Installation and Configuration Guide

Groundworks

MACHINE CONTROL SYSTEM

Version 2.00
Revision B
November 2024

Trimble

Legal Notices

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Release Notice

This is the November 2024 release (Revision B) of the *Groundworks Installation and Configuration Guide*.

Contents

1

Introduction

- Recommended tools, components, and required personnel
- Technical support

The Trimble® Groundworks™ Machine Control System is a turnkey solution for various specialty construction applications. It can be used for drill and blast operations for rock excavation in mines, quarries, and on construction projects as well as piling operations for placement of piles and caissons for structures such as bridges, dams, buildings, and solar/wind farms. In addition, the system can be used for soil stabilization to improve the engineering properties of soil through dynamic compaction, drainage, and other methods.

For additional Groundworks documentation, please refer to Partners website (community.trimble.com).

> **NOTE –** The Partners website is regularly updated to show all released documentation for the Groundworks system. If a referenced document is not found on Partners, please contact Support for further instructions.

Recommended tools, components, and required personnel

The following tools, materials, and personnel are needed for a full installation of the Groundworks system:

Tool list

- Allen key set
- Assorted wrenches and sockets
- Assorted Phillips and slot-head screwdrivers
- Wire strippers
- Box cutter knife
- Wire cutters
- Multimeter
- Small jewelers screwdriver set
- Large drill with various metal and plastic capable drill bits to support mounting components

Consumable materials required

- Spare SAE connectors
- Spare Deutsch connectors (4-, 6-, and 8-pin male and female)
- Spare male and female M12 connectors
- Zip ties of various sizes
- Assorted battery terminal and electrical connectors
- Electrical tape
- Wire loom for cable protection
- Spools of various gauge insulated stranded wire
- Assorted metal plates for bracket fabrication
- Various types of fasteners with lock washers

Personnel required

- Company/machine-owner approved welder for fabrication of brackets and mounts for sensors
- Company/machine-owner mechanic for identifying and approving sensor mounting, cable routing, and brackets
- Company/machine-owner or electrical engineer familiar with machine for identifying electrical connections

Technical support

If you have a problem and cannot find the information you need in the product documentation, contact your local SITECH® distributor.

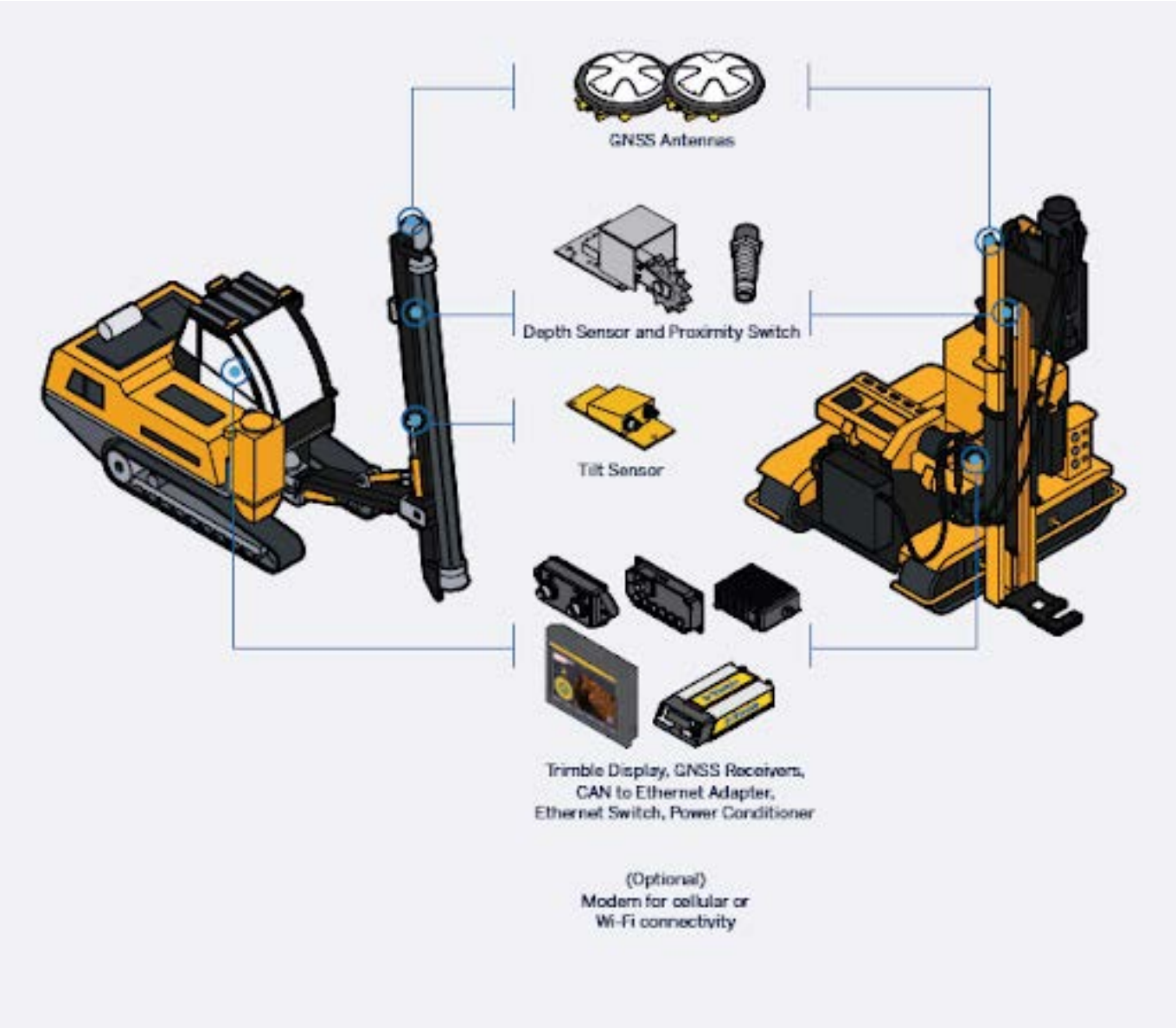
2

System Components

This chapter describes the system components for the Groundworks machine control system.

Groundworks system overview

A typical Groundworks system is installed as shown:



1. When deciding where to start your installation, always start with the Trimble VERSO 12 touch display as it needs to be easily seen by the operator and relies on a 5 m ethernet cable (P/N 132339-050) that connects it to the ethernet switch (P/N 92299-85).
2. The MPS566 receiver (see GNSS receivers) should be mounted next since it has a 3 m cable (P/N 132343) that connects it to the ethernet switch.
    a. If the GNSS receivers are mounted in the cab, you will need to find space to pass two LMR400 coaxial cables for GNSS and one LMR400 coaxial cable for radio (if used) out of the cab.

b. When connecting the GNSS cables, radio cable, and DB26 cables to the GNSS receivers, hand-tighten only.

c. Do not use tools as over-tightening can lead to damaged connectors.

d. The ethernet switch should be mounted so that all connections are accessible for troubleshooting.

e. Connect the power conditioner cable as close as possible to the battery to a stable and clean power supply after the master disconnect, using the provided in-line fuses.

3. Mount the GNSS antennas at the top of the mast and ensure they will not interfere with normal machine operation.

> **NOTE –** Mounting GNSS antennas on the machine cabin may be possible but this is not a standard configuration of hardware. For guidance with this scenario, please check with your Trimble Construction Application Specialist.

a. If using the GNSS dual-antenna mounting bracket (P/N 93057), align it square with the mast and avoid skewing antennas, if possible.

b. When connecting the GNSS cable to the GNSS antenna, hand-tighten and then use a tool to tighten an extra ¼ turn at most as over-tightening can lead to damaged connectors.

> **TIP –** If you are using a Zephyr 3 rugged antenna, also consider using P/N 111760 (adapter, RA, TNC/TNC connectors), which will face the connector down and make the GNSS cable easier to install.

c. Add electrical tape over the connections to reduce the risk of the connectors coming loose.

d. As a safety precaution, Trimble recommends using a steel cable or similar to attach the antennas and the mast mount bracket arms to a fixed location on the mast.

4. Mount the depth sensor next and continue mounting the sensors working back towards cab.

a. When mounting the CLD900 chain link drive sensor to a chain, ensure that the sprocket is aligned with the chain to avoid unnecessary tension on the sprocket.

b. When mounting the CRD900 chain rotation drive sensor to the shaft at the center of a sprocket, ensure that the sensor is centered on the shaft to increase the lifespan of flexible orange coupling.

c. When mounting the CDD900 cable depth drive sensor ensure that the cable, which is fixed at the top and bottom and wraps around the sensor, is aligned so that no unnecessary tension is applied to the sensor.

d. When mounting the FRD900 friction rotation drive sensor to the sheave, ensure that adequate tension is applied to the sheave to reduce the risk of slipping.

e. When mounting the PSD900 proximity switch drive sensor to track the machine sprocket, ensure that both proximity sensors are mounted the correct distance apart from each other to accurately track depth.

f. If using a supported third-party laser depth sensor such as Acuity AS2100 or SICK Dx100, please contact your Trimble Construction Application Specialist for support with procurement of parts and installation guidance.

5. Mount the M18 proximity switch to the mast and mount the trigger plate to the tool for automatic reset of the depth sensor.

   An alternative option is to mount the M18 proximity switch on the tool and the trigger plate on the mast.

   The M18 proximity switch must be connected to the depth sensor.

   > **NOTE –** If no M18 proximity switch is installed, the depth sensor can be reset manually in the software, but this must be done in the same location each time the system is started.

6. Mount the TS900 dual-axis tilt sensor on the mast as close as possible to the mast pivots to achieve the most stable results.

   > **NOTE –** The tilt sensor must be mounted square with the mast, with the connectors facing downwards.

7. Mount the IO900 (I/O box) in or near the electrical panel for easy access to the input/output signals.
8. Connect all CAN sensors to each other starting from CAN 1 port of the CAN-to-ETH adapter (P/N 92299-80) and continuing in a logical order based on their location. Use a CAN terminator on the last CAN sensor in the chain.

   a. The typical order of the sensors is:

      CAN-to-ETH adapter → I/O box → tilt sensor → depth sensor → M18 proximity sensor

   b. All CAN sensors are rated IP67, provided that all connectors are either connected to a cable or sealed with an end cap to close open connections.

   c. Always mount the CAN sensors exposed to weather with the connectors pointing downwards when possible.

   d. Always cover any exposed cable connectors (such as USB, CAN, power) while not in use as a preventative measure to reduce corrosion.

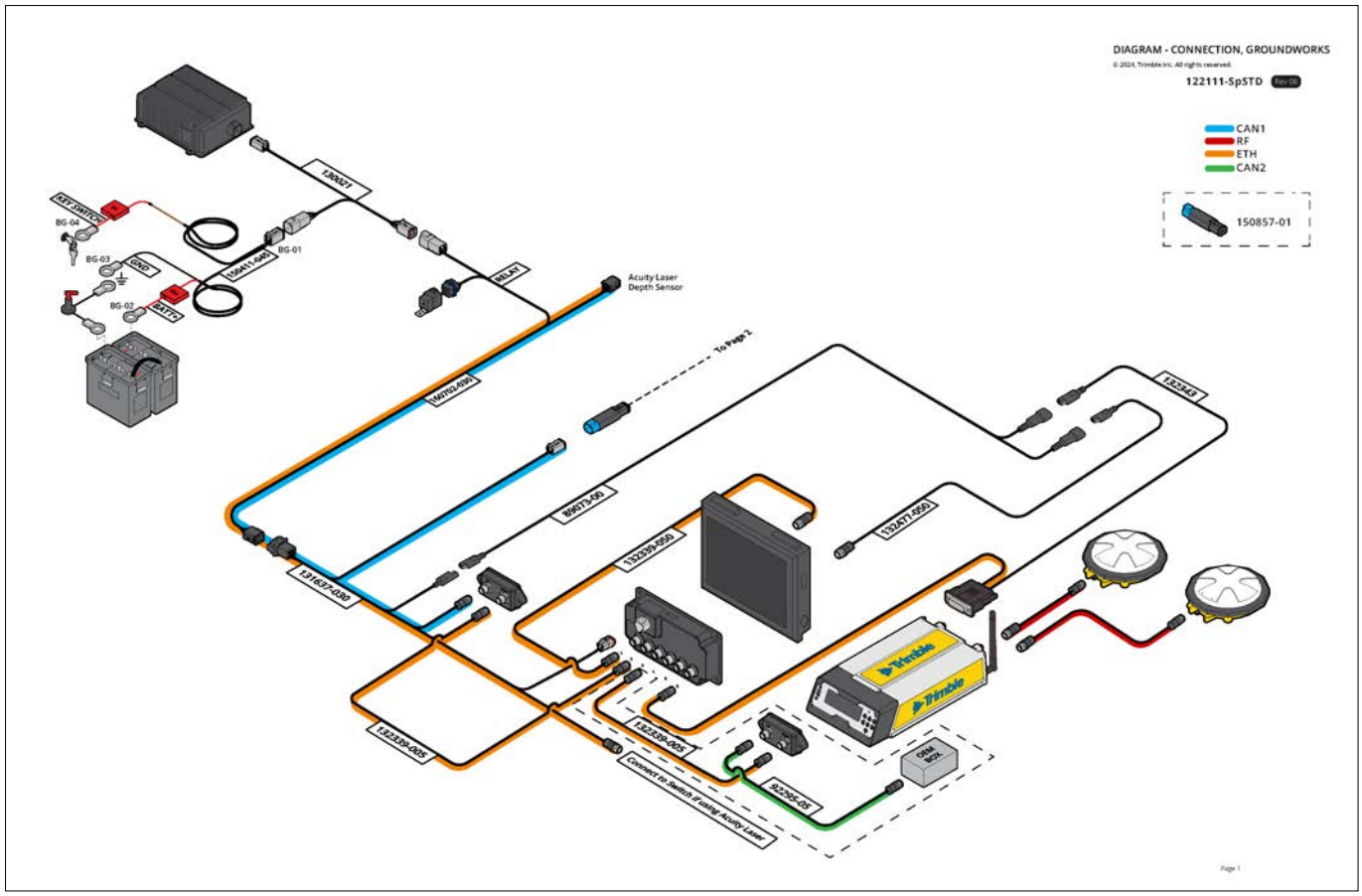


DIAGRAM - CONNECTION, GROUNDWORKS
122111-SpSTD
CAN1
RF
ETH
CAN2
150857-01
Acuity Laser
Depth Sensor
To Page 2
Trimble
Trimble
CAN
BOX
Connect to Switch if using Acuity Laser

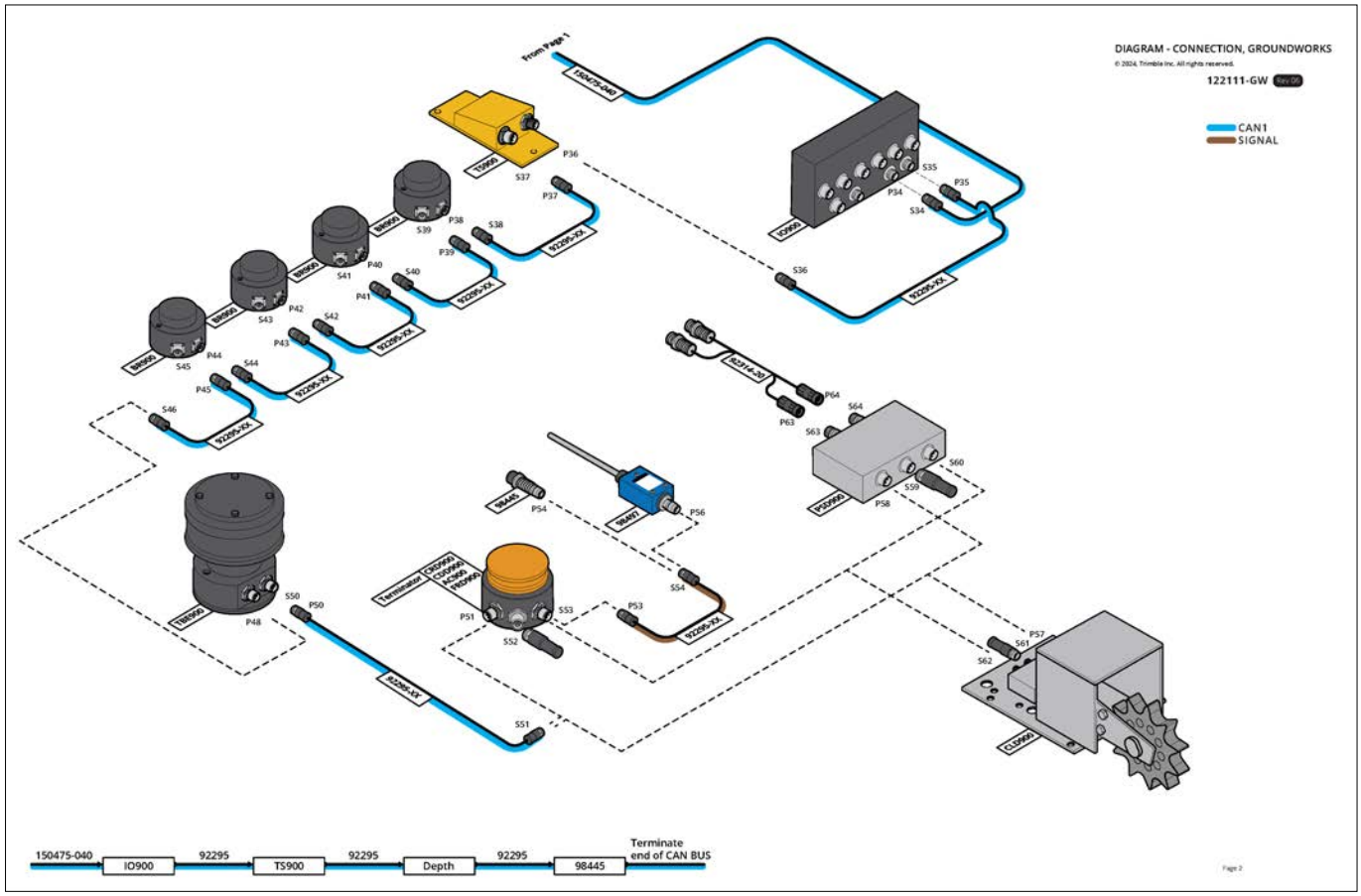


DIAGRAM - CONNECTION, GROUNDWORKS
122111-GW
CAN1
SIGNAL
From Page 1
150475-040
IO900
92295
TS900
92295
Depth
92295
98445
Terminate
end of CAN BUS

GNSS receivers

Option 1

P/N MAR-MPS566-000, MAR-MPS566-450, or MAR-MPS566-900

The positioning requirements of the Groundworks system are met using the Trimble receivers; MPS566 900 MHz, 450 MHz, or no UHF version for positioning (moving base) and heading combined in a single GNSS receiver. The two receivers are mounted separately on the back of the cabin using an individual mounting bracket (P/N 128018-00 or BRKT-DUAL-R750 BP).

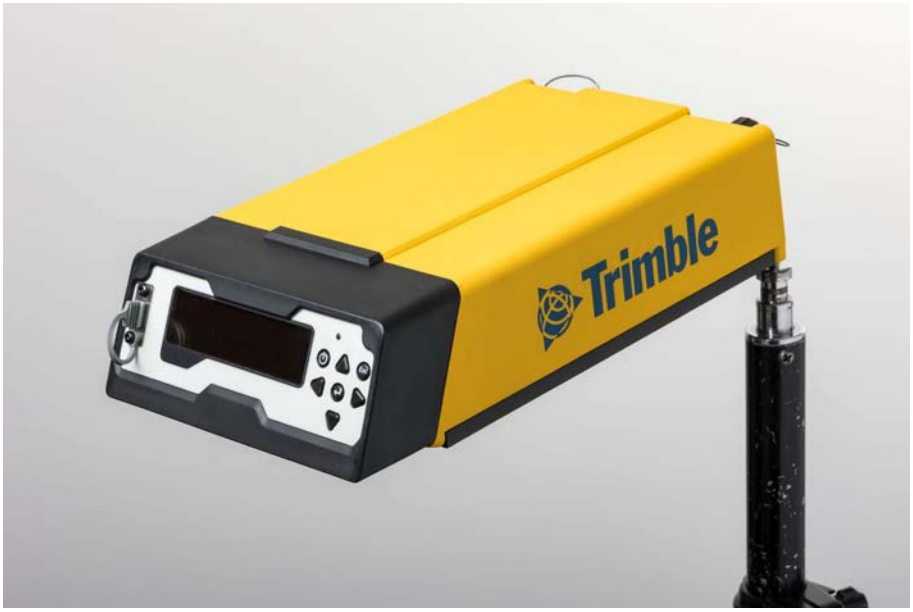
The MPS566 receiver has 30/30 precision and support for all satellite constellations. To ensure the peak performance of the receiver is achieved, it is recommended that a precision upgrade is applied. Trimble recommends Precise Rover to ensure the highest precision:

- MPS566-CFG-PR Trimble MPS566, GPS/GLN, 3F, MSK, HDG, Precise Rover

Option 2

P/N CON-R750-900 or CON-R750-450 and CON-R750-000

The positioning requirements of the Groundworks system are met using the Trimble receivers: R750 900 MHz, 450 MHz, or no UHF version for positioning (moving base) and R750 no UHF for heading. The two receivers are mounted separately on the back of the cabin using a individual mounting bracket (P/N 128018-00).



NOTE – The R750 receiver can be interchangeable with the SPS855 and SPS555H receivers. The R750 receiver can be a moving base or a heading receiver while using the other receivers.

The R750 GNSS (moving base) receiver is configured with the following option:

- P/N PR-01: Option - CCFS RTK Rover with Base backup [R750, R780]

The R750 GNSS receiver (Heading) does not require a precision RTK upgrade. It already comes standard with support for all satellite constellations and can provide a precise heading with the standard configuration, when paired with the R750 receiver (Moving Base with PR-01) as noted above.

GNSS antennas

Each of the GNSS receivers is connected to a Zephyr rugged GNSS antenna that is typically mounted on the GNSS dual-antenna mounting bracket.

P/N 125000-10

The photograph above shows a Zephyr 3 rugged GNSS antenna with mounting bracket.

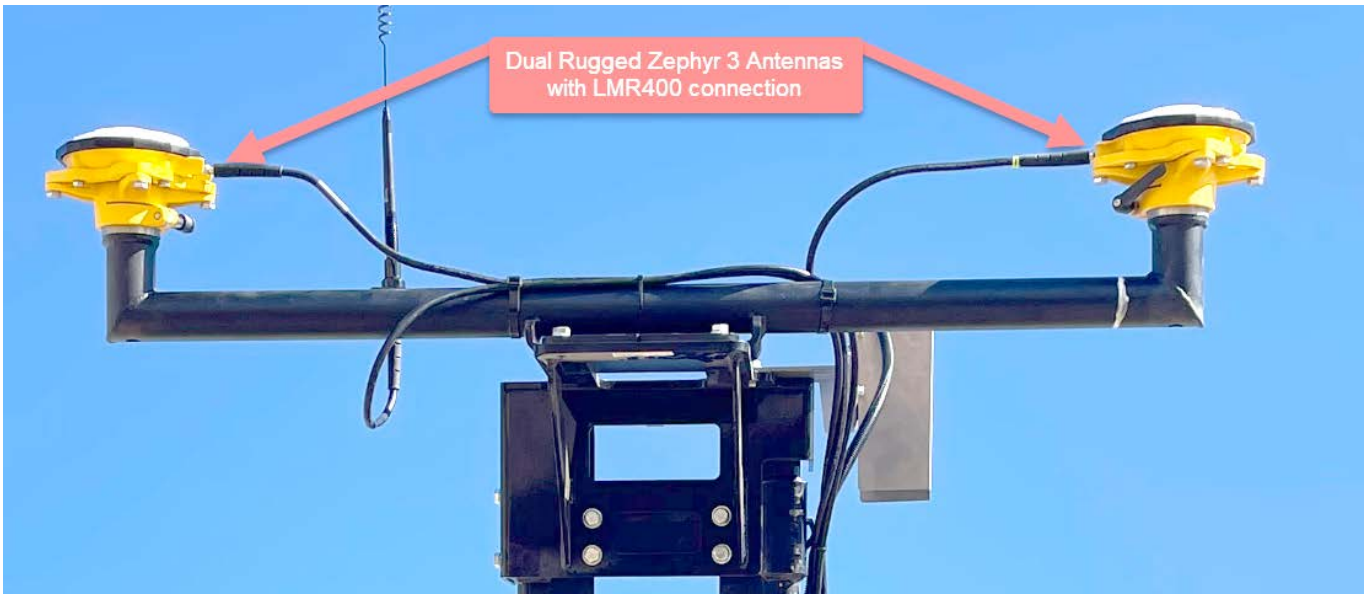
P/N 66241-10

The photograph above shows a Zephyr 2 rugged GNSS antenna with mounting bracket. *This product is no longer sold by Trimble but many are in the field on working systems.*

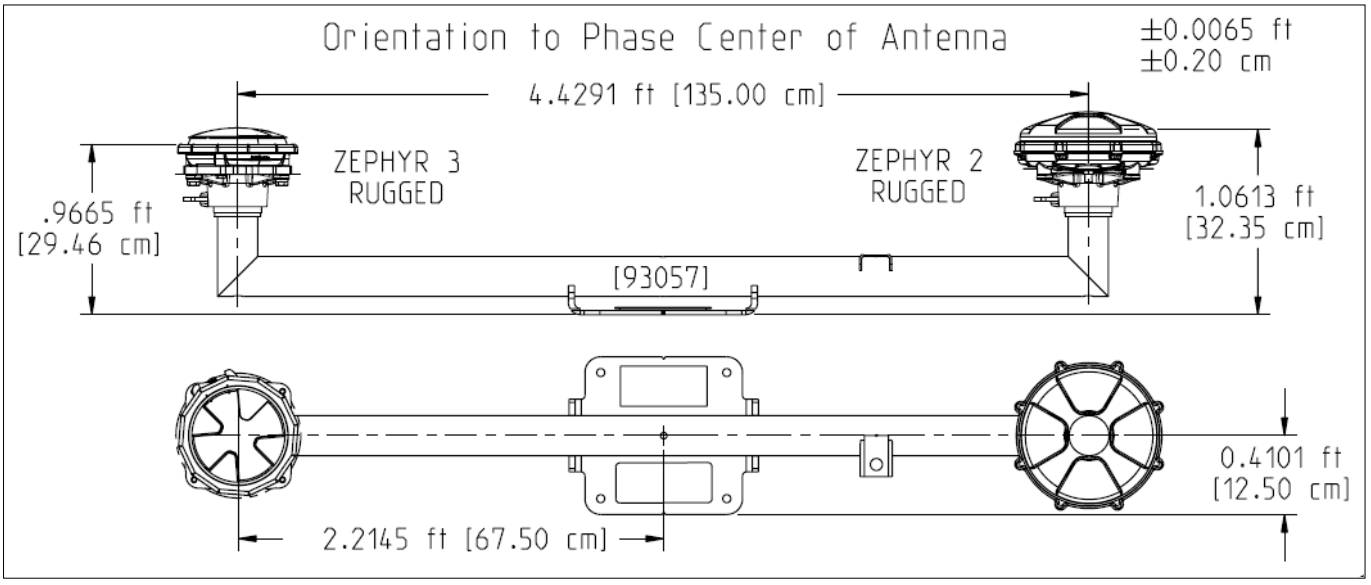
GNSS dual-antenna mounting bracket

P/N 93057

The following photograph shows a GNSS dual-antenna mast mount bracket with two mounted Zephyr rugged antennas:



The GNSS antenna offsets to the center of the GNSS dual-antenna mounting bracket are as follows:



The GNSS antenna is connected to the GNSS receiver using the LMR400 Ultraflex GNSS antenna cable (available in 5 m, 10 m, 15 m, 20 m, and 30 m lengths to suit different machine configurations).

Configure the receiver-to-antenna connections as follows:

1. Connect the positioning receiver (R750 Moving Base receiver) to the left-hand antenna (left side of the mast as seen by the operator from the machine operating position). If you are using an MPS566 receiver, connect to the TNC port on the back of the receiver marked **Antenna 1**.

2. Connect the Heading receiver (R750 Heading receiver) to the right-hand antenna (right side of the mast as seen by the operator from the machine operating position). If you are using an MPS566 receiver, connect to the TNC port on the back of the receiver marked **Antenna 2**.

NOTE – The antennas can be mounted in any position as long as their location is correctly identified in the measure up.

TIP – To reduce errors in position, a bracket can be mounted halfway up the mast in a stable location on large rigs as long as they are at least 1.5 m away from the mast to reduce multipath.


LB 28

Trimble VERSO 12 touch display

- **P/N TABV12-00-I7 Wi-Fi only**
- **P/N TABV12-10-I7 with integrated cellular modem (TAB12-00-I7-GW and TABV12-10-I7-GW includes software)**

The Groundworks system is controlled by the Trimble VERSO 12 touch display that is mounted in the cab or operating position of the machine. The VERSO 12 display is mounted to the machine using a RAM mount welded or securely bolted.

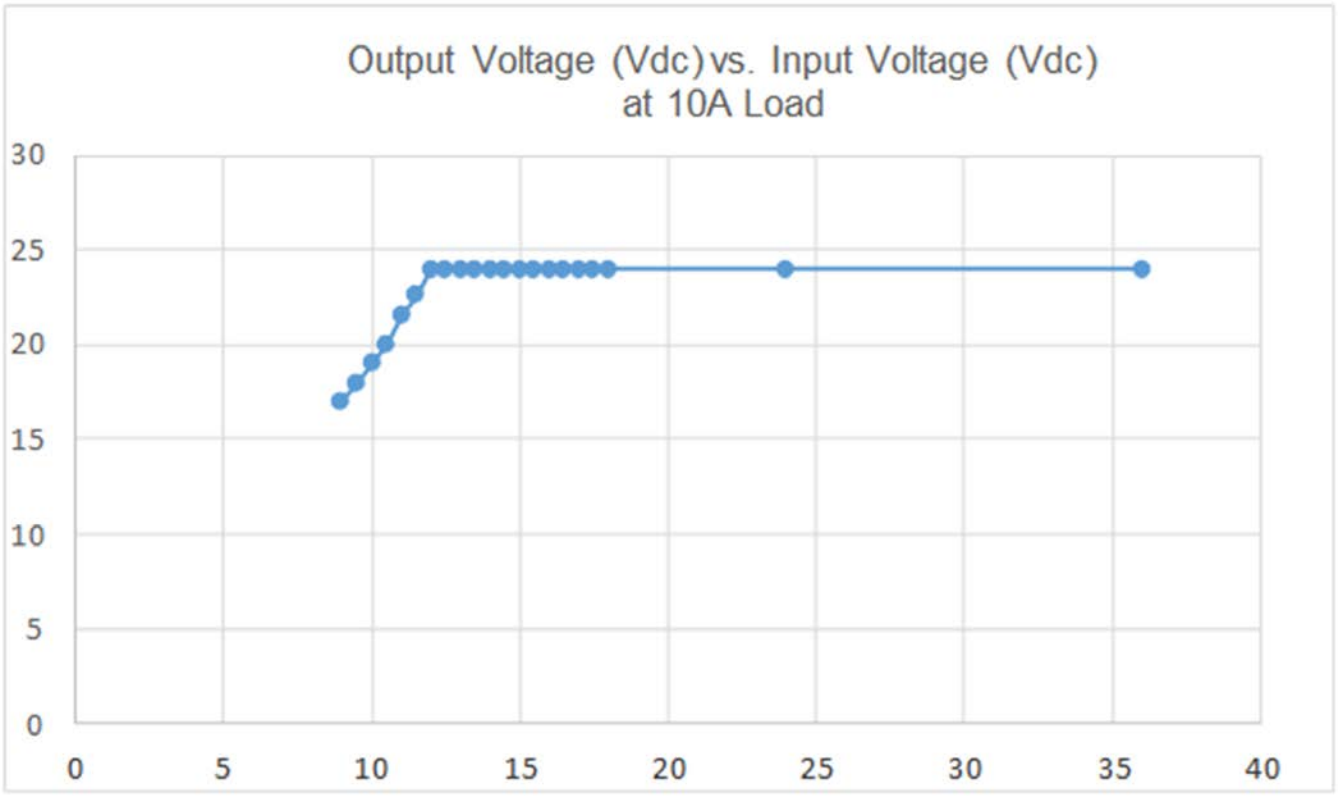
The VERSO 12 display is typically powered by the Groundworks power conditioner (P/N 92299-90), but a modified CAN cable (P/N 92295-XX) can be used as an alternative option to power the display using a bench power supply.

The female M12 end of the CAN cable connects to the power port of the VERSO 12 display and the male M12 connector can be removed to expose the wires. Connect the black and brown wires to the positive terminal and the blue and white wires to the negative terminal.

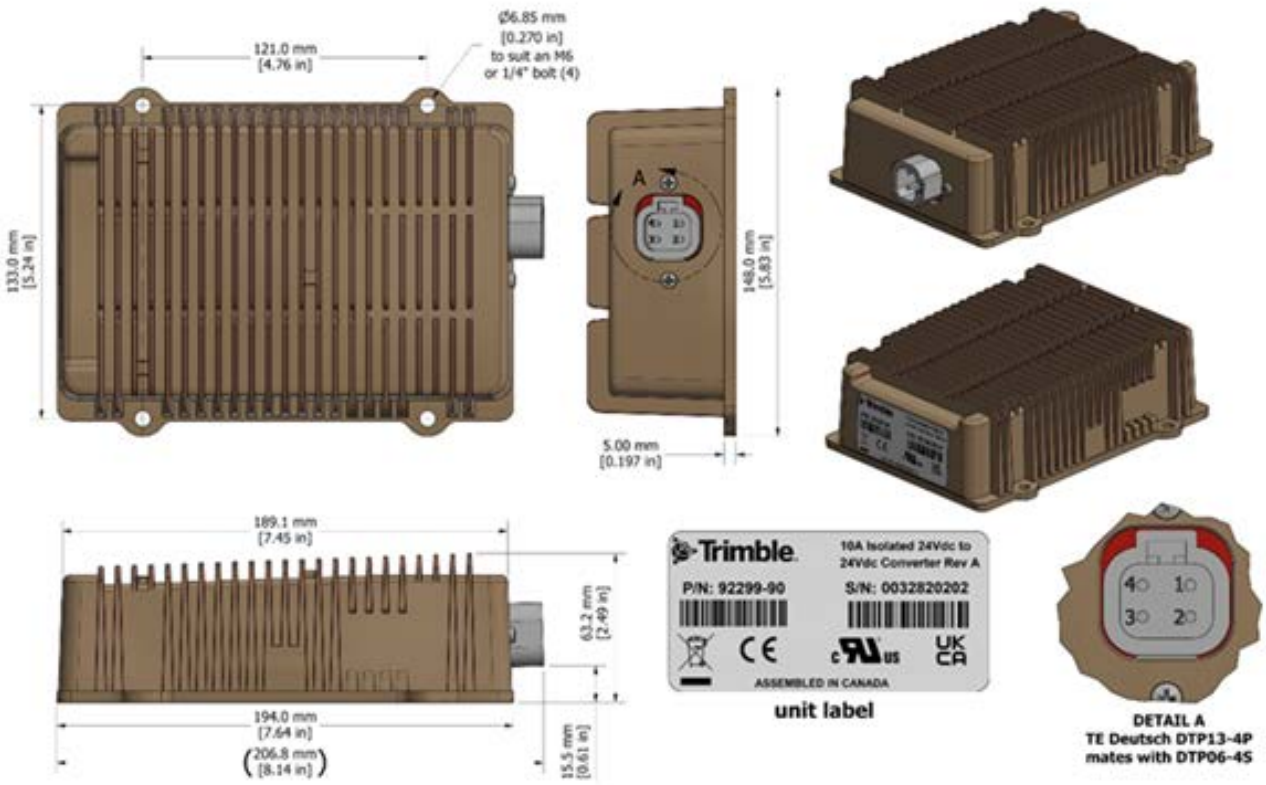
Power conditioner

P/N 92299-00

The power conditioner is a device that provides clean power supply from the battery of the machine to the rest of the system. It is the first piece of hardware to be installed after the battery. This unit takes 9 to 36 V DC and provides over- and under-voltage protection, which also allows **-40 °C to 85 °C (-40 °F to 185 °F)** operating temperature with an IP67 rating.



