MANUAL

DSS HANDHELD FIELD COMMUNICATOR

+ Conductivity

turtletoughsensors.com

Specifications

DSS Handheld Field Communicator

Turtle Tough's Handheld Field Communicator (HFC) calibrates and configures DSS Smart Digital RS485 Modbus RTU sensors at any location. All values stored in non-volatile sensor EEPROM for hot-swap portability when installed back into field service.

Product name	DSS HandHeld Field Communicator - Conductivity
Code	TT-HFC

Mechanical

Housing	ABS
Mounting	Handheld
IP Class	Housing IP40
Connector	Quick connect plug
Temperature	Usage -15 to +50 °C *(Storage -35 to +75 °C)*
Weight	130 grams with battery *(4.6 ounces)* 100 grams without battery *(3.5 ounces)*
Dimensions	D 26 x W 60 x H 120 mm (1.0" X 2.4" X 4.7")

Electrical

Supply	9V battery (Alkaline or Lithium)
Consumption	~45 mA with DSS sensor "On"
Battery life	~6 hrs Alkaline or ~12 hrs Lithium Auto shutdown after 25 seconds * without communication
Interface	Smart Digital DSS Modbus RTU Conductivity (EC) Sensors
Baud rate	9600 or 19,200 kbps (selectable)
CE mark	EN61326A

* Number of seconds until auto shutdown starts from when sensor is disconnected from HFC

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Programming and Navigation

The Handheld Field communicator (HFC) has 3-digit display and 16 LEDs to show readings and analytic data as well as to calibrate and configure sensor. Programming done by 4 key front panel. *'Mode'* key used to toggle and navigate to each LED. *'Up' or 'Down'* buttons scroll available options and adjust values. *'Mode'* key is used to make selections and save entries. *'View'* key provides additional information for the given LED mode (see table for details on use of *'View'*). Once baud rate and node of connected sensor are entered all parameters are automatically loaded for zero configuration plug and play use in the field.

DSS Handheld Field Communicator for Calibration, Configuration, Spot Measurement and Troubleshooting of Conductivity DSS Sensors RS485 Modbus RTU

Led Label	Parameter	Description and Method to Access	Range	Default
Sensor Type	Measurement type	Load options for connected sensor 'View' key shows software revision 'Up' key shows cell constant 'Mode' key used to exit and save any changes and move onto 'Reading'	pH or ORP or DO or ISE or CON 'Down' shows range mode: Standard (Std) / High (Hi) or else Ultralow (UL) 'Up' key then used to initiate toggling between Std & Hi Range Modes	Per Type
Reading***	Process Parameter ****	Display current calibrated value 0.01-9.99 µS/cm (value is flashing) 10.0-99.9 µS/cm (value is flashing) 100-999 µS/cm (value is flashing)	1.00-9.99 mS/cm (1,000–9,990 µS/cm) 10.0-99.9 mS/cm (10,000–99,900 µS/cm) 100-999 mS/cm (100,000–999,000 µS/cm) 1.00-4.00 S/cm (Reading LED flashing)	Per Measured Solution
Absolute mS	Process Parameter	Display the absolute conductivity value from connector EC sensor	Same as Reading LED mode (see above) Max raw conductivity is 4,000 mS/cm	Per Sensor & Media
Cal Temp.	Offset calibration of temperature in °C **	Adjust temp reading up and down 'View' key shows temperature offset	±25.0 °C * from raw value	0.0
Cal Offset	Offset Calibration Zero Dry in Air **	Defines the offset for dry in air 'View' shows current zero offset	0.00 to 2.00 % of the output	Per Sensor
Cal Slope	Defines Gain **	Defines gain on nominal cell constant for all measured ranges 'View' shows current gain	0.300 to 1.700 times nominal cell constant yields effective apparent calibrated cell constant in field use	Per Sensor
Dampener	Smoothing dampener and output delay ***	Sets number of seconds to be used for dampener for process value(s)	1, 2, 3, 4, 5, 8, 10, 15, 20 or 30 Seconds	10 - Dampen 1 - Delay
Step Change	'Up' & 'Down' button Sensitivity setting	% increment for each time the 'Up' or 'Down' button is depressed	Choices: 0.05, 0.10, 0.20, 0.5, 1.0 or 2.0 'View' selects TDS for Std/Hi Mode: 'nA' (NaCl), 'PoT' (KCl) or 442	0.05
Special	Set ATC Coefficient Display Computed EC Unit 1 (Reg 30005) Display Computed EC Unit 2 (Reg 30006)	Set temp compensation coefficient 'View' shows PSU for for Std/Hi MegaOhms (MΩ) for Sensor Type 7 HOLD 'View' shows TDS for Std/Hi UPW MegaOhms (MΩ) for Ultralow	Units are % per °C (Limits are 0.00-9.99) Salinity range is 0.000 to 50.000 PSU Resistivity range is 0.000 to 20.000 MΩ TDS shown in ppt. Convert ppt to ppm multiply by 1,000 (2.34 ppt is 2,340 ppm)	Per Sensor Default is 2.00%
Baudrate	Baudrate for Com	Toggle between 9600 or 19,200 kbps	9600 or 19,200 kbps	Per System
Node	Address for Com	Chose a valid address on network	From 001 to 247	Per Sensor
Item/Serial Number	Sensor Item Number and Serial Number	Item # defines model; 'View' shows Serial # (unique traceable identifier)	Item # from 0-65,535 (>999 is toggled) Serial # per YY.M-AA.DDD Scheme	Per Sensor
Days in Use	Total time DSS sensor is energized	Increments time in use to track sensor lifetime and predictive maintenance	0-65,535 in units of days (>999 is toggled) Within ±2% accuracy for any time in use	Per Sensor Field Use
Max/Min °C	Displays max & min Temp in field use	The max temp in field use is shown; Push 'View' button for min temp	-40 to +210 °C *	Per Sensor Field Use

