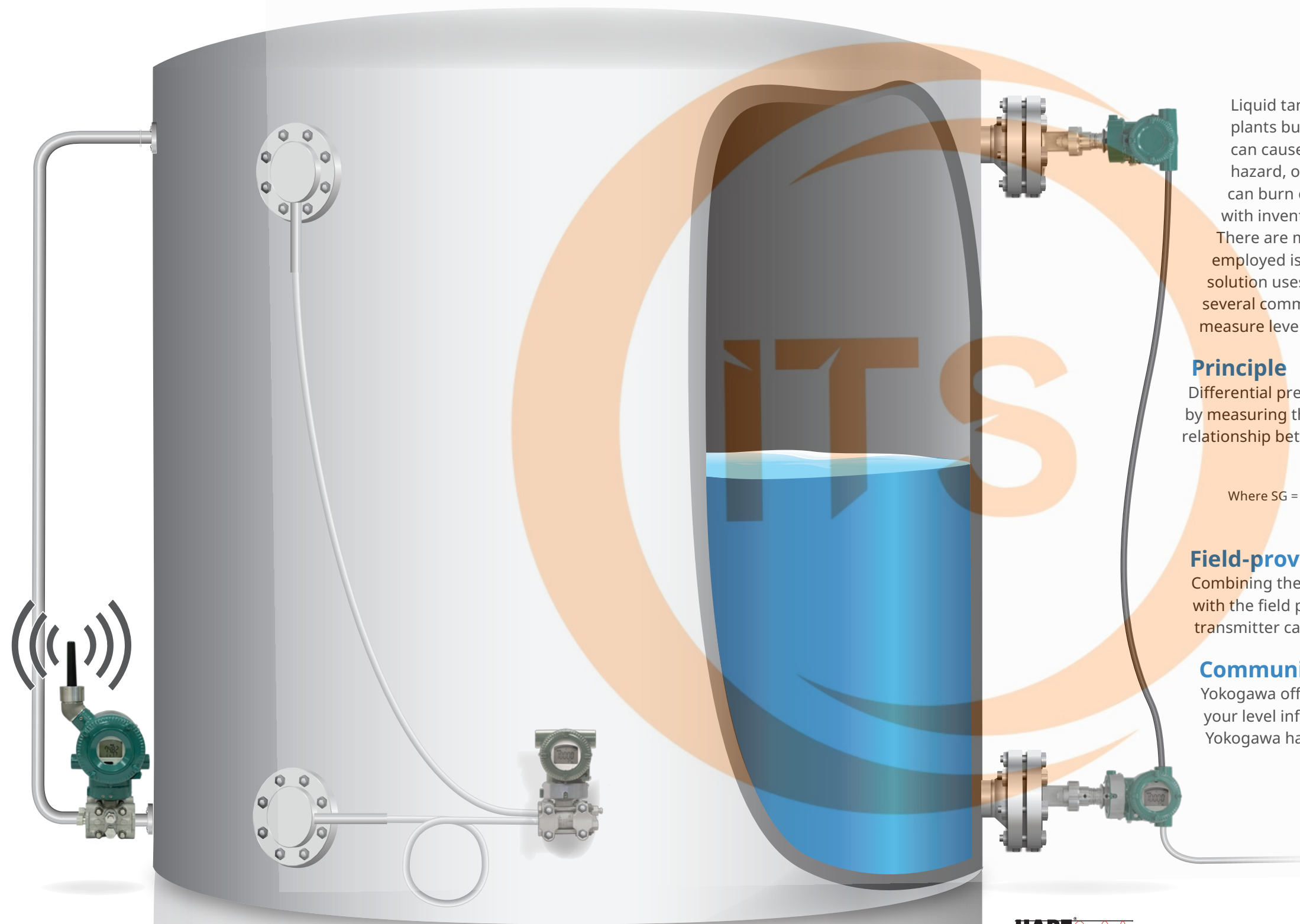




**OpreX™** Field Instruments

## Differential Pressure Level Solutions

# Differential Pressure Level Solutions



Liquid tank level is one of the basic measurements used in process plants but, its importance cannot be overstated. Incorrect high levels can cause the vessel to overflow leading to lost product, a safety hazard, or an environmental problem (or all three). Incorrect low levels can burn out pumps. Incorrect level measurement can cause problems with inventory control.

