Amphenol Sensors

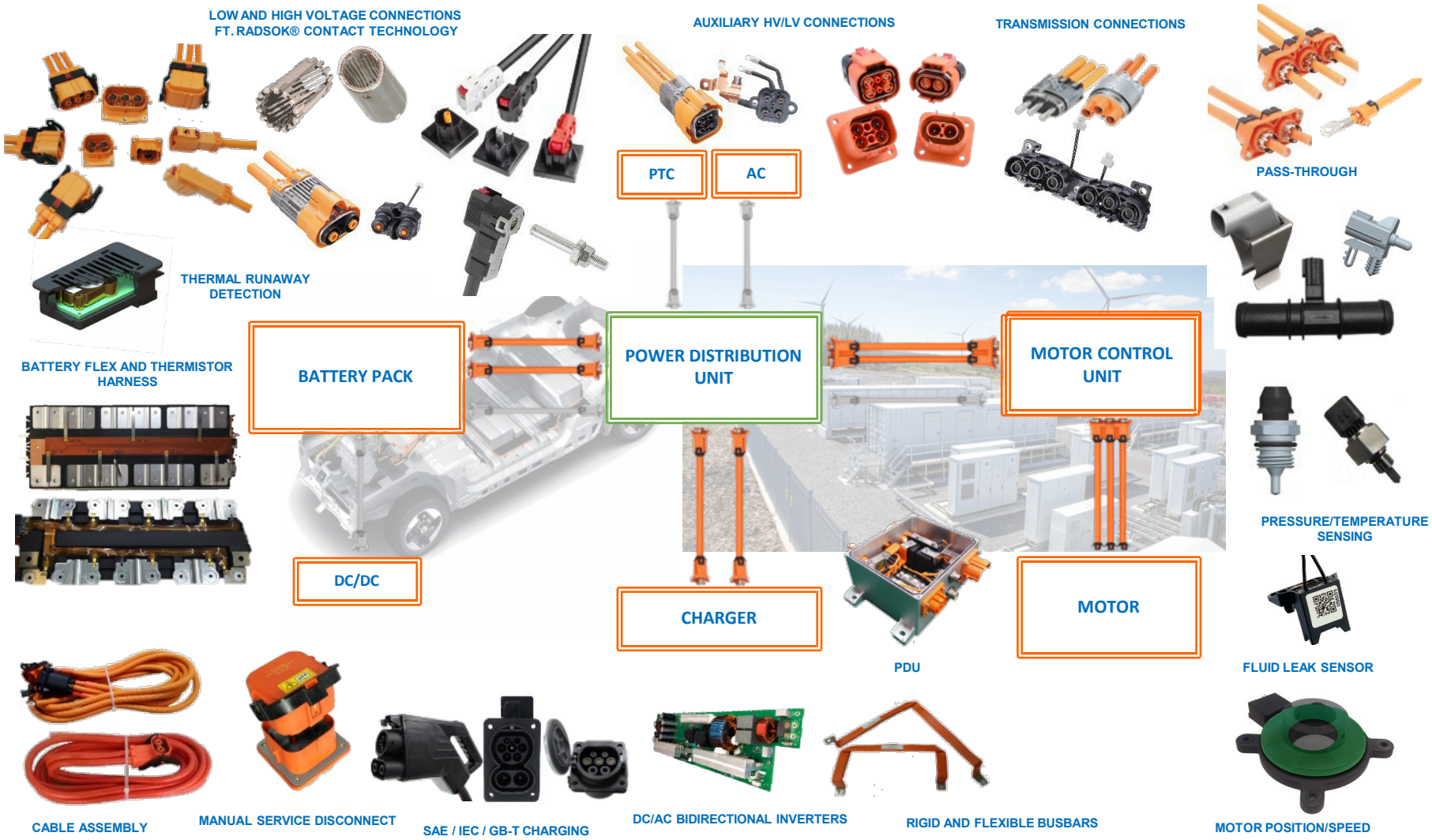
Delivering Value-Add Sensors

Amphenol Sensor Technology Group

Amphenol's Batt / ESS / xEV Products

Amphenol Sensors

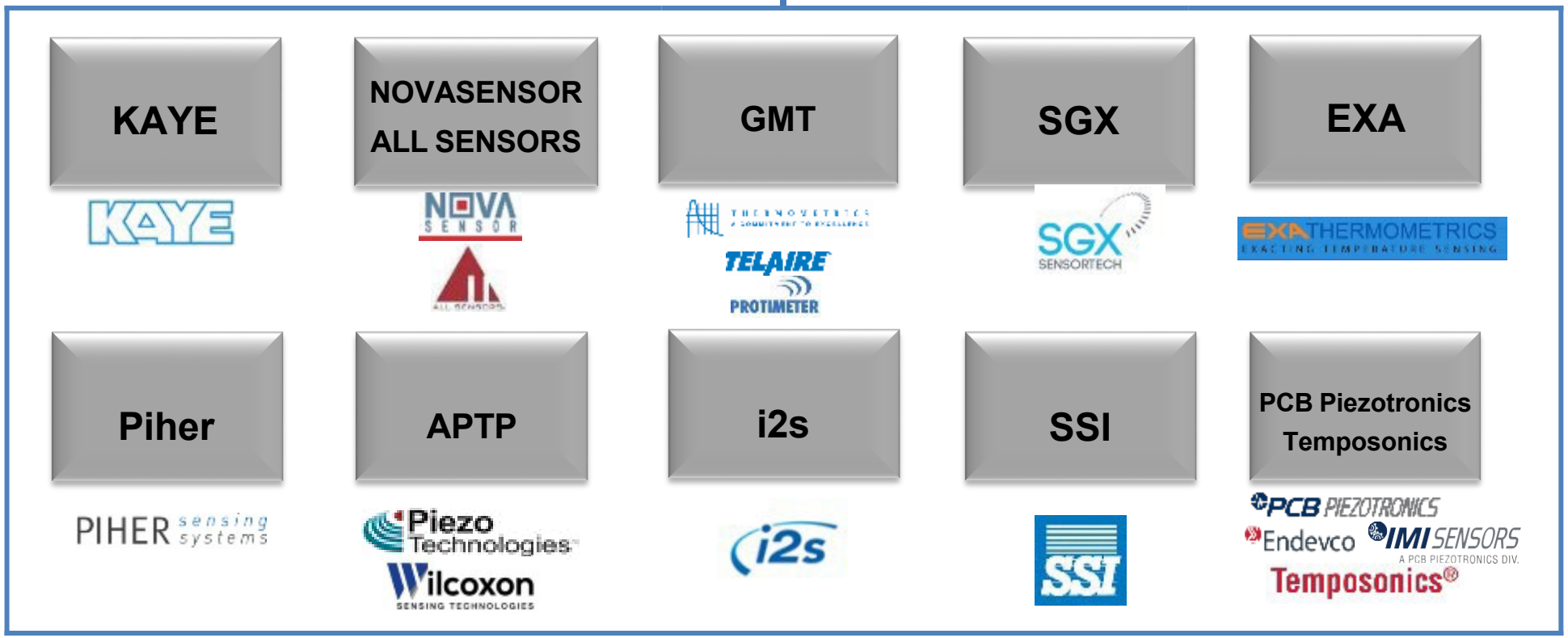
Supporting Mobile and Stationary Sensing & Electrification Solutions



