durable construction allows the product to perform under severe environmental conditions and very high vibration levels.

BENEFITS

- Automatic Reset
- Single-pole, single throw switch, normally open or normally closed
- Factory calibrated set points from vacuum to 50 bar Snap acting Klixon™ stainless steel, hermetically sealed sensor
- Environmentally sealed or vented switch
- High cycle life - proven reliability
- Custom engineered solutions

TYPICAL SPECIFICATIONS

PHYSICAL

| | |
|--|------------------|
| Operating Pressure | Vacuum to 50 bar |
| Set Point | Proof Pressure |
| <6 bar | 17 bar |
| 6-33 bar | 41 bar |
| >33 bar | 55 bar |
| Higher pressure available for certain applications | |
| Burst Pressure | 333 bar |

DIELECTRIC STRENGTH

750 Vrms Open Contacts
1550 Vrms Terminals to Fitting

LEAD WIRE MATERIAL / ELECTRICAL CONNECTION

18 or 16 AWG 600V 105°C PVC
Quick Connects .250" x .032" Male Str. Tab
Various AMP, Delphi & Deutsch Connectors

LIFE AT RATED CURRENT

100,000 cycles (All - UL Recognition)
250,000 cycles (All except 20PS)

AMBIENT TEMPERATURE

-29°C to +80°C (20PS)
-40°C to +120°C (40/41PS)

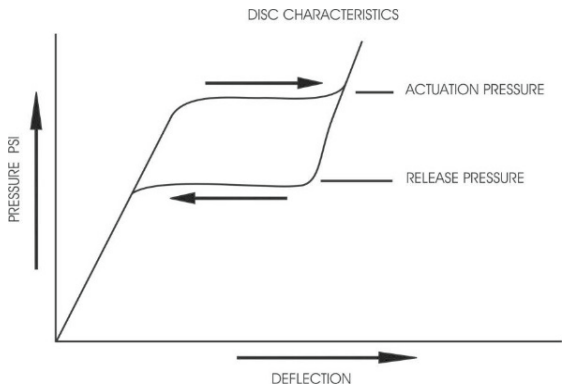
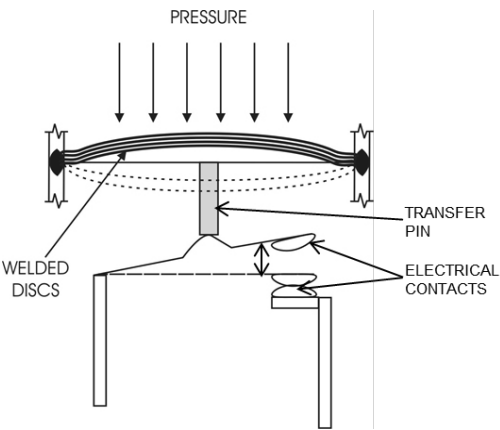
ELECTRICAL RATINGS

120 VAC - 5.8 FLA 34.8 LRA
240 VAC - 2.9 FLA 15.0 LRA
120/277 VAC -375 VA Pilot Duty
24 VAC - 125 VA Pilot Duty

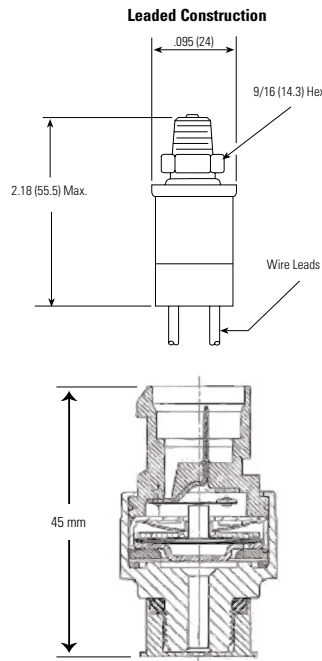
FLUID TEMPERATURE

-53.9°C to +135°C

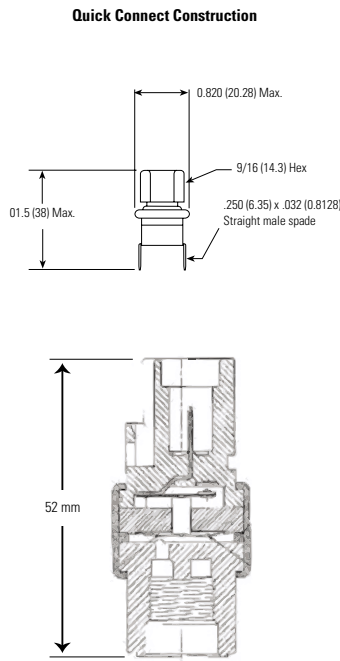
HOW IT WORKS



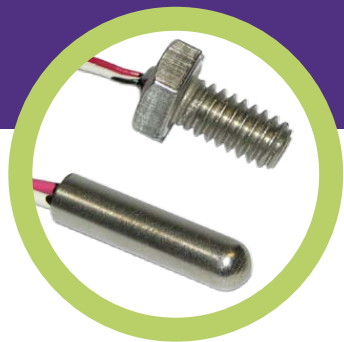
DIMENSIONAL DRAWINGS



Dual Function Pressure Switch
(HPCO / Fan or HPCO / HSLP)



Compressor Cycling Switch / Loss of
Charge



TEMPERATURE PROBES

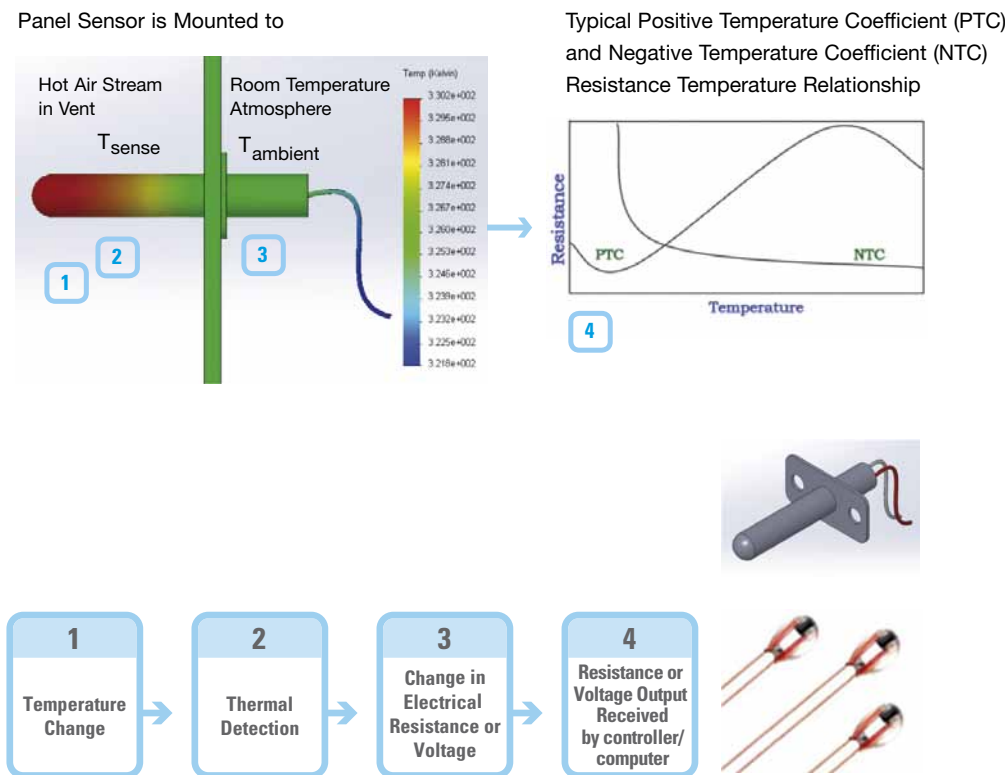
AIRPAX 3000 SERIES

An ideal solution for monitoring and regulating temperature in equipment and processes, the 3000 series offers the choice of thermistor, RTD or Integrated Circuit (IC) temperature sensing technology. Whether surface, liquid, or ambient air sensing is required, the Airpax™3000 series offers an optimal probe assembly. Flexible leads suitable for welding or soldering provide reliable connections and greater access to remote locations.

BENEFITS

- Ideal for immersion, surface and air sensing
- Thermistor, RTD or IC sensing technologies
- Stainless steel probe assembly
- RTD, IC and Thermistor Sensing
- -40°C to +150°C exposure temperature Range
- Housing configurations allow for fluid & surface temperature sensing