** Negative values are always shown as flashing.*

Color notes

Parameters in green are defined by factory at dispatch time or determined from field use.
Parameters in grey can be adjusted as desired.
Parameters in blue are obtained from wet calibrations done with DSS sensor in the field.

** *Holding the 'View' key for 3 to 5 seconds in this LED mode shows the 'Days in Use' SINCE this calibration was performed*
** *Holding both the 'View' and 'Up' keys for 3 to 5 seconds in this LED mode will reset all calibration values back to default*
*** *Holding the 'View' key for 3 to 5 seconds allows for the delay from boot value to be shown as well as adjusted*
**** *Holding both 'Up' & 'Mode' keys shows software rev or both 'Down' & 'Mode' keys shows build date in Reading LED mode*
***** *User Adjustable Timeout Feature: Press 'Down' + 'View' in 'Reading' mode to set minutes before automatic shutoff occurs*

'Modbus Com' & 'Battery Low' LED

- The "Modbus Com" LED is illuminated briefly each time that a communication packet is sent or received.
- The "Battery Low" LED will at first flash as warning & then illuminate continuously when the 9V battery should be replaced.
  - Must change 9V battery when LED is illuminated to ensure valid readings and calibrations.

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Setup of DSS Sensor RS-485 Modbus RTU to Handheld Field Communicator

1. Instructions for scanning and changing nodes* *(See notes on page 7)*
2. Press the 'Mode' button to turn on HFC. The HFC will attempt to communicate with the last used baudrate and node address. If either no sensor is connected or available at the last used baudrate and node address then three dashes "---" are shown on display. If no buttons is pressed for 25 seconds the HFC will automatically turn itself off to conserve battery life.
   a) If previous baudrate & node are valid HFC will automatically load all relevant LED options and addressable parameters for that sensor type.
3. Pressing 'Mode' button navigates to 'Node' LED mode. Use 'Up' & 'Down' keys to scroll to node of the connected sensor. Node information is typically found on label of sensor. If this information is not available, the DSS Windows software can be used scan the sensor in question to determine the current node address. The baudrate and node address of the DSS sensors can only be changed by the Windows software. When the desired node address is reached press the 'Mode' key enter the value.
   a) Default nodes: pH is 1, ORP is 2, Wide-Range ORP is 3, DO is 4, ISE is 5, Conductivity is 6. If multiple sensors of same type are used on one Modbus RTU network then node address for each same type sensor must differ from default to ensure a unique and valid node address.
4. If baudrate needs to be adjusted (9600 or 19,200 kbps) then the HFC automatically navigates to this LED mode next.
5. HFC returns to reading mode after selecting node & baudrate. If selections are valid then process reading is shown else three dashes "---" are shown.
6. Press 'Mode' button after reading LED to toggle to sensor type LED which shows type of sensor that is connected.