Output voltage versus input voltage at full load


121.0 mm
[4.76 in]
Ø6.85 mm
[0.270 in]
to suit an M6
or 1/4" bolt (4)
133.0 mm
[5.24 in]
A
148.0 mm
[5.83 in]
5.00 mm
[0.197 in]
189.1 mm
[7.45 in]
63.2 mm
[2.49 in]
194.0 mm
[7.64 in]
(206.8 mm
[8.14 in])
15.5 mm
[0.61 in]
Trimble
10A Isolated 24Vdc to
24Vdc Converter Rev A
P/N: 92299-90
S/N: 0032820202
ASSEMBLED IN CANADA
unit label
4
1
3
2
DETAIL A
TE Deutsch DTP13-4P
mates with DTP06-4S

CAN-to-ETH adapter

P/N 92299-80

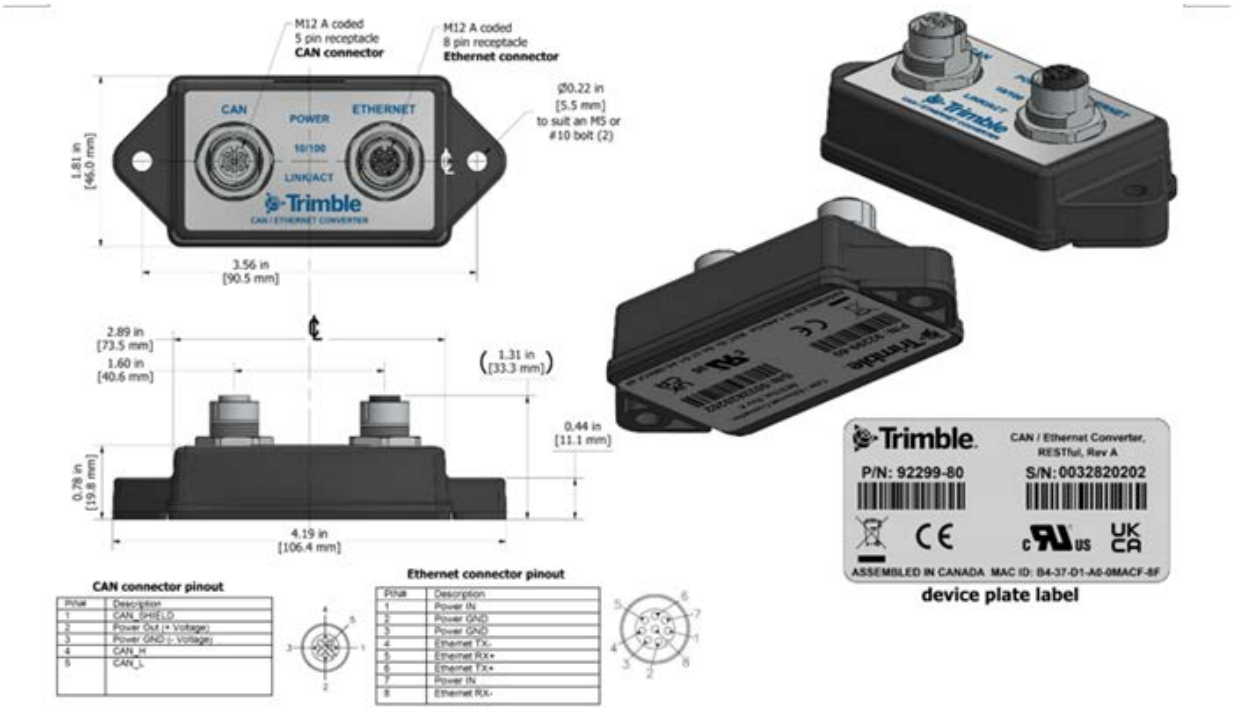
The CAN-to-ETH adapter is the device that converts all CAN communication into an ETH format. This devices converts the message and sends back to the VERSO display running the Groundworks software.

Ethernet port: power in, ethernet

No.	Description
1	Power IN
2	Power GND
3	Power GND
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Power IN
8	Ethernet RX-

1 Phoenix contact M12 5-pin connector (A-coded), P/N 1441778 (connector 2) CAN port: power out, CAN

No.	Description
1	CAN_SHIELD
2	Power OUT (+ voltage)
3	Power GND (- voltage)
4	CAN_H
5	CAN_L



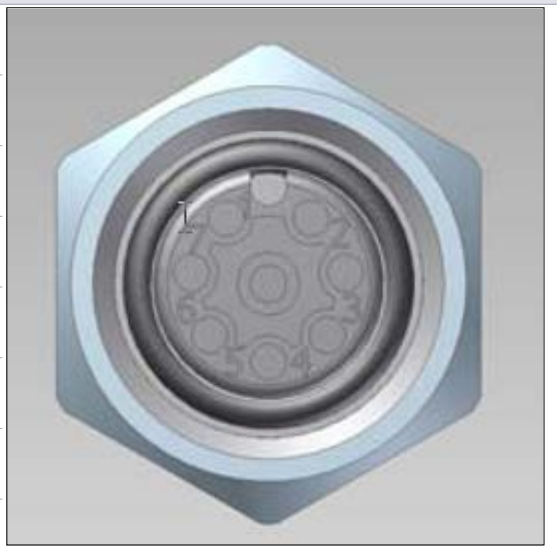
ETH switch

P/N 92299-85

The ETH switch is the connection point for all communication components of the Groundworks Machine Control System. The unit has six ports. Two of the ports provide output power of 9 to 36 VD C with 1 A current maximum.

Port 1: Power IN, ethernet 1

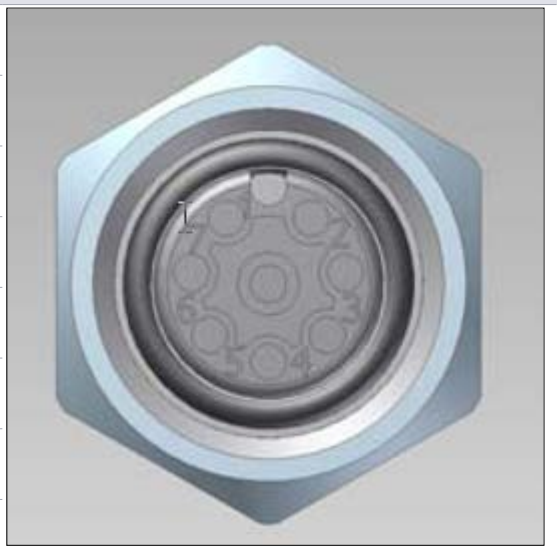
No.	Description
1	Power IN
2	Power GND
3	Power GND
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Power IN
8	Ethernet RX-



Port 2: Power OUT, ethernet 2

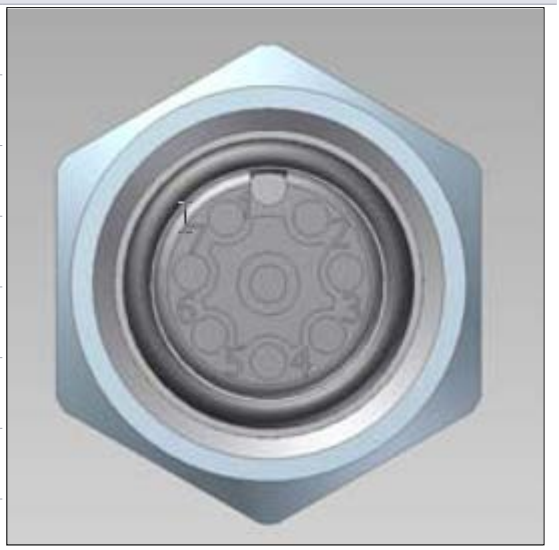
Port 3: Power OUT, ethernet 3

No.	Description
1	Power OUT
2	Power GND
3	Power GND
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Power OUT
8	Ethernet RX-



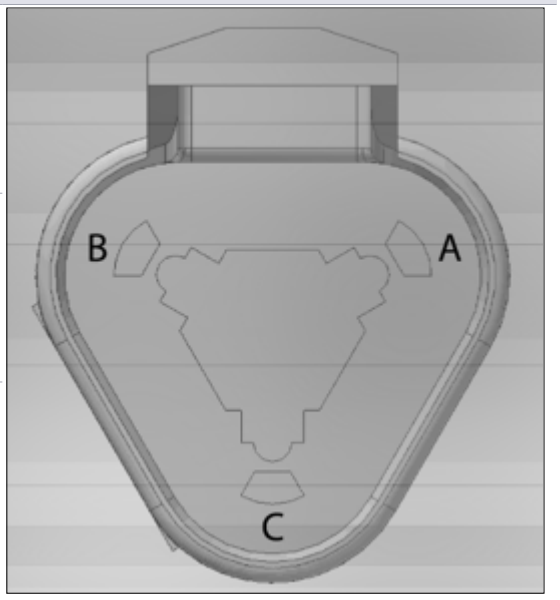
Port 4: ethernet 4
Port 5: ethernet 5
Port 6: ethernet 6

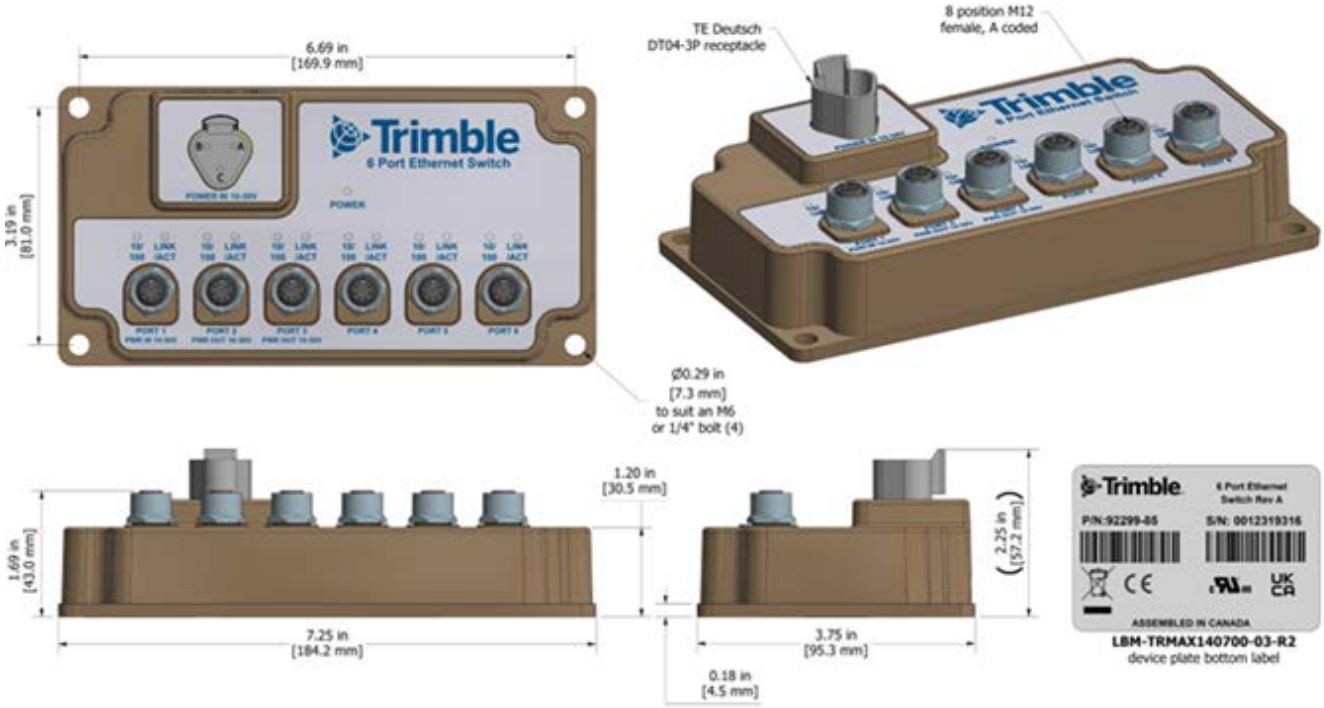
No.	Description
1	Not used
2	Not used
3	Not used
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Not used
8	Ethernet RX-



1 DT04-3P connector (Connector 7)
Port 7: Power IN

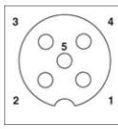
No.	Description
A	Power IN
B	Power GND
C	Accessory Switch IN (connect to Power+ to enable power input via the DT04-3P connector on Port 7




6.69 in
[169.9 mm]
3.19 in
[81.0 mm]
Trimble
6 Port Ethernet Switch
POWER
TE Deutsch
DT04-3P receptacle
8 position M12
female, A coded
Ø0.29 in
[7.3 mm]
to suit an M6
or 1/4" bolt (4)
1.69 in
[43.0 mm]
1.20 in
[30.5 mm]
7.25 in
[184.2 mm]
2.25 in
[57.2 mm]
3.75 in
[95.3 mm]
0.18 in
[4.5 mm]
Trimble
6 Port Ethernet Switch Rev A
P/N:92299-05
S/N: 0012319316
ASSEMBLED IN CANADA
LBM-TRMAX140700-03-R2
device plate bottom label

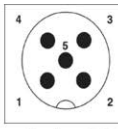
IO900 (I/O box)

P/N 92311-75



pin - 1	10..30V DC (Supply voltage)
pin - 2	Active low input (Yellow Led)
pin - 3	GND
pin - 4	Active high input (Green Led)
pin - 5	Not Connected

Digital Input 1-6



pin - 1	COM
pin - 2	Not Connected
pin - 3	Not Connected
pin - 4	NO
pin - 5	NC

Output Relay 1-2

The I/O box has six input ports used to trigger software events and two output relays used to control machine functionality based on software events.

> **NOTE –** The I/O box operates on 12 V or 24 V. If the machine uses 110 V, a 110 V to 24 V relay is required between any inputs and outputs.

I/O box inputs

The I/O box has six input ports (IN1 to IN6) that can be used to trigger various features within the software. Determine which features will be used, locate the signal to trigger the feature, and then connect it to an available input port. Connect to pin 4 if using an active high (+) signal or to pin 2 if using an active low (-) signal. The LED above the input will turn green when receiving an active high signal or yellow when receiving an active low signal to indicate the relay is active.

> **TIP –** It is recommended to take input signals from the electrical panel rather than the joystick in the cab. The joystick may unintentionally send a signal during other actions. If you get false positive signals on the relay, use an in-line resistor to filter out the false positives.

Each item below can be configured in the software for any of the available inputs:

1. **Stop/Pause depth tracking**: Allows depth tracking to be halted or paused upon receiving a signal, permitting the depth sensor to move without tracking depth. This is essential when drilling with multiple steel lengths, enabling the addition or removal of steel while maintaining accurate tool elevation.
2. **Start/Resume depth tracking**: Allows depth sensor to resume tracking depth upon receiving a signal after it has been paused. This is essential when drilling with multiple steel lengths, enabling the addition or removal of steel while maintaining accurate tool elevation.

> **NOTE –** If the system is configured to use **Start/Resume depth tracking**, but is not configured to use **Stop/Pause depth tracking**, then the depth sensor is only tracked while it is receiving the start/resume depth tracking signal.

3. **Blow count signal (piling only)**: Allows the software to track the number of blows while piling. Each signal will be tracked as one blow. This can be tracked using the M30 proximity sensor (P/N 98446) and wiring to the I/O box or by reusing an existing signal on the machine that is active for each blow.
4. **Navigation tracking mode**: Allows the software to track the time spent navigating (also known as ***tramming***) while receiving the signal. If no input is configured to use this feature, the navigation time is automatically tracked based on the machine movement.
5. **Save start point**: The hole/pile start point is saved when the signal is received so that the operator does not need to manually save the start point.
6. **Save end point**: The hole/pile end point is saved when the signal is received so that the operator does not need to manually save the end point.

Example of wiring I/O box to track steel changes

The most common use of pausing and resuming depth tracking is to accurately track tool elevation while drilling multiple steel lengths. Follow these steps to wire the I/O box for steel change tracking.

> **NOTE –** The same steps can be followed for piling/CFA piling machines that have the need to pause/resume depth tracking because of adding/removing lengths of pipe or re-gripping the pile while it is being driven.

1. Locate the machine signal to be used to pause depth tracking. Typically, this is the unthreading signal for drilling since it occurs at the start of a steel change and is a reliable time to pause depth tracking.
2. Take the signal from Step 1 and connect it to one of the available inputs. The input used must be configured as the stop/pause depth tracking input in the software.
3. Locate the signal to be used to start/resume depth tracking. Typically, this is the steel grip open (also known as a ***centralizer open***) signal for drilling since it occurs at the end of a steel change and is a reliable time to resume tracking depth.
4. Take the signal from Step 3 and connect it to one of the available inputs. The input used must be configured as the start/resume depth tracking input in the software.

> **NOTE –** If these steps are followed, the tool elevation can be tracked during drilling and while retracting steel out of the hole. If any other method is used for depth tracking, the software is unable to track the tool elevation at all times and can only track the tool elevation while drilling.

Additional methods for tracking I/O box inputs

When a signal is not available on the machine, you may need to improvise a solution using proximity switches, pressure switches, or a manual switch to generate the appropriate input. Some examples include:

- Murphy switch in the hydraulic line that is calibrated to sense the open/close status of the hydraulics.
- Proximity switch on a moving part that senses a mechanical action to determine the open/close or on/off status of the action. For example, a proximity switch on the operating levers of a mechanical/hydraulic control system.
- A manual switch trigger on the control levers that are operated by the operator on activating a function of the machine.

I/O box outputs

The I/O box has two output relays (OUT1 and OUT2) that will switch based on events within the software. Determine which features will be used and if you will use the output relays to send a signal to an existing relay or interrupt a circuit on the machine by routing cable through the I/O box. The LED above the output will turn yellow to indicate when the relay is active.

Each item below can be configured in the software for any of the available outputs:

1. **Auto stop**: The output relay will be energized when the target elevation is reached and is typically used to stop drilling/piling automatically. Raise the tool more than 5 cm to de-energize the relay.
2. **Avoidance zone**: The output relay will be energized when machine has entered the avoidance zone. Leave the avoidance zone to de-energize the relay.
3. **Steel in ground (drilling only)**: The output relay is energized when the tool elevation is below the mast foot elevation. Raise the tool above the mast foot elevation to de-energize the relay.
4. **Blow count refusal (piling only)**: The output relay is energized when the blow count refusal has been met. Tap  in the software to de-energize the relay.

Example of sending a signal to an existing relay on the machine

The following example shows how to send a +24 V signal from output 1 to an existing relay on the machine for a desired outcome. Example: Send a +24 V signal to an existing relay on machine that stops drilling to automatically stop the tool at the correct elevation.

1. Connect a wire from IN1 pin 1 (+24 V) to OUT1 pin 1.
2. Connect a wire from OUT1 pin 4 to the relay you want to send signal to.
3. When the output relay is energized, the OUT1 relay will switch and send a +24 V signal to the relay from Step 2.

NOTE – The signal could be sent to a relay to trigger visual/audio alarms or could be wired to existing machine safety features to prevent the operator from entering an avoidance zone or moving the machine while steel is in the ground.

Example of interrupting an existing circuit on the machine

The following example shows how to take an existing circuit on the machine and interrupt it for a desired outcome. Example: Interrupt the circuit for feeder down signal on a drill so that the machine stops drilling to automatically stop the tool at the correct elevation.

1. Find the relay at the electrical panel for the specified action you want to interrupt.
2. Remove this wire from the relay and connect it to OUT1 pin 1.
3. Add a new cable from OUT1 pin 5 and connect it to the relay from Step 1.
4. When the output relay is energized, the OUT1 relay will switch and interrupt the circuit between pin 1 and pin 5.

TIP – If this method is used to automatically stop drilling, Trimble recommends interrupting the feeder down and percussion. Interrupting the rotation could result in the drill bit getting stuck in the hole.

TS900 dual-axis tilt sensor

P/N 92303-10

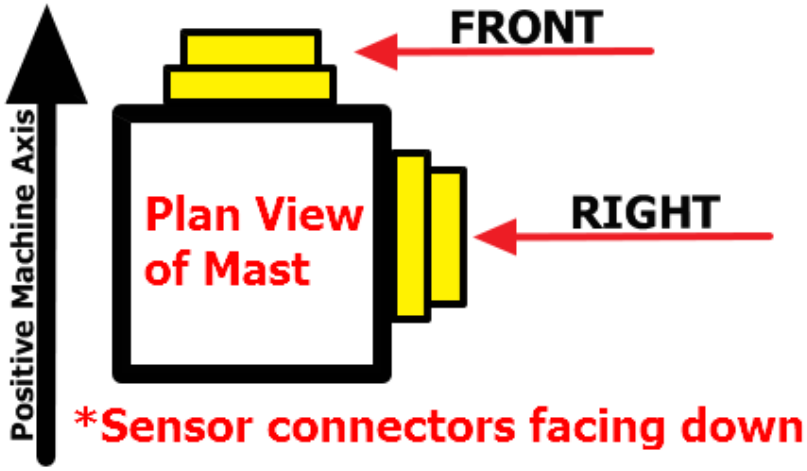
The TS900 dual-axis tilt sensor monitors the inclination of the mast or machine body. The tilt sensor is an essential component for accurate positioning in all Groundworks installations. The

tilt sensor must be configured in the Groundworks software with the appropriate node ID depending on where it is being used.

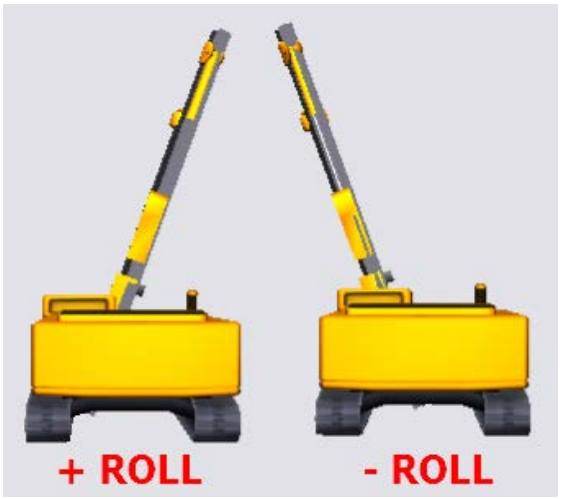
When mounting as a ***tool tilt sensor***, it should be located on the mast near the point where the boom meets the mast (less movement) with its connectors facing downwards.

When mounting as a ***body tilt sensor***, it should be located as low as possible on the machine body with its connectors facing downwards.

The following diagram shows how to determine which side the sensor has been mounted to:



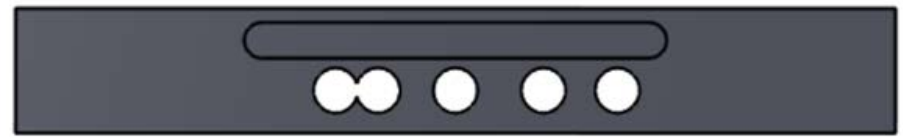
The following diagram illustrates the Groundworks terminology for positive and negative pitch and roll:



Mounted unit:

PSD900 proximity switch drive sensor

P/N 92314-00



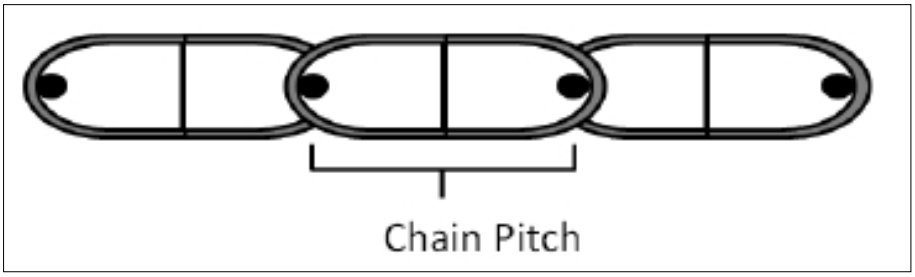
The PSD900 depth sensor uses the same M12 proximity switches as the CLD900 sensor and detects the movement of the sprocket on the machine to track depth.

To use this sensor, the sprocket drive must be accessible with at least three teeth of the sprocket visible at any one time. There also needs to be mounting space to mount the sensor bracket and electronic box in a safe and protected area with a 2 mm clearance between the proximity switches and the side of the sprocket. The proximity switches should be covered to protect them (they do not need light in order to work).

Use the provided mounting bracket to provide the correct spacing between proximity sensors depending on the chain pitch. Mount the proximity switches so that one switch points to the center of a tooth, while the other switch points to the next ***edge*** of a tooth:

Chain pitch	Proximity distance
0.75''	34 mm
1.00''	22 mm
1.25''	25 mm
1.50''	25 mm
2.00''	46 mm
2.50''	57 mm
2.75''	63 mm

Following diagram shows how to measure the chain pitch from the machine:



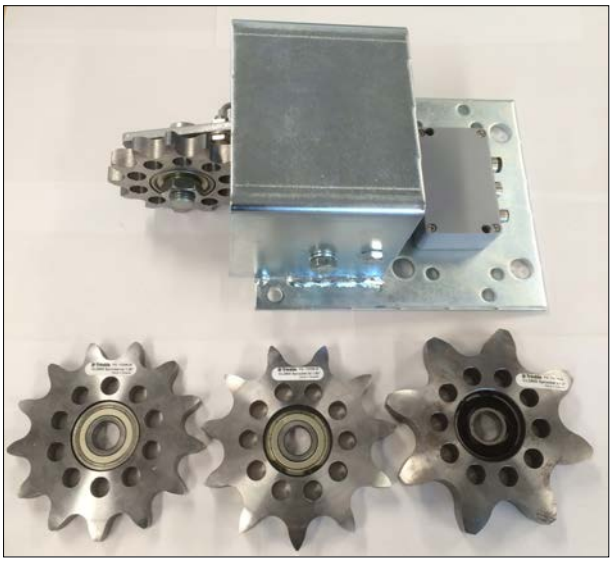
Mounted unit:

NOTE – If the depth values are not increasing/decreasing correctly, you may need to adjust the position of the sensors towards/away the center of the sprocket so they are triggered at the correct time by the sprocket teeth.

CLD900 chain link drive sensor

P/N 112308-xx

P/Ns 112308-00, -10, -20, -30, 40 (shown below)

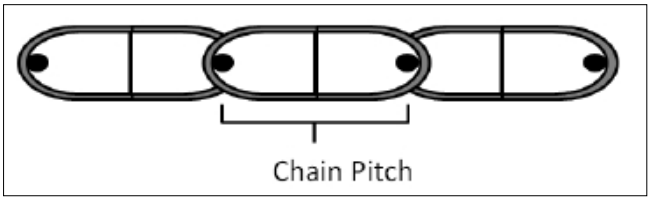


The CLD900 chain link drive depth sensor uses a sprocket attachment that is connected into the chain that lifts and lowers the tool of the machine. As the chain moves the tool up and down the mast, it rotates the sprocket wheel, which in turn is monitored by two proximity sensors that compute the direction and linear motion of the tool. Place the CLD900 sensor on the side of the mast where it is clear of any moving parts and ensure that there is tension between the sprocket and the chain for best results.

The CLD900 base is shipped with an unmounted sprocket as P/Ns 112308-15, 25, 35, and 45 but the sprockets (P/Ns 112308-10, -20, -30, and -40) can be ordered separately as spare parts. These sprockets have holes drilled in them that allow the same CLD900 base to be used with multiple size sprockets without needing to make adjustments to the locations of the proximity sensors.

The CLD900 sprocket attachment comes in four sizes: 1.00", 1.25", 1.50", and 2.00".

The following diagram shows how to measure the chain pitch from the machine to select the correct sprocket size:



Mounted unit:

CDD900 cable depth drive sensor

P/N 92305-75

The CDD900 depth sensor requires the mast to have:

- two moving parts that remain an equal distance apart
- a fixed location that lies between the two moving parts, where the sensor can be mounted so that it is protected and free of moving parts on the mast.

The tensioned cable is connected between the two moving parts and is wrapped around the wheel of the sensor. Alignment of the three fixed locations is important, so that the tensioned wire follows a linear path. The shuttle motion creates a rotation of the CDD900 sensor that is converted into linear distance by the sensor.

Another mounting option is to mount the tensioned cable at two fixed locations near the top and bottom of the mast on either side of the tool. However, the CAN connection cable to the previous sensor in the chain will then need to be allowed to flex and cover the working range, which is less desirable from an installation perspective. Trace the CAN cable along existing cables/hydraulic hoses to ensure it will handle the full working range.

Mounted unit:

CRD900 chain rotation drive sensor

P/N 92307-00

The CRD900 depth sensor is coupled to the drive sprocket of the mechanism that lifts and lowers the tool. Rotations of the sprocket are converted into linear distance movement.

This installation requires access to the drive sprocket rotation axis, and sufficient space to mount the sensor and bracket.

Mounted unit:

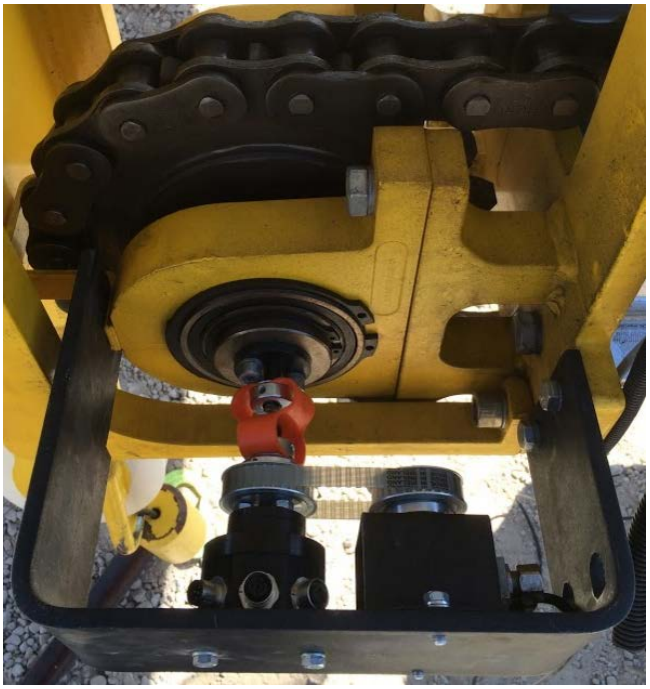
NOTE – The flexibility of the orange coupling absorbs any vibration or small movements during operation but it should not be used to account for poorly aligning the sensor with the connecting shaft.

AC900 dual-drive sensor

P/N 98499

The AC900 depth sensor is a CRD900 sensor that is mounted on a bracket with a cog belt to drive the existing depth sensor on Epiroc L6, C65, D65, and D50 drill rigs.

Mounted unit:



FRD900 friction rotation drive sensor

P/N 98498

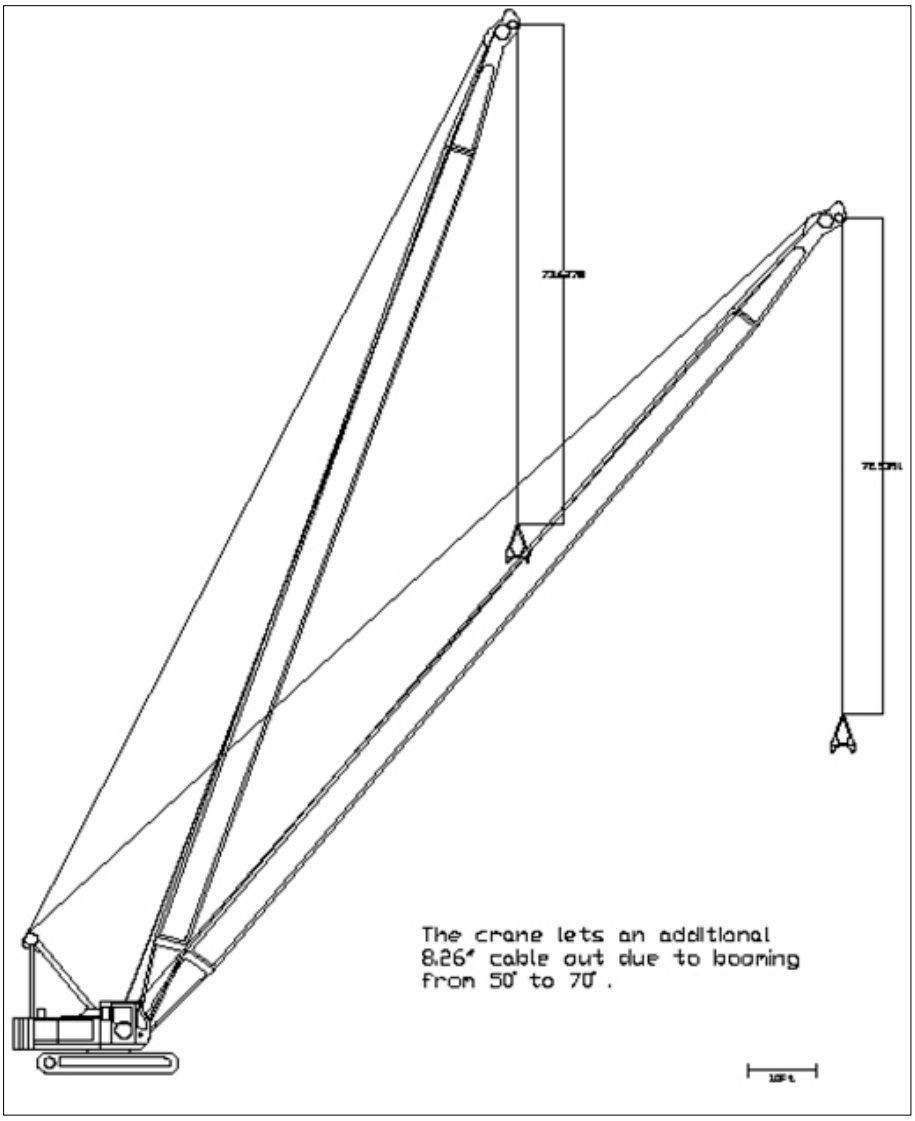
The FRD900 friction drive depth sensor is mounted on an adjustable bracket with a spring-loaded pivot that allows a friction drive wheel to be pressed up against the sheave of a machine. Trimble recommends no more than 50% of maximum tension force, which occurs around 20°.

> **NOTE –** This sensor is often required for large machines where a cable is used to lift and lower the tool.

Mounted unit:

When mounting the FRD900 sensor, you should align the wheel so that it spins as freely as possible, without sideways load transferred to it by the sheave.

For drilling and piling installs, mount the FRD900 sensor near the boom tip to get the most accurate results. If the sensor is mounted to the cable drum on the body of the machine, the depth values will not account for cable payout caused by the inclination of the boom, as shown:



For dynamic compaction installs, you can mount the FRD900 sensor on the cable drum if the cable is spooled in a single layer. For cranes using multi-layer spooling, you must mount the FRD900 sensor at the boom tip for accurate results.

TBE900 telescopic boom extension sensor

P/N 98496

The TBE900 sensor is a spring-loaded drum with that has the capability to measure 5 m of distance. It is primarily used for machines where the mast is telescopic and has a variable length during operations. It can be used in combination with a depth sensor to handle mast extension while the depth sensor solely tracks tool movement.

The sensor is mounted on one fixed point on the mast and the other end is connected to a point on the extending mast. When the mast extends, the cable pays out, allowing the amount of extension to be determined. When installing this sensor, ensure that:

- the drum is tensioned by rotating it before mounting the cable
- the path of the cable is as straight as possible to avoid issues with cable slipping or overlapping on the drum.

This sensor does not need to be reset on startup because it stores its depth reading internally. However, when it is first installed you need to use the **Reset boom extension** feature found in **Sensor Setup** to set its zero point when the sensor is fully retracted.

Mounted unit:

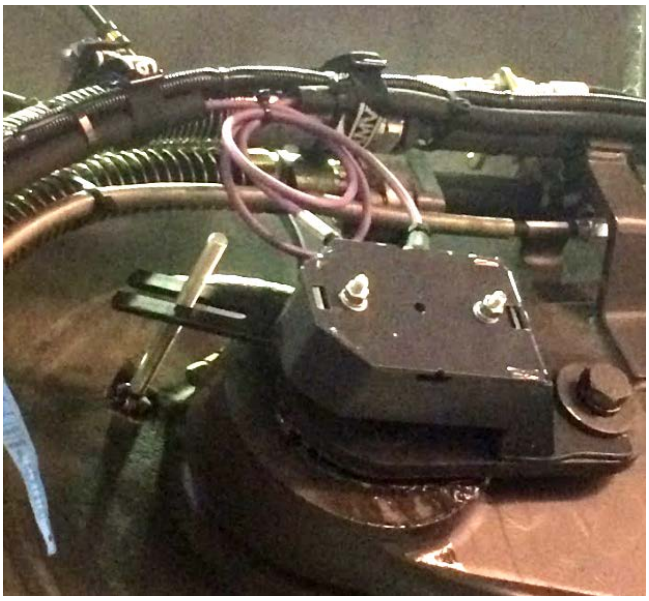
BR900 boom rotation sensor

P/N 103103

The BR900 sensor must be mounted centered on mechanical pivot points, and connected to a rod that is used to measure angles. The sensor is required for any installs where mechanical pivot points occur between the GNSS antenna mounting location and the tool being used.

The BR900 sensor must be configured in the Groundworks software with the appropriate node ID depending on where it is mounted.

Mounted unit:



Pressure sensors

P/Ns 98494 and 98495

The pressure sensors have a measuring range of 250 bar (P/N 98494) and 400 bar (P/N 98495). They are used to track MWD (Measure While Drilling) data for drilling operations and to trigger lift points for dynamic compaction operations. It must be mounted to the appropriate hydraulic hose using a T-fitting with ¼" BSPP thread.

The sensor comes with an M12 splitter to allow connection to the CAN bus.

The pressure sensor must be configured in the Groundworks software with the appropriate node ID depending on where it is being used.

> **NOTE –** Trimble recommends that qualified personnel are present to assist with the modifications to hydraulic hoses to ensure correct mounting and installation.

Mounted unit:

M30 proximity switch

P/N 98446

The M30 proximity switch has a 30 mm detection range and can be used to track blow counts by sending a signal to the I/O box each time it is triggered. It ***must be*** mounted in a location where the hammer passes it with each blow.

> **NOTE –** If an electrical signal is produced with each hammer blow, that signal can be routed to the I/O box instead of using the M30 proximity switch sensor.

M18 proximity switch

P/N 98445

The M18 proximity switch has a 13 mm detection range and is used to automatically reset the depth sensor whenever it is triggered. It ***must be*** mounted on the mast at a point where the drifter unit or trigger plate passes it before drilling/piling the first hole/pile each day. This sensor has an M12 connector and ***must be*** connected to the digital input port of the depth sensor using a modified CAN cable (see M12 connectors, page 121.

> **TIP –** For drilling rigs, lower the drill bit to the ground, then raise it approximately 1 foot to determine the mounting location where the proximity switch should be triggered, allowing for a depth reset before starting work. For piling rigs, mount the sensor in a location that will normally be passed before starting work each day.

