

MEMS Pressure Sensors

Transportation Solutions



Amphenol
Advanced Sensors

Industrial MEMS

Automotive Market

The recent industry data published shows that the environment is changing globally with more negative indicators than positive.

Automotive deliveries for November fell again for Volkswagen while BMW remained flat. The Chinese market shows signs of continued weakness as well.

Automotive MEMS pressure sensing is the largest market space accounting for 50% of the pressure sensing market with continued growth expected.

NovaSensor Differentiators

Since NovaSensor has MEMS foundry capabilities, it puts us in a unique position of controlling our supply chain.

We are currently transitioning many products from the legacy 4" wafer size to the more competitive 6" wafer size.

The business has shown strong commitment to growing our MEMS and the sensor business in general. Recent and strong investment into our Korea fabrication facility to increase overall capacity, which continues to provide positive returns.

As we continue to migrate our pressure die to the large-sized wafers we expect this to become more competitive with our packaged sensor solutions.

Several of the key players are both component and system level suppliers. Therefore, opportunities may exist to supply pressure die, or perhaps help support their system integration. Recently we have had several inquiries and wins that have helped grow the business.

Key Target Applications

- Pressure Sensing for Fuels
- Transmission Clutch Pressure
- Altimeters and Barometers
- Cabin Pressure/HVAC Sensors
- Oil Pressure Sensing
- DPS for GPF/DPF Sensors

Target Customers

1. **Cummins**
Diesel and alternative fuel engines and generators, and related components and technology.
2. **Nissan, Volkswagen, BMW, TELSR**
Automobile manufacturers.
3. **Caterpillar**
Designs, develops, engineers, manufactures, markets and sells machinery and engines.
4. **Delphi**
Powertrain and aftermarket technologies.
5. **BorgWarner**
Automotive industry components and parts supplier.
6. **Continental**
Automotive manufacturing company specializing in, brake systems, interior electronics, automotive safety, powertrain and chassis components.
7. **Alfmeier**
Develops gas & air flow control, fuel system ventilation systems, brake vacuum support, crank case ventilation, and seating comfort applications.
8. **TREMEC**
Manufacturer of automobile transmissions and drivetrain components.
9. **John Deere**
Manufacturer of agricultural, construction, and forestry machinery.
10. **DENSO**
Supplier of advanced automotive technology, systems and components.
11. **TAFE**
Manufacturers of tractors and farm equipment.
12. **AB Electronics**
Provider of manufacturing solutions.
13. **AGCO**
Agricultural equipment manufacturer.
14. **SAIC**
Provides services and solutions in the technical, engineering, intelligence & IT markets.

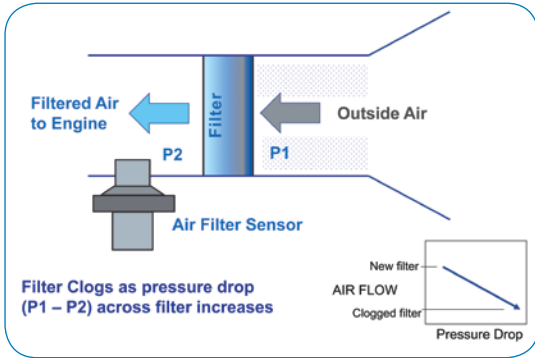
Application Target Examples

Gas Particulate Filtration (GPF)



Gasoline Particulate Filtration (GPF) represents an exciting and growing market space we need to focus on for traction. Specific to Gasoline Direct Injection (G) applications it's expected to grow from \$5.2 to \$12.95B by 2026 with a CAGR of 10.5%.

Emissions continue to drive automotive designs, and Amphenol is positioned to deliver quickly in this emerging market space.



Industry trends, especially for fleet vehicles, is to become more proactive through predictive maintenance, instead of reactionary.

Monitoring air filter blockage is one way to improve overall efficiency with nearly any type of similar engine.

The diagram to the left shows an example of our new sensor as a vacuum version where it is used for clean air to an engine. Positive pressure versions are also available for other applications, such as cabin pressure.

