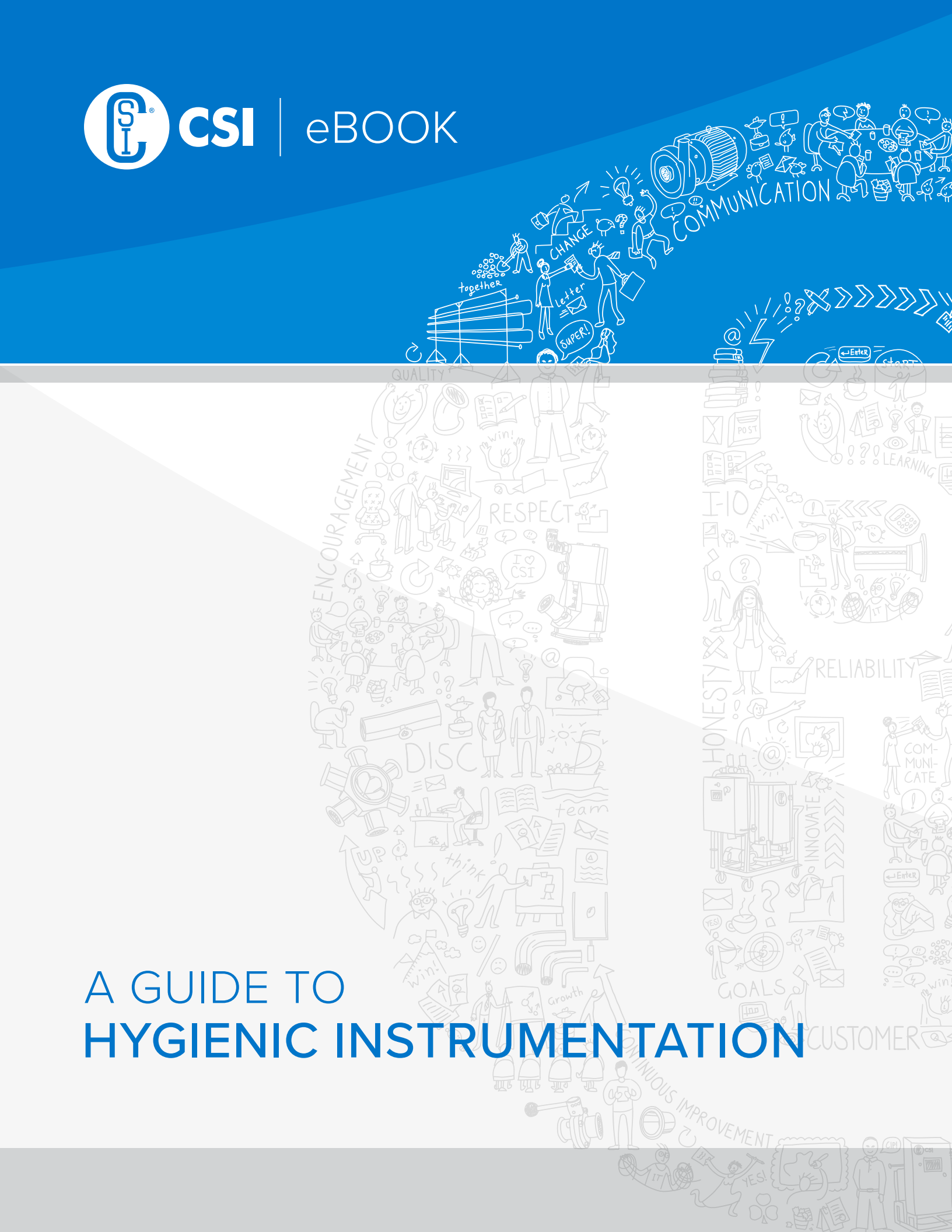




CSI

| eBook

# A GUIDE TO HYGIENIC INSTRUMENTATION



# TABLE OF CONTENTS

|   |    |
|---|----|
| INTRODUCTION .....  | 3  |
| PROCESS EFFICIENCY .....  | 3  |
| QUALITY .....   | 4  |
| SAFETY .....  | 4  |
| PREVENTATIVE MAINTENANCE .....  | 4  |
| ELECTRICAL INSTRUMENTS IN FOOD, DAIRY, BEVERAGE,<br>AND PHARMACEUTICAL PROCESSING ..... | 5  |
| DISCRETE SWITCHES .....   | 6  |
| TEMPERATURE SENSORS AND TRANSMITTERS .....  | 7  |
| PROCESS SENSORS AND TRANSMITTERS .....  | 8  |
| PROCESS SENSORS AND SWITCHES .....  | 10 |
| GUIDE TO FLOW METERS .....  | 12 |
| FLOW METERS & SWITCHES .....  | 13 |
| LIQUID ANALYSIS SENSORS .....   | 15 |
| ADDITIONAL SOLUTIONS .....  | 16 |
| Sight Glass Products .....  | 16 |
| Weighing Systems.....   | 16 |
| Paperless Process Recorder .....  | 16 |
| NEXT STEPS .....  | 17 |
| NOTES .....   | 18 |

# INTRODUCTION

Instrumentation and process control together give process and manufacturing facilities important information about a wide range of variables that help operators maintain product quality and

consistency. Monitoring the processes in your manufacturing plant is also critical to maintaining process efficiency, personnel safety, and cost-saving preventative maintenance.

## PROCESS EFFICIENCY

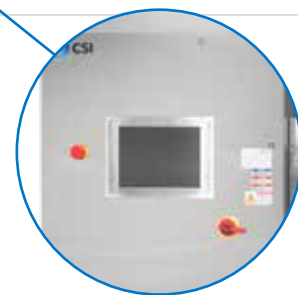
Monitoring key process parameters, such as flow rates through pipelines, is essential for optimizing plant operations. By centralizing process information in a control room or Human Machine Interface (HMI), plant operators can significantly enhance efficiency. This centralized access to real-time data reduces the need for operators to physically inspect equipment, allowing them to make informed decisions more swiftly. The following are key benefits of using real-time data and effective instrumentation:

- **Real-time Decision Making:** Real-time data from process instruments allows operators to respond promptly to changing conditions, **improving overall decision-making speed** and accuracy.
- **Optimized Yield:** Instruments ensure adherence to specific process parameters, which **helps maintain product quality and consistency**.
- **Waste Reduction:** Effective instrumentation helps minimize waste by managing product specifications, preventing overflow events, and optimizing flushing processes in piping systems.

- **Data-Driven Improvements:** Collecting and analyzing process data enables **identification of errors, facilitating recipe adjustments, and continuous process enhancements**.
- **Increased Production Rates:** Continuous monitoring helps **boost production rates** and **minimizes downtime** by promptly addressing issues related to fluid processes.



Human Machine Interface (HMI)



## QUALITY, SAFETY, AND PREVENTATIVE MAINTENANCE

### QUALITY

Monitoring critical process variables, such as temperature, is essential for ensuring and maintaining product quality. For example, in various processing industries, maintaining the correct temperature range is crucial to prevent products from becoming overcooked or undercooked, which can impact safety and regulatory compliance.

### SAFETY

Continuous monitoring of operating conditions, such as pressure levels in pipelines and vessels, is vital for maintaining safe operational parameters. This helps to prevent accidents and ensure the safety of both the equipment and personnel.

### PREVENTATIVE MAINTENANCE

Regular monitoring of equipment performance, such as tracking operational hours or usage metrics, can guide plant operators in scheduling preventative maintenance. This approach helps in identifying potential issues before they lead to equipment failure, thereby reducing downtime and maintaining optimal operational efficiency.