PSD900 energy box

P/N 92314-50

The PDS900 energy box is mainly used to capture the energy of piling hammer hitting against the piles. Two proximity sensors can be connected to the energy box to capture the energy. The first proximity switch measures the hammer as it passes it. The second proximity sensor captures the energy as the hammer exists. With this data in addition to others, the software can calculate the energy of each hit.

The energy box can also be used to capture the blow counts on a piling machine.

Required daily reset of the depth sensor

When you power up the depth sensor on system startup, the sensor always zeroes itself at its current location, and requires a reset. The reset location should be at the reference position (*zero point*) and will be the same location the tool was in while carrying out the vertical portion of the machine measure up. This daily reset can be done manually (no sensor required), or automatically (using the M18 proximity switch).

Manually resetting the depth sensor

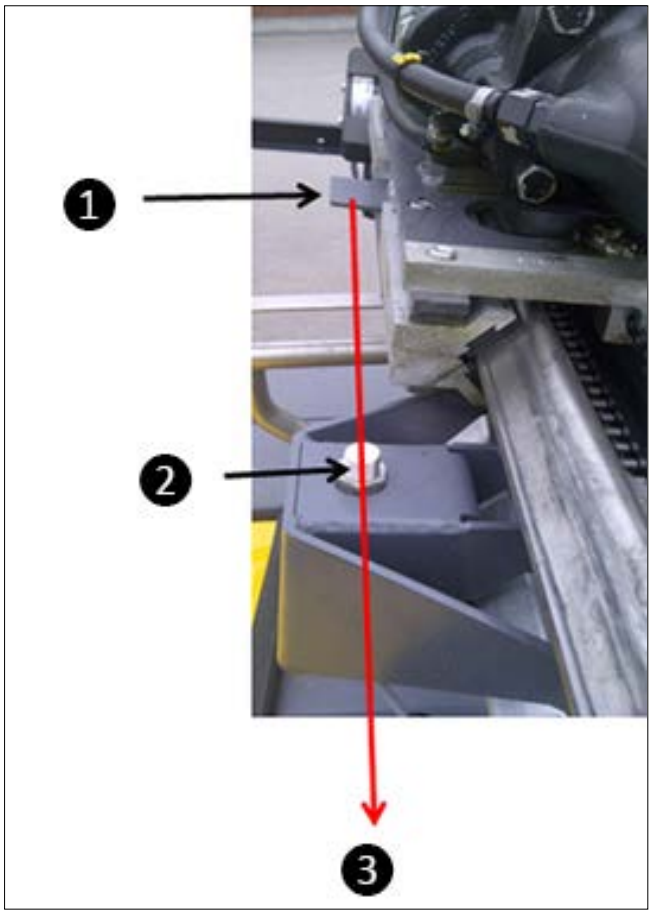
When opting to manually reset the depth sensor each day, you must choose a repeatable location that the operator can use as the reference position (*zero point*). Trimble recommends one of the following locations on the machine:

- Where the tool is at the highest point of the travel on the mast, when it reaches a mechanical stop point. In this case, raise the tool up the mast until it reaches the stop location at the start of each day.
- Where the first drill steel is in the centralizer/steel grip and is being clamped (large machines often use this position when tramming long distances). This is an easily repeatable location that the operator can see from the normal operating position.
- Mark a reference point on the mast and a reference point on the tool, and line them up.

Automatically resetting the depth sensor

To automate the daily reset of the depth sensor, the M18 proximity switch is mounted on the mast at a location where the drifter or a trigger plate always passes the proximity switch. For the proximity sensor to register, the trigger plate must fully pass before the depth sensor is reset. This action must be done prior to the start of drilling/piling each day and after each steel change for drilling.

Mounted M18 proximity switch



1 Trigger plate

2 Proximity switch

3 Travel path

Installation notes

- If there is no suitable existing trigger plate (as shown above), install a small metal plate on the tool, so the metal plate will pass the proximity switch within its detection range. For optimum results, the metal plate should have a minimum width equal to that of the proximity switch diameter. The proximity switch typically triggers when a few millimeters of the plate crosses the face of the proximity switch. The Groundworks software measures the distance at the switch ON position and switch OFF position, and calculates the center of the

plate; it is not dependent on the raising/lowering of the tool. Ensure that the entire trigger plate passes completely over the proximity switch so that the on/off trigger points can be determined precisely.

- Once installed, check that there are no other moving parts on the mast that pass close enough to the proximity switch to trigger a rogue automatic reset of the depth sensor.
- Typically, the proximity switch sensor is mounted while the mast is laid down. Raise the mast and verify that the proximity switch is close enough to trigger the sensor while the mast is vertical and at different angles. Ensure that the tool can move up and down without damaging the sensor.

3

Supported Third-Party Machine Configurations

For step-by-step instructions on supported third-party machine types, refer to the Partners website.

> **NOTE –** The Partners website is regularly updated to show all released documentation for the Groundworks system. If a referenced document is not found on Partners, please contact Support for further instructions.

The Groundworks machine control system supports the following third-party machine configurations:

- ABI
- AMV drilling attachments for excavators
- BBURG drilling rigs
- Ceteau
- CZM piling rigs
- Epiroc drilling rigs with CCI (Common Communications Interface)
- Epiroc FlexiROC drilling rigs
- Epiroc FlexiROC T30 drilling rigs (CANopen interface)
- Epiroc ROC RCS4 drilling rigs
- Epiroc SmartROC drilling rigs with HNS (Hole Navigation System)
- Fundex
- HMC (Hercules Machinery Corporation) drilling/piling rigs
- Impulsteknik
- Jetgrunn drilling/piling rigs
- Jean Lutz
- Junttan piling rigs with JPM (Junttan Piling Management)
- IHC drilling/piling rigs
- Kinetic
- Liebherr drilling/piling rigs with LIPOS (Liebherr Positioning System)
- Movax
- OJJO

- Per Aarsleff drilling/piling rigs
- Raytrack
- Soilmec
- Stonepower
- Vermeer PD10 piling rigs

4

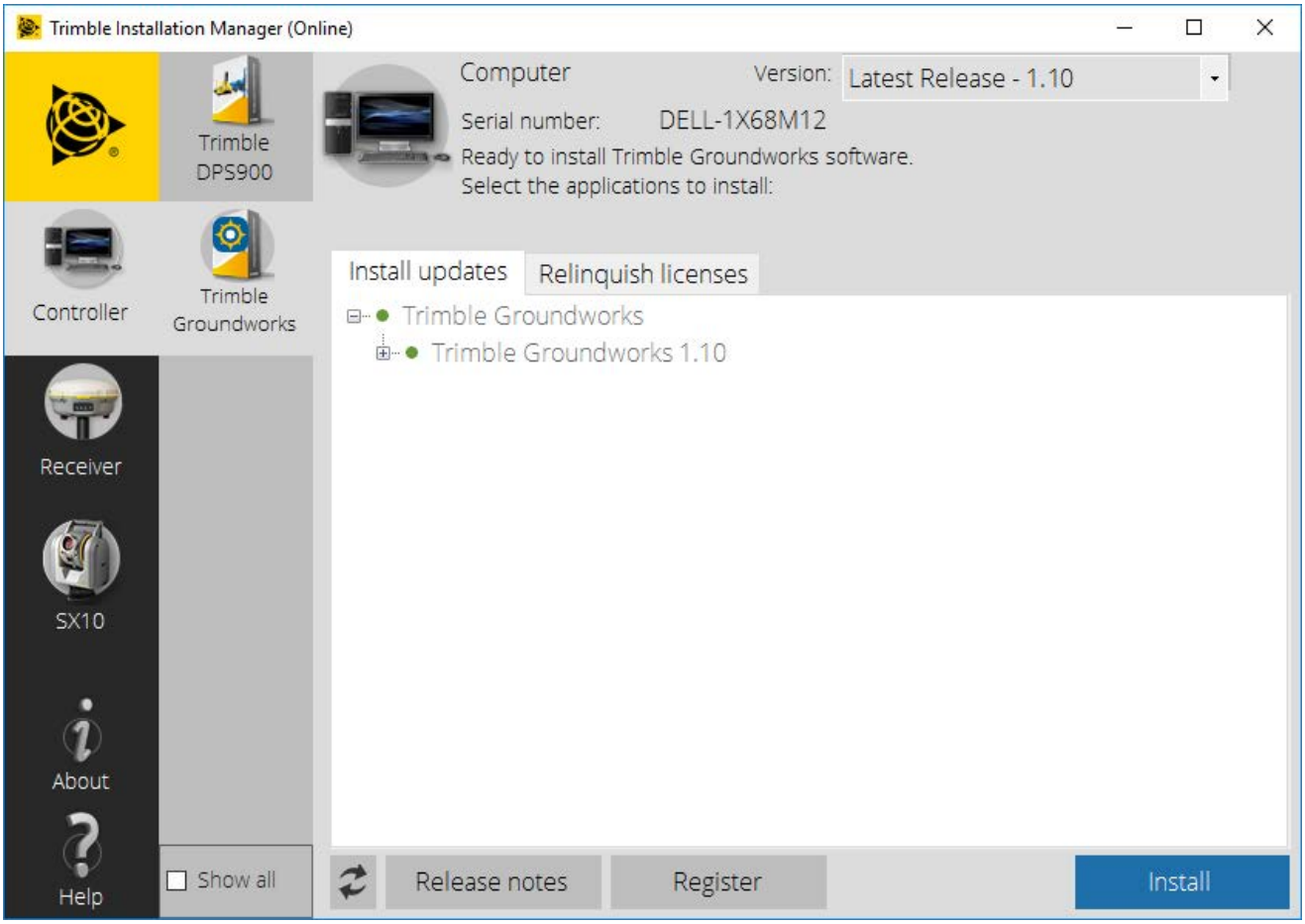
Installing the Groundworks Software on the Trimble VERSO 12 Display

The first time you start the Trimble VERSO 12 display, you must set up the Microsoft Windows® 10 operating system and accept the Microsoft License Agreements. Trimble Installation Manager should already be installed on the display and should be used to activate the Groundworks software license.

When you placed your order for the Groundworks Machine Control system, the order of the Trimble VERSO 12 display with the Groundworks software created a unique software license for your specific device. This facilitates the process for installing the Groundworks software and manages the software warranty and the registration process for the software.

Running the Trimble Installation Manager and installing the Trimble Groundworks software

1. Run the Trimble Installation Manager while connected to the internet:



> **NOTE –** Trimble Installation Manager will display the Trimble software products that have been licensed to your device (these are tied to the serial number of the device).

2. Select **Trimble Groundworks** and then select the latest release version you are entitled to.

> **NOTE –** When connecting for the first time, the complete software is installed. The installation contains the Groundworks software and all system drivers and services required by the software to operate. On subsequent connections, any available updates that are licensed to the warranty for the device are installed. If your software is out of warranty, no further updates will become available until you purchase an extension of the Software Maintenance for the Groundworks software.

3. Tap **Install**. During the installation process, follow any steps and respond to all prompts until the software has completed the installation process.
4. Tap **Finish** to complete the installation of the software.

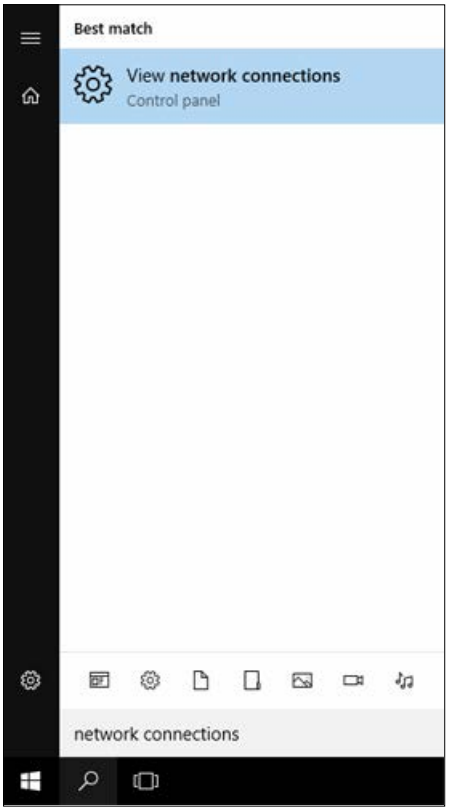
> **NOTE –** On completing the installation process, Trimble recommends that you register the software.

Setting up a static IP address on the Trimble VERSO 12 display

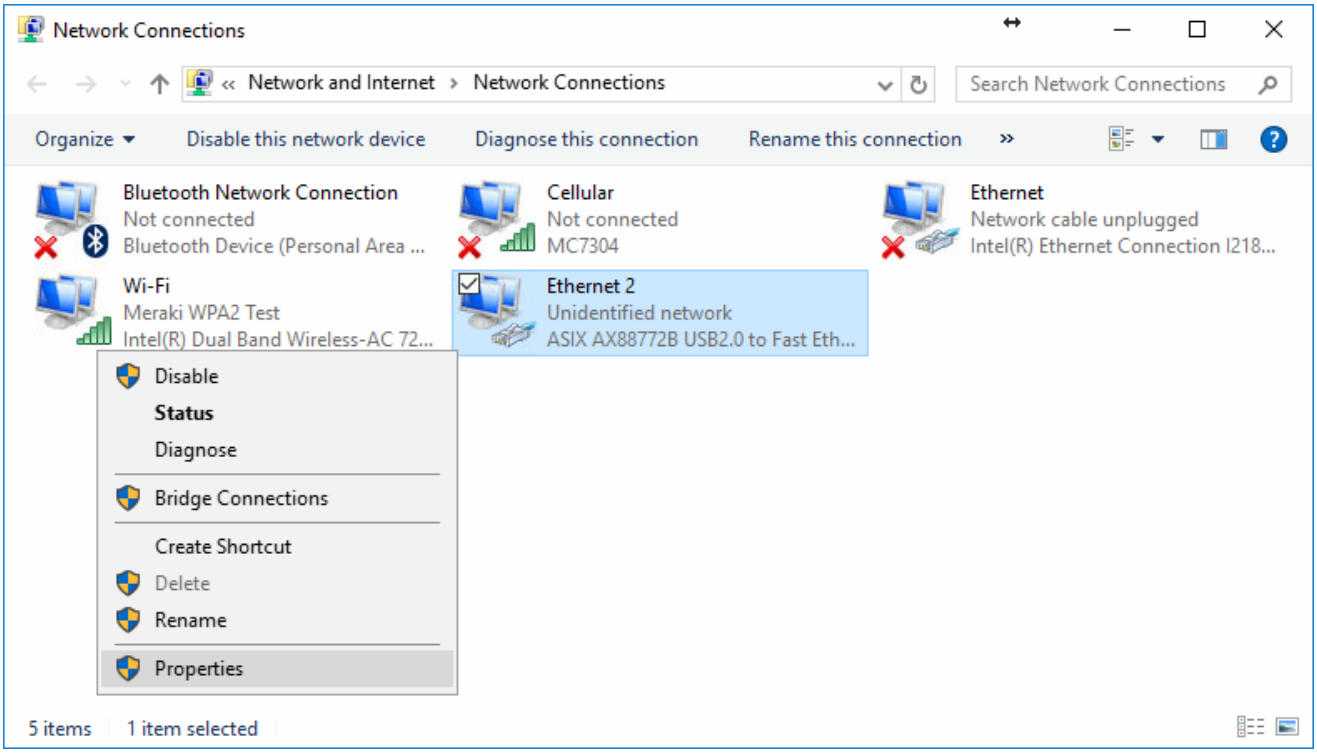
The Trimble VERSO 12 display, JB900 junction box, the two GNSS receivers and, if connected, the SNM94x Connected Site® gateway form a Local Area Network on the machine. For this to be possible, each component requires a unique and static IP address. By this point, you have already set up the GNSS receivers with static IP addresses using the clone files. In this section, you will set up a static IP address for the Trimble VERSO 12 display.

To change the IP address of the Trimble VERSO 12 display:

1. From the Windows **Start** menu, enter **Network connections** into the **Search** field. Tap the **View Network connections** link when it appears:

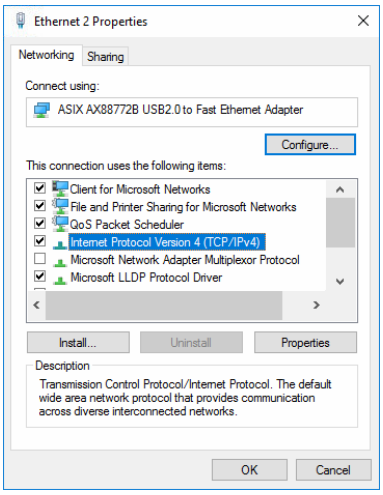


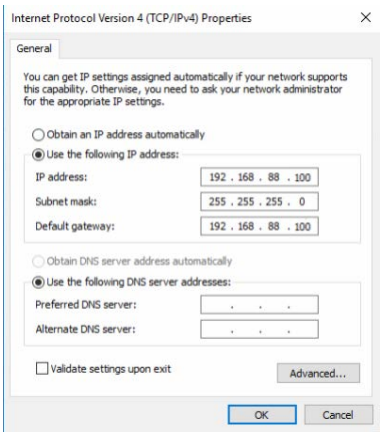
2. Tap and hold the **Ethernet** connection and then tap **Properties** (the display and receivers must be connected to the JB900 junction box to see the active LAN that will be used).



> **NOTE –** In some cases this may display as Thinkpad USB 3.0 Ethernet Adapter, ASIX AX88772B USB2.0 to Fast Ethernet Adapter, or similar.

3. In the **Properties** screen, select **Internet Protocol Version 4 (TCP/IPv4)** and then tap **Properties**. The following dialog appears:





4. Select the **Use the following IP address** group and enter the following:

   IP address: 192.168.88.4

   Subnet mask: 255.255.255.0

   Default gateway: 192.168.88.3

> **NOTE –** By default, the SNM94x is set up to use this static IP address.

5. Select the **Use the following DNS server addresses** group and enter the following:

   Preferred DNS Server: 192.168.88.3

   Alternate DNS Server: 8.8.8.8

6. Tap **OK** then close the **Properties** window.

5

Configuring the GNSS Receivers for use with Groundworks software

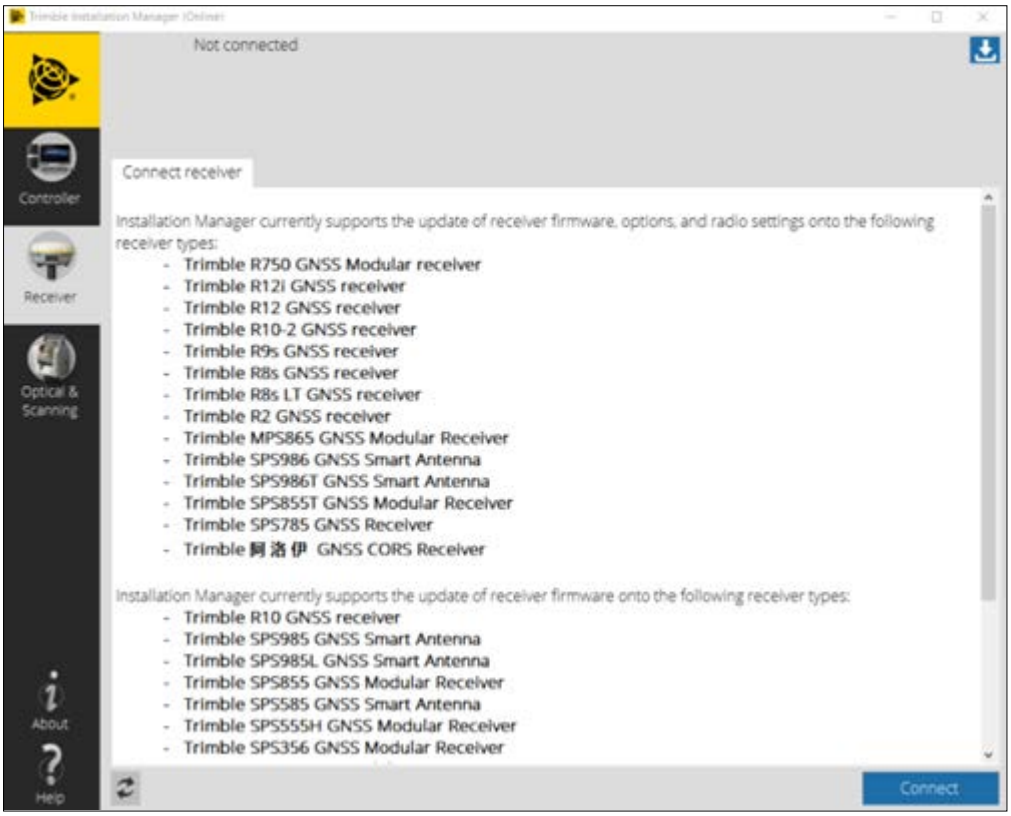
This chapter assumes that you already have a 900 MHz or 450 MHz GNSS base station set up nearby that is outputting CMR corrections via radio. There is also a non-radio version of GNSS receivers that can still receive corrections from VRS, IBSS, etc.

> **NOTE –** All screenshots show an older version of firmware on the GNSS receivers. The latest version of the Trimble GNSS firmware can be downloaded from the Trimble Installation Manager.

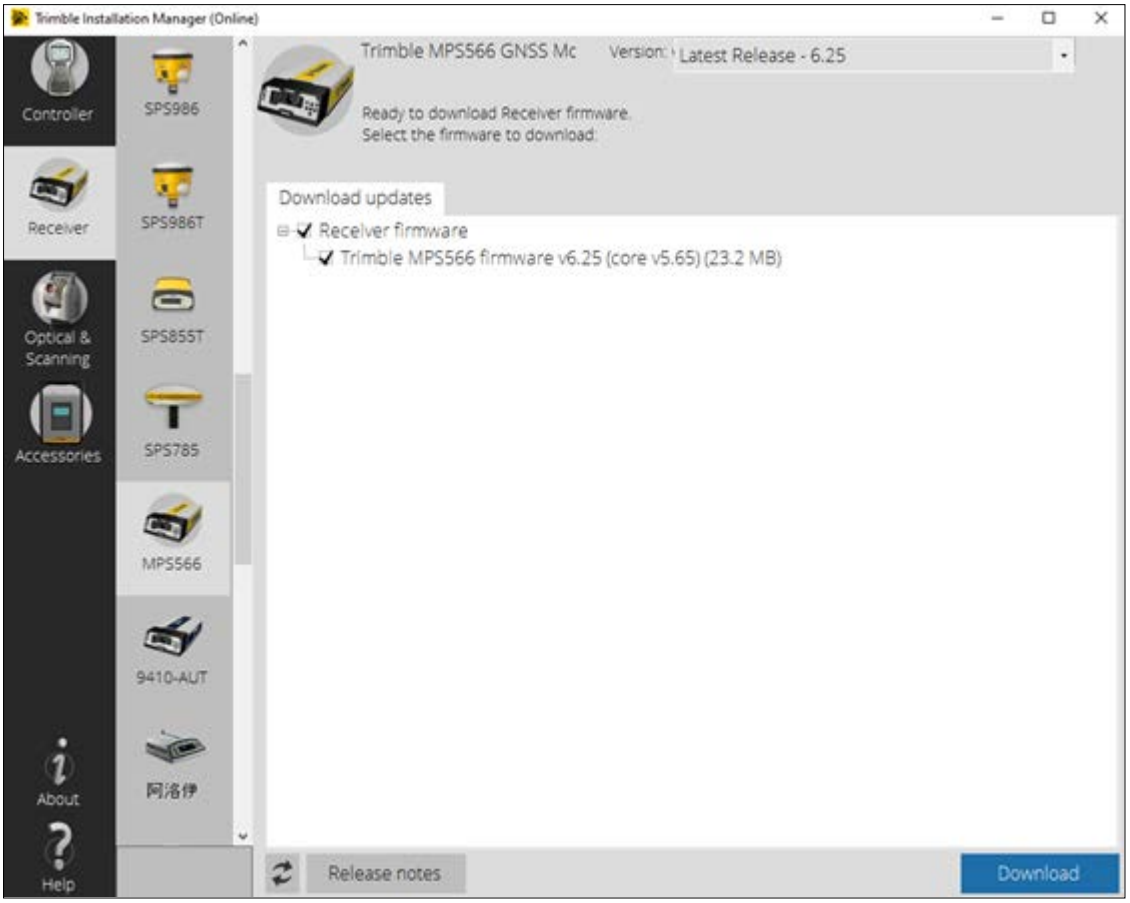
Updating the receivers to the latest version

When you first purchase Groundworks, you must update the receiver to the latest version of the firmware. To update to the latest version, you must install the Trimble Installation Manager (TIM).

1. If you are using a laptop or VERSO display that doesn't have TIM installed, download it from install.trimble.com.
2. Click the **Receiver** tab on the left column and then click the top right download symbol:



3. Find your receiver on the left side and select the version compatible to your warranty date of the receiver. The compatibility warranty date can be found on the GNSS firmware release notes. Click **Download** to download the compatible version.



4. Determine the location of where the files will be saved and download the .timg files.
5. Use an ethernet cable to connect your laptop or VERSO display to the MPS566 GNSS receiver.
6. Wait a few moments and then press the **Up** button on the MPS566 receiver until the **IP Address** screen appears. This should show either 169.254.1.0 or 169.254.1.1.
7. To access the IP address of your receiver (displayed on the front panel), you need to configure your laptop or VERSO 12 display to the appropriate network range. To do this, see Setting up a static IP address on the Trimble VERSO 12 display for the CAN-to-ETH adapter, page 84 using the following ethernet properties:

   IP Address: 169.254.1.100
   Subnet Mask: 255.255.255.0
   Default Gateway: 169.254.1.100

   Select **Use the following DNS server addresses**:

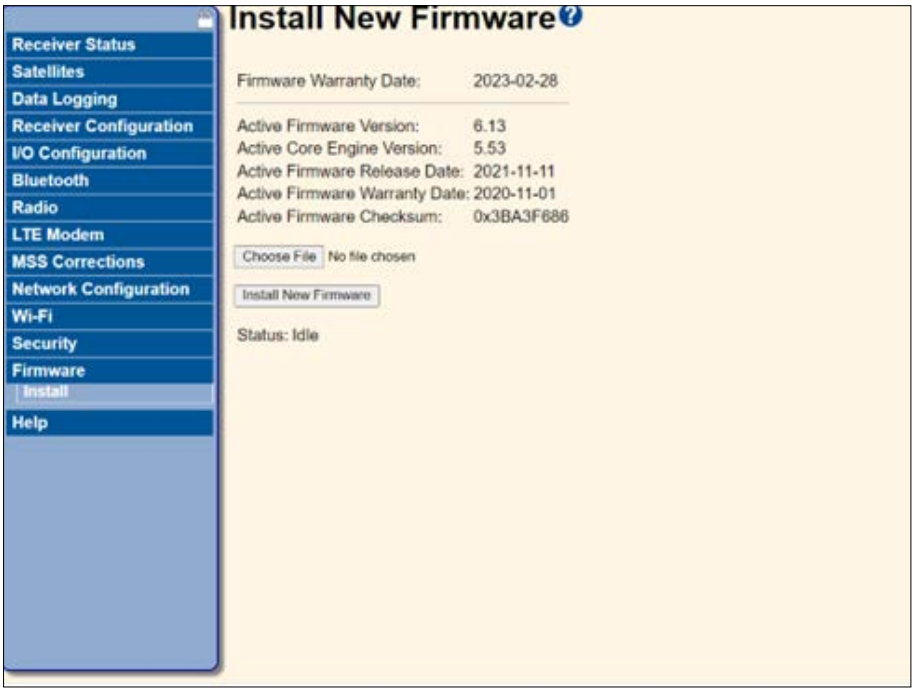
   Preferred DNS server: blank
   Alternate DNS server: blank

8. Open a web browser and enter the corresponding IP address into the search bar, for example: 169.254.1.0.

9. You are prompted to enter login credentials. The default login is:

   User: admin
   Password: password

10. From the receiver web interface menu, click **Firmware**, choose the file downloaded from Trimble Installation Manager, and click **Install New Firmware**:



Setting up the Moving Base receiver using a clone file

When you install the Groundworks software, three clone files called GW_MPS566_ZR3.XML, GW_HEADING_ZR3.XML, and GW_MBASE_ZR3.XML (for installations using Zephyr 3 rugged antennas) are copied to the following location on your device:

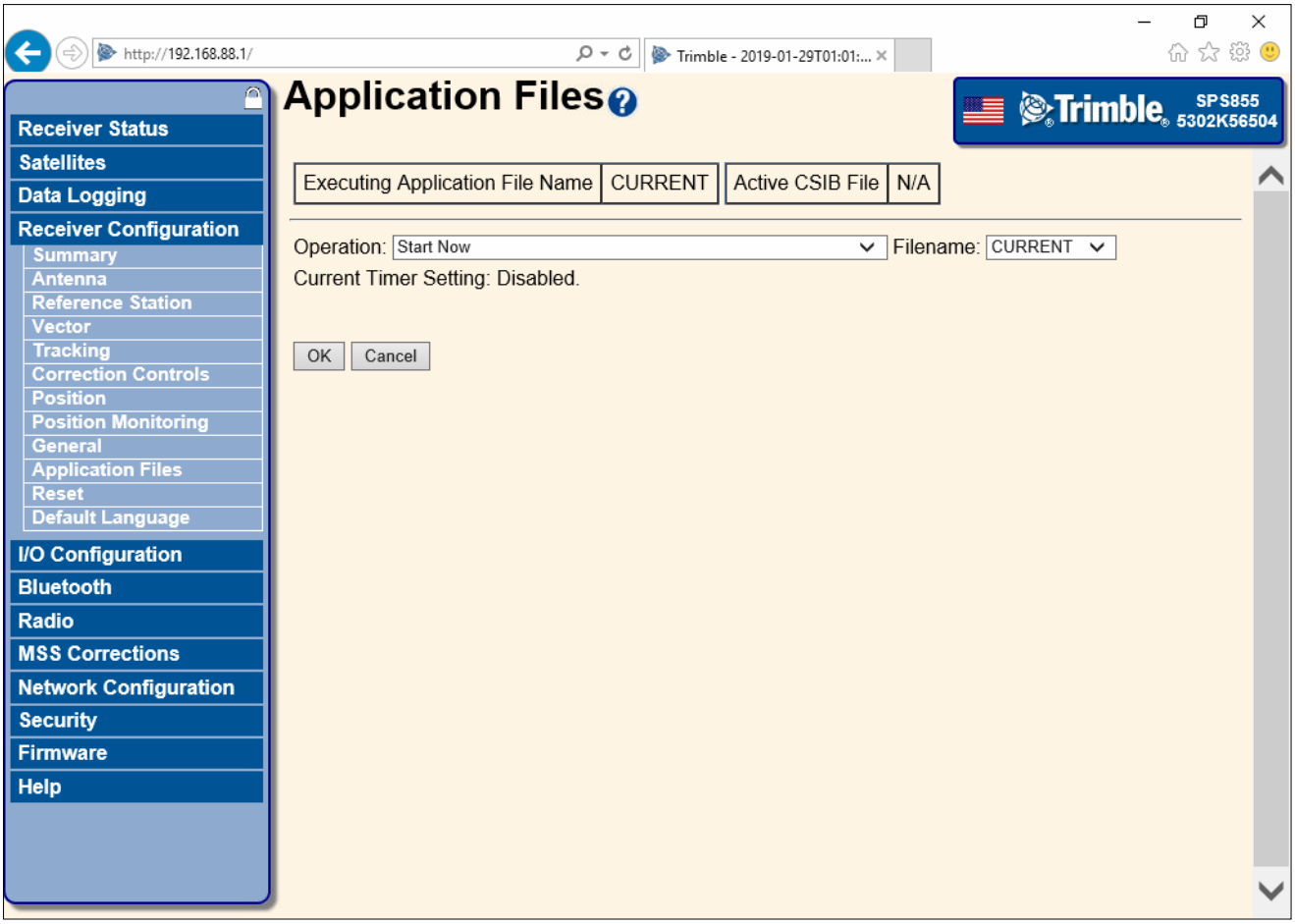
C:\Users\Username\My Documents\Trimble Groundworks Data\Scripts

These files are used to automate the configuration of either the MPS566 dual-antenna GNSS receiver (provides both moving base and heading from a single receiver thus requiring only a single clone file to configure the receiver), or an R750 moving base GNSS receiver with an R750 heading GNSS receiver if you are using a dual-R750 GNSS receiver configuration.

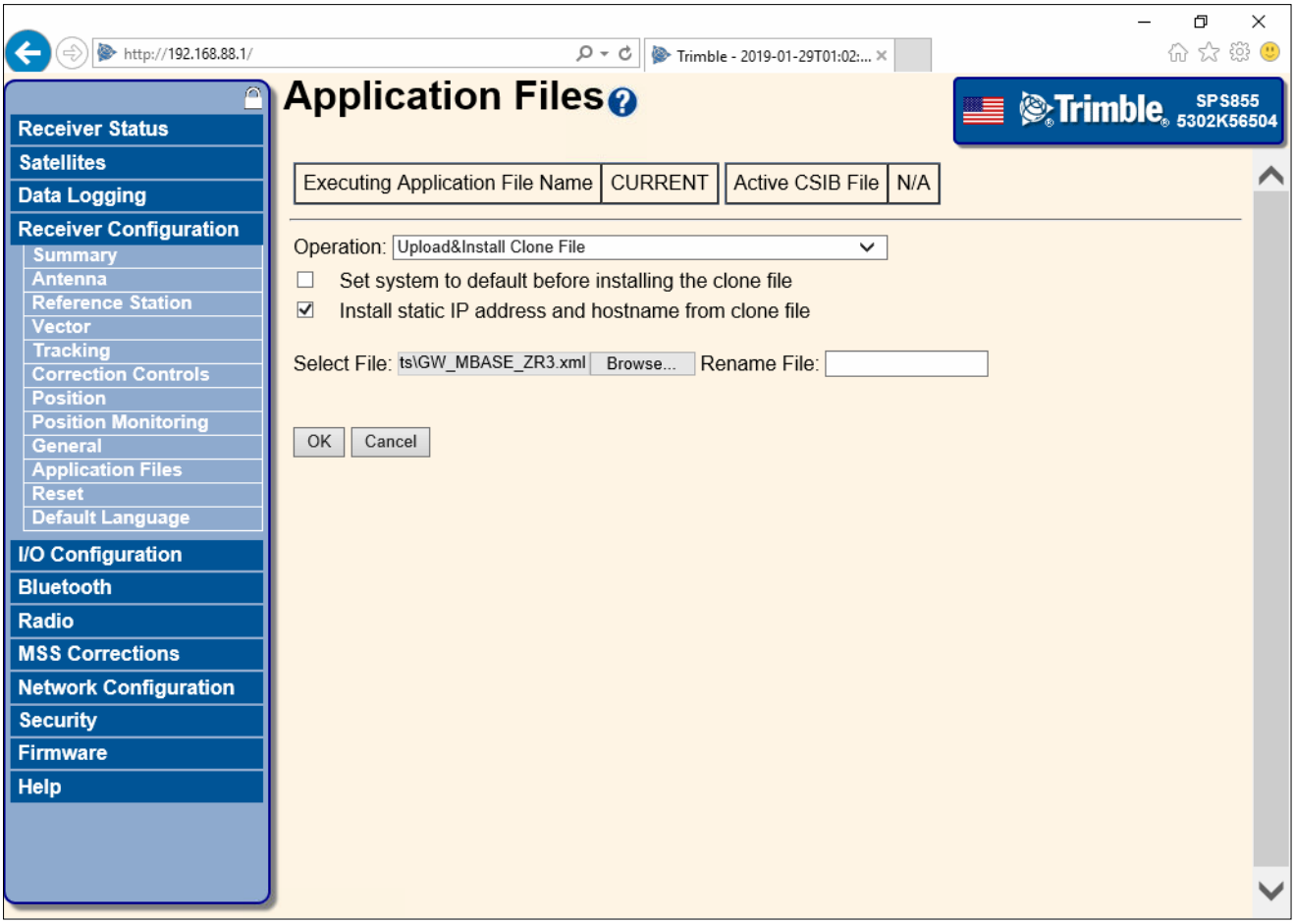
1. Use an ethernet cable to connect your laptop computer to the receiver. If you are using the Trimble VERSO 12 display to set up the receiver, connect the display and the GNSS receiver to the six-port ethernet switch and ensure the 24 V DC power is available to both components.
2. Wait a few moments and then press the **Up** button on the receiver until the **IP Address** screen appears. This should show either 169.254.1.0 or 169.254.1.1.
3. Open a web browser and enter the corresponding IP address into the search bar, for example: 169.254.1.0.
4. You are prompted to enter login credentials. The default login is:

   User: admin
   Password: password

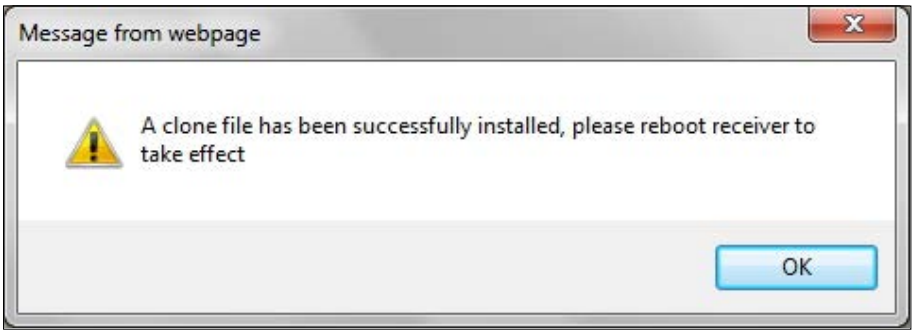
5. When the receiver web interface appears, tap **Receiver Configuration** / **Application Files**. The following screen appears:



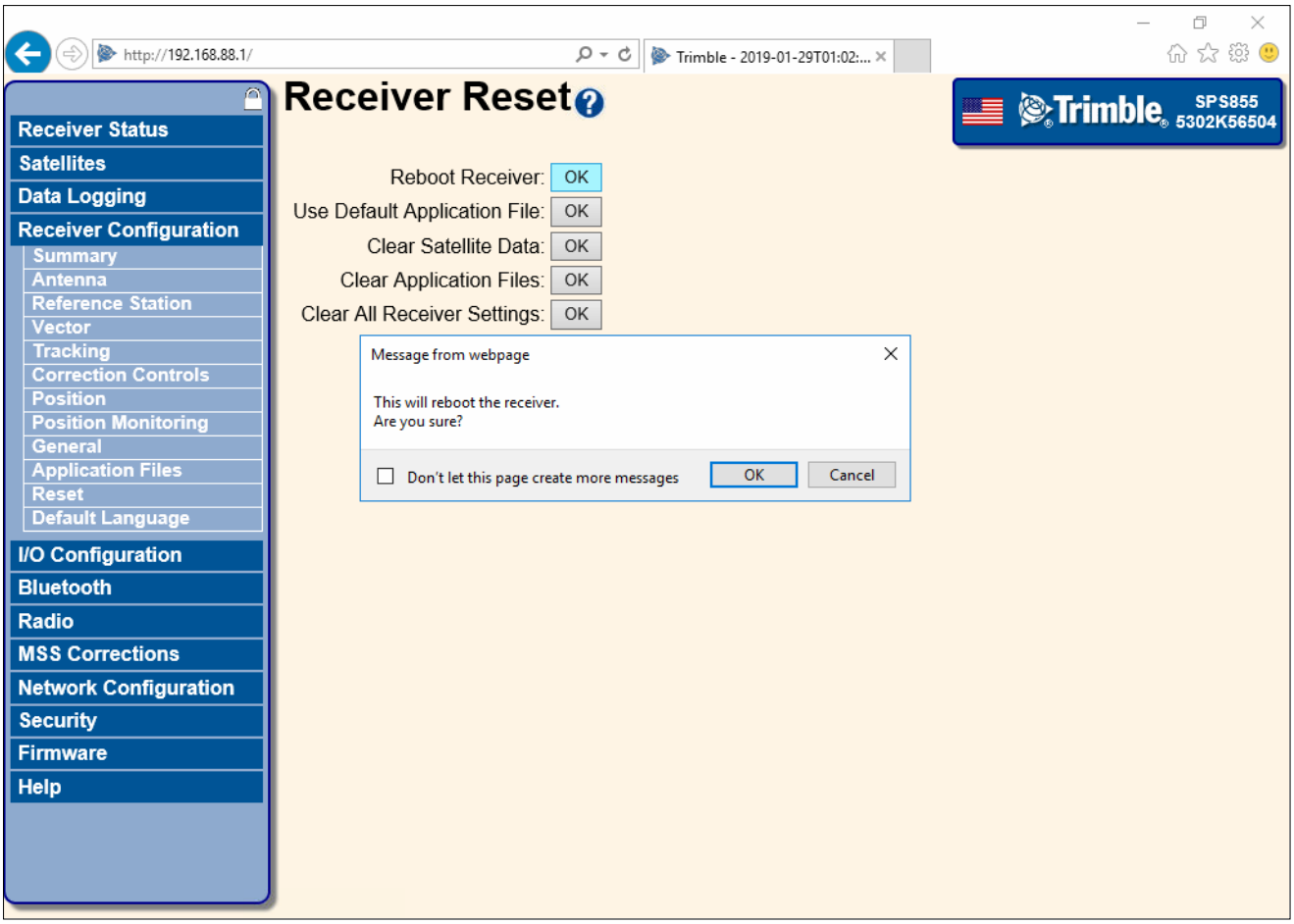
6. In the **Operation** field, select **Upload & Install Clone File**. In the **Select File** field, tap **Browse** and select GW_MBASE_ZR3.XML from the Trimble Groundworks Data folder path mentioned above. Select the **Install static IP address and hostname from clone file** check box and then tap **OK**.