Amphenol Sensor Technology Group

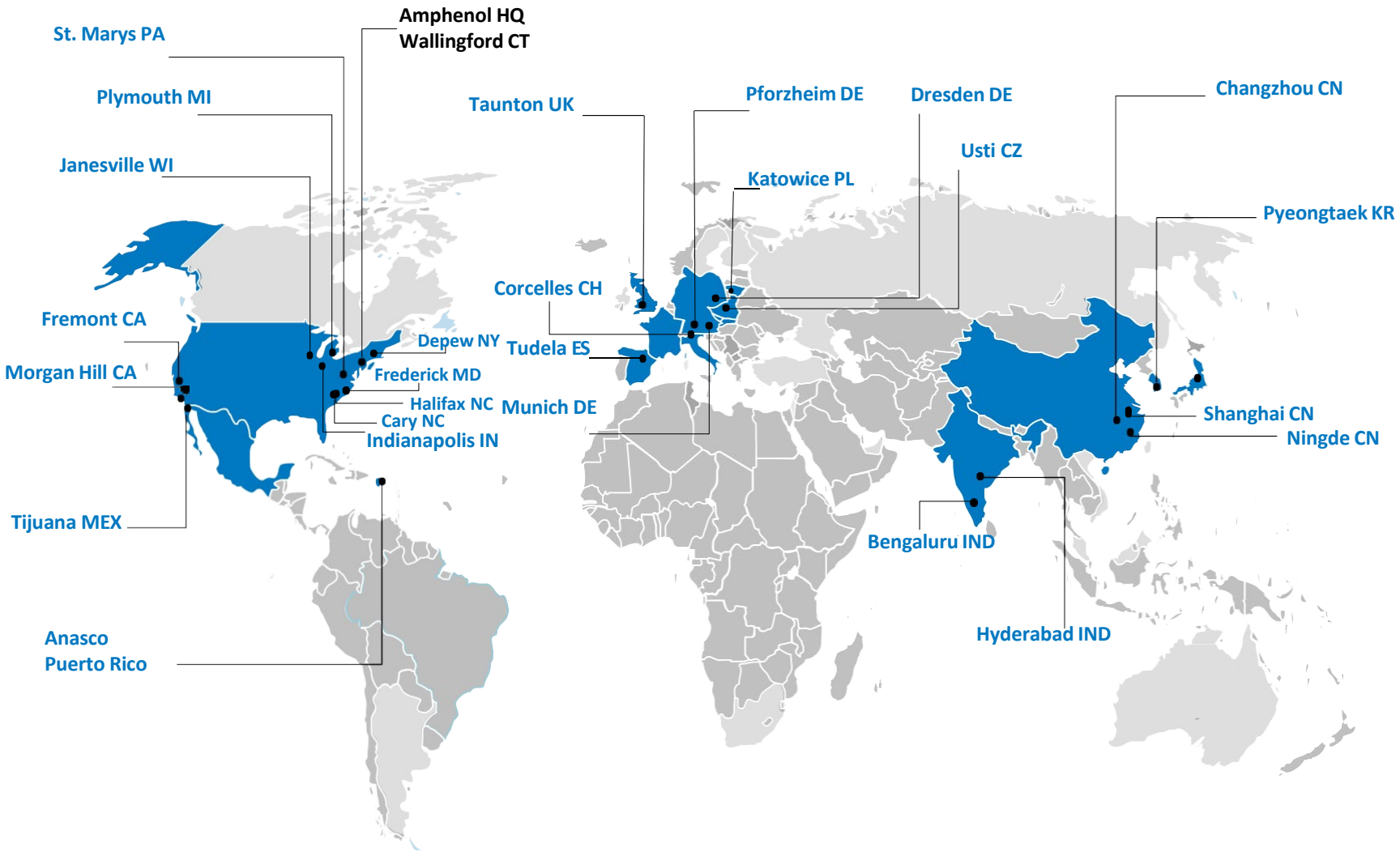
Amphenol Sensors

ASTG



20 Brands **33 sites in 12 countries** **Over 6,100 Employees**

ASTG Footprint



20 Brands **33 sites in 12 countries**

Technology Overview

Amphenol Sensors

Sensing:

- Temperature
- Pressure
- Fluid Level
- Concentration
- Speed
- Rotary/Linear Position
- Accoustic /ultrasonics
- Vibration / Acceleration
- Force
- Air Quality
- Gas concentration
- Particulates / Dust
- Moisture / Humidity
- Process Controls
- Validation Instruments