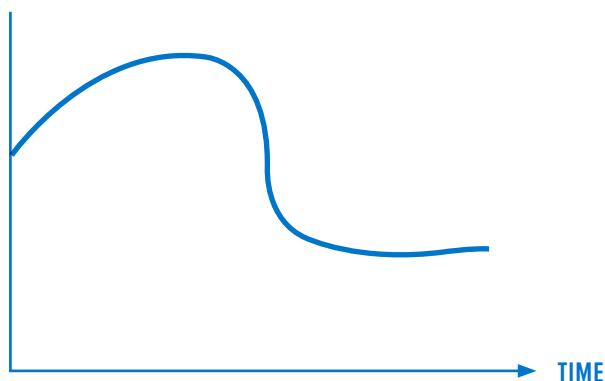
Temperature Sensors



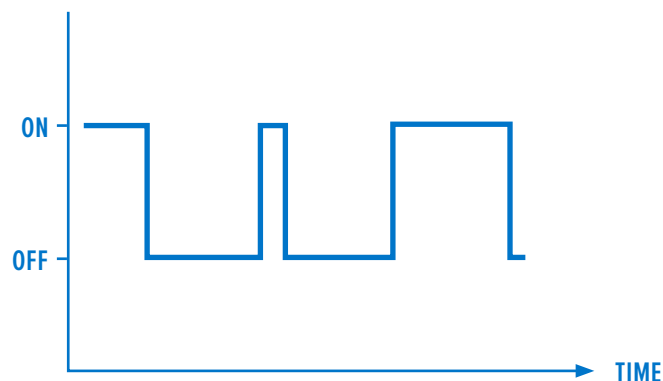
Chicago Stainless Pressure Sensor

# ELECTRICAL INSTRUMENTS IN FOOD, DAIRY, BEVERAGE, AND PHARMACEUTICAL PROCESSING

ANALOG



DISCRETE



## ANALOG VS DISCRETE SIGNALS

**Analog Instruments:** Provide continuous measurements and can represent a range of values. They are used to monitor variables where precise readings are required, such as Pressure, Temperature, Level, Flow, and Conductivity.

**Discrete Instruments:** With their binary (on/off) status indicators, discrete instruments are reliable tools often used for detecting specific conditions. They are employed where the presence or absence of a condition needs to be monitored, such as High-Level Detection, Flow Switches, High-Pressure Indicators, and Proximity Sensors.

## TRANSMITTERS AND ELECTRICAL MEASUREMENT

Electrical instruments, trusted for their reliability, are devices that measure various process parameters, including fluid levels, temperature, pressure, flow rate, weight, conductivity, pH, and turbidity. They convert these measurements into electrical signals for further processing and analysis.

At their core, instrument classification is based on their function and provides either visual indications or electrical signals. These signals are sent to chart recorders and control systems like Programmable Logic Controllers (PLCs) or stored electronically for later analysis.

Transmitters are crucial components in these instruments. They convert physical measurements (such as temperature or flow rate) into an electrical signal. The transmitter signal is then displayed on a monitor or used by control systems to manage and optimize processes. Transmitters play a critical role in ensuring accurate and reliable data by converting and transmitting measurement information efficiently.



DIGITAL INSTRUMENTATION SYSTEM

# DISCRETE SWITCHES

## TEMPERATURE SWITCHES

### Application

Temperature switches monitor process temperatures and activate or deactivate based on preset temperature thresholds. They can replace traditional thermometers and provide digital output, relay output, or both.

### General Design

These switches offer high accuracy in temperature detection. Basic models only provide relay or digital outputs without a display. More advanced versions might include a digital display, options for remote mounting, and extended control with additional relay modules.

## POINT LEVEL SWITCHES

### Application

Point-level switches detect the presence or absence of a substance at a specific level in a container, such as a tank. They are commonly used to prevent conditions like dry-running in pumps or confirm high tank levels.

### Working Principle

These switches operate by sensing changes in the electrical properties of the medium at the probe. They detect whether the substance is present at the specified level without requiring differential measurements.

### General Design

Point-level switches boast a versatile design. They typically consist of a probe connected to a switching module. This design is focused on providing a clear indication of whether a level is reached and offers the flexibility of fixed or adjustable sensitivity, empowering you with options to suit your specific needs.

