From the early 1960s, Fluid Components International recognized the need for flow and level instrumentation which met specific customer requirements and demands for the Power and Energy Industry. By utilizing Thermal Dispersion and Coriolis technology exclusively in all FCI flow, level, interface, temperature switches and mass flow meters, our products solve typical Power and Energy Industry application challenges with standard product features such as:

- No moving parts
- All welded materials of construction
- Direct mass flow measurement
- No pressure drop
- Explosion-proof design
- Wide flow range
- Low flow capability

By closely monitoring the everchanging requirements for the Power and Energy Industry, FCI has maintained its reputation as the technology leader with new product features such as:

- Modern digital communications with HART, Modbus, ProfiBus, Ethernet and ASI
- Fail-safe mode selection per Namur NE43
- Compliance with the latest approval requirements of FM, CSA, CRN, ATEX, CE Mark and PED
- Application focused marketing and engineering research and design
- Secondary sealed flow element sensor design
- Integral flow conditioners
- Two-wire loop-power flow, level and interface detection

FCI Power and Energy Industry customers

- Detroit Edison
- Energy Northwest
- Duke Power
- First Energy Corporation
- Bridgeport Resco
- Duquesne Light
- Florida Power & Light
- Georgia Power
- GPU Nuclear
- Ameren/CIPS
- United Pacific Controls
- Taiwan Power
- Korea Electric Power
- Comision Federal De Electricidad
- Niagara Mohawk
- Gulf Power
- Houston Lighting & Power
- General Electric
- American Combustion

**FCI Power and Energy Industry customers for Engineering, Procurement & Construction (EPC)**

- Bechtel Group
- Sargent & Lundy
- Black & Veatch
- Duke Engineering & Services
- Fluor
- Foster Wheeler
- VECO
- B.E. & K. Inc.
- Washington Group Intl
- Parsons
- Day & Zimmerman Intl
- Chicago Bridge & Iron

**Pulverized air flow**

The measurement and control of mill air flow in coal-fired boilers to minimize pulverizer performance problems is an industry-wide challenge. Minimizing NOx and maximizing plant efficiency has now taken center stage for this task. Measurement of air flow is important in controlling mill slugging, feeder runback and coal spillage. It is also a main factor in minimizing emissions and maximizing fuel response to the furnace, thus maximizing efficiency for these plants. FCI’s MT Series multipoint mass flow meters measure wide flow rate ranges in high temperature applications. The no moving parts design prevents highly corrosive fly ash from clogging or fouling.
**Condenser air in-leakage**

Changes in the discharge flow represent air in-leakage through the compressor. The negative effects of air in-leakage in the vacuum system are well understood. FCI’s GF90 Series mass flow meter detects small changes in flow that represent changes in efficiency of the compressor. Pre-requirements for successful monitoring require low flow sensitivity, wide flow range measurement, repeatability and accuracy -- all of which are standard features of FCI thermal mass flow meters.

![Condenser air in-leakage diagram](image)

**Hydrogen flow monitoring**

Hydrogen is a commonly used cooling agent in power plant turbine generators. Leaking hydrogen gas can pose a safety concern in the power plant. FCI’s GF90 Series mass flow meters detect increase in usage; thereby alerting operators of leaks. In addition to monitoring for hydrogen leaks, plants need to measure the flow rate for custody transfer billing verification from the gas supplier to the utility. Also, multiple plants typically draw from a common hydrogen supply by using FCI’s GF92 inline unit. FCI’s GF Series mass flow meters measure the flow at each location, so each plant can be assessed their appropriate share of hydrogen usage.

![Hydrogen flow monitoring diagram](image)

**Reverse flow vent monitoring**

To ensure critical flows and detect changes in the direction of air purge in and out of chemical plants, the solid-state RF83 bi-directional flow monitor is the best suited instrument available. It may be mounted on the inlet ducts to monitor all flow into the building. If the flow reverses, safety alarms will trip for failure notification of the fans.

![Reverse flow vent monitoring diagram](image)
**Pump protection**

FCI’s FLT93S FlexSwitch® is the ideal instrument to protect pumps from failure due to low flow operation. The no moving parts design, capable of low flow sensing, is well suited to identify a wide variety of product flows in harsh industrial environments. The dual switch points may be set to alarm low flow or high temperature, both indications of conditions that cause pump failure.