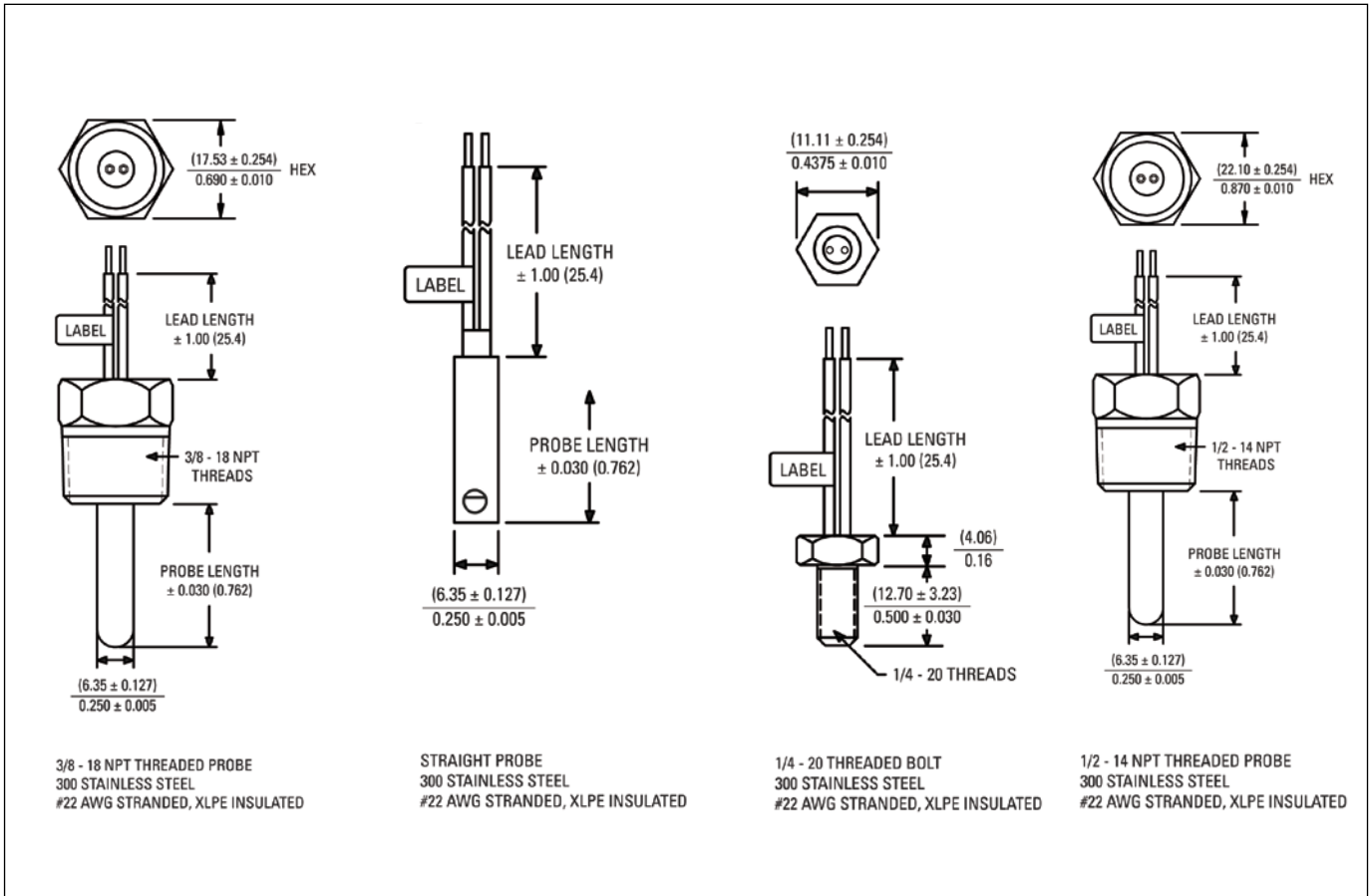
HOW IT WORKS



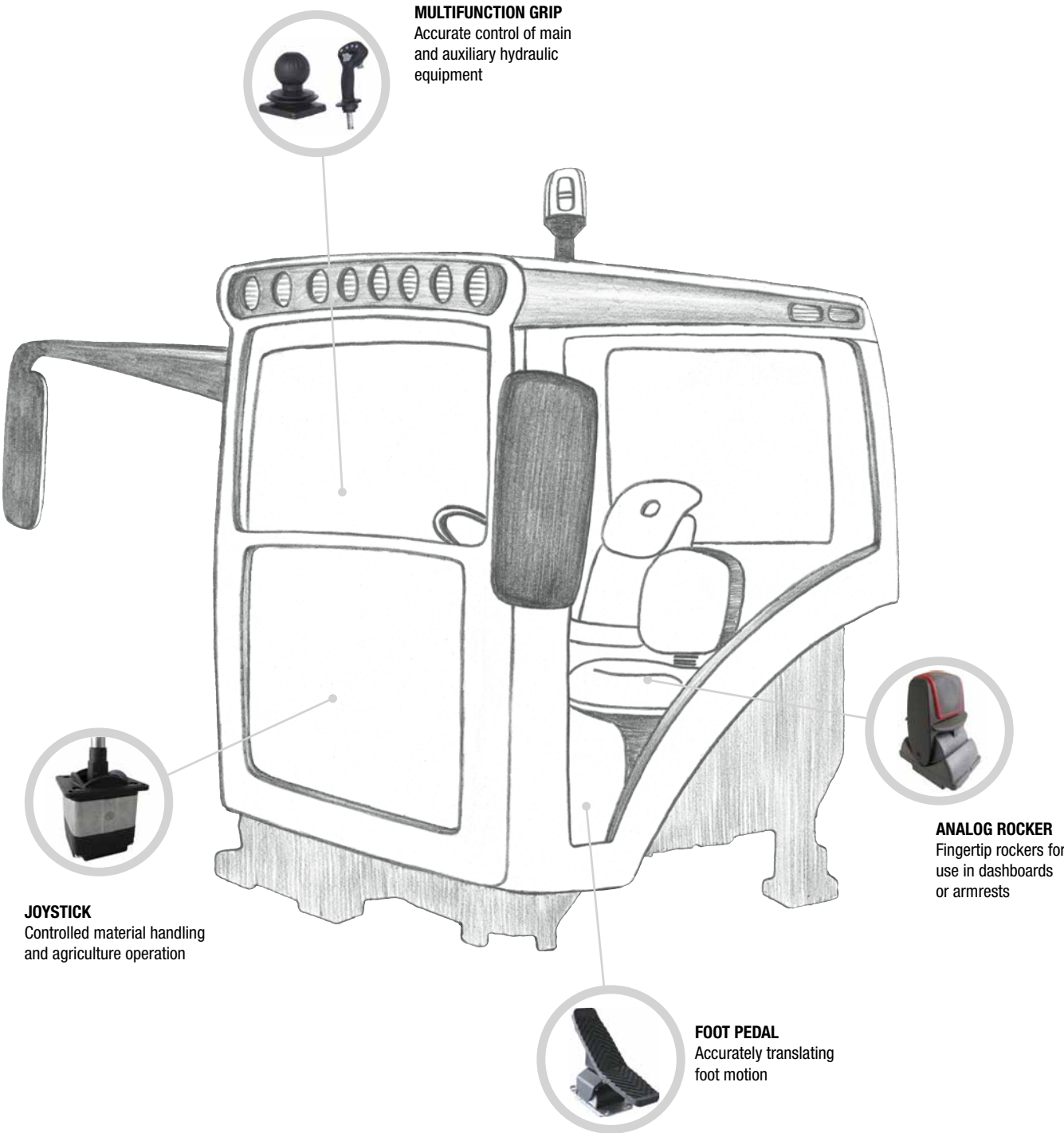
TYPICAL SPECIFICATIONS

| SENSOR SELECTION | | | | | | |
|------------------|------------|---------------|--------------------|-----------------------------|--------------------|-------------------|
| Code | type | input | output | output change w/temperature | tolerance | temperature range |
| 10 | RTD | 1 mA | 100Ω at 0°C | 0.385Ω per °C | ± 0.06Ω at 0°C | -40°C to 125°C |
| 11 | RTD | 1 mA | 100Ω at 0°C | 0.385Ω per °C | ± 0.12Ω at 0°C | -40°C to 125°C |
| 15 | RTD | 1 mA | 1,000Ω at 0°C | 3.85Ω per °C | ± 1.2Ω at 0°C | -40°C to 125°C |
| 20 | IC | 4 to 30 VDC | 0.000 Volts at 0°C | 10mV per °C | ± 1°C at 25°C | 0°C to 100°C |
| 21 | IC | 2.7 to 10 VDC | 0.600 Volts at 0°C | 10mV per °C | ± 3°C at 25°C | -25°C to 85°C |
| 30 | Thermistor | 10 mA | 1,000Ω at 25°C | NON-LINEAR (PTC) | ± 1.3°C at 25°C | -40°C to 125°C |
| 31 | Thermistor | 0.4 mA | 10,000Ω at 25°C | NON-LINEAR (NTC) | 0.2°C, 0°C to 70°C | -40°C to 125°C |

DIMENSIONAL DRAWINGS



- LEGEND:
- TEMPERATURE
 - PRESSURE
 - SPEED / POSITION
 - OPERATOR CONTROL



OPERATOR SENSING CONTROLS

Construction and agriculture equipment are some of the most demanding applications for operator controls. Sensata offers a range of products that makes this equipment more reliable, more efficient and more capable.

Sensata’s range of Operator Sensing Controls offers a variety of electromechanical devices that allow a precise translation of the operator’s intentions to the moving parts of the equipment.

The mechanical portion of the system provides precise and intuitive feel to the operator, the electronics connect the feel to the machine.

Today’s agriculture, construction and material handling equipment must have the ability to operate under diverse and often adverse conditions. Customers depend on reliability at all times, especially when it matters most.

Having been designed and thoroughly tested in the harshest of environments, the electromechanical solutions offered by Sensata’s portfolio of rockers, switches, grips and joysticks offer reliable, premium haptics under all conditions. Ergonomic shape and operation make them ideal for mounting on hydraulic levers, electronic joysticks and more.



MULTIFUNCTION GRIPS

MFG

The Multifunction grips (MFGs) from Sensata provide the reliability required in demanding environmental conditions. The high mechanical strength of the shaft and the unique look-and-feel make them ideal for rigorous use in rugged, harsh environments. MFGs can be used individually or in combination with Sensata's joysticks.

BENEFITS

- Ergonomic shape and controls position
- Variable functions and mountings
- Grips mountable for left and right handed usage
- Premium haptic feedback
- Available with various switch and analog rocker options to meet application needs