A message appears confirming the clone file was successfully installed:



7. Tap **Receiver Configuration** / **Reset**:



8. Tap **OK** next to **Reboot Receiver** and then tap **OK** again to confirm the reset.
9. You must set the static IP address manually. Select **Network Configuration** / **Ethernet IPv4** to 192.168.88.1 as shown below.

The moving base receiver is now configured and ready to use with the Groundworks software.

Setting up the Heading receiver using a clone file

> **NOTE –** This workflow is not required when using an MPS566 GNSS receiver. It is only required when using a dual-R750 GNSS receiver configuration, or the legacy SPS855/SPS555H dual-receiver configuration.

When you install the Groundworks software, a clone file called GW_HEADING_ZR3.XML (for installations using the Zephyr 3 rugged antennas) are copied to the following location on your device:

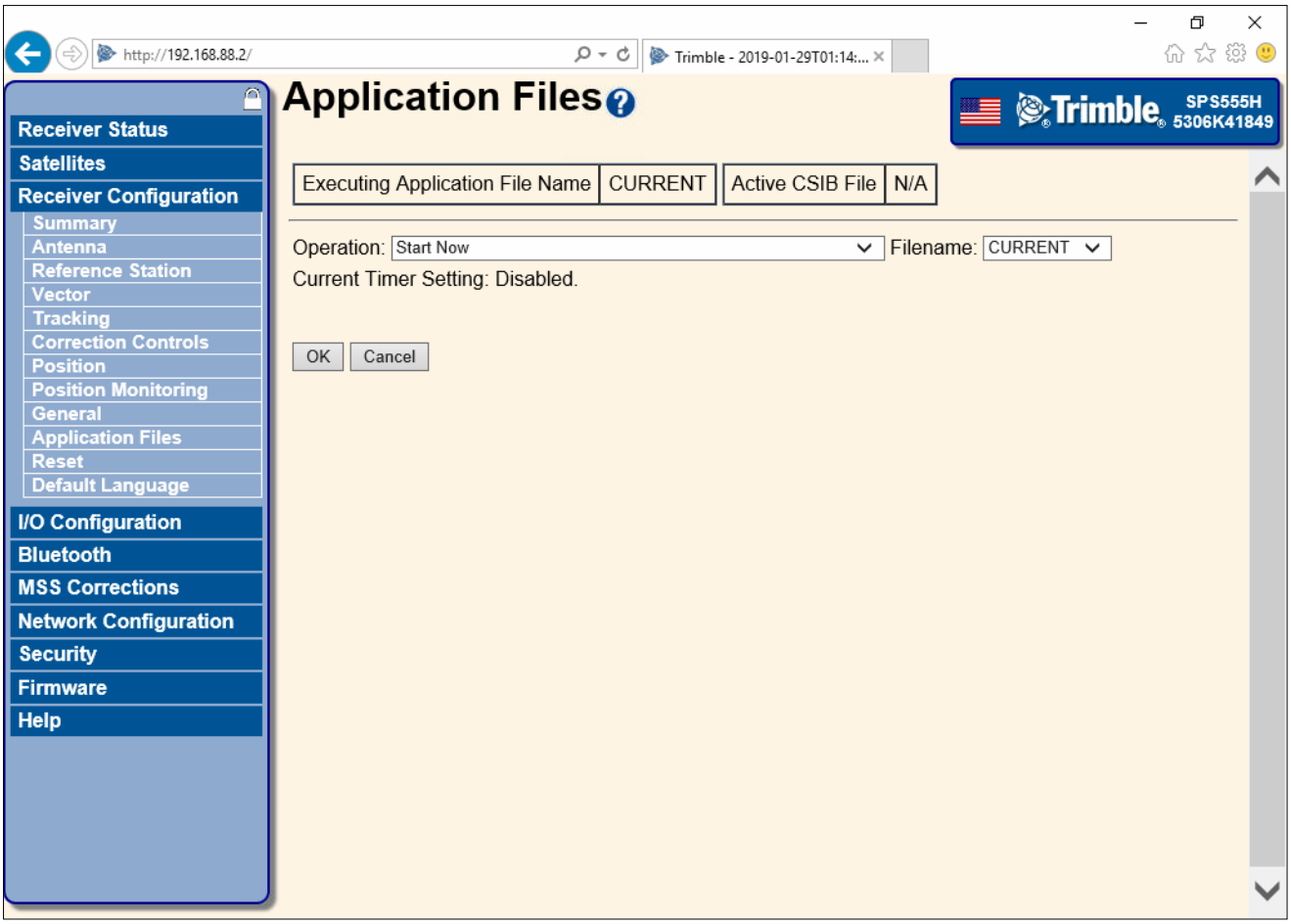
C:\Users\Username\My Documents\Trimble Groundworks Data\Scripts

These files are used to automate the configuration of the R750 Heading GNSS receiver.

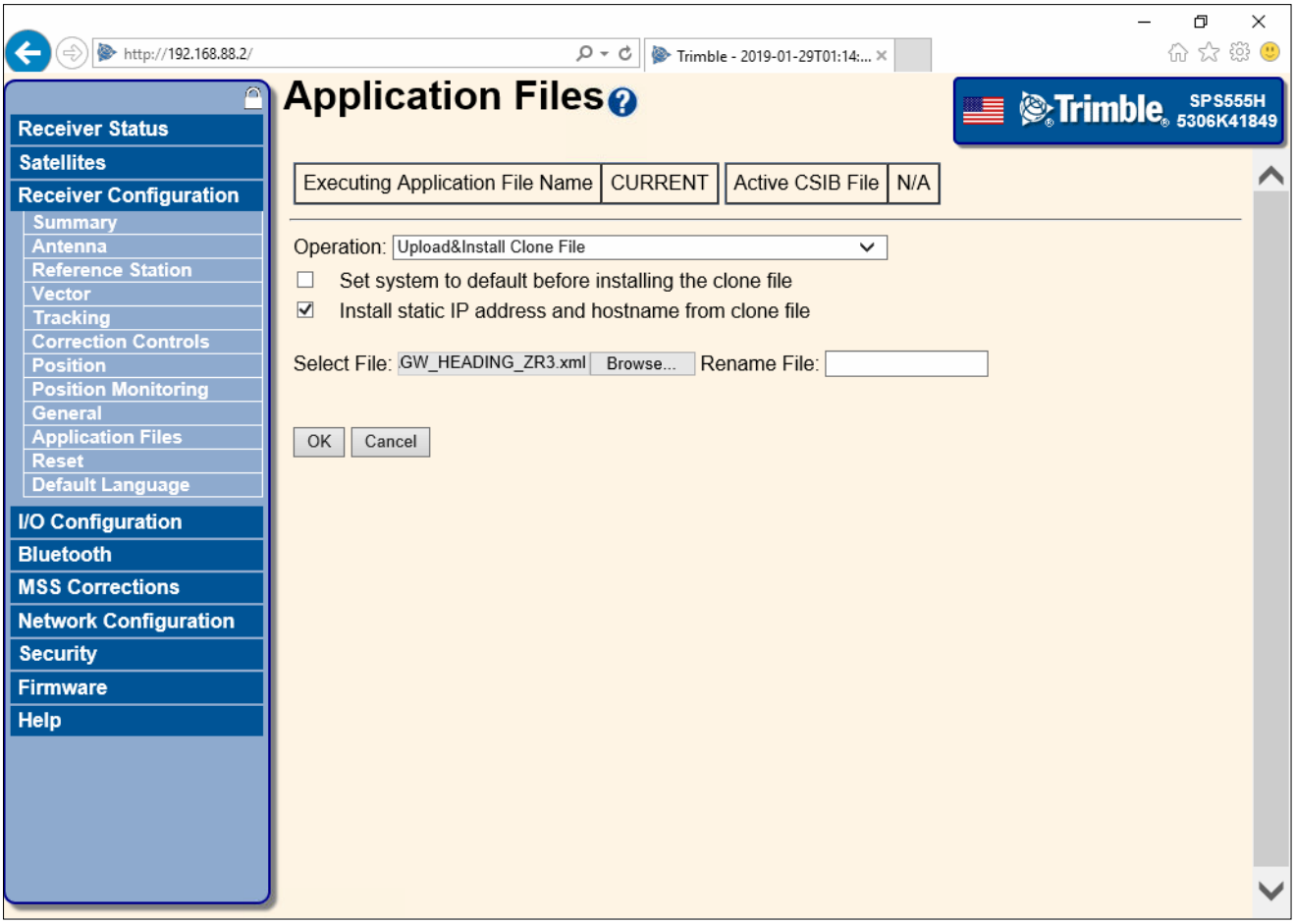
1. Use an ethernet cable to connect your laptop computer to the R750 Heading receiver. If using the Trimble VERSO 12 display to set up receiver, connect the VERSO 12 display and the GNSS receiver to the six-port ethernet switch and ensure that 24 V DC power is provided to both components.
2. Wait a few moments and then press the **Up** button on the Heading receiver until the **IP Address** screen appears. This should be either 169.254.1.0 or 169.254.1.1.
3. Set the ethernet settings on your laptop or VERSO 12 display to 169.254.100 (see Setting up a static IP address on the CAN-to-ETH adapter, page 80).
4. Open a web browser and then enter the corresponding IP address into the search bar, for example: 169.254.1.0.
5. You are prompted to enter login credentials. The default login is:

   User: admin
   Password: password

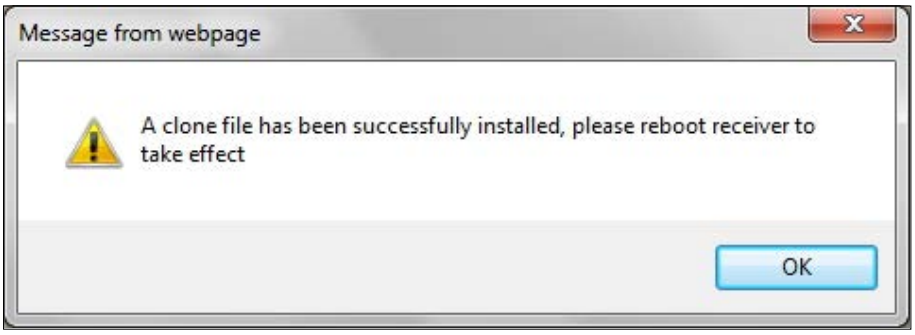
6. When the receiver web interface appears, tap **Receiver Configuration** / **Application Files**:



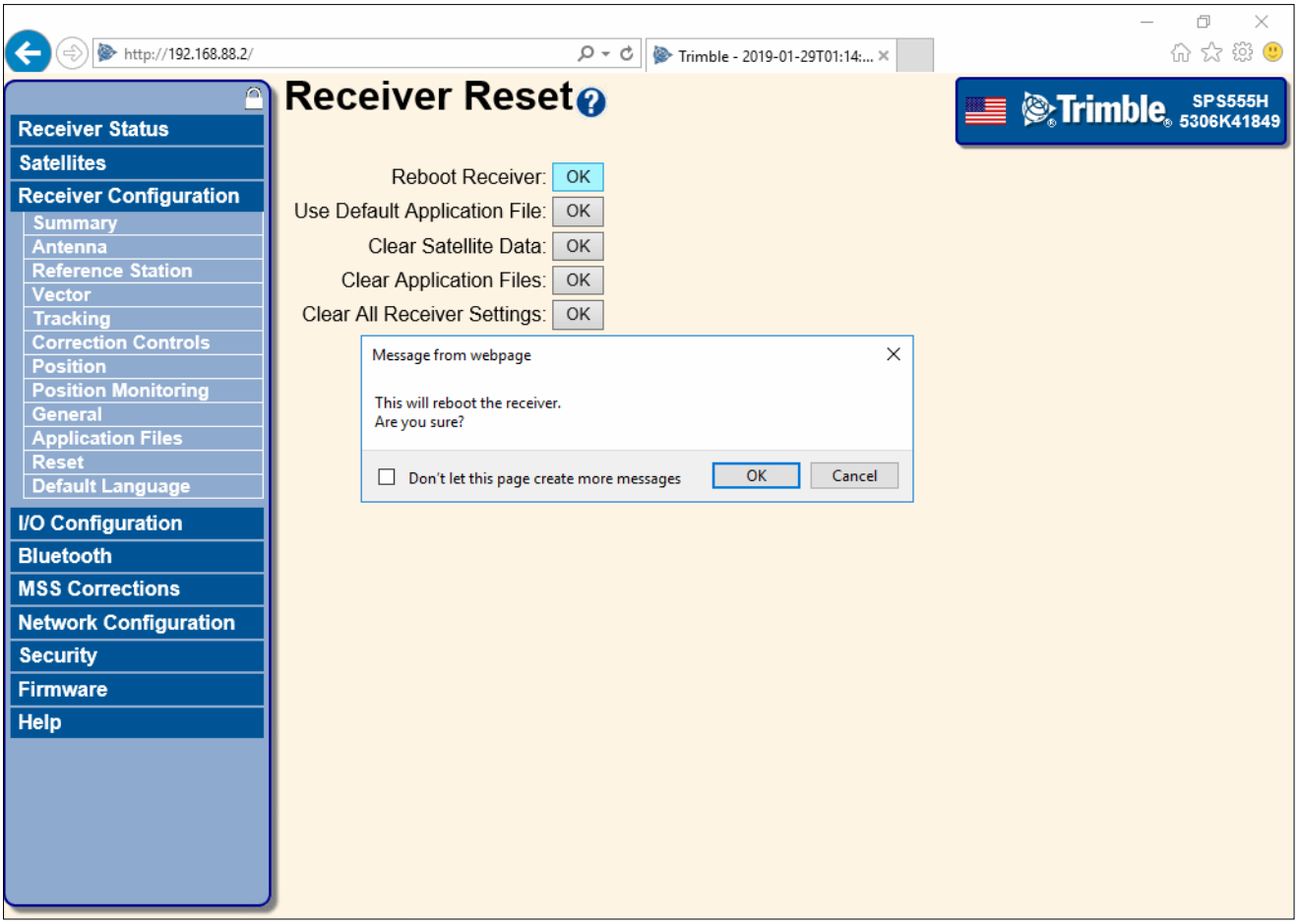
7. In the **Operation** field, select the Upload & Install Clone File option. In the **Select File** field, tap **Browse** and select the GW_HEADING_ZR3.XML from the Trimble Groundworks Data folder path mentioned above. Select the **Install static IP address and hostname from clone file** check box and then tap **OK**.



A message appears confirming that the clone file was successfully installed:



8. Tap **Receiver Configuration** / **Reset**. Tap **OK** next to the **Reboot Receiver** field and then tap **OK** again to confirm the reset.



The GNSS Heading receiver is now configured and ready to use with the Groundworks system.

Setting up a dual-GNSS receiver using a clone file

When you install the Groundworks software, three clone files called GW_MPS566_ZR3.XML, GW_HEADING_ZR3.XML, and GW_MBASE_ZR3.XML (for installations using Zephyr 3 rugged antennas) are copied to the following location on your device:

C:\Users\Username\My Documents\Trimble Groundworks Data\Scripts

Here, you will be using the clone file, GW_MPS566_ZR3, to automate the configuration of the MPS566 receiver or the BX992 dual-antenna receiver.

1. Use an ethernet cable to connect your laptop to the GNSS receiver. If using the Trimble VERSO 12 display to set up receiver, connect the VERSO 12 display and the MPS566 receiver to the six-port ethernet switch and ensure that 24 V DC power is provided to both components.
2. Wait a few moments and then press the **Up** button on the receiver until the **IP Address** screen appears. This should be either 169.254.1.0 or 169.254.1.1.
3. To access the IP address of your receiver displayed on the front panel, you need to configure your VERSO 12 display to the appropriate network range. Follow the steps in Setting up a static IP address on the CAN-to-ETH adapter, page 80 using the following ethernet properties:

   IP Address: 169.254.1.100
   Subnet Mask: 255.255.255.0
   Default Gateway: 169.254.1.100

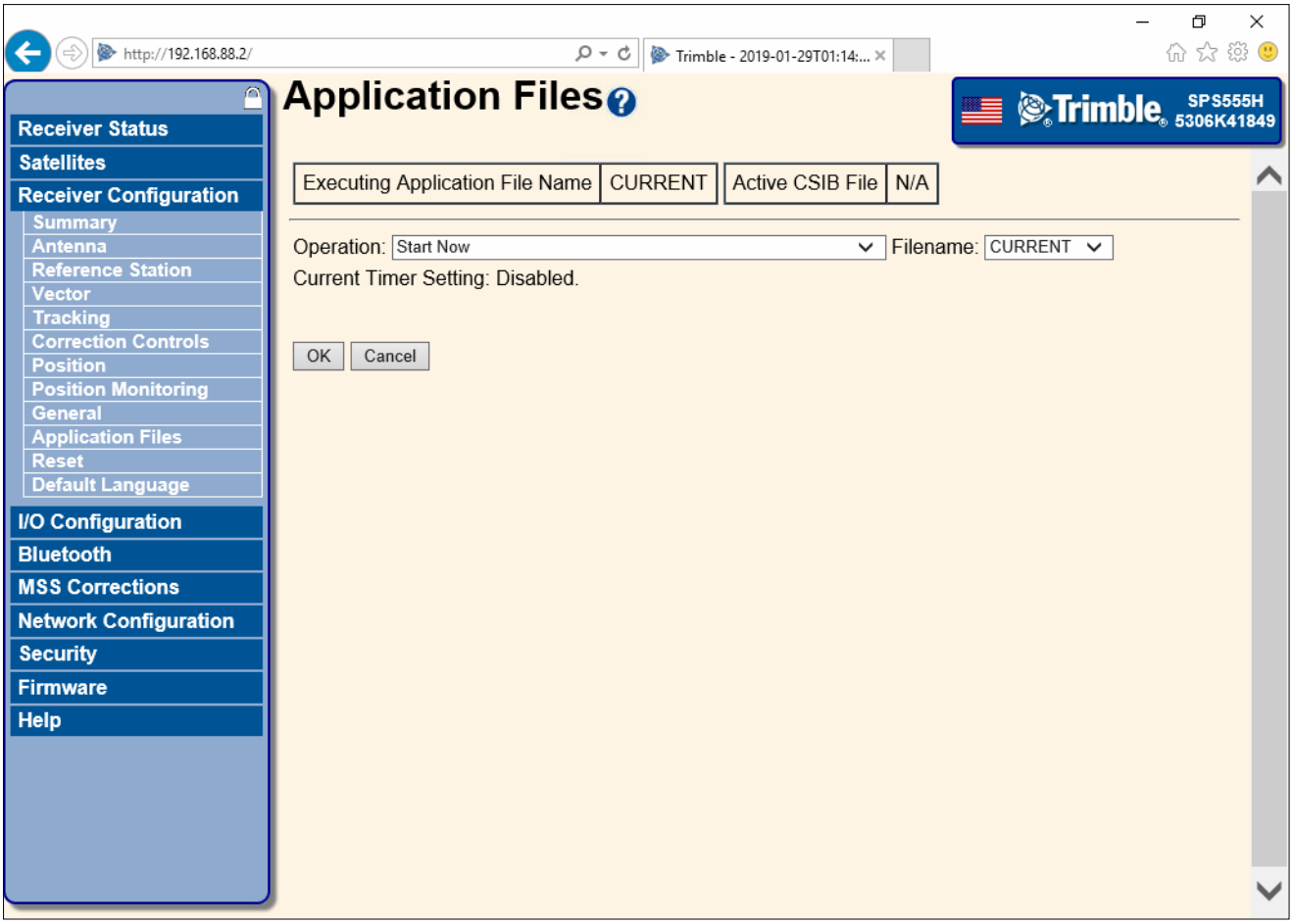
   Select **Use the following DNS server addresses**:

   Preferred DNS server: blank
   Alternate DNS server: blank

4. Open a web browser and then enter the corresponding IP address into the search bar, for example: 169.254.1.0.
5. You are prompted to enter login credentials. The default login is:

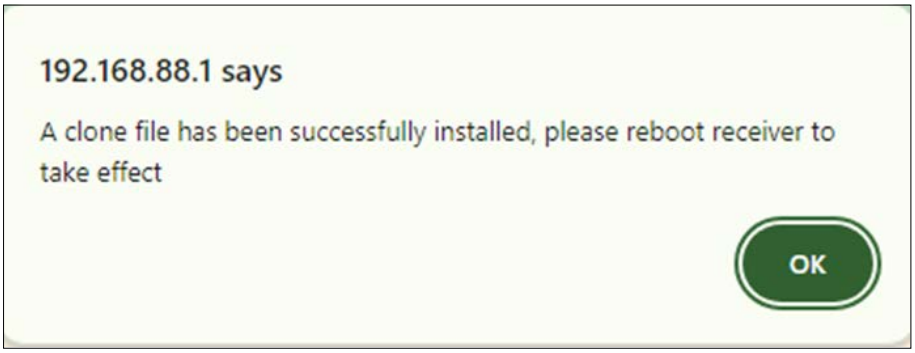
   User: admin
   Password: password

6. After successfully signing into the receiver web interface, tap **Receiver Configuration** / **Application Files**. The following screen appears:

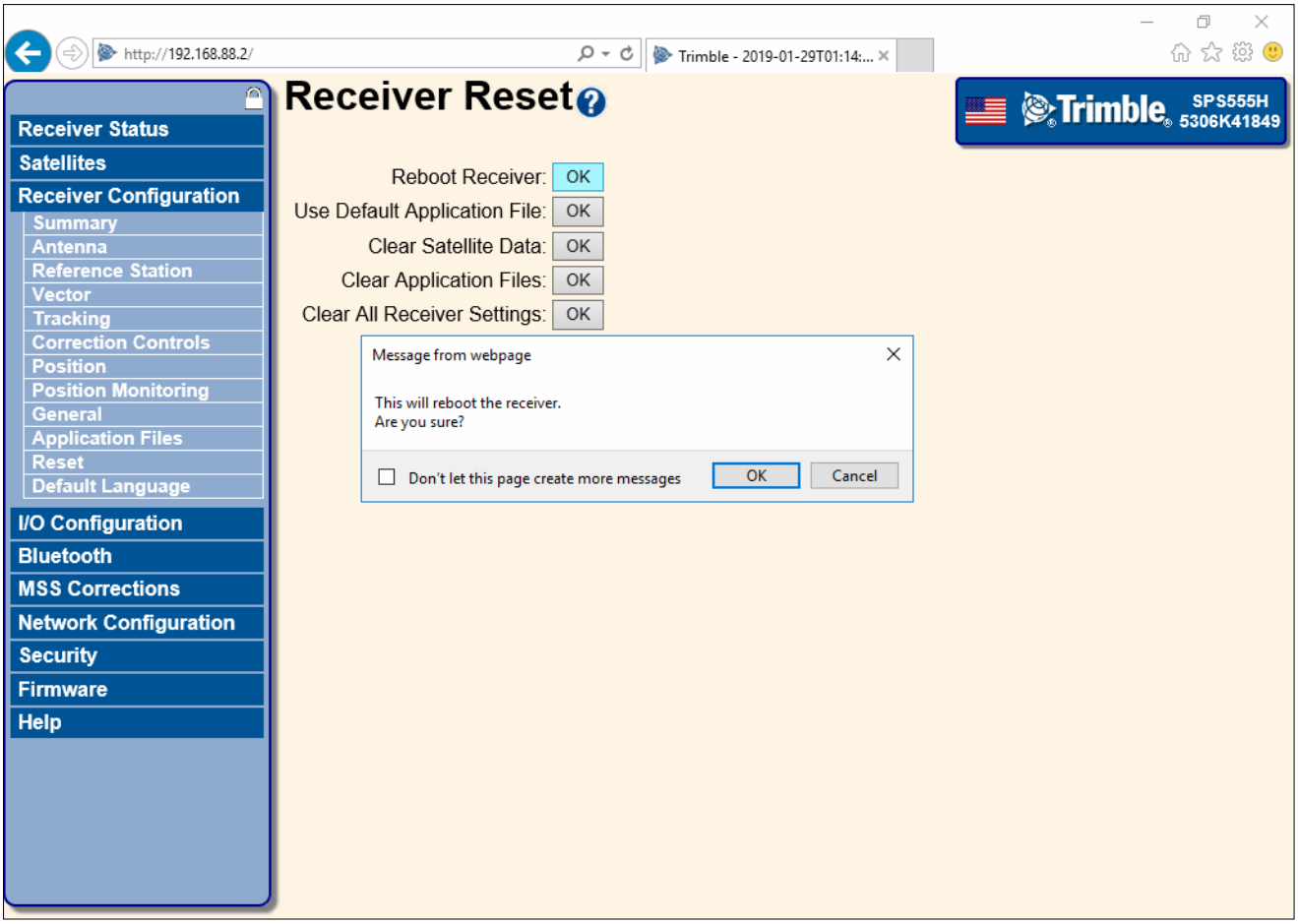


7. In the **Operation** field, select **Upload & Install Clone File**. In the **Select File** field, tap **Browse** and select GW_MPS566_ZR3.XML from the Trimble Groundworks Data folder path mentioned above. Once the file is uploaded, click **OK**.

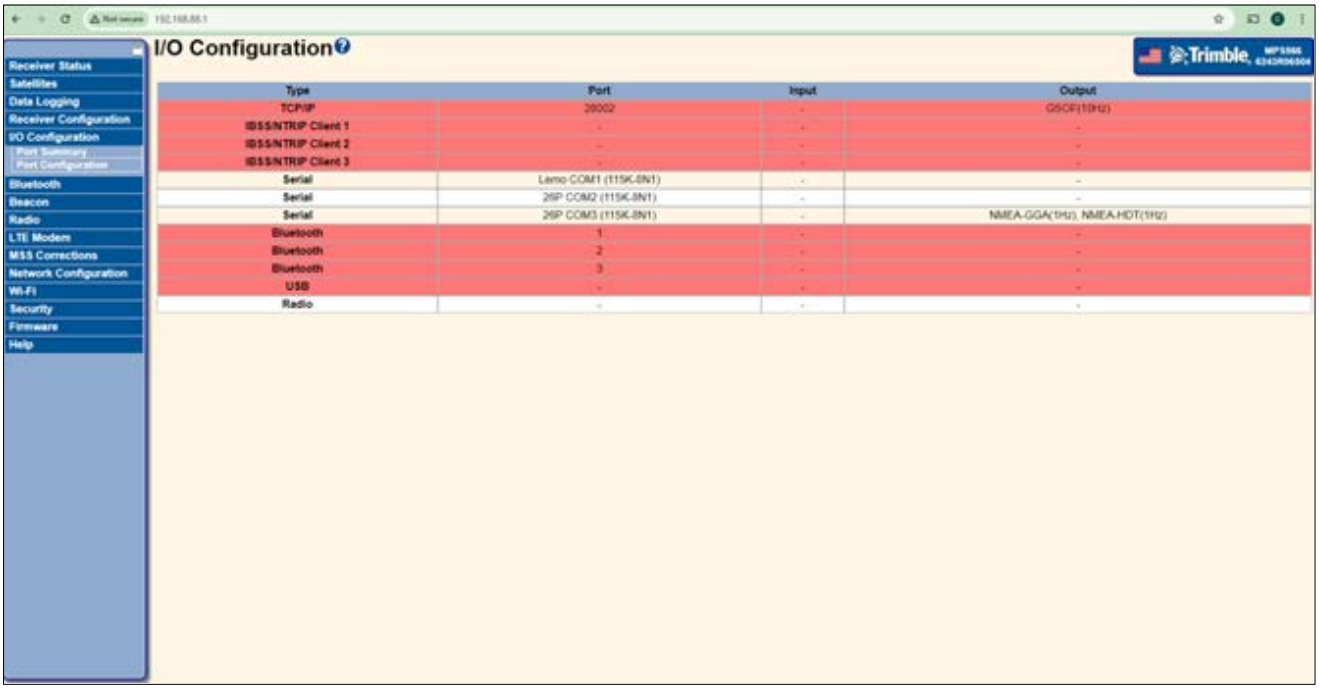
   A message appears confirming that the clone file was successfully installed:



8. Tap **Receiver Configuration** / **Reset**. Tap **OK** next to **Reboot Receiver** and then tap **OK** again to confirm the reset.



9. Once the receiver has restarted, tap **I/O Configuration** / **Port Summary**, and confirm that there is a port 28002 with an **Output** set to GSOF (10 Hz).



10. You must set the static IP address manually. Select **Networks Configuration** / **Ethernet IPv4**. From the **IP Setup** field, select **Static IP**. Enter 192.168.88.1 as shown:

11. Your receiver will now restart with the newly assigned IP address of 192.168.88.1. To access the receiver web interface, you need to once again configure your laptop or VERSO 12 display to the appropriate network range. To do this, see Setting up a static IP address on the Trimble VERSO 12 display for the CAN-to-ETH adapter, page 84, using the following ethernet properties:

    IP Address: 192.168.88.100
    Subnet Mask: 255.255.255.0
    Default Gateway: 192.168.0.

    Select **Use the following DNS server addresses**:

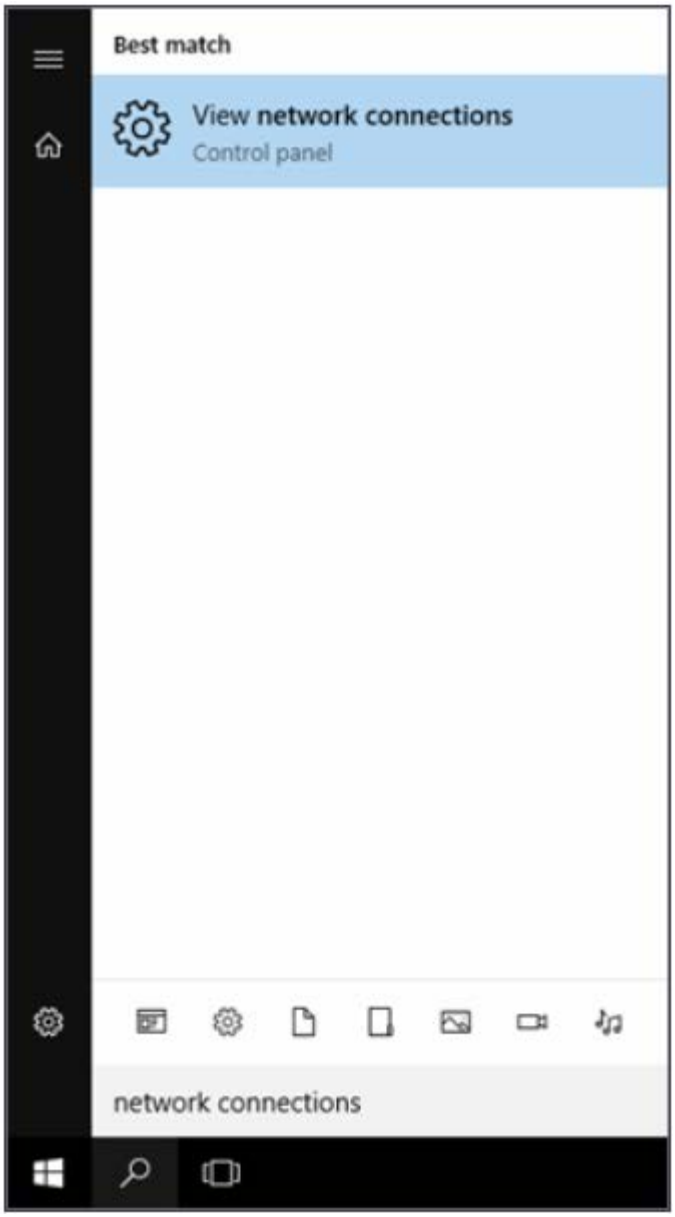
    Preferred DNS server: blank
    Alternate DNS server: blank

Setting up a static IP address on the CAN-to-ETH adapter

The Trimble CAN-to-ETH adapter requires a static IP address to be configured. The Groundworks software can handle up to 2 × CAN-to-ETH adapters. Typically, a generic aftermarket installation requires one adapter and OEM installations may require two adapters.

To change the IP address of the Trimble CAN-to-ETH adapters:

1. You must set a static IP address for your VERSO display. From the **Windows Start** menu, in the **Search**, enter Network connections. Tap the **View Network connections** link when it appears:



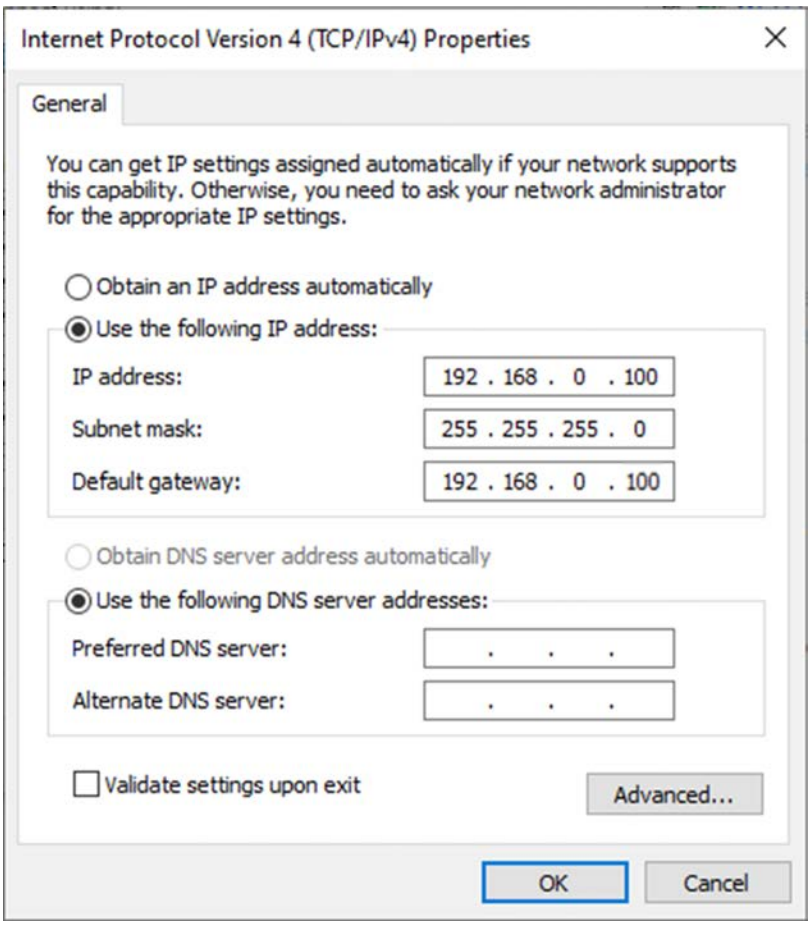
2. Tap and hold the **Ethernet** connection and then tap **Properties**.