Notes on adjustable smoothing dampener and output delay

- Dampener LED when a Conductivity DSS sensor is connected allows for display and 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 and 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.

Sensor serial number, item number and total time in field service

Systematic tracking achieved with factory stamped sensor serial and item number. The internal clock on the DSS sensor board is incremented when energized 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 and out of use for cleaning and re-calibration and/or swapped between different installations.

Important note before performing calibrations

The time averaging dampener is always on even when performing calibrations. It can be desirable to adjust dampener to a short value when performing calibrations to make the calibration process quicker and then reset the dampener back to a higher value before reinstalling the sensor back into continuous use in field service (be sure to remember this last step!)

Temperature calibration instructions

The temperature is calibrated by pushing the 'Up' or 'Down' buttons when in the temperature display (°C) mode. *

Calibration of Conductivity DSS Sensors with the Handheld Field Communicator

1. Use the 'Mode' button to toggle to 'Offset' LED to perform the zero dry in air calibration. The sensor should be completely dry and clean before starting this calibration. Pressing 'Up' or 'Down key will initiate an auto-calibration.
2. Use the 'Mode' button to toggle to the 'Slope' LED and use 'Up' and 'Down' keys until the display reads the desired value in conductivity units. If the number is not flashing and the LED is not flashing the units will be mS/cm.
   a. If the number displayed is flashing the units are then µS/cm (divide by 1,000 to get mS/cm units)
   b. If the 'Slope' LED is flashing, then the units are Siemens/cm (multiply by 1,000 to get mS/cm units)
   c. There are two slopes stored in sensor. When performing calibration with HFC slope will automatically be assigned to the range mode in which the sensor is operating at the time calibration is performed.
3. Calibration values stored inside DSS smart digital conductivity sensor in EEPROM so sensor can be powered down without loss of calibration meaning a true plug and play seamless hot-swap measurement system in the field.
4. Results of slope calibrations with conductivity sensor can be viewed by pressing the 'View' key in 'Slope' calibration LED mode which returns the current gain on the nominal cell used to compute the displayed conductivity values.

Display features available using the 'VIEW' key

- In 'Node' mode press 'View' key to invoke the node scanning feature *
- In 'Baud Rate' mode press 'View' key for 3 to 5 seconds to invoke node changing mode. **
- In 'Sensor Type' LED mode, the software revision for the connected sensor is shown when the 'View' key is pressed.
- In 'Sensor Type' LED mode, when 'Up' key is pressed then the nominal cell constant of sensor is indicated:
  - Range of cell constant is anywhere between K = 0.01/cm up to K= 20.0/cm *(see charts on pages 11 & 12)*
- In 'Sensor Type' LED mode, when 'Down' key is pressed then the currently operating range mode is displayed.
  - Press 'Up' key while range mode is displayed to initiate toggling between standard and high range modes. For the ultralow style sensors only one range mode exists. Press 'Mode' to save and exit toggling range modes.
- In 'Reading' and 'Slope' LED mode the displayed units are mS/cm unless one of the two conditions below exists:
  - When reading is flashing then the units are µS/cm (divide by 1,000 to get mS/cm units)
  - When the 'Reading' or 'Slope' LED is flashing then units are Siemens/cm (multiply by 1,000 to get mS/cm)
- In 'Cal Temp.' LED mode, the offset in °C *** for current temperature calibration is shown when the 'View' key is pressed.
- In 'Cal Offset' LED mode, the offset for the dry in air zero calibration is shown when the 'View' key is pressed.
- In 'Cal Slope' LED mode, the current gain for the connected DSS conductivity sensor is shown. The limits for the gain on the nominal cell constant of the given sensor is from 0.300 to 1.700.
  - The calibrated apparent effective cell constant for the sensor in field use is obtained by multiplying the nominal cell constant times the gain shown as the result of the slope calibration.
  - Output scaling & limits defined solely based upon the nominal cell constant and range mode in use.
  - Days since this calibration performed shown by holding 'View' in the 'Cal' mode for 3 to 5 seconds. If BOTH 'View' & 'Up' pressed for 3 to 5 seconds in any 'Cal' mode will reset all calibrations back to factory default.
- In 'Step Change' LED 'View' key displays and toggles TDS units (NaCl, 442, KCl) for std/hi range mode type sensors.
- In 'Special' LED 'View' shows salinity in PSU for Std/Hi ranges and resistivity in MegaOhm (MΩ) for ultralow range.
- In 'Special' LED if 'View' is pressed for 3 to 5 seconds then total dissolved solids (TDS) in ppt units is shown for Standard/High ranges and MegaOhm (MΩ) using ultrapure water (UPW) ATC is shown for ultralow range sensors.
  - To convert from ppt units to the ppm units multiply by 1,000 (i.e. when 3.78 is display this means 3,780 ppm

See next page for notes about node scanning instructions and node changing mode.