There are many different technologies available, but, the most widely employed is differential pressure. Yokogawa differential pressure level solution uses an easy to understand principle, field proven technology, and several communication protocols (both wired and wireless) to accurately measure level.

## Principle

Differential pressure level measurement infers liquid level in a vessel by measuring the pressure generated at the bottom of the vessel. The relationship between the measured pressure and the level is expressed by:

$$\text{Level (H)} = \text{DP} / \text{SG}$$

Where SG = Specific Gravity of the Liquid and DP = Differential Pressure measured.

This is a simple proven principle to determine liquid level.

## Field-proven Technology

Combining the widely used principle of differential pressure liquid level with the field proven DPharp pressure sensor, the Yokogawa liquid level transmitter can remove the worry of inaccurate level measurement.

## Communication Protocols

Yokogawa offers analog and digital communication protocols to get your level information where it needs to be. Whether wired or wireless, Yokogawa has what you need.





# DPharp Line-up



## Benefits of DPharp Sensor

Yokogawa’s DPharp digital Pressure transmitters set a new standard for high performance, safety and robustness.

- High Accuracy
- Long Term Stability
- Safety as Standard
- Multi-sensing
- Fast Response

## Models

Yokogawa liquid level transmitters are available with two different performance tiers and three types of process connections.

The EJA-E series is Yokogawa’s primary product line. An evolution of Yokogawa’s original DPharp transmitters, this series provides the performance and ruggedness that is expected from Yokogawa.

The EJX series is Yokogawa’s premier product line, offering the higher performance needed for the most demanding applications while maintaining the ruggedness of the design.

	EJA-E	EJX
Accuracy	Up to $\pm 0.04\%$ of Span	Up to $\pm 0.025\%$ of Span
Stability	$\pm 0.1\%$ of URL / 10 years	$\pm 0.1\%$ of URL / 15 years
Safety	SIL 2	SIL 2
Multi-sensing	DP / P	DP / P
Turndown	100:1	200:1
Response Time	90 msec	90 msec