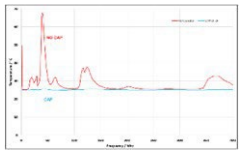
xEV / Battery Control & Safety Products

Amphenol Sensors

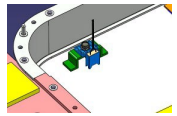
Battery:



- Busbar Temperature
- Cell Temperature
- Cold plate temperature
- Connector temperature
- Water intrusion/coolant breach
- Early Thermal Runaway Detection (REDTR)
- Cell connection systems
- HV cx temp



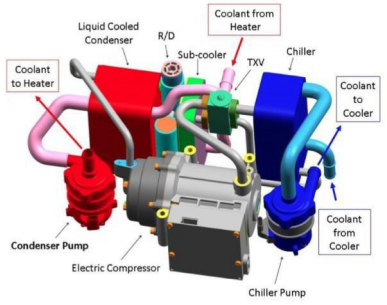


HP/HX:

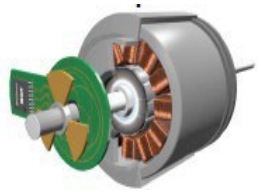


- Coolant Temperature
- Refrigerant Temperture
- Coolant Pressure
- Refrigerant Pressure/Temperature
- Evaporator Temperature
- Position sensors
- Coolant level / Quality/Dielectric Sensors



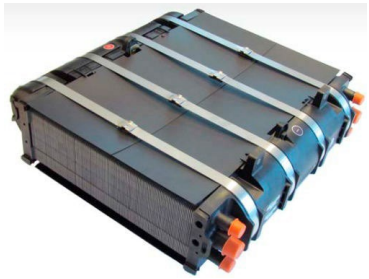
Motor / Inverter:


- Motor coil temperature
- Motor position/speed
- Inverter temperature




Fuel Cell:

- Hydrogen Pressure
- Hydrogen Temperature
- FC Stack Temperature
- Hydrogen leak
- Cathode hydrogen
- Intake Relative humidity / Temperature / Pressure



THERMAL RUNAWAY DETECTION

Temperature Sensors
Measure and monitor battery temperature to detect Thermal Runaway conditions.
- Capable of single or multiple cell detection

THERMOMETRICS

Pressure Sensors
Detect pressure change inside the battery cell that indicates Thermal Runaway conditions.
- Surface mountable
- Simple 3-command I²C interface
- Very low current consumption: <35µA

NOVA SENSOR

Gas Detection Sensors
Detect the out-gassing of Carbon Dioxide (CO_2) to indicate pre-combustion conditions.
- Single and dual channel configurations
- Self-calibration with patented ABC Logic™ Software

TELAIRE

Gas Detection Sensors
Detect the presence of combustible gases that indicate Thermal Runaway conditions.
- Sensitive to multiple gases: H_2 / CH_4 / CO_2
- Fast response time: <10 seconds
- IP6K7 rating

SGX SENSORTECH

BATTERY PACK

Temperature Sensors
Measure and monitor surface temperature of the many batteries within the battery cell, which is critical to preserving the chemistry of the battery.
- Single point temperature sensors
- Rigid and flexible types
- Custom sensor packaging

THERMOMETRICS

CELL CONNECTION SYSTEM (CCS)

Temperature Sensors
Provide temperature and voltage sensing to monitor the state of charge of the battery cells.
- High current circuit for battery cell connectivity
- Available styles: Wire Harness and Flexible Printed Circuit (FPC)

THERMOMETRICS

HIGH VOLTAGE CHARGER CONNECTOR

Temperature Sensors
Detect over-temperature conditions during charging.
- Installed within the connector

THERMOMETRICS

BATTERY COOLANT

Temperature Sensors
Measure and monitor fluid temperature of inlet/outlet battery coolant to provide indication of battery cell temperature.
- No leak path - Sensor cavity and tube are one piece
- USCAR sealed connection system
- Many part geometries: Inline tube, flying lead and integral sensor

THERMOMETRICS

Pressure Sensors
Measure the pressure in the cooling system to control pump capacity.
- Internal metal sealing for high media compatibility and no leakage
- Customized calibration for high accuracy

NOVA SENSOR, i2s

Combined Pressure & Temperature Sensors
Measure pressure in the cooling system, while, at the same time, measure temperature of the coolant for optimum thermal management.
- Available versions: R1234yf (up to 35bar) and R744 (up to 200bar)
- Tested LIN 2.1 conformity
- Automatic address assignment within LIN network (Slave Node Position Detection)

i2s

Ultrasonic Level & Temperature Sensors
Continuously monitor fluid level for early detection of coolant leakage.
- Level accuracy: ±2mm
- Temperature accuracy: ±2.5°C
- Output protocol offerings: Analog, PWM, SENT, CAN, LIN
- Input voltage options: 5V / 12V / 48V

SST

MOTOR COIL

Temperature Sensors
Measure and monitor temperature of the motor coil to provide feedback on the operating conditions of the electric motor.
- Field-proven design
- Variety of lead lengths, terminal and connector options

THERMOMETRICS

POWER INVERTER / E-MOTOR

Temperature Sensors
Measure and monitor operating temperature of the power inverter to provide feedback on unsafe conditions.
- Fast response time
- Pigtail connector

THERMOMETRICS

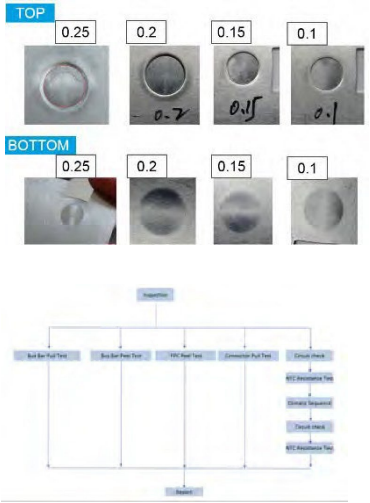
Inductive Position Sensors
Provide data on the angular position of the rotating motor shaft to optimize control of the motor inverter.
- Inductive eddy-current with weight and size reduction
- Stable output over extended temperature range (-40°C/+160°C) and radial/axial misalignment
- Robust against magnetic flux and external stray fields

