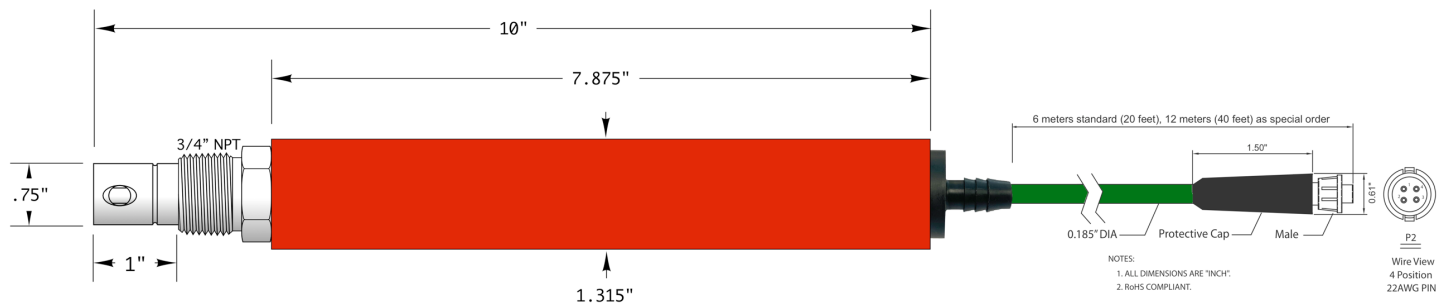


AST41 Smart *HiQDT* MODBUS RTU Conductivity Sensors for Inline Installs at Pressure to 500 psig & Temperature to 205°C



Drawing for $K = 0.05, 0.10, 0.20, 0.50, 1.0$ & 2.0 /cm cells. **Longer 2.25" insertion depth is available with 11.3" overall length.**

- Smart Digital Conductivity Sensors with Isolated RS-485 MODBUS RTU interfaces directly with any suitable PLC
- Windows software for configuration, calibration and testing of *HiQDT* smart digital sensors is provided free of charge
 - **Sensor stores temperature & cell constant calibrations including days in use since they were performed**
- AST41 was designed for high pressure and high temperature conductivity measurements and is an ideal choice for applications such as high-pressure desalination and reverse osmosis (RO) reject concentrate monitoring and control.
- High temperature and pressure water and steam is a severe environment for any elastomer requiring special features:
 - Dual EPDM O-ring seals ensure reliability (Viton & Kalrez Optional). Front seal absorbs brunt of chemical attack, allowing rear O-ring to operate in protected environment ensuring continued sealing & long service.
 - The result is that sensor life is more than double what can be expected of single sealed or epoxy sealed units.
- Compact design for 3/4" NPT inline process interface with available with either 1.0" or 2.25" insertion depth
- WPIT sealing option allows for use in areas with high levels of moisture, washdowns, rain or corrosive environment
- Wetted insulator materials of construction are PEEK insulator with 316SS sensor body and inner electrode as standard.
- Available cell constants of $K=0.05/cm$, $K=0.1/cm$, $K=0.2/cm$, $K=1.0/cm$ & $K=2.0/cm$ cover most conductivity ranges.
 - $K=0.05/cm$ can be used from 10-1,000 $\mu S/cm$ in standard range & 100-5,000 $\mu S/cm$ in high range modes
 - $K=0.1/cm$ can be used from 20-2,000 $\mu S/cm$ in standard range & 200-10,000 $\mu S/cm$ in high range modes
 - $K=0.2/cm$ can be used from 40-4,000 $\mu S/cm$ in standard range & 400-20,000 $\mu S/cm$ in high range modes
 - $K=1.0/cm$ can be used from 200-20,000 $\mu S/cm$ in standard range & 2,000-100,000 $\mu S/cm$ in high range modes
 - $K=2.0/cm$ can be used from 400-40,000 $\mu S/cm$ in standard range & 4,000-200,000 $\mu S/cm$ in high range modes
 - **Toggling between standard range and high range modes while sensor is in use is done by changing the range mode scaling factor register with handheld communicator, Windows software or customer PLC**
- Computed units available are salinity (PSU) and selectable total dissolved solids (TDS) units of NaCl, KCl or 442
- Cable terminated with quick-disconnect waterproof NEMA 6P snap connector. Max 3,280 feet (1,000 meters) length.



