TURTLE TOUGH

FIELD INSTALLATION GUIDE

DSS Direct Smart MODBUS RTU Sensors Interfaced Directly with Customer Supplied PLC

turtletoughsensors.com

This installation guide provides instructions on how to commission the DSS Direct Smart RS-485 MODBUS RTU Sensors directly to your own PLC, SCADA or other data acquisition and process control equipment.

ⓘ Note:

Instructions for commissioning DSS Direct Smart MODBUS RTU Sensors with Turtle Tough DSS touchscreen controllers is detailed in the relevant portions of DSS operation manuals. Refer to DSS operation manuals instead of this installation guide when the DSS Sensors are used with the Turtle Tough DSS touchscreen controllers. DSS touchscreen controllers software framework can serve as roadmap to implement desired functionality on your own PLC.

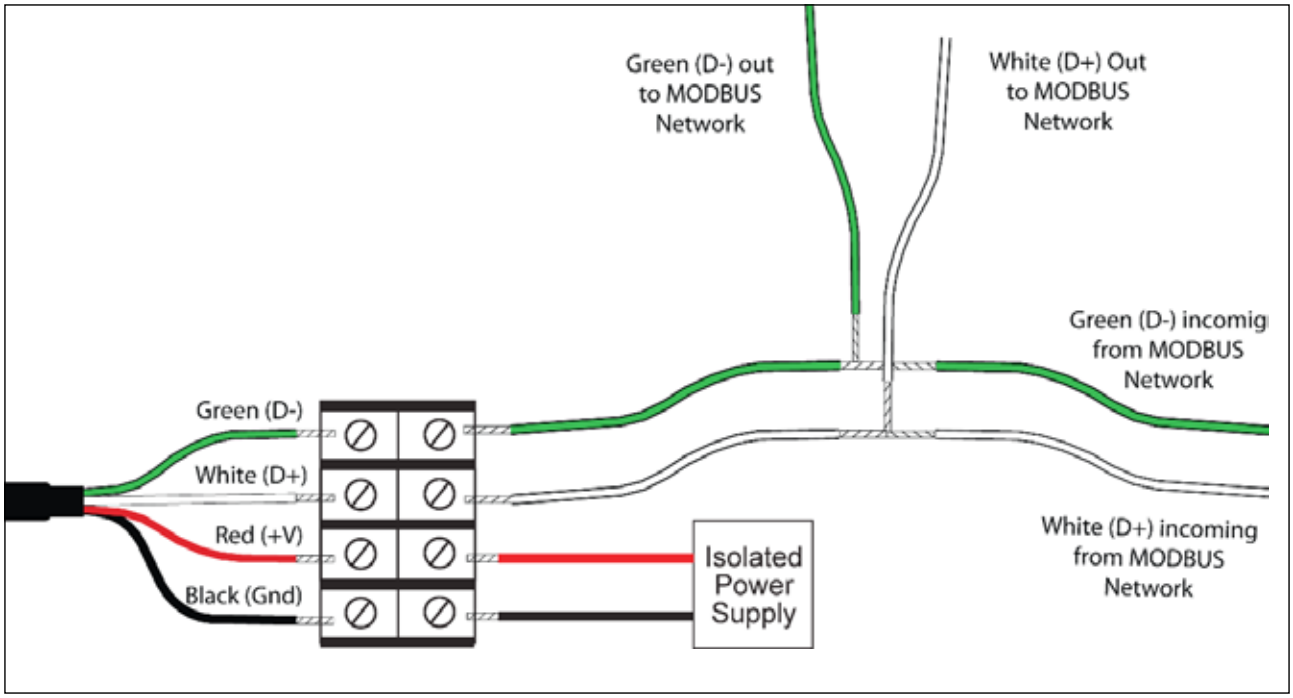
Installation of the DSS RS-485 MODBUS RTU Sensor slaves with your own RS-485 MODBUS RTU master requires:

1. Data acquisition or control device that has an isolated RS-485 input dedicated for use with only the DSS Sensors
2. There must exist an isolated and regulated 9VDC or 12VDC power supply dedicated to energize the DSS Sensors

The DSS Sensors can operate normally from 7VDC to 13VDC at the Sensor board. The 9VDC or 12VDC power supply that energizes the DSS Sensor should either be altogether dedicated to this purpose!

Alternatively a DC/DC converter & isolator can be employed to completely separate the DC ground connected to the DSS Sensors from all other equipment at site.

In addition to providing an isolated and regulated DC power supply to energize the DSS Sensors such DC/DC converter typically operate over a wide range of voltages such as 9VDC to 36VDC to allow for flexibility of installation at sites with various non-isolated and non-regulated DC power sources.



FIELD INSTALLATION NOTES REGARDING POWER:

The isolated power supply can be used to energize more than one DSS Sensor. The black ground leads and red +V leads can be bridged into the same terminal on the isolated power supply. The two main caveats apply when using the isolated power supply to power more than one DSS Sensor:
▶Isolated power supply is dedicated to power DSS Sensors & not connected to any other equipment at site.
▶The total max load of the isolated power supply used is not exceeded. Please refer to the max current consumption for each DSS Sensor to be energized to ensure that the load limit is not exceeded. Typically as many as up to 50 each DSS Sensors can be powered from a typical power supply module.

- It is possible to have remote installations that are powered from a single isolated power supply by using a four conductor cable to carry the D+ & D- modbus communications (white & green leads, respectively) as well as carrying the power connections for the DC ground & +V to energize remote DSS Sensors (black & red, respectively). Voltage drop due to cable resistance should be considered in these type of cases (contact factory for assistance).

INITIAL COMMISSIONING STEPS:

- The DSS MODBUS Direct Smart Sensor must have the correct baudrate assigned to interface with the rest of the network. Please check your field installation and properly assigned the baudrate as either 9,600 or 19,200 kbps using the handheld communicator or DSS Windows software.

- The DSS MODBUS Direct Smart Sensor must have a valid unique node address assigned to be able to interface with the rest of the network. Use the handheld communicator or DSS Windows software to assign the node address before installing the Sensor into the network.
  ▶The assignment of the baudrate and node address can only be accomplished by the handheld communicator or free DSS Windows software. Please note both values for setup on your PLC.

GENERAL NOTES:

- DSS Sensors operate to 610 metres (2,000 feet) with 9VDC or 1,000 metres (3,280 feet) with 12VDC power supply.

- The total distance can be achieved using either Turtle Tough supplied NEMA 6P rated connect extension cables or else permanently wired from a junction box (see later sections of this guide). Keyed connect termination of the Direct Smart DSS Sensors make improper wiring impossible in the field after proper initial commissioning.

- The ability to perform actions remotely is made possible in the Direct Smart DSS Sensors by the ability to run very long cable lengths and modbus calls to perform all calibration and configuration functions as well as to obtain extensive diagnostic and analytic information on the installed Sensor.

CALIBRATION & SETUP OF DSS SENSORS

- Only DSS Windows software allows you to search & change the node address & baudrate of the DSS Sensor.
  ▶All baudrates for all MODBUS devices on the same network must match.

- The DSS MODBUS Direct Smart Sensors store all information from calibrations in non-volatile EEPROM allowing for full portability and hot-swap capability between installation points so long as the baudrate & nodes are matched.

- Calibration of DSS Sensors can be performed with battery-powered handheld DSS communicator or DSS Windows software. Handheld communicator provides the power to energize the DSS Sensors during calibration.

- If all calibrations are performed with either the Turtle Tough supplied handheld communicator or DSS Windows software then just the the simple read_input_registers MODBUS function call 04 is required to receive calibrated and temperature compensated process values from the DSS Direct Smart Sensors.

- All DSS Sensors can be calibrated by implementation of the “READ/WRITE Type”

parametres using MODBUS function codes (03) and (16) in your given PLC, SCADA or data acquistion device.