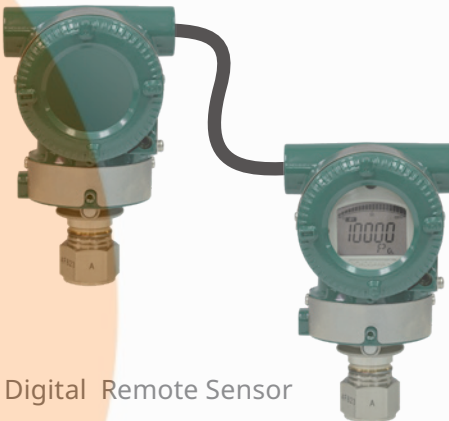
Flange Mount Seal



Traditional Mount



Direct Mount



Digital Remote Sensor



Screw Mount



Remote Mount Seal

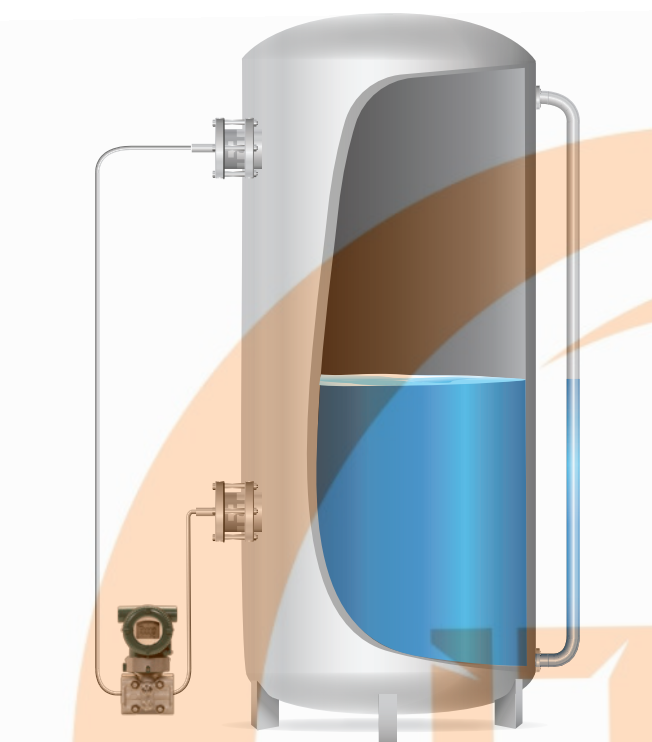
# Typical Applications

## Level Measurements with Tank Blanketing

Tank blanketing is a process of applying an inert gas to the empty space in a storage tank. Many processes use tank blanketing for various reasons. Although it varies from application to application, blanketing systems usually operate at a slightly higher than atmospheric pressure. Higher pressures are not used because they yield only marginal additional benefits while wasting large amounts of expensive blanketing gas. To monitor the level and the blanket pressure, two transmitters are used – one for level and one to monitor the blanket pressure. However, Yokogawa’s multi-sensing DPharp transmitters can measure both the level and monitor the blanket pressure in one transmitter; thus eliminating the need for a second transmitter. Using one transmitter versus two reduces your CAPEX.

## Boiler Drum Level Measurement

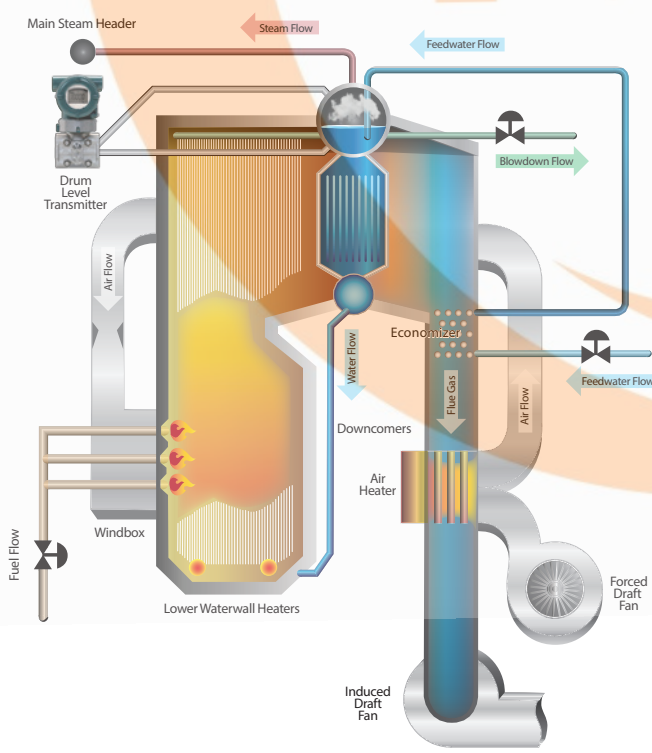
The primary function of a utility boiler is to convert water into steam which is used to turn a steam turbine thus generating electricity. An objective for safe and efficient boiler operation is to maintain a constant level in the boiler drum. This can be accomplished by maintaining a balance between the amounts of steam leaving and water entering the boiler drum. Boiler drum level is one of the most difficult power plant pressure transmitter applications due to high static and low level differential pressures. A change in static pressure can cause significant output shifts in level transmitters. Static pressure changes occur when a boiler is starting up or shutting down at which time accurate level measurement is most critical. Yokogawa’s EJA130E and EJX130A pressure transmitters in boiler drum level measurement applications is superior to other types of pressure transmitters on the market. A unique hysteresis-free sensor and overpressure protected capsule design safeguards the DPharp transmitter from calibration shifts due to pressure surges. DPharp has a lower cost of ownership in boiler drum level applications due to superior static pressure performance and the ability to maintain transmitter calibration after overpressure events that can occur during boiler blow down. Fewer transmitter calibrations are required as a result and contributes to OPEX savings.