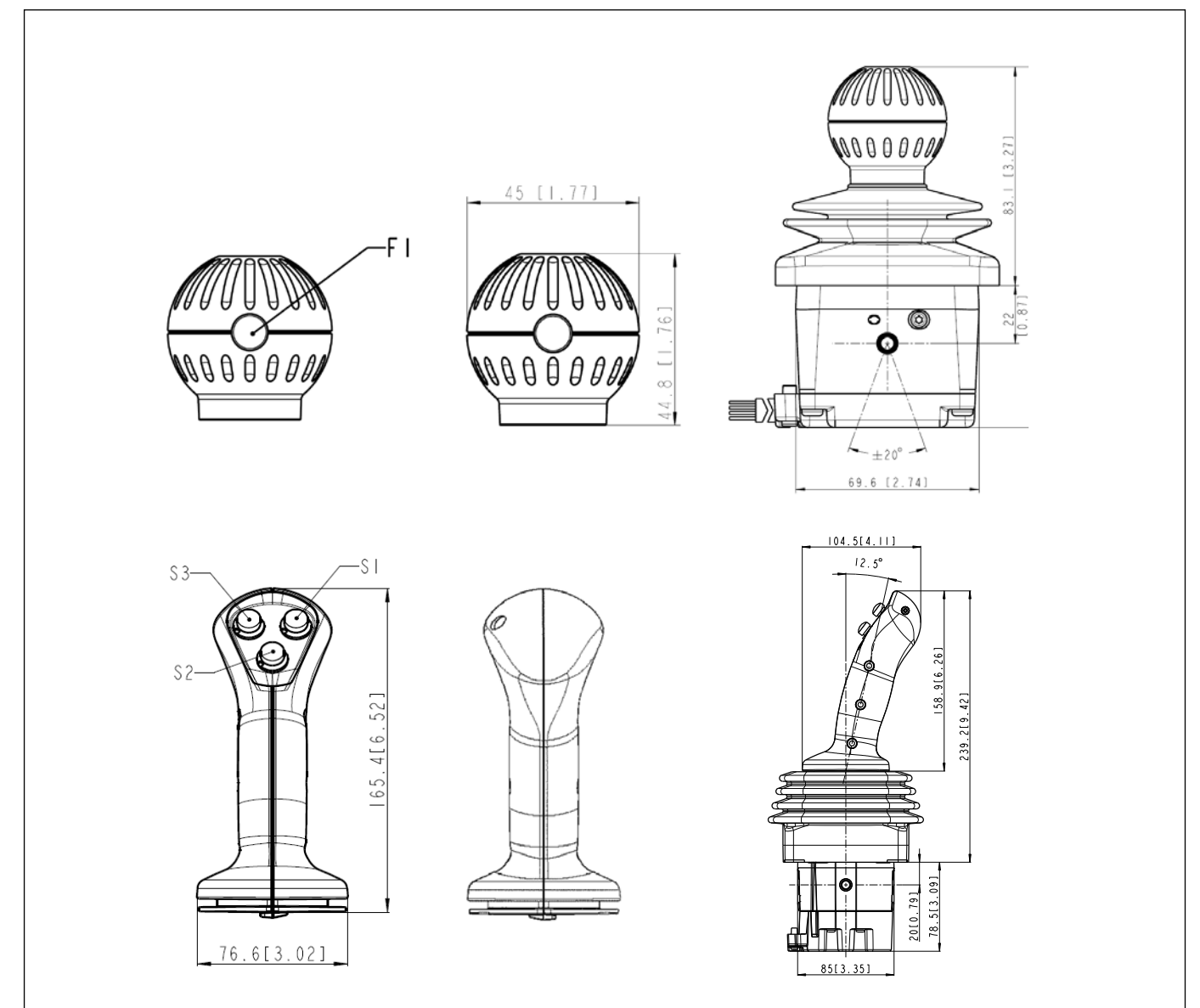
EXAMPLE CONFIGURATIONS



TYPICAL SPECIFICATIONS

| | |
|--------------------|-------------|
| Signal | Value |
| V bat | 8V...30V |
| GND | |
| Output center pos. | 0V/Ubat |
| Output X-Axis | 0,5V...4,5V |
| Output Y-Axis | 0,5V...4,5V |

DIMENSIONAL DRAWINGS





JOYSTICKS

AJ

The Joystick family from Sensata are an excellent solution for demanding environmental conditions such as construction material handling and agricultural applications.

BENEFITS

- Contactless Hall sensor
- Life > 10 million cycles
- Potted electronics
- Integrated temperature compensation
- Standard or customized multifunction grips
- Various output options
- Customizable travel angle
- High overload force
- Various detent options available

EXAMPLE CONFIGURATIONS



TYPICAL SPECIFICATIONS

| ELECTRICAL DATA | VARIANT | |
|----------------------------------|---------|---------------------------------|
| Supply Ratings | | 12V or 24V dc |
| System Voltage | | 7V ... 36V |
| Maximum current | | 180 mA at 24V dc |
| Voltage Output | | |
| (maximum output current 5 mA) | VO2 | 0 ... 5V dc |
| | VO8 | 0.5 ... 4.5V dc |
| | VO9 | 25% Vsupply ... 75% Vsupply |
| PWM Output | PW2 | 500 Hz ± 80 Hz |
| CAN Bus Output | CAO | CAN open |
| | J19 | SAE J1939 |
| Output Center position | C2 | Inactive 0V / active 5V ** |
| (signal) | C3 | Inactive 0V / active Vsupply ** |
| Other electrical Characteristics | EMI | 100 V/m |

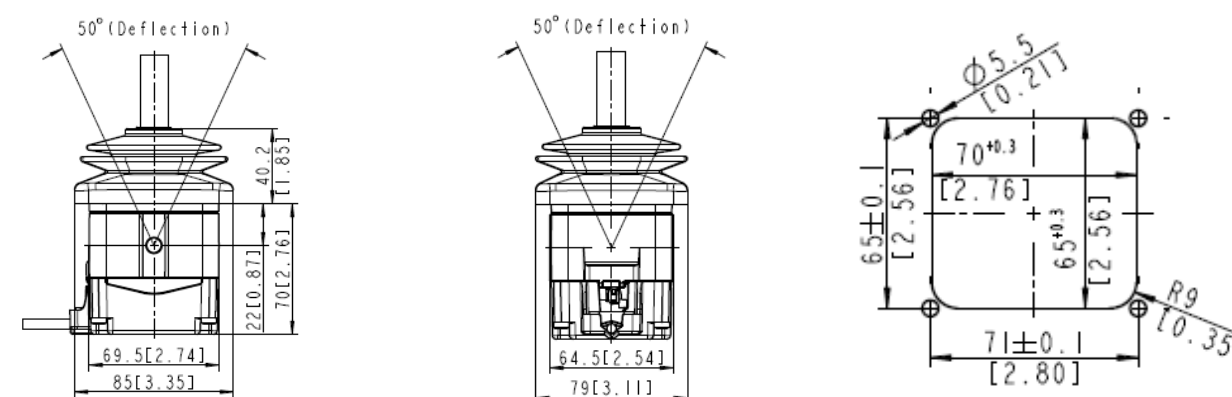
MECHANICAL DATA

| | |
|--|---|
| Life | > 10M cycles (equivalent > 20M movements) |
| Operating temperature | - 40°C to 85°C |
| Storage temperature | - 55°C to 90°C |
| Operating torque (measured 140 mm from pivot point) | 0.56 Nm, 1.2 Nm, 1.7 Nm, 2.2 Nm |
| Horizontal load maximum | 150 Nm |
| Vertical load maximum | 1000 N |
| max. Torque (Z-axis) | 20 Nm |
| Protection Level | IP 67 |
| Gate options | square, cross, single axis * |
| Lever deflection X/Y | ± 20°, up to ± 25° possible * |
| Dead band | < ± 2° |

* others available on request

** active, if the lever is in the center position inactive, if the lever is outside of the center position

DIMENSIONAL DRAWINGS





ANALOG ROCKERS

AR

Sensata's Analog Rockers have been developed to provide the reliability required in demanding environments - such as dashboards or arm-rest controls - for heavy duty industrial and off-road applications.

The unique design makes the rocker module an ideal proportional function solution for off-road machinery for cost-effective custom designs.

BENEFITS

- Contactless sensing – Hall effect
- Rocker life > 2 million cycles
- Optional: detent, life > 200K cycles
latching, life > 100K cycles
- Single sensor – optional second sensor for redundancy
- Integrated temperature compensation
- Short circuit protection
- Ideal solution for fingertip rocker designs
- Potted electronics
- Deflection angle
- Detent / Latching detent
- Lever design allows for usage of longer levers
- Connector / Harness

EXAMPLE CONFIGURATIONS



TYPICAL SPECIFICATIONS

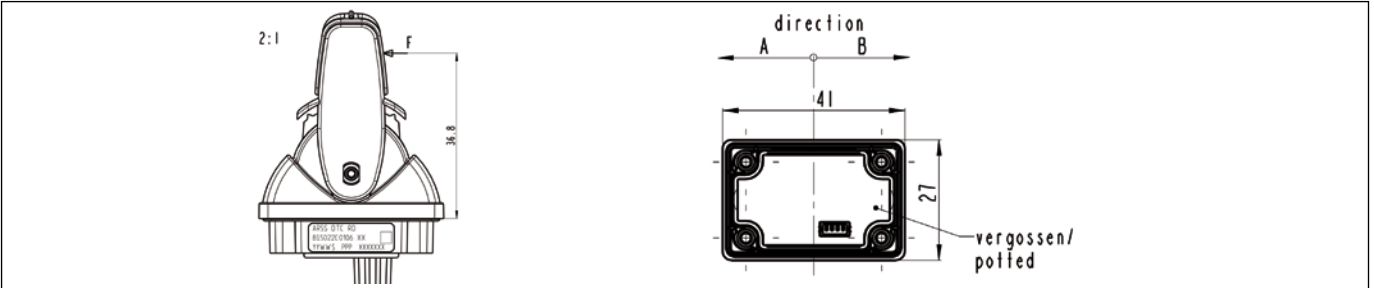
| ELECTRICAL DATA | | |
|----------------------------------|------------------|-------------------------------------|
| Supply Ratings | Voltage range DC | 5.0V ± 5% |
| Voltage Output | current | max. 30mA |
| | T ambient | 25°C, Vcc = 5V |
| Pull-down resistor | Recommendation | Output proportional to Vcc 4.7kΩ |
| Output current | | 1 mA max. |
| Other electrical Characteristics | EMI | > 100 V/m |

| MECHANICAL DATA | |
|-------------------------|---|
| Life: | - rocker - detent - latching |
| | > 2M cycles (equivalent > 4M movements) > 200k cycles > 100k cycles |
| Operating temperature | |
| - Storage | - 40°C to 85°C |
| - Working | - 40°C to 85°C |
| Operating force | 4-6 N |
| Vertical load maximum | 30 N |
| Protection Level | IP 67 |
| Rocker deflection angle | ± 43° max. |
| * for redundant version | |

| | | | | |
|--|-------------------------------------|-----|--------|----------------------------------|
| Deflection Angle | 40/40 = ± 40° | PIN | SIGNAL | FUNCTION 5V |
| Detent* | D26/26 = standard ± 26 detent | 1 | Ub* | Not connected |
| Latching* | L32/32 = standard ± 32 latching | 2 | GND | Reference Ground |
| Electrical supply | 1 = 5 V ± 5% | 3 | Vcc* | Supply Voltage |
| Sensors | 2 = 2 sensors (for redundancy) | 4 | Out1 | Output Signal |
| Output Voltage Code ** | 00 = output 1 / 0.5 V ... 4.5V; 1mA | 5 | Out2* | Optional redundant Output Signal |
| | Output 2 / 4.5V ... 0.5V; 1mA | | | |
| *detent and latching position must be taught-in in application | | | | |
| **ratiometric to 5V supply | | | | |

```
graph LR
    PS[Power Supply] --- GND[GND]
    PS --- Out1[Out1]
    PS --- Out2[Out2*]
    HAL1[HAL1] --- Out1
    HAL2[HAL2*] --- Out2
```

DIMENSIONAL DRAWINGS





FOOT PEDALS

FP

The foot pedals from Sensata have been developed to provide the reliability required in demanding environmental conditions such as heavy duty industrial applications. The FPs have been designed to accommodate standard and custom designed pedal lever.

