FLOW, LEVEL, TEMPERATURE AND PRESSURE SENSORS

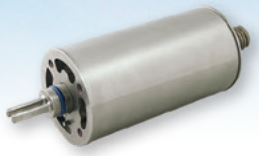
FOR AIRCRAFT APPLICATIONS

PERFORMANCE | RELIABILITY | QUALITY

FCI® AEROSPACE

F C I A E R O S P A C E

FLOW, LEVEL, TEMPERATURE AND PRESSURE SENSORS FOR AIRCRAFT



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Boeing MQ-25 photo by Kate Lowry/Boeing
Bell Boeing V-22 Osprey photo by FOX 52/Wikipedia

- **Flow, level, temperature, and pressure sensors for on-board aircraft installations**
- **Sensor systems to meet a broad range of flight applications**
- **Comprehensive engineering and technical support**
- **AS9100 and ISO-9001 certification**
- **ANSI/NCSL Z540**
- **RTC DO-160 and DO-178B**

FCI Aerospace provides flow, level, temperature and pressure measuring solutions for on-board aircraft installations. Recognizing that aircraft and sub-system manufacturers have diverse and technical measurement and sensing requirements, FCI Aerospace is a world leading manufacturer of commercial off-the-shelf (COTS) and built-to-specification flow, level, temperature and pressure sensors with designs that meet and exceed specifications for performance, reliability and quality.

Whether fixed wing or rotary aircraft, FCI Aerospace has designed and manufactured qualified, flight-worthy sensor systems to meet a broad range of applications. Manufacturers and sub-system suppliers of commercial, business, defense and military aircraft throughout the world have specified and installed FCI sensors with confidence for more than three decades.

APPLICATION ASSISTANCE FROM FCI

To learn what solutions FCI Aerospace can provide for your sensor application, simply complete an Application Data Sheet (page 11 or online at www.FCIAerospace.com). Submit the ADS via mail or email.

NIST Net

ANSI American National Standards Institute

Aircraft and System Manufacturers Using FCI Aerospace Products

COMMERCIAL

A318
A319
A320/NEO
A330/NEO
A340
A380
B747-200B
B767ER
B777/777X
CHALLENGER
CL415
E-JET E2
ERJ190
GLOBAL EXPRESS
LEARJET
LEGACY
LINEAGE
MD11
NASA ISS
PC-24
Q400
RJ700, 900, 1000
TALON-A

