# 4532/9 Series Average Temperature/ Water Bottom Sensors and Convertors

Intrinsically safe temperature and water bottom measurement for inventory control and custody transfer tank gauging applications

FM APPROVED

Ex

FuelsManager® Compatibility

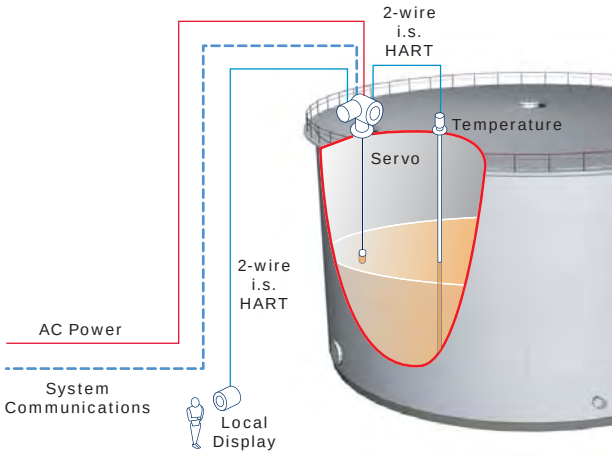
## Benefits and Features

- Multiple product options available based on customer requirements:
  - Converter Only
  - Converter and Temperature probe
  - Converter and water bottom probe
  - Converter, temperature and water bottom probe
- Both explosion proof Exd and intrinsically safe versions are available for installation in various classes of explosion hazardous areas
- Continuous measurement of average liquid and /or average vapor temperature – Temperature profile throughout the tank is available by reading the position and temperature of each element
- Easy Configuration using Varec's 6005 Servo Tank Gauge or 4590 Tank Side Monitor
- Variety of process connections and cable entries available to meet worldwide classifications
- Options available for Pt100, Cu90, Cu100 and PtCu100 input conversion to HART compatible outputs
- Measurements based on API (American Petroleum Institute) Manual of Petroleum Measurement Standard, Chapter 7

## Applications

The 4532/9 Series of Average Temperature/Water Bottom Sensors and Convertors (ATC) provide a highly capable solution for a variety of bulk storage tank gauging applications.

They can be combined with various HART compatible devices and tank sensors, such as Varec's 6005 Servo Tank Gauge, 7500 and 7200 Radar Tank Gauges and 4590 Tank Side Monitor.




Typical Radar Tank Gauge System Diagram

# Function and System Design

## Measuring Principle

Varec's modular range of temperature devices ensure accurate data for the calculation of the volume correction factor (VCF) and the net standard volume required for accurate inventory measurement.

## Product Selection

### 4532 ATC

The 4532 Average Temperature Sensor and Converter (ATC) provides 2–6 resistance elements (Pt100) which have fixed interval (6.6 ft [2 m] or 9.9 ft [3 m]) that measure the average product temperature in bulk liquid storage tanks. The measured value is converted into a HART® compatible output for use in temperature compensated volumetric calculations.

### 4539 ATC

The 4539 ATC is a highly capable solution for a variety of tank gauging applications and provides both constant average temperature data and water interface data via HART communication.

- Average Temperature Convertor – The 4539 ATC can be retrofitted onto an existing average temperature sensors. It converts Cu90, Cu100, PtCu100 and Pt100 temperature element resistance values into digital numeric data on HART protocol signal output. It is compatible to both multi-resistance thermometers (MRT) and multi-spot thermometers (MST).
- Average Temperature Converter and Sensor – To meet the tough demands of custody transfer applications, the 4539 ATC sensor and convertor combination is intrinsically safe and provides a maximum of 16 class A Pt100 elements for average temperature measurement.
- Water Bottom Converter and Sensor – Combining only the 4539 ATC water bottom sensor with convertor allows independent measurement of water interface level.
- Average Temperature & Water Bottom Sensor and Convertor – Both high accuracy temperature and continuous water interface measurement data are transmitting along only one pair of HART signal cables to the host device – 6005 Servo Tank Gauge (STG) or 4590 Tank Side Monitor (TSM).

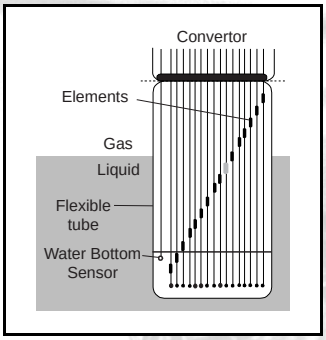
## Custody Transfer Approved Measurement

The 4539 Average Temperature Converter and Sensor combination is custody transfer approved and provides less than ±0.18 °F (0.1 °C) of measurement deviation. Once configured to "W&M mode", all the changeable parameters are frozen by software and mechanical switch protection.