PI–ER sensing systems

Cell Connection Systems (CCS)

Amphenol Sensors

- **Global supplier of CCS/bus hardware**
- **Producing @ Millions units/year**
- **Engineering design and manufacturing capabilities**
  - *Wired and Flex low voltage harnesses*
  - *Sensors with EMC protection*
  - *Stamping studies to optimize laser welding features*
  - *Plating when required*
  - *Heat-stake and adhesive-mounted flex circuits*
  - *Designing sensor traces with <100mOhm resistance*
  - *Single and multilayer flex*
  - *Typical busbars Al 1100*
  - *0.5mm pitch flex connectors for low voltage*



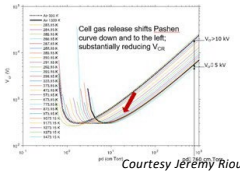
Developments in Robust Early Detection of Thermal Runaway

Issue:

Lithium Ion Battery Thermal Runaway incidents have resulted in death, property damage and concerns over technology acceptance in automotive applications.

Although rare, thermal runaway in lithium batteries are pernicious in transportation applications.

- Battery cell venting releases hazardous and flammable gases and electrolyte:
- Cells can achieve temperatures of >600C, transferring heat to adjacent cells
- Electrolyte can cause external fires on other cells
- Gas release increases potential for HV discharge
- Once external oxygen is consumed, flammable gases can reignite with reintroduction of O2
- Stranded energy /damaged cells can cause reignition events
- Battery packs in EV's and ESS applications can be difficult to access
- It is often difficult to remotely assess the state of a battery cell
- Difficult to determine "End of Event"
- While fire retardants and thermal isolation improve the situation, they do not prevent cascading TR events



Courtesy Jeremy Riousset, FIT

Hyundai to recall 77,000 Kona electric cars over risk of battery fire, fights LG Chem over cause

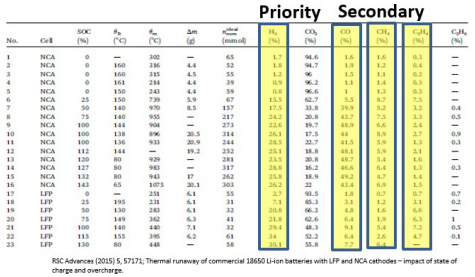
Redefining the Problem:

Once a cell vents, there is an imminent hazard to the pack enclosure including flammable gases above the explosive limit as well as the release of hazardous gas, including hydrogen fluoride in concentrations that are extremely hazardous; therefore, detection of initial cell vent is critical

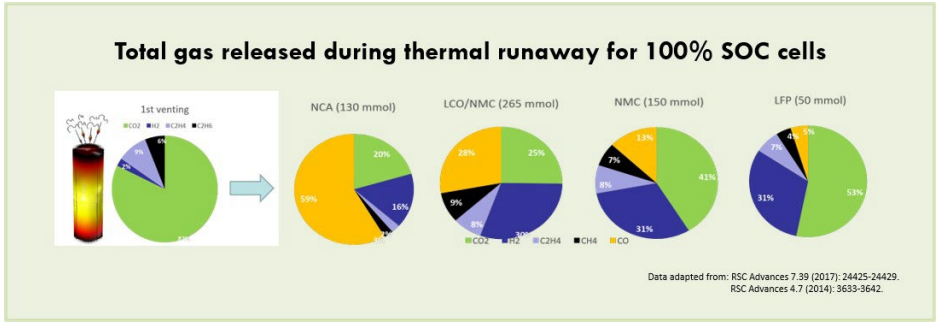
CHINA EV Safety & EV Battery Safety Regulation: GB 18384 2020, GB 38031 2020, GB 38032 require detection of single cell TR, notify driver, and provide at least 5 minutes safe egress for occupants

Detection of initial cell vent gases:

- Majority of total gas released during thermal runaway is CO2, H2
- Hydrogen release >100x background concentration
- CO2 release >100x background concentration
- Gas signal consistent across electrochemistry and cell type in typical pack air space



RSC Advances (2015) 5, 57171; Thermal runaway of commercial 18650 Li-ion batteries with LFP and NCA cathodes – impact of state of charge and overcharge.



Detection needs:

- Sensors must last life of pack (up to 20 years) without replacement or recalibration
- Must be able to reliably detect cell venting in seconds; 0 missed / 0 false positive events
- Continuous monitoring with minimum power consumption

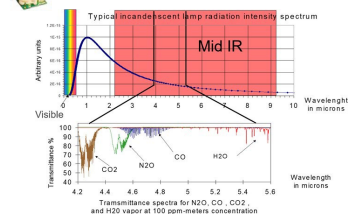
Sensor Solution based on physics:

Chemical sensors utilizing catalysts do not meet system requirements for robustness & reliability, eliminating CMOS, electrochemical, & pellistor technologies

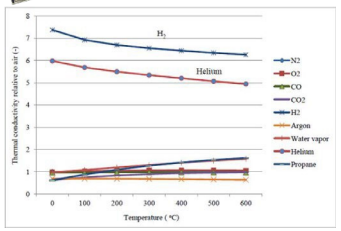
Carbon dioxide absorbs 4.3micron wavelength in the mid IR range, making it a candidate for infrared spectroscopy, which is highly selective for CO2 and does not suffer drift/contamination.