BENEFITS

- Contactless sensing
- Life greater than 3 million cycles
- 2 sensors for redundancy
- Optional rubber lever cover
- Integrated temperature compensation
- Protection Class IP67
- Available in a voltage (VO) version or a CAN (CA) solution

EXAMPLE CONFIGURATIONS



TYPICAL SPECIFICATIONS

ELECTRICAL DATA FP CA (CAN)

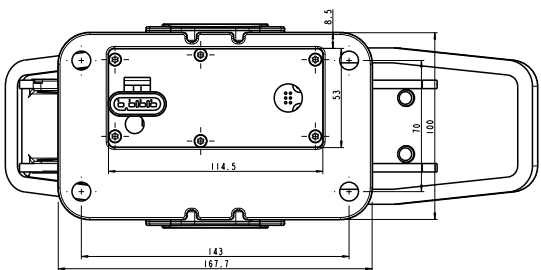
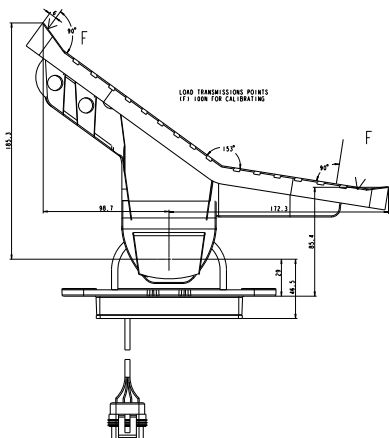
| | | |
|----------------------------------|------------------|------------------------------|
| Supply Ratings | Voltage range DC | 9V ... 36V |
| | Current | max. 85 mA |
| | System Voltage | 12 /24V |
| Dead band at end of travel | | max. 5 % |
| Other electrical Characteristics | EMI | ≥ 100V/m |
| Connection (Interface) | | Harness with 4 pin connector |

MECHANICAL DATA

| | |
|-------------------------------------|------------------------|
| Life | > 3 M cycles |
| Operating temperature | - 40°C to 85°C |
| Operating force | 60 N ± 20N |
| Load maximum | 2000 N |
| Protection Level | IP 67 |
| Deflection angle | ± 14° tolerance ± 1° |
| Weight | 3 kg |
| Housing | Steelplate / Aluminium |
| Pull-down resistor (Recommendation) | 10kΩ |

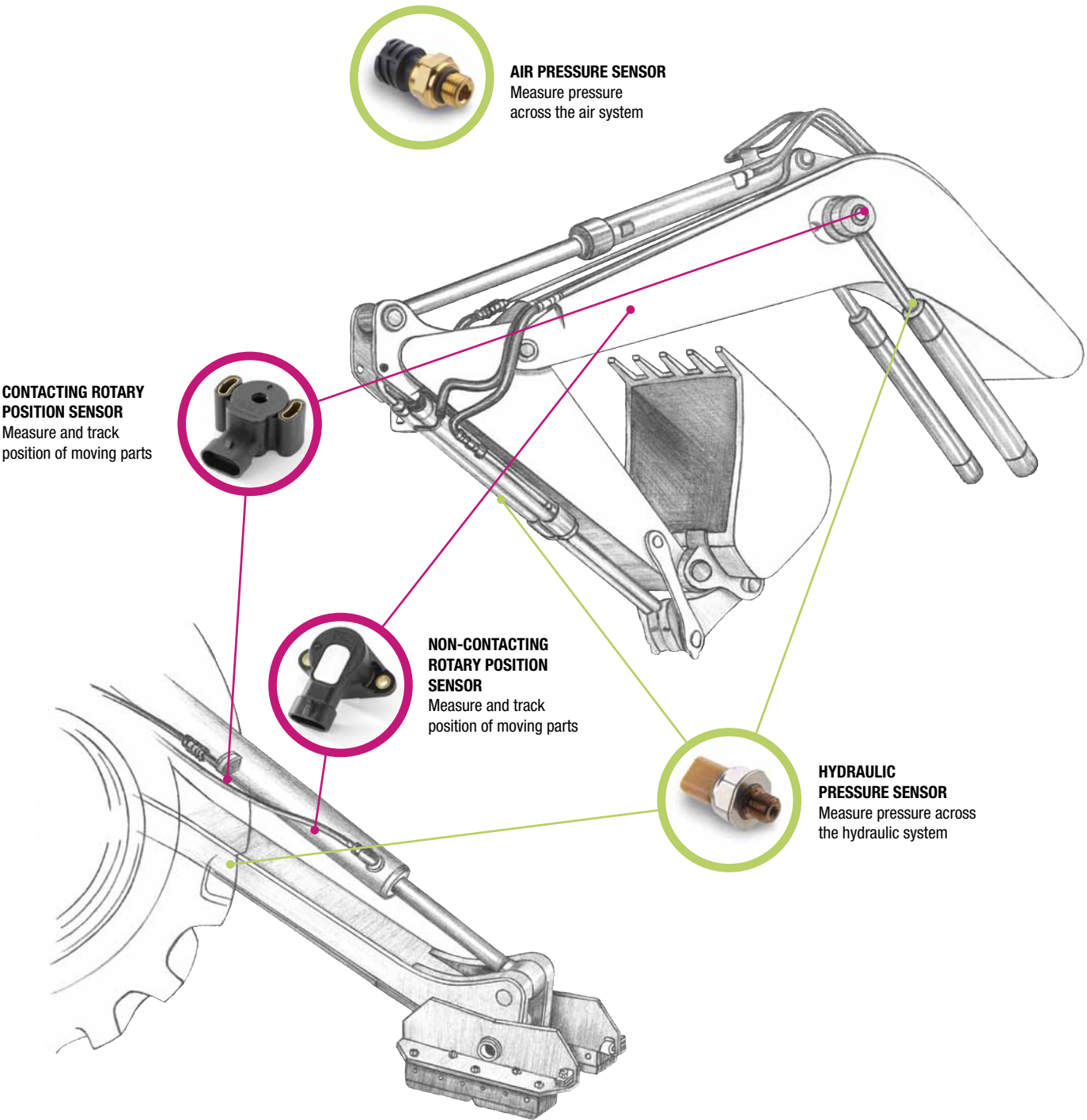
| | |
|------------------|---------------------------|
| Function | CA = CAN |
| Deflection angle | (+14°± 1°) End position 1 |
| Deflection angle | (-14°± 1°) End position 2 |
| Operation Force | 60 N ± 20 N |
| Output signal | |
| DFP CA | J19 = SAE J1939 |

DIMENSIONAL DRAWINGS



LEGEND:

- TEMPERATURE
- PRESSURE
- SPEED / POSITION
- OPERATOR CONTROL



AUXILIARY SYSTEMS APPLICATIONS

Today's construction and agriculture equipment comes with a wide variety of auxiliary systems to carry out the task at hand.

These vary from scrapers, backhoes, booms to buckets, to mention just a few. Heavy on-road vehicles may sometimes carry similar equipment. These tools are typically operated from the cabin, but may sometimes also feature local controls. Moving the tools is made possible with the use of on-board hydraulic or air systems. To operate these systems safely and efficiently a range of sensors is available to measure pressure and the actual position of levers, pedals or other moving equipment. Sensata offers a range of products suited specifically for these applications.

PRESSURE SENSORS

Pressure sensors are used to measure the pressure across hydraulic or air based systems. Using a proven capacitive ceramic sensing technology, Sensata's sensors offer accurate and durable measurements, even in challenging operating environments.

POSITION SENSORS

Accurate control of auxiliary equipment depends on accurate information about the position of moving parts as well as its actuators (pedals, steering wheels or joysticks). Whether contacting or non-contacting, rotary or stationary, Sensata offers a range of reliable position sensors. These sensors were specifically developed for the HVOR markets and offer durability and accuracy, when it matters most.



AIR PRESSURE SENSOR APT

Sense the air pressure in an auxiliary air system.

BENEFITS

- Sensor designs available for in different pressure ranges
- Sensor designs available for use in humid air

TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-------------------------|-----------------|
| Supply Voltage (Vs) | 5 Vdc \pm 10% |
| Supply Current | 8 mA max |
| Output Voltage @ 5 Vdc | 0.5 - 4.5 Vs |
| Output Current | 2.5 mA max |
| Response Time | 10 ms max |
| Overvoltage Protection | 16 Vdc |
| Reverse Voltage Protect | 14 Vdc |
| EMC (10 MHz-1GHz) | >50 V/m |

PHYSICAL

| | |
|-----------------------------|---------------|
| Operating Pressure | up to 16 bar |
| Proof Pressure | >2 FS |
| Burst Pressure | >3x FS |
| Minimum Pressure Cycle Life | >2M FS cycles |
| Sine Vibration (50-2000 Hz) | >12 g |

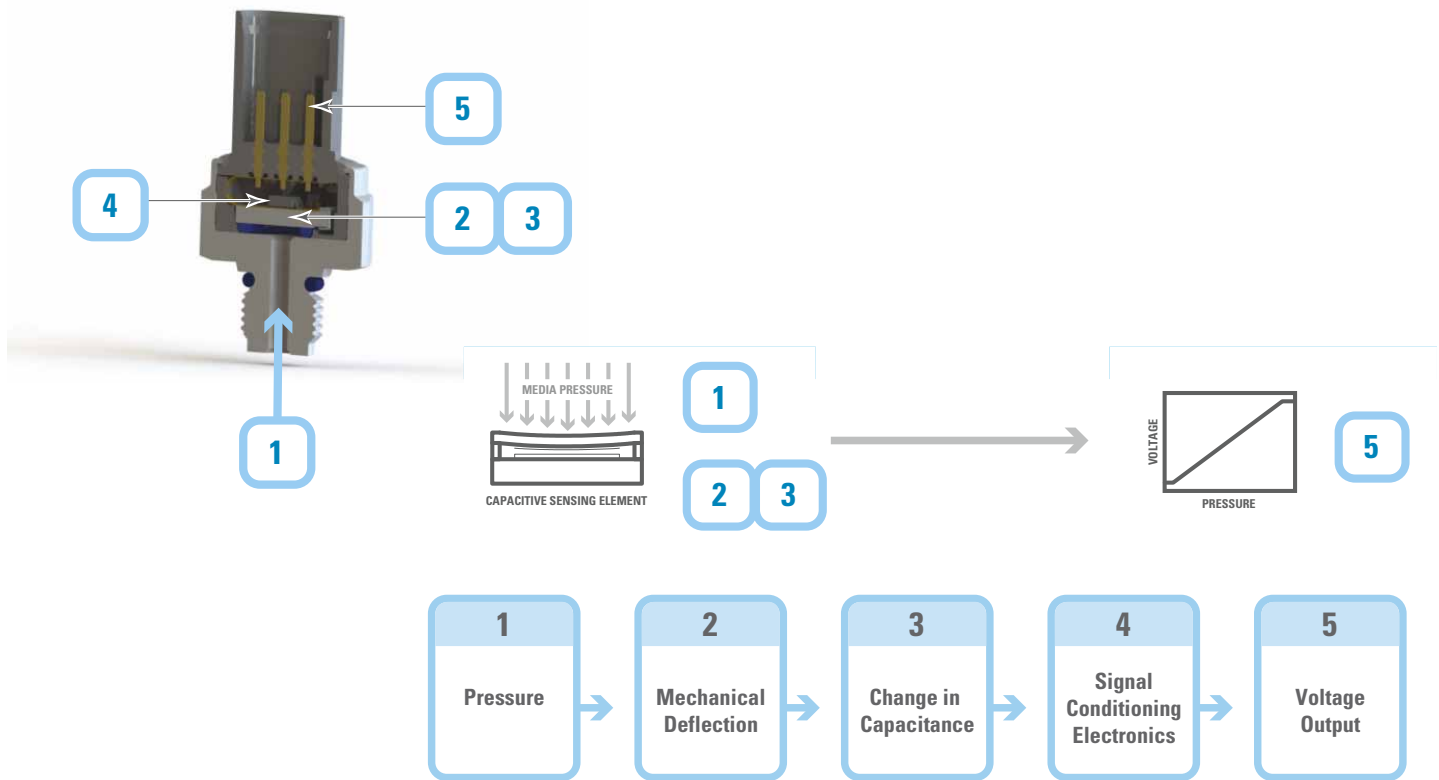
ENVIRONMENTAL

| | |
|----------------|---------------|
| Operating Temp | -40 to +135°C |
| Storage Temp | -40 to +145°C |

