Trimble Groundworks

Machine Control System

Installation and Configuration Guide

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Legal Notices

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Release Notice

This is the June 2022 release (Revision A) of the Groundworks Installation and Configuration Guide.

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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.

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. Alternatively, go to the Support area of the Trimble website (www.trimble.com/support/index_support.aspx). Select the product you need information on. Product updates, documentation, and any support issues are available for download.

2

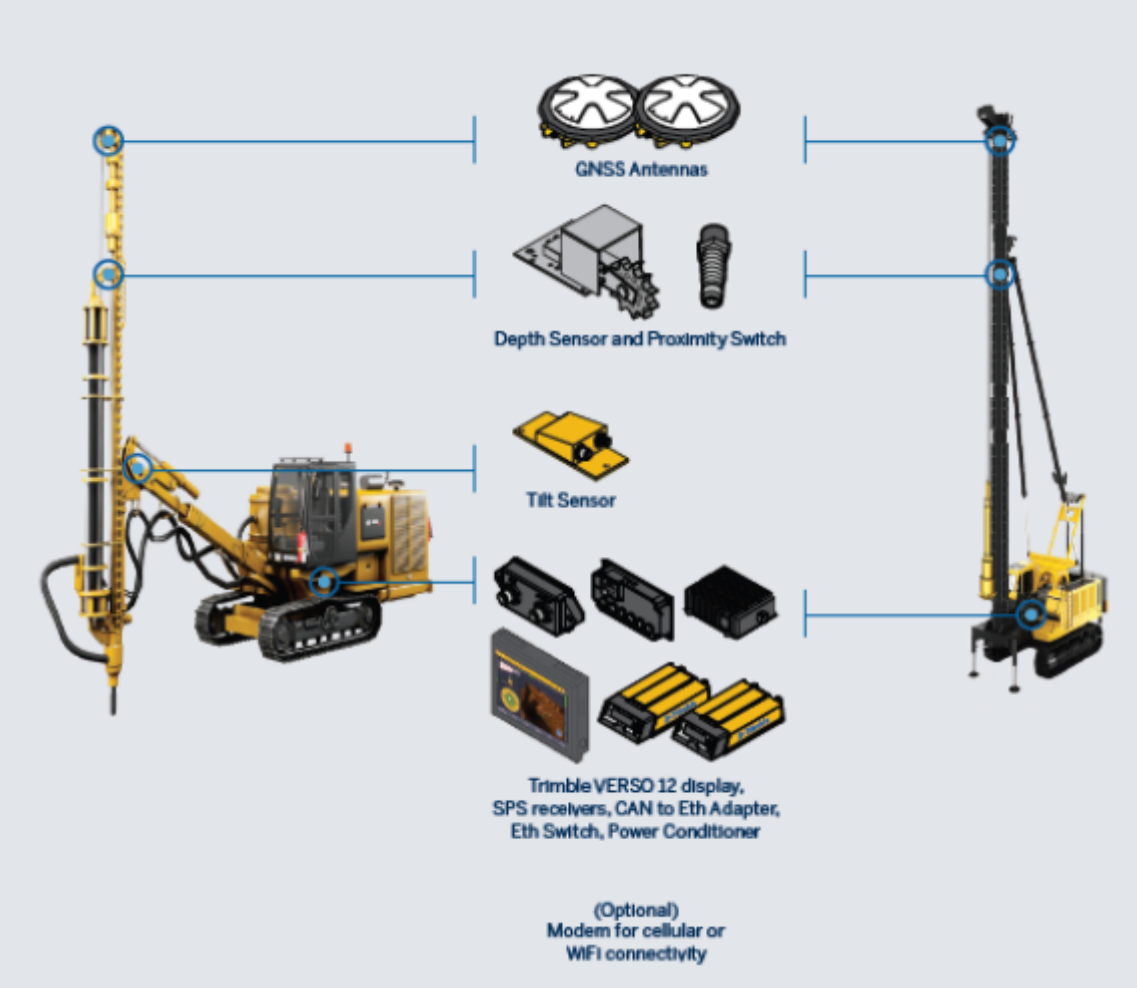
System Components

- Groundworks system overview
- GNSS receivers
- GNSS antennas
- Trimble VERSO 12 touch display
- JB900 Junction Box
- Trimble CAN sensors
- Required reset of the depth sensor

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 has a 0.5m or 2m Ethernet cable that connects it to the Ethernet switch (PN:92299-85)
2. The GNSS receivers should be mounted next since they have a 3 m cable that connects them 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.
3. The Ethernet switch must be mounted within 2 m cable length from the VERSO 12 display and 3 m cable length from the GNSS receivers.

a. The Ethernet switch should be mounted so that all connections are accessible for troubleshooting.

b. 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.

4. Mount the GNSS antennas at the top of the mast and ensure they will not interfere with normal machine operation.
   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. If using Zephyr Rugged 3, use the PN: 111760 (Adaptor, RA, TNC/TNC connectors which will face the connector down and the GNSS cable are 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.
5. Mount the depth sensor next and continue mounting the sensors working back towards the 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.
6. Mount the M18 Proximity Switch to the mast and mount the trigger plate to the tool for automatic reset of the depth sensor.
   a. An alternative option is to mount the M18 proximity switch on the tool and the trigger plate on the mast.

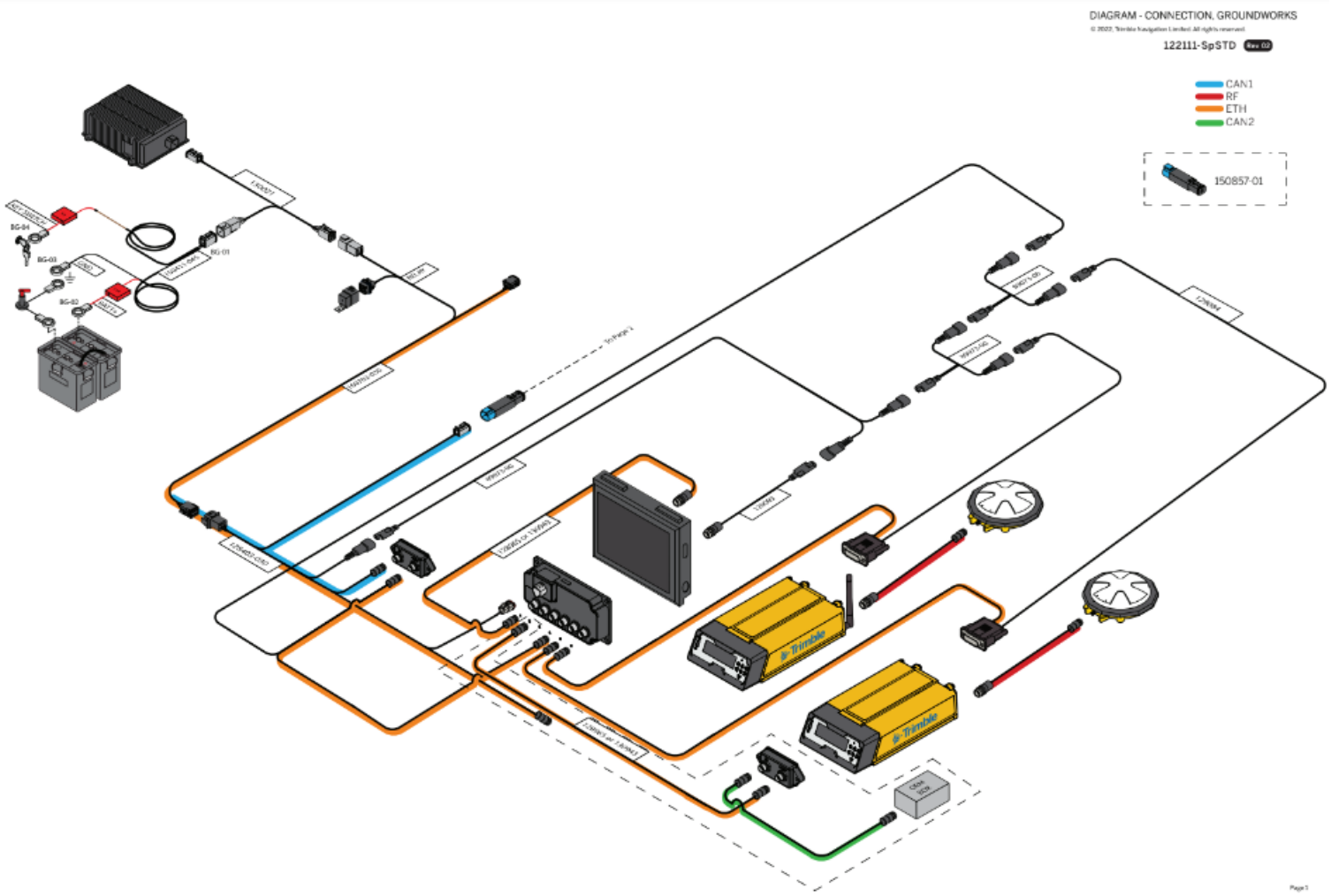
b. The M18 proximity switch must be connected to the depth sensor.

   c. If no M18 proximity switch is installed, the depth sensor can be reset manually in the software, but it must be done in the same location each time the system is started.

7. Mount the TS900 Dual-Axis Tilt sensor on the mast as close as possible to where the mast pivots to achieve the most stable results.
   a. The tilt sensor must be mounted square with the mast with the connectors facing downwards.
8. Mount the IO900 (I/O box) in or near the electrical panel for easy access to the input/output signals.
9. 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 using 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 as IP67, excluding the Whisker Switch (P/N 98497), provided that all connectors are either connected to a cable or an end cap to seal 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
Trimble
Trimble

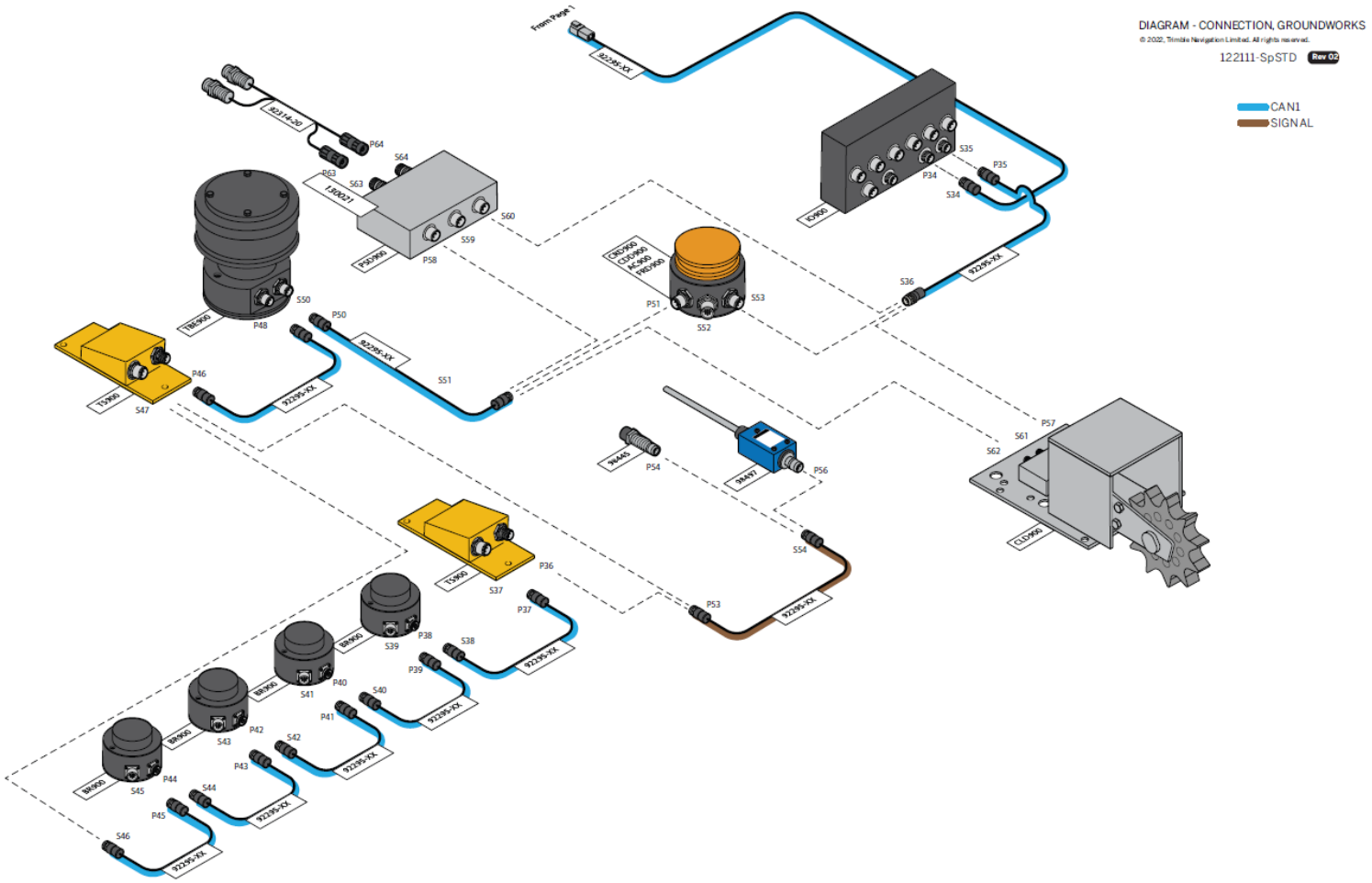


DIAGRAM - CONNECTION, GROUNDWORKS

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122111-SpSTD Rev 02

CAN1
SIGNAL

GNSS receivers

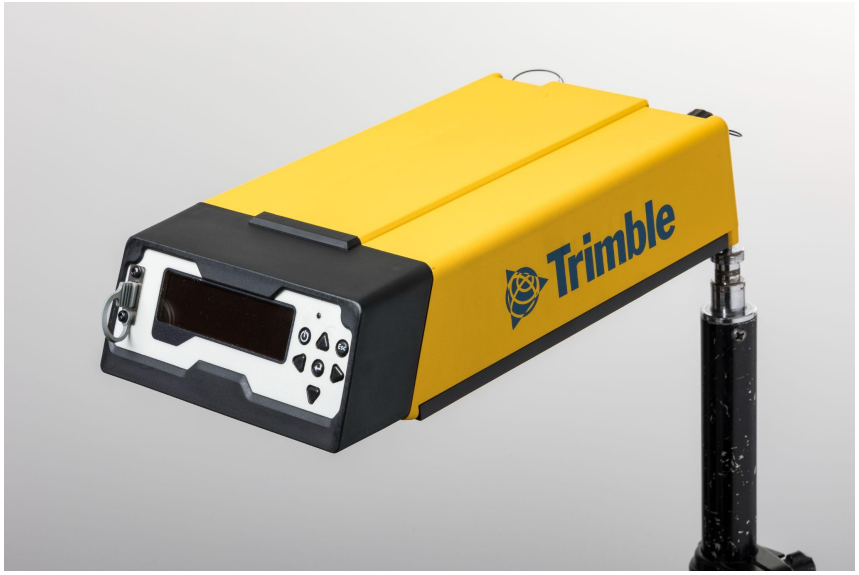
Option 1

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 900Mhz, 450Mhz, 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 (PN:128018-00)

Note: The R750 can be interchangeable with SPS855 and SPS555H

R750 can be combined with SPS855 and SPS555H meaning, R750 can be a moving base or a heading receiver while using the other receivers.