The thermal conductivity of hydrogen is approximately 7xall other atmospheric gases, except helium, which is not present in this application

CO_2 Spectroscopy

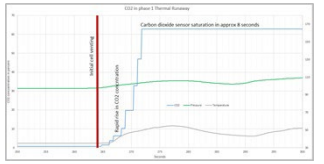


H_2 thermal conductivity

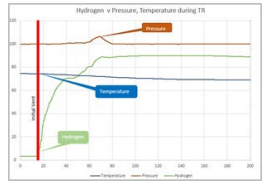


System Performance:

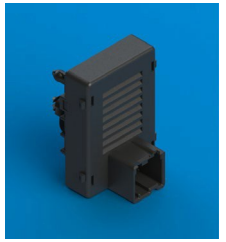
CO_2 detection



H_2 detection



- Detection of both gases in seconds
- Can detect with damaged pack
- Can operate independently of BMS for continuous monitoring / CAN comms
- Can monitor cascading events



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Amphenol

Supplemental Information

Operating Business

A global, diverse, and industry leading sensor business

Sensor Types	Temperature	Level & Concentration	Pressure	Position	Vibration	Test & Meas.	Gas & Moisture

Sensor Technology	Piezo Ceramic	MEMS	NTC/PTC Ceramic	Magnetostrictive	Systems	Strain Gauge	Other

CATL · Ford · ResMed · GE · DENSO · NXP · BOSCH · PHILIPS · VOLVO · BD · Edwards Lifesciences · GEELY · BorgWarner · John Deere · VW · MAHLE · DELPHI · Honeywell · CATERPILLAR · stryker · OSHKOSH · Vestas · GE Energy · Bently Nevada · NORTHROP GRUMMAN · EMERSON

Thermometrics

Amphenol Sensors

- Amphenol **THERMOMETRICS** specializes in **thermistor** and **infrared temperature sensors**
- Products designed for automotive, industrial and healthcare applications
- THERMOMETRICS designs **multi-sensor solutions** including temperature, humidity and pressure using sensor elements from sister companies within Amphenol

THERMOMETRICS
A COMMITMENT TO EXCELLENCE

AUTO MEDICAL INDUSTRIAL

CATL RENAULT NISSAN JOHN DEERE CAT Ford Edwards

Honeywell HARLEY-DAVIDSON MOTOR CYCLES DENSO vyaire MEDICAL

Sensor Modality:	Temperature
Headquarters:	St. Marys, PA
Manufacturing:	United States Mexico United Kingdom China South Korea

PRODUCT HIGHLIGHTS

Thermistor Temperature Sensors

- **NTC thermistors**; general temperature measurement from -196°C to 300°C
- **PTC thermistors**; used for self reset-capable fuses and heater applications
- Accuracies to 0.05°C

NTC Thermistors

PTC Thermistors

Interfaced Multi -Sensors

- **Non-contacting** temperature measurement

Soot sensor for
Diesel Particulate Filter (DPF)

Infrared elements

Dew Point & Glass Temp
(IDGT)

QuadCan multi-sensor
(Temp, Humidity, Pressure)

Customized Assemblies

- **Custom** package **solutions** for harsh environments and extended temperature ranges

NovaSensor

Amphenol Sensors

- Amphenol **NOVASENSOR** specializes in MEMS piezo-resistive **pressure sensors** ranging from 2 inH_2O up to 5,000 PSI
- Products designed for automotive, healthcare and industrial applications
- NOVASENSOR designs and manufactures sensor element die at **in-house wafer fabrication** facilities in the United States and South Korea

AUTO MEDICAL INDUSTRIAL

NOVA SENSOR

Edwards BorgWarner CooperStandard DELPHI APTIV ResMed PHILIPS RESPIRONICS

Sensor Modality:	Pressure
Headquarters:	Freemont, CA
Manufacturing:	California, USA South Korea Puerto Rico

PRODUCT HIGHLIGHTS

Pressure Sensor Overview

- Silicon **MEMS pressure sensors**
- Bare die and die mounted into application-specific packaging
- Wide range of micro-fused silicon strain gauge pressure sensors
- Compact designs with excellent relatability and accuracy (better than 0.1%)
- Supplier to leading OEMs and developers of sensor and control systems

Healthcare Pressure Sensors

Kidney Dialysis Machine Pressure Sensor

Infusion pump Blockage monitoring

Blood Pressure Monitoring

Sleep apnea monitoring & control sensor

Automotive Pressure Sensors

Fuel delivery pressure Monitor & control

Dual Clutch Transmission pressure monitor & control

Engine Air Filter Monitor

Passenger Occupancy Detection

All Sensors

Amphenol Sensors

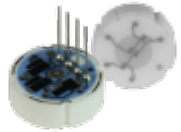
- Amphenol **ALL SENSORS** specializes in MEMS piezo-resistive **ultra-low pressure sensors** ranging from 0.25 inch H_2O to 150 PSI
- Products designed for healthcare, industrial and HVAC applications
- ALL SENSORS high accuracy, high repeatability pressure die are designed in-house
- Custom port fittings and packaging design options available

HVAC-R MEDICAL INDUSTRIAL

ALL SENSORS

Sensor Modality:	Pressure
Headquarters:	Morgan Hill, CA
Manufacturing:	United States China

PRODUCT HIGHLIGHTS

Ultra-Low Pressure Sensors	Ultra-Low Pressure Sensor Examples
• Output available in millivolt, analog and digital • Programmable to operate in low-power mode between readings to minimize power consumption • Dual-die design to ensure accuracy and repeatability • Compensated and non-compensated signal output available	 Wind Tunnel Simulation Machine Pressure Sensor  Hospital Respirator Sensor  Pneumatic & Hydraulic Pump Sensor  HVAC pressure sensor  Media isolated ceramic pressure sensor

I2s Intelligente Sensorsystem

Amphenol Sensors

- Amphenol **i2s** specializes in **harsh environment** piezo-resistive **pressure sensors, mass air flow sensors,** and **temperature sensors**
- Products designed for automotive and industrial applications
- i2s designs and manufactures a variety of pressure sensors using stainless steel, ceramic, silicon and hot-film technologies
- i2s maintains a core competency in electronic calibration with in-house system designers and software engineering

AUTO INDUSTRIAL

Sensor Modality:	Pressure Temperature
Headquarters:	Dresden, DE
Manufacturing:	Germany

PRODUCT HIGHLIGHTS

Pressure Sensor Overview

- Hermetically sealed sensors designed for harsh environment and corrosive environments
- Meets EMC and ESD requirements for automotive and industrial applications
- Miniaturized module packaging options available
- Reliable in high vibration environments

