TECHNICAL REFERENCE

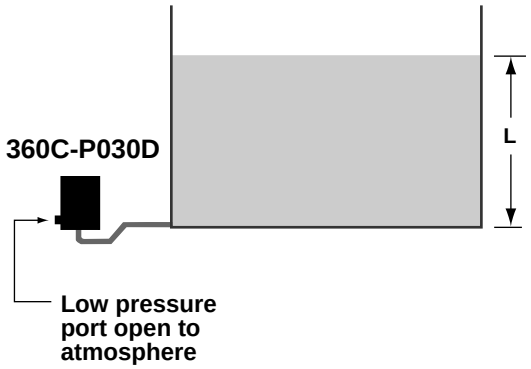
LIQUID LEVEL MEASUREMENT

One of the most difficult applications frequently encountered in the building automation industry involves measuring the level of liquid in a tank. The Bubbler System is one solution for continuously measuring liquid level. This system involves forcing a stream of compressed air through a tube that is inserted into a tank. The pressure required to force the air out of the tube is equal to the pressure created by the liquid above the end of the tube. By measuring this pressure, the level in the tank may be determined.

A simpler method of measuring liquid level is to install a pressure transmitter level with the bottom of the tank, or at the lowest level that must be monitored. If the specific gravity of the liquid in the tank is known, then the liquid level may be easily calculated. The **Model 360C Differential Pressure Transmitter** is excellent for this application. When used on a vented (non-pressurized) tank, the high pressure port is piped to the liquid at the bottom of the tank, and the low pressure port is vented to the atmosphere. The **360C** then measures the pressure created by the liquid (See Fig. 1A). This method may also be used to measure liquid level in a pressurized tank by piping the low pressure port to the top of the tank above the liquid. The **360C** will then measure the difference in pressure which is created by the liquid in the tank (See Fig. 1B).

Now that we know the pressure created by the liquid in the tank, how can we convert this to liquid level? Due to gravity, a column of water at 70°F, 2.31 feet high creates a pressure of 1 psi. Therefore, if the liquid in the tank is water, multiplying the pressure indicated by the **360C** by 2.31 will give you the level of water in the tank in feet. As you can see in Fig. 2, the value of 2.31 ft/psi is relatively accurate for the temperature of water in most HVAC processes. If the temperature of water being monitored is known, the value for ft/psi corresponding to the water temperature in Fig. 2 may be used in place of 2.31.

Fig. 1A Vented tank



For example, refer to Fig. 1A again. Assume the tank contains 100°F water. The **360C-P030D** has a range of 0-3 psi (4 mA output at zero pressure, and 20 mA at 3 psi). If the output from the **360C** is 17.8 mA, what is the water level?

Fig. 1B Pressurized tank

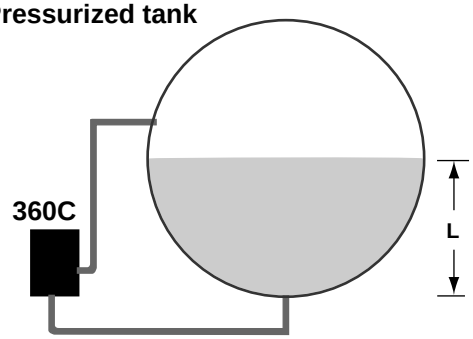


Fig. 2

Temperature °F	ft/psi for water
32	2.307
40	2.307
60	2.309
80	2.314
100	2.323
120	2.333
140	2.346
160	2.361
180	2.377
200	2.396
210	2.406

$$\text{Level (ft)} = \frac{(\text{mA out} - 4) \times R \times \text{ft/psi}}{16}$$

where: mA out = mA output of the **360C**
R = Range of the **360C** in psi
ft/psi = Feet of water per psi at a specific temperature (from Fig.2)

$$\text{Level} = \frac{(17.8 - 4) \times 3 \times 2.323}{16} = 6 \text{ Feet}$$

What if the liquid being monitored is not water? Simply modify the formula to account for the specific gravity of the liquid being monitored.

$$\text{Level (ft)} = \frac{(\text{mA out} - 4) \times R \times 2.31}{16 \times \text{Specific gravity of liquid}}$$

One of the features of the **Model 360C** that makes it ideal for liquid level applications is the wide variety of ranges available. Assume you want to monitor a water level of 0-60" in a vented tank. To select the correct range for the **360C**, simply convert the 60" water column to psi.

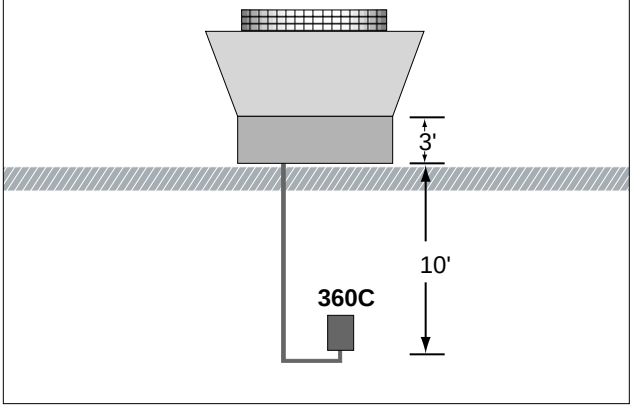
LIQUID LEVEL MEASUREMENT

60" water column = 5 ft water column

$$\frac{5\text{ft}}{2.31\text{ ft/psi}} = 2.16\text{ psi}$$

The **360C** is available in 16 standard ranges from 10" W.C. to 300 psi. The best selection for an application measuring 0-2.16 psi is the **360C-P030D** with a standard range of 0-3 psi. Assume a cooling tower with a 3' deep sump is mounted on a roof, and a **Model 360C Differential Pressure Transmitter** used to monitor the level is in an equipment room on the top floor (See Fig. 3).

Fig. 3 Cooling Tower Sump



The pressure at the **360C** when the sump is full is:

$$\frac{3\text{ ft} + 10\text{ ft}}{2.31} = 5.6\text{ psi}$$

Of this 5.6 psi, the pressure caused by the water in the cooling tower sump is: $\frac{3\text{ ft}}{2.31} = 1.3\text{ psi}$

The remaining 4.3 psi is created by the water in the tube between the **360C** and the bottom of the sump.

A **360C-P060D** (0-6 psi range) would be the proper transmitter.

When using pressure transmitters for liquid level measurement, the following precautions should be taken:

Model 360C

1. Verify that the pressure transmitter is compatible with the liquid being monitored.
2. Protect the pressure transmitter from freezing and over-temperature.
3. To protect the pressure transmitter from rust, scale, sand, etc., do not connect the sensing tube to the low point of the sump. Either connect into the side of the tank, or insert the sensing tube into the bottom of the tank so the tip of the tube is slightly above the bottom of the sump.
4. When used on pressurized systems, be sure that the system pressure plus the liquid pressure does not exceed the static pressure rating of the differential pressure transmitter.

If you have any questions, please call your Kele Sales Engineer.