## Average Temperature Calculation

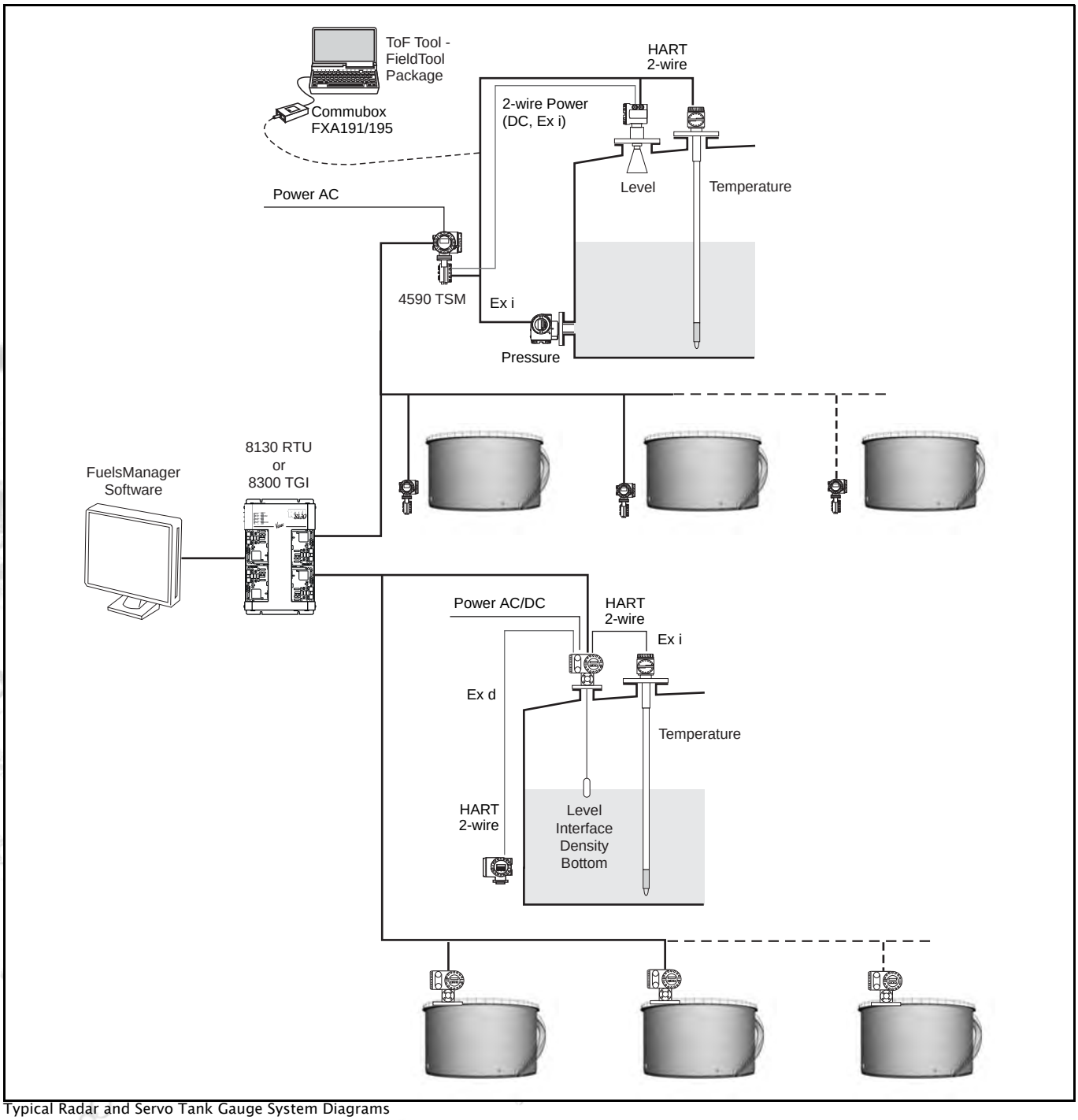
Both liquid and gas average calculation are performed based on level input from the host gauge. In order to provide sufficient averaging data, the 4532/9 Series ATC considers appropriate elements, positioning 300 mm (11.8") below (for liquid average) or above (for gas average) liquid surface, to be a factor of precise average temperature calculation (default setting).

## Water Bottom Sensor




The water bottom (capacitance) sensor is important for the detection of water below product (mainly crude oil) and determines water level by sensing the dielectric constant of the product in the tank. Measured data is transmitted via coaxial cable to the converter housing, where the capacitance signal is converted to a HART signal.

The sensor is generally set at the bottom of the average temperature sensor. The 4539 ATCs standard water bottom measurement ranges are 1m (3.3 ft) and 2m (6.6 ft). Pt 100 elements can be set inside of this tube structure so that water bottom functionality does not effect temperature measurement.




Typical Radar and Servo Tank Gauge System Diagrams

# Installation Guidelines

The following information should be used as a guide only; please refer to the operation and maintenance manual of the specific instrument for complete installation instructions.

## Temperature Sensor Installation

The 4532/9 ATC temperature sensor is primarily used in vertical cylindrical tanks with cone, dome, internal or external floating roof. The top mounted unit is connected via a flange and the sensor is connected to the bottom of the tank using a weight or anchor hook. Alternatively, a thermowell (slotted or unsettled) may be used to prevent turbulence.