The R750 moving base GNSS receiver is configured with the following options

- P/N R750-PPR: Option - Premium Precise Rover R750, includes all constellation (no tilt)

The R750 Heading GNSS receiver is configured with the following options as a minimum requirement:

- P/N CON-R750-BDS: Option- R750, BeiDou
- P/N CON-R750-GAL: Option- R750, Galileo

Option 2

P/N 69555H-00 and 69855-00, -61, -91

The positioning requirements of the Groundworks system are met using the Trimble SPS receivers; SPS855 for positioning (moving base) and SPS555H for heading. The two receivers are mounted together in the dual-receiver fixed-bracket mast mount as shown below:



The SPS855 GNSS receiver is configured with the following options as a minimum requirement:

- P/N IS60989-40: Activation – SPS985L(Rover), SPS985, SPS855, SPS555H
- P/N IS59827-72: Upgrade – Precise Rover, SPS985/SPS855/BX982, Marine
- P/N IS50990-25: Upgrade – Heading & Moving Base, SPS985/SPS855, Construction
- P/N IS51951-80: Option – Combo GLN/GAL/BeiDou/L5, SPS985/SPS855/SPS555H, Construction

The SPS555H GNSS receiver is configured with the following options as a minimum requirement:

- P/N IS60989-40: Activation – SPS985L(Rover), SPS985, SPS855, SPS555H
- P/N IS51951-80: Option – Combo GLN/GAL/BeiDou/L5, SPS985/SPS855/SPS555H, Construction

Option 3

P/N 108567-15-MAR

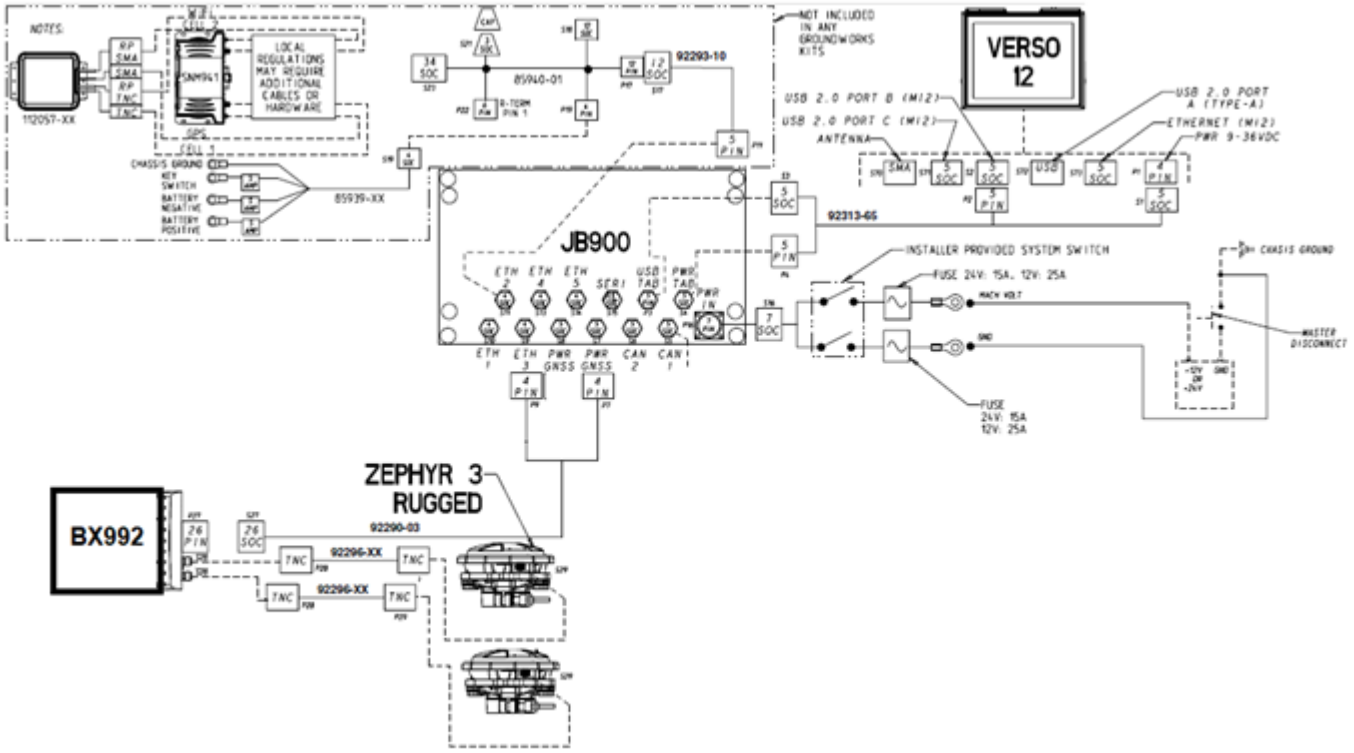
Using the Version 1.4 of the Groundworks software, there are two new options

when it comes to GNSS choices. Option 2 specifically talks about the BX992. There are three configurations of the BX992 setup of no radio, 450mhz radio and 900 mhz. Regardless of the configuration of the BX992 setup, each receiver will require these option codes below

Part number	Description	Quantity
IS59827-72	Upgrade - Precise Rover, SPS985/SPS855/SPS585/BX982 Marine	1
IS51951-81	Option - Combo GLN/GAL/BeiDou/L5, SPS985/SPS855/SPS555H/9205/BX982, Marine	1
IS59827-25	Upgrade - Heading and Moving Base, SPS985/SPS855/BX982, Marine	1

Configuration 1 (no radio)

The wiring diagram is below and there are no changes to any harness of the system except the installer only needs one connection from the receiver to JB900 instead of two for sps855 and 555H.

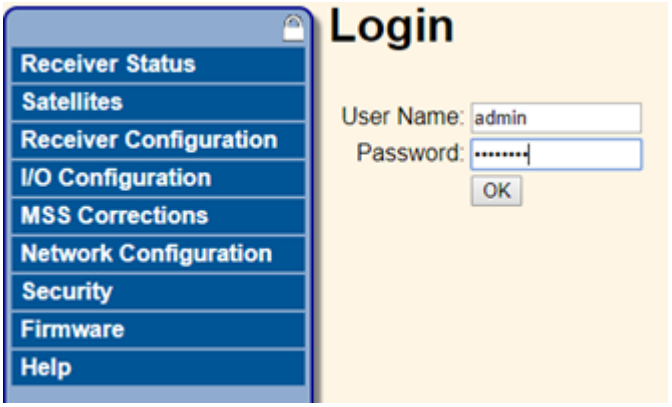


Configure the BX992 WebUI

1. Connect the hardware as the above diagram
2. Connect the BX992 to the Verso to gain access to BX992 webUI
3. Default webui address is : **169.254.1.0**

   a. Once you've established a connection to the BX992, you will be prompted to log in to the Web UI.

The default username is **admin**
The default password is **password**



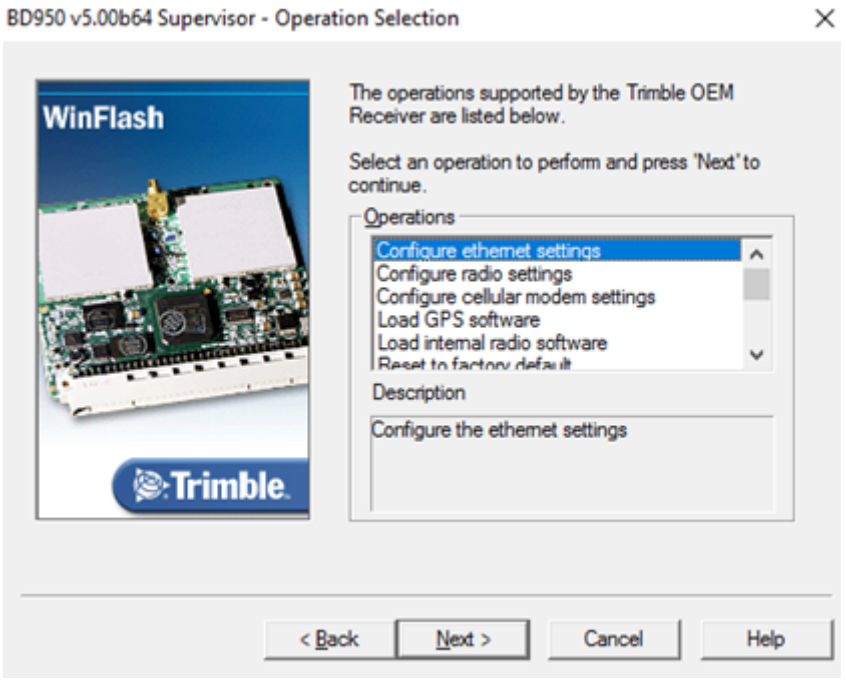
IF you are looking to determine the IP address or change DHCP to static follow the next steps below

b. You may also use Trimble Winflash to establish a serial connection to the “SERIAL 3” 9 pin connector on the included PN 78235-10 adapter cable. The latest version of Winflash may be downloaded at the link below.

[Trimble Groundworks Technician Community]



Select the appropriate COM port and press Next. Choose Configure ethernet settings from the Operations Menu. Click Next then Finish to establish the connection.



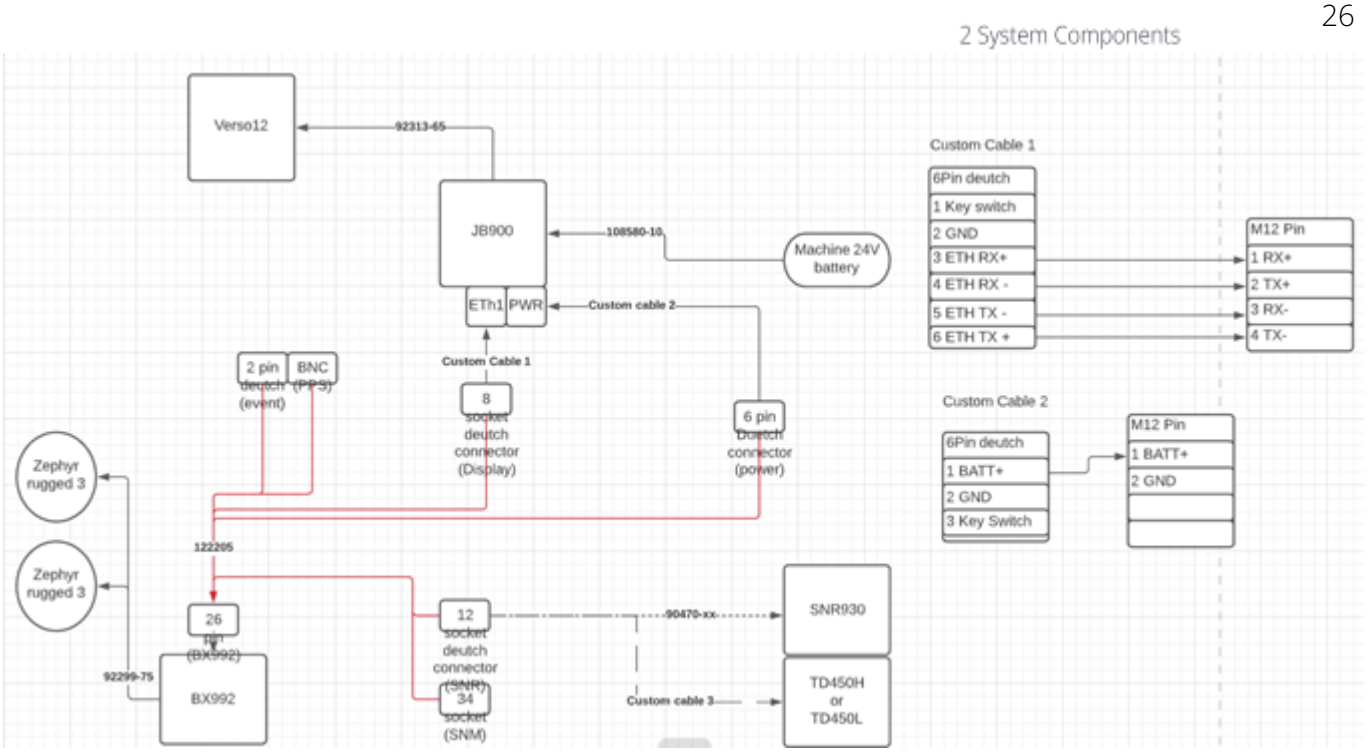
c. Winflash shows the current IP address and allows you to change the IP address from DHCP to Static if needed.

4. Need to first change Receiver ID from 504 to 164
   a. This is to change the name of the BX992 via an option code
   b. Need to send the SN of the BX992 to your RAR
      1. RAR will send the information back to the BA to provide the options code.
5. Apply option codes
   1. **IS59827-72** -Upgrade - Precise Rover, SPS985/SPS855/SPS585/BX982 Marine
   2. **IS51951-81** -Option - Combo GLN/GAL/BeiDou/L5, SPS985/SPS855/SPS555H/9205/BX982, Marine
   3. **IS59827-25**- Upgrade - Heading and Moving Base, SPS985/SPS855/BX982, Marine
6. Apply clone file to BX992
. BX992-GW.xml
7. Only for no radio version **

Assuming the SNM941 is connected and receiving cellular data Input VRS credentials to allow BX992 to get corrections

Configuration 2 (450Mhz and 900Mhz)

BX992 with SNRx3x radio



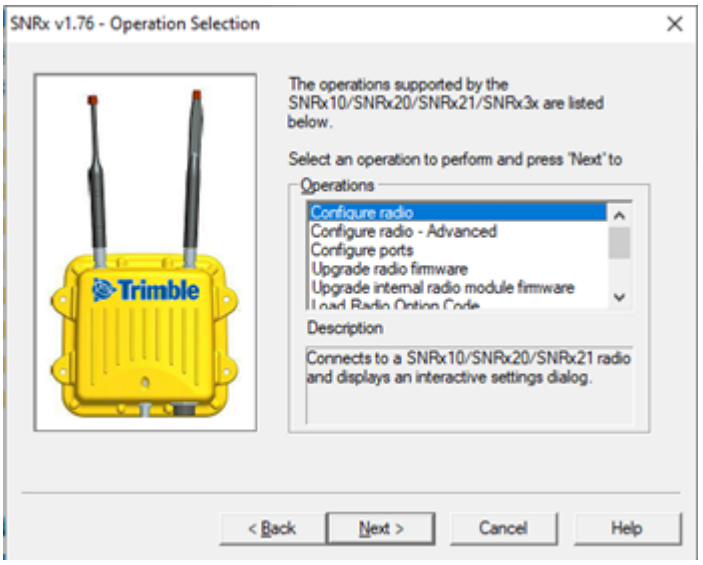
Configure Radio (SNRx30) for BX992

1. Please follow the Configure the BX992 WebUI section above
2. Configure the SNR radio using Winflash [Download here]
    a. Connect the SNRx3x using the service cable PN: 82725-00
        i. Connect the serial cable of the service cable into the PC (adapter maybe needed if the computer does not support DP9)
    b. Using Winflash

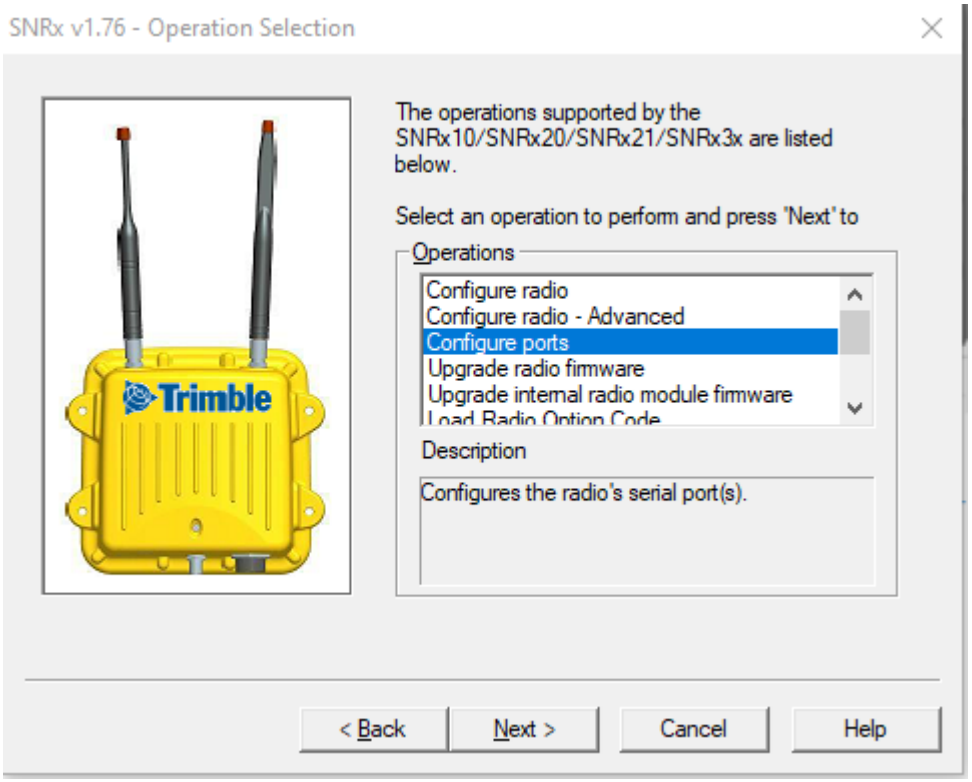


.