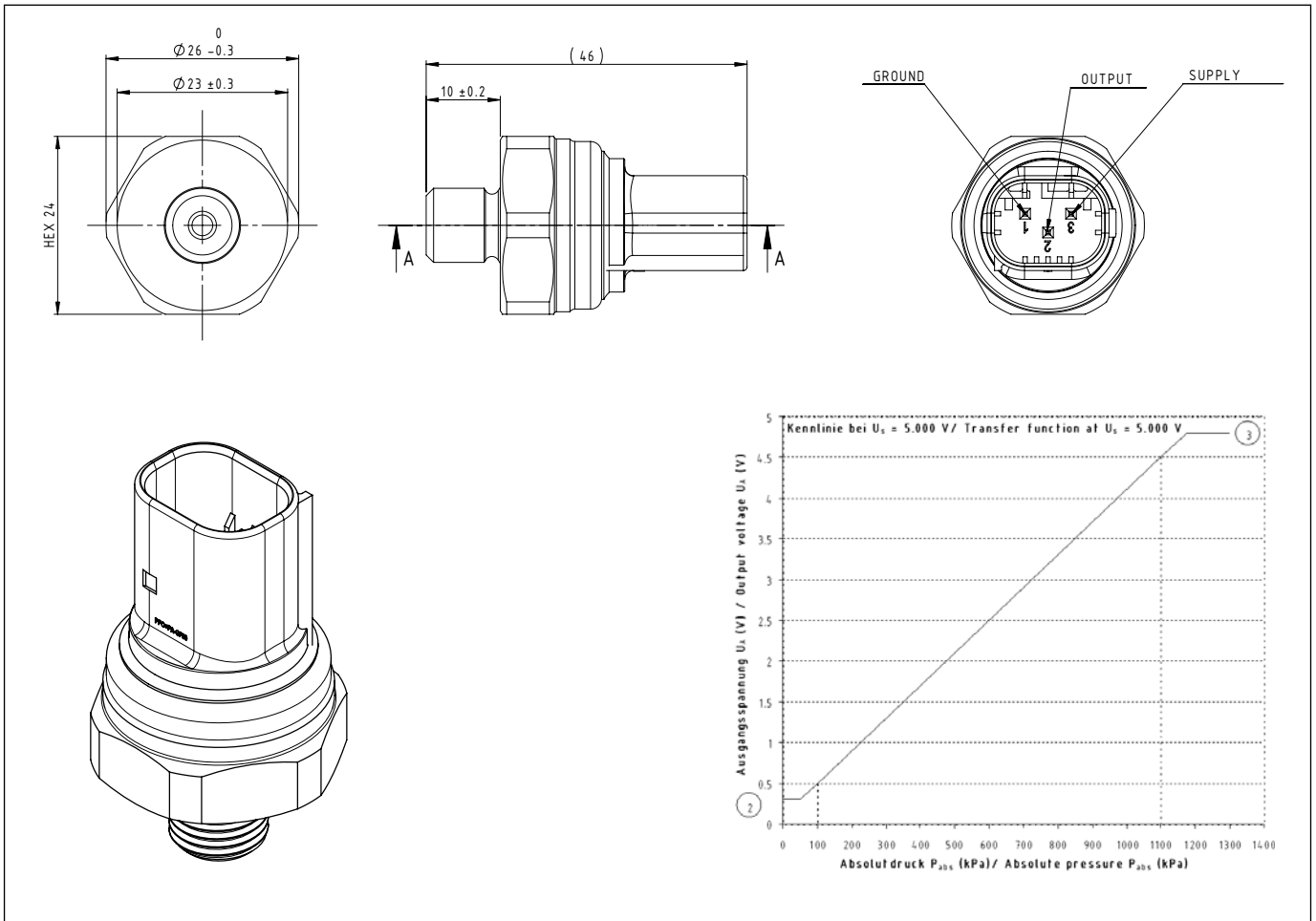
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|-----------------|
| 0 to +100°C | \pm 2.5% Span |
| -40 to +135°C | \pm 3.0% Span |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





HYDRAULIC PRESSURE SENSOR MSG

Measure the hydraulic pressure with a rugged design which survives over pressure spikes.

BENEFITS

- Allows direct measurement and control of hydraulics for modulating supply and saving energy consumption
- Measures pressure spikes used for safety and monitoring

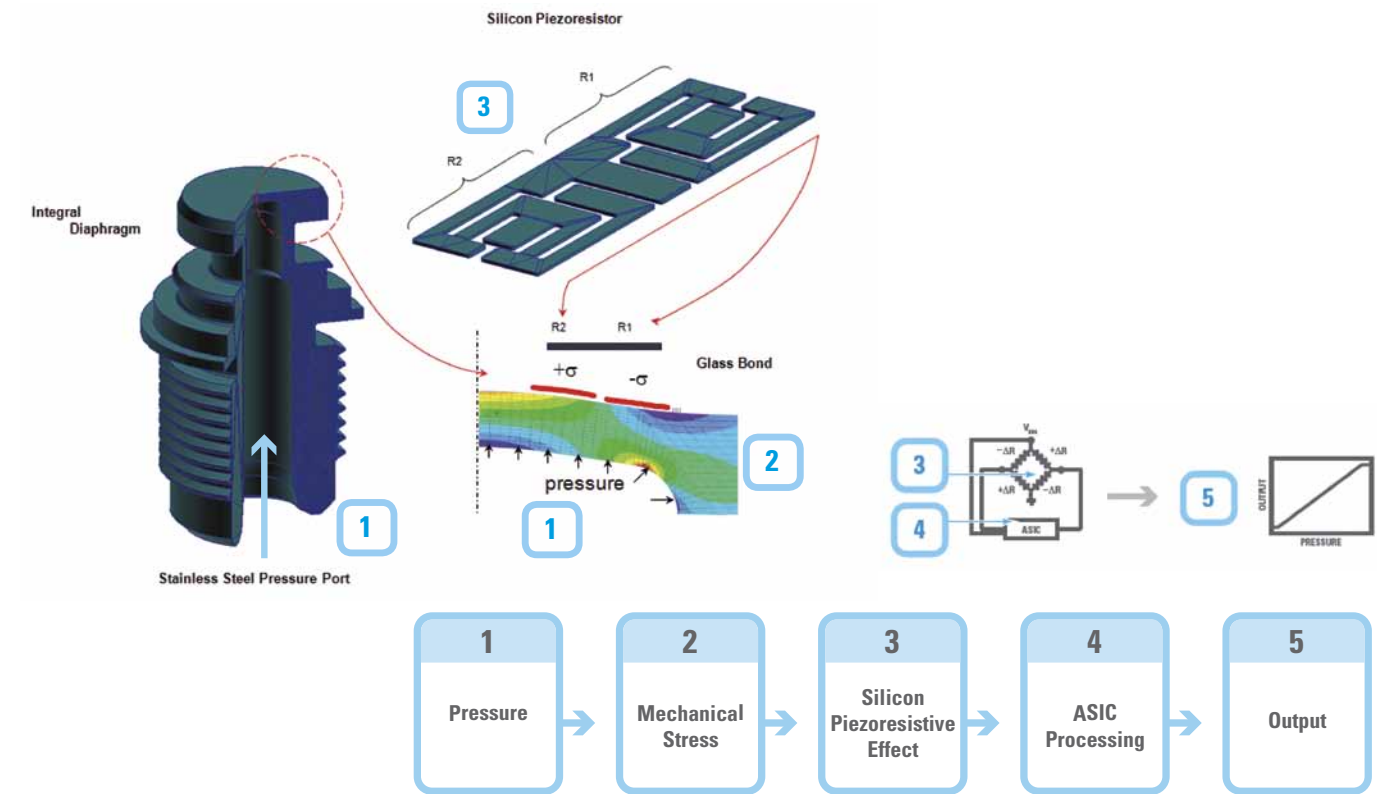
TYPICAL SPECIFICATIONS

| ELECTRICAL | | PHYSICAL | |
|-------------------------|---------------|------------------------|------------------------|
| Supply Voltage (Vs) | 5 V \pm 10% | Operating Pressure | up to 500 bar relative |
| Supply Current | 15 mA max | Proof Pressure | 1.1 x FS min |
| Output Voltage @ 5 Vs | 0.5 - 4.5 Vdc | Burst Pressure | 1.8 x FS min |
| Response Time | 10 ms max | Minimum Cycle Life | >10M FS Cycles |
| Overvoltage Protection | 16 Vdc | Vibration (50-2000 Hz) | up to 40g sine |
| Reverse Voltage Protect | 14 Vdc | | |
| EMC (1 MHz - 4GHz) | >100 V/m | | |
| ESD (ISO 10605) | >8 kV | | |
| | | ENVIRONMENTAL | |
| | | Operating Temp | -40 to +140°C |
| | | Storage Temp | -40 to +145°C |