▶ To perform inline offset adjustments for the process reading and/or temperature without removing the Sensor from field service at any point in time this type of calibration would needed to be performed from the connected PLC either with a local or remote HMI.

▶ Alternatively a field junction box switching scheme can be employed to perform such inline offset adjustment from the handheld communicator (Sensor temporarily goes offline in this approach).

▶ If PLC has remote access via ethernet or wireless gateway offset calibration to Sensor can be made offsite.

▶ Ability to perform remote offset calibrations desirable if grab sample is analyzed in an offsite lab.

- Diagnostic information such as the days in use since the given calibration was performed, total days in field use (energized), as well as the maximum & minimum temperature experienced in use are stored inside the sensor as well as factory assigned information such sensor serial number, item number and software revision.

- There exists certain adjustable parametres such as the dampener (time averaging of process reading) and delay from boot to send process values that can be optimized for the given installation location and application.

BASE DSS SENSOR CONFIGURATION:

- All DSS style Sensors come standard with male quick connect. Standard integral cable length is 6 metres (20 feet).
- Shorter 3 metres (10 feet) or 1.5 metres (5 feet) integral sensor cable lengths also terminating with male quick connect available for same price as standard 6 meter (20 foot) length. Specify shorter lengths by –DSS-1.5m or –DSS-3.0m. If standard –DSS option is invoked sensor is supplied with standard 6 metres (20 feet) of cable & male quick connect.
- **12 metres (40 feet) integral sensor cable with male quick connect available as special order option (-DSS-12m).**

Best practice is to always use the well stocked standard Sensor cable lengths and cable extension options to ensure the lowest cost and best availability of any given installation. Longer non-standard cable lengths can be achieved by using **special order options** although this may lead to longer lead times.

For assistance with best practice commissioning inquire, email Turtle Tough to info@turtletoughsensors.com

FIELD INSTALLATION SCHEMES
- PART 2 -

GENERAL COMMENTS:

All connections are NEMA 6P rated waterproof and corrosion-resistant when interfaced and sealing caps are provided for all connector that should be installed when not in use or when cable is being pulled through conduit. Longer cable runs can be achieved by interfacing the tinned lead wire terminations from the female quick connect to tinned lead extension cables across any suitable junction box installed into a waterproof J-Box enlcosure assembly using proper cable sealing glands as needed.

Alternatively a Turtle Tough supplied junction box assembly where the male quick connect can be directly interfaced can be employed and extension cable wired from the terminal block inside. Since all DSS Sensors are terminated with a male quick connect, at some point in the installation scheme a female to tinned lead type extension cable or junction box must be employed.

Any combination of female quick connect to male quick connect and female quick connect to tinned lead extension cables can be used so long as the total maximum cale length permissible for the power supply used and sensor type is not exceeded.

Detailed below standard and special order cable length installation options using the DSS platform.

Female to Male Quick Connect Cable Extension Options

3 metres (10 feet)	DSS4F-3m-DSS4M
6 metres (20 feet)	DSS4F -6m-DSS4M
12 metres (40 feet)	DSS4F-12m-DSS4M
24 metres (80 feet)*	**DSS4F-24m-DSS4M Special Order Option Only**

Female Quick Connect to Tinned Leads Cable Extension Options

1.5 metres (5 feet)	DSS4F-1.5m-TL
3 metres (10 feet)	DSS4F-3m-TL
6 metres (20 feet)	DSS4F-6m-TL
12 metres (40 feet)*	**DSS4F-12m-TL Special Order Option Only**

Possible total cable lengths using selected example installation approaches

INSTALLATION APPROACH # 3

DSS Sensors with integral cable terminated with male quick connect and one (1) each female quick connect to tinned leads cable extension cable employed (simplest OEM made installation scheme):

	+1.5 metres	+3 metres	+6 metres	+12 metres
With 1.5m (5ft) integral sensor cable:	3m (10 feet)	4.5m (15 feet)	7.5m (15 feet)	13.5m (45 feet)*
With 3m (10ft) integral sensor cable:	4.5m (15 feet)	6m (20 feet)	9m (30 feet)	15m (50 feet)*
With 6m (20ft) integral sensor cable:	7.5m (15 feet)	9m (30 feet)	12m (40 feet)	18m (60 feet)*
With 12m (40ft) integral sensor cable:	9m (30 feet)*	12m (40 feet)*	18m (60 feet)*	24m (80 feet)*

INSTALLATION APPROACH # 3 SPECIAL

DSS Sensors with integral cable terminated with male quick connect and one (1) each female quick connect to male quick connect extension cable & one (1) each female quick connect to tinned leads extension cable

	+4.5 metres	+9.0 metres	+18 metres	+36 metres
With 1.5m (5ft) integral sensor cable:	6m (20 feet)	10.5m (35 feet)	19.5m (65 feet)	37.5m (125 feet)*
With 3m (10ft) integral sensor cable:	7.5m (25 feet)	12m (40 feet)	21m (70 feet)	39m (130 feet)*
With 6m (20ft) integral sensor cable:	10.5m (35 feet)	15m (50 feet)	24m (80 feet)	42m (140 feet)*
With 12m (40ft)* integral sensor cable:	16.5m (55 feet)*	21m (70 feet)*	30m (100 feet)*	48m (160 feet)*

ⓘ INSTALLATION APPROACH # 3 SPECIAL NOTES:

+4.5 metres uses 1 each DSS4F-3m-DSS4M quick connect to bridge & 1 each DSS4F-1.5m-TL quick connect to tinned lead extension cables

+9.0 metres uses 1 each DSS4F-6m-DSS4M quick connect to bridge & 1 each DSS4F-3m-TL quick connect to tinned lead extension cables

+18 metres uses 1 each DSS4F-12m-DSS4M quick connect to bridge & 1 each DSS4F-6m-TL quick connect to tinned lead extension cables

+36 metres uses 1 each DSS4F-24m-DSS4M quick connect to bridge & 1 each DSS4F-12m-TL quick connect to tinned lead extension cables

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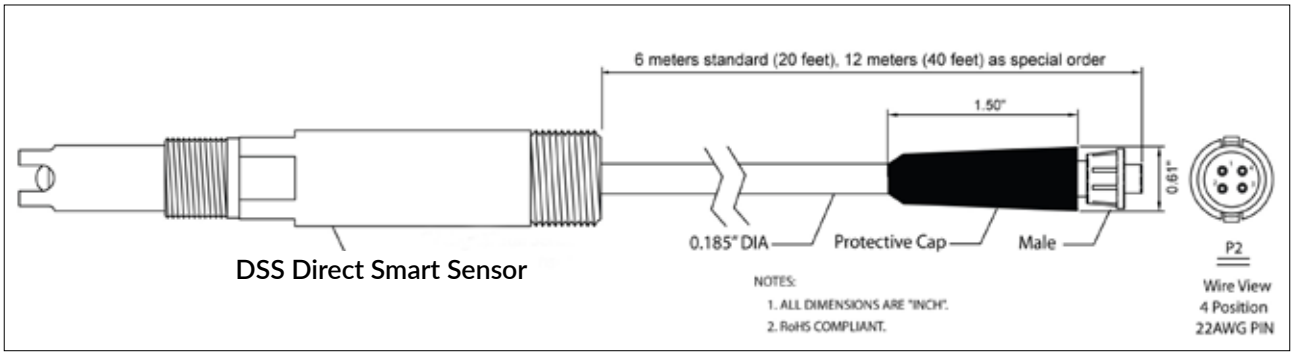
ⓘ SPECIAL ORDERS: Items denoted in GREEN are special orders.