1. Select SNRx 10/SNRx20/SNRx21/SNRx3x
2. And PC serial port that connects to the SNR radio

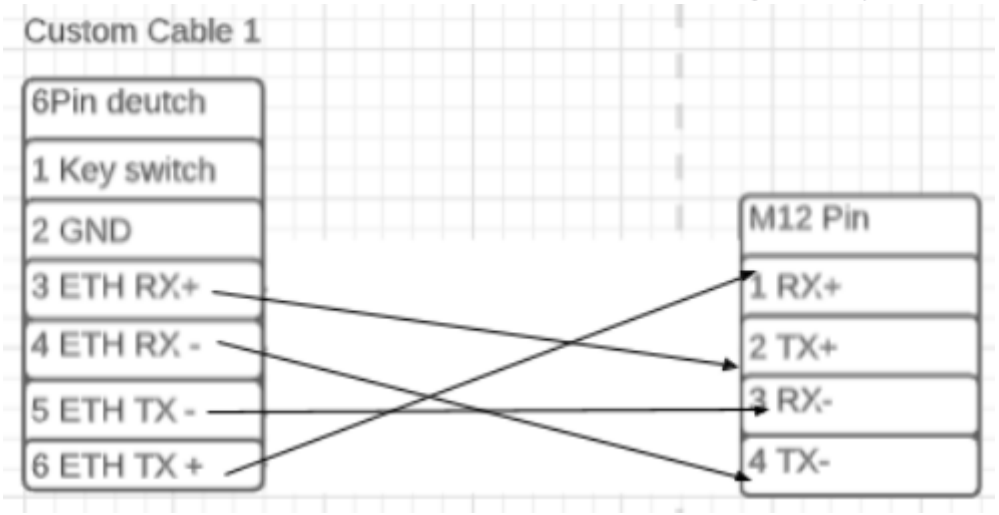


1. Configure the radio and select the channel (450mhz)/network ID(900mhz).
2. Configure ports

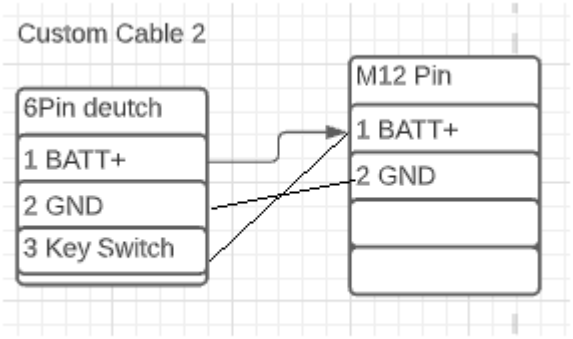


3. Write down your Baud Rate information

3. Create 2 custom cables
    1. First 6 socket deutsch connector to M12 Pin



Second 6 pin deutsch connector to M12 pin

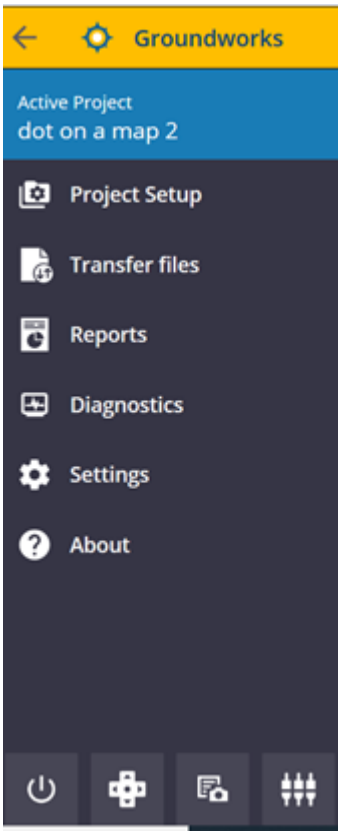


Groundworks setup with BX992

1. Version 1.4 or higher Groundworks software is required
2. Click on the Hamburger menu



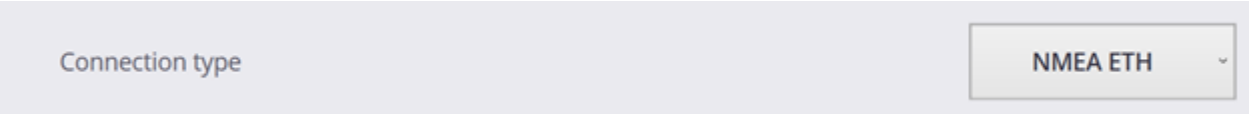
3. Click Settings



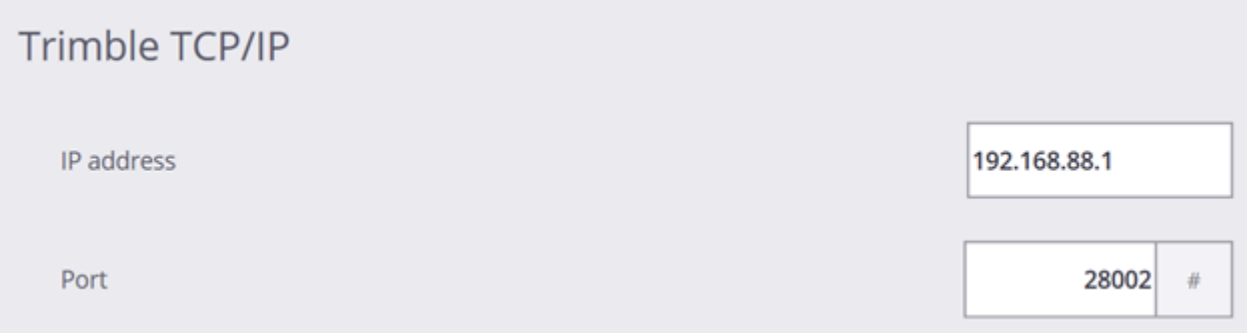
4. Click GNSS Setup



5. Connection type is NMEA ETH



6. Add your IP address and port that corresponds to your BX992

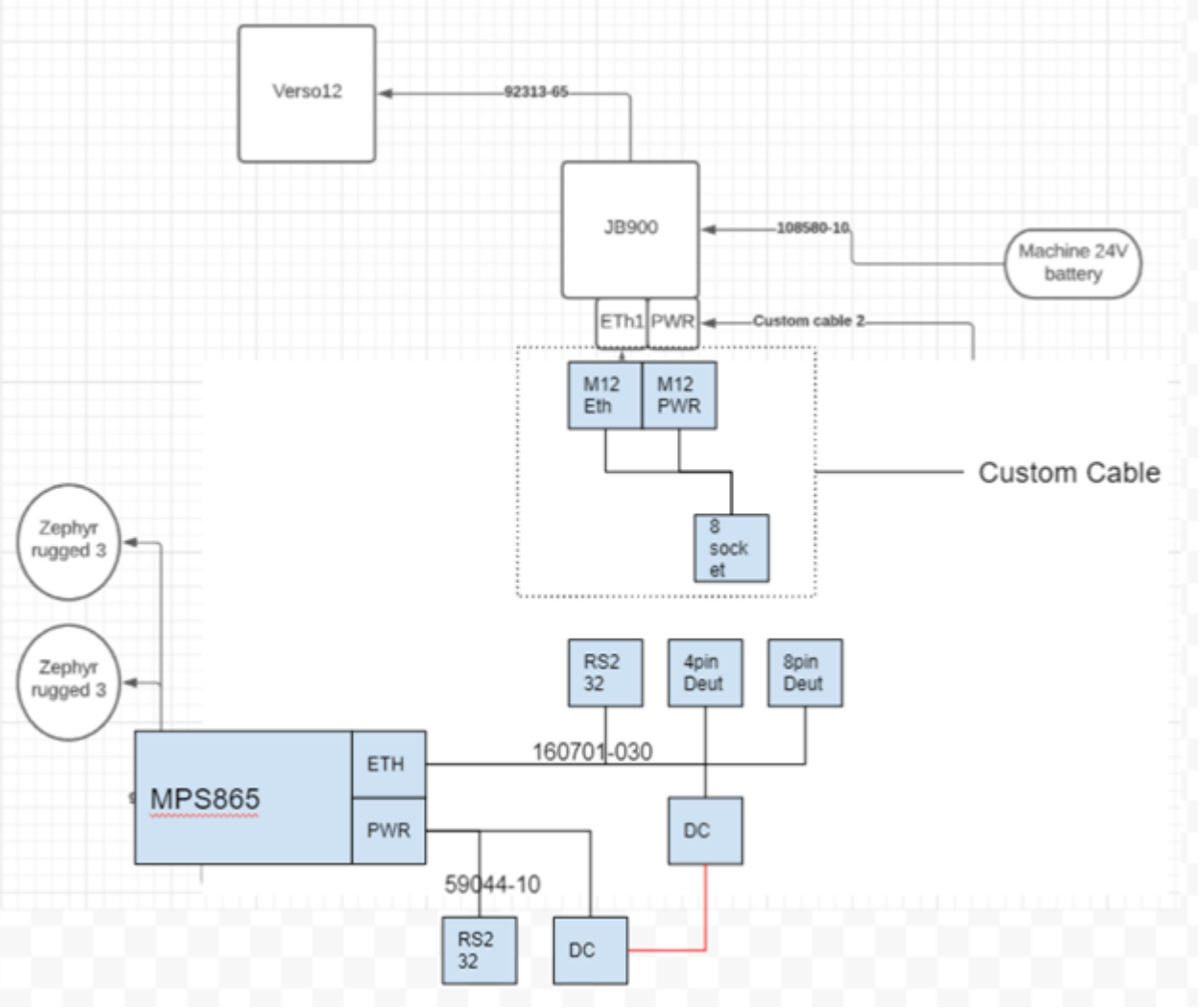


Option 4

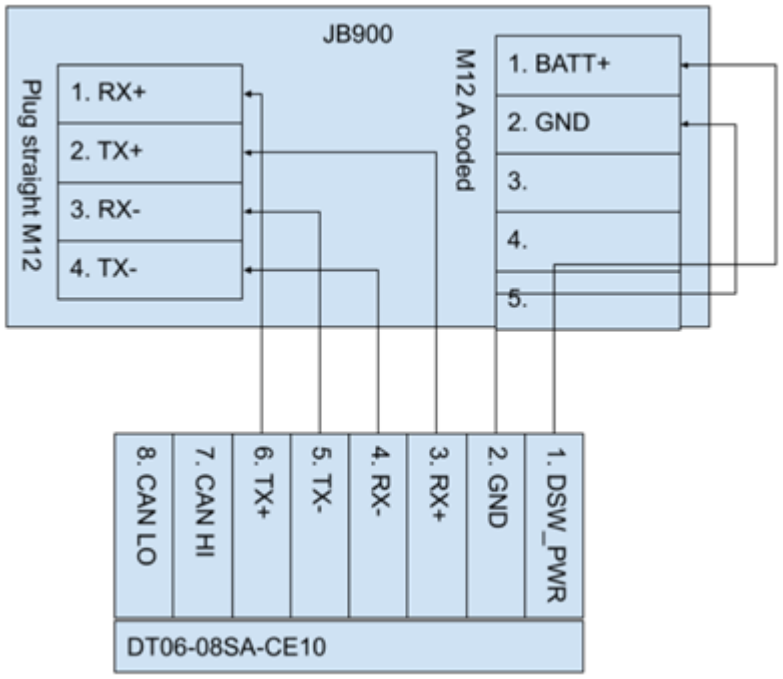
P/N 200865-604

MPS865 is the third optional receiver that can be used with Groundworks software. The schematics below show the two different methods to incorporate the receiver into the Groundworks system

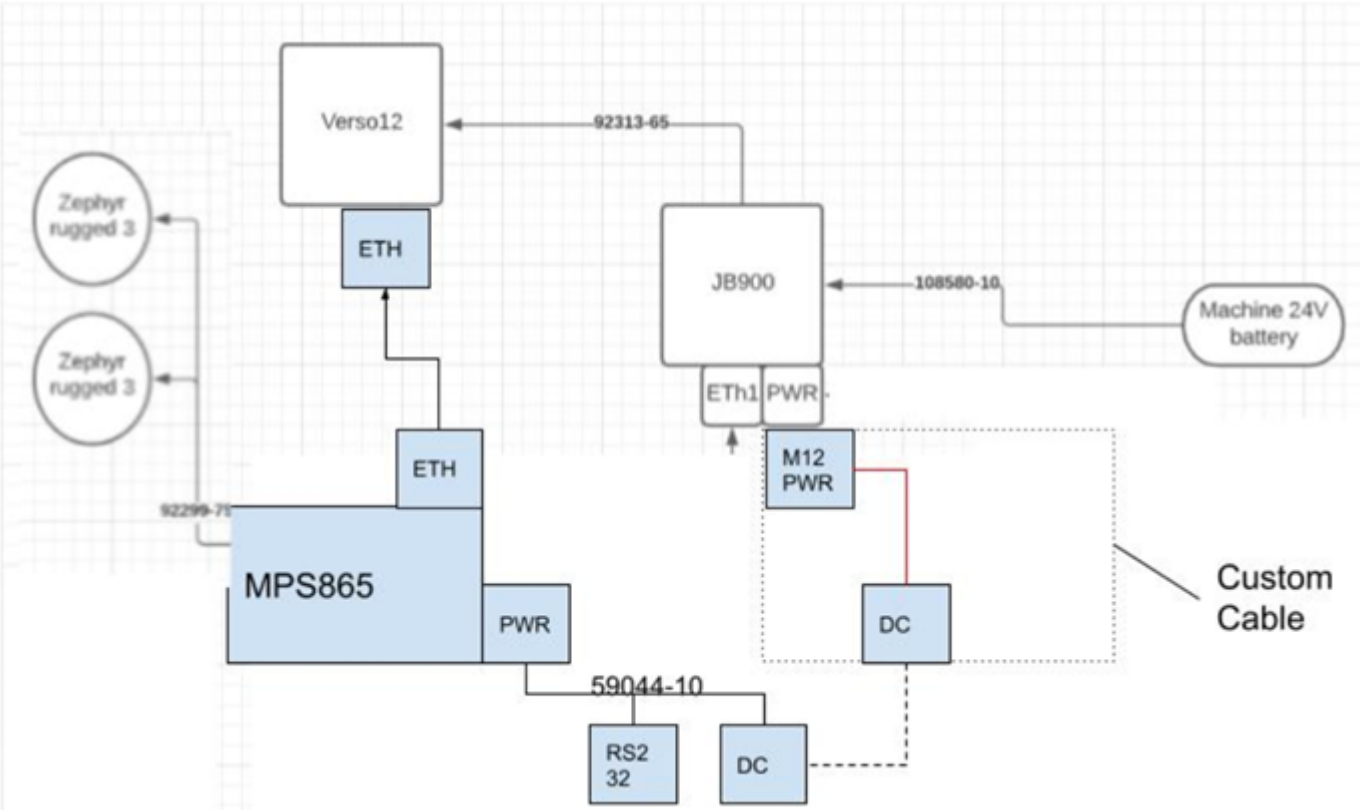
Configuration Option 1:

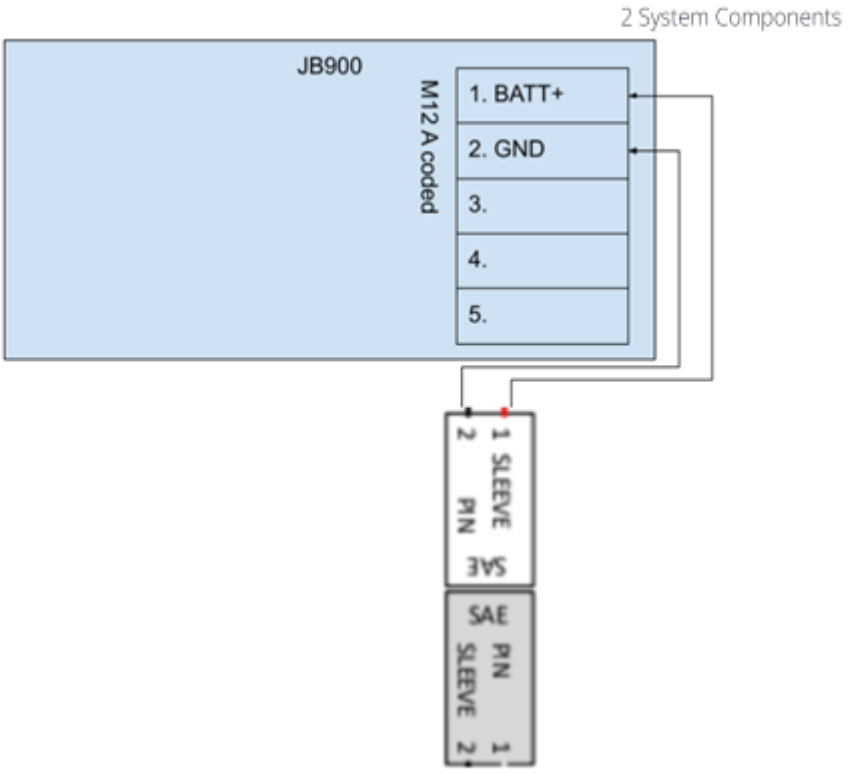


Custom cable for MPS865 option 1



Configuration option 2

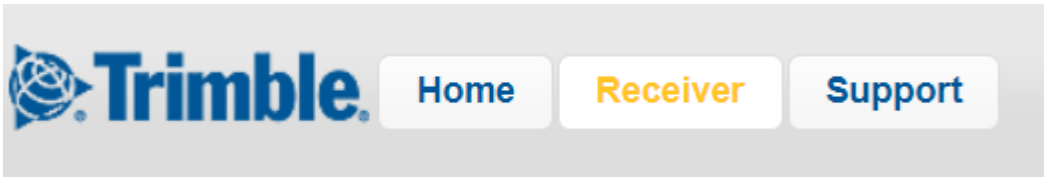




Custom cable for option 2

MPS865 Configuration

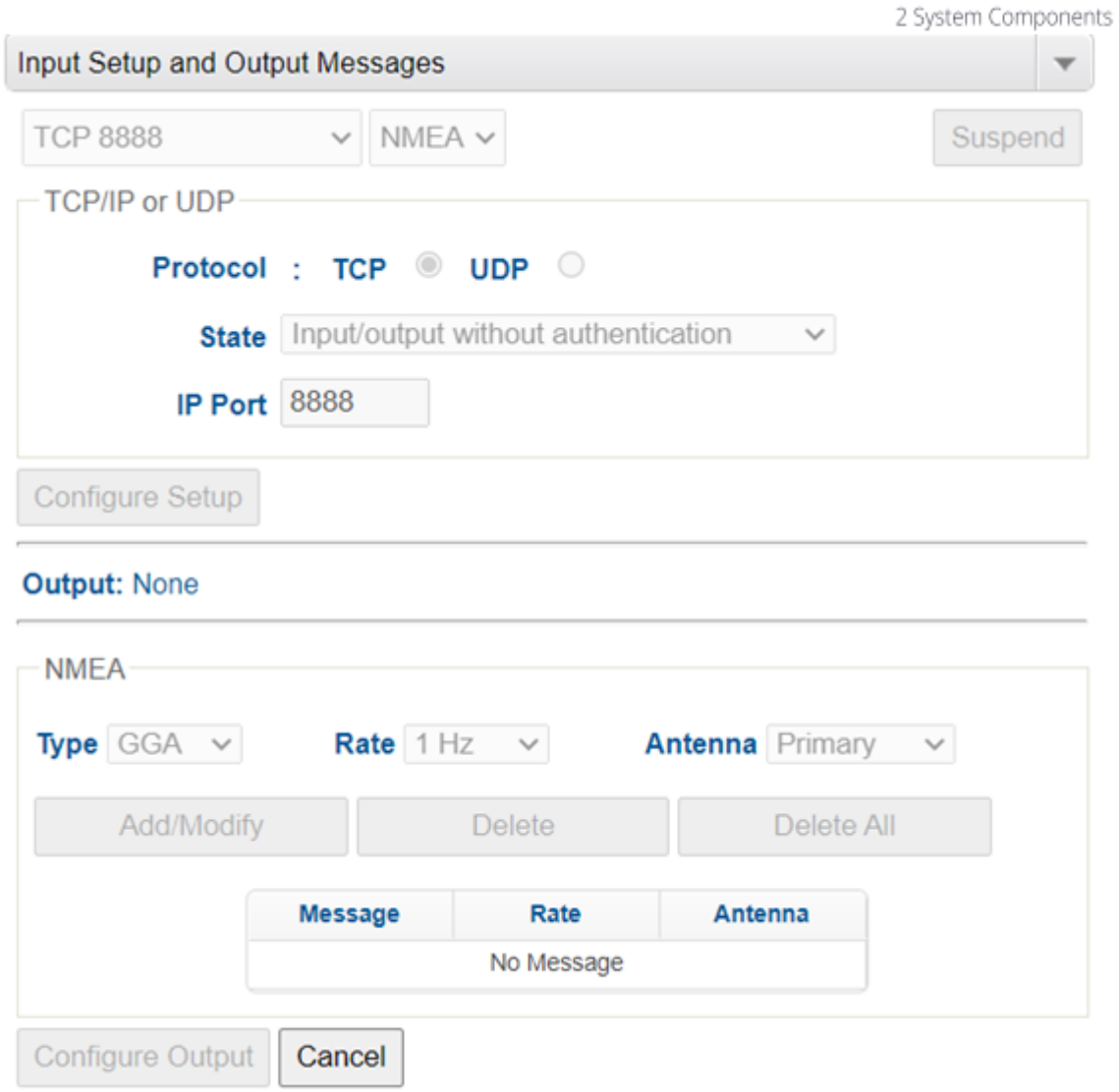
1. Enter the webUI of the MPS865
2. Click Receiver



3. Click I/O



4. Setup the TCP address so that the MPS865 is outputting NMEA



5. NMEA message Type needed
    a. Type: GGA and HDT
    b. Rate : 10Hz
    c. Antenna: Primary
6. ADD/Modify
7. Configure Output

Groundworks configuration with MPS865

Refer to BX992 configuration setup 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.

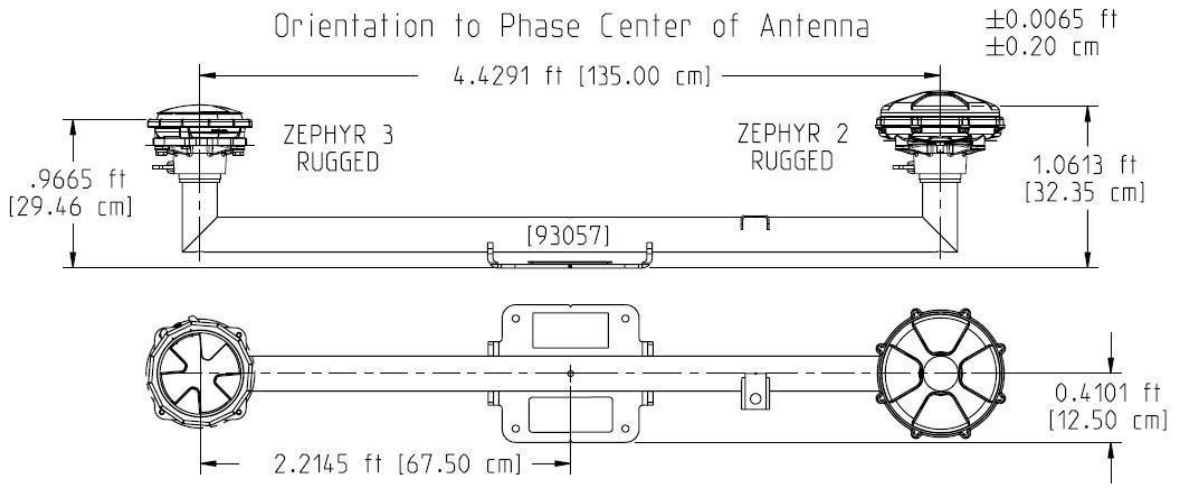
GNSS dual-antenna mounting bracket

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 (SPS855 Moving Base receiver) to the left-hand antenna (left side of the mast as seen by the operator from the machine operating position).
2. Connect the Heading receiver (SPS555H Heading receiver) to the right-hand antenna (right side of the mast as seen by the operator from the machine operating position).

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.



Trimble VERSO 12 touch display

P/N TABV12-00 and TABV12-10

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, 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 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 92299-90

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 hardware to be installed after the battery. This unit takes 9 to 36 VDC and provides over and under voltage protection, which also allow -40°C to 85°C (-40°F to 185°F) operating temperature with an IP67 rating.

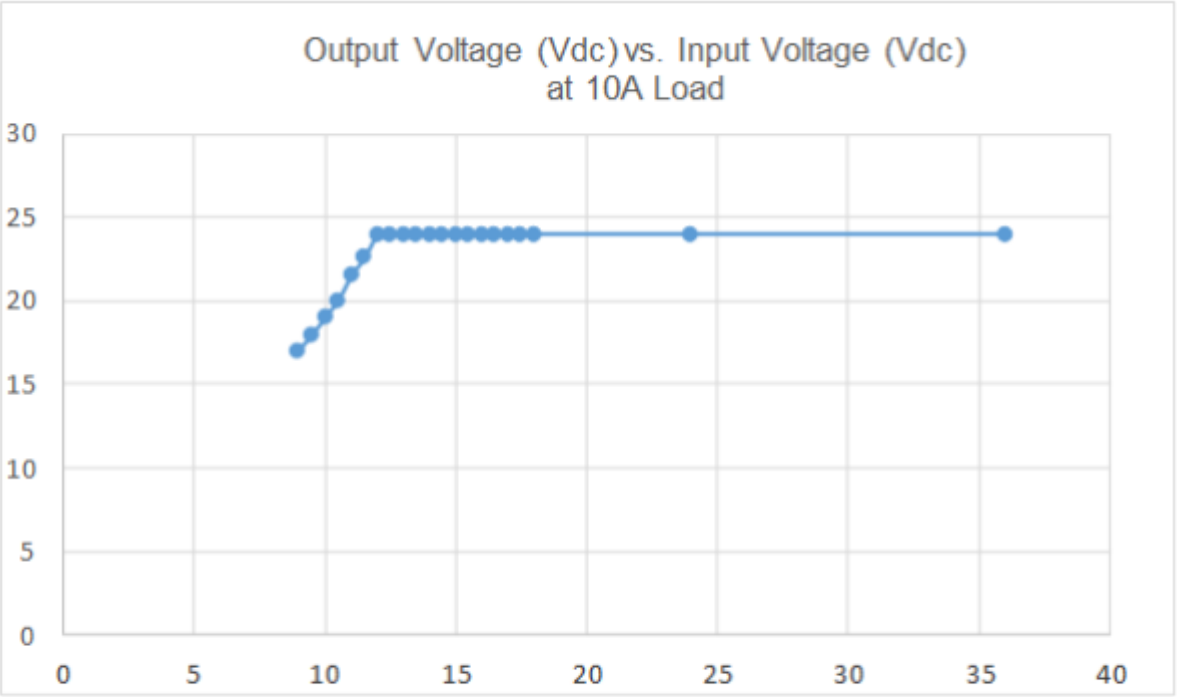
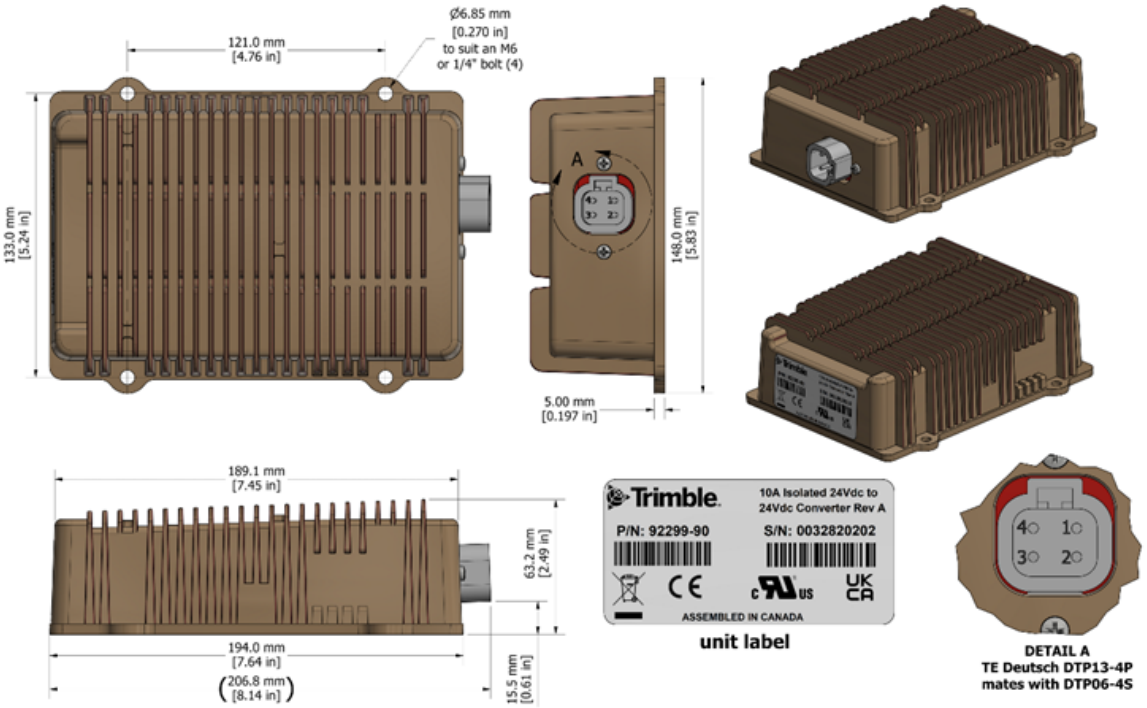


Figure 1.0 Output Voltage vs. Input Voltage at Full Load



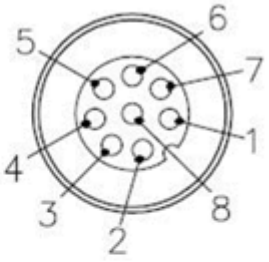
CAN to ETH adapter

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 running Groundworks software

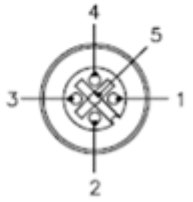
Ethernet Port: Power In, Ethernet

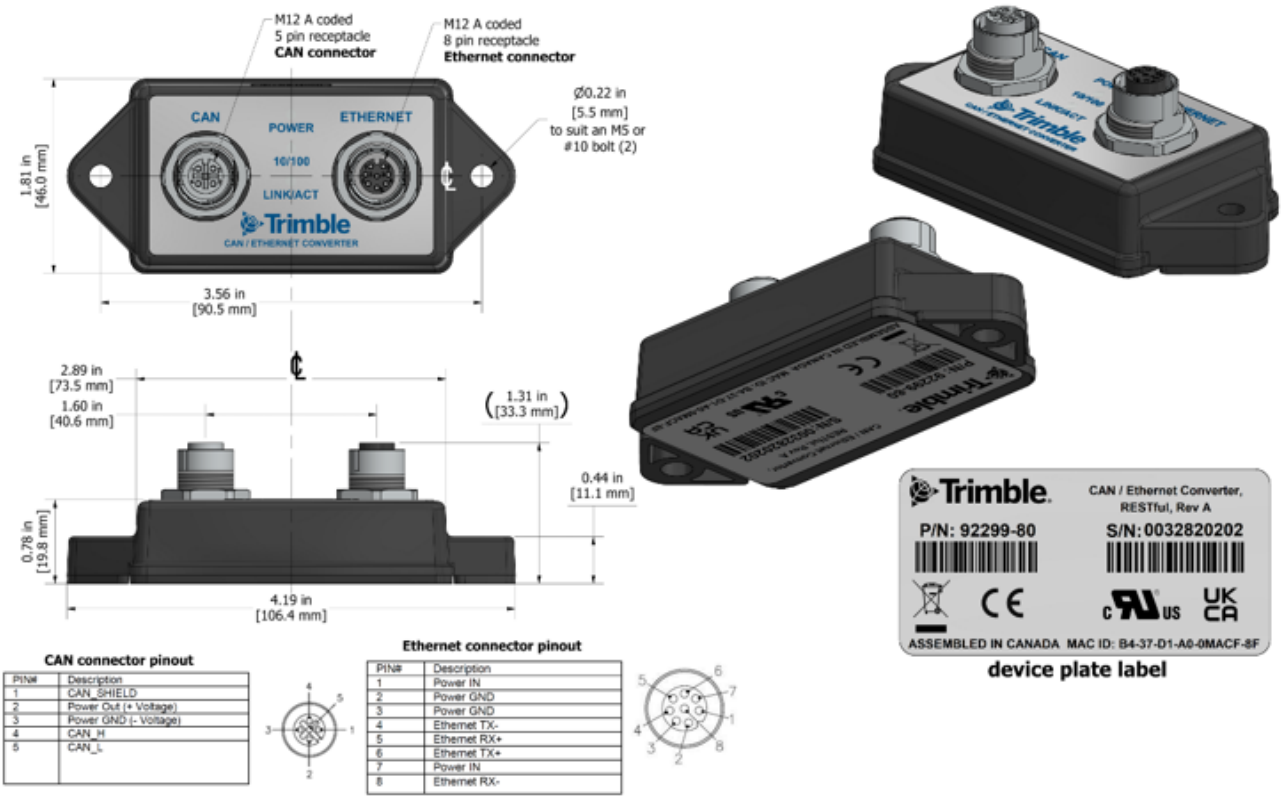
PIN#	Description
1	Power IN
2	Power GND
3	Power GND
4	Ethernet TX-
5	Ethernet RX+
6	Ethernet TX+
7	Power IN
8	Ethernet RX-



1 Phoenix Contact M12 5-pin connector (A-coded), P/N: 1441778 (Connector 2)
CAN Port: Power Out, CAN

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





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-

device plate label

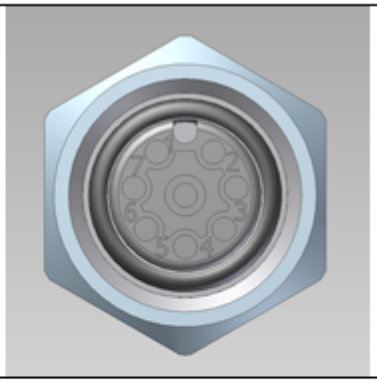
ETH Switch

P/N 92299-85

The ETH switch is the connection point for all communication components of Groundworks. The unit has 6 ports and two of them provides output power of 9 to 36VDC with 1 A current maximum.