   Select **Use the following IP address**:

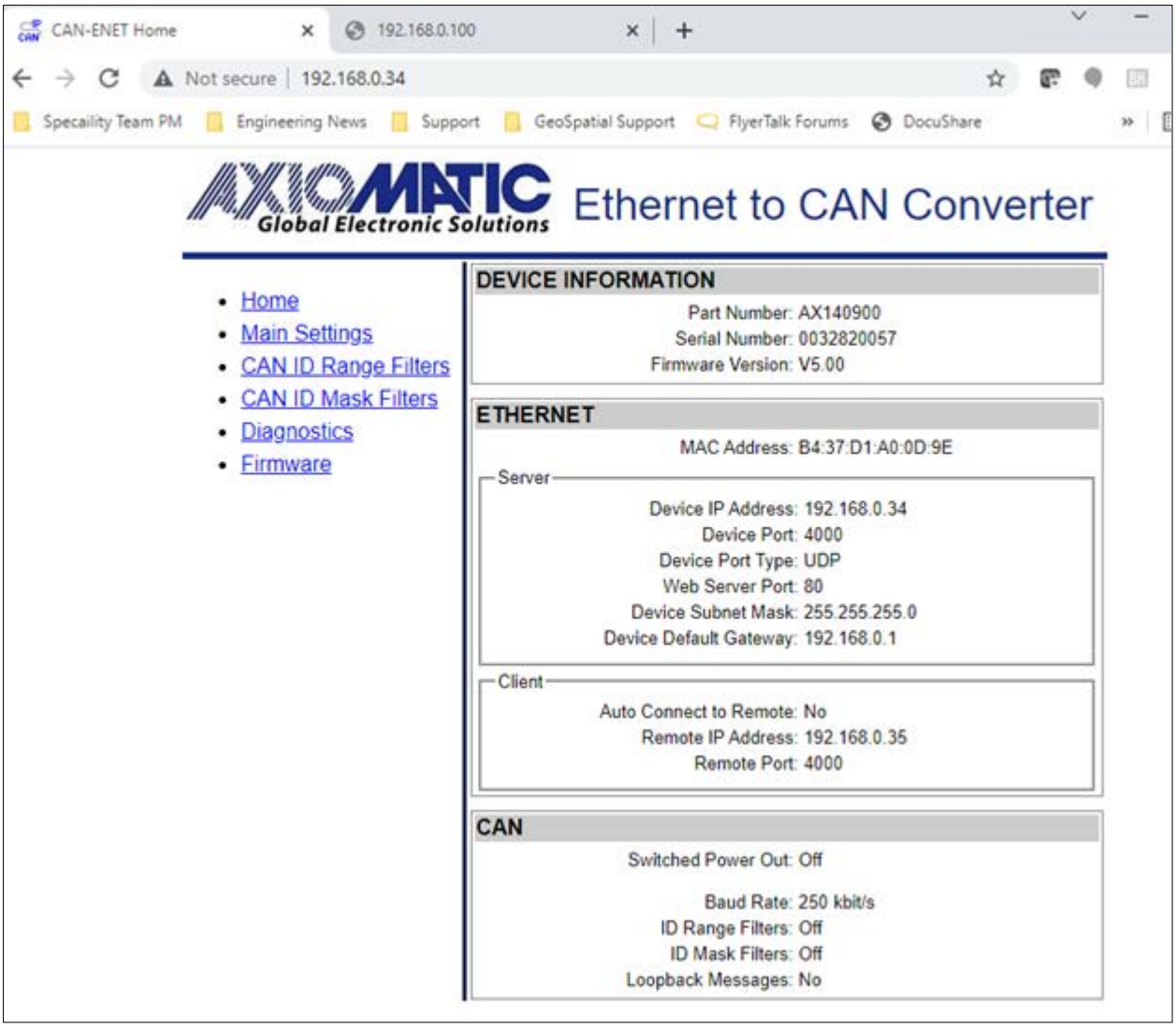
   IP Address: 169.254.1.100
   Subnet Mask: 255.255.255.0
   Default Gateway: 169.254.1.100

   Select **Use the following DNS server addresses**:

   Preferred DNS server: blank
   Alternate DNS server: blank

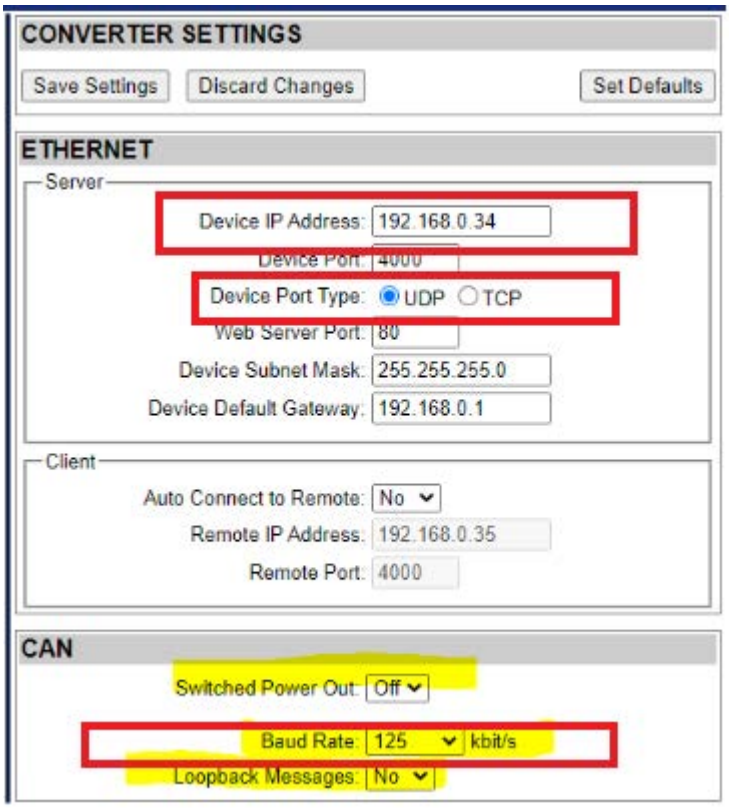


3. At this point your CAN-to-ETH adapter should be connected to the system. If you are using two adapters, connect one at a time to configure them as out-of-the-box adapters have the same static IP address.
4. Open an Internet browser and type in address **192.168.0.34** (Google Chrome is the recommended browser):



5. Change the Device IP address from the default to **192.168.88.34**.

> **NOTE –** Your CAN-to-ETHERNET converter should come with firmware version 5.05. If an older firmware is present on the converter, please update to version 5.05, which is available on Trimble Partners. If you update the firmware, you must reconfigure the static IP address because the firmware upgrade will revert to the factory settings.



Device Port Type: Set to TCP
Baud Rate: 125

6. If you are using two CAN-to-ETH devices, as in the case of an OEM integration, please modify the IP address for the second device following the steps above to **192.168.88.35**.

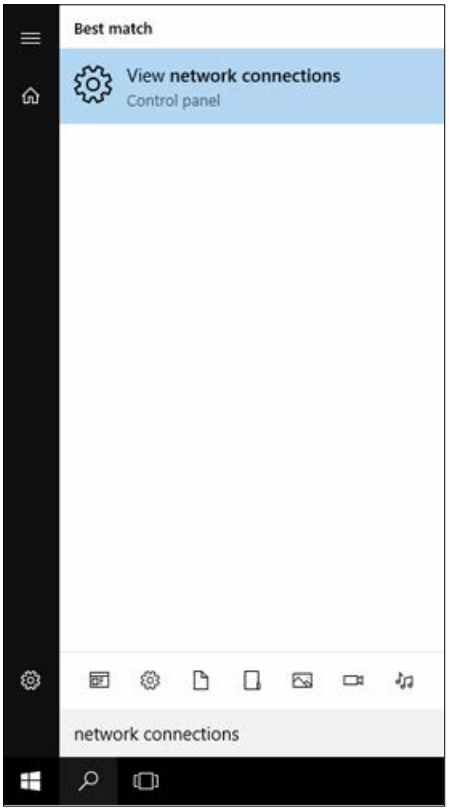
> **NOTE –** If using a second CAN-to-ETH converter, the baud rate for all OEM integrations is 250 kbits/second as opposed to 125 kbits/second for all Trimble sensors.

Setting up a static IP address on the Trimble VERSO 12 display for the CAN-to-ETH adapter

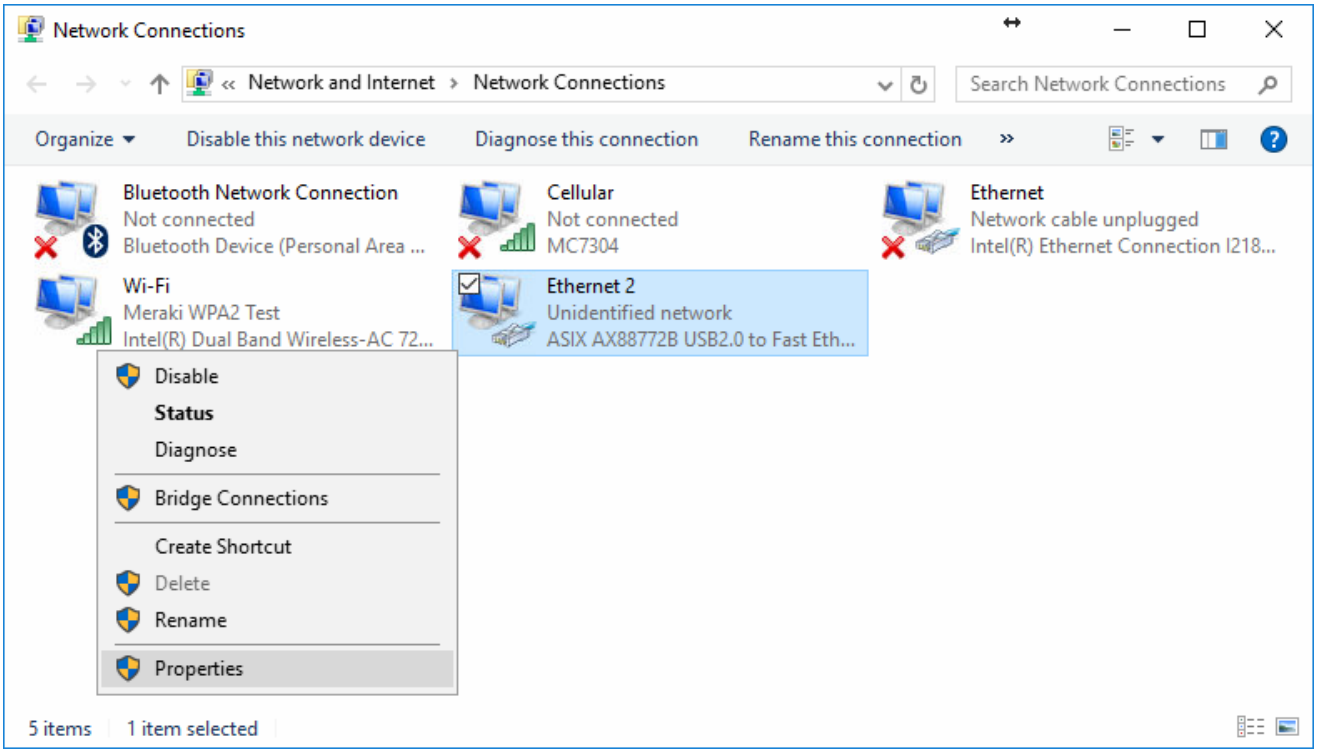
The Trimble VERSO 12 display, CAN-to-ETH adapter, and the GNSS receiver(s) must be configured on the same network. For this to be possible, each component requires a unique and static IP address. By this point, you have already set up the GNSS receiver(s) with static IP addresses using the clone files. In this section, you will set up a static IP address for the Trimble VERSO 12 display.

To change the IP address of the Trimble VERSO 12 display:

1. From the Windows **Start** menu, enter **Network connections** into the **Search** field. Tap the **View Network connections** link when it appears:

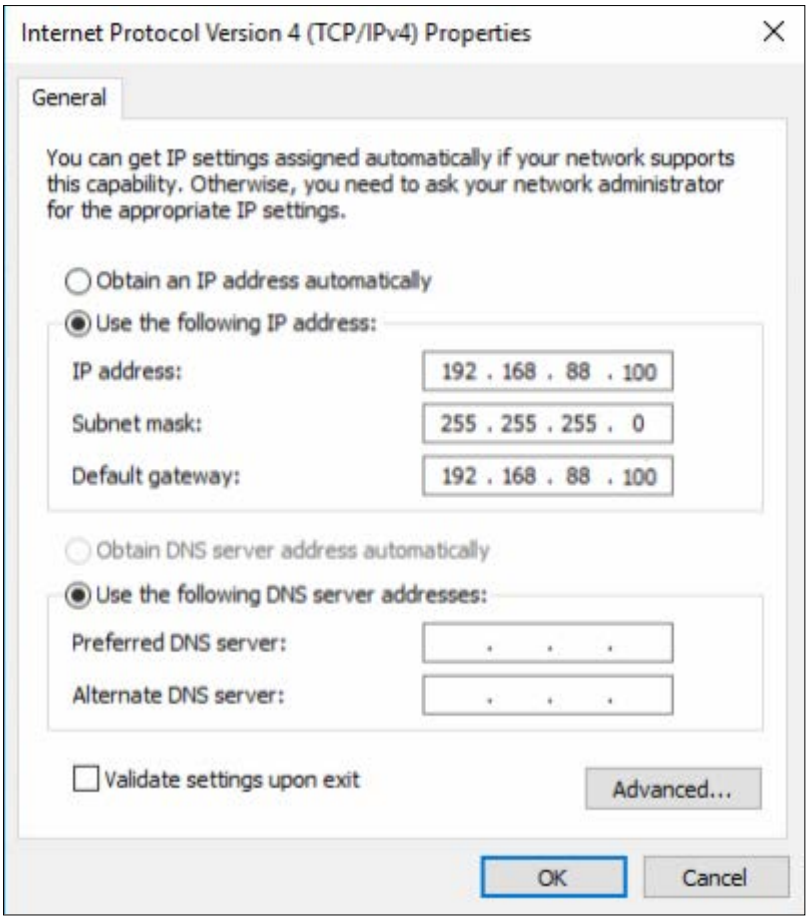


2. Tap and hold the **Ethernet** connection and then tap **Properties** (the display and receivers must be connected to the ethernet switch to see the active LAN that will be used).



> **NOTE –** In some cases this may display as Thinkpad USB 3.0 Ethernet Adapter, ASIX AX88772B USB2.0 to Fast Ethernet Adapter, or similar.

3. In the **Properties** screen, select **Internet Protocol Version 4 (TCP/IPv4)** and then tap **Properties**. The following dialog appears:



4. Select **Use the following IP address**:

   IP address: 192.168.88.100
   Subnet Mask: 255.255.255.0
   Default Gateway: 192.168.88.100

   Select **Use the following DNS server addresses**:

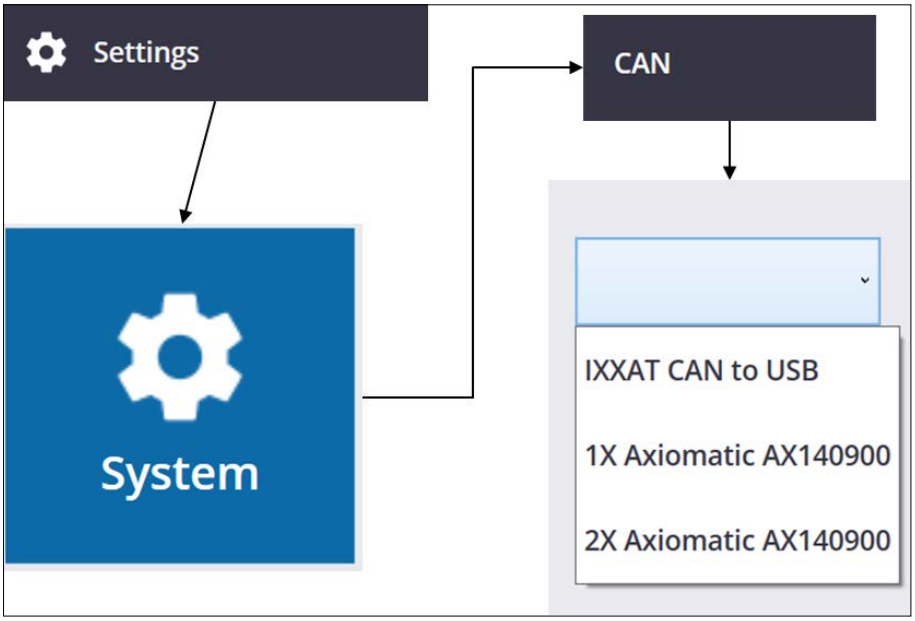
   Preferred DNS server: blank
   Alternate DNS server: blank

5. Tap **OK** then close the **Properties** window.

Setting up the Groundworks software

After the hardware is configured, the Groundworks software must be configured to match the existing configuration.

1. Open the Groundworks executable file.
2. Create a machine profile and user profile and log in.
3. Select **Setting** / **System** / **CAN**.
4. From the drop-down menu, select:
   - **1 × Axiomatic AX140900**, if using one CAN-to-ETH adapter.
   - **2 × Axiomatic AX140900**, if using two CAN-to-ETH adapter.
   - **IXXAT CAN to USB**, if using legacy JB900 hardware.



7

Measuring up the Machine

For step-by-step instructions on measuring up a machine for the Groundworks system, please refer to the *Groundworks Measure-Up Guide* found on the Partners website.

> **NOTE –** The Partners website is regularly updated to show all released documentation for the Groundworks system. If a referenced document is not found on Partners, please contact Support for further instructions.

8

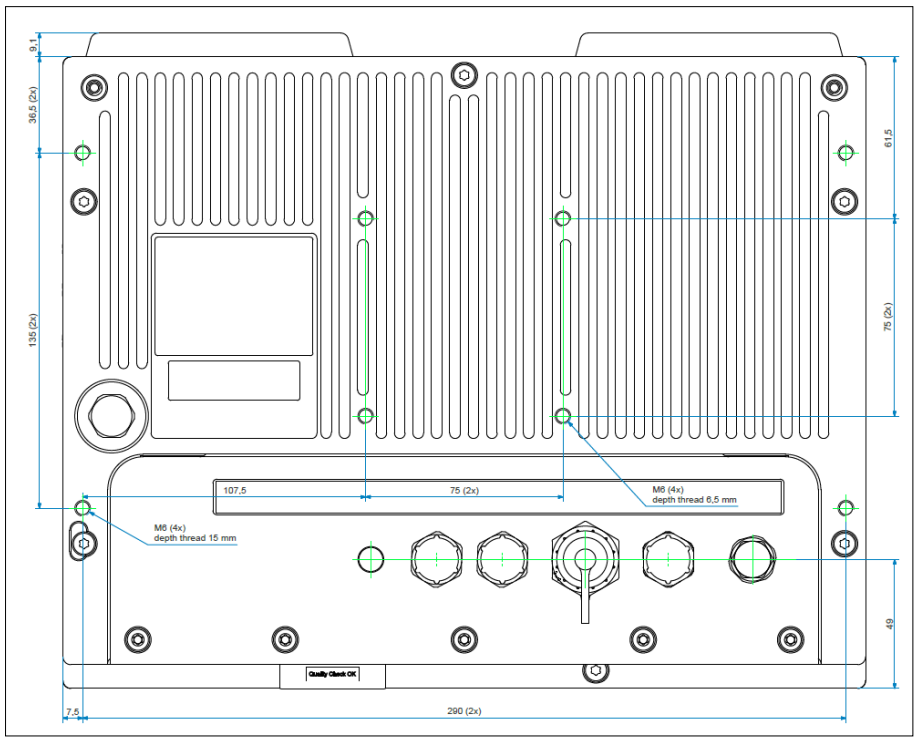
Detailed Drawings

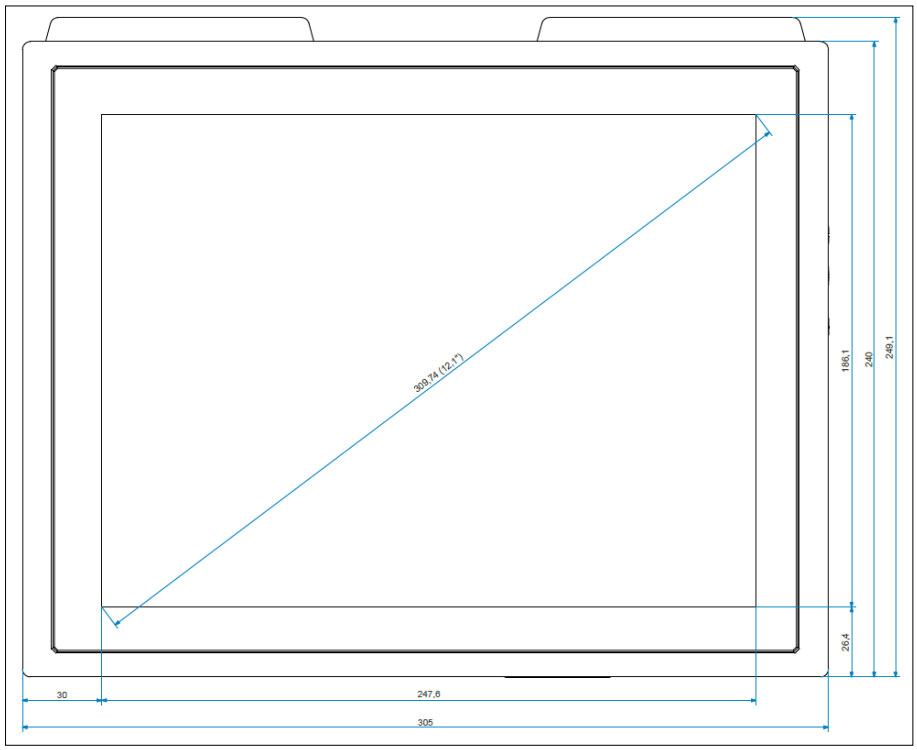
This chapter shows detailed drawings of the system components.

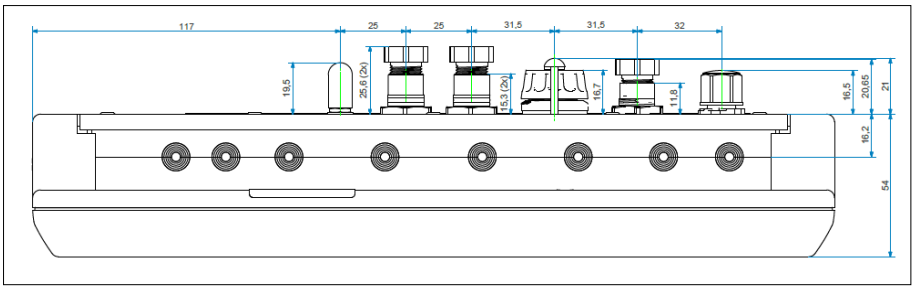
> **NOTE –** All units are in mm unless otherwise noted.

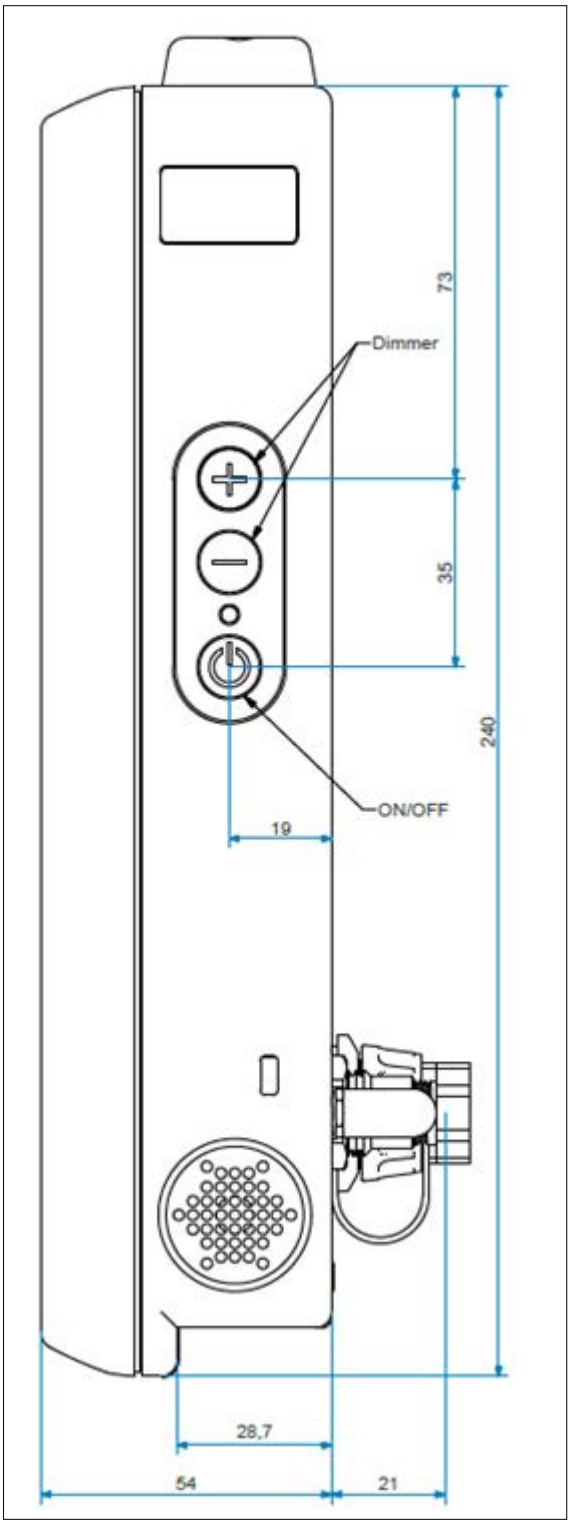
VERSO 12 touch display

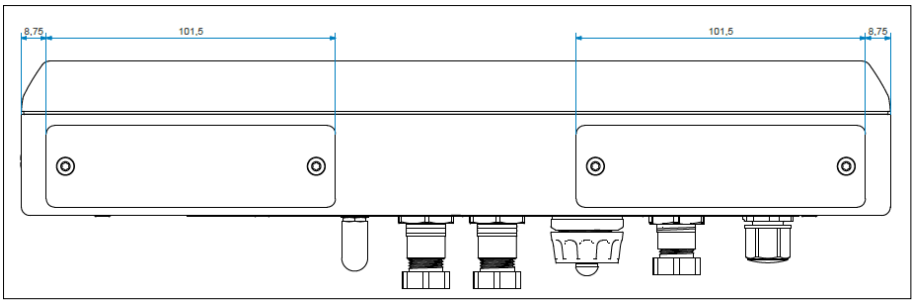
P/Ns TABV12-00-i7 and TABV12-10-i7



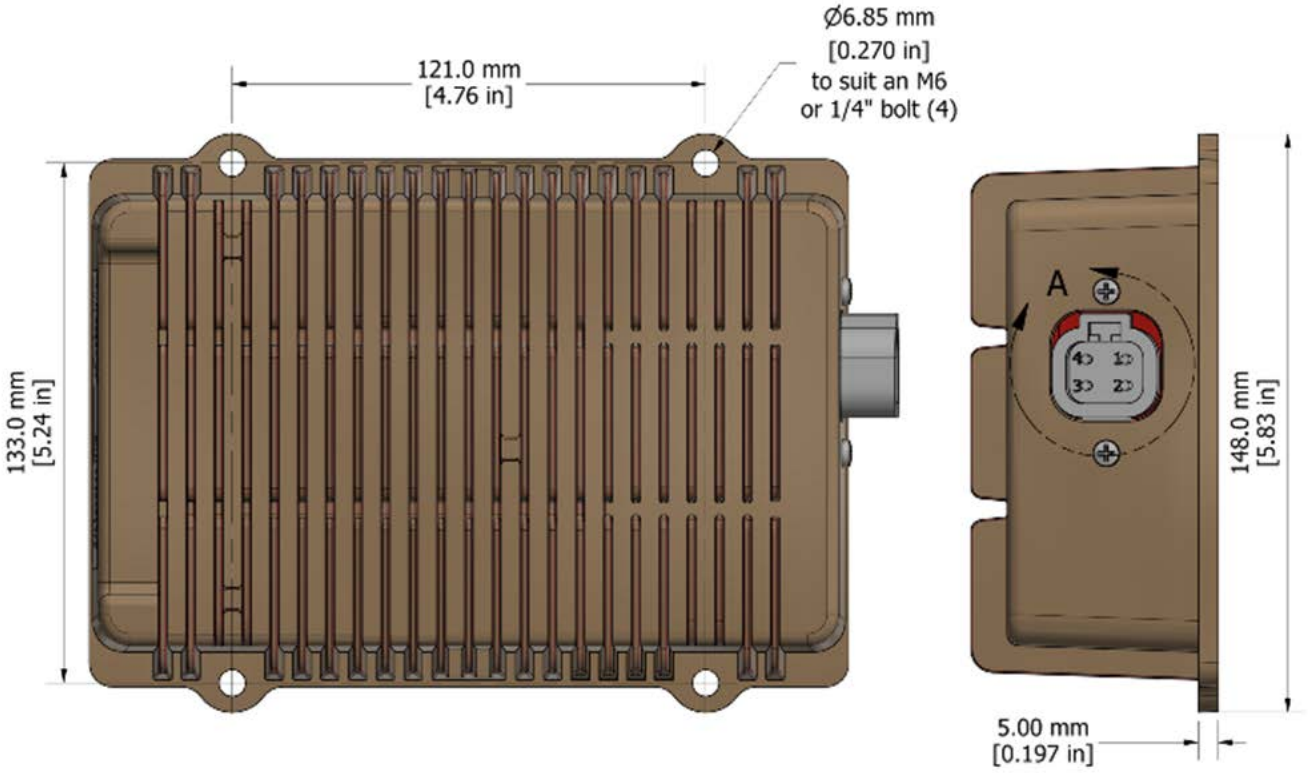


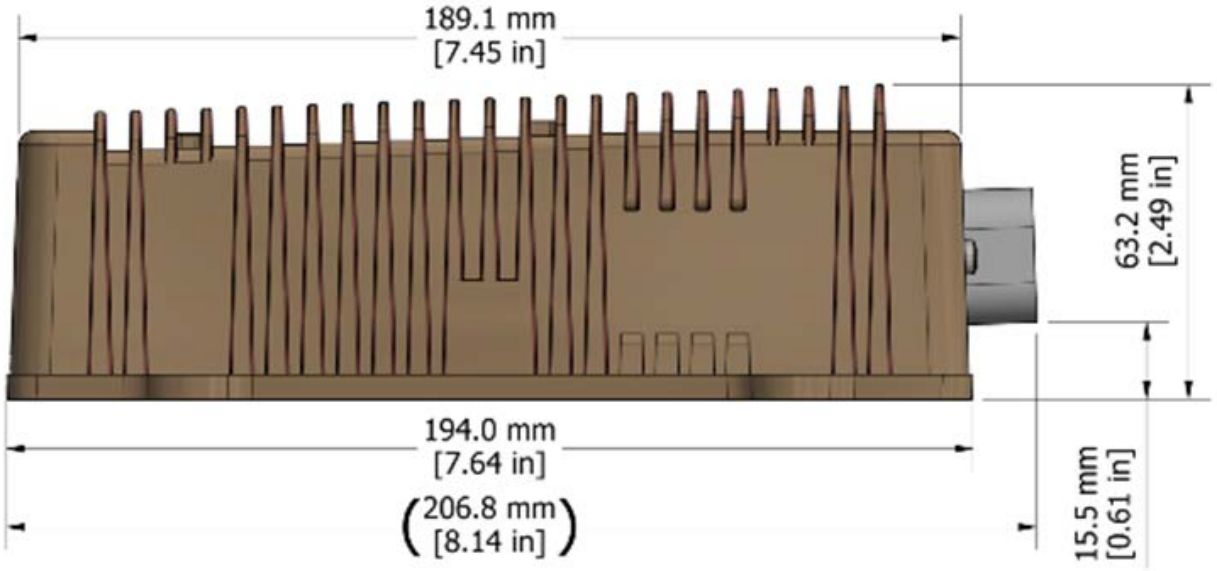

117
25
25
31,5
31,5
32
18,5
25,6 (2x)
15,3 (2x)
16,7
11,8
16,5
20,65
21
16,2
54


73
Dimmer
35
240
ON/OFF
19
28,7
54
21

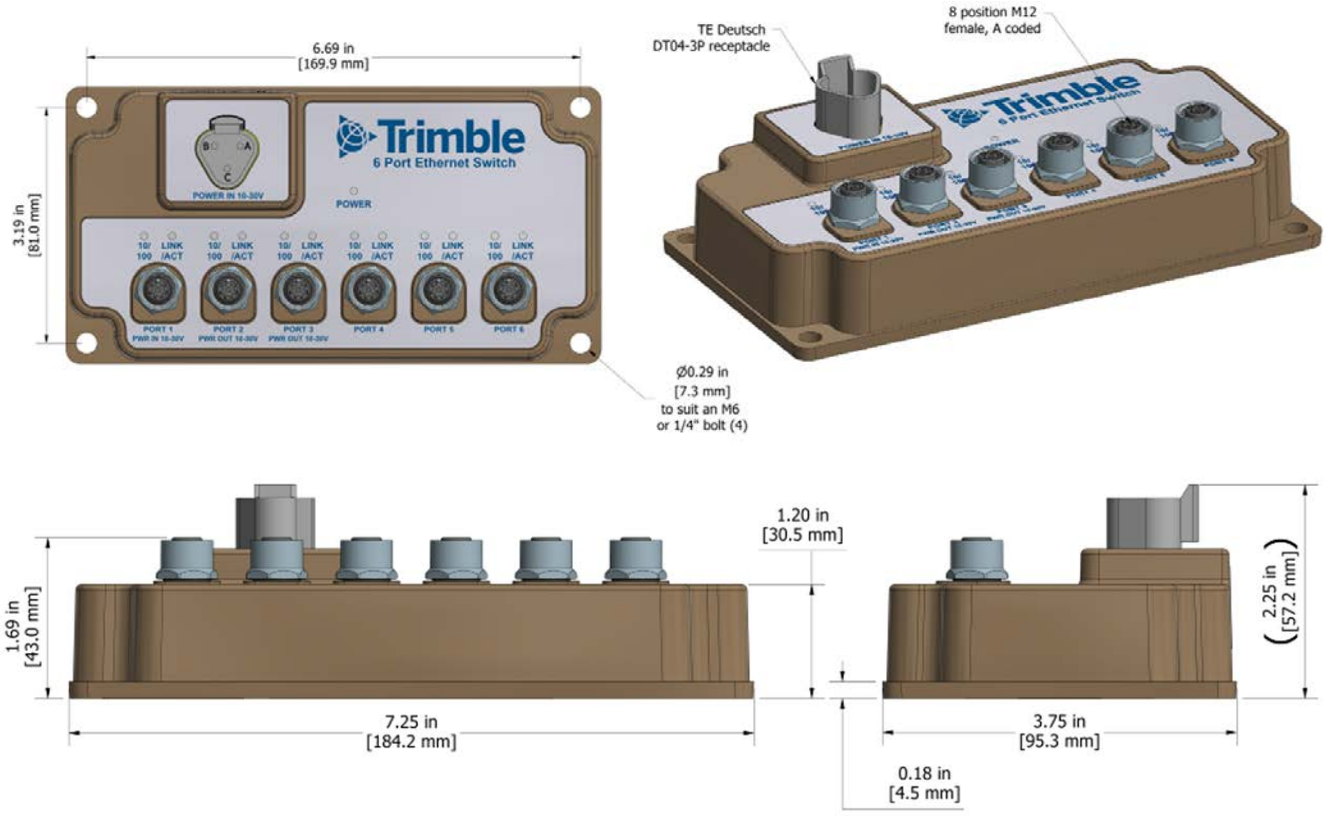

8,75
101,5
101,5
8,75

Power conditioner

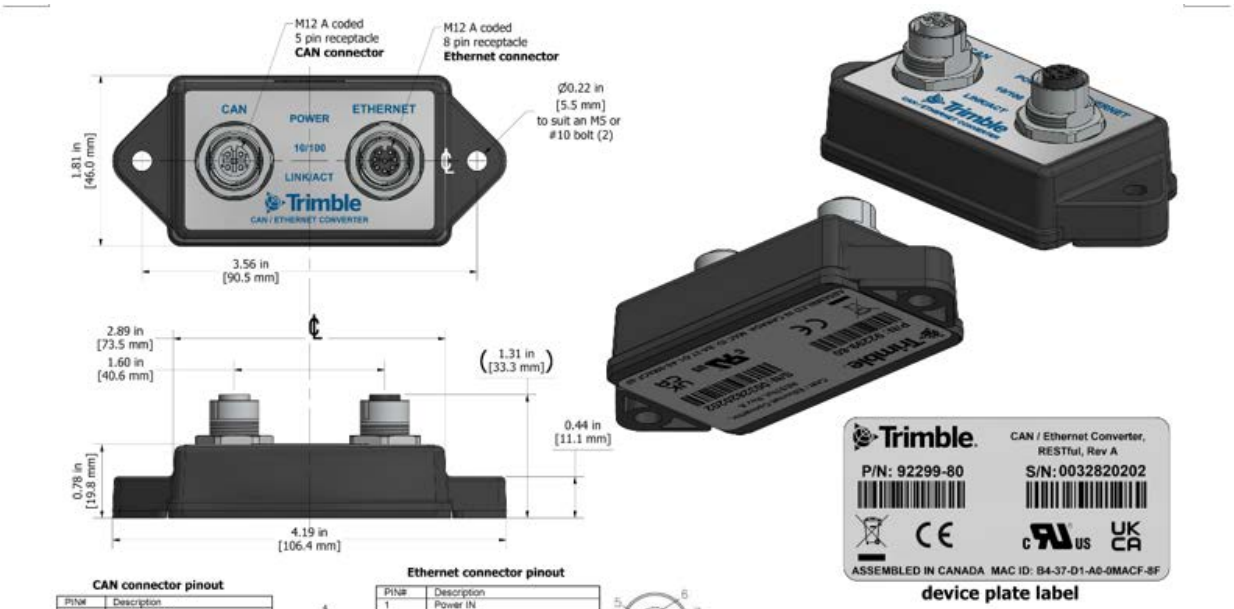




ETH switch



CAN-to-ETH adapter



CAN connector pinout

PIN#	Description
1	CAN_SHIELD
2	Power Out (+ Voltage)
3	Power GND (- Voltage)
4	CAN_H
5	CAN_L