# DISCRETE SWITCHES

## FLOW SWITCHES

### Application

Flow switches detect the presence of liquid flow within pipes. They are primarily employed to prevent pumps from running dry or signal high tank levels.

### Working Principle

Flow switches, by monitoring liquid flow and detecting changes in flow characteristics, ensure the continuous operation of the system. They are not designed to measure flow rates but to guarantee that flow is occurring, thereby enhancing the reliability of the system.

### General Design

Flow switches are designed to effectively handle variations in flow conditions. They feature a sensor optimized for detecting the presence of liquid flow.

## PROXIMITY SWITCHES

### Application

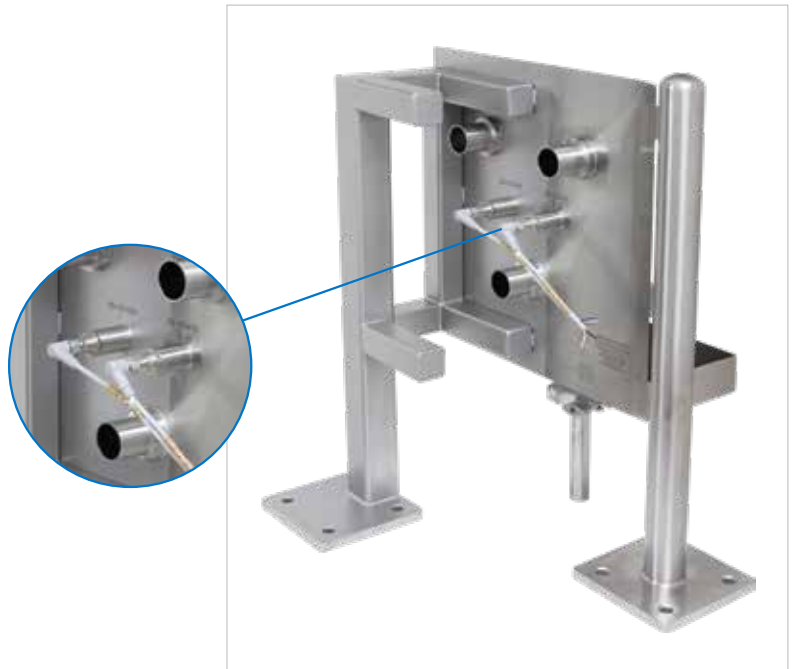
Proximity switches detect the presence or position of objects without direct contact. They are used for safety applications, such as on tank manways or valve handles, and to ensure correct connections in process systems.

### Working Principle

Proximity switches use inductive or magnetic technologies to sense the presence of nearby objects. When they detect an object within their sensing range, they generate an electronic signal.

### General Design

Standard inductive and magnetic proximity switches feature durable housings that operate reliably in sanitary environments. They include visual indicators for operational status and are generally straightforward to maintain.



Proximity Switches on Transfer Panel

# TEMPERATURE SENSORS AND TRANSMITTERS

## IMPORTANCE OF TEMPERATURE MONITORING

Maintaining accurate temperature control is crucial for product quality and process efficiency. Temperature changes can affect the final product and signal potential issues like fouling, bake-on, or system leaks.

## SANITARY RTDS AND TEMPERATURE TRANSMITTERS

### Application

Resistance Thermometer Detectors (RTDs) provide precise temperature readings and are used in a wide range of sanitary applications or thermowells. They have multiple configuration options, including a display at the sensing point or integration with a transmitter, making them versatile for different needs.

### Working Principle

RTDs use a platinum element whose resistance changes with temperature. A 3-wire configuration enhances measurement accuracy by compensating for wiring resistance. These sensors can relay temperature data with analog or smart transmitters.

### Standard Design

RTDs may have factory-sealed cables or quick disconnects and can be paired with standard wiring heads. Configurations include transmitters with or without displays, and are suitable for various applications.