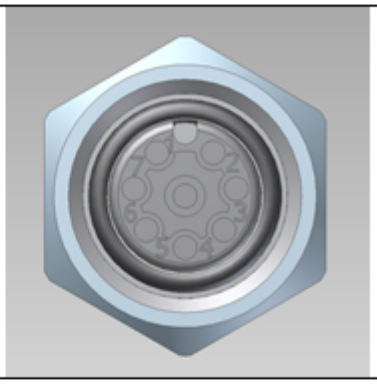
Port 1: Power In, Ethernet 1

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



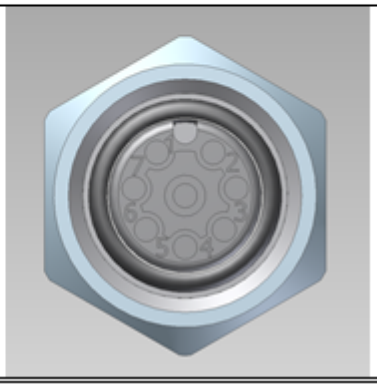
Port 2: Power Out, Ethernet 2
Port 3: Power Out, Ethernet 3

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



Port 4: Ethernet 4
Port 5: Ethernet 5
Port 6: Ethernet 6

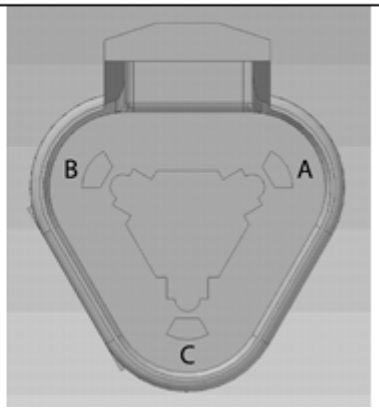
PIN#	Description
1	Not Used
2	Not Used
3	Not Used
4	TX-
5	RX+
6	TX+
7	Not Used
8	RX-

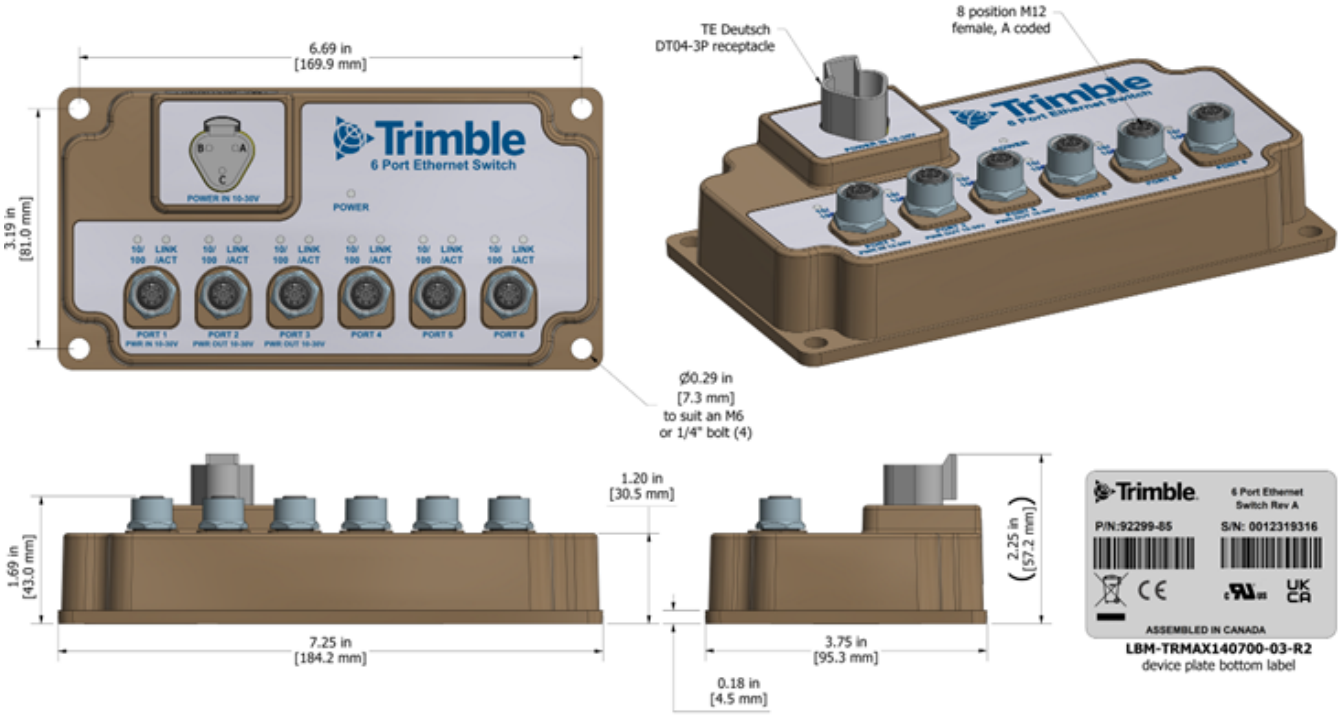


1 DT04-3P connector (Connector 7)

Port 7: Power In

PIN#	Description
A	Power IN
B	GND
C	Accessory Switch IN (Connect to Power+ to enable power input via the DT04-3P connector or Port 7.)





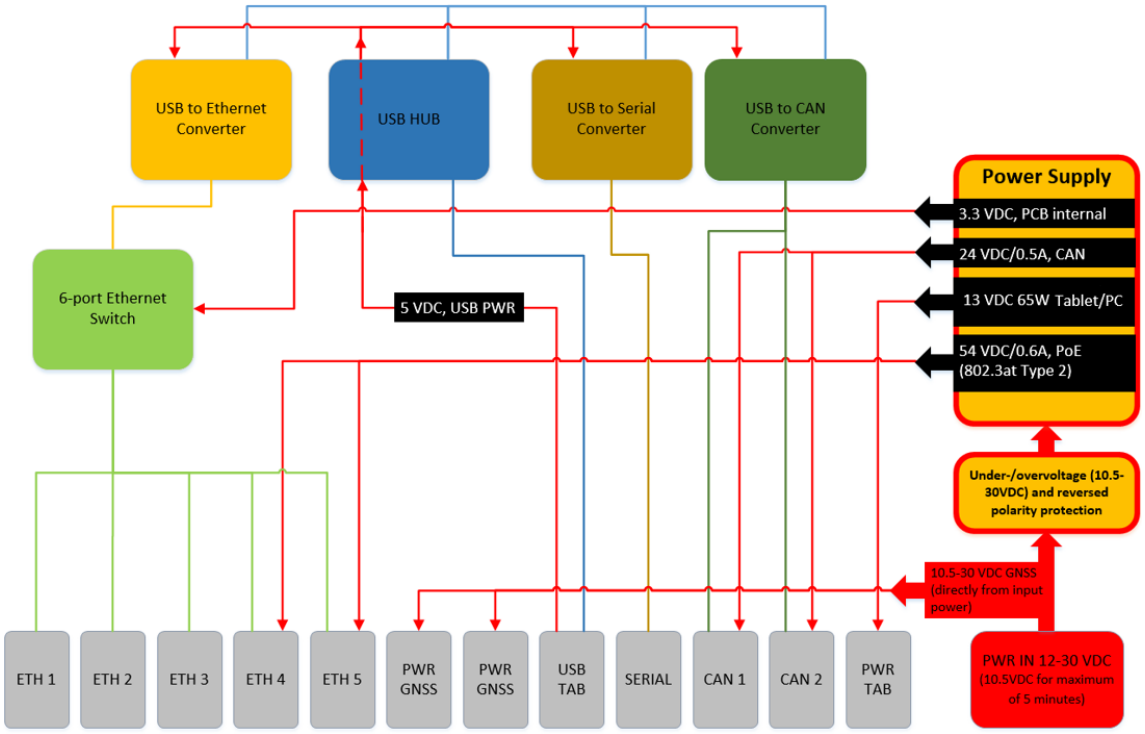
JB900 Junction Box

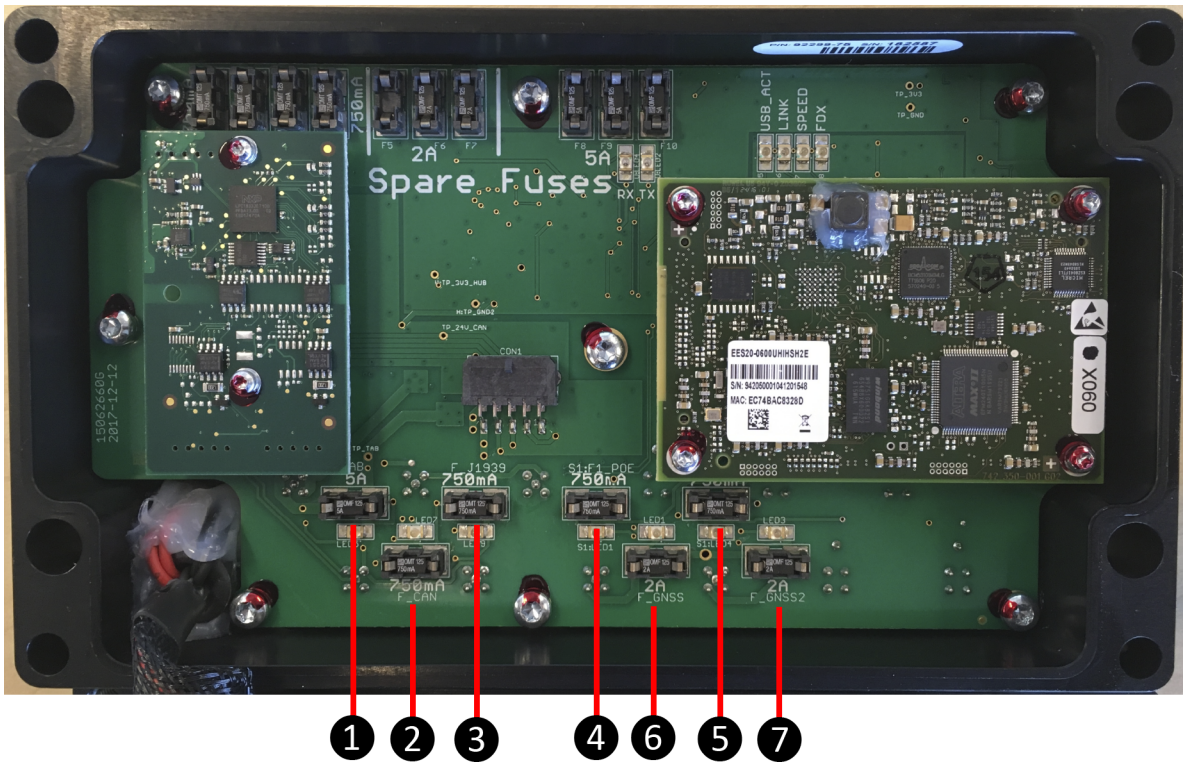
P/N 92299-75

The JB900 Junction Box is the connection point for all components of the Groundworks system including the VERSO 12 display, CAN sensors, GNSS receivers, and the SNM94x telematics box. The JB900 Junction Box provides power regulation, USB-to-CAN, USB-to-Ethernet, Power over Ethernet (PoE), and USB-to-Serial conversion.

Wiring diagram

The JB900 Junction Box has surface mount fuses for all input/output power connections. Each fuse has a different rating and has a red diode visible from outside box that lights up when a fuse has blown (while power is being applied to the JB900 and there is a load on the port). Inside the JB900, there are spare fuses in the event of a blown fuse. If for any reason the JB900 fails to operate, check the fuses and replace as necessary.





No.	Fuse location	Fuse rating
❶	PWR TAB	5 A
❷	CAN 1	750 mA
❸	CAN 2	750 mA
❹	ETH 5	750 mA
❺	ETH 4	750 mA
❻	PWR GNSS 1	2 A
❼	PWR GNSS 2	2 A

The fuses used in JB900 Junction Box are Schurter OMT 125 Series Surface Mount Fuses:

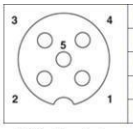
- 5 A = Manufacturer P/N 3404.0017.xx
- 2 A = Manufacturer P/N 3404.0012.xx
- 750 mA = Manufacturer P/N 3404.0113.xx

NOTE – The last two digits denote the size of the package.

IO900 (I/O box)

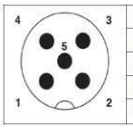
P/N 92311-75





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 runs off of 12 V or 24 V, so if the machine is running off 110 V, then the I/O box requires a 110 V to 24 V relay in between any inputs/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 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 that input signals are taken from the electrical panel rather than the joystick in the cab. The joystick may unintentionally send a signal when other actions are used. If you get false positive signals on the relay you are attached to, use an in-line resistor to filter out the false positive signal.

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 stopped/paused once the signal is received to enable the depth sensor to move without tracking depth. This is necessary when drilling with multiple steel lengths to be able to add/remove steel and maintain accurate tool elevation.
2. Start/Resume depth tracking: Allows depth sensor to resume tracking depth once the signal is received (after depth tracking has been paused). This is necessary when drilling with multiple steel lengths to be able to add/remove steel and maintain accurate tool

elevation.

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 will only be 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 will be tracked automatically based on the machine movement.
5. Save start point: The hole/pile start point will be 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 will be 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 will only be able to 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 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

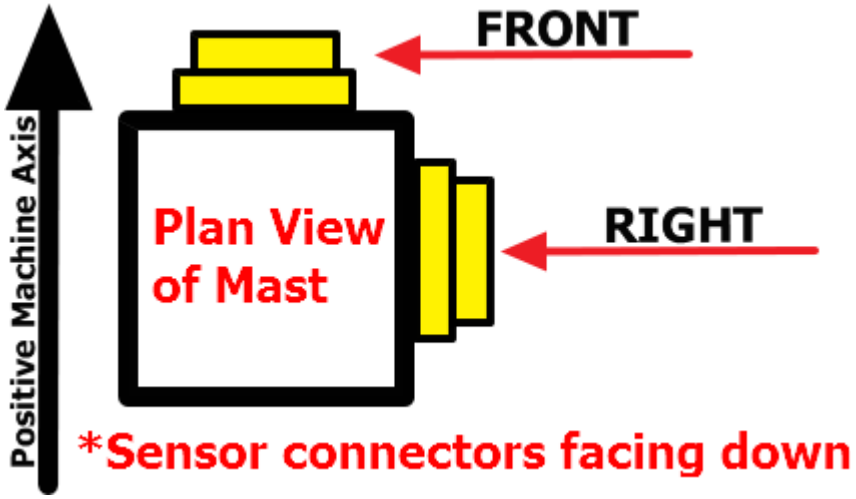


The TS900 Dual-Axis Tilt sensor monitors the inclination of the mast or machine body. The tilt sensor is an essential component for accurate positioning in all Groundworks installations. The tilt sensor must be configured in the Groundworks software with the appropriate node ID depending on where it 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.