Pressure Sensors

Exhaust Aftertreatment
Differential pressure sensor

Motorsport gear oil
Pressure sensor

Oil Pressure Sensor

Mass Air Flow & Temperature Sensors

Mass Air Flow Sensor
for emission control
& motor management

Temperature Sensor (thermistor or PT RTD)
for fuel cell, H2 and water cooling systems

SSI Technologies

Amphenol Sensors

- Amphenol **SSI** specializes in **liquid level**, **liquid concentration**, **speed** and industrial **pressure**
- Level, concentration and speed sensors designed for **passenger vehicle**, **heavy-vehicle** and **off-road markets**
- Pressure sensors designed for heavy duty and industrial markets
- Level sensing elements include patented **ultrasonic** technologies

AUTO OFF-ROAD INDUSTRIAL HEAVY TRUCK

Sensor Modality:	Level Concentration Speed Pressure
Headquarters:	Janesville, WI
Manufacturing:	United States China Czech Republic

PRODUCT HIGHLIGHTS

Vehicle Fluid & Concentration Sensors

- Accuracy of +/- 2% of scale -40°C to 70°C
- Up to 45° angle performance
- Reduces warranty claims vs. mechanical devices
- Ideal for On-Highway or Off-Highway applications

Digital Fluid Level Sensor
Top-Mounted, Air-Coupled

Fluid Level Sensor
Bottom-Mounted, Fluid-Coupled

Fluid Level Sensor
Top-Mounted, Air-Coupled

Speed & Position Sensors

- Automotive qualified
- Crimped electrical connections
- Common applications: Vehicle Speed, Crank Position, ABS Wheel Speed, Bank Angle, Side Stand Sensors, Clutch Position, Gear Position, Rotary Position

Vehicle Speed Sensor
Active IC

ABS Wheel Speed Sensor
Active-Magneto-Resistive

Transmission Sensor
Active IC

Industrial Pressure Sensors

- Robust SS304L & SS316L construction
- 100% tested over temp. and pressure
- Stable over temp. (-40°C to 125°C) and pressure (3psi – 7500 psi)
- Media isolated, hazardous environments
- Extremely high burst and proof pressures

Integral, Cabled Pressure Senso & Digital Pressure Gauge
All Wheatstone Bridge

Telaire & Protimeter

Amphenol Sensors

- Amphenol **TELAIRE** specializes in **gas, humidity** and **particulate ("dust") sensors**
- Amphenol **PROTIMETER** specializes in **moisture** instruments & test meters
- Products designed for automotive, industrial and commercial/residential building applications
- TELAIRE designs and manufactures sensor elements, packaged sensors, transmitters and hand-held devices

TELAIRE

PROTIMETER

AUTO

INDOOR AIR QUALITY (IAQ)

INDUSTRIAL

LENNOX BAPI Kele RENSON DRIEAZ

Sensor Modality:	Gas Humidity Moisture
Headquarters:	St.Marys, PA
Manufacturing:	St.Marys, PA Tijuana, MX China

PRODUCT HIGHLIGHTS

CO_2 Gas Sensors

- **Non-dispersive infrared (NDIR)**
- 50 ppm accuracy
- Patented **self-calibrating** single channel and dual channel sensors

Humidity Sensors

- OEM fully calibrated humidity sensing element
- +/- 2% relative humidity (RH) accuracy

Humidity & Temperature Sensor for OEM installations (temperature compensated)

ChipCap Humidity & Temperature Sensor

Dust / Particulate Sensors

- **Industry Compliant PM2.5** - Laser LED and photo detector used to optically sense 2.5µm particulate matter (PM)
- Commonly used in HVAC, indoor air quality monitoring and air cleaners & purifiers
- Increasing automotive app

Laser based PM2.5 sensor

PROTIMETER Handhelds

- Handheld moisture test meters for home & commercial applications
- Flood damage restoration
- Home & building inspections

SGX Sensortech

Amphenol Sensors

- Amphenol **SGX SENSORTECH** specializes in **Air Quality Sensing: gas sensors, PM2.5/10 sensing modules**
- ASGX designs and manufactures sensors technologies capable of detecting gases such as CO, NO_2, hydrocarbons, Ammonia, VOCs/CO_2 equivalent, Ozone, combustible and flammable gases
- Products designed for automotive, industrial, safety and building air quality

AUTO

INDOOR AIR QUALITY (IAQ)

INDUSTRIAL

OUTDOOR AIR QUALITY (OAQ)

MAHLE DENSO Valeo VOLVO GM

Sensor Modality:	Gas, Dust Air Quality
Headquarters:	Switzerland
Manufacturing:	Poland China

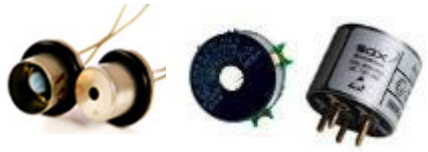
PRODUCT HIGHLIGHTS

Gas Detection Sensors

- Wide range of gas sensor technology including **catalytic**, **infrared and metal oxide.**
- Sensor portfolio includes flammable and toxic gas solutions

Toxic Gas Sensors

Oxygen Detection Sensors



Flammable Gas Sensors

Air Quality Sensors

- Air quality sensor portfolio includes **volatile organic compound (VOC)** sensors and CO_2 equivalent sensors
- Multi-gas Automotive qualified sensors for NOx, CO, NH3, etc
- **Low power** and **fast response time** (<1 second)

VOC & Air Quality Sensors

PM 2.5 Sensor

2-Gas & 3-Gas Sensor Modules

Piezo Technologies

Amphenol Sensors

- Amphenol **PIEZO TECHNOLOGIES** specializes in **piezoelectric ceramics** and **ultrasonic transducers**
- Products designed for the broader market, including healthcare, oil & gas and NDT testing
- PIEZO TECHNOLOGIES designs and manufactures ceramics in-house from raw base powders to ceramic disks to transducer modules