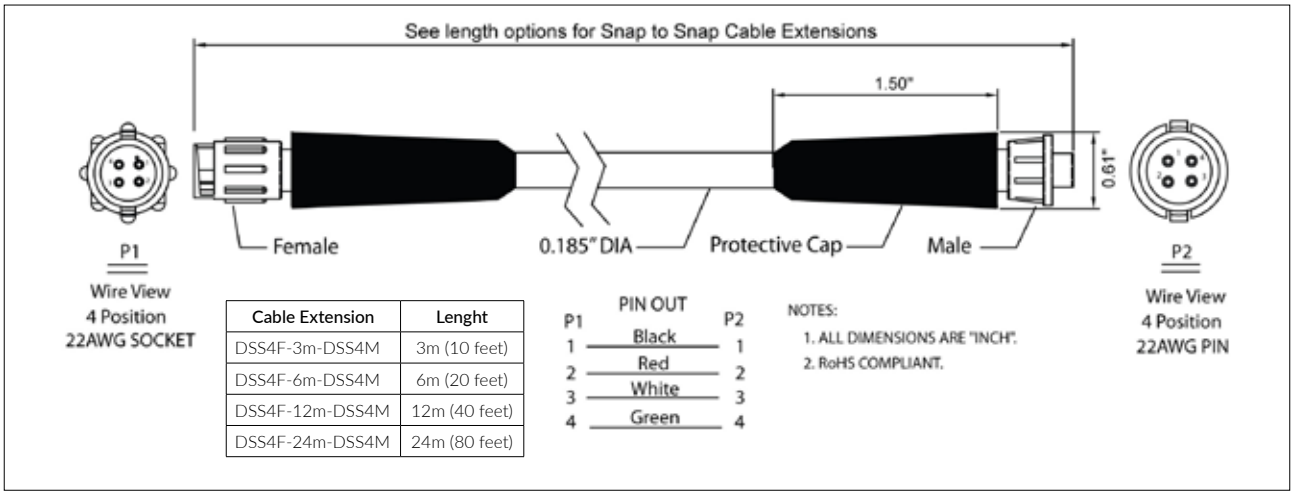
This means that there may be limited availability and/or extended lead times for purchase of these items or to invoke these options. For further details contact Turtle Tough factory to info@turtletoughsensors.com or your distributor.

FIELD INSTALLATION SCHEMES
- PART 3 -

Detail drawing for standard Direct Smart DSS Sensor male quick connect cable termination (-DSS-Xm)

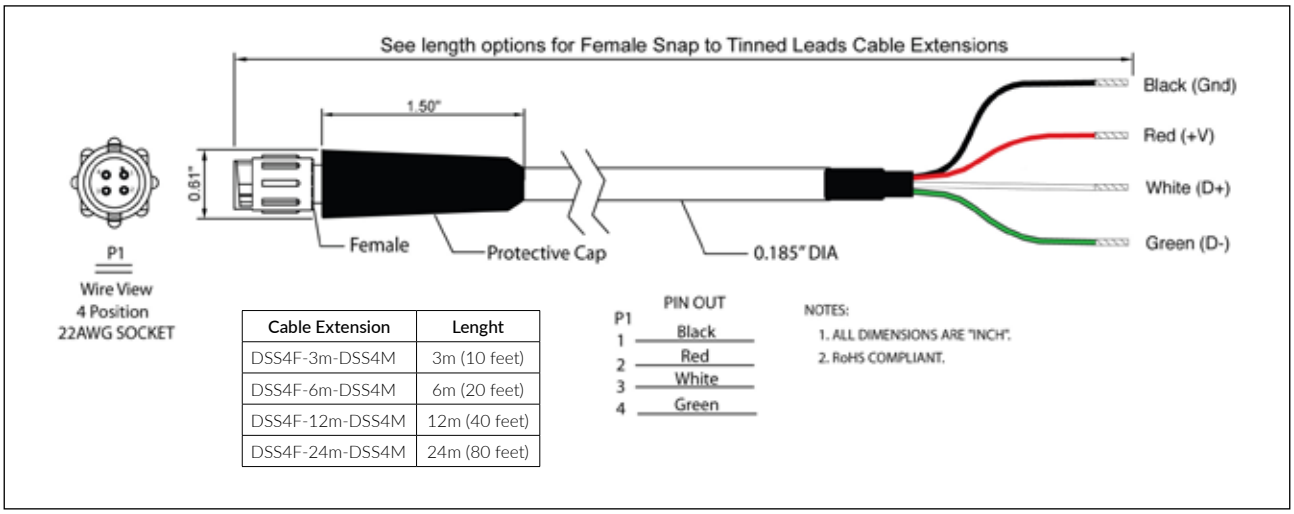


Detail drawing for female quick connect to male quick connect DSS4F-Xm-DSS4M cable extensions:



Cable Extension	Lenght
DSS4F-3m-DSS4M	3m (10 feet)
DSS4F-6m-DSS4M	6m (20 feet)
DSS4F-12m-DSS4M	12m (40 feet)
DSS4F-24m-DSS4M	24m (80 feet)

Detail drawing for female quick connect to tinned leads DSS4F-Xm-TL cable extensions:



Cable Extension	Lenght
DSS4F-3m-DSS4M	3m (10 feet)
DSS4F-6m-DSS4M	6m (20 feet)
DSS4F-12m-DSS4M	12m (40 feet)
DSS4F-24m-DSS4M	24m (80 feet)

ⓘ **IMPORTANT NOTE:** *Contact Turtle Tough factory for proper wiring to your data acquisition, SCADA, PLC or other control device/system* ***BEFORE*** *commissioning installation with the DSS Direct Smart Sensor.*

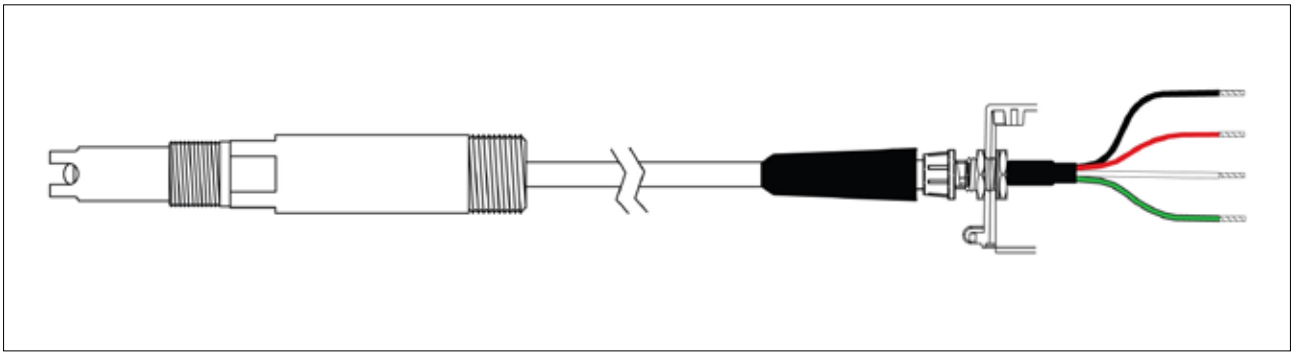
FIELD INSTALLATION SCHEMES
- PART 4 -

ⓘ *The designations for red, black, white & green colored leads from the DSS Sensors are detailed the previous page of this installation guide. Care should be taken when making connections from these leads to follow the best practice installation scheme to avoid damaging the DSS Sensor. It is recommended to inquire to factory for assistance.*

Approach 1

Assembly drawing for installation using the Turtle Tough supplied junction box assembly (See page 4)