* **Node scanning feature, instructions:**
  - *Initial node of '0' will be shown (press 'Mode' when node address is '0' to exit scan mode).*
  - *Select starting address for scan with 'Up' or 'Down' keys. Node address scrolled in increments of 10. For example, pressing 'Up' key gives address of 1→10→20→30… and so forth while pressing 'Down' key gives addresses of→240→230→220… and so forth.*
  - *Press 'Mode' to begin scan. Scanning is always performed in an ascending fashion. Scan will stop when sensor is found. Sensor type for node address found displayed flashing with node address.*
  - *Press 'Mode' to select this node and you will enter 'Reading' mode.*
  - *Press 'View' to continue scanning. If no sensors found when address 247 is reached, then 'Err' is displayed. Press 'Mode' to resume scan and repeat these procedures.*

* **Node changing mode notes:**
  - *Select the current node for the attached sensor. If the current node is not known use the node scanning feature to determine it. When in the 'Baud Rate' LED mode, hold the 'View' key for at least 3 seconds to initiate the node changing mode. The current node of the sensor will be shown and the 'Sensor Type' and 'Node' LED will flash.*
  - *If the 'Mode' key is pressed immediately after entering this node changing mode, then no change to the address will be made since the address displayed will equal the current node address.*
  - *Use 'Up' and 'Down' keys to adjust the node to the modified address if desired.*
  - *Press 'Mode' key to enter the new node address selected with 'Up' & 'Down keys.*

* ** Negative values shown as flashing.*

Modbus RTU setup of DSS sensor enables all the functionality detailed below.

READ-ONLY Data	Core Process Value Description	READ-ONLY Data	Analytic Sensor Value Description
Calibrated & Temperature Compensated Process Values for DSS-CON(-L)	Conductivity sent as 0 to 50,000 steps for all cell constants & range modes. To compute conductivity value sent is multiplied by cell constant integer (nominal cell * 100) & range mode scaling factor which is then finally divided by 50,000 to yield µS/cm units.	Connected Sensor Type	1 - DSS-pH 2 - DSS-ORP Standard Range 3 - DSS-ORP Wide Range 4 - DSS-DO (Dissolved Oxygen) 5 - DSS-ISE (Ion Selective) 6 - DSS-CON (EC Standard/High) 7 - DSS-CON-L (EC Ultralow)
Raw Process Values Temperature Process Values	Scaling for raw conductivity values is the same as temperature compensated conductivity values for the given sensor. Calibrated temp with the range -40.0 to +210.0 °C sent as 0 to 2,5000	Sensor Serial Number Sensor Diagnostics	Unique Serial Number Designation: YY.M-AA.DDD ** Sensor Item Number Software Revision Max Temp in Use Min Temp in Use Days in Field Use
Computed units for DSS-CON(-L)	Computed units of salinity/resistivity sent as 0-50,000 correspond to 0-50.000 PSU/MΩ Computed units of total dissolved solids (TDS) NaCl, 442 or KCl sent as 0 to 50,000 correspond to 0 to 100,000 ppm. On handheld communicator the units of ppt are displayed instead of ppm (1ppt = 1,000ppm	Calibration Values	Temperature Offset Days since Temp Offset Cal Process Offset (Zero Dry in Air) Days since Process Offset (Zero) Cal Slope Low Cal Days since Slope Low Cal Slope High Cal Days since Slope High Cal

*** Serial format YY is last digits of year; M is month with A=Oct, B= Nov & C=Dec; AA is letter(s) from A to nY (as permissible); DDD 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** The temperature to which reading is adjusted is sent as 0 to 2,500 corresponding to -40.0 to +210.0 °C	Reset Calibrations Temp. Comp. Coefficient	Will reset all user adjustable sensor calibrations back to factory default values Adjustable from 0.00 to 9.99 % per °C as appropriate for measured sample
Offset to create true zero for dry in air condition	**Adjustment up to 2% of full scale is possible to achieve a zero value for dry in air calibration.**	Dampener Delay from Boot	Time averaging of process value Time until process values are sent from boot 1, 2, 3, 4, 5, 8, 10, 15, 20 or 30 Seconds
Adjust Sensor Slope	**Gain on Nomial Cell Constant** Sent as 300 to 1,700 corresponding to 0.300 to 1.700 multiplier to nominal cell constant of the sensor	Step Change	Increment value for stepwise calibration on the handheld communicator: 0.05, 0.10, 0.20, 0.5, 1.0 or 2.0 % per °C