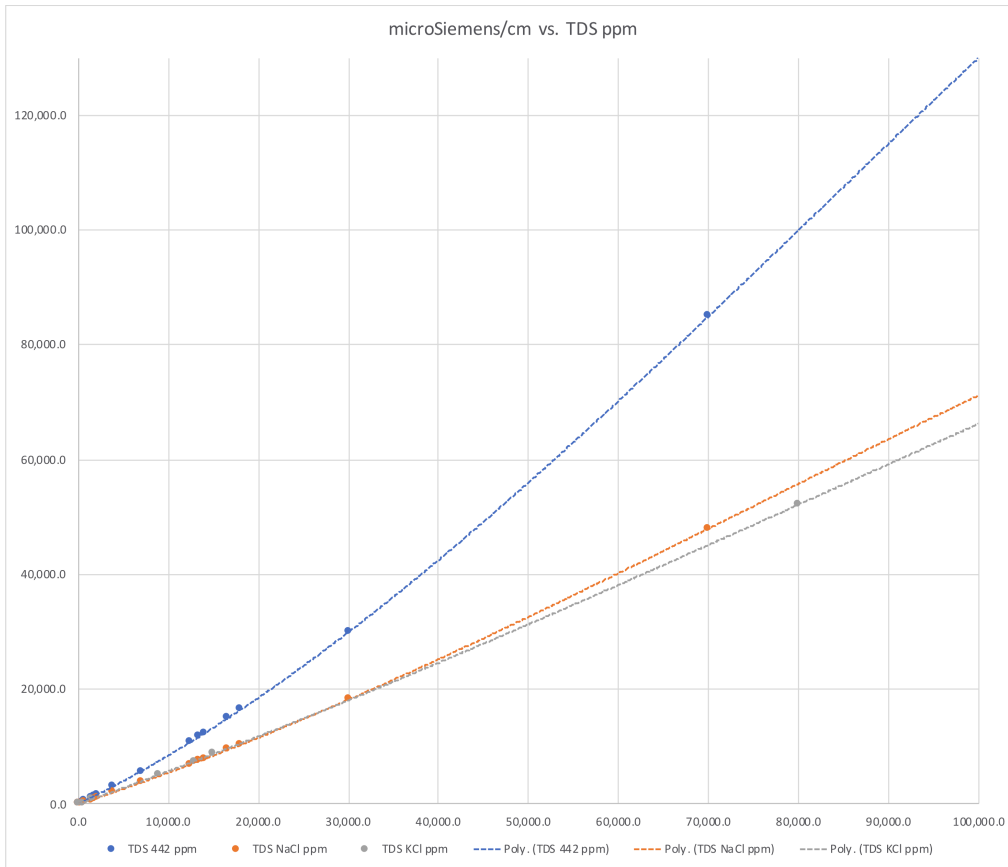
AST41 Smart *HiQDT* MODBUS RTU Conductivity Sensor Specs

Measurement Range:	See table below for <u>standard & high range configuration</u> of each cell constant
Operating Temperature Inline Use:	-35 to +205 °C (-31 to +401 °F) **
Operating Pressure:	Max 500 psig @ 100°C or 250 psig @ 205°C with front 316SS Threads
Process Connections:	¾”MNPT 316SS Front Threads
Wetted Materials of Construction:	
Insulator:	PEEK
O-Rings:	EPDM (Standard) or Viton/Aflas/Kalrez (Optional), Redundant
Electrodes:	316SS Standard
Sensor Body (Front):	316SS Standard
Rear Nipple:	CPVC or KYNAR (PVDF)
Temperature Element:	Pt1000 temperature sensor (included standard, required for all <i>HiQDT</i> sensors)
Temperature Input Range:	-40 to +210 °C (-31 to +410 °F) ±0.3°C Limited by actual sensor specs **
Cell Constants Available for AST41:	K = 0.05, 0.1, 0.2, 1.0 or 2.0 /cm
Cable Length Limits:	Standard 20 feet (6 meters), Max 3,280 feet (1,000 meters) with 12VDC supply
End of Cable Terminations:	4-pole waterproof & corrosion-resistant NEMA 6P rated HiQ4M snap connector
Storage and Shelf-Life:	One (1) year from date of dispatch from factory when stored at ambient.
Dimensional Details:	See following pages for drawing of each particular cell constant configuration.
Sealing Hose Options:	Braid reinforced vinyl tubing or NORPRENE tubing is available