## TEMPERATURE SENSORS

### Application

Temperature sensors are used for high-accuracy monitoring and can include features such as local display, remote mounting of transmitters, and programmable high/low set points for alarm triggering.

### Working Principle

These sensors may be battery-operated or DC-powered, with local and remote indication options. Some models offer low-voltage contacts for configurable outputs and optional relays for triggering specific temperatures.

### Standard Design

Temperature sensors, designed for easy field calibration and high-resolution feature displays, are not just replacements for mechanical thermometers but modern ones, ushering in a new era of temperature monitoring.



# TEMPERATURE SENSORS AND TRANSMITTERS

## REFERENCE THERMOMETER

### Application

Digital reference thermometers ensure compliance with industry standards, such as the Pasteurized Milk Ordinance (PMO), for consistent processing where precise temperature verification is required.

### Working Principle

These thermometers utilize dual-element sensors and comparator circuitry for self-diagnostics and accuracy verification. Internal test features facilitate easy performance checks.

### Standard Design

Reference thermometers, built to meet sanitary standards, may be interchangeable and require minimal field calibration.



Reference Thermometer

## TEMPERATURE SENSORS FOR RETORT APPLICATIONS

### Application

Digital Temperature Gauges (DTGs) provide reliable temperature monitoring and error checking in the retort cooker industry, offering advantages over traditional mercury-in-glass thermometers.

### Working Principle

DTGs include redundant temperature elements for continuous error checking and up to five user-configurable calibration points to align with in-house references.

### Standard Design

DTGs feature large displays for easy reading, field calibration capabilities, and onboard diagnostics, ensuring compliance with regulatory standards in the retort cooker industry.

## FEATURED TEMPERATURE SENSORS AND TRANSMITTERS

FD Reference Thermometer

FJ Temperature Sensors

FH Temperature Sensors

FH3/FH4 Temperature Sensor  
for Retort Applications

SW/SA/CT Sanitary RTDs &  
Temperature Transmitters

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# PROCESS SENSORS AND TRANSMITTERS

## HYDROSTATIC SENSORS & TRANSMITTERS

### Application

Hydrostatic sensors measure fluid levels in tanks or vessels by detecting the pressure exerted by the fluid. This information is crucial for managing inventory, ensuring timely refilling, and preventing overflows.

### Working Principle

These sensors measure the difference between the fluid columns and atmospheric pressure. The pressure from the fluid column is proportional to the height of the liquid, allowing for precise level measurement.

### Standard Design

Hydrostatic sensor designers have prioritized durability and ease of maintenance. Many models have modular designs, enabling the replacement of individual components rather than the entire unit. This modularity can reduce downtime and maintenance costs. For models that do not have modular options, if a component fails, complete unit replacement is usually necessary. However, it's important to note that these sensors are designed to deliver dependable performance and lasting value.

## RADAR LEVEL SENSORS

### Application

Radar level sensors continuously measure liquid or solid levels in various industries, including food processing and pharmaceuticals. They are suitable for both hygienic and non-hygienic environments.

### Working Principle

These sensors emit high-frequency radar pulses that reflect off the medium's surface. By precisely measuring the time it takes for the pulses to return, the sensor calculates the distance to the surface and determines the level with high accuracy.

### Standard Design

Radar sensors, designed with precision in mind, feature antennas to send and receive radar pulses. They include protective enclosures to shield against

environmental factors like dust and moisture, ensuring the data processed provides accurate and reliable level readings.

## POINT LEVEL SENSORS

### Application

Point-level sensors detect specific high or low levels within a tank or vessel. They provide alerts when levels reach preset points, helping to manage filling operations and prevent overflows or shortages.

### Working Principle

These sensors trigger alarms or signals when the liquid level reaches a predetermined high or low point. This feature is instrumental in preventing overfilling or running out of material, enhancing safety and efficiency in sanitary processes.

### Standard Design

Point-level sensors, typically installed in the side-walls of vessels, detect liquid levels directly. Their design ensures accurate level detection at specific points.