** Negative values shown as flashing.*

Note 1: *All Modbus devices on network must use the same baudrate and have a unique node address. The Handheld Field Communicator (HFC) is Modbus master while all DSS sensors are Modbus slaves. To interface the HFC with a DSS sensor, either removed it from the network, or else bypass with a junction box with switch scheme. Access any given DSS sensor on the Modbus network with the HFC is possible if the existing Modbus master is disconnected or powered down. If the node of DSS sensor is not known, use the Widows Software or HFC search feature to find it. Please see the DSS installation guide and DSS controller manual for additional recommendations and 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 and Adjustable Parameters Column gained through Modbus function code (03).*

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

Conductivity Cell Constant and Available Range Modes for Smart DSS Sensors with RS-485

STANDARD RANGE MODE * - in microSiemens/cm

Range Scaling Factor 200			Max Temp. Compensated Conductivity using 2% per °C Coefficient			
Cell Constant (K)	Max Raw Input Limit	Resolution	Lowest Recommended Measurement @ 25°C	@ 25°C	@ 75°C	@ 125°C
0.01	200	0.004	2	200	100	66.67
0.02	400	0.008	4	400	200	133.33
0.05	1,000	0.02	10	1,000	500	333.33
0.10	2,000	0.04	20	2,000	1,000	666.67
0.20	4,000	0.08	40	4,000	2,000	1,333.33
0.50	10,000	0.2	100	10,000	5,000	33,33.33
1.00	20,000	0.4	200	20,000	10,000	66,66.67
2.00	40,000	0.8	400	40,000	20,000	13,333.33
3.00	60,000	1.2	600	60,000	30,000	20,000.00
5.00	100,000	2	1,000	100,000	50,000	33,333.33
10.00	200,000	4	2,000	200,000	100,000	66,666.67
20.00	400,000	8	4,000	400,000	200,000	133,333.33

HIGH RANGE MODE * - in microSiemens/cm

Range Scaling Factor 2,000

			Max Temp. Compensated Conductivity using 2% per°C Coefficient			
Cell Constant (K)	Max Raw Input Limit	Resolution	Lowest Recommended Measurement @ 25°C	@ 25 °C to 75°C	@ 125°C	@ 175°C
0.01	2,000	0.04	20	1000	666.67	500
0.02	4,000	0.08	40	2,000	1,333.33	1,000
0.05	10,000	0.2	100	5,000	3,333.33	2,500
0.10	20,000	0.4	200	10,000	6,666.67	5,000
0.20	40,000	0.8	400	20,000	13,333.33	10,000
0.50	100,000	2	1,000	50,000	33,333.33	25,000
1.00	200,000	4	2,000	100,000	66,666.67	50,000
2.00	400,000	8	4,000	200,000	133,333.33	100,000
3.00	600,000	12	6,000	300,000	200,000.00	150,000
5.00	1,000,000	20	10,000	500,000	3333,33.33	250,000
10.00	2,000,000	40	20,000	1,000,000	666,666.67	500,000
20.00	4,000,000	80	40,000	2,000,000	1,333,333.33	1,000,000