**Compressed air flow monitoring**

Frequently, in a plant environment, there is a controller that monitors the use of compressed air within the facility. The controller automatically determines the optimum number of compressor units that need to be in operation at any given time to handle the facility load. By only operating the units that the demand requires, a tremendous amount of energy is saved. The demand is determined by the total mass flow of air used by the plant, and FCI’s ST98 FlexMASSier® Series mass flow meters are designed specifically for this purpose. The controller then sets the compressor usage based on the mass flow rate indicated by the ST98.

**Seal gas detection**

Coolant and lubricant seal leakage are a serious threat to the efficiency of pumping systems. Fluid contamination to the product and loss of product through damaged seals are avoided with FCI’s FD93L inline FlexSwitch or FR78 inline low flow monitor. Even a leak as small as 1.0 cc/sec is detected by these highly sensitive instruments. Because the FCI sensor elements operate without obstructing the seal vent line, there is no excessive pressure drop if a severe seal rupture occurs. For slurry pumps, the dual switch point option may be used to identify either a low seal water flow or a high flow seal rupture.
CI introduced the first thermal flow switch/monitor in 1964 and has since established a worldwide reputation for the design and production of precision high performance flow, level and temperature instrumentation. With reliability second to none, FCI has placed over 200,000 units in the field covering the full range of liquid, gas and slurry process requirements. FCI products service some of the world’s most demanding processes in industries such as food & beverage, pharmaceutical, chemical, oil and gas, pulp and paper, power and energy, water and wastewater, nuclear power, aerospace and more. FCI offers a broad range of instrumentation solutions and services, from off-the-shelf devices to custom engineered systems. FCI’s engineering staff provides expertise in mechanical, electronic and thermo-dynamic disciplines offering innovative solutions to specialized customer application needs, configuration objectives, software enhancements, and material problems.

**Thermal Dispersion principle**
The typical sensing element contains two thermowell-protected precision platinum Resistance Temperature Detectors (RTDs). When placed in the process stream, one RTD is heated and the other RTD senses the process temperature. The temperature difference between the two RTDs is related to the process flow rate as well as the properties of the process media. Higher flow rates or denser media cause increased cooling of the heated RTD and a reduction in the RTD temperature difference.

**FlexSwitch® FLT93 Series**
The FLT93 Series utilizes proprietary thermal dispersion technology to provide the highest reliability in flow, level and temperature detection. The sensing element is composed of two matched RTD’s. One RTD is preferentially heated. The other RTD is unheated and thermally isolated to provide continuous process condition temperature and baseline indication. At no flow or under dry conditions, the temperature differential between the two RTDs is greatest.

**For flow/no flow detection**
No-flow conditions produce a large signal. As flow increases, the heated RTD is cooled and proportionally reduces the temperature differential. Changes in flow velocity directly affect this rate of heat dissipation. An electronic circuit normalizes the differential measurement with the process media temperature and converts the RTD temperature/resistance differential into a DC voltage signal. This signal is provided at output terminals and used to drive two adjustable setpoint alarm circuits that are independently field configurable for specific flow service applications.

**For liquid level/interface detection**
Dry conditions (no liquids present) produce the greatest temperature differential. The signal decreases when the level element is submerged as the cooling effects of the fluid drive the temperature/resistance differential downward. Since all process fluids have different thermo physical properties, different fluids exhibit unique heat transfer characteristics. Interface detection between non-miscible fluids can be factory or field calibrated to alarm when the fluid changes from liquid to foam, between two different fluids, or between fluid and rag layer or emulsion.

continued on back cover
### FCI’s complete line of flow, level and temperature instrumentation

**ST98 FlexMassStar**
- **Insertion Gas Mass Flowmeter**
- **Flow Element Range:** 0.25 to 600 SCFM
  - [0.3 to 720 NCMH]
- **Process Connection:** 1.4” male NPT stainless steel adjustable compression fitting with flange or rated flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Aluminium is rated for hazardous location use Class I and Division 1 and 2, Group B, D, E, F, and G, and IECx and complies with the effect of weather and corrosion.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - 40°F to +250°F
    - [4°C to +121°C]
  - Pressure: 
    - To 250 psi [17 bar(g)]

**ST98I FlexMassStar**
- **Insertion Liquid Mass Flowmeter**
- **Flow Element Range:** 0.0002 to 1850 SCFM
  - [0.003 to 3150 NCMH]
- **Process Connection:** 1.5” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -40°F to +150°F
    - [-40°C to +65°C]
  - Pressure: 
    - To 250 psi [17 bar(g)]