If the 4532/9 ATC temperature sensor is installed in a tank with a pressure of greater than atmospheric pressure (at sea level), a closed pipe (thermowell) must be used to isolate the pressure. The recommended mounting position is a minimum of 500 mm (19.7") from the tank wall to prevent the ambient temperature change from influencing the measurement.

Various probe protections are available (pending function)

- Standard flexible tube
- Steel armored flexible tube
- Nylon or Teflon outer tube (installation must be in protection pipe only)

### 4539 ATC installation height adjuster

The height adjuster is an additional feature of the 4539 ATC. It can be used to adjust installation height of the 4539 temperature sensor within ±180 mm (7") from original height.

**Note!** The height adjuster is not included in "Converter only" version.

### Lowest element position

The standard location of the lowest temperature element should be set at 500 mm (20") from the tank bottom regardless of probe type. The factory setting of the height adjuster is set to the middle of adjustable range. Apply necessary adjustment during installation for desired height.

**Note!** The required bottom clearance of both the temperature probe and Water Bottom sensor depends on the anchoring method. Consider the required bottom clearance when ordering the 4539 ATC. Please see the recommended bottom clearance and/or consult your Varec representative for further information.

**Note!** When ordering the 4539 ATC with special element position and bottom clearance, please refer to "Ordering Information," Element Spacing. Select 4, Custom element position and spacing.

**Note!** The 4532 ATC provides multi-spot Pt100 (Max.6) elements which have a fixed interval of 2 or 3 meters.

## Average Temperature Convertor

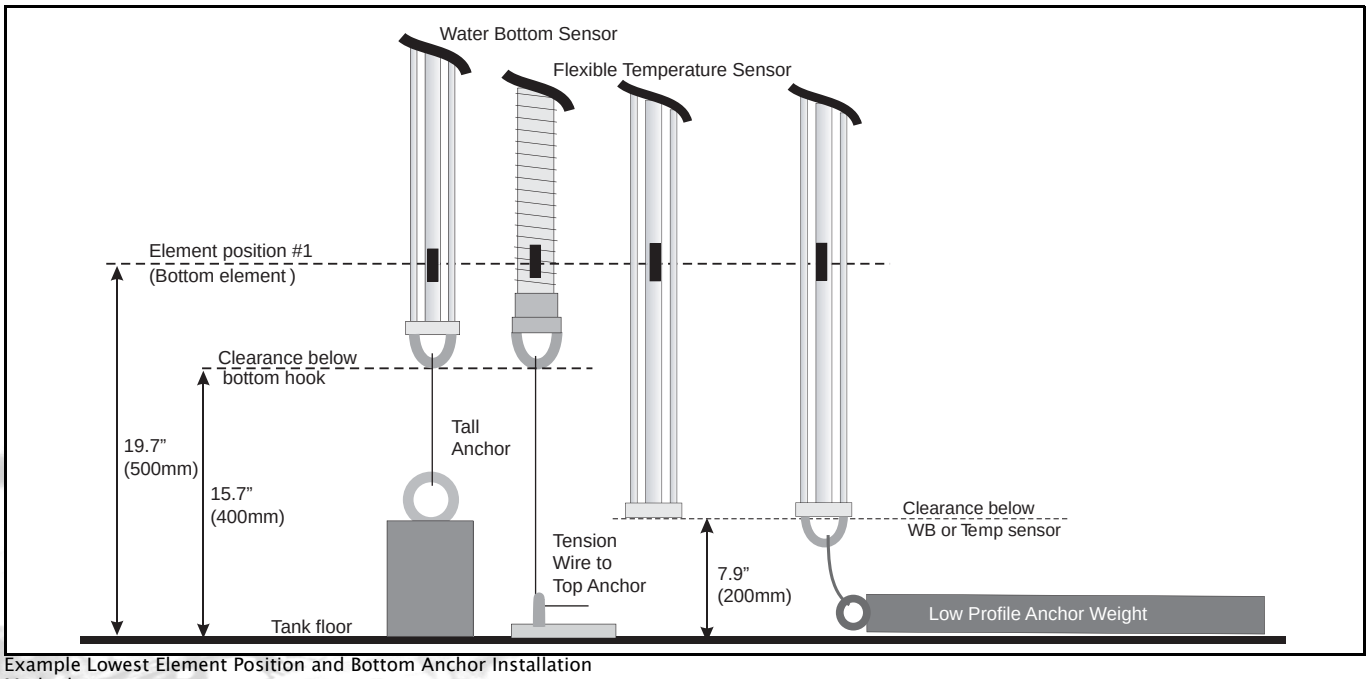
The 4538/9 ATC temperature and water bottom version has an additional terminal housing for the coaxial cable from the capacitance water bottom sensor and a cable outlet for easy accessibility.

**Note!** Due to the characteristic of capacitance measurement, precise initial calibration must be performed in order to achieve the maximum measurement accuracy. Condition of the tank contents (both oil & water), liquid temperature, individual probe characteristic can greatly effect the measurement performance.