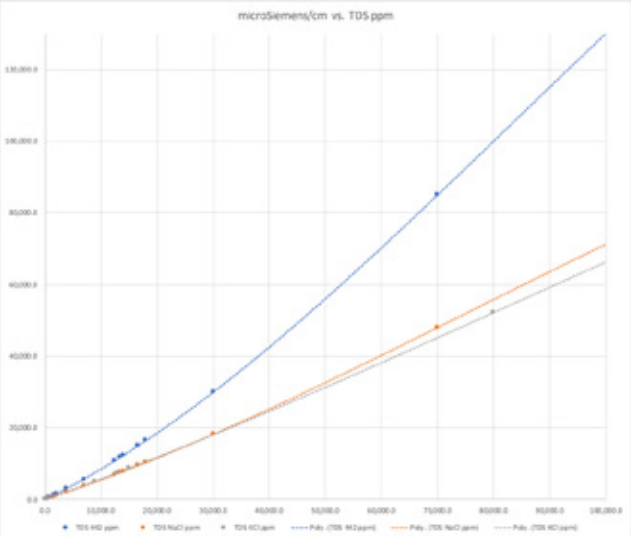
** Sensor can toggle between standard/high range mode range mode while in use. Standard/high range mode sensor is one configuration and associated sensor board hardware. Ultralow range mode sensor is a different configuration and associated sensor board. While you can toggle between standard and high range modes you cannot toggle between the standard/high and ultralow modes since these are two different sensor boards. Two slope calibrations are stored in dual mode standard/high sensors; slope low is used for the standard mode and slope high for the high mode. Slope calibrations are automatically assigned based upon range mode in use for sensor at time when calibration is performed. The ultralow range mode only uses the single low slope (slope high is unused).*

Conductivity Cell Constant and Available Range Modes for Smart DSS Sensors with RS-485

ULTRA-LOW RANGE MODE * - in microSiemens/cm

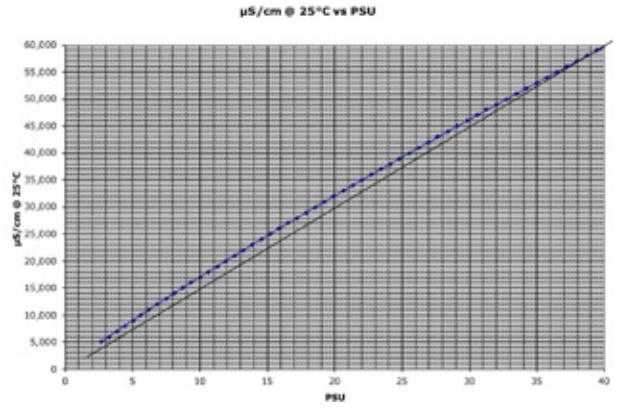
Range Scaling Factor 2

			Max Temp. Compensated Conductivity using 2% per °C Coefficient			
Cell Constant (K)	Max Raw Input Limit	Resolution	Lowest Recommended Measurement @ 25°C	@ 25°C	@ 75°C	@ 125°C
0.01	2	0.00004	0.02	2	1	0.667
0.02	4	0.00008	0.04	4	2	1.333
0.05	10	0.0002	0.1	10	5	3.333
0.10	20	0.0004	0.2	20	10	6.667
0.20	40	0.0008	0.4	40	20	13.333
0.50	100	0.002	1.0	100	50	33.333
1.00	200	0.004	2.0	200	100	66.667
2.00	400	0.008	4.0	400	200	133.33



Total dissolved solids (TDS) units are computed from measured conductivity. The curves that define relationship between the measured conductivity and user selectable total dissolved solid (TDS) units of NaCl, KCl or 442 are preprogrammed into sensor with full range of 0 to 100,000 ppm. The actual usable range may be limited by the choice of cell constant and range mode in which the sensor is operated.

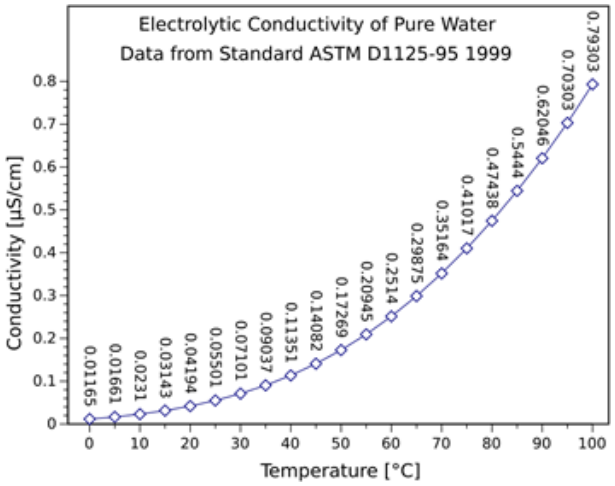
Other types of total dissolved solids (TDS) for other electrolytes or electrolyte mixtures can be programmed into the sensor on a special order basis (minimum order requirements apply for such special programming requests). Inquire to the factory if you have need for such special TDS units for your smart digital DSS Modbus RTU conductivity sensors.



Salinity computed from the measured conductivity. Curves that define the relationship between measured conductivity and the computed salinity in PSU are preprogrammed into the sensor with a full range of 0.000 to 50.000 PSU.