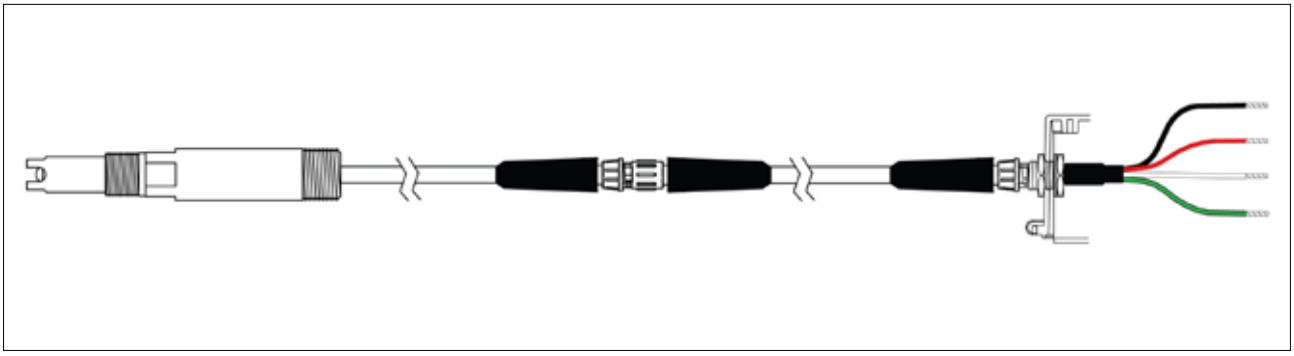
Direct Smart DSS Sensor with male quick connect interfaced directly to female panel mount connect that has been installed into enclosure assembly. This approach requires max distance between sensor & transmitter is no more than 6 metres (20 feet) for standard digital DSS Sensors or 12 metres (40 feet) for the special order longer cable version.



Approach 2

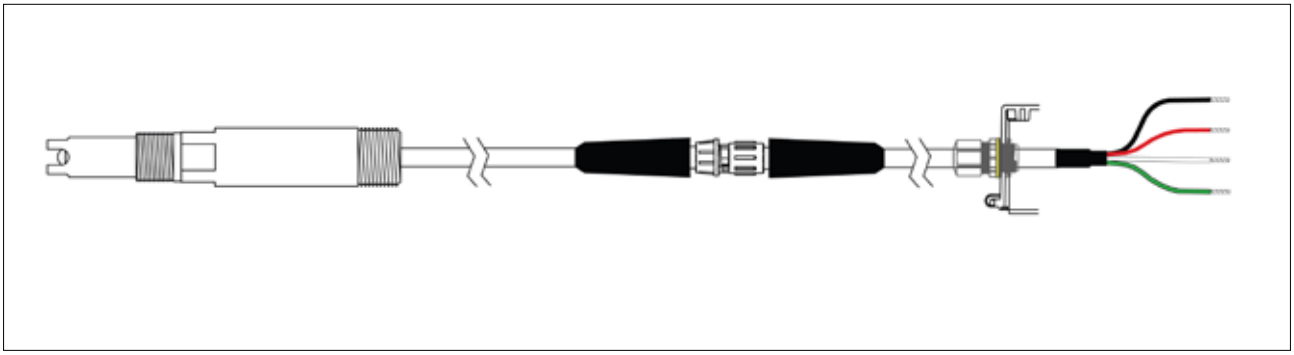
Assembly Drawing for Installation Using the Turtle Tough supplied junction box assembly (See Page 4)

Direct Smart DSS Sensor terminated with male quick connect is bridged with connect to connect (DSS4F-Xm-DSS4M) cable extension which is interfaced to female panel mount connect that has been installed into enclosure assembly. Multiple connect-to-connect extension cables can be employed as desired at time of commissioning or thereafter.



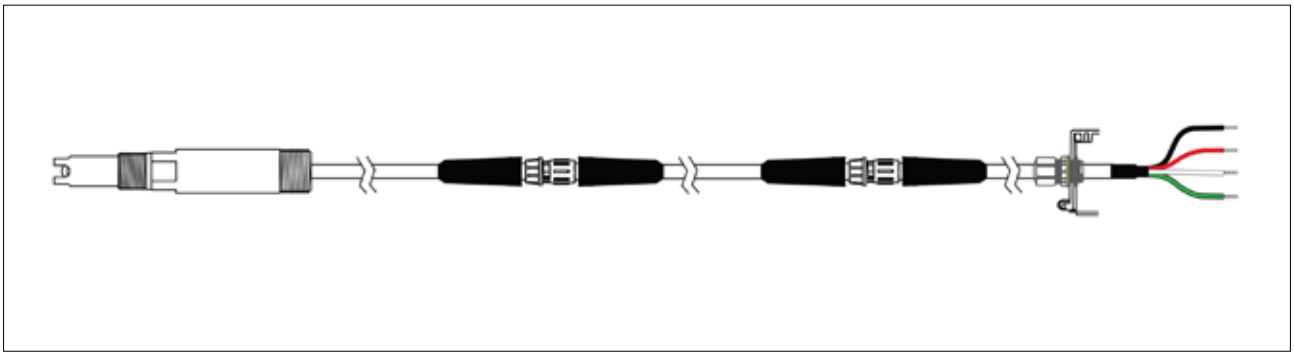
Approach 3
Assembly drawing for installation

Direct Smart DSS Sensor terminated with male quick connect is bridged with connect to tinned leads (DSS4F-Xm-TL) cable extension. The tinned leads are interfaced to PLC & sealing cable gland is installed in enclosure assembly to secure the cable. This approach is typically used for OEM made installations where a cable gland has already been installed.



Approach 3 (Special)
Assembly drawing for installation

Direct Smart DSS Sensor terminated with male quick connect is bridged with both connect to connect (DSS4F-Xm-DSS4M) cable extension and connect to tinned leads (DSS4F-Xm-TL) cable extensions. The tinned leads are interfaced to PLC terminals and sealing cable gland is installed in enclosure assembly. See page 1 for details on terminal assignments.



APPROACH 1 & 2

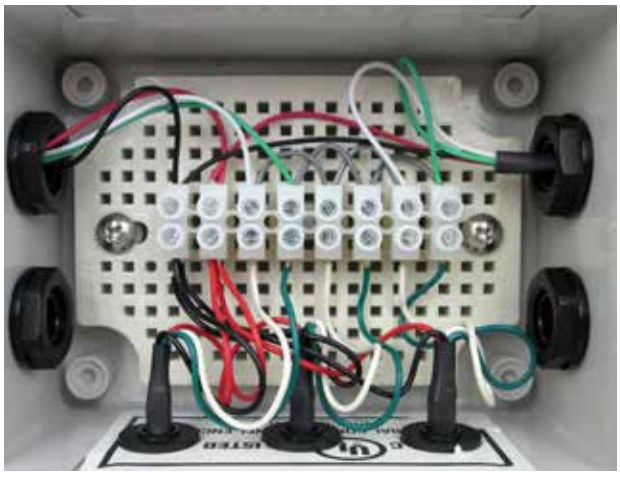
Field installation employing DSS4FP panel mount connect for Direct Smart DSS Sensors using junction box assemblies to support long cable runs if necessary

1MF-3EA-DSS4FP-DSS-4EA-SCG

Triple Input Junction box without integral power supply

- 3 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from Sensor or cable extension
- 1 each eight (8) pole terminal strip to connect power and communication leads for up to 3 each Sensors
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals

Four (4) conductor cable carries both modbus communications as well as power connections to energize the connected DSS Sensors. Suitable isolated power supply is located remote to installation in this scheme. Versions of this assembly with just one or two input ports are also available where the maximum supported number of DSS Sensors that can be interfaced is three (3) each for this size junction box assembly. Sensors can be connected and disconnected at will without the need to power down.Timeout error may occur for the connected PLC if the Sensor is removed from network and so some type of hold functionality should be implemented to allow for servicing of the Sensor for cleaning and recalibration as it may be required.