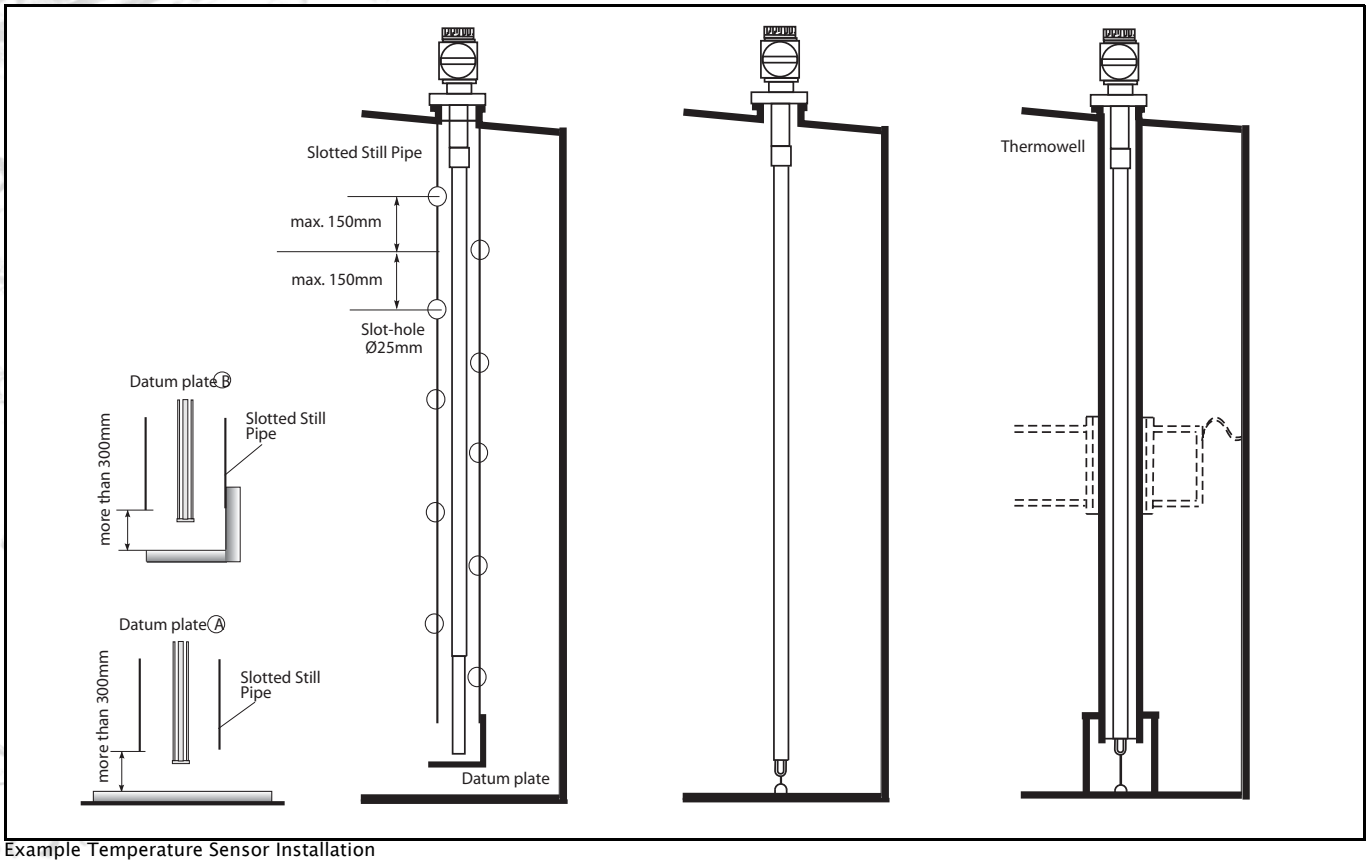
## Cable Glands

A metal cable gland (not a plastic one) that has shield cable grounding functionality should be used to meet the condition of EMC certification. Size and condition of the communication cable must also meet the requirements of intrinsically safe HART communication.

| Contents of anchoring hardware: Based on the choice of "100: Mounting attachment" | | | | | |
|---|---|---|---|---|---|
| | **A: No installation Material** | **B: Anchor weight (High profile, D120)** | **C: Anchor weight (Low profile, hexagon H41)** | **D: Tension wire + wire hook + NPT1 top anchor** | **F: Tension wire + wire hook + R1 top anchor** |
| **0: Converter only** | none | none | none | none | none |
| **1: Temp. + Converter** | bottom hook | bottom hook<br>anchor weight<br>sling wire | bottom hook<br>anchor weight<br>sling wire | bottom hook<br>base plate<br>wire hook<br>NPT1 top anchor<br>tension wire | bottom hook<br>base plate<br>wire hook<br>R1 top anchor<br>tension wire |
| **2: WB + Converter** | none | same as above | same as above | same as above | same as above |
| **3: Temp. + WB + Converter** | none | same as above | same as above | same as above | same as above |




Example Lowest Element Position and Bottom Anchor Installation Method




Example Temperature Sensor Installation

# Operation

### Configuration and Operation

The 4532/9 Series ATC can be integrated into a Varec servo or radar tank gauging system. Both the 6005 STG and 4590 TSM support local configuration and diagnostics (Basic functionality of the 4539 ATC is displayed and configured on the 4590 TSM). Additionally, the 6005 STG displays the compatibility details of the exact element type and software version.