** Contact factory for applications where the measurement is below 0°C or else above 175°C prior to purchase.

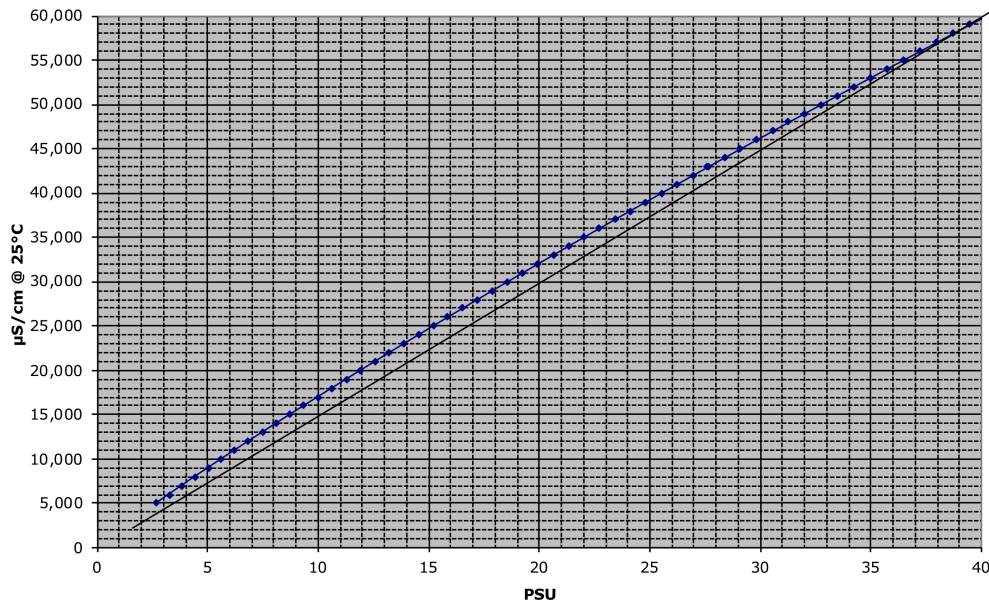
Temperature compensated conductivity ranges shown below at each temperature assumes the typical 2% per °C coefficient is used. If alternate temperature compensation coefficient is used recommended conductivity ranges will vary accordingly (inquire to factory).

Cell Constant of AST41	Full Range of Raw Conductivity Input	Temp. Compensated Conductivity @ 25°C	Temp. Compensated Conductivity @ 75°C	Temp. Compensated Conductivity @ 125°C	Temp. Compensated Conductivity @ 175°C
K=0.05/cm Standard K=0.05/cm Hi Range	10-1,000 µS/cm 100-10,000 µS/cm	10-1,000 µS/cm 100-5,000 µS/cm	5-500 µS/cm 50-5,000 µS/cm	3.33-333.33 µS/cm 33.33-3,333.33 µS/cm	2.50-250 µS/cm 25-2,500 µS/cm
K=0.1/cm Standard K=0.1/cm Hi Range	20-2,000 µS/cm 200-20,000 µS/cm	20-2,000 µS/cm 200-10,000 µS/cm	10-1,000 µS/cm 100-10,000 µS/cm	6.67-666.67 µS/cm 66.67-6,666.67 µS/cm	5-500 µS/cm 50-5,000 µS/cm
K=0.2/cm Standard K=0.2/cm Hi Range	40-4,000 µS/cm 400-40,000 µS/cm	40-4,000 µS/cm 400-20,000 µS/cm	20-2,000 µS/cm 200-20,000 µS/cm	13.33-1,333.33 µS/cm 133.33-13,333.33 µS/cm	10-1,000 µS/cm 100-10,000 µS/cm
K=1.0/cm Standard K=1.0/cm Hi Range	200-20,000 µS/cm 2,000-200,000 µS/cm	200-20,000 µS/cm 2,000-100,000 µS/cm	100-10,000 µS/cm 1,000-100,000 µS/cm	67-6,667 µS/cm 667-66,667 µS/cm	50-5,000 µS/cm 500-50,000 µS/cm
K=2.0/cm Standard K=2.0/cm Hi Range	400-40,000 µS/cm 4,000-400,000 µS/cm	400-40,000 µS/cm 4,000-200,000 µS/cm	200-20,000 µS/cm 2,000-200,000 µS/cm	133-13,333 µS/cm 1,333-133,333 µS/cm	100-10,000 µS/cm 1,000-100,000 µS/cm



Total dissolved solids are computed from the measured conductivity. Curves that define relationship between measured conductivity and user selectable total dissolved solid (TDS) of NaCl, KCl or 442 are preprogrammed into sensor. The supported min and max TDS may be limited by the choice of cell constant and range mode configuration used with full range of 0 to 100,000 ppm. Curves for other types of TDS units representing other salt mixtures available upon request as special orders (minimum order quantity may apply).