**ST98HP FlexMassStar**
- **Insertion High Purity Mass Flowmeter**
- **Flow Element Range:** 2.0 to 7085 SCFM
  - [3.4 to 4549 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**ST990 FlexMassStar**
- **Insertion Gas Mass Flowmeter**
- **Flow Element Range:** 0.25 to 1600 SCFM
  - [0.4 to 288 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**ST990I FlexMassStar**
- **Insertion Liquid Mass Flowmeter**
- **Flow Element Range:** 0.6 to 2000 SCFM
  - [10 to 399 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**ST992 FlexMassStar**
- **Insertion Gas Mass Flowmeter**
- **Flow Element Range:** 0.25 to 1600 SCFM
  - [0.4 to 288 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**ST992I FlexMassStar**
- **Insertion Liquid Mass Flowmeter**
- **Flow Element Range:** 0.6 to 2000 SCFM
  - [10 to 399 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**ST993 FlexMassStar**
- **Insertion Gas Mass Flowmeter**
- **Flow Element Range:** 0.25 to 1600 SCFM
  - [0.4 to 288 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

**MT Series**
- **Multi-Point Mass Flowmeters**
- **Flow Element Range:** 0.5 to 150 SCFM
  - [8 to 46 NCMH]
- **Process Connection:** 1” male NPT stainless steel adjustable compression fitting with flange connection and bolt-removable packing gland assembly available.
- **Field Adjustable Lengths:** 1 to 4’ [25 to 122 mm]
  - 1 to 12’ [30 to 365 mm]
  - 1 to 20’ [305 to 610 mm]
  - 1 to 50’ [1524 mm]
- **Endorsement Classification:** Standard: NEMA/CSA Type 4X (equivalent to IP65) and Division 2 (Ex d)
  - Option: Stainless steel flange connection and bolt-removable packing gland assembly available.
- **Sensing/Flow Element Operating Conditions:**
  - Temperature: 
    - -50°F to +150°F
    - [-50°C to +65°C]
  - Pressure: 
    - To 1000 psi [69 bar(g)]

---

*Air at 70°F (21.1°C) and 14.7 psi [1.00325 bar(g)] (reference)*
## Flow, Level and Temperature Switch Series

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Flow/Level</th>
<th>Temperature</th>
<th>Pressure</th>
<th>Size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL1935 FlexSwitch</td>
<td>FlexSwitch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>FL1935 FlexSwitch</td>
<td>FlexSwitch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>FL1935 FlexSwitch</td>
<td>FlexSwitch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>FL780000 Insertion Flow Switch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1500 psi</td>
<td>1/2&quot;</td>
<td>Stainless steel</td>
<td></td>
</tr>
<tr>
<td>12-648</td>
<td>Insertion Flow Switch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>FR78B</td>
<td>Insertion Flow Switch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>FR73B</td>
<td>Insertion Flow Switch</td>
<td>Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>NuTec FS2000L</td>
<td>In Line, Level/Temperature Switch</td>
<td>-40°F to 150°F</td>
<td>1000 psi</td>
<td>1/4&quot;</td>
<td>Stainless steel</td>
<td></td>
</tr>
</tbody>
</table>

**Flow Rates:**
- Water-Based Liquids: 0.01 to 5.0 gpm
- Hydrocarbon-Based Liquids: 0.01 to 5.0 gpm

**Air Flow:**
- 2.5 to 50 ft/min

**Level:**
- From 0.5 inches to 1 inch

**Level:**
- From 0.5 inches to 1 inch

**Temperature:**
- -40°F to 150°F

**Pressure:**
- 1000 psi

**Size:**
- 1/4" NPT

**Notes:**
- Stainless steel

---

**Temperature:**
- -40°F to 150°F

**Pressure:**
- 1000 psi

**Size:**
- 1/4" NPT

**Notes:**
- Stainless steel

---

**Temperature:**
- -40°F to 150°F

**Pressure:**
- 1000 psi

**Size:**
- 1/4" NPT

**Notes:**
- Stainless steel

---

**Temperature:**
- -40°F to 150°F

**Pressure:**
- 1000 psi

**Size:**
- 1/4" NPT

**Notes:**
- Stainless steel

---

**Temperature:**
- -40°F to 150°F

**Pressure:**
- 1000 psi

**Size:**
- 1/4" NPT

**Notes:**
- Stainless steel
For temperature detection
The unheated RTD serves as the baseline for establishing the differential temperature and continuous monitoring of the process temperature. Being thermally isolated, the unheated RTD provides accurate indication and detection of process fluid temperatures. Simultaneous temperature and flow and level detection can provide comprehensive process monitoring as well as critically supplement operator process health and efficiency awareness.