The 4532/9 Series ATC are also supported by the 'Time of Flight' platform and ToF Tool.

All gathered data in the interface unit is sent to inventory management software, such as Varec's FuelsManager or directly sent to the customer's specific DCS or PLC.

# Inputs & Outputs

### Terminal Connections

| Function | 4532/9 ATC Terminal | 4590 TSM Terminal | 6005 STG Terminal |
|---|---|---|---|
| Temperature & water bottom data (I.S.) | H1- | 24+ or 26+ or 28+ | 24+ |
| | H1+ | 25+ or 27+ or 29+ | 25- |
| Multi-drop HART loop daisy chain connection | H2- | | |
| | H2+ | | |

**Note!** For detailed connection information to 6005 STG and 4590 TSM please refer specific product technical documentation for each.

**Note!** 4539 ATC allows an intrinsically safe HART connection only. Please refer to the intrinsically safe regulations for establishing wiring & field device layout

**Note!** 4532/9 ATC has convenient DG chain HART loop terminals that enable 4532/9 ATC to be a terminal junction of HART multi-drop instruments

### 4590 TSM Terminal Connections

The Tank Side Monitor can interface to a maximum of 6 i.s. HART sensors. All HART sensors are connected to one HART multi-drop communication loop. In order keep wiring simple, 3 interconnected terminal pairs are available. The terminal pairs are marked respectively H+ and H-.

**Note!** Do not connect signal HART lines from 4532/9 ATC to terminal 30 & 31 of the 4590 TSM - They are designed to supply drive power of 7500 Radar Tank Gauges only.

### 6005 STG Terminal Connections

**Note!** Do not connect 4532/9 ATC HART communication on terminal 4 & 5 on the 6005 STG. These terminals are designed to connect Ex d HART communication.

**Note!** Intrinsically safe instruments can be connected to the Ex i side/HART connection of the 6005 STG terminal housing.

### External Standards and Guidelines

IEC 61326 App: A, Immunity according to table A-1

- EN 60529 Protection class of housing (IP-code)
- EN 61326 Emissions (equipment class B), compatibility (appendix A – industrial area) EN61000-4-2 Immunity to electrostatic discharge
- IEC 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems

# 4532 ATC Technical Specifications

The following specifications apply to the 4532 ATC over the normal (ambient) operating temperature range.

## System Design

| | |
|---|---|
| **Number of elements** | 2 – 6 points |
| **Measuring element** | Platinum (Pt. 100), Class A element, multi spot configuration (standard type)<br>IEC PUB 751 1995 |
| **Measuring range** | −20... + 100 °C, −4... +212 °F (standard) |

## Physical

| | |
|---|---|
| **Enclosure** | IP65<br>Explosion-proof die-cast epoxy-coated aluminium<br>PF 3/4" (NPS 3/4") universal coupling |
| **Flange material** | SUS304 |
| **Flange size (Process connection)** | ANSI 150 lbs. 2" RF (SUS304)<br>DIN DN50 PN10RF (SUS304)<br>Others (optional) |
| **Probe material** | SUS 316 flexible tube<br>SUS 316 flexible tube + SUS316 armoured mesh.... pending |
| **Conduit entries** | NPT ½<br>M20 |
| **Element position (standard)** | Fixed interval of 2 or 3 meters |
| **Flexible tube minimum installation height** | 400 mm from tank bottom |
| **Weight** | Approx. 8kg<br>Condition:<br>6 elements<br>Temp. probe : 11.5m<br>Flange : 2" 150lbs RF, SUS304 |
| **Material** | Elements : Class A Pt100, IEC PUB 751 1995<br>Housing : Aluminium diecast<br>Temp probe : SUS316 flexible tube |

## Field Communications

| | |
|---|---|
| **Output** | 2-wire, HART multi drop |

## Power

| | |
|---|---|
| **Power supply** | DC16-30V<br>Normally the 6000 Servo Tank Gauge or the 4590 Tank Side Monitor will supply DC24V ±10% on i.s. HART communication line. |
| **Current consumption** | The 4532 ATC consumes fixed current of average 6.0 mA constantly. |
| **Input** | 16.... 30VDC (via HART line from host gauge) |

## Environmental

| | |
|---|---|
| **Ambient temperature** | −40 °F and +185 °F<br>(−40 °C and +85 °C)<br>Converter (housing) |
| **Climate Class** | DIN EN 60068-2-38 (test Z/AD) |
| **Degree of Protection** | Housing : IP65, (Converter only, open housing: IP20)<br>Probe : IP68 |
| **Electromagnetic Compatibility** | When installing the probes in metal and concrete tanks and when using a coax probe:<br>• Interference Emission to EN 61326, Electrical Equipment Class B<br>• Interference Immunity to EN 61326, Annex A (Industrial) |

## Performance

| | |
|---|---|
| **Accuracy of conversion** | ±0.15 °C (±0.27 °F), or better<br>Based on IEC 60751 class A standard |

## Certifications and Approval

| |
|---|
| CE approval<br>4532 ATC meets the legal requirement of the EC-guidelines. Varec confirms the instrument passing required tests by attaching the CE-mark. |
| Factory Mutual (FM)<br>FM – Intrinsically Safe – Class I, Division 1, Groups A/B/C/D<br><br>ATEX<br>EEx [ia] IIB T4 –T6 |

# 4539 ATC Technical Specifications

The following specifications apply to the 4539 ATC over the normal (ambient) operating temperature range.