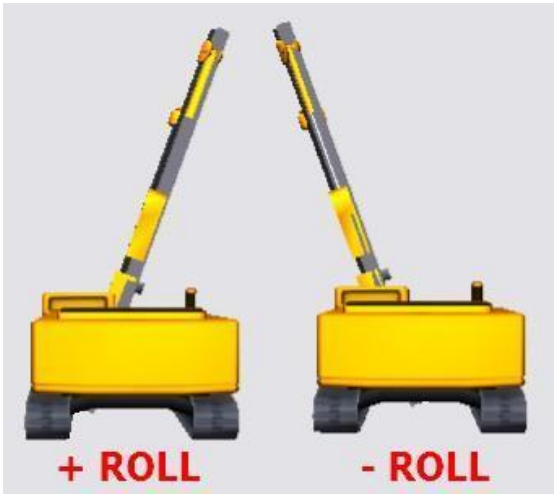
When mounting as a ***body tilt sensor***, it should be located as low as possible on the machine body with its connectors facing downwards.

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



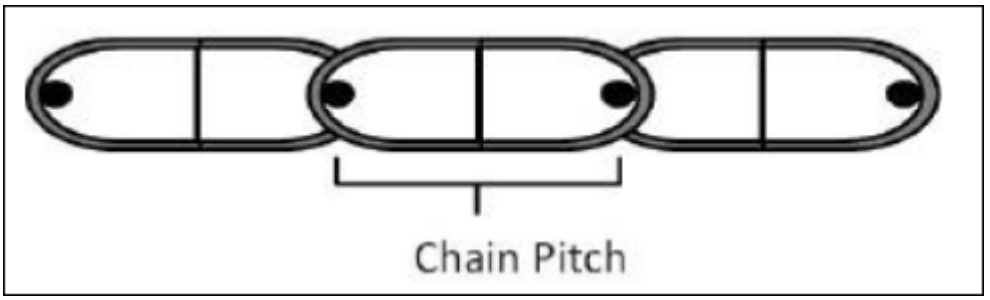
The PSD900 depth sensor uses the same M12 proximity switches as the CLD900 and detects the movement of the sprocket on the machine to track depth.

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''	38 mm
2.00''	46 mm
2.50''	57 mm
2.75''	63 mm

The following diagram shows how to measure the chain pitch from the machine:



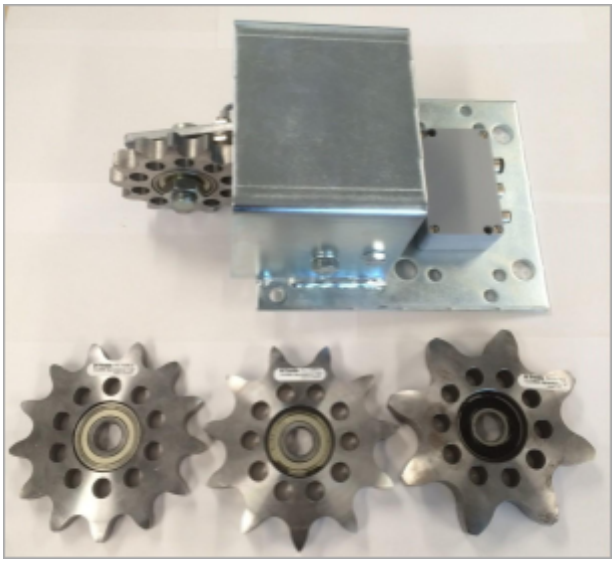
Mounted unit:



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



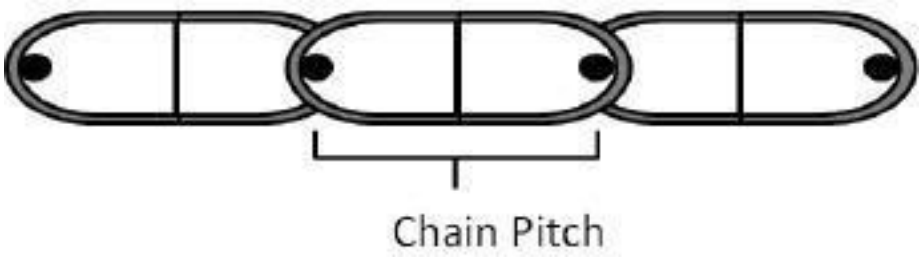
P/Ns 112308-00, -10, -20, -30, 40 (shown above)

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, and 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 top and bottom of 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 will absorb any vibration or small movements during operation although 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.

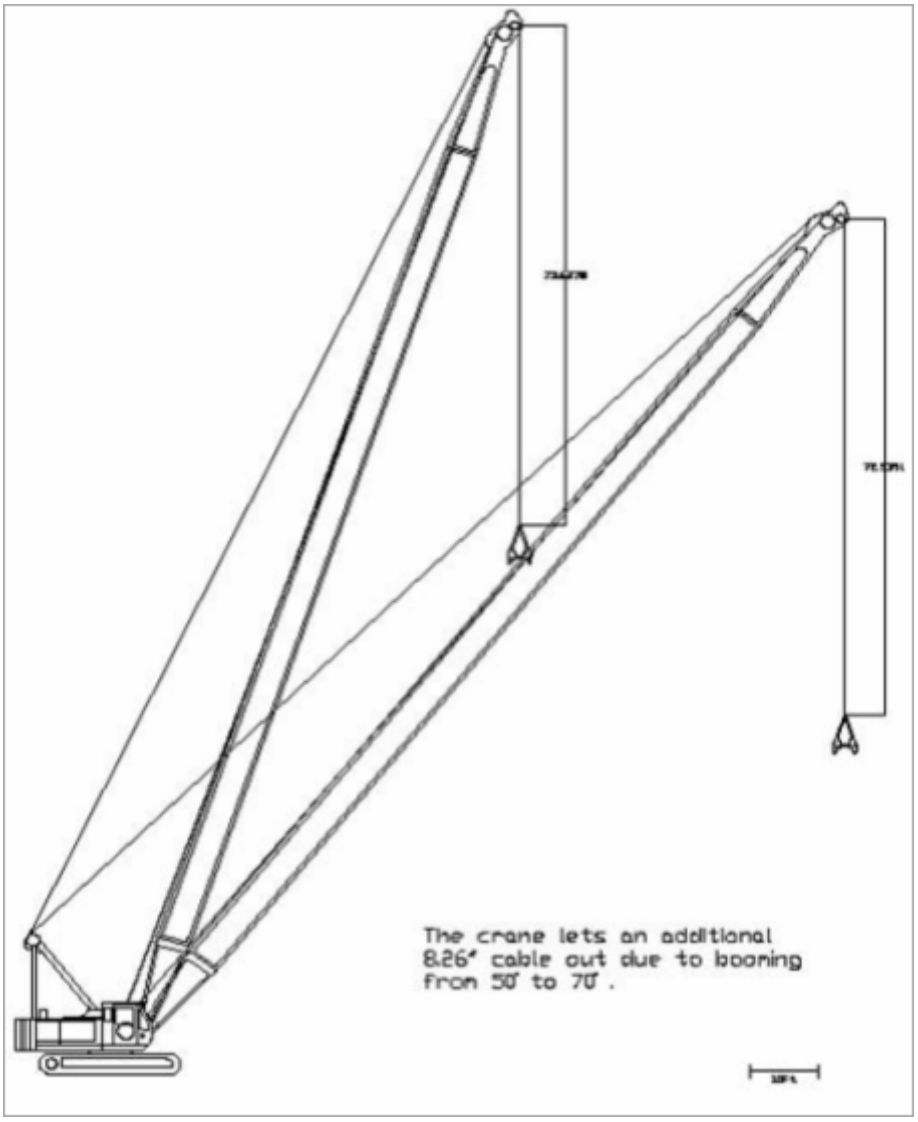
Mounted unit:





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, the FRD900 sensor should be mounted 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, the FRD900 sensor can be mounted on the cable drum if the cable is spooled in a single layer. For cranes using multi-layer spooling, the FRD900 must be mounted 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 and 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 start up because it stores its depth reading internally. However, when it is first installed you will 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/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 I/O box each time it gets 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 in lieu 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 Mounting loose M12 connectors, page 88

TIP – For drilling rigs, lower the drill bit to the ground then raise it ~1' off the ground to find the mounting location where the proximity switch should be triggered to allow depth reset before the start of work. For piling rigs, mount the sensor in a location that will normally be passed before the start of work each day.

Whisker Switch

P/N 98497



The Whisker Switch is an alternative to the M18 proximity switch for automatic reset of the depth sensor system. Typically, it is mounted near the top of the mast where it can consistently be triggered in a repeatable manner by the tool as it is raised along the mast. 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 Mounting loose M12 connectors, page 88.

Energy Box

P/N 92314-50



The 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 will measure the hammer as it passes it and the second proximity sensor will capture as the hammer exists, and with this data in addition to others, Groundworks is able to calculate the energy of each hit.

This unit can also be utilized to capture the blow counts on a piling machine

Required 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/Whisker Switch).

Manually resetting the depth sensor

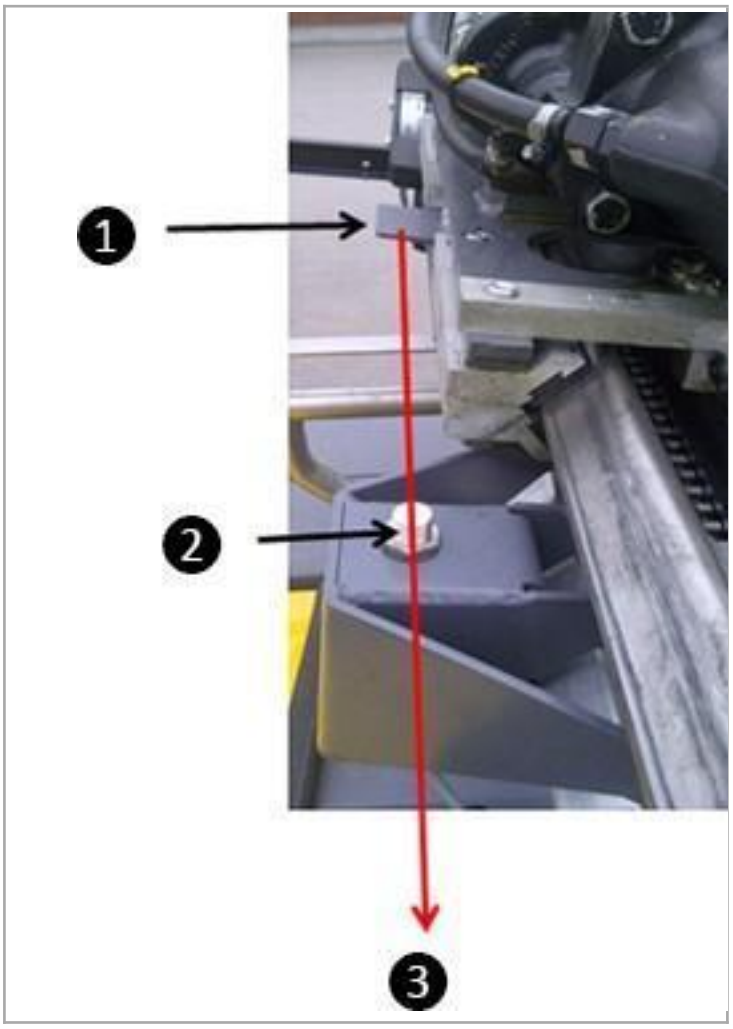
When opting to manually reset the depth sensor each day, you must choose a repeatable location that the operator can use as the reference position (Zero Point). Trimble recommends one of the following locations on the machine:

- 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/Whisker Switch is mounted on the mast at a location where the drifter or a trigger plate will always pass the proximity switch. In order 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:



❶ Trigger plate

❷ Proximity switch

❸ 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 is no other moving parts on the mast that passes 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 to ensure that the tool can move up/down without damaging the sensor.

3

Supported Third-Party Machine Configurations

- Overview

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.

Overview

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

- AMV drilling attachments for excavators.
- Epiroc SmartROC drilling rigs with HNS (Hole Navigation System).
- Epiroc FlexiROC drilling rigs.
- Epiroc ROC RCS4 drilling rigs.
- Epiroc drilling rigs with CCI (Common Communications Interface).
- Epiroc FlexiROC T30 drilling rigs (CANopen interface).
- BBURG drilling rigs.
- HMC (Hercules Machinery Corporation) drilling/piling rigs.
- Jetgrunn drilling/piling rigs.
- Junttan piling rigs with JPM (Junttan Piling Management).
- IHC drilling/piling rigs.
- Liebherr drilling/piling rigs with LIPOS (Liebherr Positioning System).
- Per Aarsleff drilling/piling rigs.
- Vermeer PD10 piling rigs.

4

Installing the Groundworks Software on the Trimble VERSO 12 display

- Installing the Trimble Installation Manager
- Running the Trimble Installation Manager and installing the Trimble Groundworks software

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. You can then install the Trimble Installation Manager and then the Groundworks software.

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.

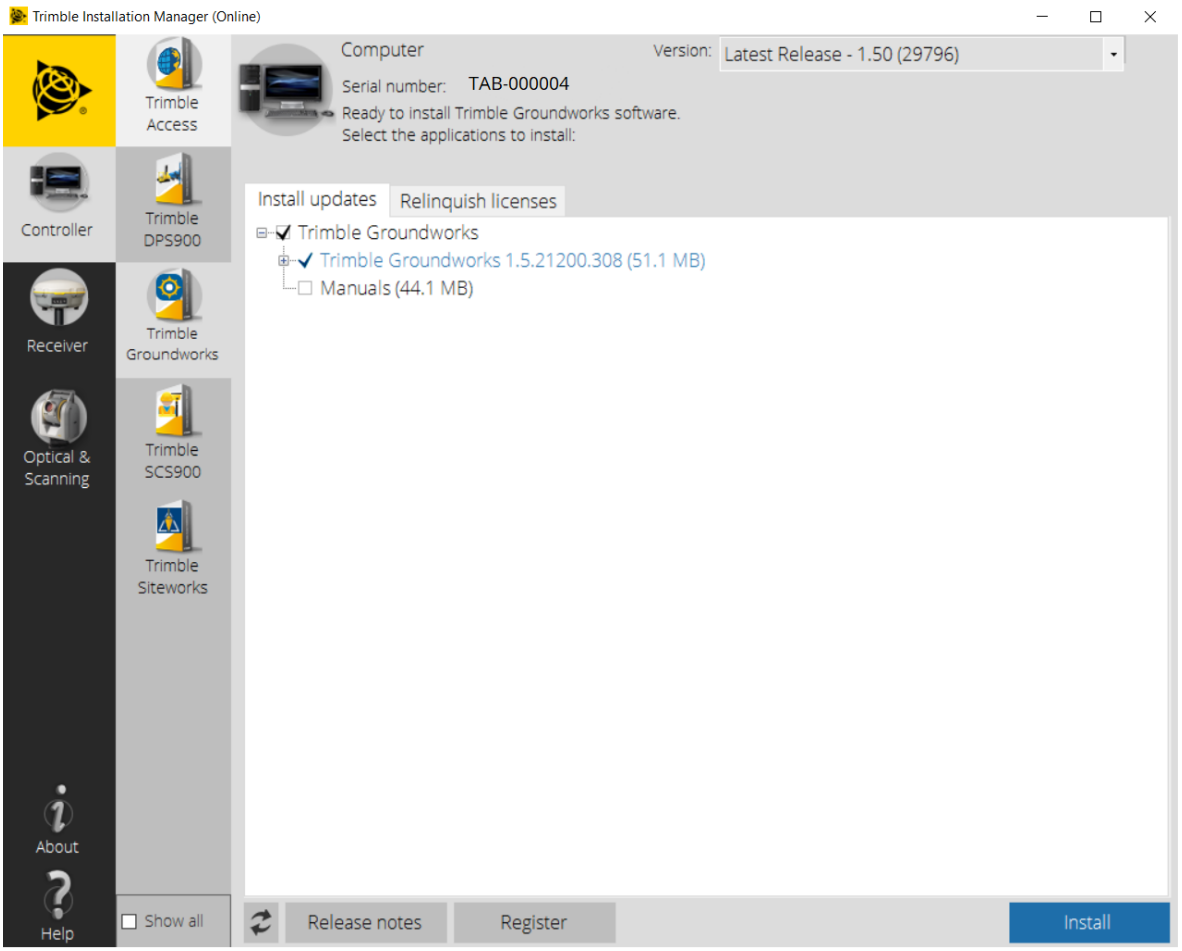
Installing the Trimble Installation Manager

The Trimble Installation Manager controls the installation of the Groundworks software, all future upgrades to the software, the software license warranty, and enables you to register the product ownership with Trimble. To use the Trimble Installation Manager you will require Internet access.