MIL FIXED WING

A400M
C-130
C-5
E2D
E7 AEW&C
F18
F35
KC390
KFX
MQ-25
P8
RC135
T-7A

ROTOR

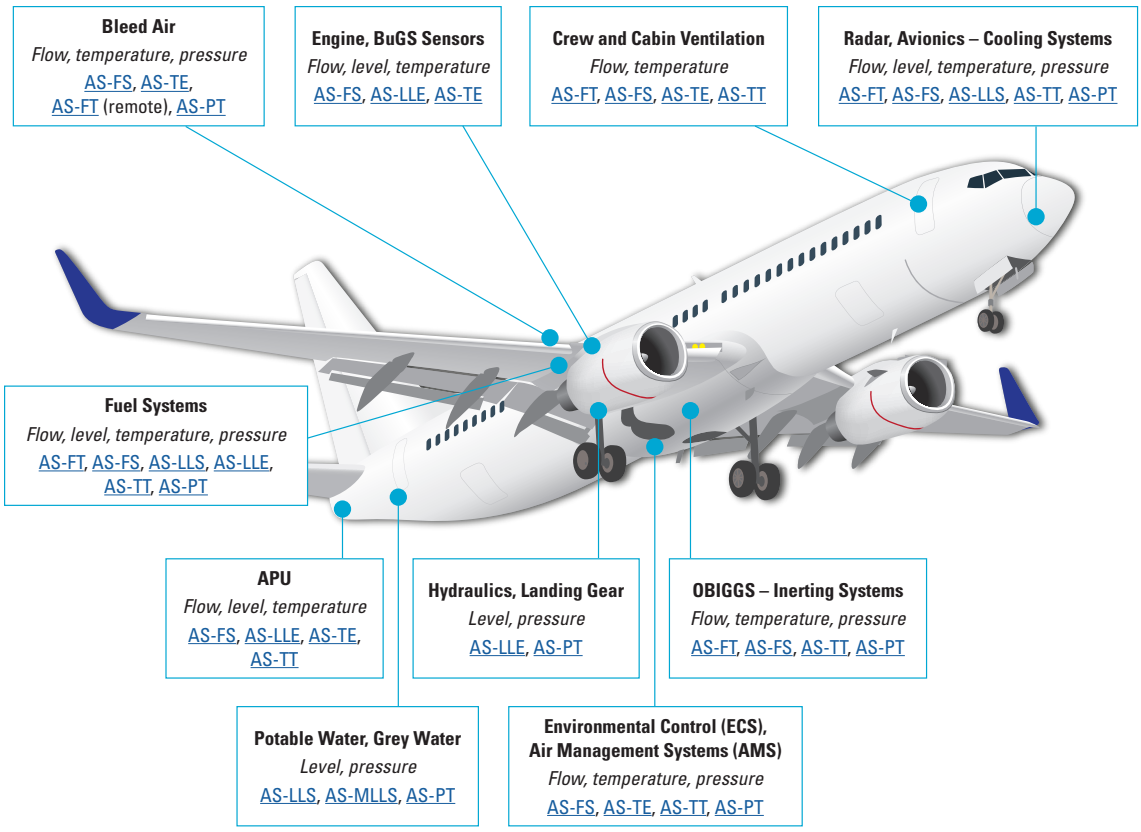
AH64D/E
CH46
CH53K
MQ-8
CH-148
KUH-1 SURION
V22
HAL-ALH