The actual supported range may be limited by cell constant and range mode used). Contact the factory to determine the most suitable sensor model and cell constant configuration for your desired salinity range of interest.

Ultralow Range Conductivity Sensors for Ultrapure Water (UPW)



The conductivity of pure water varies significantly with temperature in a well defined but non-linear fashion as detailed in the graph to left. This behavior is preprogrammed into the DSS-CON-L Modbus RTU conductivity sensors for the automatic temperature compensation feature to make it suitable for ultrapure water (UPW) type applications.

Although the recommended cell constant for performing conductivity measurement in UPW is K=0.01/cm for best resolution and lower bounds of measurement there may be situations where this K=0.01/cm cell constant cannot be used for the planned installation location because of limitations such as piping arrangement and low-flow. The higher cell constants of K=0.05/cm or K=0.10/cm can be used instead in such cases albeit they require the sample to be at a higher temperature to ensure best results. Table below details recommended minimum temperature for various cell constants for use in UPW. The minimum temperature for UPW measurement for each cell is determined based upon the lowest absolute conductivity value for which the cell constant is recommended & temperature at which this conductivity occurs for UPW. Resistivity are computed units are the inverse of the measured conductivity value.

ULTRA-LOW RANGE MODE - MicroSiemens/cm unless otherwise indicated

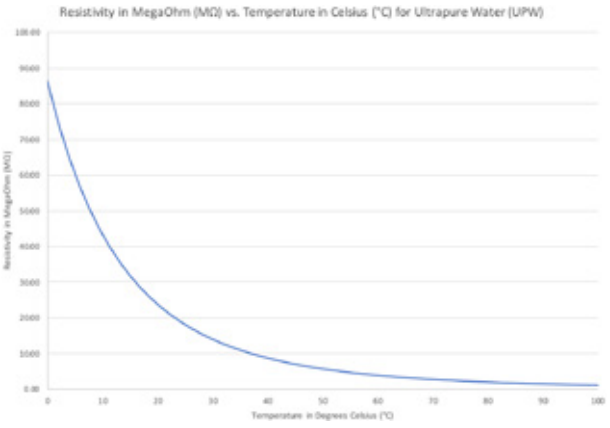
Range Scaling Factor 2

Cell Constant (K)	Raw Max Input @ 25°C	Resolution	Lowest Recommended Absolute Measurement	Minimum Temp °C *	Absolute MegaOhm (MΩ) @ Min Recommended °C *
0.01	2	0.00004	0.02	8	50
0.05	10	0.0002	0.1	40	10
0.10	20	0.0004	0.2	55	5

** Minimum recommended temperature is conductivity of UPW which is 1% of ultralow range mode for the given cell and the associated MegaOhm units. Measurements can be performed below the recommended minimum temperature with an associated higher uncertainty for those situations.*

For ultralow range conductivity sensors the 5th read input register (30005) sends the computed resistivity MegaOhm (MΩ) using the user defined linear automatic temperature compensation (ATC) while the 6th read input register (30006) sends computed resistivity MegaOhm (MΩ) using the special non-linear ultrapure water style automatic temperature compensation. The resistivity values sent as 0 to 50,000 steps corresponding to 0.000-50.000 MegaOhm (MΩ) for both the 5th (30005) & 6th (30006) read input registers. Theoretical temperature compensated resistivity value can never go above 18.18 MegaOhm (MΩ) for uncontaminated pure water since this is the ideal value at 25 degrees celsius.

Temperature compenated conductivity and resistivity are referenced back to the 25 °C condition for all ATC. Ultrapure water with no contaminants has a value of 0.055 µS/cm conductivity or 18.18 MΩ in resistivity. The most common units for measurement of pure water is resistivity (MΩ) MegaOhm due to high resolution and convenient scaling in the very low conductivity levels. Temperature compensated conductivity and computed resistivity values sent for the ultralow range mode smart digital DSS-CON-L style Modbus RTU conductivity sensors as well as the raw conductivity.



Graph above shows relationship between the resistivity of pure water at various temperatures. Computed resistivity MegaOhm (MΩ) units are the inverse of measured conductivity and so are the mirror image of the conductivity at various temperatures for ultrapure water (UPW). The graph above shows absolute raw resistivity at various temperatures. Resistivity values sent include ATC referencing reading to 25 °C state.

TURTLE TOUGH