# LEVEL MEASUREMENT SYSTEMS

## Flow Reference Section

## INTRODUCTION

Level measurement is an integral part of process control, and may be used in a wide variety of industries. Level measurement may be divided into two categories, point level measurement and continuous level measurement. Point level sensors are used to mark a single discrete liquid height, a preset level condition. Generally, this type of sensor is used as a high alarm, to signal the existence of an overfill condition, or as a marker for a low alarm condition. The more sophisticated continuous level sensors can provide complete level monitoring of a system.
A continuous level sensor, as the name implies, measures the fluid level within a measurement range, rather than at a specific, single point. The continuous level sensor provides an analog output that directly correlates to the level within the containing vessel. This analog signal from the sensor may be directly linked to a visual indicator or to a process control loop, forming a level management system.

## FLOAT SWITCHES

The basic float switch is a simple point level sensor.
A magnet-equipped float, which moves directly with the liquid surface, actuates a hermetically sealed switch within the stem. The rugged construction of the reed switch design provides long, trouble free service. The float switch is designed to provide high repeatability, minimizing the effects of shock, vibration and pressure. Float switches can be used in a variety of media, as they are available with various materials of construction. Also, minimum maintenance is required, and installation is simple. The reed switch incorporated in a float switch is a hermetically sealed, magnetically actuated, make-and-break type. For various models, the switches may be either single pole-single throw (SPST), or single pole-double throw (SPDT).

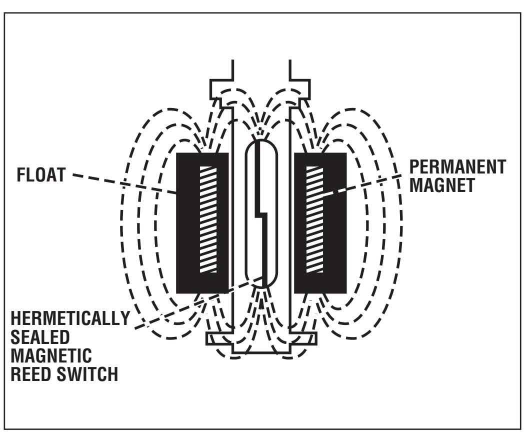


*Figure 1: Reed-relay float switch*

## NON-CONTACT ULTRASONIC SENSORS

The non-contact ultrasonic level sensors consist of the following elements: sensor, analog signal processor, microprocessor, binary coded decimal (BCD) range switches, and an output driver circuit. The microprocessor generates a series of transmit pulses and a transmit gate signal that are routed through the analog signal processor to the sensor.
The sensor transmits an ultrasonic beam to the surface level, and the returned echo from the surface is detected by the sensor and routed to the microprocessor, which processes the signal into a digital representation of the distance between the sensor and the surface level. The microprocessor stores the distance value and, by means of a moving average technique built into the software program, compares it to the value of others stored in memory. If the value does not correspond to prior signals or new signals being received, it is rejected. Incorporation of a moving average technique and a non-linear digital filter ensures rejection of spurious signals and noise. The microprocessor constantly updates and reviews the signals received, creating new averaged values which are indications of the actual fluid level in the tank.

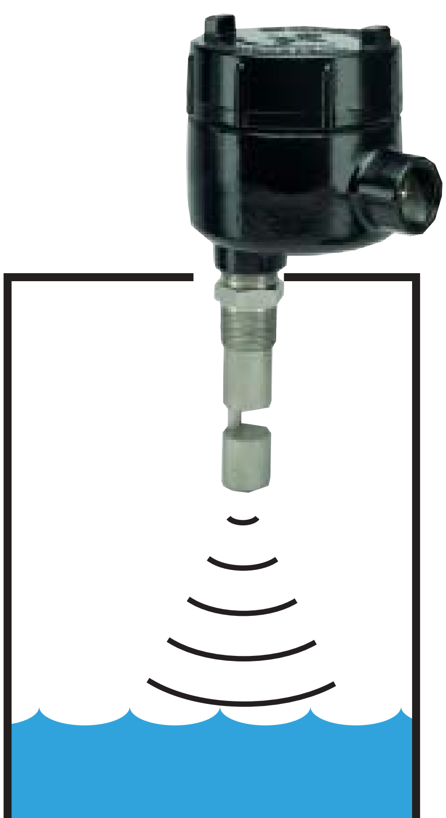

*Figure 2: Non-contact ultrasonic sensor*

### Continuous Sensors

For continuous sensors, the averaged value from the microprocessor is converted into an analog 4 to 20 mA signal which is linear with the liquid level. In an empty pipe or low level condition, when the echo from the level does not return to the sensor for more than 8 seconds, the output signal from the system drops below the minimum 4 mA.

### Point Sensors

When the averaged value from the microprocessor coincides with the BCD switch setting, the microcomputer energizes an output relay, for either high or low level indication. A momentary loss of signal from the sensor will not change the output status; the microprocessor's memory retains the last valid value. However, a signal loss for more than 8 seconds will cause the relays to de-energize and return to original state. A fixed half-second time delay is incorporated into the electronics to minimize the effects of surface turbulence and agitation on the unit's output.

## CONTACT ULTRASONIC SENSORS

The contact ultrasonic liquid level switch detects and controls the level of liquids, at a point, by means of a low energy ultrasonic device having no moving parts. The system consists of a field-mounted sensor with an integral solid state amplifier. Terminal blocks are provided for connecting the system to a power source and to external control devices. No calibration or adjustment is required for automatic, trouble-free operation.