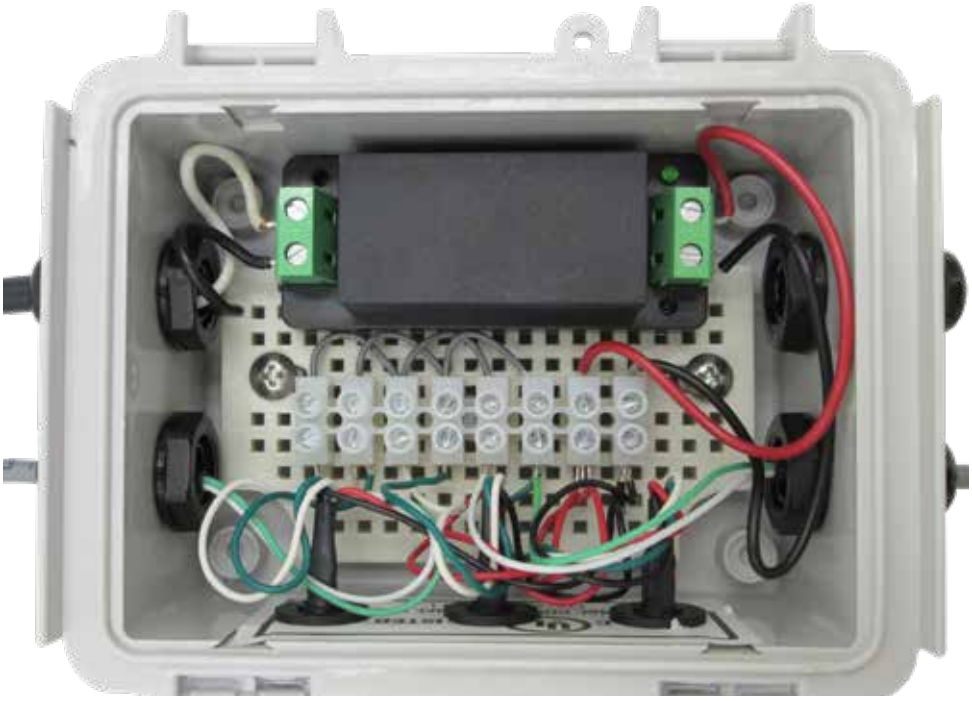
Wiring detail for the three sensor input lead terminations as well as the input and output cables of the MODBUS network.

1MF-3EA-DSS4FP-DSS-4EA-SCG-PS12

Triple Input Junction box for 85-265 VAC line powered operation

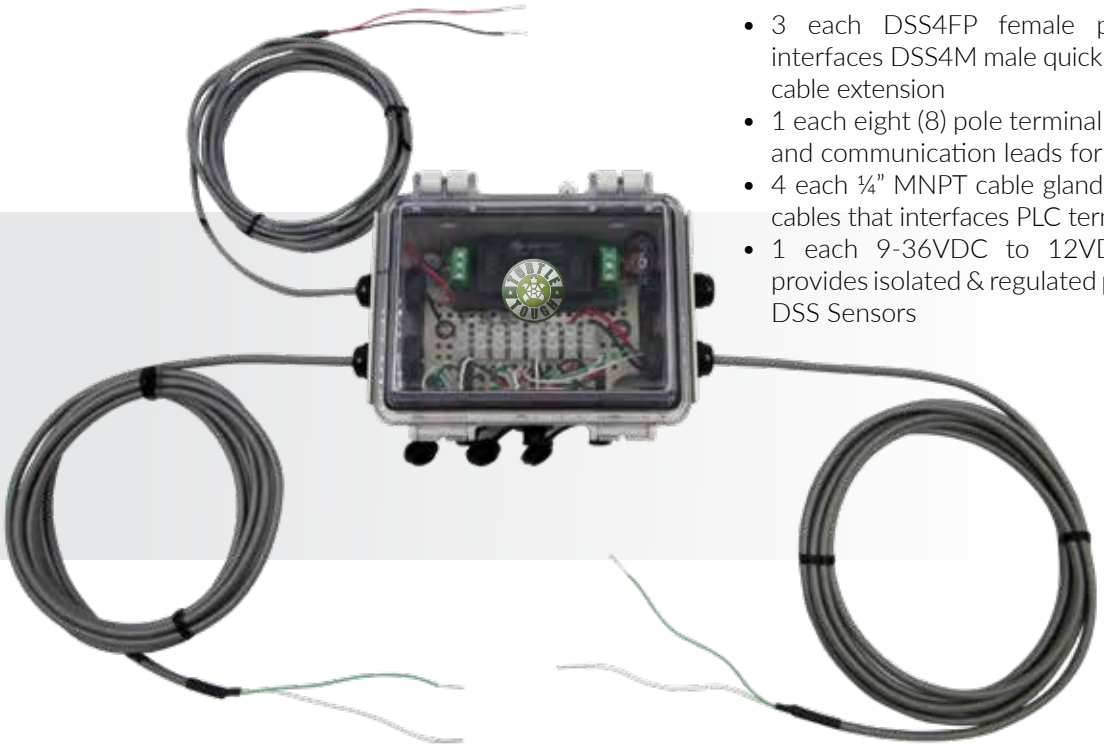
- 3 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from sensor or cable extension
- 1 each eight (8) pole terminal strip to connect power and communication leads for up to 3 each sensors
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals
- 1 each 85-265 VAC to 12VDC transformer to provides isolated & regulated power for up to 100 each DSS Sensors

ⓘ *AC power cord is used to allow for operation from 85 to 265 VAC. The isolated & regulated 12VDC power supply can be sent out to remote external additional junction boxes to power additional DSS Sensors so long as the max load rating is not exceeded. Note that the incoming and outgoing cables for the modbus network only carry the D+ (white) and D- (green) communications as the power is provided from integral transformer.*



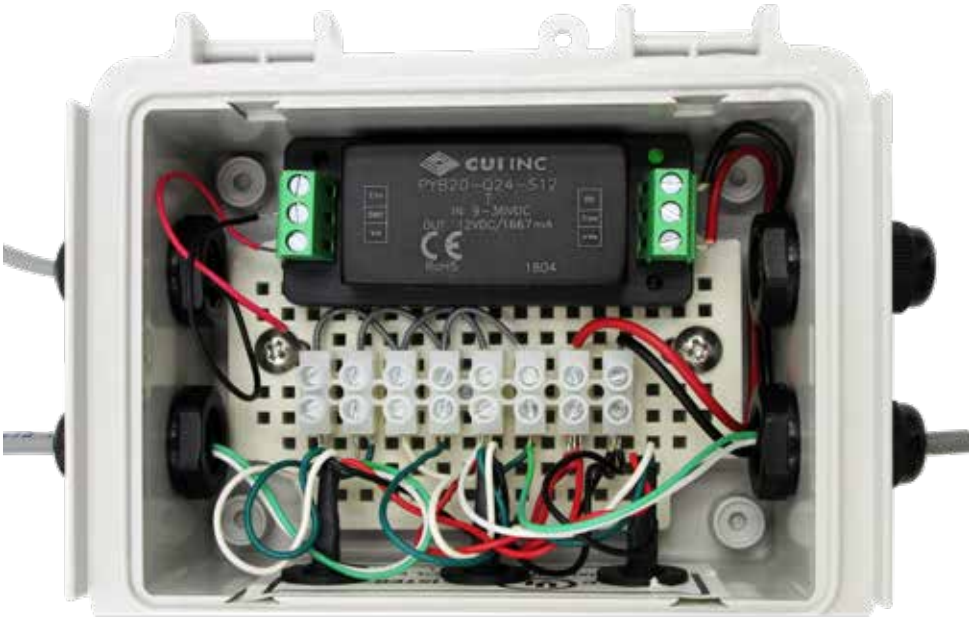
1MF-3EA-DSS4FP-DSS-4EA-SCG-PSDC12

Triple Input Junction box for 9VDC to 36VDC power operation



- 3 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from sensor or cable extension
- 1 each eight (8) pole terminal strip to connect power and communication leads for up to 3 each sensors
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals
- 1 each 9-36VDC to 12VDC DC/DC converter provides isolated & regulated power for up to 80 each DSS Sensors