D3P Level Sensor

# PROCESS SENSORS AND SWITCHES

## PRESSURE SENSORS AND SWITCHES

### Application

Pressure sensors and switches monitor critical pressure levels in food and beverage processing applications. They trigger alarms or halt processes in response to pressure changes.

### Working Principle

These devices monitor system pressure and generate output signals based on preset thresholds. Some models offer additional features like process data and diagnostic information through communication interfaces.

### Standard Design

Pressure sensors are often digital, providing precise pressure readings. While pressure switches generally do not include a local display, some models offer an optional display for enhanced monitoring. They include adjustable switches with relay outputs for control and alarm.

## PRESSURE GAUGES

### Application

Pressure gauges measure and display pressure levels in applications such as food, dairy, and beverage processing. Their primary role is to ensure processes remain within safe pressure limits, providing a sense of security.

### Working Principle

Digital pressure gauges, with their electronic sensors, not only provide accurate readings but also offer improved visibility, surpassing traditional gauges.

### Standard Design

Pressure gauges, with their stainless steel construction, ensure durability and ease of cleaning. They may also include additional protection options, such as coatings for corrosive environments, and some models offer battery backup to retain data in case of power loss.

### FEATURED PRESSURE SENSORS, SWITCHES & TRANSMITTERS

EL/EM Pressure Sensor  
EN/EP Pressure Sensor/Switch  
MPF/MPP Modular Pressure Transmitter  
L3 Pressure and Level Transmitter

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# A GUIDE TO FLOW METERS

Flow meters are used to measure the flow rate of gasses and fluids through piping during production operations. Flow meters can be used to monitor both product and utility flows (steam, water, glycol, etc.). Some flow meters also indicate temperature and density information.

## WHY MEASURE FLUID FLOW?

- **Dosing Operations:** Accurate flow measurement is crucial when combining multiple ingredients, such as dough preparation.
- **Production Monitoring:** Flow measurement helps determine the quantity of product produced in continuous or batch processing.
- **Product Quality:** Shear forces from resistance to flow can affect product properties. Monitoring flow rate helps maintain quality.
- **Clean-in-Place (CIP) Operations:** To ensure effective cleaning, a specified flow rate of cleaning fluids is required. Measuring and recording flow rates are essential for the proper performance of CIP.

## VOLUMETRIC FLOW RATE VS. MASS FLOW

- **Volumetric Flow Meters:** Ideal for fluids with stable densities (e.g., milk, water), measuring the fluid volume per unit of time (e.g., gallons per minute).
- **Mass Flow Meters:** Suited for fluids with variable densities (e.g., ice cream), measuring the fluid mass per unit of time (e.g., pounds per minute).



Anderson-Negele Micro Motion Coriolis Mass Flow and Density Meter



E&H Promag H 100 Flowmeter

# FLOW METERS & SWITCHES

Flow meters employ various working principles to measure fluid flow. The flow meter choice depends on the application, fluid type, and accuracy requirements. Here's an overview of standard flow meter technologies used in hygienic processing industries:

## ELECTROMAGNETIC FLOW METERS

### Applications

Electromagnetic flow meters provide accurate volumetric measurements of conductive liquids and slurries. Their compact design makes them suitable for integration into compliance and process safety systems.

### Working Principle

These meters utilize coils to create opposing magnetic fields. As fluid flows through these fields, the movement of charged particles induces a voltage. Based on Faraday's law of electromagnetic induction, this voltage is measured to determine the flow rate.

### Standard Design

Electromagnetic flow meters often feature compact, all-stainless-steel housings that withstand harsh cleaning agents and environmental conditions. Some models integrate temperature and flow measurements into a single device. Many are maintenance-free, with no moving parts and minimal pressure loss.

## TURBINE FLOW METERS

### Application

Turbine flow meters effectively measure the flow of thin, clear fluids such as water, vinegar, beer, clear juices, or CIP solutions.