OIL & GAS MEDICAL INDUSTRIAL

Piezo Technologies

Sensor Modality:	Piezoceramics Ultrasonic/Acoustic
Headquarters:	Indianapolis, IN
Manufacturing:	United States

PRODUCT HIGHLIGHTS

Piezoelectric Ceramics

- Typically manufactured as discs, plates and tubes
- Ceramics enable oil & gas downhole logging, healthcare ultrasound treatments and sonar devices
- High output, wide bandwidth applications
- High power, monotone applications

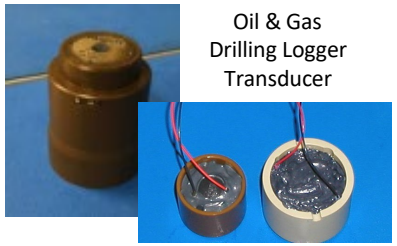
Ceramic base powders formulated in-house at Piezo Technologies

Ceramic Disc Formation piezoceramic examples (discs, tubes, plates)

Ultrasonic/Acoustic Sensors & Transducers

- Highly reliable & reproduceable customized products
- Ruggedized ultrasonic transducers; high-temp (>175°C) & high-pressure (>30 kpsi)

Ceramic integration into ultrasonic transducer



Oil & Gas Drilling Logger Transducer

Air-in-Line bubble detection acoustic sensor (healthcare)

Wilcoxon

Amphenol Sensors

- Amphenol **WILCOXON** specializes in **piezoelectric vibration sensors, accelerometers** and **marine hydrophones**
- Products designed for the industrial, power gen, oil & gas, marine, food & beverage and defense markets
- WILCOXON designs and manufactures sensors for hazardous, harsh and demanding environments and conditions when long-term reliability is critical

OIL & GAS | MILITARY | INDUSTRIAL | PROCESS AUTOMATION

Wilcoxon SENSING TECHNOLOGIES

SHINKAWA | SKF | GE Energy | NORTHROP GRUMMAN | siemsa | Valmet FORWARD

Sensor Modality:	Vibration Acceleration Condition Monitoring
Headquarters:	Frederick, MD
Manufacturing:	United States

PRODUCT HIGHLIGHTS

Vibration Sensors

- Extended temp, low power & voltage
- High EMI & radiation resistant
- Low frequencies
- Triaxial
- 4-20mA and HART protocols

Hazardous area vibration sensor

Food & Beverage general purpose vibration sensor

Mil-Aero Naval System Sensors

- Underwater hydrophones & tonpilz
- Seismic sensors
- Vector sensors

Various examples of acoustic marine sensors

Accessory Equipment

- Transmitters & cable assemblies
- Custom explosion-proof enclosures
- Handheld vibration instruments

Sensor Transmitter

Handheld Instrument for Vibration Sensor

Cable Assemblies

Piher

Amphenol Sensors

- Amphenol **PIHER** specializes in **linear & rotary position sensors** and **potentiometers**
- Products designed for the automotive, off-road, building & factory automation and white goods markets
- PIHER designs and manufactures custom and off-the-shelf position sensor products which meet a broad range of resistive tolerances and rotation cycles for both light-duty and heavy-duty applications

AUTO · OFF-ROAD · INDUSTRIAL · PROCESS AUTOMATION

PIHER sensing systems

KOSTAL · Honeywell · JOHNSON ELECTRIC · TE AUTOMOTIVE INTERFACE SOLUTIONS · BOSCH

Sensor Modality:	Position
Headquarters:	Tudela, ES
Manufacturing:	Spain China

PRODUCT HIGHLIGHTS

Position: Contactless

- Hall-Effect magnetic, inductive & reed switch technology
- Through shaft & end-of-shaft mounting
- Two-piece construction with contactless air gap
- Linear & rotary with 360° sensing
- Heavy-duty / extreme environment capable

Industrial
Linear contactless position sensor

Automotive active suspension
Rotary contactless position sensor

Brake-by-wire & drive-by-wire
through-shaft position sensor

Position: Potentiometers

- Rotary and linear resistive track position recognition
- SMD & through-hole designs
- Various diameters & resistive tolerances

SMD potentiometer for in-cabin vehicle controls

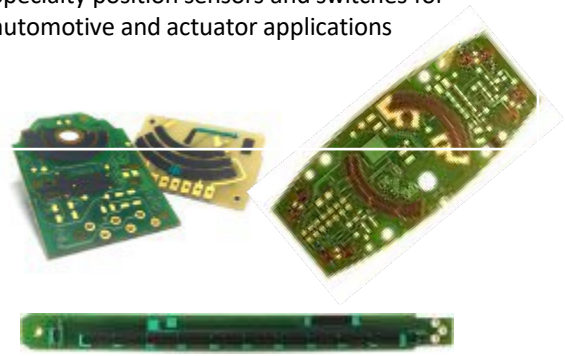
HVAC duct actuator flap position sensor

Airbag activate position switch

White goods' knob position switch

Position: Printed Circuit Resistors

- Carbon printed resistor tracks on rigid, hybrid and flexible PCB
- Custom resistive profile with laser trimming
- Specialty position sensors and switches for automotive and actuator applications



Kaye

Amphenol Sensors

- Amphenol **KAYE** range is relied upon by the world's leading **pharmaceutical and biotechnology** companies to **validate and monitor** critical assets and processes like sterilization as required by governing regulatory bodies.
- Products designed for healthcare, pharmaceuticals, biotechnology and other regulated industries
- KAYE designs wired and wireless solutions
- Calibration services and equipment rentals available

MEDICAL

KAYE

Sensor Modality:	Validation Instruments
Headquarters:	Pforzheim, DE
Manufacturing:	United States

PRODUCT HIGHLIGHTS

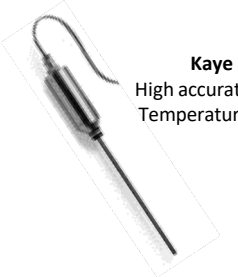
Thermal Validation & Environmental Monitoring