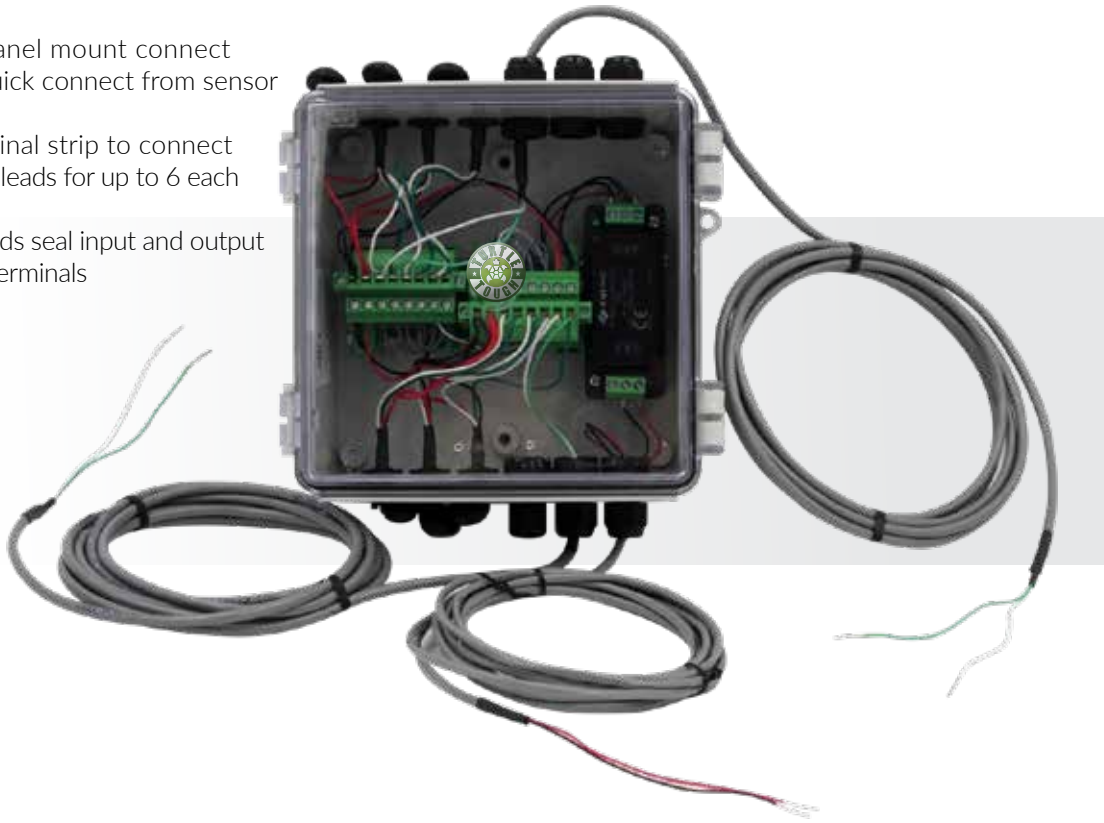
ⓘ *This bridge box allows for operation from 9 to 36 VDC from a non-isolated power source. Isolated & regulated 12VDC power supply can be sent to remote additional bridge boxes to power more DSS sensors so long as the max load rating is not exceeded. Note that the incoming and outgoing cables for the modbus network only carry the D+ (white) and D- (green) communications as the power is provided from integral transfomer.*

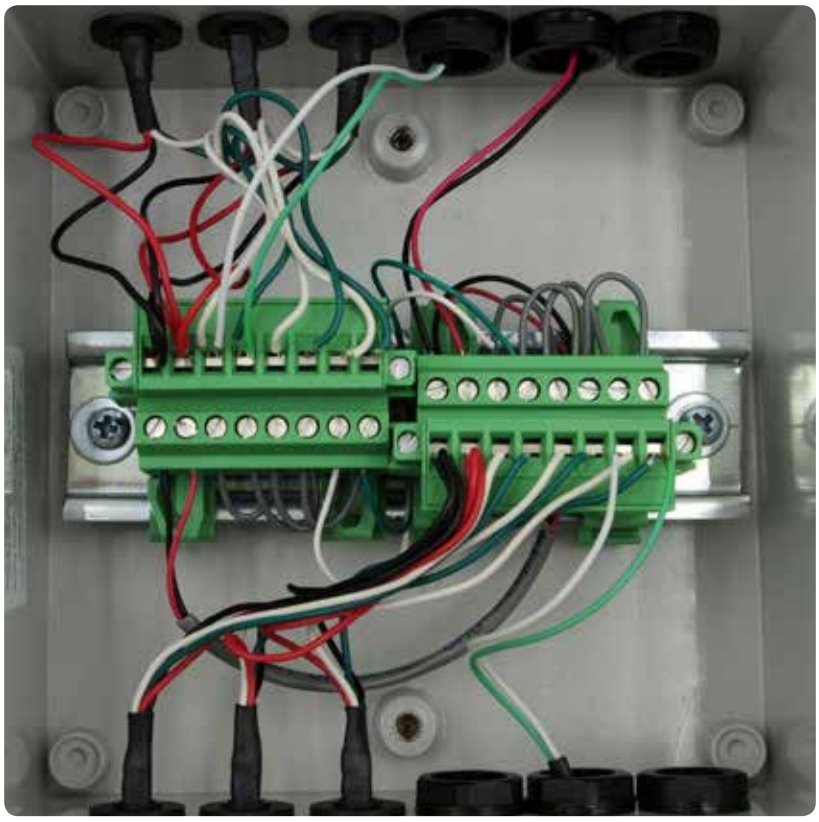


3MF-6EA-DSS4FP-DSS-4EA-SCG

Six (6) Channel Input Junction box without integral power supply

- 6 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from sensor or cable extension
- 2 each eight (8) pole terminal strip to connect power and communication leads for up to 6 each sensors
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals



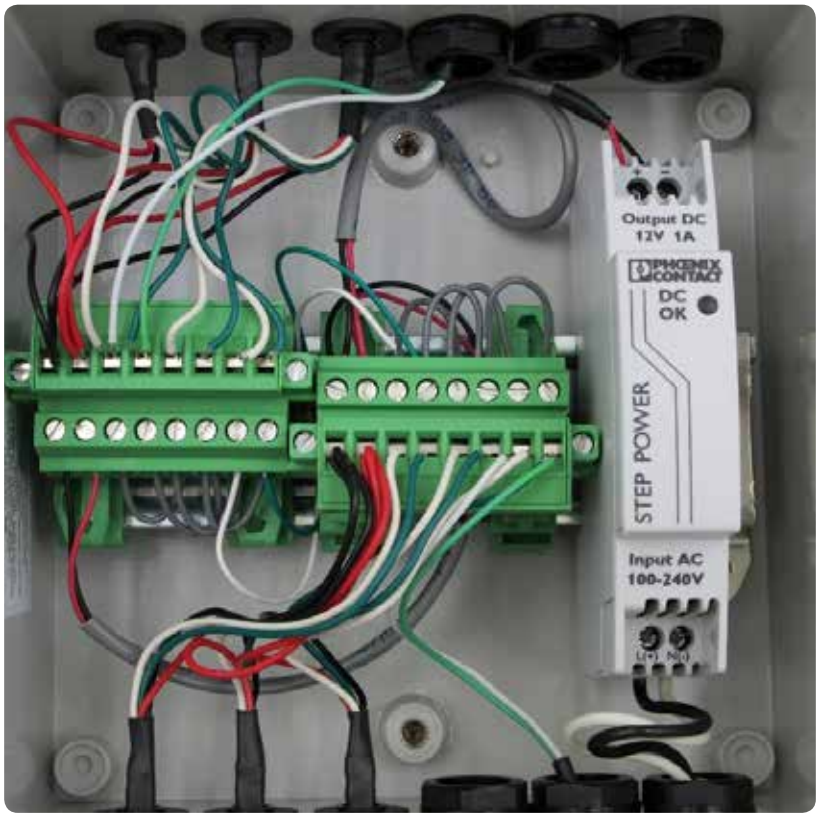


(Special order 6 each shown in photo above)