### Working Principle

These meters use a turbine rotated by the flowing liquid. Non-magnetic sensing technology counts the turbine rotations, providing accurate flow measurement without the drag that can affect accuracy and longevity.

### Standard Design

Constructed entirely from 316L stainless steel, turbine flow meters are durable and feature robust stainless steel shafts and bearings, and their two-piece design allows for easy internal inspection.



Anderson-Negele Flow Meters

## FEATURED FLOW METERS:

E&H H100 Mag Meter  
 Micro Motion H Series Mass Flow Meters  
 IZMAG Electromagnetic Flow Meters

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# FLOW METERS & SWITCHES

## CORIOLIS MASS FLOW METERS

### Application

Coriolis mass flow meters are ideal for challenging applications, including dosing and batching for non-conductive liquids. They provide precise mass flow measurements.

### Working Principle

Fluid flows through oscillating tubes, which are set into motion by an electrical exciter at a known frequency. The fluid's movement dampens these oscillations, and the change in oscillation is measured to determine the mass flow rate.

### Standard Design

Coriolis meters meet rigorous hygienic standards, with many models carrying certifications such as 3-A, ASME-BPE, and EHEDG. They may be self-draining if installed vertically and are available in various configurations to suit different applications.

## CALORIMETRIC FLOW SWITCHES

### Application

Calorimetric flow switches detect low-particulate, aqueous liquids at stable temperatures, monitor liquid presence in pipes or vessels, provide dry-run protection, and monitor filters, agitators, or cooling loops.

### Working Principle

These switches use a temperature sensor heated by an element. When liquid flows past the sensor, it changes the heat transfer and the temperature difference between the heated and unheated state, indicating the flow rate.

### Standard Design

Manufacturers design calorimetric flow switches for reliability and minimal maintenance. They are made of durable materials such as stainless steel for corrosion resistance and have a compact footprint to fit into various installations. These switches utilize advanced temperature sensing technology for accurate flow detection and are versatile enough to handle multiple fluid types. Their design ensures long-lasting performance with minimal upkeep.

## ULTRASONIC FLOW METERS

### Application

Ultrasonic flow meters are versatile and mounted on the pipe's outer wall or inside of the pipe. They are suitable for water and sanitary processing applications.

### Working Principle

Ultrasonic flow meters use two sensors to transmit and receive ultrasonic signals alternately. The difference in transit times of these signals, influenced by the flow direction and speed, is used to calculate the flow rate.

### Standard Design

These meters have no moving parts, require minimal maintenance, and are corrosion-resistant. They are available in in-line and clamp-on designs to accommodate various measurement needs.

# LIQUID ANALYSIS SENSORS

## CONDUCTIVITY SENSORS

### Application

Conductivity sensors measure the concentration of detergents or acids in CIP systems and detect when only clean water is present during flushing processes.

### Working Principle

These sensors use a magnetic field to induce a current in the liquid, and the strength of the induced current indicates the liquid's conductivity. An additional sensor that adjusts for temperature variations provides temperature compensation.

### Standard Design

Some sensor models combine conductivity and temperature measurements in a single unit. These sensors often feature flexible output configurations, temperature compensation from 0°C to 150°C, and operational ranges up to 999 mS/cm. They may include single or dual cable operations for different application needs.

## pH SENSORS

### Application

pH sensors optimize processes in food, beverage, biotech, and pharmaceutical industries, including CIP and SIP applications. They help maximize yields and improve processing uptime.

### Working Principle

These sensors convert pH values to digital signals to avoid contact corrosion and signal distortion. They feature integrated electronics that save calibration and process data, allowing for quick, plug-and-play replacement and easy maintenance.

### Standard Design

pH sensors have moisture-resistant plug-in heads and cable couplings. They can include ceramic or glass membranes, with some models capable of withstanding CIP/SIP processes and autoclaving up to 140°C/284°F.