Kaye Valprobe RT
Newest RF technology collecting wireless real-time temperature and pressure data

Kaye Validator AVS
Advanced Validation System

Kaye Calibration Equipment
Calibration accuracy and reliability over a wide temp range

Kaye ICE Point
reference to get highest accuracy possible for thermocouple calibrations



Kaye IRTD
High accurate traceable Temperature Standard

Kaye RF Valprobe
Real-time wireless high accurate measurement of temperature and humidity

Kaye Service & Rental
Calibration & maintenance of your critical equipment by trained experts

Kaye LabWatch
Complete Monitoring & Alarming Solution to protect critical assets

Kaye Log
Cold Chain Monitoring during Transport

EXA Thermometrics

Amphenol Sensors

- Amphenol **EXA THERMOMETRICS** specializes in **thermistor** based **temperature sensors**
- Products designed for automotive, HVAC-R and healthcare applications
- EXA manufactures NTC thermistor Chips and Discs and assembles them into customized temperature sensing solutions for OEM customers in a range of applications.

HVAC-R MEDICAL AUTO

EXA THERMOMETRICS EXACTING TEMPERATURE SENSING

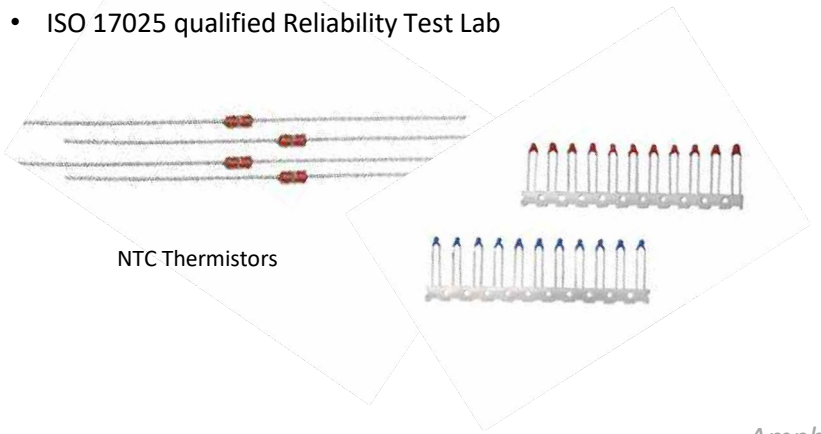
INDUSTRIAL

TRANE BOSCH HELLA Honeywell UNO MINDA

Sensor Modality:	Temperature
Headquarters:	Bengaluru, India
Manufacturing:	Bengaluru, India

PRODUCT HIGHLIGHTS

NTC Thermistors	Customised Assemblies
• NTC thermistor components • Glass and resin coating environmental protection available • UL Safety Qualified • ISO 17025 qualified Reliability Test Lab	• High Reliability probes for boiler and refrigeration applications • Non-penetrating pipe clip temperature sensors • Automotive probes for Bharat 6 requirements



NTC Thermistors

Boiler probes

Pipe Clips

Temposonics

Amphenol Sensors

- Amphenol **Temposonics specializes in position and liquid-level Sensors**
- The Temposonics magnetostrictive technology is maximized with powerful electronics and double shielded construction that assures immunity against interference.
- Position sensors for mobile machinery are specifically designed for direct stroke measurement in hydraulic cylinders. They increase the machines productivity, automate recurring operation sequences and reduce downtime.
- Products designed for various industrial, HVOR, and energy sectors

INDUSTRIAL MEDICAL OFF-ROAD

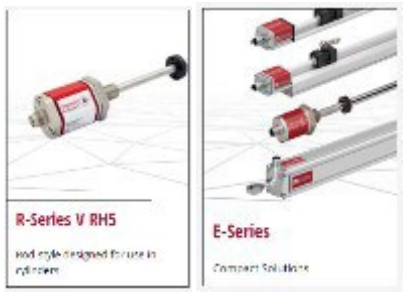
Temposonics®

Vestas BOSCH SMS group CATERPILLAR

Sensor Modality:	Position & Liquid Level
Headquarters:	Cary, NC
Manufacturing:	NC/Germany

Industrial

- Position sensors feature all relevant industry outputs to support a large variety of industrial applications in automation/Industry 4.0 solutions. High precision (microns), extremely rugged for harsh environments (shock, vibration, oil, dirt, etc)
- Highly configurable product lines for external machine mounting or integration in hydraulic / pneumatic cylinders. Measuring lengths from 25mm to 20M



Heavy Equipment

Liquid Level

- Developed for automatic tank gauging of above ground storage tanks and process vessels
- Wide range of industrial level measurement applications

PCB Piezotronics

Amphenol Sensors

- Amphenol **PCB Piezotronics specializes in vibration, pressure, force, acoustics, load, and torque sensors**
- Products designed for Industrial, Military Aerospace, and Test & Measurement
- PCB Piezotronics has grown to offer one of the largest selection of physical measurement sensors worldwide. Engineers and scientists at leading businesses, research institutions, and independent laboratories around the world specify PCB® as their first choice.

INDUSTRIAL MILITARY PROCESS AUTOMATION OIL & GAS

PCB PIEZOTRONICS

ULA United Launch Alliance, Ford, ASML, Baker Hughes, BOEING

Sensor Modality:	vibration, acceleration, pressure, force, and sound
Headquarters:	Depew, NY
Manufacturing:	NY/NC/China

PRODUCT HIGHLIGHTS

Condition Monitoring	Acceleration	Pressure Sensors
• Full range of industrial monitoring instrumentation • Piezoelectric accelerometers, velocity sensors, dual output vibration sensors, vibration transmitters, switches, relays, cables, displays, and accessories	• Signal and Multi-Axis • Harsh environment • Cryogenic through high temp ranges	• Fast, micro-second response time • Resonant frequency to ≥500 kHz • Measure small pressure changes at high static pressure levels • Rugged solid state construction