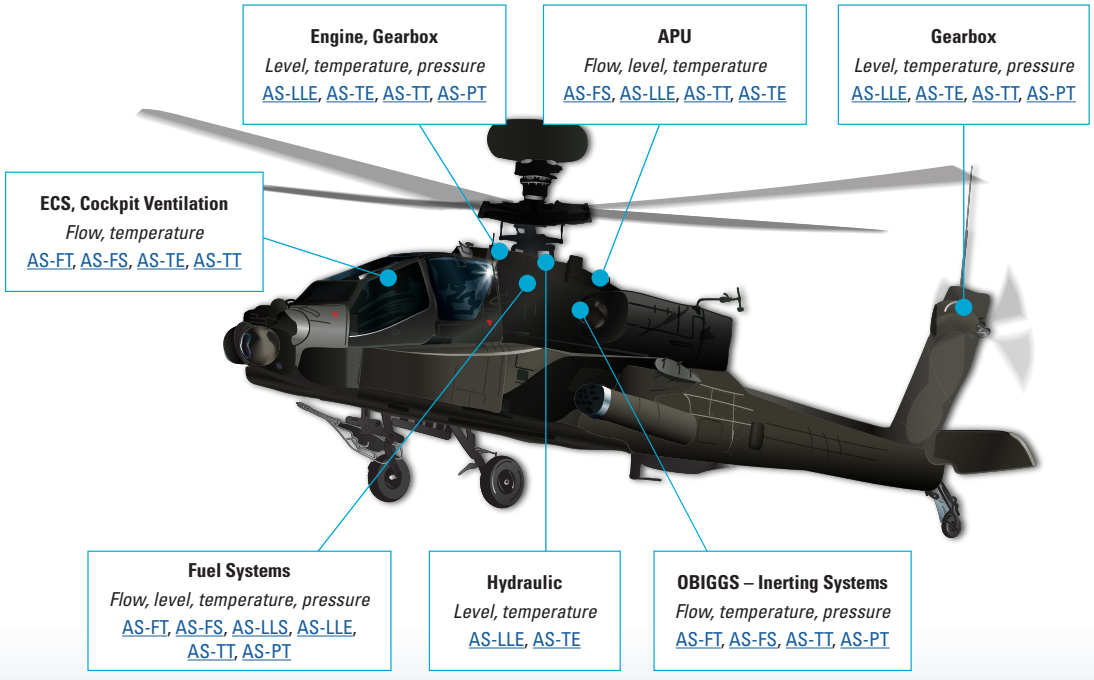
PC-24 photo by Pilatus Aircraft Ltd

Aircraft System Applications

FCI AEROSPACE SENSORS are installed and successfully applied throughout the aircraft. From aircraft operation to passenger comfort, from actual measurements to alarms and warnings, FCI sensors provide the solutions for commercial, military, and general aviation applications, in fixed wing or rotary aircraft.

Air Flow Applications	**Flow**	**Level**	**Temperature**	**Pressure**
PACK Air – mass flow, temperature, and pressure	■		■	■
Avionics and ECS Low Air Flow Alarms – mass flow and temperature switches and transmitters	■		■	
Cooling Effects Detectors (CED) – dual-function mass flow and temperature switch	■		■	
Bleed Air – high temperature mass flow and pressure switches and transmitters	■		■	■
Cabin Temperature – multiple point temperature and transmitter outputs			■	
Crew Cabin Ventilation – flow and temperature switches and transmitters	■		■	
Water, Waste and Service Cart Systems	**Flow**	**Level**	**Temperature**	**Pressure**
Potable Water – temperature and multi-point liquid level elements with controller electronics		■	■	
Warm Water Wash Reservoirs – temperature and liquid level switches		■	■	
Waste Tank – high alarm liquid level and pressure		■		■
Toilet Flush Fluid Leak Detection – low flow switch	■			
Service Cart Condensate Overflow Detection – high liquid level alarms and pressure		■		■
Oil Detection in Engine, Auxiliary Power Unit and Integrated Drive Generator Gearboxes and Reservoirs	**Flow**	**Level**	**Temperature**	**Pressure**
Gearbox Remote Oil Level Sensors (ROLS) – liquid level elements		■		
Oil Temperature Sensors – temperature elements and switches			■	
Oil Reservoir Sensors – single/multi-point liquid level switches, pressure switches, and pressure transmitters		■		■
Hydraulic Systems	**Flow**	**Level**	**Temperature**	**Pressure**
Hydraulic Oil Sensors – flow, level and pressure transmitters, temperature elements	■	■	■	■
Hydraulic Oil Reservoir Monitor – liquid level, temperature, and pressure switches and transmitters		■	■	■
Fuel Systems	**Flow**	**Level**	**Temperature**	**Pressure**
Engine Control – flow and temperature transmitters	■		■	
Fuel Transfer – flow switches and pressure transmitters	■			■
OBIGGS / Fuel Tank Inerting Sensors – flow, temperature and pressure transmitters	■		■	■
Cooling Systems	**Flow**	**Level**	**Temperature**	**Pressure**
Ethylene Glycol – flow, level, temperature and pressure	■	■	■	■
Poly-Alpha-Olefin (PAO) – flow, level, temperature and pressure	■	■	■	■


Bleed Air
Flow, temperature, pressure
AS-FS, AS-TE, AS-FT (remote), AS-PT
Engine, BuGS Sensors
Flow, level, temperature
AS-FS, AS-LLE, AS-TE
Crew and Cabin Ventilation
Flow, temperature
AS-FT, AS-FS, AS-TE, AS-TT
Radar, Avionics – Cooling Systems
Flow, level, temperature, pressure
AS-FT, AS-FS, AS-LLS, AS-TT, AS-PT
Fuel Systems
Flow, level, temperature, pressure
AS-FT, AS-FS, AS-LLS, AS-LLE, AS-TT, AS-PT
APU
Flow, level, temperature
AS-FS, AS-LLE, AS-TE, AS-TT
Hydraulics, Landing Gear
Level, pressure
AS-LLE, AS-PT
OBIGGS – Inerting Systems
Flow, temperature, pressure
AS-FT, AS-FS, AS-TT, AS-PT
Potable Water, Grey Water
Level, pressure
AS-LLS, AS-MLLS, AS-PT
Environmental Control (ECS), Air Management Systems (AMS)
Flow, temperature, pressure
AS-FS, AS-TE, AS-TT, AS-PT