Digital pH Sensor

## ADDITIONAL SOLUTIONS

### SIGHT GLASS PRODUCTS

[Sight glasses](#) are non-electronic view windows that allow visual inspection of products in tanks, drains, or hoses. They help monitor the product's presence, color, and consistency during transfer. Available in in-line and cross types for different applications, these semi-permanent components provide clear visibility while protecting the process from external elements.

### WEIGHING SYSTEMS

[Weighing systems](#) use hygienic processes to measure liquid levels, mix ratios, dosage, or batching. Generally constructed with fully laser-welded components, they are durable and suitable for frequently hosed-down environments. Accurate weighing relies on high-quality load cells tailored to the specific needs of the installation.



SP54 and SP56 Sight Glasses

#### FEATURED SIGHT GLASS PRODUCTS

SP56  
SP54  
SP54SW

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### PAPERLESS PROCESS RECORDER

The [Paperless Process Recorder \(PPR\)](#) is a digital solution for monitoring various process parameters like temperature, flow, pressure, level, conductivity, and turbidity. Replacing traditional chart recorders, it connects to existing sensors and offers real-time data visualization, and integrates with [Legendary™](#)-cloud software. This system reduces maintenance costs and human error by eliminating mechanical failures and damaged charts.

### CONDITION MONITORING

[Condition monitoring](#) sensors assess the performance of pumps using a three-axis accelerometer and internal temperature sensor. The device attaches to a pump to continuously collect data, allowing timely maintenance based on performance deviations. [CM Connect](#) consolidates data from up to ten monitors within Bluetooth range, providing real-time updates and automated notifications for maintenance needs.

### PRE-SURE™ CAP

The [Pre-Sure™ Cap](#) is a smart notification device that informs operators of system pressure, ranging from 5 to 150 PSI. It allows the operations team easy, tool-free installation and removal. It is a durable, cleanable diaphragm that ensures long-lasting performance while providing pressure alerts to enhance safety and efficiency. A bright red indicator that extends when the pressure reaches or exceeds 5 PSI visually signals that it's unsafe to unclamp or modify connections, ensuring plant operators have a reliable and straightforward warning system.



## NEXT STEPS

Contact CSI for expert assistance with quoting and purchasing new devices or replacing existing ones. Our customer service representatives, engineers, designers, and product specialists are ready to provide tailored solutions and support across a wide range of brands and technologies. Reach out to us to explore our comprehensive line of instruments for hygienic processing and find the right solutions for your needs.

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To speak with a CSI instrumentation expert, call 417.831.1411 or email [sales@csidesigns.com](mailto:sales@csidesigns.com).



# ABOUT CSI



Central States Industrial Equipment (CSI) is a leading provider of design and execution solutions for hygienic process systems across various industries, including food, dairy, beverage, pharmaceutical, biotechnology, and personal care. We offer a comprehensive range of sanitary processing equipment, such as fittings, pumps, valves, tubing, and instrumentation.

At CSI, we understand that each client's needs are unique. That's why our expertise extends to cleaning systems, process piping, system start-ups, and equipment testing. We leverage advanced technology, intellectual property, and industry knowledge to design and optimize both new and existing systems. Our collaborative approach, using cutting-edge CAD technology and 3D scanning, ensures that we develop tailored solutions that meet our clients' specific requirements.

CSI's state-of-the-art Clean-in-Place (CIP) systems ensure reliable and repeatable cleaning, maintaining product quality and consistency. Our experienced fabricators and project managers, who adhere to the highest industry standards, are dedicated to delivering custom fittings, valve manifolds, skid systems, and more, efficiently meeting customer needs and timelines. This commitment to efficiency gives our customers peace of mind.

With over 40 years of experience, CSI serves processors, OEMs, contractors, engineering firms, and resellers across the U.S. from our four strategically located warehouses. We stock a full line of corrosion-resistant materials, including Super Alloys™ AL-6XN® and Hastelloy® C-22®. Our unwavering commitment to innovation and expertise ensures that CSI is the premier choice for all your hygienic processing needs, providing you with the highest quality and reliability.



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