μS/cm @ 25°C vs PSU



The salinity units are computed from the measured conductivity. The curves that define the relationship between the measured conductivity and computed salinity in PSU are preprogrammed into the sensor. The supported min and max salinity values may be limited by the choice of cell constant and range mode configuration employed. Full range available is 0.000 to 50.000 PSU



Technical Specifications for Smart *HiQDT* AST41 MODBUS RTU Conductivity Sensors with Cell Constants 0.05, 0.1, 0.2, 1.0 & 2.0

BENEFITS OF SMART DIGITAL HiQDT MODBUS CONTACTING CONDUCTIVITY SENSORS

- **Integral RS-485 MODBUS RTU interfaces all-modern PLC controllers & data acquisition systems.**
- **Communicator provides easy management of field installations** without the cost of a mating transmitter. This is ideal for locations where a local display is not necessary or possible due to installation limitations.
- **Windows software for setup and calibration of HiQDT conductivity sensors is free allowing for easy and low-cost field commissioning for setup & pre-calibration of sensors** without the cost of a transmitter. Ideal for installation locations where a local display is not needed or possible due to site specific needs.
- **Intelligent management of sensor calibrations and service life-cycle** for efficient commissioning & maintenance. All aspects of installation are completely portable from the shop to the field site location.
- **The 'Days in Use' since calibration was performed is stored** allowing for optimal maintenance planning.
- **All digital sensors ensure** reliable operation even in noisy process environments.
- **No degradation in digital output** even with very long cable runs. **Max of 1,000 meters (3,280 feet) with 12VDC power** supply to support for remote installation sites and consolidation of collected data.
- **Bridging connections & modifying installations easily** without loss of signal quality with **NEMA 6P & IP67 rated quick disconnect waterproof and corrosion-resistant dual snap connector**. Simple plug and play operation for intelligent maintenance planning & smart management of sensor installations and stocking.
- **Low-cost snap digital extension cables** facilitate consolidation of very many HiQDT sensors outputs into one panel enclosure where very many remote field installations can all be conveniently all viewed at once.
- **All Extension cables for HiQ & HiQDT sensors are intercompatible**. Uniform extension cables minimize stocking. Separate field installation guide details available options to commission & exchange sensors.

Mechanical & Thermal

Housing: 316SS (Front) & CPVC/KYNAR (Rear)
 Mounting: Inline Only; 3/4" NPT Process Connection
 Connector: NEMA 6P rated HiQ4M male snap connector for HiQDT snap extension cables; Extension cables for 3TX-HiQ platform can also be used for HiQDT type smart digital sensors as well
 Max Cable: Up to 3,280 feet (1,000 meters) using 22 AWG leads when employing 12VDC power supply
 Temp.: Inline max per sensor specs
 Pressure: Up to 500 psig inline use
 Weight: Per Sensor, Typically 0.6-2.0 kg (1.3-4.4 lbs)
 Dimensions: 3/4" MNPT Process Connection for inline installations; Length is 10.0 to 11.3 inches Excluding any hose sealing installed

Electrical

Operating VDC: 8.0 to 13.0 VDC at sensor board
 Power Supply: Isolated & Regulated 9V or 12V DC
 Current draw: Max 35mA Absolute, Typical ~25mA
 Conductivity Range: See Conductivity Range Table on Page 2 for Each Cell Constant Type
 Temp Sensor: Integral Platinum 1000Ω TC Element
 Temp Range: -40 to +210°C ±0.3°C (*limited by actual sensor specifications*) Max Temp is +85°C at sensor board
 Temp. Comp.: Automatic for all measurements
 Digital Output: Isolated RS-485 MODBUS RTU
 Baud rate: 9600 or 19,200 kbps (selectable)
 Compatibility: For use with ASTI HiQDT Handheld or ASTI HiQDT Windows software or any PLC with isolated RS-485 input that can serve as a MODBUS RTU master to HiQDT sensor slave
 CE mark: EN61326A