## System Design

| | |
|---|---|
| **Compatible element type** | Pt100, Cu100, Cu90, PtCu100, JPt100 |
| **Number of elements** | Maximum of 16 can be connected to the convertor<br>Note! 4539 Converter + Temp. version has only Pt100 elements installed. The element types above can be utilised in foreign average temperature probes, such as the Varec 9909, 1700 or Weed Beacon MWR. Other manufacturer multi-resistant and multi-spot average temperature probes may be compatible. Please consult your Varec representative for further details. |

## Physical

| | |
|---|---|
| **Enclosure** | Explosion-proof die-cast epoxy-coated aluminium<br>Weather Proof - IP 65 |
| **Process connection** | PF 3/4" (NPS 3/4") universal coupling<br>M20, Varec 1700 probe connection only |
| **Conduit entries** | NPT ½<br>M20 |

## Field Communications

| | |
|---|---|
| **Output** | Temperature & Water Bottom data via 2-wire intrinsically safe HART protocol. |

## Power

| | |
|---|---|
| **Input** | 16.... 30VDC (via HART line from host gauge) |
| **Power consumption** | 6mA@16VDC (HART converter only) |
| | 6mA@16VDC (Temp. probe + HART converter) |
| | 12mA@16VDC (Water Bottom sensor + HART converter) |
| | 12mA@16VDC (Temp. probe + Water Bottom sensor + HART converter) |

## Performance

| | |
|---|---|
| **Temperature accuracy** | ±0.15 °C (±0.27 °F), or better<br>Based on IEC 60751 class A standard |
| **Water bottom accuracy** | 4mm (±2mm) or better (at reference condition) |

## Environmental

| | |
|---|---|
| **Ambient temperature** | -40...+85 °C<br>(-40...+185 °F)<br>Converter housing |
| **Climate class** | DIN EN 60068-2-38 (test Z/AD) |
| **Degree of protection** | Housing : IP65, (Converter only, open housing: IP20)<br>Probe : IP68 |
| **Electromagnetic compatibility** | When installing the probes in metal and concrete tanks and when using a coax probe:<br>• Interference Emission to EN 61326, Electrical Equipment Class B<br>• Interference Immunity to EN 61326, Annex A (Industrial) |

## Temperature Probe Specifications

| | |
|---|---|
| **Temperature element** | Class A Pt100, IEC PUB 751 1995 |
| **Installation height adjuster** | ±360mm threaded, (SUS 316) |
| **Probe material** | SUS 316 flexible tube<br>SUS 316 flexible tube + SUS316 armoured mesh.... pending |
| **Operation temperature** | -170...+235 °C (-274...+455 °F) |
| **Flange size (Process connection)** | JIS 10K 50A RF<br>ANSI 150 lbs. 2" RF<br>JPI 150 lbs. 2" RF<br>DIN DN50 PN10RF<br>Others (optional) |

## Water Bottom (Capacitance) Sensor Specifications

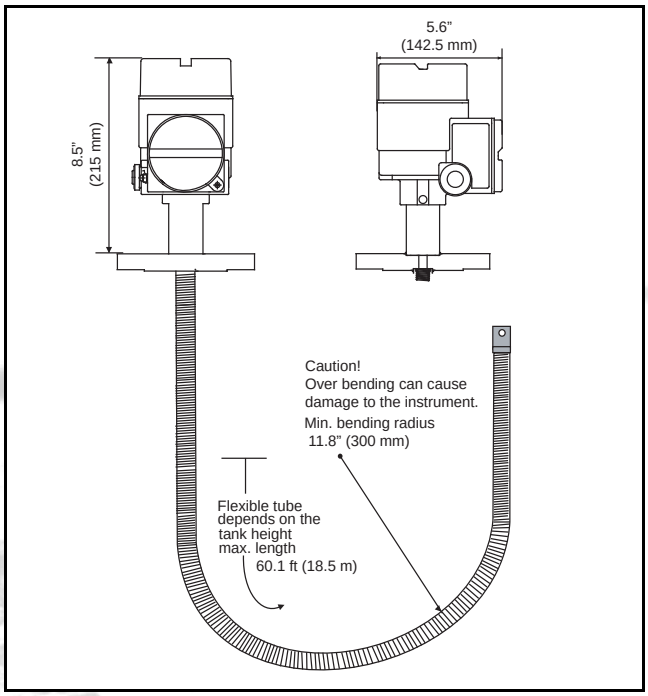
| | |
|---|---|
| **Sensor material** | SUS 316 (center rod SUS 304 & PFA protected) |
| **Operation range** | 1m (3.3 ft) and 2m (6.6 ft) |
| **Operation temperature** | -0...+100 °C (-32...+212 °F) |
| **Data transmission** | 2.5mm coaxial cable & common ground |