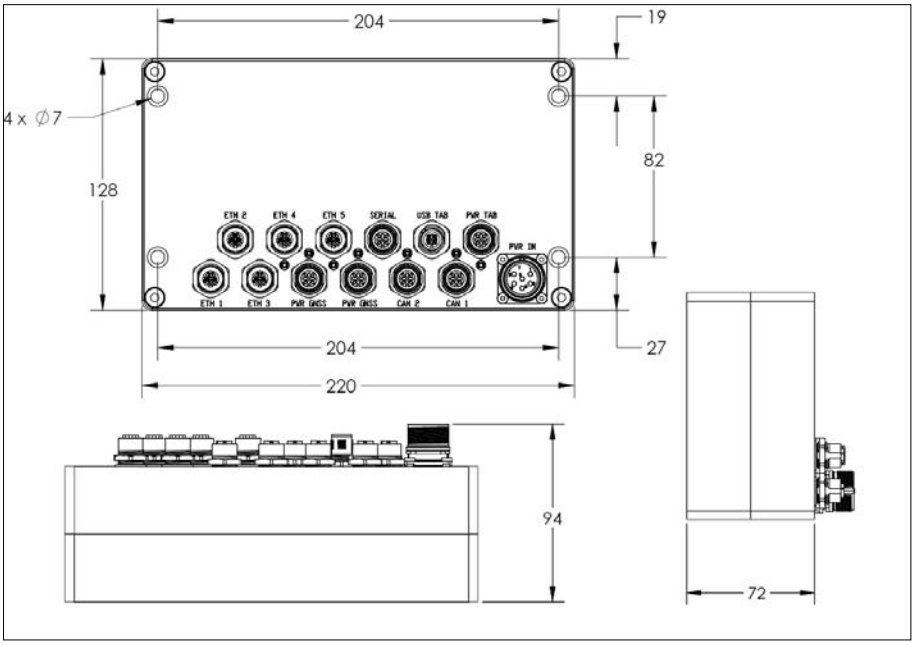
Ethernet connector pinout

PIN#	Description
1	Power IN
2	Power GND
3	Power GND
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Power IN
8	Ethernet RX-

JB900 junction box

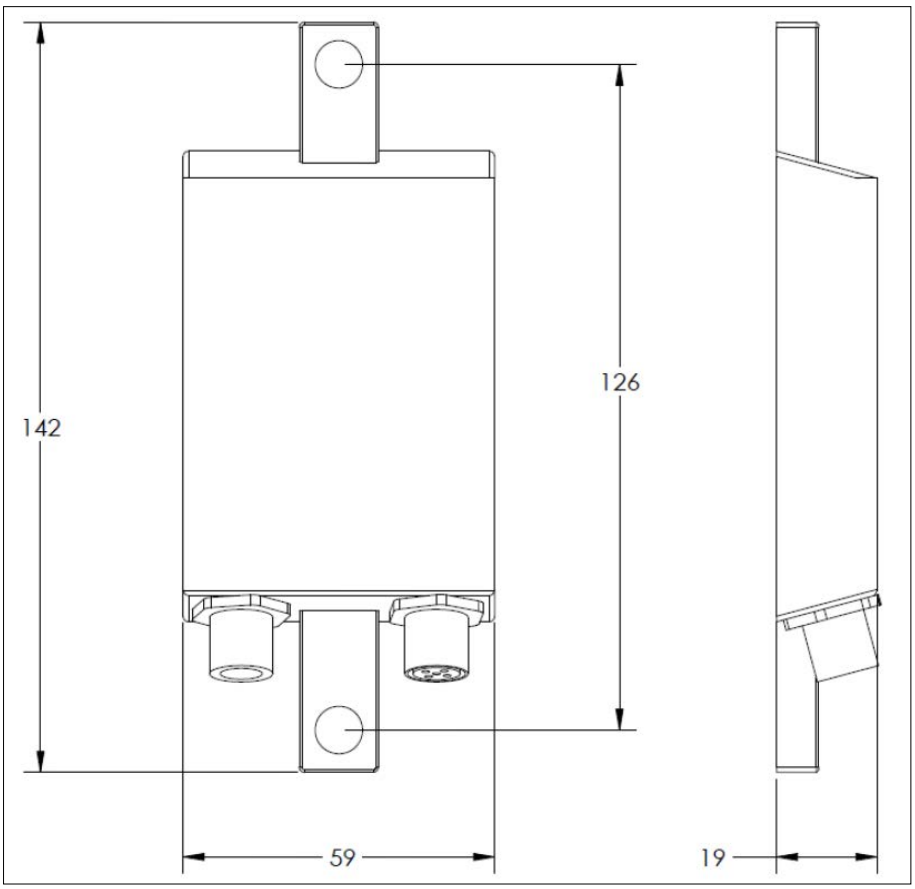
P/N 92299-75

> **NOTE –** This hardware is obsolete.



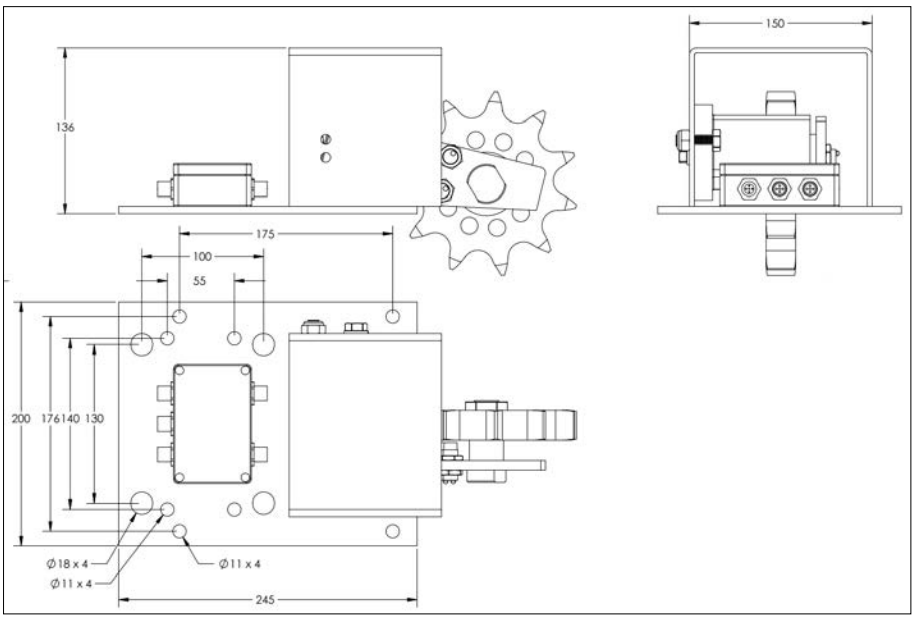
TS900 dual-axis tilt sensor

P/N 92303-10

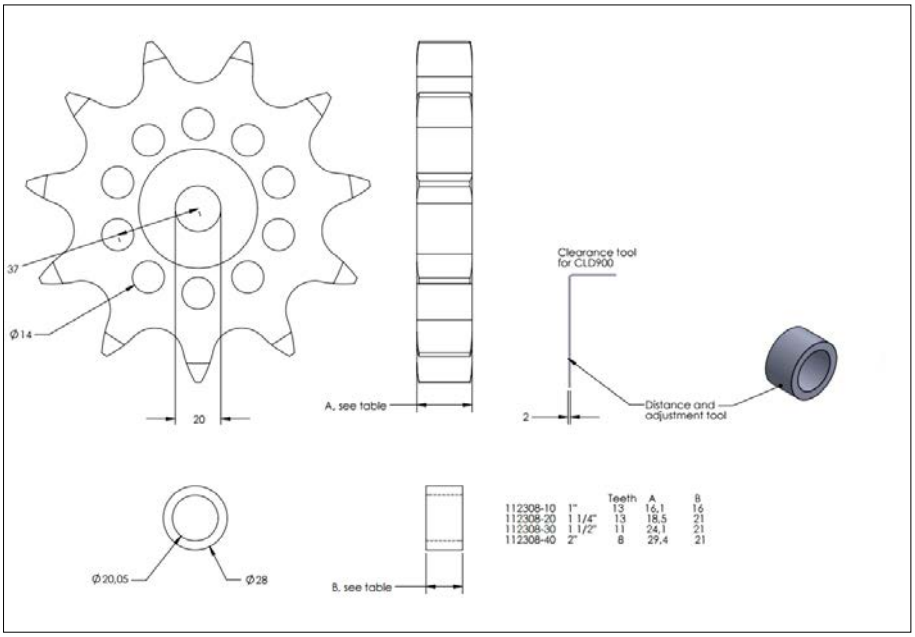


CLD900 sensor

P/Ns 112308-15, -25, -35, -45

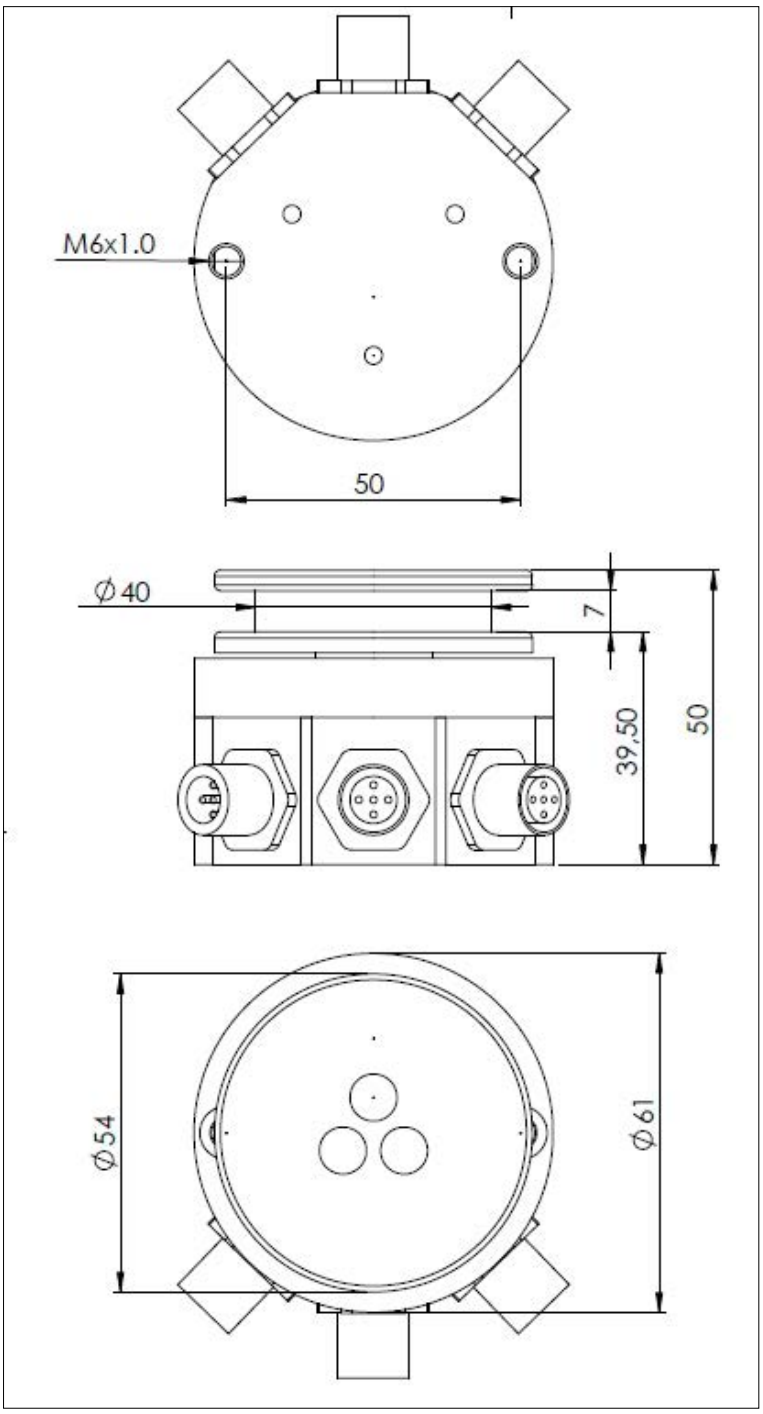


P/Ns 112308-10, -20, -30, -40 (Sprockets only)



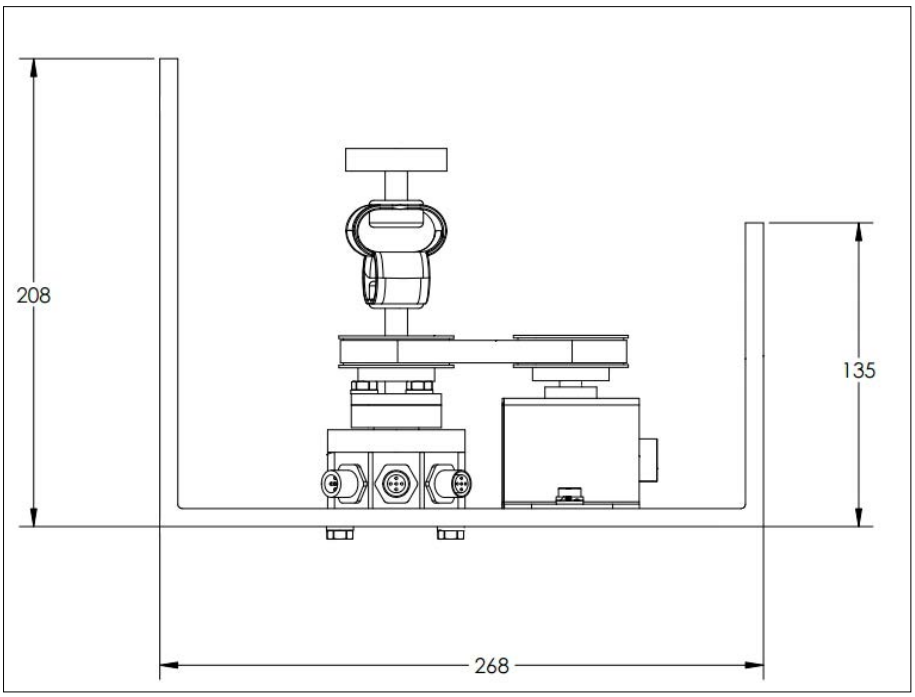
CRD900 and CDD900 sensors

P/Ns 92307-00 (CRD900) and 92305-75 (CDD900)



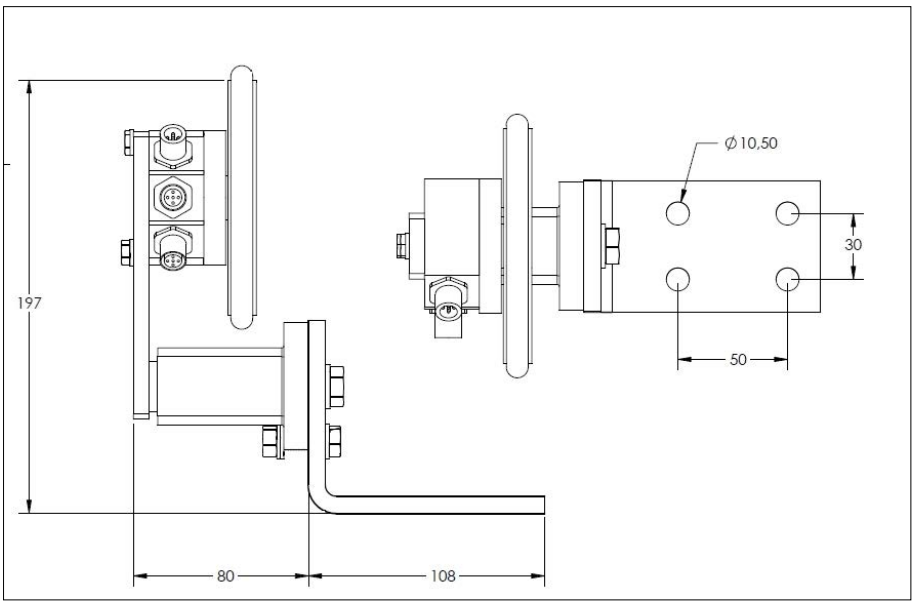
AC900 sensor

P/N 98499



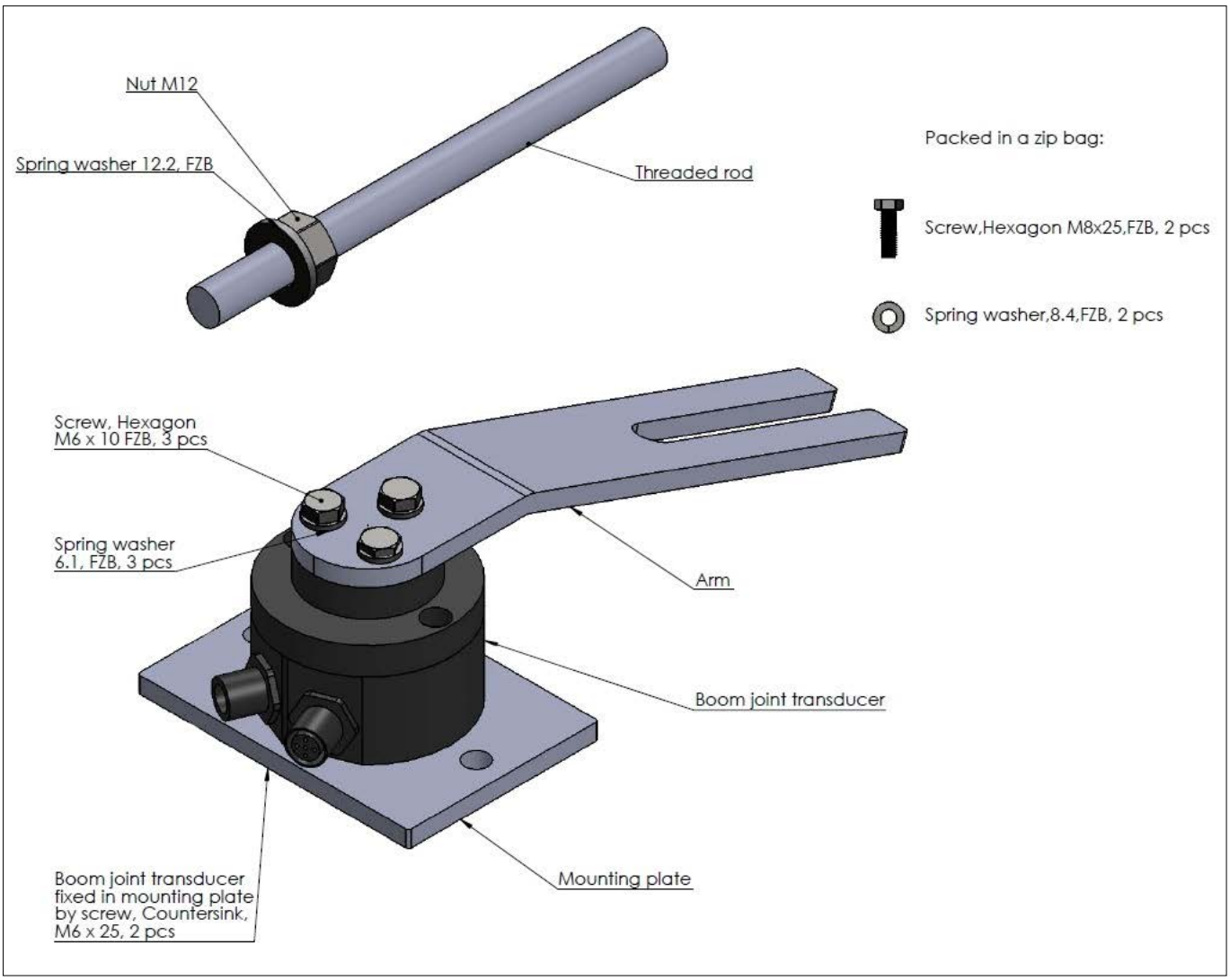
FRD900 sensor

P/N 98498



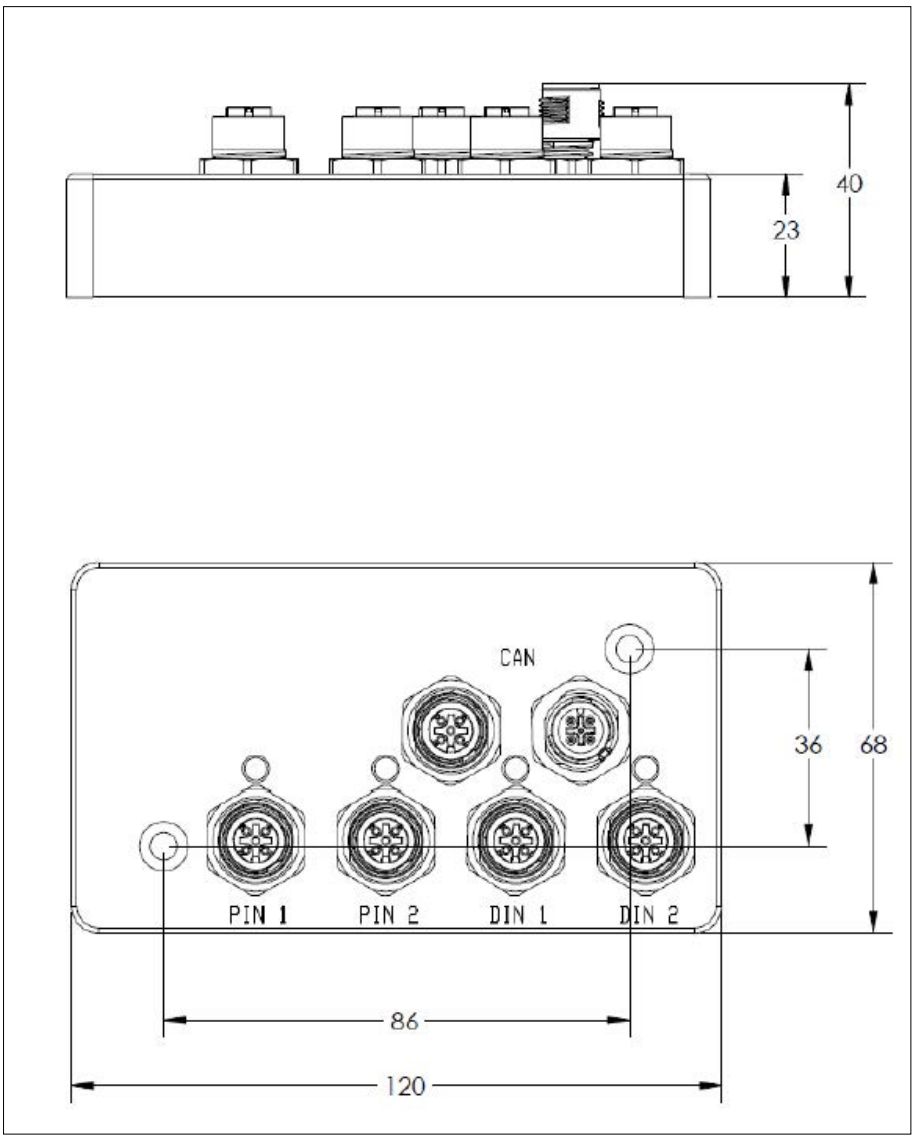
BR900 sensor

P/N 103103



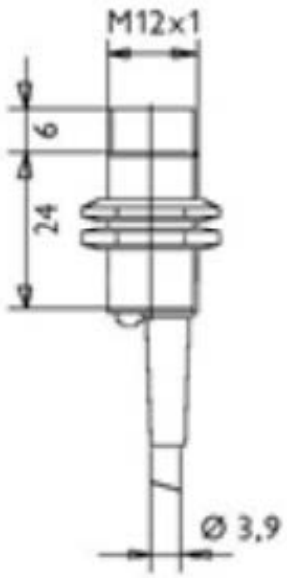
Electronic box

P/N 92314-50 (CLD900 and PSD900)



M12 proximity switch

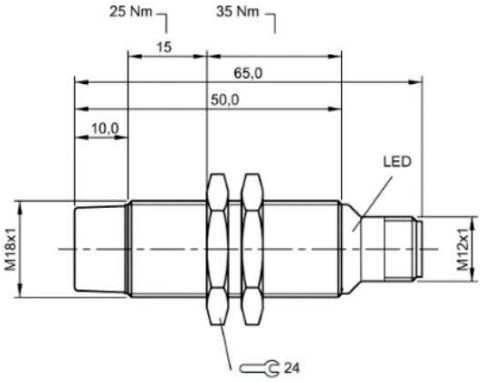
P/N: 92314-20 (CLD900 and PSD900)



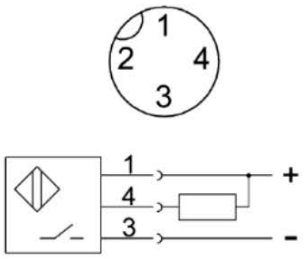
Function	Inductive
Size	M12
Output	PNP-NO
Mounting	Non flush mountable
Connection	2 m. cable
Detection range	4 mm
Frequency	1 kHz
Material	Brass

M18 proximity switch

P/N: 98445



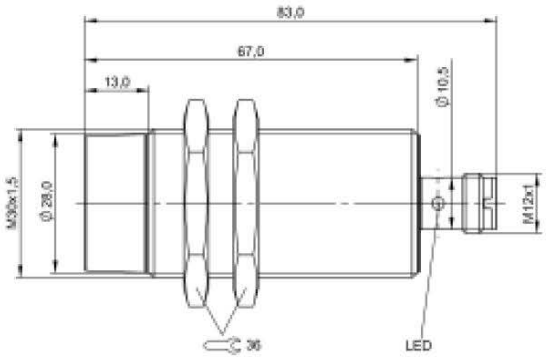
DC, direct current
NPN/Normally open (NO)
Sn= 16 mm
Non embeddable



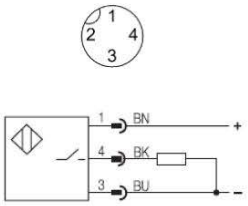
1= Brown (+)
3= Blue (-)
4= Black (signal)

M30 proximity switch

P/N: 98446



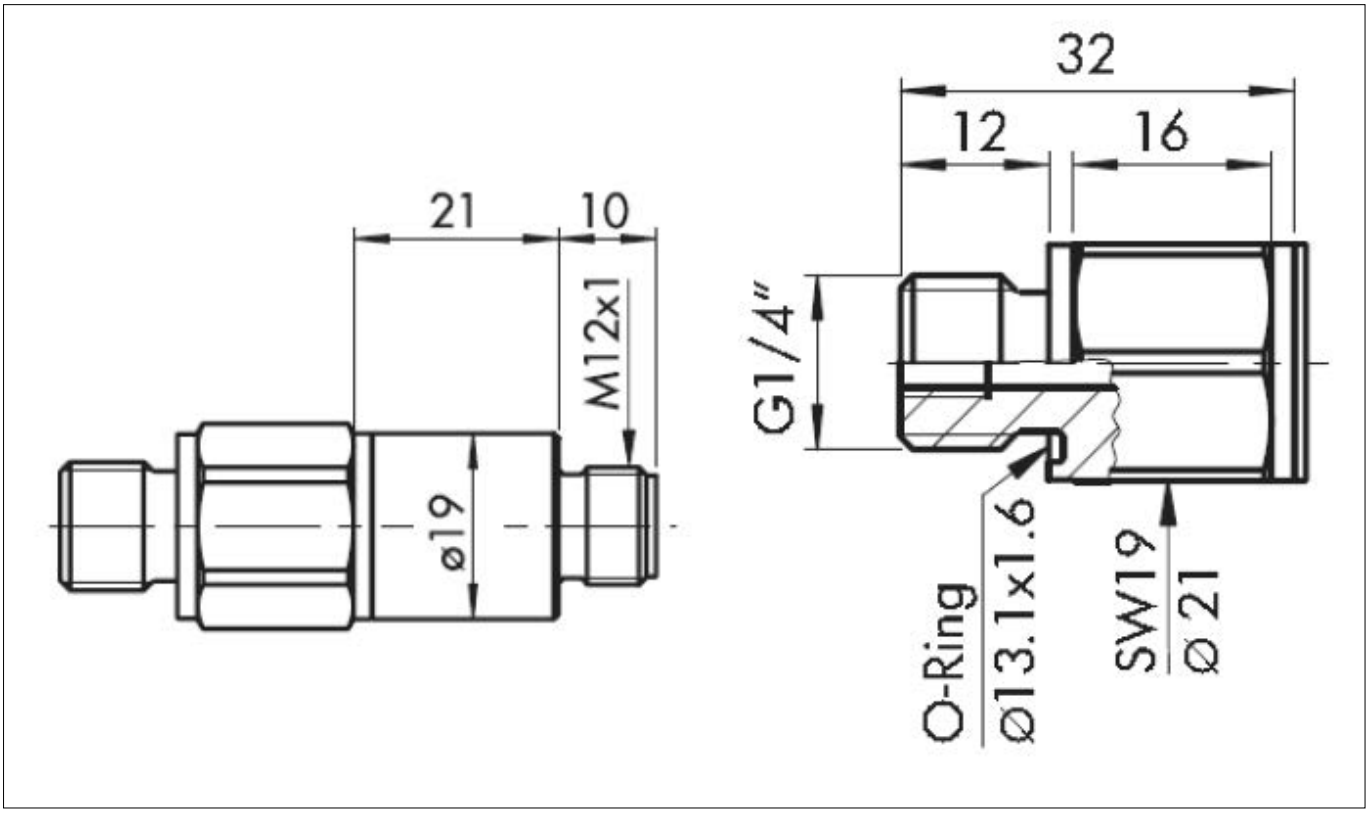
DC, direct current
PNP/Normally open (NO)
Sn= 30 mm
Non embeddable



1= Brown (+)
3= Blue (-)
4= Black (signal)