3MF-6EA-DSS4FP-DSS-4EA-SCG-PS12

Six (6) Channel Input Junction box for 85-265 VAC line powered operation

- 6 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from sensor or cable extension
- 2 each eight (8) pole terminal strip to connect power and communication leads for up to 6 each sensors in total
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals
- 1 each 85-265 VAC to 12VDC transformer to provides isolated & regulated power for up to 50 each DSS Sensors

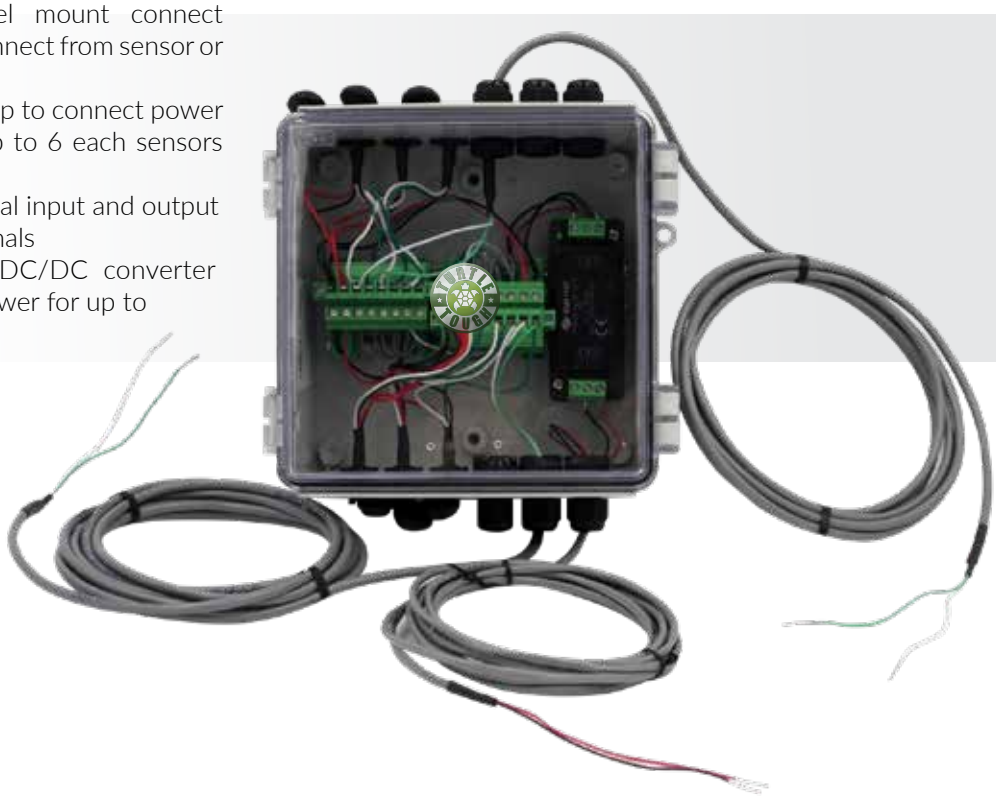


(Special order 6 each shown in photo above)

3MF-6EA-DSS4FP-DSS-4EA-SCG-PSDC12

Six (6) Channel Input Junction box for 9VDC to 36VDC power operation

- 6 each DSS4FP female panel mount connect interfaces DSS4M male quick connect from sensor or cable extension
- 2 each eight (8) pole terminal strip to connect power and communication leads for up to 6 each sensors in total
- 4 each ¼" MNPT cable glands seal input and output cables that interfaces PLC terminals
- 1 each 9-36VDC to 12VDC DC/DC converter provides isolated & regulated power for up to 80 each DSS sensors

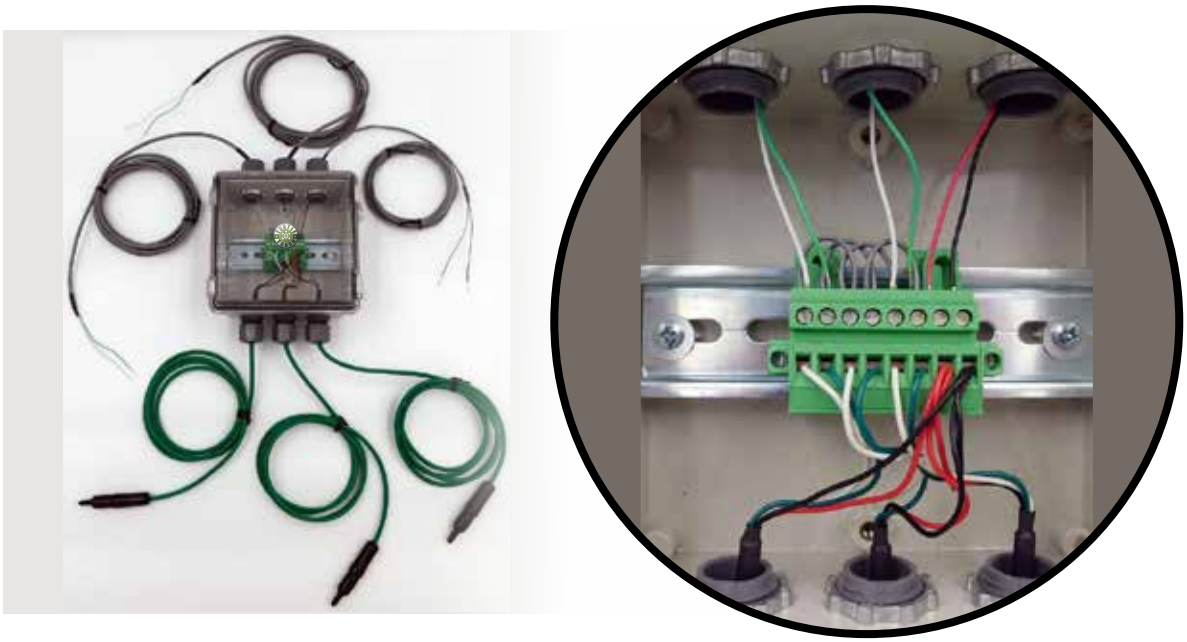


(Special order 6 each shown in photo above)

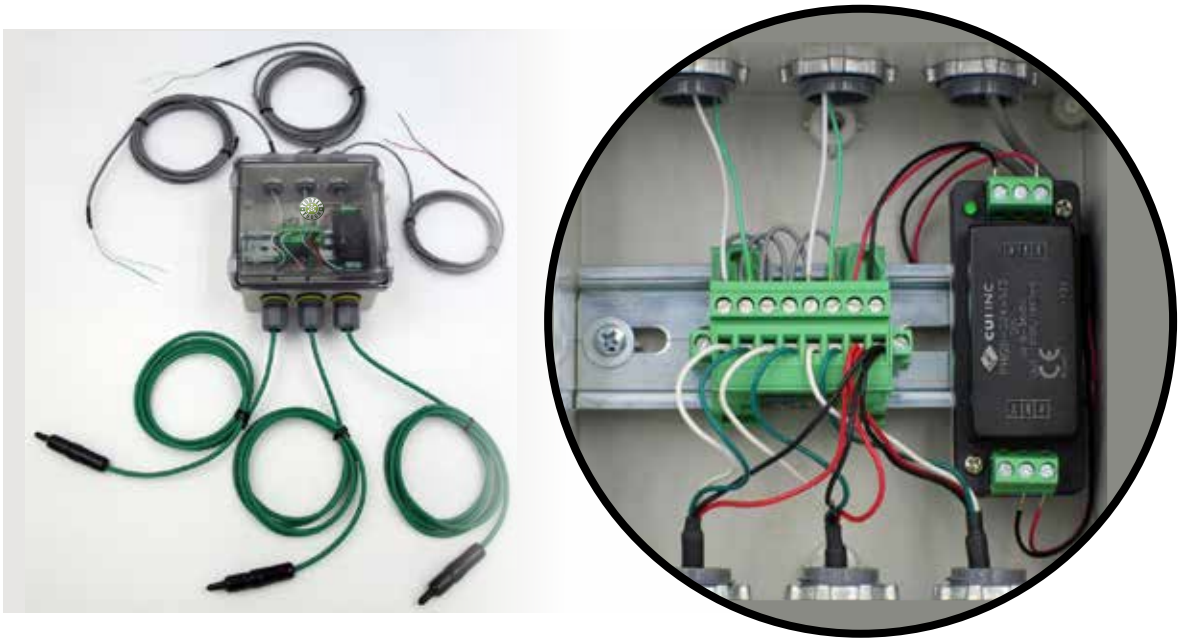
APPROACH 3

Installation using female connect to tinned leads extension cables (DSS4F-XM-TL) for Direct Smart DSS sensors as inputs connecting to RS-485 MODUS RTU PLC network