1. Locate and run the Trimble Installation Manager installer found on the desktop of the VERSO 12 computer.
2. Follow all prompts until the installation is complete.

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 software is installed completely. 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.

5

Configuring the GNSS Receivers for use with the Groundworks Software

- Updating the receivers to the latest version
- Setting up the Moving Base receiver using a clone file
- Setting up the Heading receiver using a clone file
- Setting up a Static IP address on the Trimble VERSO 12 display

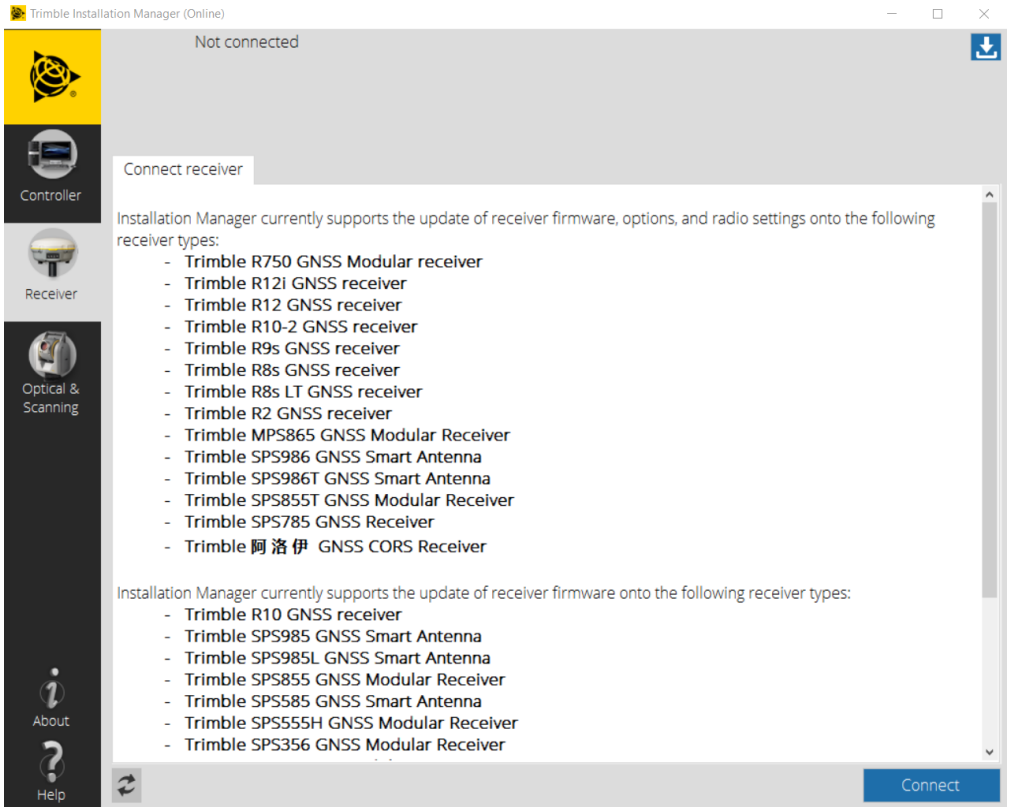
This chapter assumes that you already have a 900 MHz or 450 MHz GNSS base station set up nearby that is outputting CMR corrections via radio. There is also a non-radio version of GNSS receivers that can still receive corrections from VRS, IBSS etc.

NOTE – All screen shots show version 5.40 firmware on the GNSS receivers.

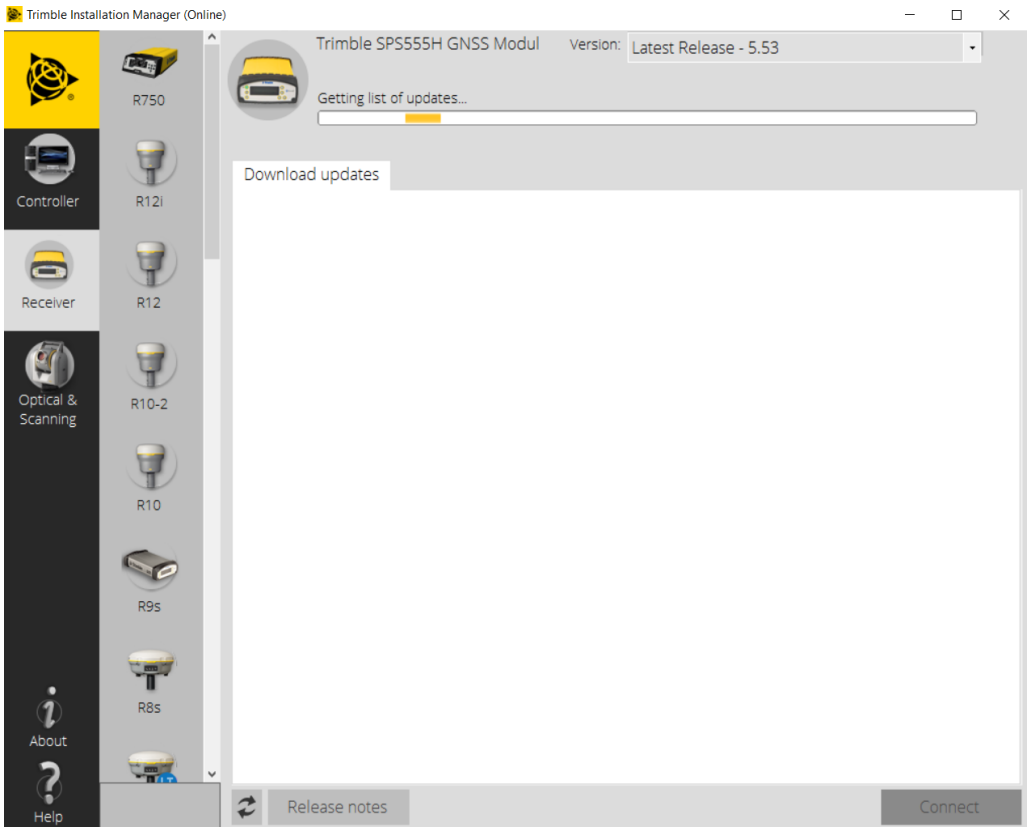
Updating the receivers to the latest version

When you first purchase Groundworks, you must update the receiver to the latest version. In order to update to the latest version, Trimble installation manager must be installed to obtain the latest version of the receiver

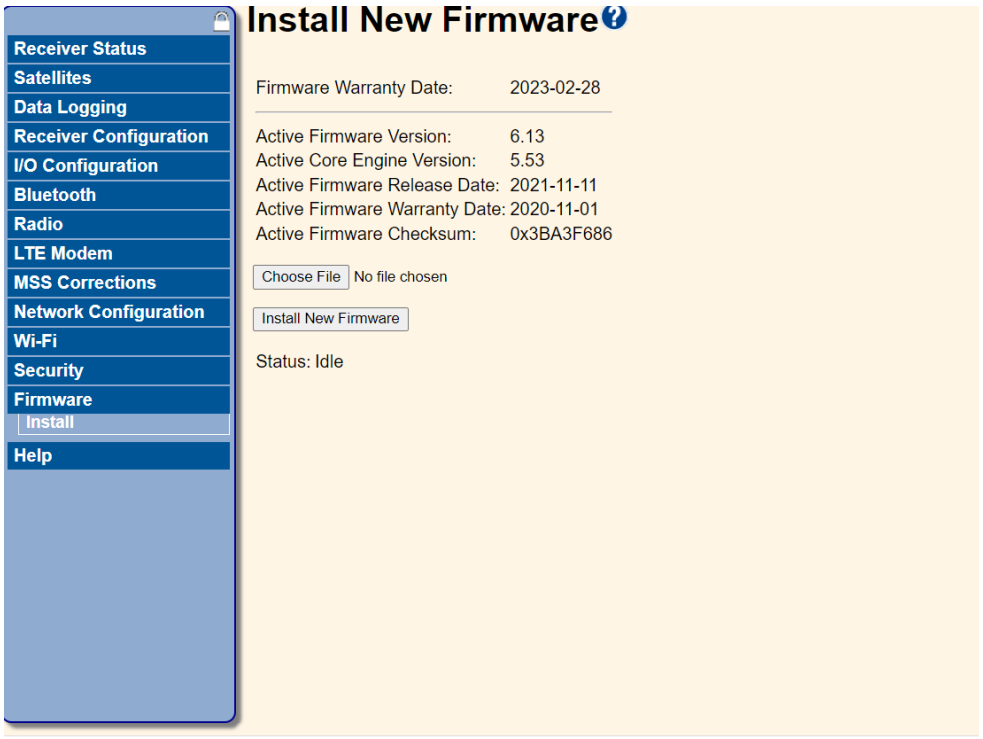
1. Install Trimble installation from the web. Either by searching for Trimble installation manager or go to the link here
2. Click on Receiver tab on the left hand column and click on top right download symbol



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



4. Determine the location of where the files will be saved and download .timg files
5. Use an Ethernet cable to connect your laptop computer to the SPS855/R750 Positioning receiver. If using the Trimble VERSO 12 to set up the receiver, connect the Trimble VERSO 12 to the JB900 Junction Box and then connect the JB900 Junction Box to the GNSS receiver.
6. Wait a few moments and then press the Up button on the SPS855/R750 receiver until the IP Address screen appears. This should show either 169.254.1.0 or 169.254.1.1.
7. Open a web browser and enter the corresponding IP address into the search bar, for example: 169.254.1.0.
8. You are prompted to enter login credentials. The default login is
   User: admin
   Password: password
9. From Hamburger menu click Firmware and choose the file downloaded from Trimble installation manager and install the New Firmware



Setting up the Moving Base receiver using a clone file

When you install the Groundworks software, two clone files called GW_MBASE_ZR2.XML (for installations using Zephyr 2 rugged antennas) and GW_MBASE_ZR3.XML (for installations using Zephyr 3 rugged antennas) are copied to the following location on your device:

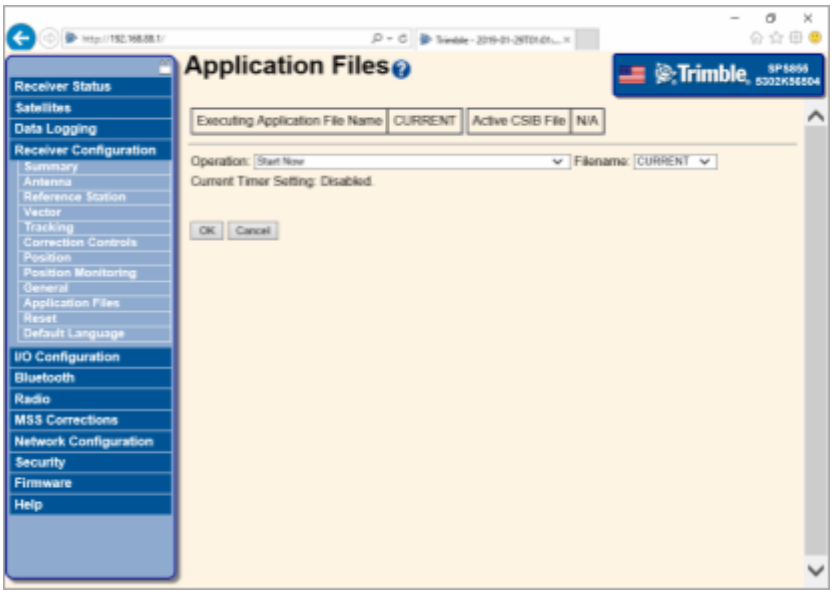
C:\Users\Username\My Documents\Trimble Groundworks Data\Scripts

These files are used to automate the configuration of the SPS855/R750 Moving Base GNSS receiver.

1. Use an Ethernet cable to connect your laptop computer to the SPS855/R750 Positioning receiver. If using the Trimble VERSO 12 to set up the receiver, connect the Trimble VERSO 12 to the JB900 Junction Box and then connect the JB900 Junction Box to the GNSS receiver.
2. Wait a few moments and then press the Up button on the SPS855/R750 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

When the SPS855 web interface appears, tap Receiver Configuration / Application File. The following screen appears:

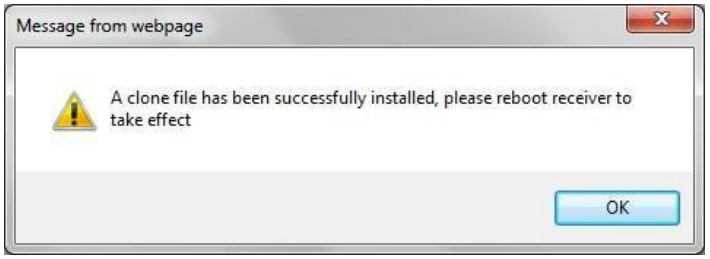
5. In the Operation field, select the Upload & Install Clone File option. Tap Browse and



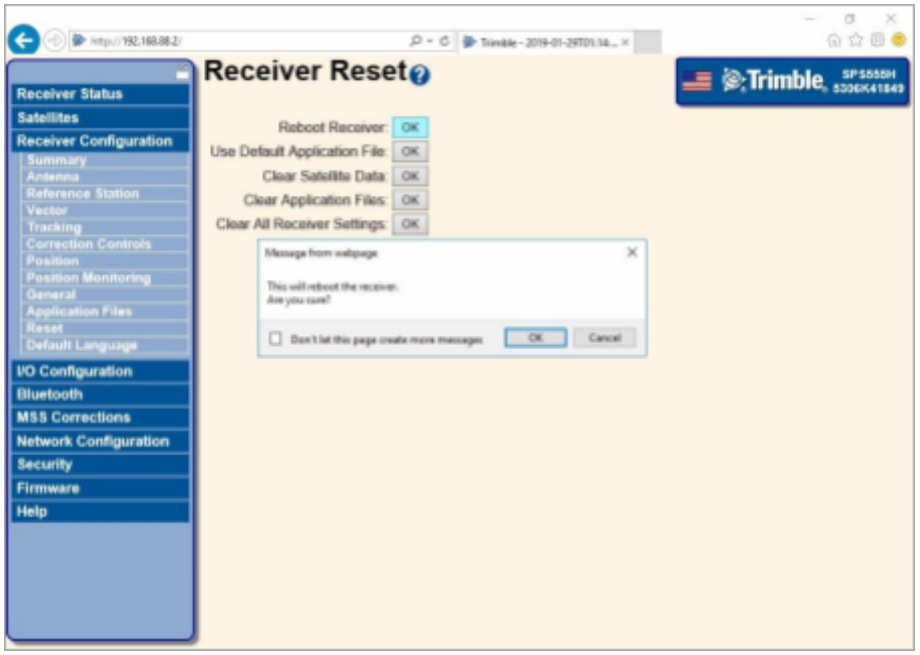
6. In the Operation field, select the Upload & Install Clone File option. Tap Browse and select either the GW_HEADING_ZR2.XML or GW_HEADING_ZR3.XML file (depending on the antenna type being used) from the Trimble Groundworks Data folder path mentioned above. Select the Install static IP address and hostname from clone file check box and then tap OK.