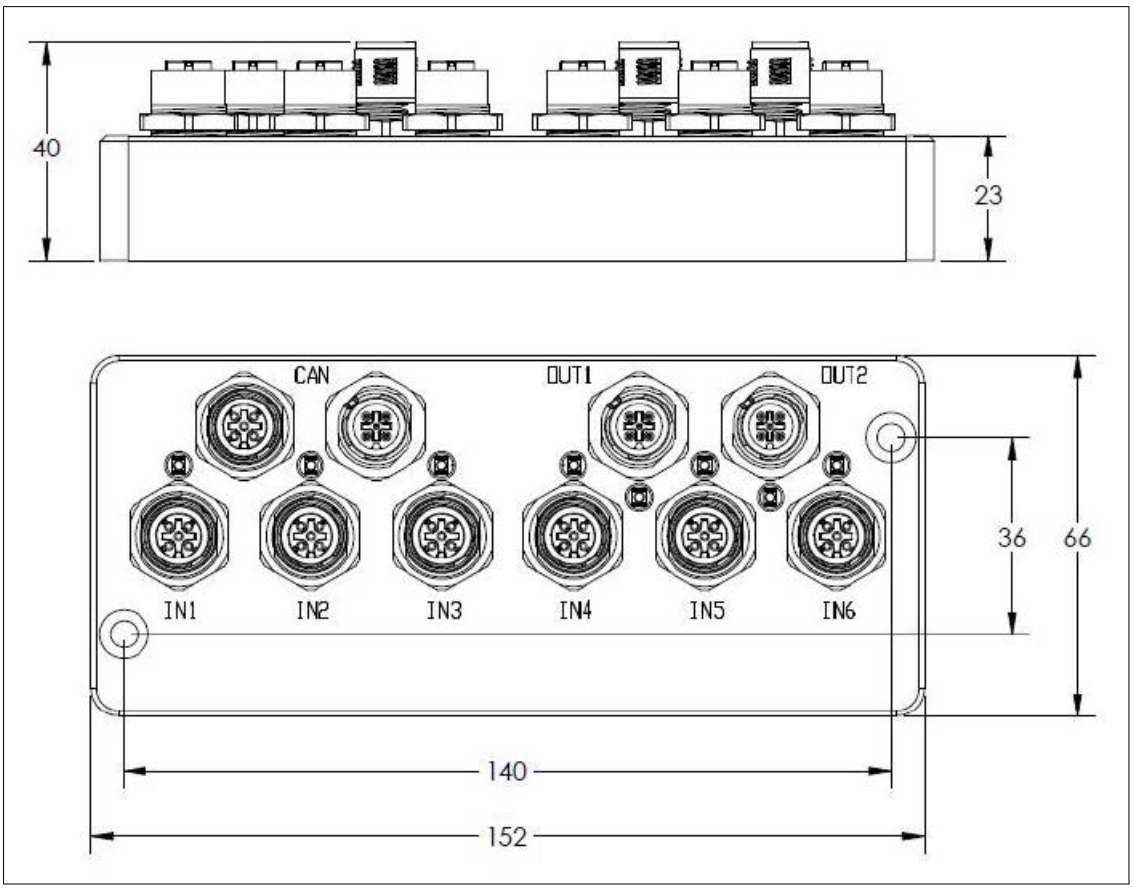
Pressure sensors

P/N: 98494 and 98495



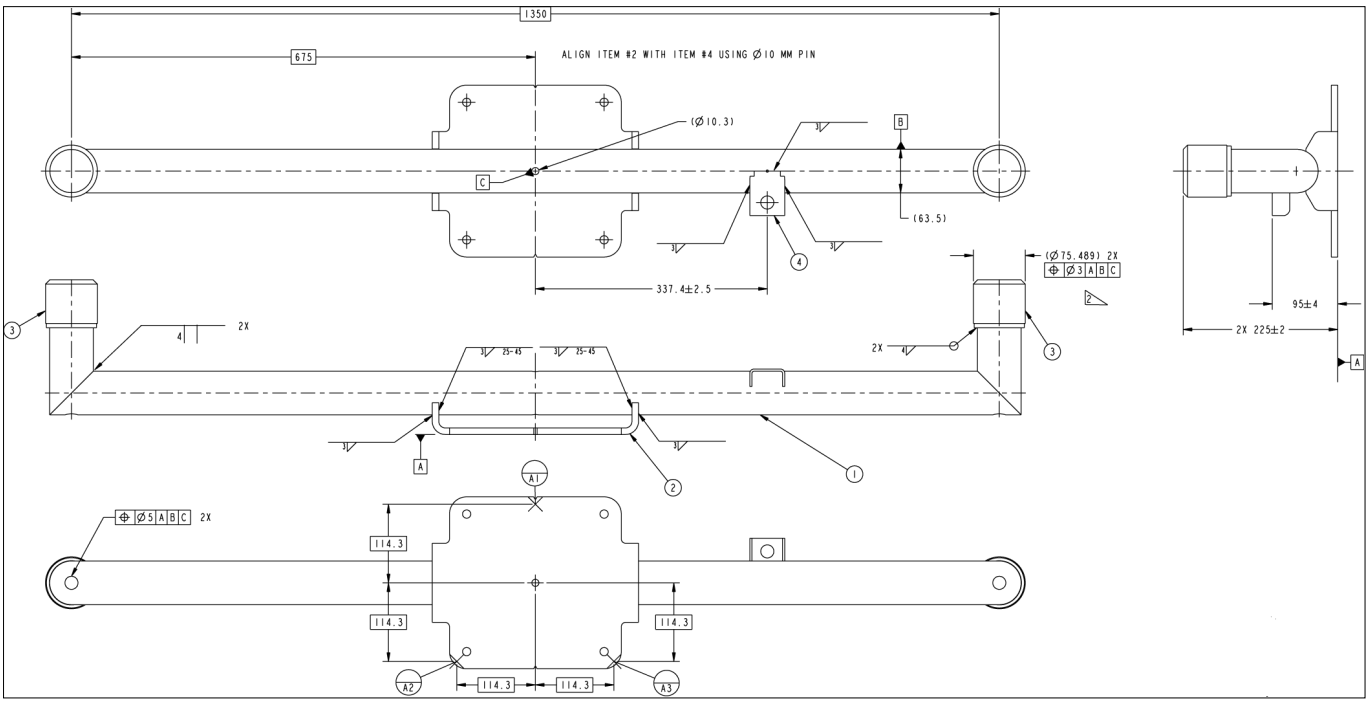
IO900 I/O box

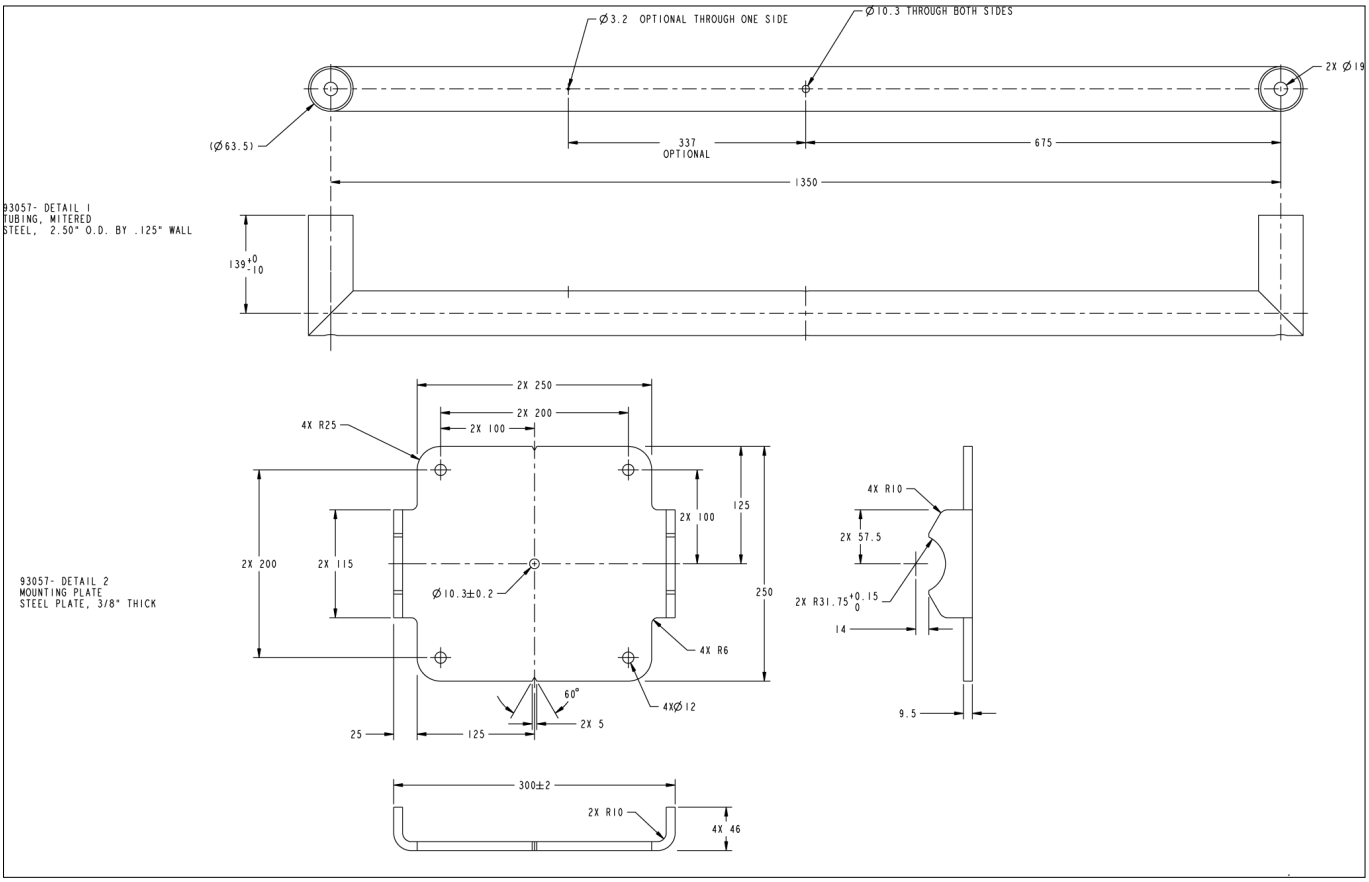
P/N: 92311-75



GNSS dual-antenna mounting bracket

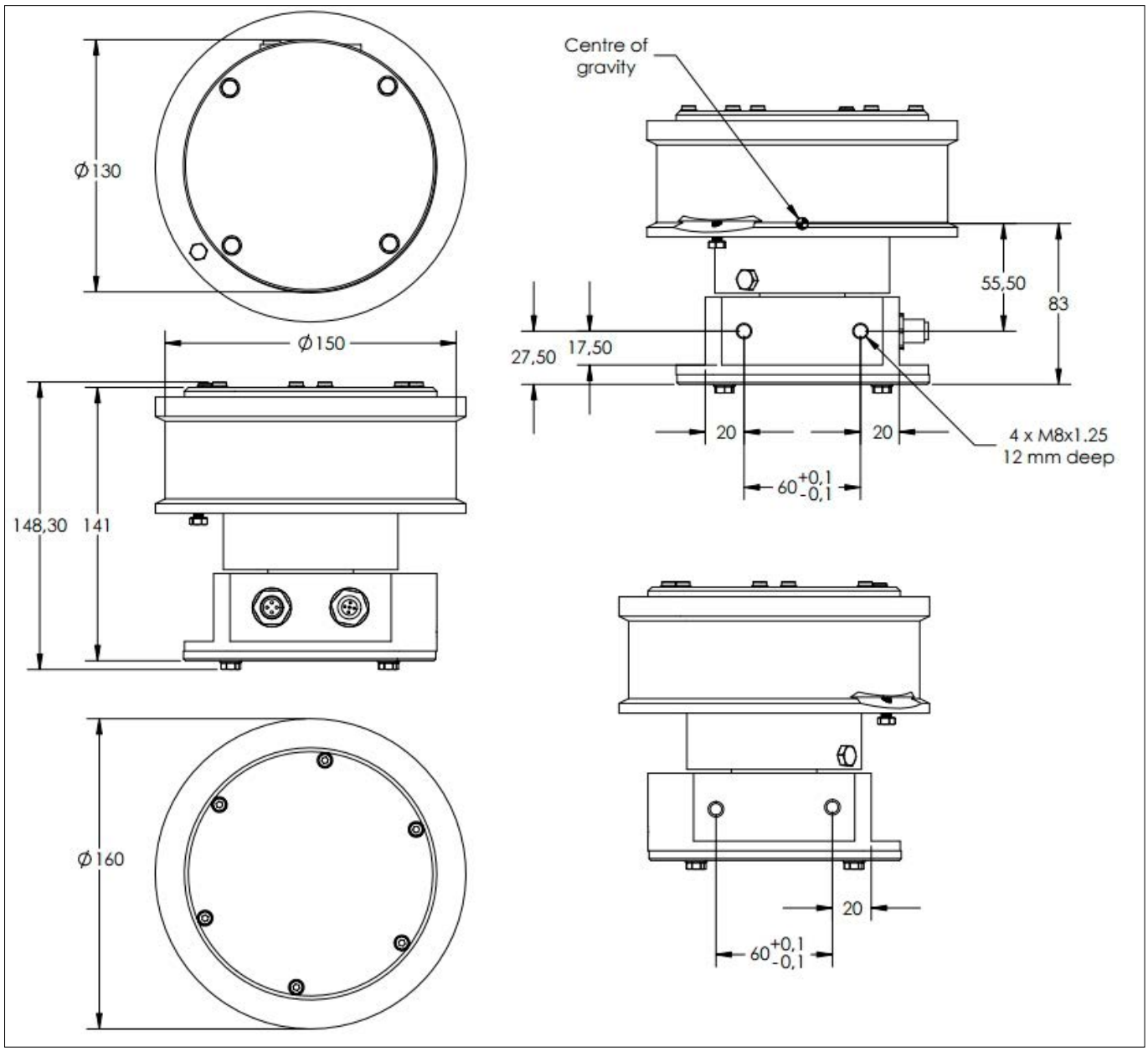
P/N 93057





TBE900 sensor

P/N 98496



9

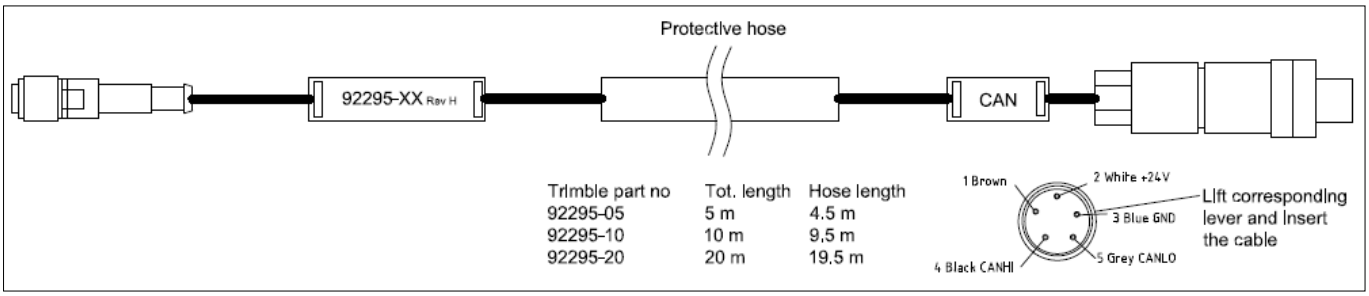
Cables and Connectors

This chapter describes the system cables and connectors.

Groundworks system cables

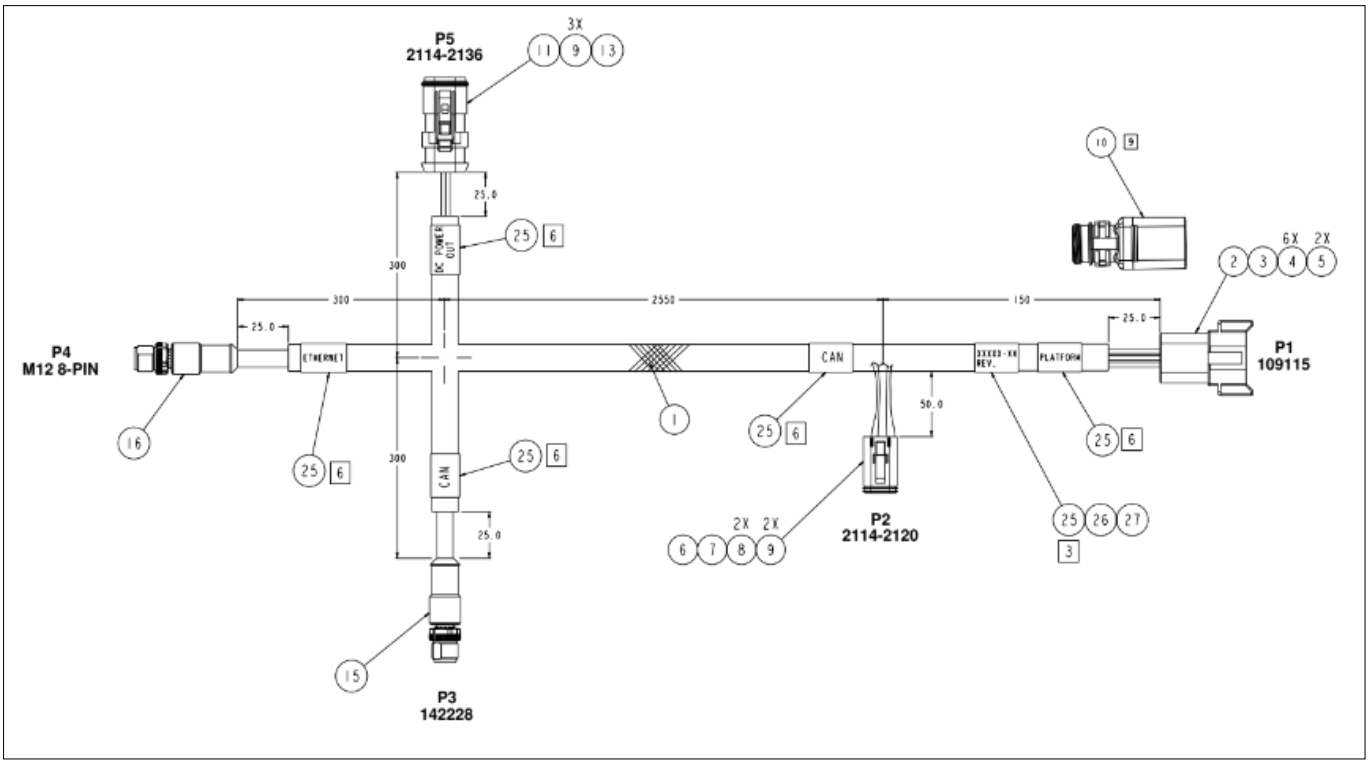
CAN cable

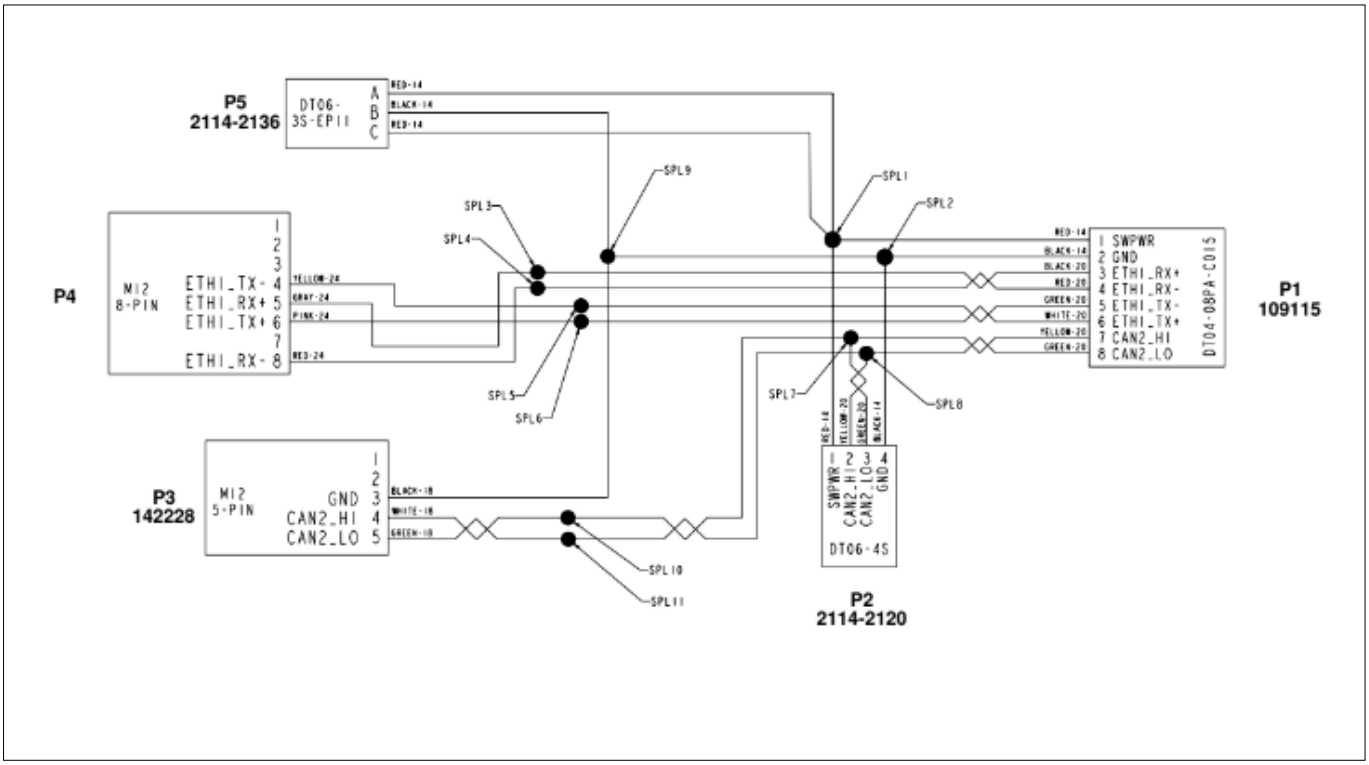
P/Ns 92295-05, -10, -20 (5 m, 10 m, and 20 m)



CAN/ETH/Power 3 m

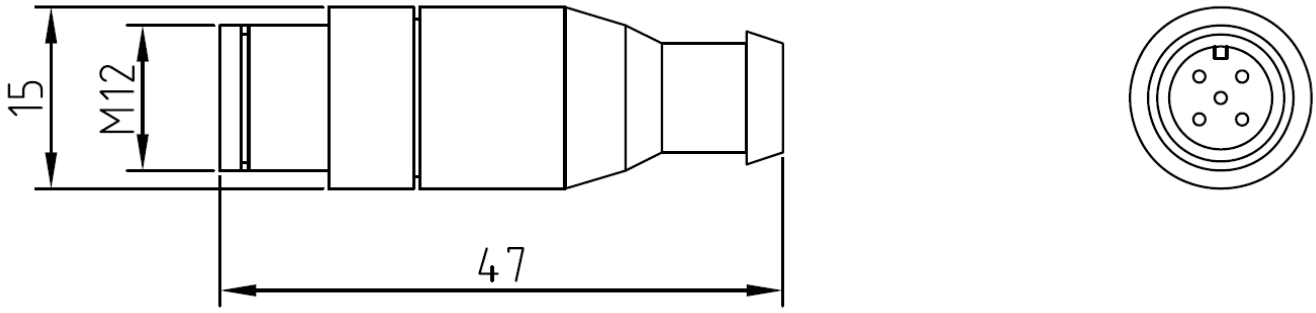
P/N 131637-030





CAN termination plug

P/N 92312

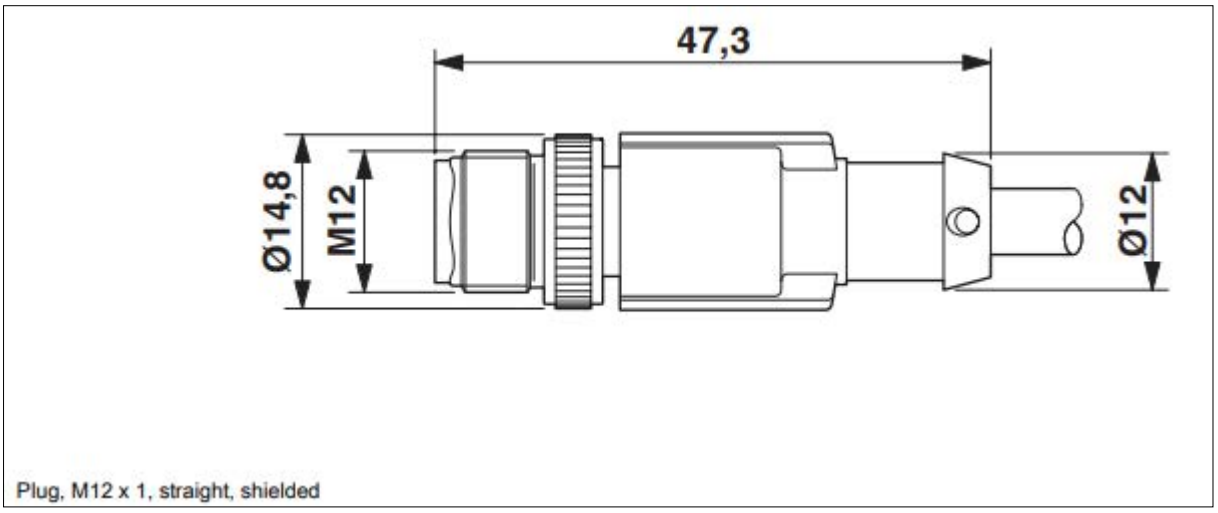


NOTE – For the last sensor in the CAN chain.

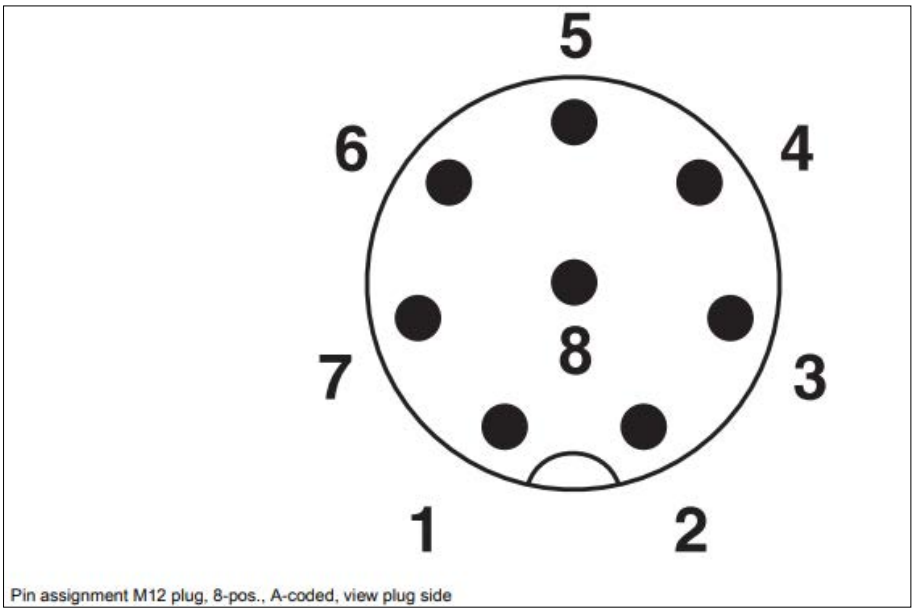
Ethernet M12 8-pin A-coded cable for Signal/Power to CAN-to-ETH converter

P/N 132339-005

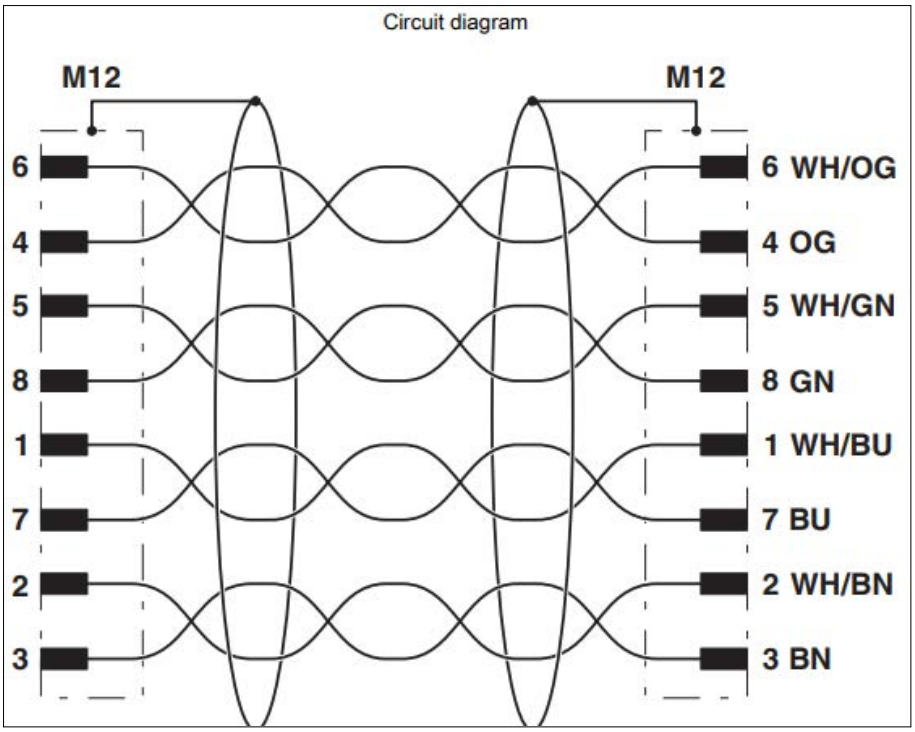
NOTE – This cable replaces cable P/N 128965.



Plug, M12 x 1, straight, shielded

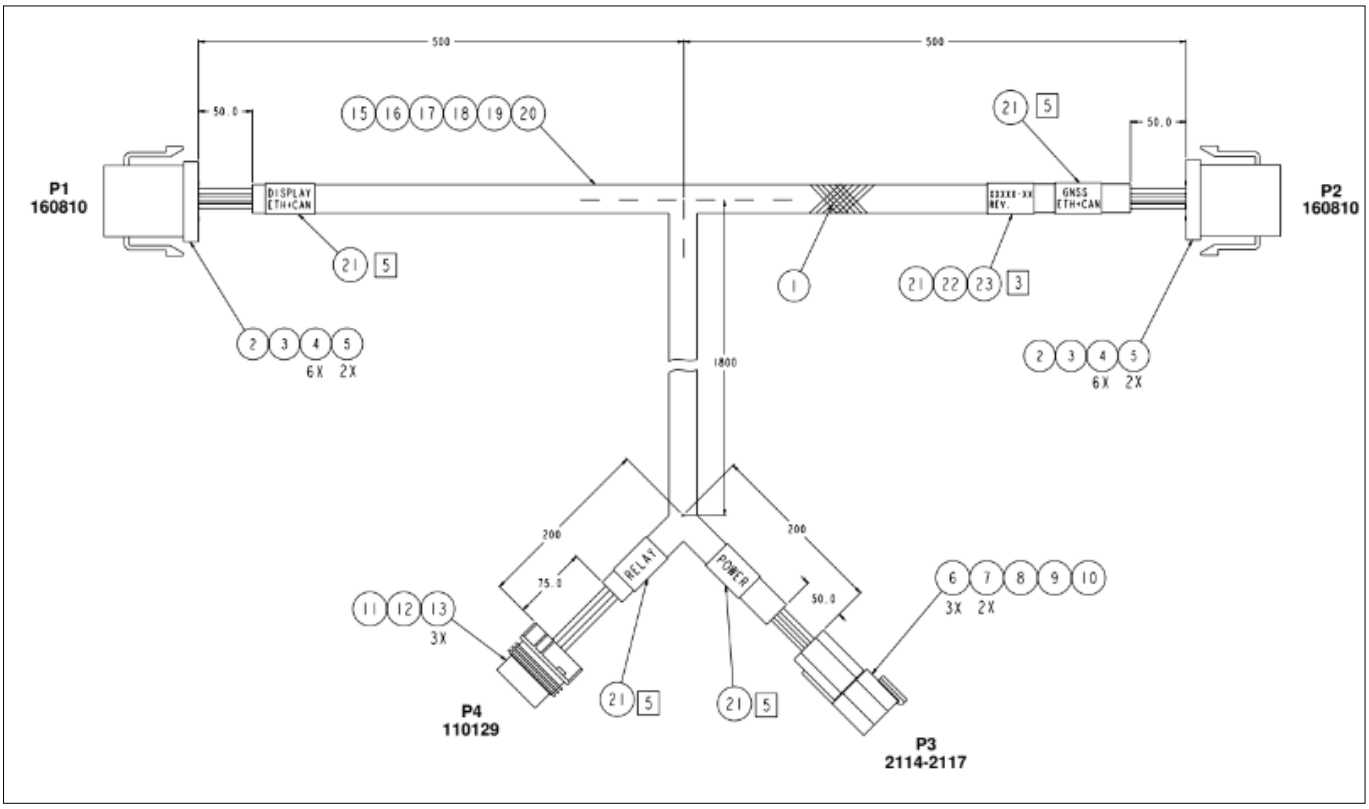


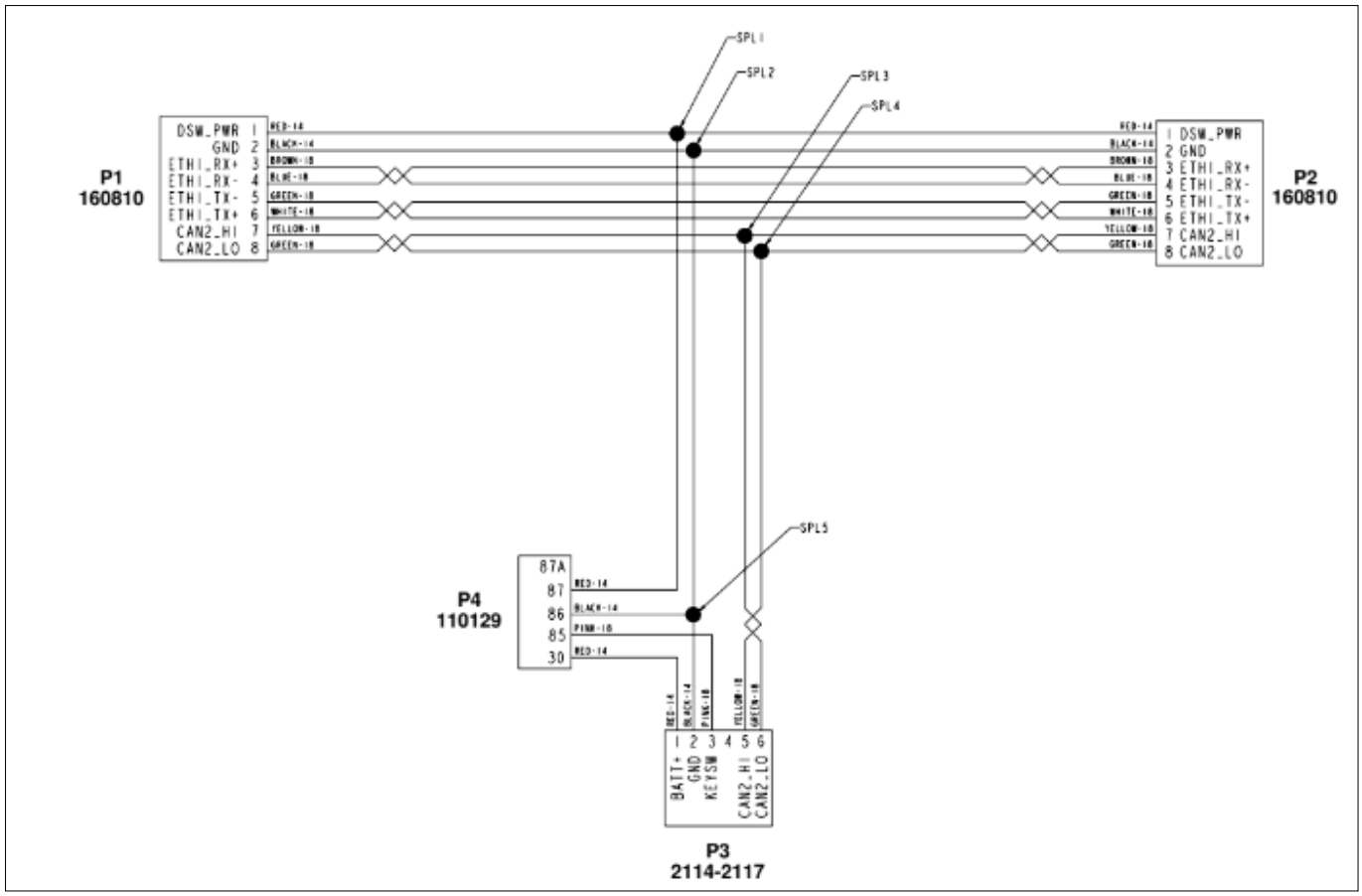
Pin assignment M12 plug, 8-pos., A-coded, view plug side



Cable harness

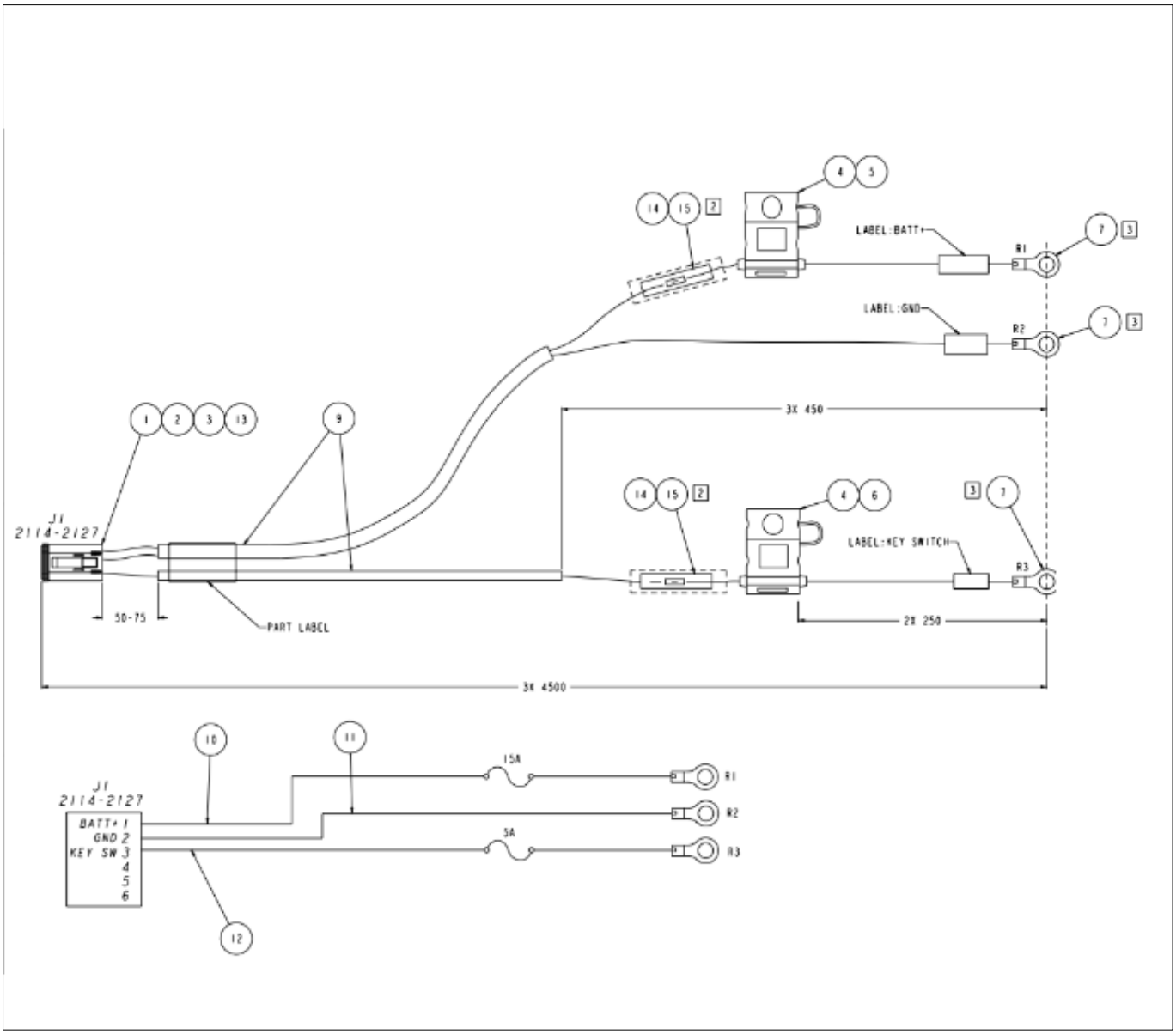
P/N 160702-030




SPL1
SPL2
SPL3
SPL4
SPL5
P1
160810
DSW_PWR 1
GND 2
ETH1_RX+ 3
ETH1_RX- 4
ETH1_TX- 5
ETH1_TX+ 6
CAN2_HI 7
CAN2_LO 8
P2
160810
1 DSW_PWR
2 GND
3 ETH1_RX+
4 ETH1_RX-
5 ETH1_TX-
6 ETH1_TX+
7 CAN2_HI
8 CAN2_LO
P4
110129
87A
87
86
85
30
P3
2114-2117
BATT+
GND
KEYSW
CAN2_HI
CAN2_LO

Power cable

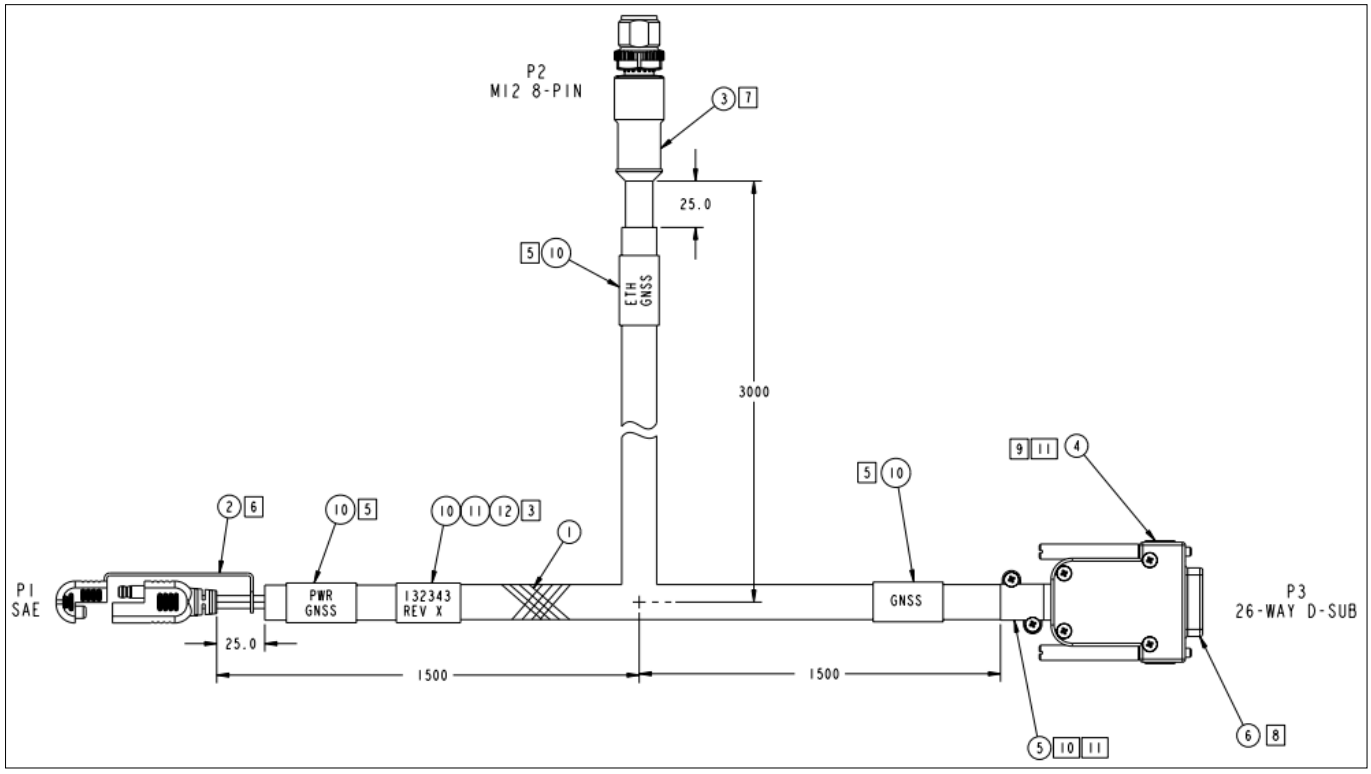
P/N 150411-045

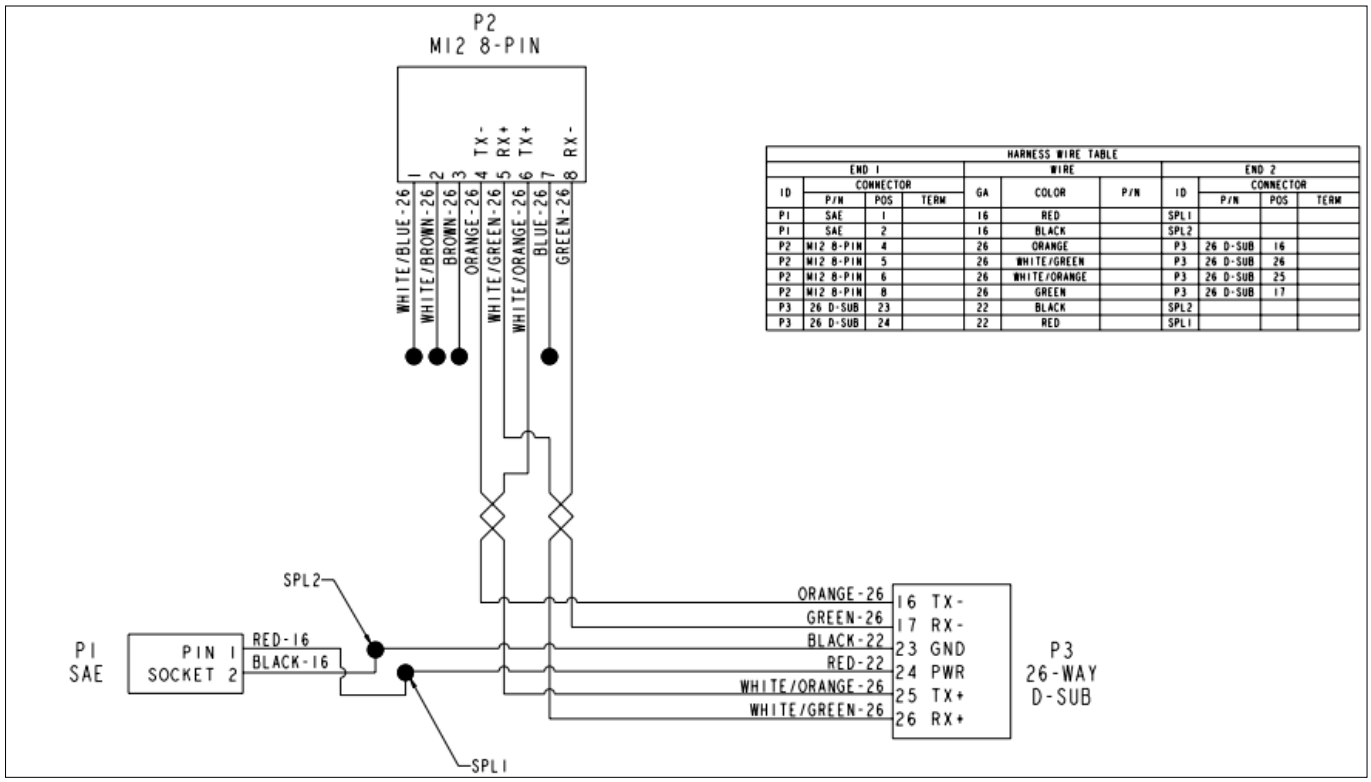


GNSS power and signal cable

P/N 132343

NOTE – This cable replaces cable P/N 131681.