HiQDT SMART DIGITAL CONDUCTIVITY SENSOR FEATURES & BASIC USAGE

The smart digital HiQDT conductivity sensor with integral RS-485 MODBUS RTU communications allows for a simple and fully portable installation. The sensor may be calibrated anywhere (lab, shop or field) and interfaced with any data acquisition or control system in the field via the RS-485 MODBUS RTU output. Temperature & cell constant calibrations can be done with sensor left in service if grab sample adjustments are desired to agree with reference values. Waterproof and corrosion-resistant NEMA 6P HiQ4M snap connectors come standard for easy seamless hot-swap of sensors from service for cleaning, recalibration and other maintenance requirements as well as eventual replacement in time.

SENSOR SERIAL NUMBER, ITEM NUMBER & TOTAL TIME IN FIELD SERVICE

Systematic tracking is achieved with factory digitally stamped serial number and item number as well as the build date of sensor. The internal clock on the HiQDT sensor board is incremented when sensor is continuously energized for one-hour period to monitor the total number of days in active field service. If the sensor is disconnected the incrementing of the time in service will stop. When the sensor is energized the incrementing of time in service will once again resume. The number of days in service is always the actual real-time total usage. The total days in use is shown in days and equally accurate for continuous or intermittent service such that the time in service is accurate even if the sensor is taken in & out of use for cleaning & re-calibration and/or swapped between different installations. The total time in service since each calibration was performed is shown when the 'View' key is pressed for 3 to 5 seconds in the given calibration LED mode.

CALIBRATION OF HiQDT MODBUS RTU CONTACTING CONDUCTIVITY SENSORS

- Calibrate modes of the HiQDT Windows software & handheld communicator allows for the following adjustments:
 - Temperature offset adjustment (typically only required at initial time of commissioning)
 - Dry in air zero calibration in 'Offset' calibrate mode (typically only required at initial time of commissioning)
 - 'Slope' calibration adjusts conductivity to grab sample or standard to give the effective apparent cell constant
- Calibration values are stored inside the HiQDT smart digital conductivity sensor in EEPROM such that sensor can be powered down or moved without loss of calibration resulting in a true plug and play low maintenance installation.
- Grab sample offset type calibration is done with sensor left in service after stabilized. A grab sample is analyzed offline by the preferred method. The inline field reading is made to agree with any grab sample analysis. The value of the sensor installed in service is adjusted in gain calibration mode to agree with the reference determined value.

COMPUTED UNITS BASED UPON MEASURED CONDUCTIVITY

Units of measure are native conductivity expressed as either $\mu\text{S}/\text{cm}$ or mS/cm for all cell constants depending upon particular range of interest. Computed units of salinity available from 0.000 to 50.000 PSU and user selectable computed units of total dissolved solids (TDS) for NaCl, KCl or 442 available from 0 to 100,000 ppm. The actual min and max for computed units may be limited by cell constant and range mode used for sensor configuration. Other computed units are available on a special-order basis (minimum order quantities may apply for any special computed unit requests).

IMPORTANT NOTE FOR POWERING HiQDT SMART DIGITAL SENSORS

- Although RS-485 MODBUS RTU communications from HiQDT conductivity sensors is isolated, the mating PLC serving as MODBUS Master should still have an isolated RS-485 input port for ensure best results in field use.
 - The power source that energizes sensor should be isolated (dedicated & separate from all other devices) or
 - DC/DC isolator can be added to the existing power supply employed to accomplish the same net result as having a dedicated and isolated 9V or 12V to DC power source.

NOTES ON ADJUSTABLE SMOOTHING DAMPENER & OUTPUT DELAY:

- Dampener LED when HiQDT conductivity sensor is connected allows for display & modification of the variable that is used to set the number of seconds used for the smoothing dampener and delay from boot to send the output values
- For intermittent operation, it is recommended to set this dampener & output delay variable to a low number in order to minimize power consumption while from battery power sources and maximize sampling time of process output



MODBUS RTU setup of HiQDT sensor is available to enable all functionality detailed below:

