Pulp and Paper Industry

User Application Guide

FLUID COMPONENTS INTERNATIONAL LLC

The mass flow experts for flow, level and temperature instrumentation
From the early 1960s, Fluid Components International recognized the need for flow and level instrumentation which met specific customer requirements and demands for the Pulp and Paper 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 Pulp and Paper 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 Pulp and Paper Industry, FCI has maintained its reputation as the number one technology leader with new product features such as:

- Modern digital communications with HART, Modbus, Profieldbus, 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 intrinsically-safe flow, level and interface detection

FCI Pulp and Paper Industry customers

- International Paper
- Georgia-Pacific
- Kimberly-Clark
- Proctor and Gamble
- Smurfit-Stone
- Weyerhaeuser
- MeadWestvaco
- Appleton Papers
- Bowater
- Tenbec
- Abitibi-Consolidated
- Alabama River Pulp
- Mobile Paperboard
- Boise Cascade

FCI Pulp and Paper Industry customers for Engineering, Procurement & Construction (EPC)

- B.E. & K.
- Kvaerner PLC Group
- Jacobs Engineering
- Kellogg Brown & Root
- R.M. Parsons
- J.A. Jones
- The Boldt Company
- Fru-Con Construction
- Fluor Corporation
- H.B. Zachry
- Sandwell Engineering

Interface Detection

The difficult and challenging interface application of black liquor and soap is solved by using FCI’s thermal dispersion technology to differentiate between the black liquor and soap at the high and low levels in the skim tank. FCI’s FLT93S FlexSwitch® level switches feature a rugged, no moving parts design with 316L all welded stainless steel that is not prone to the typical failure of mechanical flotation devices or dp level systems. The FLT93S FlexSwitch also feature two field adjustable alarm relays and is temperature compensated for wide temperature changes in process media.
**Natural gas flow monitoring**

The amount of chemical recovery that takes place in pulp and paper mills has a direct impact on profitability. Lime is an important chemical used in the mill cooking process and the lime kiln consumes tremendous amounts of fuel that can be very costly to its recovery. FCI’s ST98 FlexMASSter® Series mass flow meters provide exceptional accuracy in measuring mass flow to insure proper natural gas/air ratio for maximum efficiency. The ST98 FlexMASSter features thermal dispersion technology with no moving parts and all welded 316L stainless steel construction. This technology also features mass measurement of very low flow rates with wide turndown capabilities and no pressure drop in the process media.

**Fuel oil monitoring**

The start up cycle of recovery boilers is a very critical application that commonly uses atomized #2 fuel oil and steam. Inconsistencies in fuel oil flow leads to a longer start up process that directly impacts profitability. FCI’s FLT93L FlexSwitch inline flow switches feature no moving parts with 316L all welded stainless steel construction that provide outstanding reliability and extreme low flow sensitivity. The FLT93L FlexSwitch also features two alarm relay circuits that can be field adjusted or factory preset for low and high flow alarm conditions, offering additional safety during process operation.

**Combustion air flow monitoring**

Mill power plants maximize efficiency and reduce NOx emissions by accurately measuring the ratio of pulverized coal to air in coal-fired boilers. Air flow measurement and accuracy is also important in controlling mill slugging, feeder runback and coal spillage. FCI’s MT Series multipoint mass flow meters accurately and reliably measure wide flow ranges in these high temperature, erosive applications. The MT Series features flow elements with no moving parts design and stainless steel or optional Hastelloy C materials of construction that will not plug or foul when exposed to very high temperatures.
**Pump protection**

FCI’s FLT93S FlexSwitch flow switch is the ideal instrument to protect pumps from failure due to low flow or loss of flow. With no moving parts design, high reliability and extreme low flow sensitivity, the FLT93S FlexSwitch is ideally suited to monitor a wide variety of processes in harsh industrial environments. The FLT93S dual switch point circuitry is field adjustable to alarm on low flow or high temperature, both contributing factors of pump failure.