Engine, Gearbox
Level, temperature, pressure
AS-LLE, AS-TE, AS-TT, AS-PT
APU
Flow, level, temperature
AS-FS, AS-LLE, AS-TT, AS-TE
Gearbox
Level, temperature, pressure
AS-LLE, AS-TE, AS-TT, AS-PT
ECS, Cockpit Ventilation
Flow, temperature
AS-FT, AS-FS, AS-TE, AS-TT
Fuel Systems
Flow, level, temperature, pressure
AS-FT, AS-FS, AS-LLS, AS-LLE, AS-TT, AS-PT
Hydraulic
Level, temperature
AS-LLE, AS-TE
OBIGGS – Inerting Systems
Flow, temperature, pressure
AS-FT, AS-FS, AS-TT, AS-PT

FCI Aerospace Models

FCI AEROSPACE SENSORS provide measurements, warnings, and alarms on aircraft flow rates, liquid levels, temperature, and pressure. FCI sensors are compact and lightweight to support aircraft design goals to reduce space and minimize weight to improve energy efficiency. Sensors can be simple elements only, for integration with system electronics to provide excitation, linearization, and diagnostics, or as a complete, integrated sensor + electronics in a compact, self-contained unit, or with their sensor and electronics remoted mounted and connected via an interconnect cable. Sensors can be provided with mechanical process connections and electronic connection to match your installation requirements. Whether your applications indicate a COTS, modified COTS, or custom engineered product, FCI Aerospace has sensor solutions to meet your specifications.

Model Type	Outputs	Application(s)	Flow	Level	Temperature	Pressure
Element Only	Direct, non-linearized from sensor	For direct integration into customer electronics	N/A	AS-LLE	AS-TE	N/A
Switch Electronics	Solid state (open collector), digital; single, dual or triple	High and/or low setpoint warning, alarms or on/off control	AS-FS	AS-LLS, AS-MLLS	AS-TS	AS-PS
Transmitter/ Meter Electronics	Linearized and conditioned 0-5 Vdc or 0-10 Vdc over specific range	Displaying, reading or recording actual measured value of specified process	AS-FT	N/A	AS-TT	AS-PT

FLOW SENSORS

FCI flow products utilize FCI patented, exclusive thermal dispersion technology. FCI uses a proprietary constant power technique which is effective in flow switch designs. For flow meter type applications, FCI utilizes either of two effective techniques, constant power or constant ΔT, which ever is best suited for the specific application. Further, because FCI thermal dispersion sensors have no moving parts to clog or foul, maintenance costs are virtually eliminated. Flow sensor designs are available for either flanged or threaded process connections into the aircraft's duct or pipe.

For most fluids, FCI thermal dispersion flow meters are calibrated using the actual fluid at the actual temperature and process conditions of your application. The result is a flow sensor you can install with total confidence and assurance that it meets your application.

Flow

AS-FS

AS-FT

LEVEL and INTERFACE SENSORS

FCI level products utilize FCI exclusive constant power, thermal-dispersion as the sensing technology which yields a highly sensitive and low power element. FCI level sensors have no moving parts to clog or foul, maintenance costs are virtually eliminated. Level element designs are available for either flanged or threaded process connections through the reservoir or gearbox and is equipped with an electrical connector or flying lead to the electronics. FCI has also provided level elements for mounting internally within the reservoir or sump with a flying electrical lead passing through a seal in the wall of the vessel and attaching to remote mounted electronics. Multi-point level sensing element designs are available for up to eight (8) separate elevations in a reservoir.