READ-ONLY Data	Core Process Value Description	READ-ONLY Data	Analytic Sensor Value Description
Calibrated & Temperature Compensated Conductivity & Temperature for HiQDT AST41 Smart Sensors See table on page 2 for recommended low and high conductivity levels for use at various temperatures for each cell constant Computed Values	<u>K=0.05/cm Standard & High Range</u> Range 0-1,000 µS/cm & 0-10,000 µS/cm <u>K=0.1/cm Standard & High Range</u> Range 0-2,000 µS/cm & 0-20,000 µS/cm <u>K=0.2/cm Standard & High Range</u> Range 0-4,000 µS/cm & 0-40,000 µS/cm <u>K=1.0/cm Standard & High Range</u> Range 0-20,000 µS/cm & 0-200,000 µS/cm <u>K=2.0/cm Standard & High Range</u> Range 0-40,000 µS/cm & 0-400,000 µS/cm All cell constants have temperature range of -40.0 to +210.0 °C Salinity 0.000-50.000 PSU sent as 0 to 50,000 TDS 0-100,000 ppm sent as 0 to 50,000	Sensor Serial Number Sensor Diagnostics	Unique Serial Number Designation: YY.M-A.DD ** Sensor Item Number Software Revision Max Temp in Use Min Temp in Use Hours in Field Use
Raw Process Values	Same as the calibrated and temperature compensated conductivity and temperature for each cell constant configuration. Max recommended temperature compensated conductivity range depends upon cell constant, range mode and temperature.	Calibration Values	Temperature Offset Hours since Temp Offset Cal Zero Dry in Air Offset Hours since Dry in Air Zero Offset Cal Cell Constant Standard Range Cal Time since Standard Range Cal Cell Constant High Range Cal Time since High Range Cal

** Serial number format YY is the last digits of year M is month with A=Oct, B= Nov & C=Dec A is a letter from A to Z (as permissible) DD is value from 0 to 255

READ/WRITE Type	Adjustable Calibration Description	READ/WRITE Type	Adjustable Parameter Description
Offset Adjust Temperature	Calibrated Temperature Value Limit ±25.0 °C * from raw value	Reset Calibrations	Will reset all user adjustable sensor calibrations back to factory default values
Zero Dry in Air Offset	Conductivity Reading Adjusted to Zero for dry in air condition	Dampener & Delay from Boot	Time averaging of process value 1, 2, 3, 4, 5, 8, 10, 15, 20 or 30 Seconds
Wet Gain Calibration to determine effective apparent cell constant	Calibrated Conductivity Value ±70% from nominal cell constant	Step Change	Increment value for stepwise calibration on the handheld communicator: 0.05, 0.10, 0.20, 0.5, 1.0 or 2.0 %
Range Mode	Standard Range or High Range Mode operation is selectable while sensor is in operation.	Special - Temp Compensation	0.00 to 9.99 % per degree Celsius (Default 2.10%)

NOTE 1: All MODBUS devices on network must use the same baudrate and have a unique node address. Handheld Communicator (HHC) is MODBUS master while all HiQDT sensors are MODBUS slaves. To interface HHC with HiQDT sensor, either removed it from the network, or else bypass with a bridge box with switch scheme. Access any given HiQDT sensor on the MODBUS network with HHC is possible if the existing MODBUS master is disconnected or powered down. If node of HiQDT sensor is not known, use Widows Software or HHC search feature to find it. Please see HiQDT installation guide and HiQDT controller manual for additional recommendations & details about commissioning, calibration and troubleshooting.