Development Target Examples

Extreme Environment Temperature Measurement

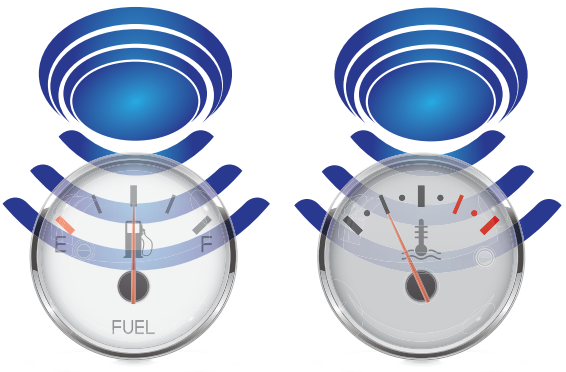


Car manufacturers today are requesting sensing solutions that can withstand higher operating temperatures for under-hood applications. To withstand this extreme environment, new MEMS technology has been developed.

NovaSensor already has CV-level MEMS pressure die that can be used for this type request. Packaging and test portions of the development remain in order to bring this type of product to market.

As the overall market shows signs of slowing, this is the perfect time to engage development teams to work together on solutions to meet upcoming demands.

Multi-Measurement and Sensing



Another area for potential opportunity is multi-measurement and sensing. Manufacturers are working to improve overall functionality of sensing by combining sensor types with one another. This provides cheaper overall integration costs, as well as reducing repair costs once in service.

Opportunities here would not only apply to the pressure business, but can also easily include our sister sensing companies that offer temperature, humidity and/or gas detection.

Amphenol already has a combined temperature-and-pressure sensor, and , other combinations can be done.

MEMS Sensor Standard Product Overview

NovaSensor is a leader in the design and fabrication of MEMS Pressure Sensors and the inventor of **SenStable®** Processing Technology providing an excellent stability of its sensors. NovaSensor MEMS Pressure Sensors are known for their accuracy, reliability, and miniature size. Our sensors offer best-in-class performance for Industrial, Healthcare, and Transportation Applications.

NPI Series - Media Isolated Sensors

Designed to operate in hostile environments while providing outstanding sensitivity, high linearity, and low hysteresis.

Features

- Best in class stability
- Stainless steel media isolation
- Suitable for use with liquids or gases
- Pressure ranges from 5 to 10,000 psi (custom specs)
- Absolute, Gauge, or Differential



Applications

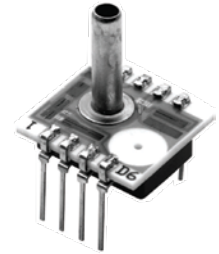
- Industrial automation
- Process control
- Level/Depth sensing
- Corrosive fluids and gas measurements

NPC Series - Low/Medium Pressure Sensors

Cost-effective solution for applications that require compensated performance.

Features

- Best in class stability
- PCB mountable DIP packaging
- Multiple tube & pin configurations
- Pressure ranges from 10" H₂O to 100 psi
- Absolute, Gauge, or Differential



Applications

- Industrial automation
- Air flow monitors
- Process control
- Medical equipment

NPA Series - Pressure Sensors

Compact packaging and a cost-effective solution for applications that require calibrated performance and amplified output.

Features

- Best in class stability
- Surface mount SOIC-14 package
- Digital, Analog, or Amplified Analog output
- Multiple port configurations
- Pressure ranges from 2" H₂O to 30 psi
- Burst pressure up to 10X for low pressure models
- Absolute, Gauge, or Differential



Applications

- Medical equipment
- Process control
- HVAC
- Consumer appliances

NPH Series - Medium Pressure Sensors

Reliability at a low cost and small size.

Features

- Best in class stability
- Standard PCB mountable TO-8 package
- Media compatible with non-corrosive gases and dry air
- Pressure ranges from 2" H₂O to 100 psi
- Absolute, Gauge, or Differential



Applications

- Industrial automation
- Process control

NPC-100 Disposable Sensor

Low cost design.

Features

- Designed to AAMI BP-22 Specs
- Solid State high reliability
- 25 Years in volume production
- Media Compatible Dielectric Gel
- High Performance Small Size



Applications

- Blood Pressure Monitoring
- Infusion and Dialysis Pumps
- All Disposable Applications
- Medical Instrumentation

NPP-301 Pressure Sensors

Low cost board mount plastic packages.

Features

- Small SOIC-8 Package
- Low Power
- Wide temp range (-40°C to 125°C)
- Easy to automate

Applications

- TPMS
- Barometric Absolute Pressure
- In Line Pump Monitoring
- Medical Device Atmospheric Compensation
- Short Term Implantable Diagnostics