PRESSURE SENSORS

FCI pressure products are built using piezoresistive sensors in a wheatstone bridge, strain-gage, or capacitance ceramic technology. They can be specified for absolute or sealed gauge pressure measurement. The pressure element is threaded for direct installation into pipes, ducts, tanks, reservoirs, sumps and gearboxes on the aircraft.

TEMPERATURE SENSORS

FCI Aerospace provides a complete line of temperature measurement solutions for on-board aircraft applications. The products include temperature sensors and elements (AS-TE models), temperature switches (AS-TS models), and temperature transmitters (AS-TT models).

FCI temperature measuring products utilize precision resistance temperature detectors (RTDs) to provide superior accuracy, repeatability, and long life, making them the ideal choice for demanding aerospace applications.

Level

AS-LLS

AS-LLE

AS-MLLS

Pressure

AS-PS

AS-PT

Temperature

AS-TS and AS-TT

AS-TE

ENGINEERING FOR SUCCESS

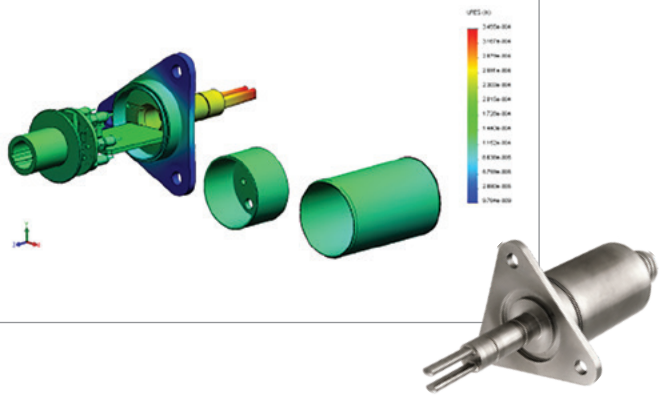
In support of customer sensing solutions, FCI provides comprehensive engineering and technical support that meets aircraft manufacturers' highest standards. Documentation, flight test qualifications, fabrication, use of specific ducting or piping to simulate vehicle conditions and installation are all within the scope of any FCI project. FCI also operates a world-class flow calibration laboratory with calibrations performed on more than 19 different flow stands, using equipment traceable to NIST (US National Institute of Standards and Technology), and ISO/IEC 17025 (International Standards for test lab quality systems) and meets ANSI/NCSL Z540 requirements. FCI continuously invests in engineering tools and development systems to bring you the most effective measurement product solutions while minimizing your investment. By applying computer design, modeling and analysis, FCI is able to dramatically reduce development times, provide improved diagnostics and eliminate excessive prototyping, which results in a better product with significant cost savings to you.

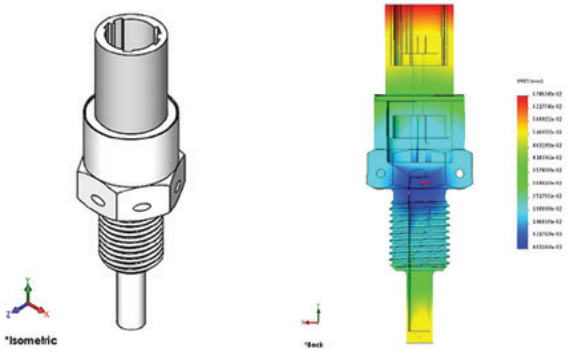
APPLICATION VERSATILITY

Sensor elements can be specified to interface directly to customer supplied electronics or with FCI electronics.

FCI electronics are combined with sensor elements to create complete flow, level, temperature and pressure switches or transmitters. For switch outputs, FCI can supply up to three solid state switch outputs, or a combination of solid state switches and analog outputs for limit control or alarm applications. For transmitter applications, FCI electronics can provide one or more linearized 0-5 Vdc or 0-10 Vdc analog outputs.

Electronics for either switch or transmitter products may be integrally mounted with the sensor element or remote mounted with an interconnecting cable. Electrical connections are typically made using MIL-STD connectors.