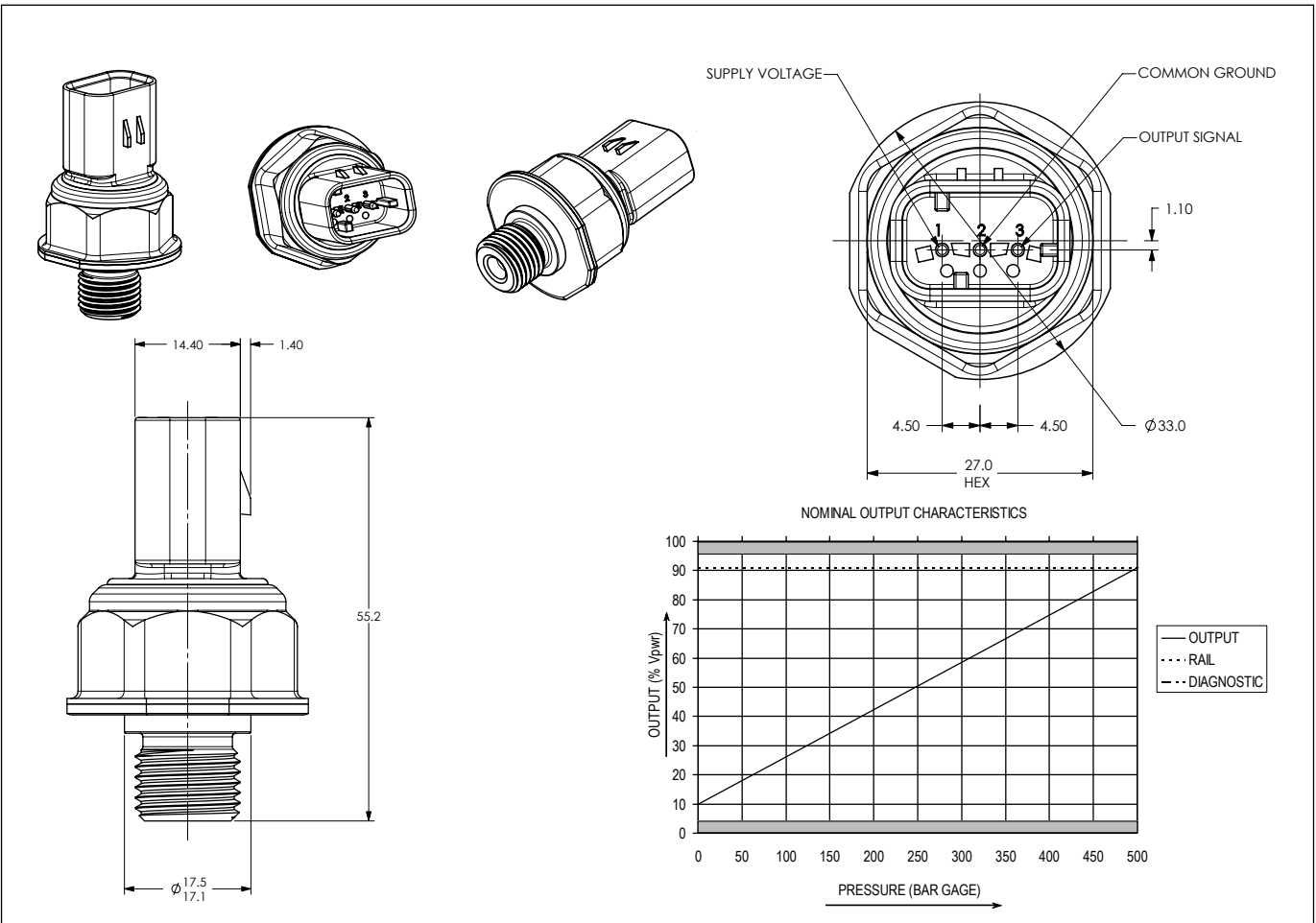
PERFORMANCE - ACCURACY AFTER LIFE (See page 110 for explanation)

| | |
|---------------|---------------|
| 0 to +100°C | \pm 2.0% FS |
| -40 to +140°C | \pm 2.5% FS |

HOW IT WORKS



DIMENSIONAL DRAWINGS & TRANSFER CURVE





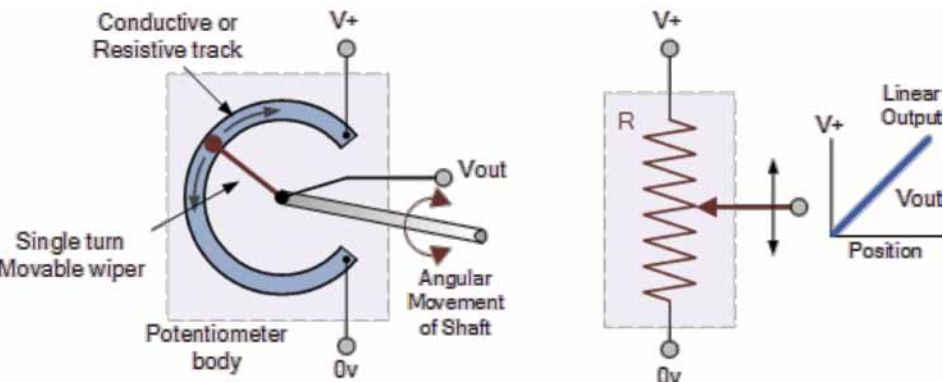
CONTACTING ROTARY POSITION SENSOR 1029

The 1029 Sensor is designed for use in drive-by-wire throttle applications. The primary configuration conforms to SAE J1834 standards, yet modifications can be made to meet customer specific demands. The tough, reliable 1029 PPS features patented silver-in-glass encoder sensing technology to provide exceptional accuracy and extended life. The tested, field proven product withstands the harshest operating environments.

BENEFITS

- Ideal for pedal position sensing
- Conforms with SAE J1834 standards
- Offers low cost options with minimal tooling investment
- Proven and tested in tough environments
- Can be used in many other rotary position sensing applications, such as hand controls and throttle bodies
- Up to 3 outputs possible, including switches
- EMC robust

HOW IT WORKS



TYPICAL SPECIFICATIONS

ELECTRICAL -POTENTIOMETERS

| | |
|-----------------------------|---|
| Potentiometer 1 | |
| Total Resistance | 2.5k ohms at 20°C ± 10°C |
| Resistance Tolerance | ± 15% |
| Index Point (Idle position) | *13% at 40° ± 2° |
| Output Gradient | 1.048% /° ± 0.05% /° |
| Potentiometer 2 | |
| Total Resistance | 2.5k ohms at 20°C ± 10°C |
| Resistance Tolerance | ± 15% |
| Index Point (Idle position) | *13% at 40° ± 2° |
| Output Gradient | 1.205% /° ± 0.05% /° |
| Both Potentiometers | |
| Linearity (independent) | ± 2% over 5% to 85% of output |
| Power Rating | 0.15 watts at 85°C Derated to Zero at 105°C |
| Temperature Coefficient | ± 600 ppm/°C |
| Insulation Resistance | 1000 M ohms/min., 500 V DC |
| Maximum Voltage | 13.5 V DC |

ENVIRONMENTAL

| | |
|--|--|
| Tests Include | |
| Rotational Life | 5M Full Cycles 10M Dither Cycles (2° rotation) |
| Temperature Range | |
| Storage | -40°C to + 105°C |
| Operating | -40°C to + 85°C |
| Sealing | Pressure Jet Wash |
| Relevant sealing specifications are only valid where appropriately sealed electrical connectors are fitted | |

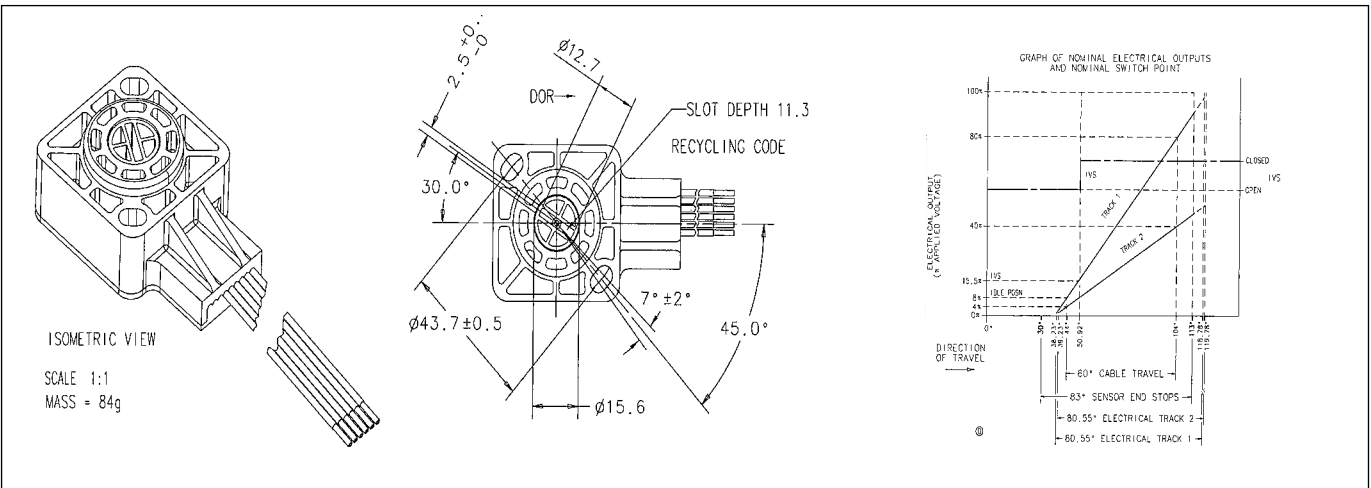
ELECTRICAL SWITCHES

| | |
|--|----------------------------------|
| Mean Switch Position | 43° ± 2° |
| Angle Between Switches | 0.5° to 3.5° |
| Switch State at Idle | Switch 1 Closed Switch 2 Open |
| Max Continuous Current | 20 mA |
| NOTE: All angles are quoted in direction of rotation from center line. | |

MECHANICAL

| | |
|----------------------------|---|
| Rotation | 83° ± 2° |
| Spring Torque (min return) | 20 mNm |
| Stop Strength | 5 Nm Minimum |
| Lead Wires | |
| - Length | 762 mm |
| - Size | 0.5 mm CSA, 1.75/1.85 mm OD |
| - Type | To ISO 6722 for Low Tension, Thin Wall Cable |
| Pull Strength | 5 kg Max for 1 H on all Cables in Direction of Cable Exit |

DIMENSIONAL DRAWINGS & TRANSFER CURVE





CONTACTING ROTARY POSITION SENSOR 1036

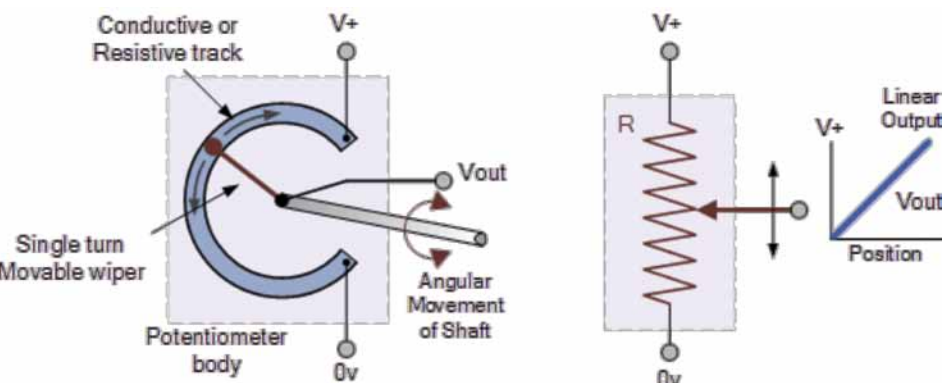
The 1036 Rotary Position Sensor (RPS) is a versatile device that is fully sealed to ingress protection IP67. This provides exceptional mechanical durability and long electrical life, making it ideal for applications such as steering angle and gear lever position.