NuTecc® 2000 Series
> 2-wire loop-power and non-intrusive switches
Extraordinarily responsive and accurate, the versatile NuTec flow/level switch series offers superior reliability in extreme process conditions. The FS2000 and LS2000 switches feature the first 2-wire thermal flow/no flow and level detection switches. These insertion switches are designed with FCI’s proven thermal mass flow sensor technology in a rugged package that is easy to install and requires minimal maintenance. The FS2000L inline flow switch has an advanced non-intrusive sensor design constructed of 316L stainless steel with up to a 10 Ra electropolish finish approved for 3A sanitary and high purity applications. The FS2000L is available with inline sizes of 1/2 inch, 1 inch and 2 inches for easy installation using male NPT, butt-weld or sanitary flanges.

FlexMASSter® ST Series and GF Series mass flow meters
Because the relationship between flow rate and cooling effect directly relates to mass flow in gas applications, FCI thermal mass flow meters provide a highly repeatable and accurate measurement of gas or air mass flow rates. The ST98 Series “smart” electronics, equipped with advanced micro-processor-based circuitry, enable customers to reconfigure the signal outputs easily, as well as, display or alarm in the field by using either a built-in key pad or a handheld communicator. The GF Series offers wide turndown ratios up to 800:1 with multiple gas calibrations with analog electronic circuitry.

FlexMASSter technology delivers performance and value by offering the most innovative, accurate and cost effective gas mass flow measurement systems available in the industrial flowmetering marketplace today. This highly reliable instrument provides the durability and speed required for today’s harsh process environments and delivers true direct mass flow measurement. FCI’s FlexMASSter simplifies gas mass flowmetry with a single process penetration, eliminating costly temperature or pressure transmitters and a flow computer required with other technologies.

CMF FlexCOR® Series
The CMF FlexCOR Series Coriolis flow meters push development a giant leap forward in Coriolis measurement technology. Unaffected by variations in pressure, temperature, density, electrical conductivity and viscosity, the FlexCOR Series provides highly accurate mass flow measurement over wide flow ranges while utilizing its advanced technology to achieve unsurpassed operational performance stressing safety, reliability and quality.

VORTAB® flow conditioners
FCI ensures the field performance of its highly accurate mass flow meter product lines by offering VORTAB flow conditioners. VORTABs ensure accurate, repeatable gas flow measurement and are the efficient alternative to long lengths of straight piping or ducting upstream of a flow meter installation location. VORTAB units reduce or eliminate pressure drop, swirl, jetting and more, while requiring just six diameters of pipe upstream from the flow meter. Each of the three available flow conditioner configurations consists of a short section of swirl reduction tabs combined with three arrays of patented VORTAB profile conditioning tabs.

FCI’s extensive instrument test and calibration laboratory
FCI maintains an extensive, instrument test and calibration laboratory at its headquarters in San Marcos, California. Utilizing the latest in advanced, computerized data acquisition systems and calibration test equipment, this facility permits comprehensive product development, testing, and calibration. Any FCI product can be calibrated in accordance with customer specifications. Laboratory standards are maintained with NIST (National Institute of Standards and Technology) traceable Cavitating Venturis (CVs) and precision calibrated, pressure and temperature corrected turbine flow meters. Combustible and non-combustible gas calibration flow stands allow for the calibration of FCI products in a wide range of gases as gas mixtures in flow stand sizes as small as 1/8 inch to 30 inches [3 to 760 mm] in diameter. A variety of flow profiles from laminar to turbulent conditions are generated to duplicate actual field conditions. Flow rates from 0 to 20,000+ SCFM [0 to 34,000 NCMH], velocities from 0 to 800 SFPS [0-240 NMPS], pressures from vacuum to 3000 psig [200 bar(g)], and temperatures from -100° to 850°F [-70° to + 454°C].

FCI on-site instrument calibration and training
In-situ calibration is available from FCI’s Field Service Engineers where precise test and calibration is accomplished in actual media conditions.