UNIQUE 'FLOW + TEMPERATURE' AND 'LEVEL + TEMPERATURE' SENSING TECHNOLOGY

FCI's thermal dispersion technology excels in applications where both flow and temperature or level and temperature are measured. Because temperature sensing is inherent in FCI's thermal dispersion flow and level measurement technology, a second output of the fluid's temperature is always available. A single sensor provides dual measuring functions. Aircraft manufacturers save weight, save space, and save costs over two or more discrete sensors. You realize reduced qualification installation costs and complexity.

CERTIFICATIONS AND QUALITY TO RELY ON

FCI is ISO 9001 and AS 9100 certified and a continuous improvement manufacturer. FCI's design, manufacturing and calibration systems, processes, and facilities are continuously reviewed and audited by all major contractors and airframe manufacturers, enabling FCI to provide proposals directly to system suppliers and contractors alike.

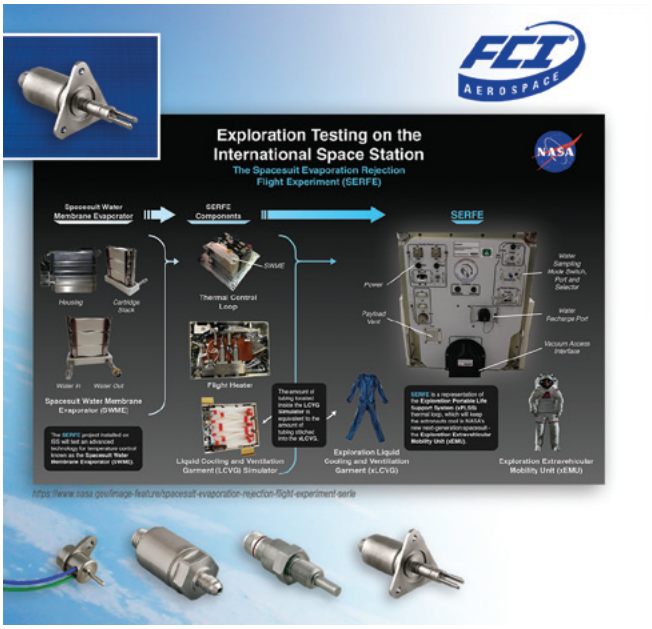
FCI's Quality Assurance Management System has been reviewed, audited, and approved by numerous commercial and military aircraft, space, vehicle, and marine contractors and approval agencies.

FCI as a Production Approval Holder (PAH) provides 8130-3 Airworthiness Tags under the Federal Aviation Administration- Parts Manufactures Approval (FAA-PMA).

Following this system, FCI provides the highest quality products while consistently meeting or exceeding the quality goals and objectives of our aerospace customers.

VEHICLE and SHIPBOARD APPLICATIONS

FCI's flow, level, temperature and pressure measuring solutions are also successfully applied in service in military vehicle and shipboard applications. Submit the Application Data Sheet for product information and solutions.



FCI Flow Switch Embarks On Out-of-This-World Mission for Spacesuit Experiment Aboard International Space Station

The reliable, precision Model AS-FS flow switch has been inserted into the Spacesuit Water Membrane Evaporator (SWME) – Spacesuit Evaporation Rejection Flight Experiment (SERFE), which was installed aboard the International Space Station (ISS).

FCI's thermal mass AS-FS flow switches are suitable for a wide range of aircraft and spacecraft applications. They have proven themselves for decades in environmental cooling systems, air management systems, cooling fan failure alarms, RAM air flow failure alarming, fuel tank inerting systems, and PACK and bleed air systems.

Read the AS-FS article at www.FCIAerospace.com

FOR GROUND-BASED, FUEL DEPOT, TEST STANDS OR PLANT OPERATIONS APPLICATIONS, FCI's industrial product division manufactures a broad range of air flow and gas flow meters, liquid and air/gas flow switches, and liquid level switch solutions. Boiler fuel and air feed controls, HVAC, compressed air monitoring and leak detection, pump low/no flow alarms, are just a few examples of plant operation applications served by FCI industrial products. Check out these products and solutions at www.FluidComponents.com.