## Density Measurement

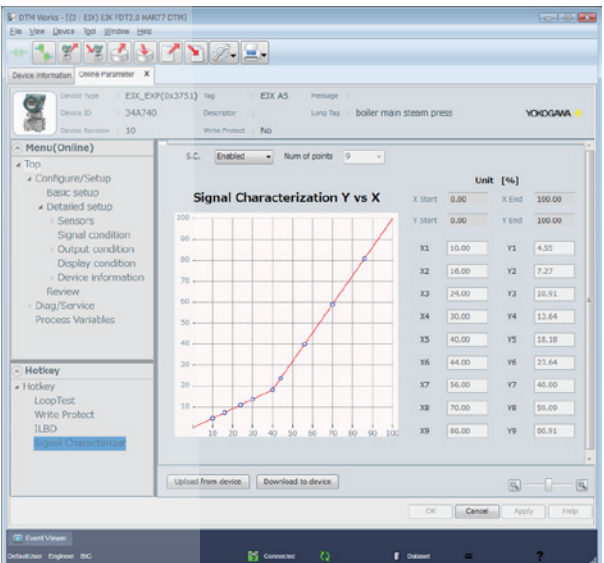
Incorrect level measurement can cause the tank to overflow leading to lost product, safety hazards, environmental problem, or burn-out pumps, or errors in inventory control. Changes in temperature or variations in composition of the liquid being measured in the tank can cause a change in density. Since density is a critical part of the level measurement, we need to be able to measure it. By mounting a pressure transmitter on two fixed position taps on the tank, the density can be calculated. Both taps would need to be submerged in the liquid to be measured. Comparing the distance to the measured pressure, density can be calculated. The DPharp sensor yields an accurate density measurement.

$$\text{Density} = \text{DP} / \text{Height}$$



## Volumetric Measurement

Volumetric level measurement is challenging in tanks that have irregular shapes. The DPharp transmitters have a Signal Characterizer function as standard to simplify the set-up for such measurements. This function compensates the output of the transmitter for the non-linear measurement by using a strapping table. The values can be easily programmed using the powerful DTM functionality of the transmitter.





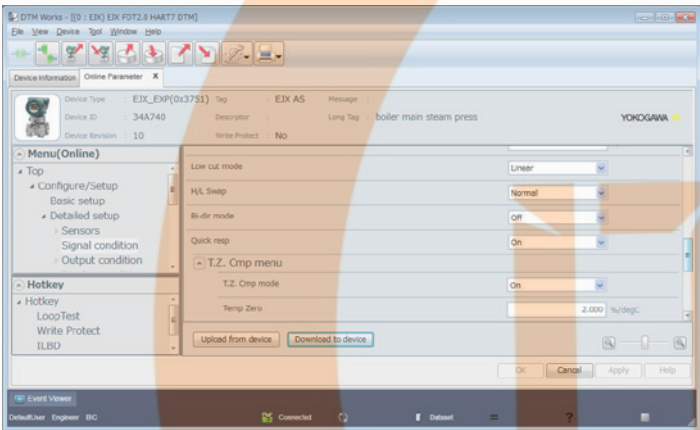
# Challenges and Solutions

## Ambient Temperature Effects

Temperature can have a major impact on the accuracy of pressure transmitters, especially those using diaphragm seals attached via capillaries. As temperature changes, fill fluid in the capillaries change density. This density change causes a Zero Shift leading to an inaccurate level measurement. This effect gets worse as the length of the capillary increases. Yokogawa's DPharp transmitters have three different solutions, fill fluid density compensation, compensating capillaries, and digital remote sensors to overcome this problem.

## Fill Fluid Density Compensation

Available on DPharp transmitters with remote diaphragm seals, the Fill Fluid Density Compensation function uses the pressure sensor's on-board temperature sensor and a set of coefficients to dynamically correct for shifts in temperature. This feature compensates for the Zero Shift experienced during swings in ambient temperature, yielding an accurate level measurement.