The 1036 RPS functions perfectly in the harshest environmental conditions, including temperature extremes, continuous vibration, chemical exposure and water immersion.

BENEFITS

- Offers low cost options with minimal tooling investment
- Proven and tested in tough environments
- Sealed package
- Can be used for through-hole shaft applications
- EMC robust

HOW IT WORKS



TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|-----------------------------|-------------------------------|
| Track Resistance (RT) | 5K Ω @ 20°C \pm 10°C |
| Resistance Tolerance | \pm 30% |
| Protection Resistance (RP) | 20% of measured RT \pm 30% |
| Index Point | 50% \pm 2% @ 180° |
| Output Gradient (Ref. Only) | 0.289%° |
| Electrical Angle | 346° \pm 1° |
| Linearity (Absolute) | \pm 2% |
| Max. Voltage | 30.0 V DC |
| Temperature Coefficient | \pm 600 ppm |

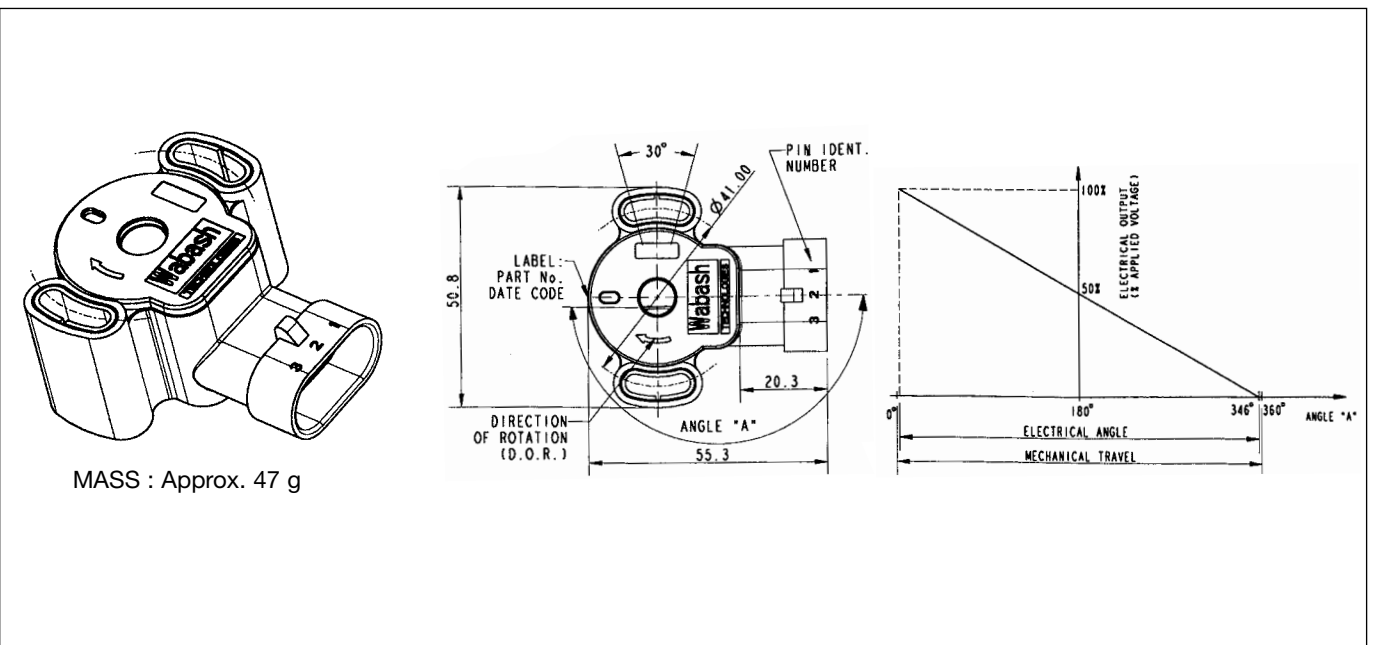
MECHANICAL

| | |
|------------------------|----------|
| Rotation | 360° |
| Max. Speed of Rotation | 120 rpm |
| Fixing Torque | 2 - 3 Nm |

ENVIRONMENTAL

| | |
|---------------------------------|---|
| Rotational Life | 5M full rotation 10M dither cycles (2° rotation) |
| Temperature Range | -40°C to +130°C |
| Vibration | 10 - 57 Hz 1mm displacement 57 - 100 @ 10 g 100 - 500 @ 27 g |
| Shock (Operational) | 3 Axis 100 x 40g 6ms (BS EN 60068-2-29) |
| Shock (Handling) | 1m drop (concrete) |
| Sealing | IP67 |
| Pressure Wash (Amb Temp & 90°C) | 1000 PSI (0.3 - 0.5m, 2.5 min.) |
| Humidity | 96% RH @ 40° C (504 hrs) |
| Salt Spray | 5% solution @ 40°C (336 hrs) |
| Chemical Resistance | Diesel, Hydraulic oil, Gearbox oil, Engine coolant, Brake fluid DOT 4, Ethylene Glycol 50% Aqueous, Urea nitrogen, Liquid lime 10% Aqueous, 7.5% N.P.K fertilizer, Battery acid |

DIMENSIONAL DRAWINGS & TRANSFER CURVE





NON-CONTACTING ROTARY POSITION SENSOR

852

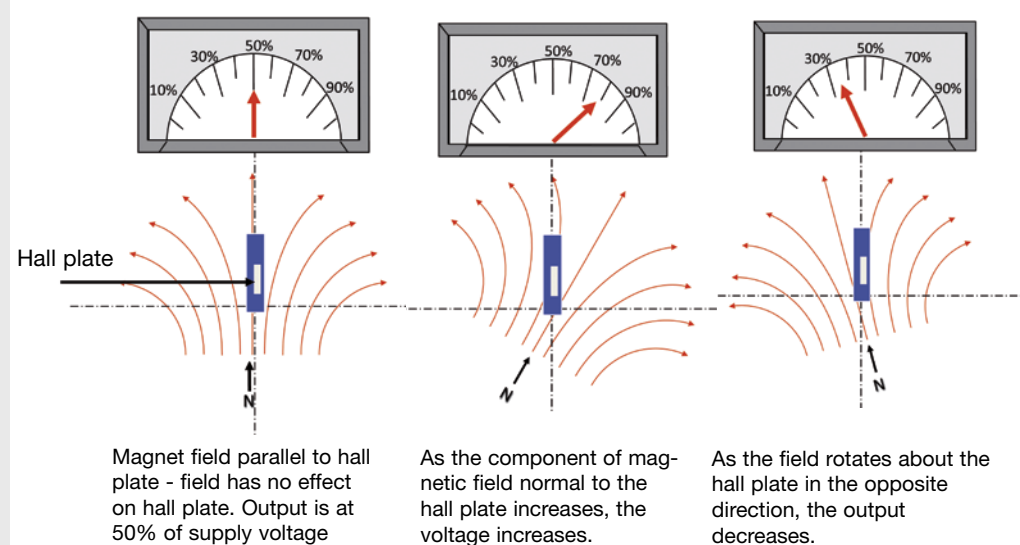
BENEFITS

- Fully sealed robust package
- Clockwise and counter-clockwise rotation available
- Programmable to customer requirements
- Multiple Hall effect options
- Long life

The 852 Non-Contacting Rotary Position Sensor (NCRPS) is a versatile device that can be programmed to customer requirements within its 110 degrees travel range. It is available with clockwise or counter-clockwise rotation and reversible voltage protection. The sealed PCB construction meets IP67 standards, making it ideal for a variety of position sensing applications.

The 852 NCRPS shares the rugged durability of all Sensata Technologies Position sensors and is able to withstand temperature extremes and harsh environments while providing fast, dependable system response.

HOW IT WORKS



TYPICAL SPECIFICATIONS

ELECTRICAL

| | |
|------------------------------|--------------------------------------|
| Supply Voltage (Vs) | 5.0V \pm 10% |
| Supply Current | 10mA Max |
| Reverse Voltage Protection | -16.0V Max. < 1 minute |
| Output (V) Typical | 10% to 90% Vs |
| Independent Linearity | \pm 1.5%Vs (All Conditions) |
| Total Error | \pm 3.0%Vs (All Conditions) |
| Functional Electrical Range | 27.5° - 90° Customer Specified) |
| Operational Electrical Range | 110° - Extended Specifications Apply |
| Output Modes | Analog, PWM and mix option available |

DURABILITY

| | |
|-----------------|------------------------------|
| Rotational Life | >2M Full Cycles |
| Dither | >5M Cycles (10° Rotation) |