## Certifications and Approval

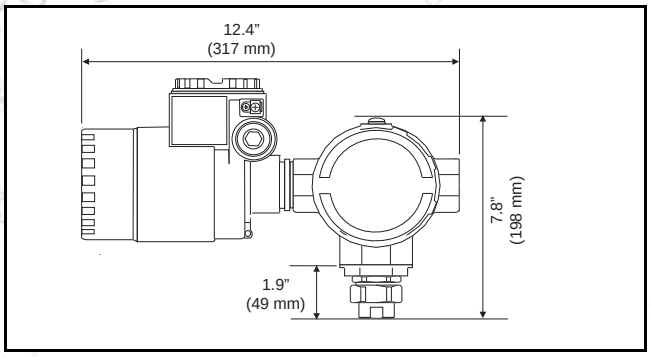
| |
|---|
| CE approval<br>4539 meets the legal requirement of the EC-guidelines. Varec confirms the instrument passing required tests by attaching the CE-mark. |
| ATEX<br>ATEX - II 1/2 G EEx ia IIC T2...T6 or II 2 G EEx ia IIC T2...T6<br>Factory Mutual (FM)<br>FM - Intrinsically Safe - Class I, Division 1, Groups C & D |

## Product Dimensions

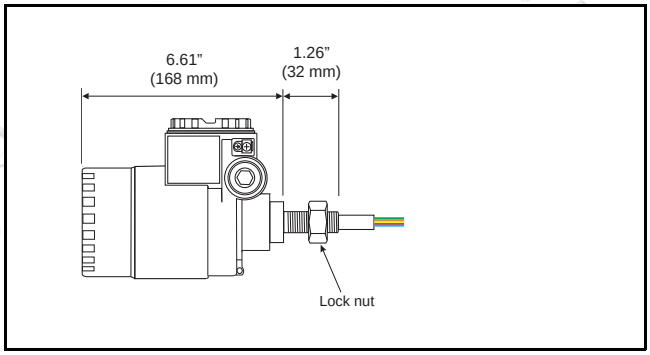
### 4532 Average Temperature Sensor and Convertor