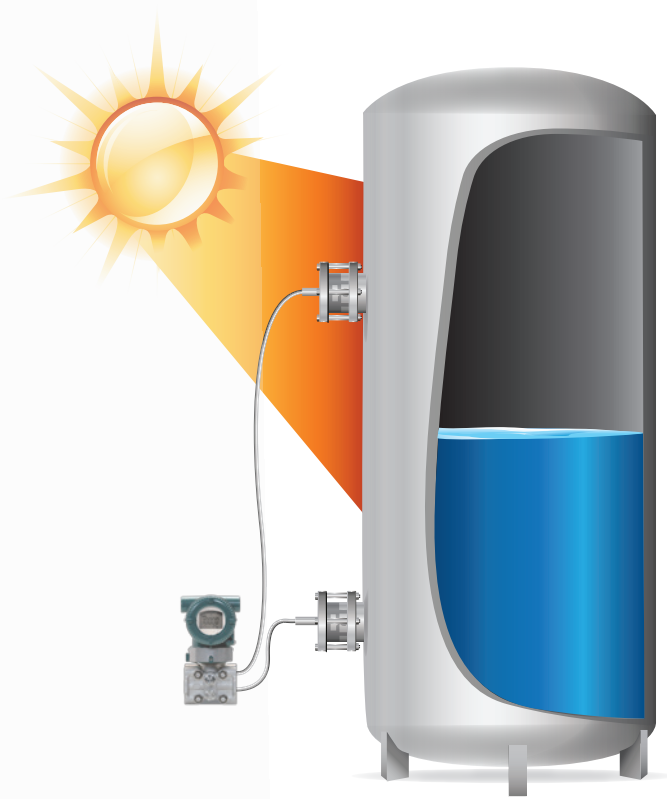
## Compensating Capillaries

Yokogawa's diaphragm seal system transmitter can also be provided with a special compensating capillary that eliminates both ambient and density effects from a simple reliable design with a single differential pressure transmitter. The high-side of the transmitter has a separate "leg" that runs along the low-side capillary. The dummy capillary on the high side exposed to similar temperature effect cancels out any pressure changes due to density variation in the process capillary of the low side. It eliminates the effects of changes in temperature, yielding an accurate level measurement.



## Digital Remote Sensors

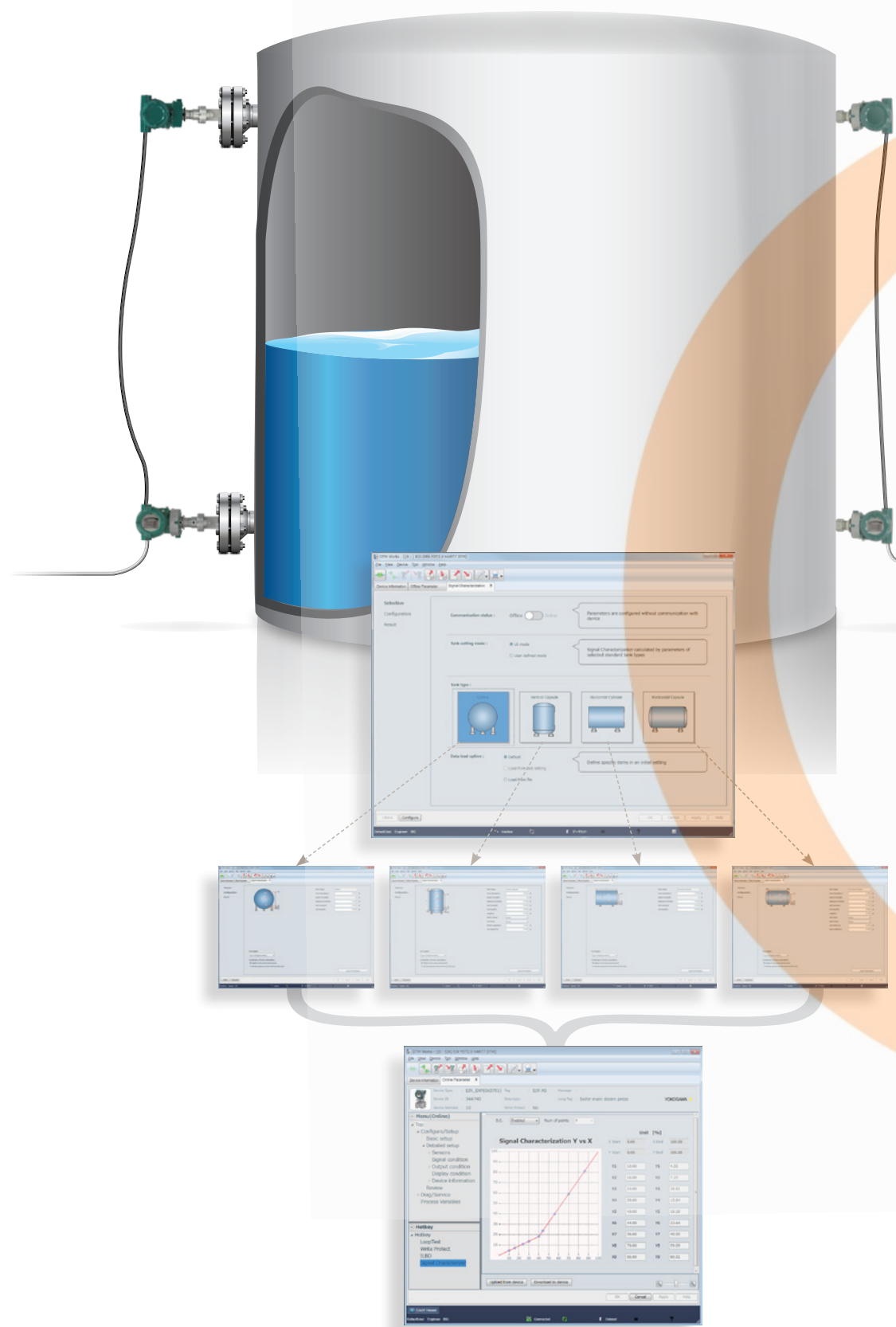
Temperature effects get worse as capillaries get longer. This can be especially true in tall distillation towers, evaporators, or other vessels that would require long capillaries. Yokogawa's DRS system eliminates the capillaries and replaces them with electrical wiring. The electrical wiring is not affected by changes in temperature, yielding an accurate level measurement.