General Capabilities and Specifications

	Flow	Level	Temperature	Pressure
Fluid Service (Compatibility)	Air, Gas, Liquids	Liquids, Interface	Air, Gas, Liquids	Air, Gas, Liquids
Base Series Model Number				
Element	N/A	AS-LLE	AS-TE	N/A
Switch	AS-FS	AS-LLS, AS-MLLS	AS-TS	AS-PS
Transmitter/Meter	AS-FT	N/A	AS-TT	AS-PT
Installation	Insertion or in-line flow body	Insertion	Insertion	Insertion
Accuracy	±2% FS	± 0.25 inch [6.35 mm]	±0.5 °F [± 0.3 °C]	± 1% of reading
Repeatability	±1% FS	± 0.1 inch [2.54 mm]	±0.05% reading	± 0.1% of reading
Element Materials of Construction	300 series stainless steel, Titanium and other materials available; brazed or all-welded	300 series stainless steel, Titanium and other materials available; metals brazed or all-welded PVC/Kapton (AS-MLLS)	300 series stainless steel, Titanium and other materials available; all welded	300 series stainless steel, Titanium and other materials available; all welded
Process Connections	Flanged or threaded	Flanged or threaded	Flanged or threaded	Flanged or threaded
Element Operating Temperature	-65 °F to 800 °F [-54 °C to 427 °C]	-65 °F to 800 °F [-54 °C to 427 °C]	-50 °F to 800 °F [-46 °C to 427 °C]	-40 °F to 257 °F [-40 °C to 125 °C]
Element Operating Pressure	to 7500 psig [517 bar g]	to 7500 psig [517 bar g]	to 7500 psig [517 bar(g)]	to 10,000 psig [690 bar(g)]
Element Proof Pressure	to 12,500 psig [861 bar(g)]	to 12,500 psig [861 bar(g)]	to 12,500 psig [861 bar(g)]	to 20,000 psig [1380 bar(g)]
Other	Flow turndown 5:1 to 100:1, depending on fluid			
Integral or Remote Mounting	Yes	Yes	Yes	Yes
Operating Temperature	-40 °F to 257 °F [-40 °C to 125 °C]	-40 °F to 257 °F [-40 °C to 125 °C]	-40 °F to 257 °F [-40 °C to 125 °C]	-40 °F to 257 °F [-40 °C to 125 °C]
Power Input	28 Vdc nominal per MIL-STD-704	28 Vdc nominal per MIL-STD-704	28 Vdc nominal per MIL-STD-704	28 Vdc nominal per MIL-STD-704
Outputs				
Switch Configurations	Open collector/drain	Open collector/drain	Open collector/drain	Open collector/drain
Transmitter Configurations	0-5 Vdc, 0-10 Vdc; linearized and conditioned	N/A	0-5 Vdc, 0-10 Vdc; linearized and conditioned	0-5 Vdc, 0-10 Vdc; linearized and conditioned
Housing Materials	300 series stainless steel; hermetically sealed; (opt) nickel-plated aluminum, O-ring sealed	300 series stainless steel; hermetically sealed; (opt) painted aluminum alloy	300 series stainless steel; hermetically sealed; (opt) nickel-plated aluminum, O-ring sealed	300 series stainless steel; hermetically sealed
EMI and Lightning Protection	MIL-STD-461, RTCA/DO-160	MIL-STD-461, RTCA/DO-160	MIL-STD-461, RTCA/DO-160	MIL-STD-461, RTCA/DO-160
Additional Qualifications	MIL-STD-810, RTCA/DO-160	MIL-STD-810, RTCA/DO-160	MIL-STD-810, RTCA/DO-160	MIL-STD-810, RTCA/DO-160
Other Features, Options	• Process temperature output • Controller functions (time delays, etc.) • Extended temperature service • Extended pressure service	• Process temperature output • Controller functions (time delays, etc.) • Extended temperature service • Extended pressure service	• Three (3) switch points, or two (2) switch points + one (1) analog	

For ground-based, fuel depot, test stands or plant operations applications, see FCI's industrial product line.