**Chemical injection**

In monitoring chemical and other additive injection flow, the ultra-sensitive FLT93L inline FlexSwitch outperforms the competition. It detects gas flows down to 0.6 cc/sec and liquid flows down to 0.02 cc/sec -- ideal for virtually all injection processes. The no-moving-parts flow element design provides outstanding durability and reliability under the harshest process conditions. And, the inherent thermal time delay, available in all FCI flow switch/monitors, prevents false alarms caused by flow pulsation and eliminates the need for auxiliary time delay relays. Optional dual switch point circuitry helps maintain product quality and process safety by alarming both high flow and low flow conditions.

**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 FlexMASSter 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.
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*
<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Flow Element Range</th>
<th>Adjustable Response Time</th>
<th>Process Connection</th>
<th>Insertion Length or Inline Sensor Assembly Body Length</th>
<th>Endurance Classification</th>
<th>Sealing/Flow Element Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST98 FlexMassStar*</td>
<td>In-Line Gas Mass Flowmeter</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
<tr>
<td>ST98LP FlexMassStar*</td>
<td>In-Line Gas Mass Flowmeter</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
<tr>
<td>ST98HF FlexMassStar</td>
<td>In-Line Gas Mass Flowmeter</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
<tr>
<td>GF90</td>
<td>In-Line Gas Mass Flowmeter</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
<tr>
<td>GF92</td>
<td>In-Line Gas Mass Flowmeter</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
<tr>
<td>GF93</td>
<td>Multi-Point Mass Flowmeters</td>
<td>0.015 to 2000 SCFM</td>
<td>N/A</td>
<td>N/A</td>
<td>1/4&quot; male NPT standard</td>
<td>Standard: NEMA/CSA Type 45, equivalent to IP66 and Division 1 and 2 (Ex d)</td>
<td>Temperature: -50°F to +150°F (-47°C to +66°C) Pressure: to 350 psig (24 bar)</td>
</tr>
</tbody>
</table>

* Air at 70°F (21.1°C) and 14.7 psi (1.01325 bar (g)) (reference)
# Flow, Level and Temperature Switch Series

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Water-Based Liquids</th>
<th>Hydrocarbon-Based Liquids</th>
<th>Air/Gas</th>
<th>Flow Rate</th>
<th>Lead</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLY93 FlexSwitch</td>
<td>Insertion Flow/Low Level Switch</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
<tr>
<td>FLY93C FlexSwitch</td>
<td>Insertion Sanitary Flow/Low Level Switch</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
<tr>
<td>12-64B</td>
<td>Low Level Monitor</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
<tr>
<td>FR78B</td>
<td>Ultra Low Flow Monitor</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
<tr>
<td>MuTeC F20000</td>
<td>Insertion Flow Switch</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
<tr>
<td>MuTeC F20001</td>
<td>Insertion Non-Intrusive Flow Switch</td>
<td>0.01 to 3.0 PPS</td>
<td>0.005 to 3.0 PPS</td>
<td>0.005 to 8.0 lb/min</td>
<td>15 to 50 ft/min</td>
<td>0.05 to 0.1 in.</td>
<td>Stainless steel, 316L, or 304L&lt;br&gt;Custom lengths available.&lt;br&gt;Standard: 3/4&quot; NPT, 1&quot; female NPT&lt;br&gt;Voltage: 18VDC</td>
</tr>
</tbody>
</table>

**Temperature:***
-40°F to +150°F (-40°C to 65°C)
Pressure: 3000 psi [206 bar(g)]

**Pressure:**
-20°F to +10°F (-29°C to -21°C)
Pressure: 3000 psi [206 bar(g)]
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.

NuTec® 2000 Series

2-wire, intrinsically-safe 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 only 2-wire thermal flow/no flow and level detection switches with intrinsically-safe design. 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 Flowmeters

Because the relationship between flow rate and cooling effect directly relates to mass flow in gas applications, FCI Thermal Mass Flowmeters 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 flow metering 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 flowmeters pushes 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 flowmeter 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 flowmeter installation location. VORTAB units reduce or eliminate pressure drop, swirl, jetting and more, while requiring just six diameters of pipe upstream from the flowmeter. Each of the three available flow conditioner configurations consist 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 flowmeters. 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.