## Level Measurement Technology Comparison

Temperature Effect		Height Difference	Accuracy
			
 DP Measurement using capillaries			
★ Affect on fill fluid volume		★★★ Length limitation due to capillaries	★★★★ Constant high accuracy regardless of high Static Pressure
 DP calculation via digital data comm.			
★★★★ Not affect on digital communication		★★★★ No limitation to cable length	X Unsuitable for fine pressure difference of high pressure tank

# Digital Remote Sensors



## Digital Remote Sensor (DRS)

Traditional differential pressure measurements using capillaries have reduced performance when the capillaries are longer. There comes a point when the performance of the traditional system is no longer good enough for the measured parameter to be useful. Yokogawa's DRS can solve this problem. DRS uses two individual pressure sensors; one placed on the high-pressure tap and the second placed on the low-pressure tap. The two sensors communicate via a dedicated communication cable. The system uses the information from the two sensors to derive the differential pressure between the taps and transmits it via an analog 4 to 20 mA signal and a digital HART signal. The HART signal also transmits the pressure at both the high-pressure and low-pressure taps. This system basically replaces the fluid filled capillaries of a traditional diaphragm seal system with electrical wiring, thus eliminating temperature effects of those capillaries.

Yokogawa's Digital Remote Sensor (DRS) system has a tank strapping program built into the DTM. The DTM has several basic tank designs included. Simply adding the details of the requested information the DTM calculates the correct coefficients for the output – saving setup time of the transmitter.

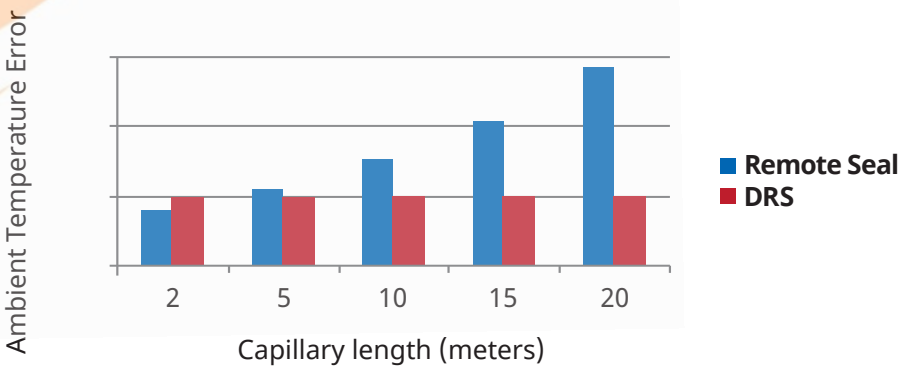
## Key Benefits

### Improved Performance

- Eliminate ambient temperature effects; 2X better performance over traditional diaphragm seals with capillaries.
- Faster response time, up to 250 msec
- Easy installation and maintenance
- Reduced installation cost for cold climate – eliminate heat tracing
- Reduced spare inventory

## Typical Applications

- Application with wide ambient temperature swings
- Long capillaries
- Extreme low ambient temperature



Ambient Temperature Error

Capillary length (meters)

■ Remote Seal  
■ DRS



OpreX™

Through the comprehensive OpreX portfolio of products, services, and solutions, Yokogawa enables operational excellence across the enterprise.

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