The sensor contains a ½" gap across which an inaudible, high frequency ultrasonic signal is generated. When liquid is in the gap, the ultrasonic signal easily travels across the gap, and the control relay switches. The sensing level is approximately midway in the gap for horizontally mounted sensors, and is at the top face of the gap for vertically mounted sensors. As the liquid falls below this level, the ultrasonic signal is attenuated and the relay switches back to its previous state. This type of level switch can be used in vessels or pipes to automatically operate pumps, solenoid valves and/or audible or visual high and low alarms. Two units can control tank filling (or emptying), or metering of a specific volume of liquid. The switch will perform satisfactorily in most liquids, and is unaffected by coatings, clinging droplets, foam or vapor. Liquids which are highly aerated, or so highly viscous as to cling in the sensor gap, however, may present operating difficulties.

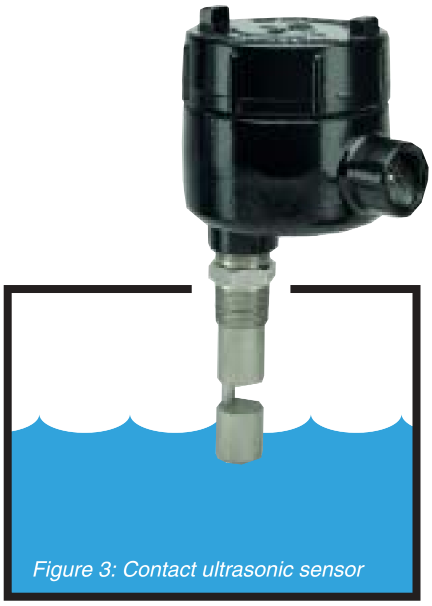
*Figure 3: Contact ultrasonic sensor*

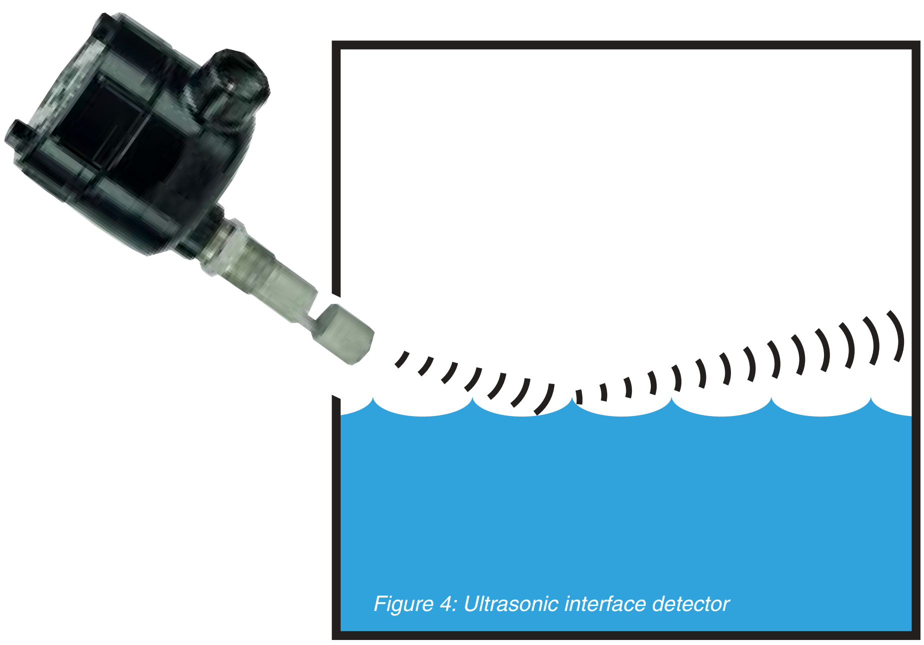
*Figure 4: Ultrasonic interface detector*

## CAPACITANCE LEVEL SENSORS

As with ultrasonic sensors, this level measurement technology can be used for either point or continuous level measurement. A probe inserted into the fluid tank senses the material level changes. These changes are electronically conditioned into retrospective capacitive and resistive values, and are further processed and converted into an analog signal. The probe and the vessel wall form the two plates of a capacitor, with the liquid medium serving as the dielectric. The signal is generated only from true level changes, thus rejecting the unwanted effects of material built-up on the probe. Note that for a non-conductive fluid vessel, special systems utililizing either dual probes or an external conducting strip may be required. The sensing probe may be constructed from different materials, with either a rigid or flexible design. The most common design is a conducting wire insulated with Teflon®. A stainless steel probe is also available for applications where greater probe sensitivity is necessary. For example, low dielectric or non-conductive fluids (dielectric constant under 4) or granular fluids require the stainless steel probe. The flexible probes are used when there is not enough overhead clearance for the rigid probe, or in applications requiring the longer length. The rigid probe provides higher stability, especially in turbulent systems. If the probe sways to and from the vessel wall, the signal from the probe may fluctuate.

**Switch Ratings Max. Resistive Load**

| VA | Volts | Amps ac | Amps dc |
|---|---|---|---|
| 10 | 0-50 | .2 | .13 |
| | 120 | .08 | .05 |
| | 240 | .04 | .02 |
| 20 | 0-30 | .4 | .3 |
| | 120 | .17 | .13 |
| | 240 | .08 | .06 |
| 50 | 0-50 | .5 | .5 |
| | 120 | .4 | .4 |
| | 240 | .2 | .2 |
| 100 | 120 | .8 | N.A. |
| | 240 | .4 | N.A. |