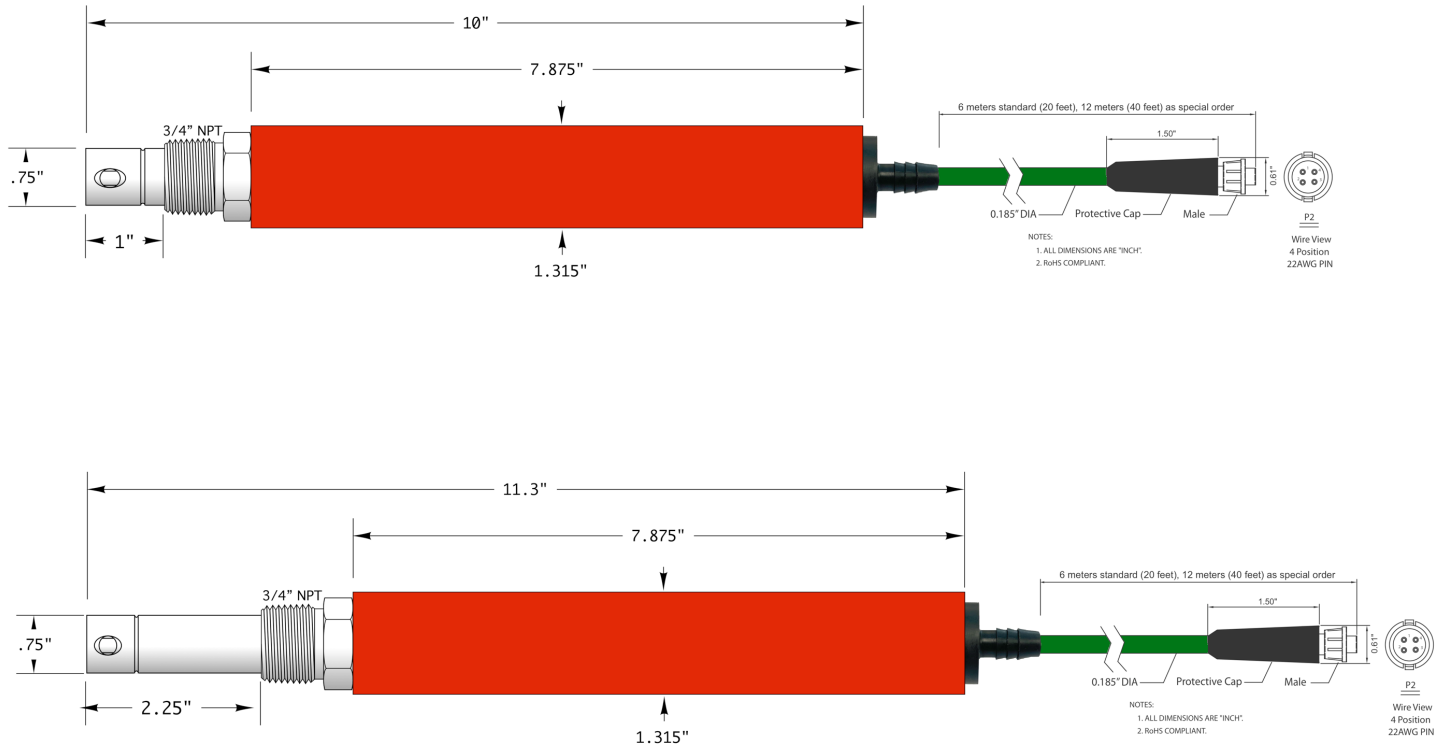
NOTE 2: Access to **READ** values in *Core Process Value Column* gained through MODBUS function code (04).

NOTE 3: Access to **READ** parameters in the *Analytic Sensor Value Column, Adjustable Calibration Column & Adjustable Parameters Column* gained through MODBUS function code (03).

NOTE 4: Access to **WRITE** parameters in the *Analytic Sensor Value Column, Adjustable Calibration Column & Adjustable Parameters Column* gained through MODBUS function code (16).

Last Revised January 8, 2021

Dimensions for *HiQDT* AST41 Cell Constants 0.05. 0.1, 0.2. 1.0 & 2.0



NOTES:

- 1) All cell constants are available in both the standard 1.0 and extended 2.25 insertion depth configurations.
- 2) The wetted materials of construction for the front portion of the sensor are 316SS for metal electrodes and PEEK for the insulator
- 3) The material of construction for the rear eight (8) inch nipple is either CPVC or KYNAR (PVDF).
 - a. For inline installations using the front 3/4" MNPT threads only the 316SS & PEEK materials of construction are wetted.
- 4) The sensors may be installed at any orientation as desired. Care should be taken that the installation scheme is such that the measuring cell is always completely full at all times (no entrapped air bubbles or times when this part of the line is dry).
- 5) For batch operations where the tank is drained, installation with the sensor tip to the top of the tank (inverted style) is preferred.
- 6) For inline installations, the vent hole should be entirely in the path of flow and unobstructed by the compression fitting to ensure that the sample in the measuring cell is representative of the process fluid at all times. Alternatively, if the vent hole cannot be installed to be entirely in the flow the tip should be installed into the direction of flow typically at an elbow in the piping.
- 7) For low-flow installations please contact the factory for additional assistance. Custom insertion depth may be available for selected sensor configurations as special order options upon request.
- 8) Dimensions for all drawings are in inches.