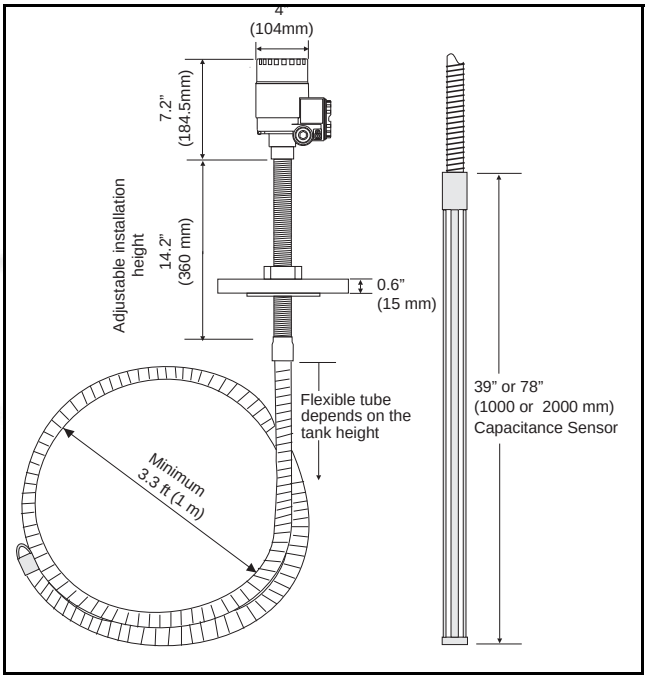

### 4539 Average Temperature and Water Bottom Convertor




### 4539 Convertor Only




### 4539 Flexible Average Temperature and Rigid Water Bottom Sensors



# Ordering Codes

## 4532 Average Temperature Sensor and Convertor

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Protection class** | | | | | | |
| | 7 | FM - Intrinsically Safe - Class I, Division 1, Groups C & D | | | | | |
| | B | ATEX - II 1/2 G EEx ia IIB T4 | | | | | |
| | | **Cable entry** | | | | | |
| | | B | Thread NPT 1/2 | | | | |
| | | D | Thread M20 | | | | |
| | | | **Process connection (SUS304)** | | | | |
| | | | 1 | 2" 150lbs RF, 304 flange ANSI B16.5 | | | |
| | | | 2 | DN50 PN0 B1, 304 flange EN1092-1 (DIN2527 C) | | | |
| | | | | **Element #, Interval, Probe range (Below flange to end of probe)** | | | |
| | | | | 022 | ...mm; 2x Pt100; 2 m (min 2,500 mm, max 4,500 mm) | | |
| | | | | 032 | ...mm; 3x Pt100; 2 m (min 4,500 mm, max 6,500 mm) | | |
| | | | | 042 | ...mm; 4x Pt100; 2 m (min 6,500 mm, max 8,500 mm) | | |
| | | | | 052 | ...mm; 5x Pt100; 2 m (min 8,500 mm, max 10,500 mm) | | |
| | | | | 062 | ...mm; 6x Pt100; 2 m (min10,500 mm, max 12,500 mm) | | |
| | | | | 023 | ...mm; 2x Pt100; 3 m (min 3,500 mm, max 6,500 mm) | | |
| | | | | 033 | ...mm; 3x Pt100; 3 m (min 6,500 mm, max 9,500 mm) | | |
| | | | | 043 | ...mm; 4x Pt100; 3 m (min 9,500 mm, max 12,500 mm) | | |
| | | | | 053 | ...mm; 5x Pt100; 3 m (min 12,500 mm, max 15,500 mm) | | |
| | | | | 063 | ...mm; 6x Pt100; 3 m (min 15,500 mm, max 18,500 mm) | | |
| | | | | | **Specific probe length, Length within selected item at Pos. 040(UP to max. 18,500)** | | |
| | | | | | A | Not selected | |
| | | | | | B | Anchor weight 7.09" tall, diameter 4.72" (180mm tall, diameter 120mm) | |
| | | | | | C | Anchor weight - Low Profile to be laid on bottom of tank Length 39.37" (1000mm); Diameter 1.61" (41mm) | |
| | | | | | D | Tensioning wire, wire hook, NPT 1" top anchor | |
| | | | | | F | Tensioning wire, wire hook, R1 top anchor | |
| **4532 -** | | | | | | | Complete product designation |

## 4539 Average Temperature/Water Bottom Sensor and Convertor

**Protection class**

| | |
|---|---|
| 0 | Protection: Waterproof IP 65 |
| 7 | FM - Intrinsically Safe - Class I, Division 1, Groups C & D |
| B | ATEX - II 1/2 G EEx ia IIC T2...T6 or II 2 G EEx ia IIC T2...T6 |

**Measuring function**

| | |
|---|---|
| 0 | Converter only |
| 1 | Temperature + Converter |
| 2 | Water Bottom + Converter |
| 3 | Temperature + Water Bottom +Converter |

**Temp. measuring range**

| | |
|---|---|
| 0 | Temp. device not selected |
| 1 | -40...+100 °C (-40...+212 °F) |
| 2 | -55...+235 °C (-67...+455 °F) |
| 3 | -170... +60 °C (-328...+158 °F) |

**Water Bottom measuring range**

| | |
|---|---|
| 0 | Water Bottom device not selected |
| 1 | 1 m (3.3 ft) |
| 2 | 2 m (6.6 ft) |

**Cable entry**

| | |
|---|---|
| B | 1 x NPT ½, thread |
| D | 1 x M20, thread |

**Process connection**

| | |
|---|---|
| 0 | Flange JIS 10K 50A RF, Stainless steel 316 |
| 1 | Flange ANSI 2" 150lbs RF, Stainless steel 316 |
| 2 | Flange DIN DN50 PN10 RF, Stainless steel 316 |
| 3 | Flange JPI 2" 150lbs RF, Stainless steel 316 |
| 4 | Universal coupling, PF(NPS)3/4, (converter only) |
| 5 | Thread M20 (converter only) |

**Number of elements**

| | |
|---|---|
| A | 2...Pt100 elements |
| B | 3...Pt100 elements |
| C | 4...Pt100 elements |
| D | 5...Pt100 elements |
| E | 6...Pt100 elements |
| F | 7...Pt100 elements |
| G | 8...Pt100 elements |
| H | 9...Pt100 elements |
| J | 10...Pt100 elements |
| K | 11...Pt100 elements |
| L | 12...Pt100 elements |
| M | 13...Pt100 elements |
| N | 14...Pt100 elements |
| O | 15...Pt100 elements |
| P | 16...Pt100 elements |
| Q | Element not selected |

**Element spacing**

| | |
|---|---|
| 1 | 2m (2000mm or 79") |
| 2 | 1.5m (1500mm or 59") |
| 3 | 1m (1000mm or 39") |
| 4 | Custom element position & spacing |
| 5 | 3m (3000mm or 118") |
| 6 | Spacing not selected |

**Probe length 3 ft to 131ft below flange to edge of probe price per 3ft (1000 mm)**

| | |
|---|---|
| A | .....mm probe length |
| B | Probe not selected |
| C | .....mm probe length, gas-tight feed through |

**Mounting attachment**

| | |
|---|---|
| A | No installation material |
| B | Anchor weight 7.09" tall, diameter 4.72" (180mm tall, diameter 120mm) |
| C | Anchor weight - Low Profile to be laid on bottom of tank Length 39.37" (1000mm); Diameter 1.61" (41mm) |
| D | Tensioning wire + top anchor |
| F | Tensioning wire, wire hook, R1 top anchor |

| | |
|---|---|
| N4539- | Complete product designation |

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