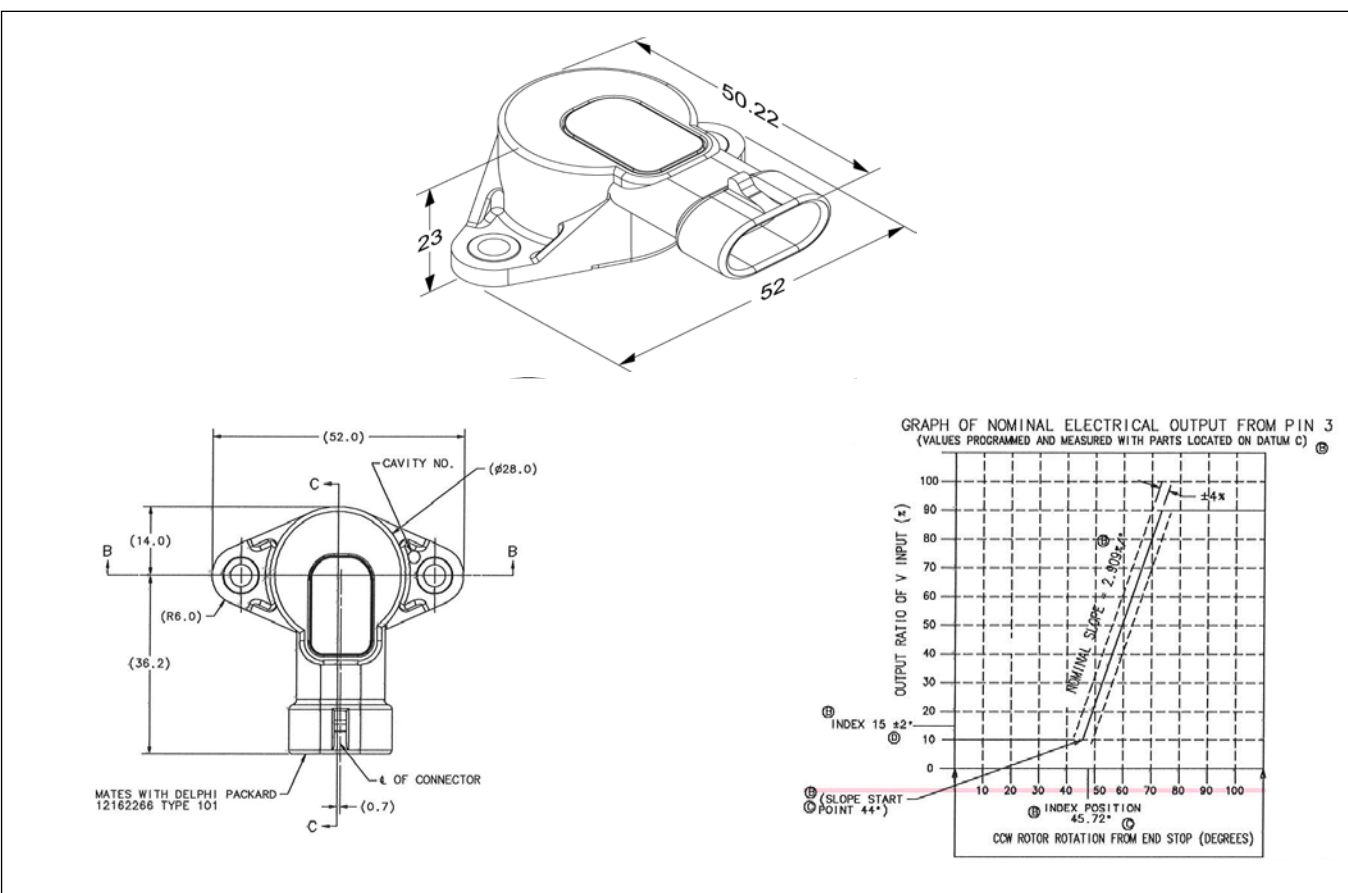
ENVIRONMENTAL

| | |
|-----------------------|----------------------------------|
| Operating Temperature | -40°C to +150°C |
| Environmental Tests | Automotive Underhood Environment |

MECHANICAL

| | |
|---------------------------|--------------------------------------|
| Mechanical Rotation Range | 110° End-Stop to End-Stop |
| Spring Torque | 14 mNm -130 mNm |
| Fixing Torque | 2-3 Nm |
| Connector Type | Power & Signal (Metri Pack) 12162266 |

DIMENSIONAL DRAWINGS & TRANSFER CURVE



ACCURACY

Sensata accuracy is generally defined as the after life exposure accuracy of all supplied sensors as percentage of Full Scale (% FS). Please note the "all". As an automotive company we are experienced in making highly reliable products in high amounts. It is important to consider the details behind the accuracy specification in this document. This will be explained in this section.

%VS AND %FS

The base of our accuracy values given are in percentage of supply voltage (% Vs), as most of our sensors are ratiometric to the supply voltage. A change in supply voltage will result in a change in output. This is the most complete definition, which requires a given transfer curve and requires the supply voltage to be measured. A typical sensor has a measurement range from 0.5 to 4.5V with a 5V supply. Outside of these limits the clamp (over and under pressure) and diagnostic ranges are defined. An output outside 0.5 and 4.5V is thus typically an indication of an error. To more accurately focus on the subject of pure accuracy performance the % FS scale is used. This is zoomed-in on the 4V pure measurement range between 0.5 and 4.5V (with 5V supply).

TRANSFER CURVE

An example of a transfer curve is shown below. 10% Vs output corresponds to 0.5V and 90% Vs output corresponds to 4.5V with a 5V supply.

The nominal transfer curve is defined as: $V_{out} = V_s \cdot (K_2 \cdot P + K_1)$

With:

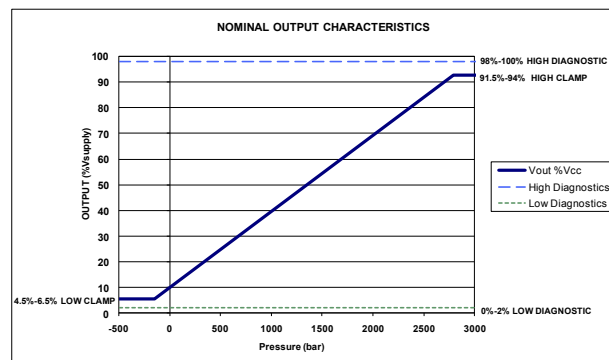
Output : V_{out}

Supply : V_s

Offset : K_1

Slope / Gain : K_2

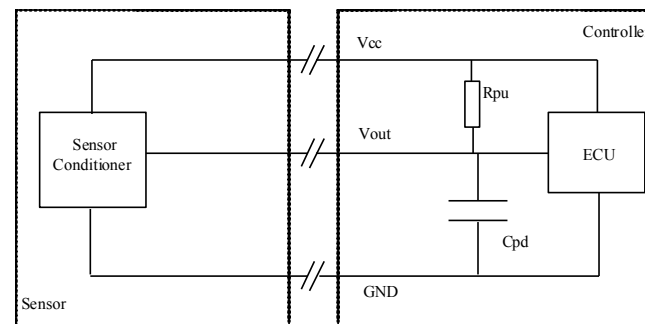
P : Pressure (in chosen unit and either absolute or relative)



With above example the clamp levels indicate where the sensor sees over or under pressure outside of the normal pressure range. It most cases this is an early system warning. Nothing is wrong with the sensor but for instance unsuspected system pressure pulses might be occurring. For sensor or cabling errors, the sensor, in combination with the pull up or pull down resistor, will be pulled into the diagnostic range. Sensata offers different type of ASICs (Application Specific Integrated Circuits) with dual outputs, self-diagnosis, redundancy or digital outputs (SENT protocol).

ELECTRICAL CONNECTION

A possible sensor connection schematic is shown below.



R_{pu} represents the system pull-up resistor. C_{pd} represents the maximum allowed capacitive load of the sensor. Some sensor types feature pull up resistors whereas others prefer pull down resistors. Our sensors are calibrated versus the chosen pull up (or pull down) and for most accurate use the sensor should be used with this chosen value. Dependent on sensor type there is not always much flexibility to choose the value. As explained above, the resistor has a function in pulling the sensor into an error band dependent on fault mode. For specifics on the fault diagnostics please contact our engineers.

INITIAL VS. AFTER LIFE ACCURACY

Initial accuracy is defined as: The accuracy of the sensor as it leaves our factory. This extends to its start in the application after assembly. Of course this is conditional to proper storing, mounting and handling. Initial accuracy is interesting for factory control but does not always have direct value for in application use. The after life accuracy is defined as: The accuracy of the sensor after accelerated life testing on sensor level. The tests range from vibration, temperature shock, thermal soak, cold soak to pressure life cycle testing. If needed our engineers can help assess the correlation of the life testing towards the application use or support in assessing the accuracy of sensors after system or vehicle tests in the field.

ACCURACY CAPABILITY

Our sensors come supplied with a per-batch initial accuracy Cpk of 1.67, or otherwise stated, an average with a minimal of ± 5 times standard deviation towards the specified limits. Example: A batch of a 1000 sensors is produced. The limits on accuracy are $\pm 1\%$ FS. All 1000 sensors are checked. The average accuracy is 0.0 % FS and the standard deviation 0.2% FS. 997 are found to be within $\pm 0.6\%$ FS and 3 are found to be in the ± 0.6 -0.8% FS accuracy range. The 3 are singled out due to being outside of control limit of ± 3 standard deviation from the mean. None are found to be in the ± 0.8 -1.0% FS range. 997 sensors can be directly shipped to the customer, 3 need further analysis.

ACCURACY OVER TEMPERATURE RANGE AND PRESSURE RANGE

Our sensors are specified over temperature and/or pressure range. An example is shown in the adjacent table.

| Temperature [°C] | After life Accuracy [% FS] | | Pressure [bar] |
|------------------|----------------------------|--------------------|----------------|
| +125 to +140 | 2.3 | 2.7 | |
| +100 to +125 | 1.4 | 1.6 | |
| -10 to +100 | 1.1 | 1.3 | |
| -40 to -10 | 2.3 | 2.7 | |
| 0 to half scale | | half to full scale | Pressure [bar] |

Most of our sensor types are calibrated and checked across multiple temperatures in our production sites. Specific areas of the sensor accuracy can be optimized by improved (non standard) calibration protocols. Integrated into the error budget are ratiometric error, calibration error, linearity error, hysteresis, repeatability, noise and temperature error. Each individually can be a factor 10 more accurate than the total accuracy budget.

SUMMARIZING

Sensata offers accuracy, which is highly reliable and valid for all supplied products. Please contact our engineers for any specific accuracy request or question.

LEGAL DISCLAIMER PRODUCT USE

Sensata Technologies products are developed for HVOR and automotive applications. They may only be used within the parameters of these Product Specifications. Sensata Technologies products are provided with the express understanding that there is no warranty of fitness for a particular purpose. They are not fit for use other than specified, tested and validated within the release process during product launch. Fit for use warranty claims will be compared with the provided PPAP release package. Warranty claims beyond of what is agreed in that PPAP package will not be awarded.

The resale and/or use of our products are at the Purchaser's own risk and his own responsibility. The examination of fitness-for-the-intended-use is the sole responsibility of the Purchaser.

The Purchaser shall indemnify Sensata Technologies from all third party claims, including any claims for incidental or consequential damages, arising from any product use not covered by the Product Specifications and PPAP release

status or not approved by Sensata Technologies and reimburse Sensata Technologies for all costs in connection with such claims.

The Purchaser must monitor the market where the products are used, particularly with regard to product safety, and inform Sensata Technologies without delay of all safety relevant incidents.

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CONTACT US
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