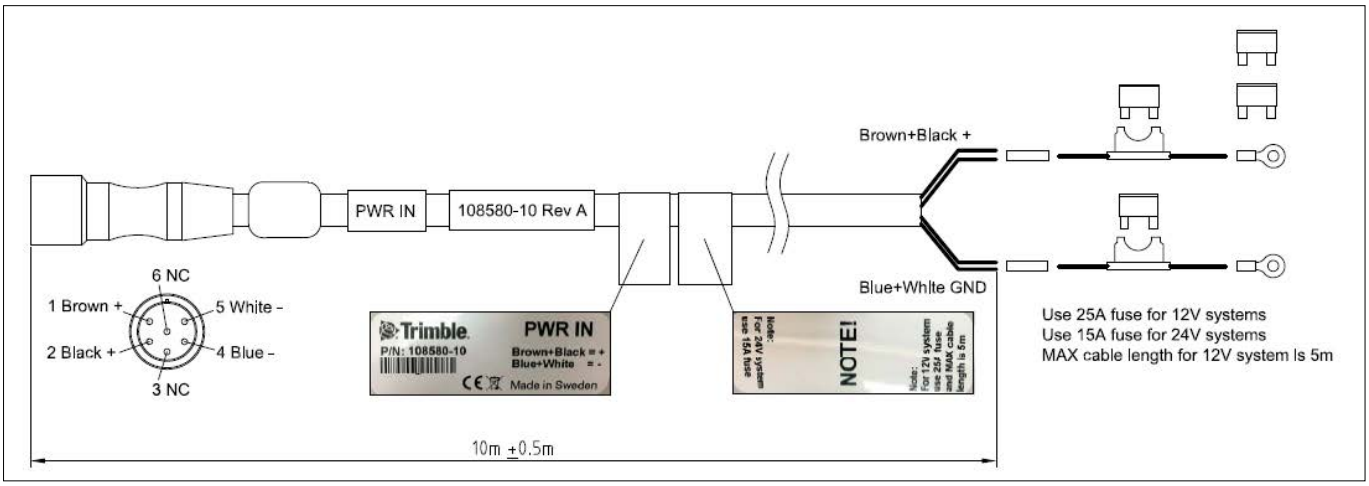
HARNESS WIRE TABLE

END 1				WIRE			END 2			
ID	CONNECTOR P/N	POS	TERM	GA	COLOR	P/N	ID	CONNECTOR P/N	POS	TERM
P1	SAE	1		16	RED		SPL1			
P1	SAE	2		16	BLACK		SPL2			
P2	M12 8-PIN	4		26	ORANGE		P3	26 D-SUB	16	
P2	M12 8-PIN	5		26	WHITE/GREEN		P3	26 D-SUB	26	
P2	M12 8-PIN	6		26	WHITE/ORANGE		P3	26 D-SUB	25	
P2	M12 8-PIN	8		26	GREEN		P3	26 D-SUB	17	
P3	26 D-SUB	23		22	BLACK		SPL2			
P3	26 D-SUB	24		22	RED		SPL1			

JB900 power cable

P/N 108580-10

NOTE – Legacy cable, now obsolete.

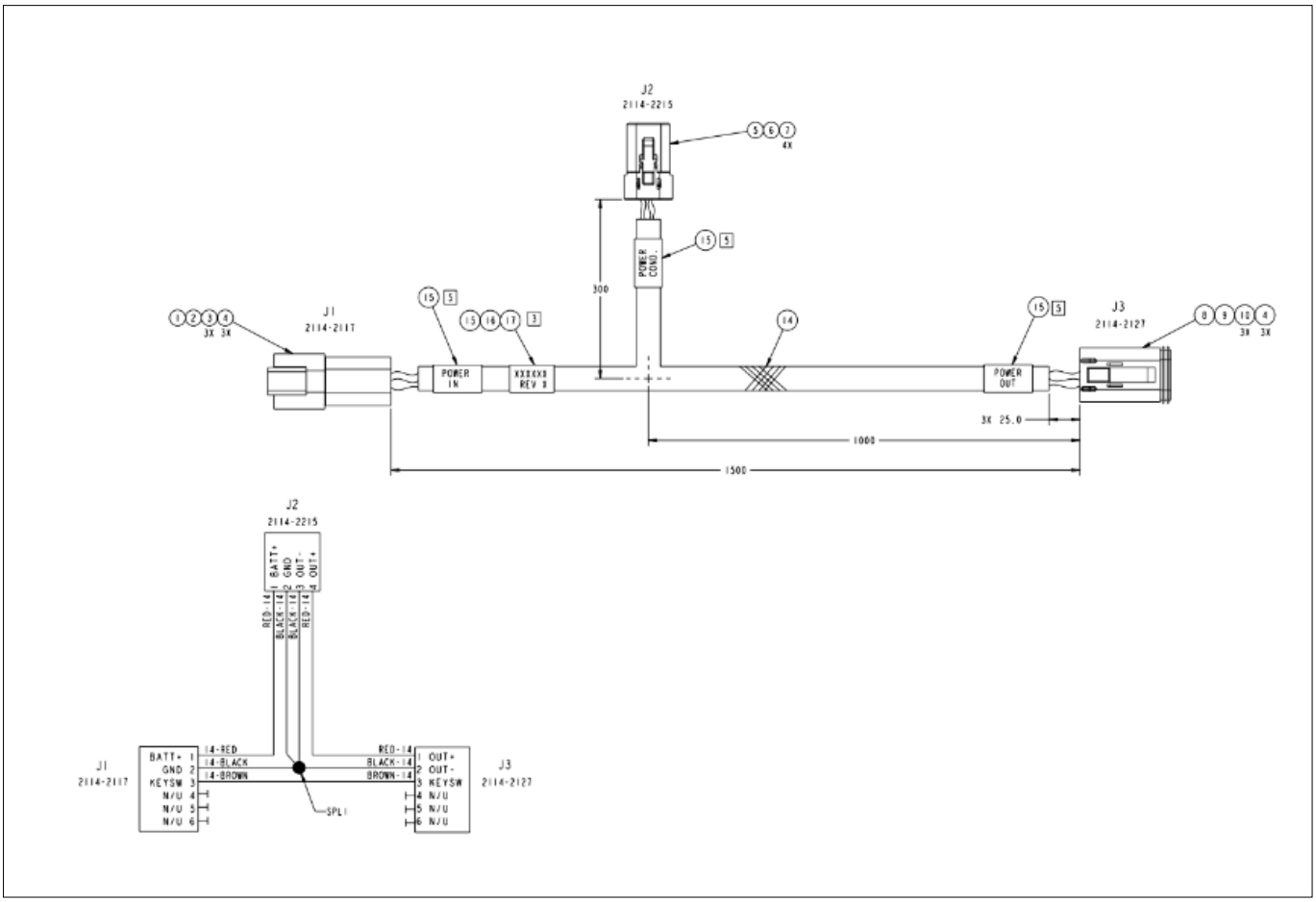


NOTE – The power cable is labeled showing that the brown and black wires should be connected to the 10.5 to 30 V DC terminal and the blue and white wires should be connected to the GND terminal. The cable is shipped with fuses that need to be connected in line with the wires, and they should be attached to the wires after routing the cables through the machine to the power source of the machine. Use the 15 A fuses for 24 V systems. Use the 25 A fuses for 12 V systems and reduce the cable length to 5 m or less.

CAUTION – To maintain the IP rating of the JB900 Junction Box, torque the connector to 2.0 Nm.

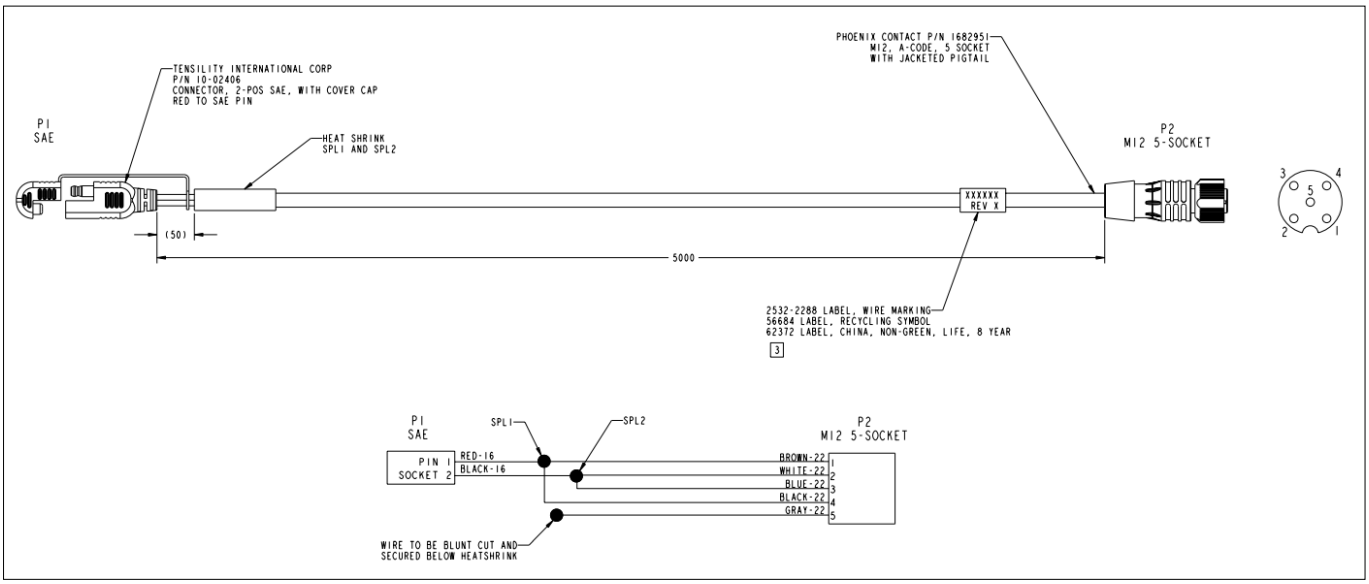
TMC power cable

P/N 130021



VERSO 12 display power cable

P/N 132477-050

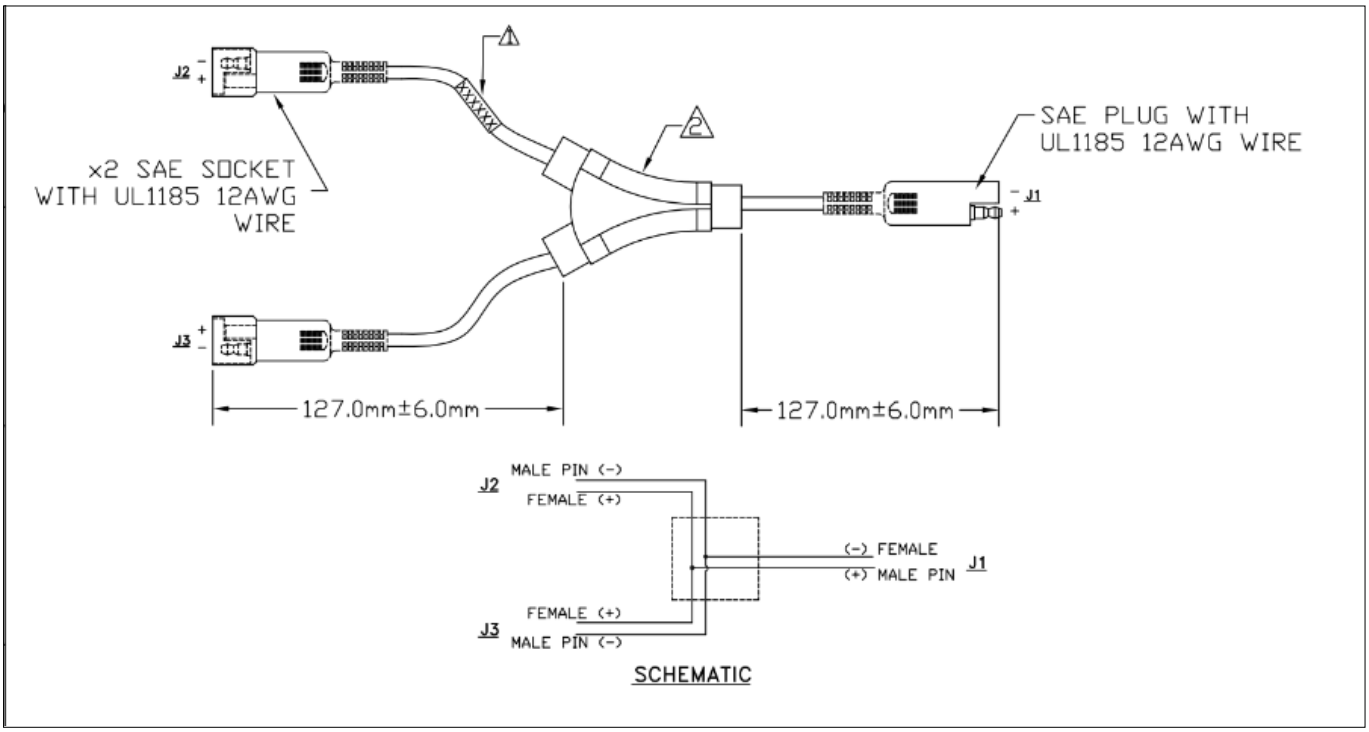


Relay 24 V

P/N 109333-24

SAE splitter

P/N 89073-00



M12 connectors

Reference the correct table below depending on which sensor/cable you are using:

CAN cable wire	goes to … of male M12 connector for standard CAN cable connections
White (+24 V DC)	Pin 2 / White (+ 24 V DC)
Blue (GND)	Pin 3 / Blue (GND)
Black (CAN Hi)	Pin 4 / Black (CAN Hi)
Gray (CAN Lo)	Pin 5 / Gray (CAN Lo)

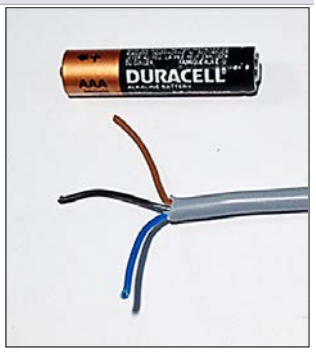
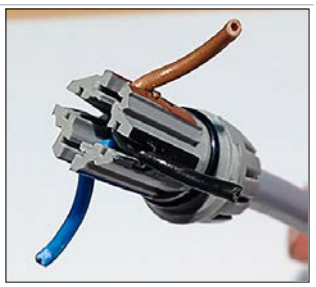
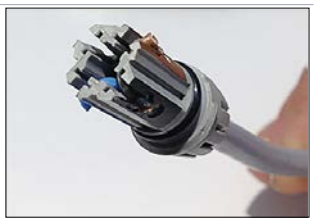
CAN cable wire	goes to … of male M12 connector that connects to the digital input port of the depth sensor for M18 proximity sensor (P/N 98445)
Brown (+24 V DC)	Pin 1/ Brown (+24 V DC)
Blue (GND)	Pin 3 / Blue (GND)
Black (signal)	Pin 2 / White (signal)

NOTE – If the above table results in incorrect functionality, plug the black (Signal) wire into pin 4 / black of the male M12 connector.

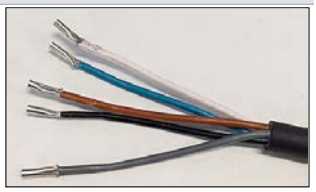
Tools needed:

- Wire cutters
- Knife
- Small jeweler's flat-head screwdriver
- Multimeter

Connector type 1

Step	Description	
1	Expose about 4 cm of the wire.	
2	Insert wires through cap and self-splicing insert. Press cable sleeve into self-splicing insert.	
3	Bend and insert color-coded wires into corresponding colored slots.	
4	Clip the ends of the wires nearly flush with the outside of the insert.	
5	Line up the indicator on the connector plug assembly and the arrow on the self-splicing insert, and then press together firmly.	
6	Screw cap on firmly.	

Connector type 2

Step	Description	
1	Expose about 4 cm of the wire. Strip about 1 cm off the ends of each wire.	
2	Push wires through the connector.	
3	Use a small flat-head screwdriver to back out screws on each port to make space for the wires. 	
4	Insert the wires one at a time (according to the table above) and use a screwdriver to tighten till wires are held tightly in place.	
5	Screw the three pieces of the connector together.	

Connector type 3

Step	Description	
1	Expose about 4 cm of the wire. Strip about 1 cm off the ends of each wire.	
2	Push the wires through the connector.	
3	Push the wires one at a time into the corresponding colored port, holding down the pin while pushing the wire, and releasing the pin when the wire has pushed all the way in. Releasing the pin should result in wire being held in place. Verify that each wire is held snugly in place before moving on to the next wire.	
4	Screw the three pieces of the connector together.	

Connector type 4

Step	Description	
1	Expose about 4 cm of the wire. Strip about 1 cm off the ends of each wire.	
2	Push the wires through the connector.	
3	Push the wires one at a time into the corresponding colored ports, lifting the lever while pushing the wire, and lowering the lever when the wire has pushed in all the way. Lowering the lever should result in the wire being held in place. Verify that each wire is held snugly in place before moving on to the next wire.	
4	Screw the three pieces of the connector together.	

10

Specifications

This chapter details the specifications of the system components.

VERSO 12 touch display

P/Ns: TABV12-00-i7 and TABV12-10-i7

Hardware	
Size	305 mm × 255* mm × 59 mm (12 in × 10 in × 2.3 in) * including antenna domes
Weight	3.5 kg (7.7 lb)
RAM	16 GB DDR 4
Storage	CFast 128 GB
Processor	Intel® Core™ i7 1185GRE
WLAN	Dual-band WLAN 802.11 ac
WWAN	Sierra Wireless MC7411 for North America (TABV12-101-i7)
	Sierra Wireless MC7421 for RoW (TABV12-102-i7)
Power	Uninterruptible Power Supply (UPS): Internal battery for graceful shutdown at unexpected power outages
Environmental	
Temperature – Operating	-30 °C to +55 °C (-22 °F to +131 °F)
Temperature – Storage	-35 °C to + 75 °C (-31 °F to +167 °F)
Humidity	10 to 95 % RH
IP Rating	IP65
Drops	30 g for 11ms XYZ - IEC 60068-2-27
Vibration	5 to 500 Hz / 0,04 g2 / Hz XYZ - IEC 60068-2-64 Fh
Interface	
Display – General	12.1” XGA LED 1000 NIT
	Capacitive touch with JLT PowerTouch™ display technology and hardened glass
Display – Resolution	1024 × 768
Keyboard	1 × power button and 2 × brightness buttons
Audio	2 × integrated speakers
Operating system	Microsoft Windows 10 IoT
Input/Output	

Power	9 to 36 V DC unisolated
	M12 4-pin connector, A-coded male
USB	2 × M12 5-pin connector, A-coded female
	1 × Type A female
Bluetooth	Yes, Bluetooth v4.2
Ethernet	1 × M12 8-pin connector, A-coded female
External Cellular Antenna	1 × SMA female connector ***Not available for TABV12-00-i7***

TS900 dual-axis tilt sensor

P/N: 92303-10

Supply voltage	10 to 30 V DC
Power supply	35 mA
Number of axis	2
Measurement range – each axis	± 180°
Measurement method	Accelerometer
Accuracy	± 0.2°
Resolution	Better than 0.01°
Communication method	Fully compatible with ISO 11896
Communication profile	DS301
Device profile	DSP410
Connector types	M12 5-pin (×2) (CAN input/output)
Operating temperature	-40 to +70 °C
Storage temperature	-40 to +85 °C
Temperature stability	± 130 x 10^{-6} / °C f.s.
Housing	Aluminum
Mounting	2 × M8 screws
IP rating	IP67

BR900 boom rotation sensor

P/N: 103103

Supply Voltage	10 to 30 V DC
Power Supply	Max 100 mA
Measurement Range	± 180°
Resolution	0.001°
Accuracy	± 0.25°
Resolution	Better than 0.01°
Communication Method	CANopen (ISO 11896)
Communication Profile	DS301 DSP406 for absolute linear encoder
Connector Types	M12 5-pin (×2) (CAN input/output)
Housing	Steel housing, zinc plated
Mounting	2 × M8 screws
Operating Temperature	-40 to +70 °C
Storage Temperature	-40 to +85 °C
Temperature Stability	± 130 x 10^{-6} / °C f.s.
IP Rating	IP67

CLD900 Chain Link Drive sensor

P/Ns: 112308-15, 25, 35, 45

Supply Voltage	10 to 30 V DC
Power Supply	Max 100 mA
Measurement Method	Proximity switches
Communication Method	CANopen (ISO 11896)
Communication Profile	DS301 DSP406 for absolute linear encoder
Connector Types	M12 5-pin (×2) (CAN Input / Output) M12 4-pin (×2) (Digital Inputs)
Digital Inputs	2
Digital Input Type	Active High
Operating Temperature	-40 to +70 °C
Storage Temperature	-40 to +75 °C
Sprocket Wheel Pitch Available	1.00” 1.25” 1.50” 2.00”
Housing	Steel with zinc plating
Mounting	2 × M6 screws
IP Rating	IP67

CDD900, CRD900, AC900, and FRD900 sensors

P/Ns: 92305-75, 92307-00, 98499, and 98498

Supply Voltage	10 to 30 V DC
Power Supply	Max 100 mA
Measurement Method	Encoder
Communication Method	CANopen (ISO 11896)
Communication Profile	DS301 DSP406 for absolute linear encoder
Connector Types	M12 5-pin (×2) (CAN input/output) M12 4-pin (×1) (Digital inputs)
Digital Inputs	2
Digital Input Type	Active High
Housing	Steel housing, zinc plated
Mounting	2 × M6 screws
Measurement Wheel Diameter	40 mm
Operating Temperature	-40 to +70 °C
Storage Temperature	-40 to +85 °C
IP Rating	IP67

TBE900 telescopic boom extension sensor

P/N: 98496

Supply voltage	24 V DC
Power supply	Max 100 mA
Measurement wheel	Diameter 150 mm
Measurement length	5,000 mm
Wire length	5,500 mm
Communication Method	CANopen (ISO 11896)
Communication profile	DS 301 DSP-406 for absolute linear encoder
Connector types	M12 5-pin (×2) (CAN input/output)
Mechanical error	± 12 mm only when changing direction
Electrical error	± 2 mm
Housing	Aluminum
Mounting	2 × M8 screws 60 mm separated
Operating temperature	-40 °C to +70 °C
Storage temperature	-40 °C to +85 °C
IP Rating	IP 67

Electronic box

P/N 92314-50

NOTE – Used by PSD900 and CLD900.

Supply Voltage	10 to 30 V DC
Power Supply	Max 100 mA
Measurement Method	Proximity switches
Communication Method	CANopen (ISO 11896)
Communication Profile	DS301 DSP406 for absolute linear encoder
Connector Types	M12 5-pin (×2) (CAN input/output) M12 4-pin (×2) (Digital inputs)
Digital Inputs	2
Digital Input Type	Active High
Operating Temperature	-40 to +70 °C
Storage Temperature	-40 to +75 °C
Housing	Steel with zinc plating
Mounting	2 × M6 screws
IP Rating	IP67

M12 proximity switch

P/N: 92314-20

> **NOTE –** Used by PSD900 and CLD900.

Function	Inductive proximity sensing
Size	M12
Output	PNP-NO
Mounting	Non-flush mountable
Connection	2 m cable
Detection range	4 mm
Frequency	1 kHz
Material	Brass
IP Rating	IP67

M18 proximity switch

P/N: 98455

Rated operational voltage	24 V DC
Local current capacity	200 mA
Time delay before availability	10 ms
Electrical type	DC
No load supply current – damped	14 mA
No load supply current – undamped	3 mA
Switching output	NPN
Switching element function	NO
Operating frequency	800 Hz
Supply voltage max	30 V DC
Supply voltage min	10 V DC
Connection type	M12 connector
Number of wires	3 wire
Tightening torque	35 Nm
Rated operating distance	16 mm
Diameter	18 mm
Mounting	Flush mountable
Ambient temperature max	+70 °C
Ambient temperature min	-25 °C
Housing material	CuZn
Repeat accuracy max	5%
IP rating	IP67

M30 proximity switch

P/N: 98446

Rated operational voltage	24 V DC
Local current capacity	200 mA
Time delay before availability	20 ms
Electrical type	DC
No load supply current – damped	10 mA
No load supply current – undamped	3 mA
Switching output	PNP
Switching element function	NO
Operating frequency	300 Hz
Supply voltage max	30 V DC
Supply voltage min	10 V DC
Connection type	M12 connector
Number of wires	3 wire
Tightening torque	370 Nm
Rated operating distance	30 mm
Diameter	30 mm
Mounting	Flush mountable
Ambient temperature max	+70 °C
Ambient temperature min	-25 °C
Housing material	Brass
Repeat accuracy max	5 %
IP rating	IP67

Pressure sensors

P/N: 98494 and 98495

Supply Voltage	8 – 32 V DC
Current Consumption	Approximately 20 mA
Rise Time	Typ. 1 ms / 10 ... 90% nominal pressure
Communication Method	CANopen (DS 404)
Measuring Principle	Thin film on steel
Measuring Range	0 to 250 bar (P/N 98494) 0 to 400 bar (P/N 98495)
Over Pressure	500 bar (P/N 98494) 800 bar (P/N 98495)
Accuracy	Accuracy @ 25°C typ. ± 0.5 % FS typ.
Long Term Stability	Long term stability 1 year @ +25°C < ± 0.2
Operating Temperature	-40 °C to +125 °C
Media Temperature	-50 °C to +135 °C
Humidity	Max 95% relative
Vibration	40 g (20...200 Hz)
Shock	100 g / 11 ms
IP Rating	IP67

IO900 I/O box

P/N 92311-75

Supply Voltage	10 to 30 V DC
Power Consumption	Max 100 mA
Digital Inputs	6
Digital Input Type	Active High 1 = 6 to 28 V DC 0 = <2 V DC
Digital Outputs	2
Digital Output Type	Potential free relay, changeover contacts, maximum load 1 A
Communication Method	CANopen (ISO 11896)
Communication Profile	DS
Communication Ports	M12 5-pin (x2) (CAN input/output) M12 5-pin (x6) (Digital input) M12 5-pin (x2) (Digital output)
Operating Temperature	-40 to +70 °C
Storage Temperature	-40 to +85 °C
IP Rating	IP67

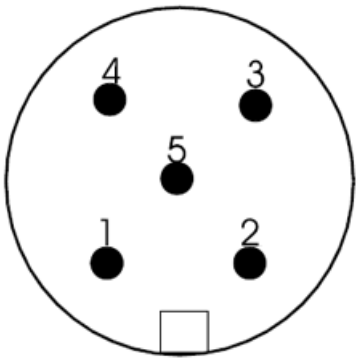
11

Pinout Diagrams

This chapter shows the pinout diagrams for the CAN sensors of the Groundworks system.

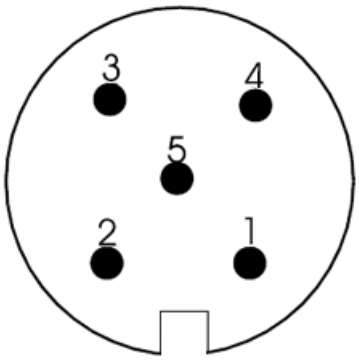
CAN In/Out ports for AC900, BR900, CDD900, CLD900, CRD900, Electronic box, FRD900, IO900, PSD900, Pressure sensors, TBE900, and TS900

CAN input (A-coded male)

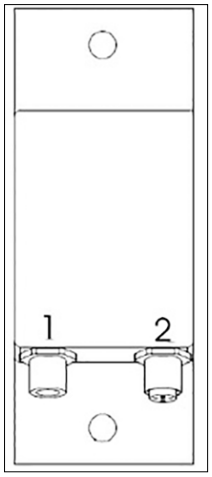


Pin	Signal
1	Not used
2	+ 24 V
3	GND
4	CAN Hi
5	CAN Lo

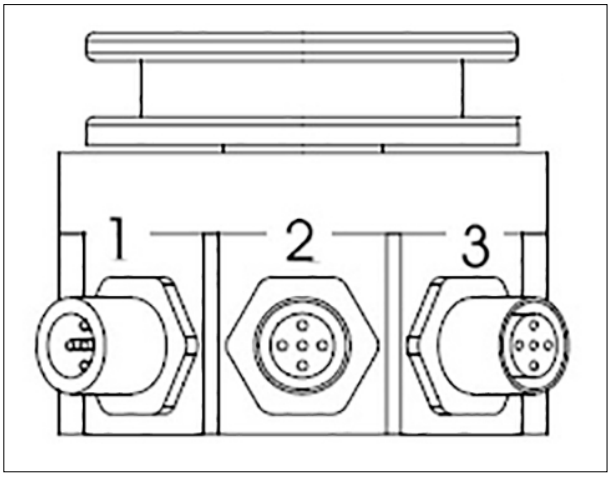
CAN output (A-coded female)



Pin	Signal
1	Not used
2	+ 24 V
3	GND
4	CAN Hi
5	CAN Lo



Pin	Signal
1	CAN In
2	CAN Out

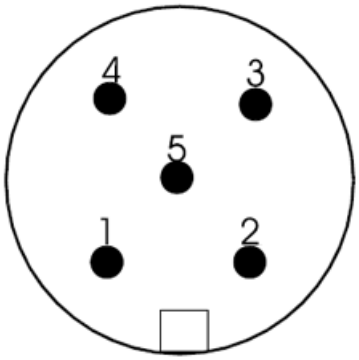


Pin	Signal
1	CAN In
2	CAN Out
3	Digital Input

Digital Input/Output ports for IO900

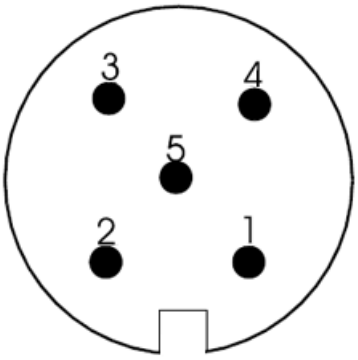
NOTE – Digital input pinout also applies to AC900, CDD900, CLD900, CRD900, Electronic box, FRD900, and PSD900.

Input 1 to 6



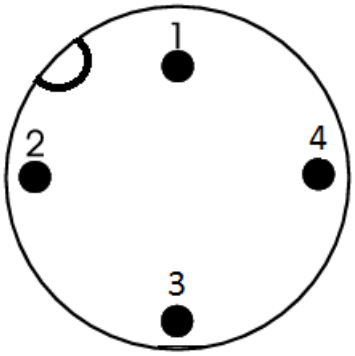
Pin	Signal
1	+ 24 V
2	Signal 1 active low
3	GND
4	Signal 2 active high
5	Not used

Output 1 to 2



Pin	Signal
1	Common
2	Not used
3	Not used
4	Normally open
5	Normally closed

M18 and M30 proximity switch



Pin	Signal
1	+ 24 V
2	Not used
3	GND
4	Signal

12

Accessories

This chapter describes the available Groundworks Machine Control System accessories.

CAN cable accessories

Male M12 connector

P/N 98492

Female M12 connector

P/N 98508

CDD900 sensor accessories

Length transducer cylinder cable (15 m) including tension spring & cable locks

P/N 92305-41

CRD900 sensor accessories

Coupling for the CRD900 sensor

P/N 92307-20

FRD900 sensor accessories

Friction ring for the FRD900 depth sensor

P/N 98906

Wheel kit for the FRD900 depth sensor

P/N 98907

Brackets

RAM mounting plates

P/N 105108 – RAM D plate

P/N 105109 – Medium length D arm

TS900 mounting plate

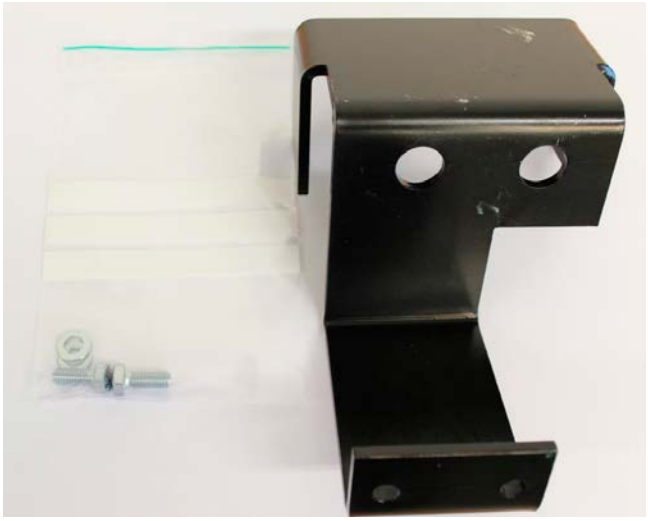
P/N105501-30

CRD900 mounting plate

P/N 105501-40

Dual proximity switch mounting plate for Epiroc

P/N 105501-70



Assorted hardware for Groundworks sensors

P/N105501-99

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