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Application Data Sheet (ADS)

Aerospace & Military Products

Temperature, Flow, Liquid Level & Pressure Sensors

** Required information*

Customer Information

Date: _____

*** Company Name:** _____

* Address: _____

_____

* City: _____ State: _____ * ZIP/Postal Code: _____

Country: _____ ☐ Commercial ☐ Military

*** Technical Contact:** _____

* Phone: _____ Fax: _____

* Email: _____

Procurement Contact: _____

Phone: _____ Fax: _____

Email: _____

Application Information

Sensor type: ☐ Temperature ☐ Pressure ☐ Flow ☐ Level/Interface ☐ Other: _____

Mounting connection: ☐ Thread ☐ Flange Description _____

Input Power: ☐ 28 Vdc ☐ 110 Vac, 60 Cycle ☐ Other: _____

Alarm Output: ☐ Open Collector ☐ Analog Output Only ☐ Other: _____

Application Sketch

☐ **Sending sketch via email**

Process Conditions

Primary process media (at sensor location): _____

☐ Gas ☐ Liquid

Temperature - specify units: ☐ °F ☐ °C ☐ Other: _____

Minimum: _____ Nominal: _____ Maximum: _____

Pressure - specify units; ☐ psig ☐ psia ☐ bar(g) ☐ atm ☐ Other:_____

Minimum: _____ Nominal: _____ Maximum: _____

Secondary process media (flow or level): _____

☐ Gas ☐ Liquid

Temperature - specify units: ☐ °F ☐ °C ☐ Other: _____

Minimum: _____ Nominal: _____ Maximum: _____

Pressure - specify units; ☐ psig ☐ psia ☐ bar(g) ☐ atm ☐ Other:_____

Minimum: _____ Nominal: _____ Maximum: _____

Interface description (specify interface state; foam, sediment, slurry): _____

Calibration Conditions *(Customer must specify calibration media)*

Temperature/Pressure Applications

Temperature/Pressure range:

☐ As entered for the primary media in Process Conditions section above

☐ As entered for the secondary media in Process Conditions section above

☐ Other _____

Alarm set point: No. 1 _____
No. 2 _____
No. 3 _____

Analog output signal: ☐ Not required
☐ 0-5 Vdc
☐ 0-10 Vdc
☐ Other _____

For temperature applications only

Element type: ☐ RTD
☐ Thermistor
☐ Thermocouple

Flow Sensor Applications

Duct inside diameter: _____ ☐ Inch ☐ mm

Pipe orientation: ☐ Horizontal ☐ Vertical

Sensing element mounting: ☐ Side ☐ Top

Flow direction: ☐ Right to left ☐ Left to right
☐ Top to bottom ☐ Bottom to top

Flow rate: Min. _____ Max. _____

Nominal flow rate: _____

Flow units: _____

Alarm set point: No. 1 _____
No. 2 _____
No. 3 _____

Signal output: ☐ 0-5 Vdc ☐ 0-10 Vdc

Media: ☐ Air ☐ Fuel
☐ Hydraulic fluid ☐ Coolant

Description: _____

_____

Level/Interface Applications

Sensing element mounting: ☐ Side ☐ Top ☐ Bottom

Level or interface rate-of-change (at sensing element): _____

☐ Inch/sec ☐ mm/sec
☐ Inch/hr ☐ mm/hr

Alarm set point elevation distance from mounting connection: No. 1 _____
No. 2 _____
No. 3 _____
No. 4 _____
No. 5 _____

Analog output signal:

☐ Stepped ☐ Continuous
☐ 0-5 Vdc ☐ 0-10 Vdc
☐ Not required
☐ Other _____

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Locally represented by:

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