ISOLATED 9VDC OR 12VDC
POWER CONFIGURATION



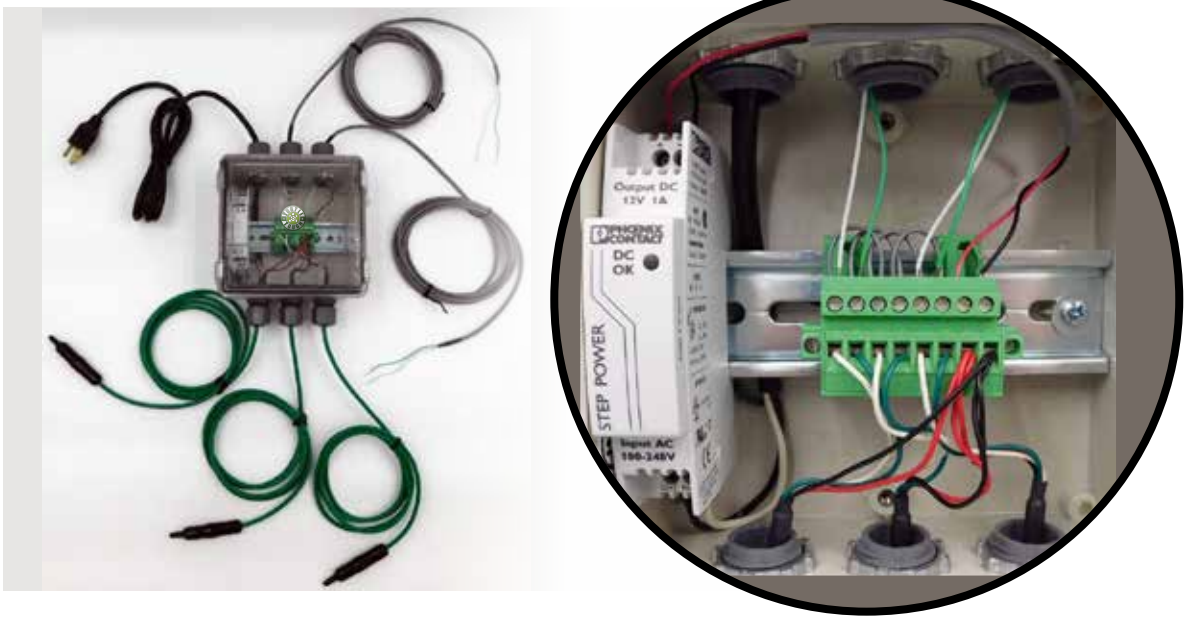
NON-ISOLATED UNREGULATED 9 TO 36 VDC
POWER CONFIGURATION



APPROACH 3 (Special)

Field Installation using female snap to tinned leads extension cables (DSS4F-Xm-TL) for Direct Smart DSS Sensors as inputs connecting to RS-485 MODUS RTU PLC network

85-265 VAC LINE
POWER CONFIGURATION



ⓘ NOTES:

* Both the DC/DC converter and AC transformer power configuration provide isolated & regulated 12VDC power with max 1,000mA load rating allowing for up to 50 each DSS Direct Smart MODBUS RTU industrial Sensors to be simultaneously energized from one power module.

* Larger NEMA 4X boxes are available if more than 3 each DSS Sensors are to be supported at a given installation site. Please inquire for alternate enclosure assembly configurations for these needs.

* The junction box assemblies as visualized from the photos above can be supplied complete by Turtle Tough if desired or else fabricated independently. Inquire to factory if you plan to build your own assemblies (Turtle Tough factory would supply only the female quick connect to tinned lead extension cables in such situations)

* Shortest 1.5 meter (5 feet) female quick connect to tinned lead extension cables shown in photos above. Longer 3 meter (10 feet), 6 meter (20 feet) or 12 meter (40 feet) female quick connect to tinned lead extension cables are also available as standard order items (other lengths are special order items). Long cable lengths for field installations can be achieved by using a combination of bridging connect to connect extension cables in conjunction with the terminating female quick connect to tinned lead extension cables with the installation approach # 3 special type scheme.

* Modbus network in and modbus network out cable connections shown with white leads as D+ and green leads as D- signals. DC power configurations are shown with black leads as the ground and red leads as the V+ connections.

TROUBLESHOOTING GUIDE & FREQUENTLY ASKED QUESTIONS

ⓘWARNING!

The communicator used for calibration & configuration is ONLY for use with genuine Turtle Tough supplied Direct Smart DSS MODBUS Sensors. Connecting any other sensor may permanently damage the communicator or sensor. If there should be any doubt as to whether you are connecting a genuine Turtle Tough supplied DSS digital Sensor and/or mating communicator please inquire to the Turtle Tough factory for verification.

The Direct Smart DSS MODBUS Sensors are designed for a seamless and simple plug and play type operation with the universal handheld communicator for calibration, configuration & obtaining diagnostic information. The handheld communicator will automatically recognize the type of sensor that is connected and load the appropriate options for each LED mode in use once the node address is entered. If the node address of the DSS Sensor is not known the DSS Windows software should be used to scan for this information (please refer to the respective manuals for instructions on use). In the unlikely event that an exception occurs a variety of diagnostic information may be displayed in the form of error codes reported on the communicator display. Instructions about what should be done if any of these error codes or diagnostic messages are displayed can be provided by the Turtle Tough factory in the unlikely event that they should occur.

NO SENSOR CONNECTED OR IMPROPER PAIRING

If no genuine Direct Smart DSS MODBUS Sensor is connected, it is expected that either one or more error codes will be reported or else it is also possible that there will be no discernable response at all. It is possible to connect the sensors for use with the TT-MA-DSS-pH into the handheld communicator since they are both terminated with the same DSS4M male quick connects. Although there will be no damage from this improper pairing you will not be able to interface the sensor (that requires the TT-MA-DSS-pH transmitter or DSS Windows calibration & setup software).

MODBUS COMMUNICATION PROTOCOL

The information about how to access all available parametres on the DSS Sensors is provided as a separate standalone document that is inteded to be used in conjunction with this field installation guide for field commissioning at the job site.

GENERAL TROUBLESHOOTING TIPS

- Ensure that all connect connections with the extension cables are secure and that none of the pins are damaged.
- Ensure that there is good ingerity of PVC insulation on leads & cable jacket for both sensor and/or extension cables.
- Disconnect and reconnect the DSS Sensor via the connect connection. Allow ~5 to 10 seconds before reconnecting.
- Cycle the power to the DSS Sensor and swap out the extension cable for a unit that is known to be working.
- Connect a genuine DSS Sensor known to be working to ensure the receiving device is working properly.

For further information regarding Turtle Tough products please contact Turtle Tough factory directly or your distributor.

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