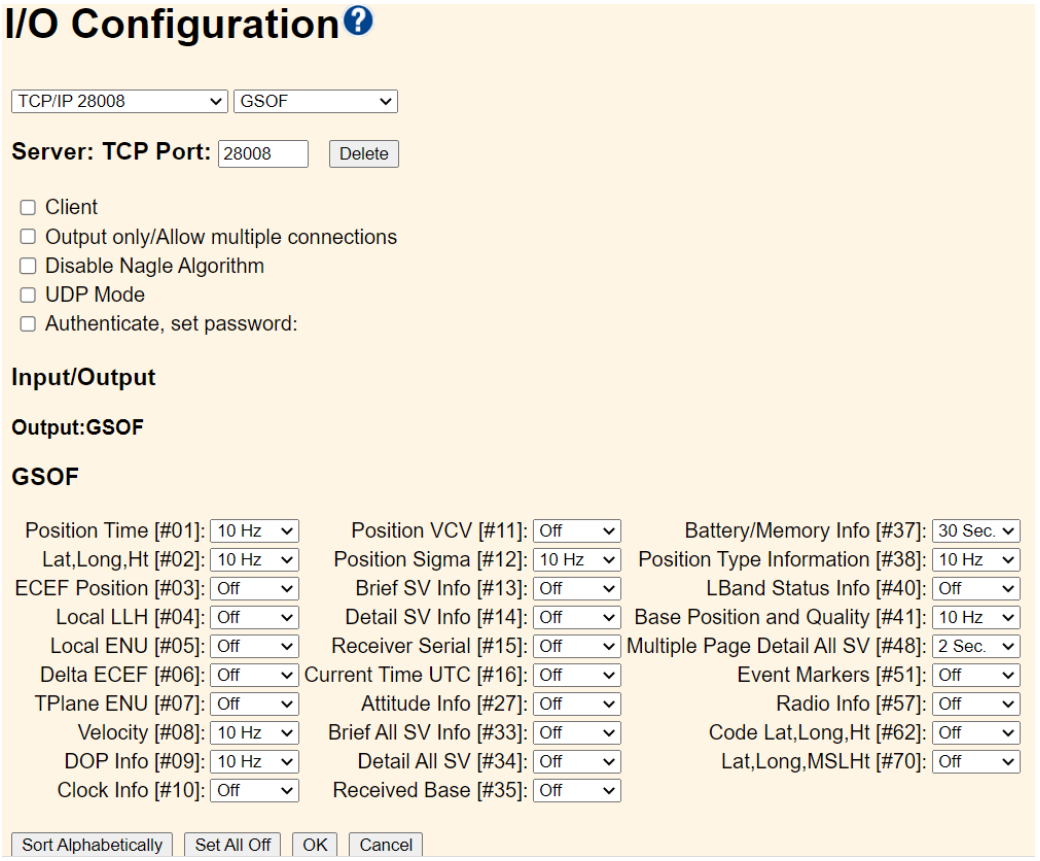


A message appears confirming that the clone file was successfully installed:



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





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

Setting up the Heading receiver using a clone file

When you install the Groundworks software, two clone files called GW_HEADING_ZR2.XML (for installations using Zephyr 2 rugged antennas) and GW_HEADING_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

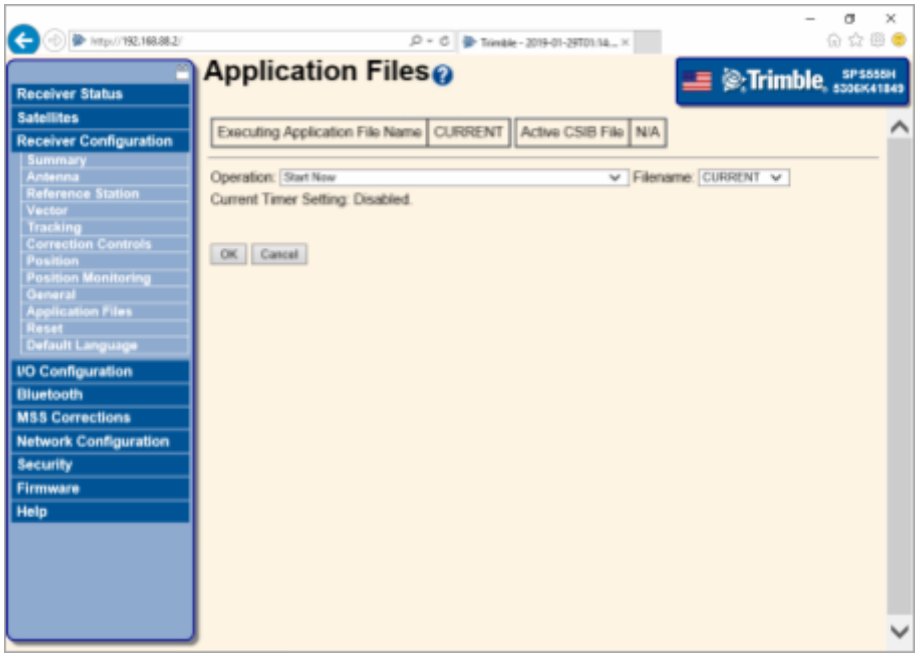
These files are used to automate the configuration of the SPS555H.R750 Heading GNSS receiver.

1. Use an Ethernet cable to connect your laptop computer to the SPS555H Heading receiver. If using the Trimble VERSO 12 to set up receiver, connect the Trimble VERSO 12 to the JB900 Junction Box and then connect the JB900 Junction Box to the GNSS receiver.
2. Wait a few moments and then press the Up button on the SPS555H/R750 receiver until the IP Address screen appears. This should be either 169.254.1.0 or 169.254.1.1.
3. Open a web browser and then 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

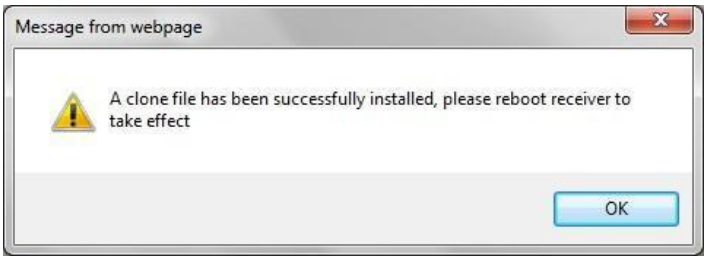
5. When the SPS555H web interface appears, tap Receiver Configuration / Application File. The following screen appears:



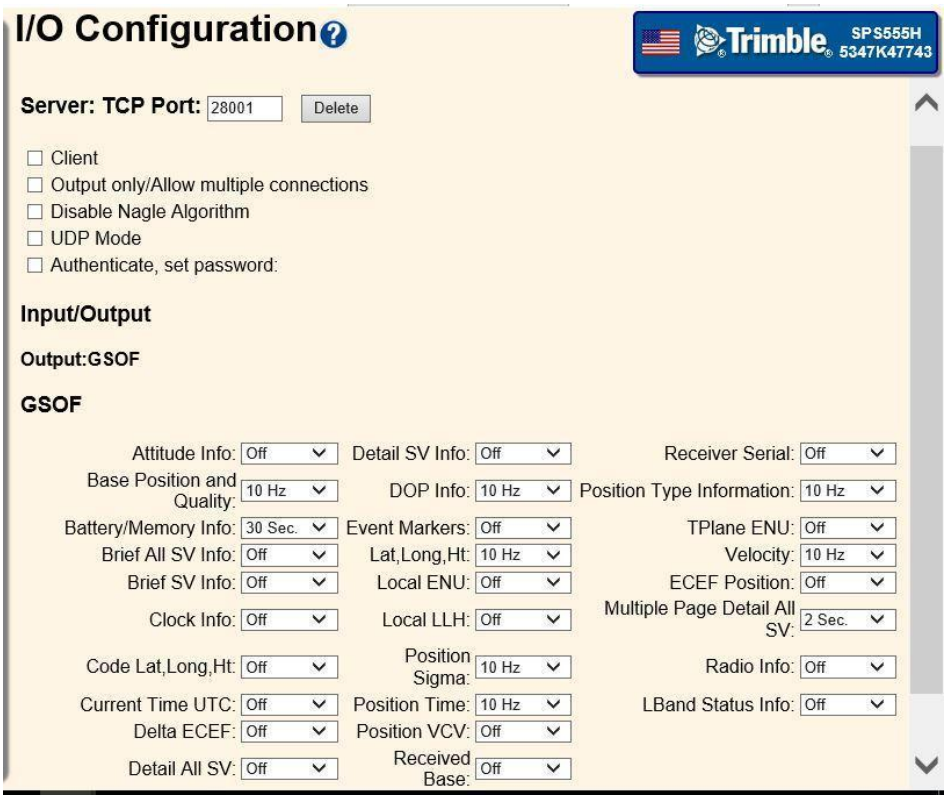
6. In the Operation field, select the Upload & Install Clone File option. Tap Browse and select either the GW_HEADING_ZR2.XML or GW_HEADING_ZR3.XML file (depending on the antenna type being used) from the Trimble Groundworks Data folder path mentioned above. Select the Install static IP address and hostname from clone file check box and then tap OK.



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



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



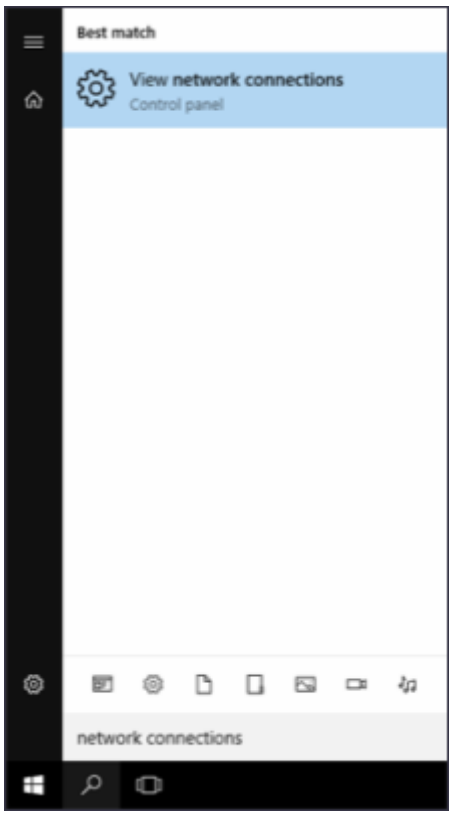
The SPS555H Heading receiver is now configured and ready to use with the Groundworks system.

Setting up a Static IP address on the CAN to ETH adapter

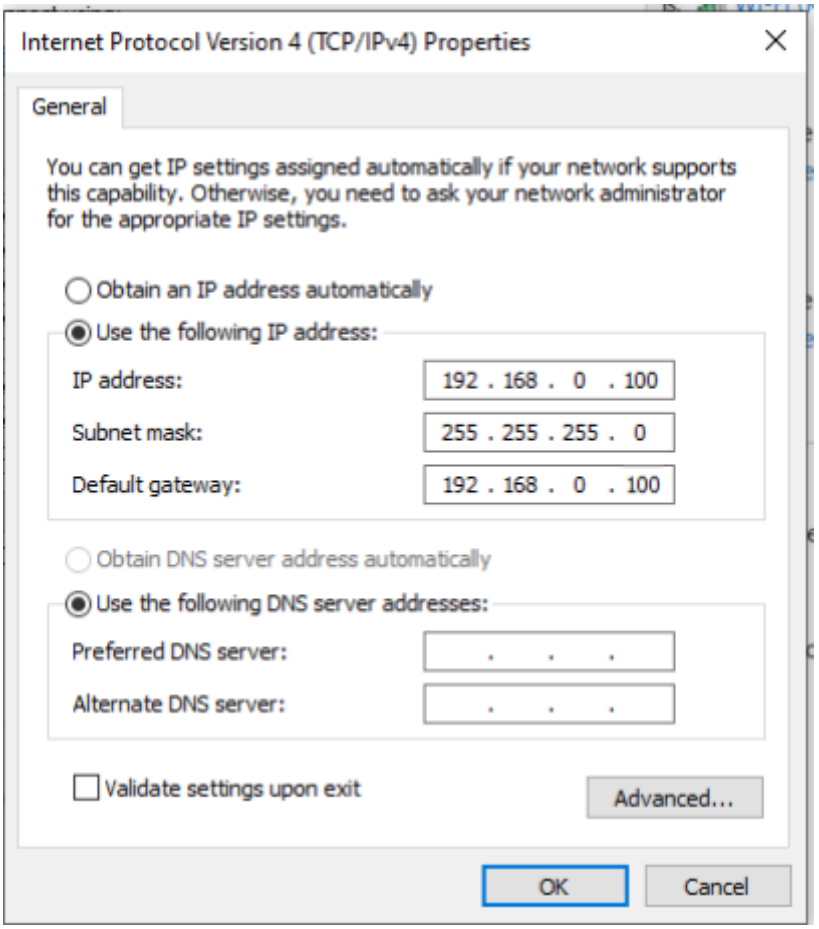
The Trimble CAN to ETH adapter requires a static IP address to be configured. The Groundworks system can handle up to 2 x CAN to ETH adapters. Typically a generic aftermarket install will require one adapter and OEM installation may require two adapters.

To change the IP address of the Trimble CAN to ETH Adapters

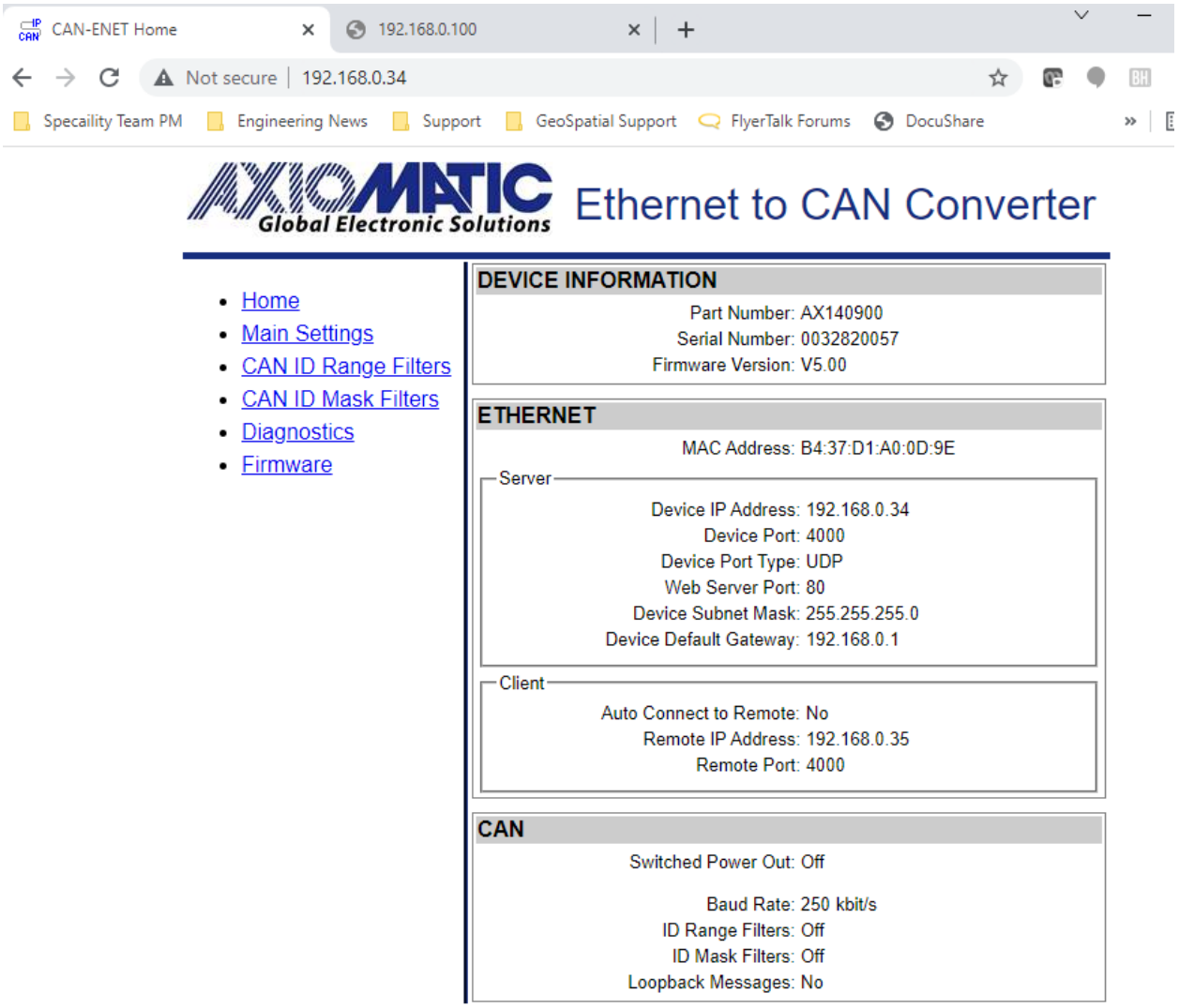
1. From the Windows Start menu, enter Network connections into the Search field. Tap the View Network connections link when it appears:



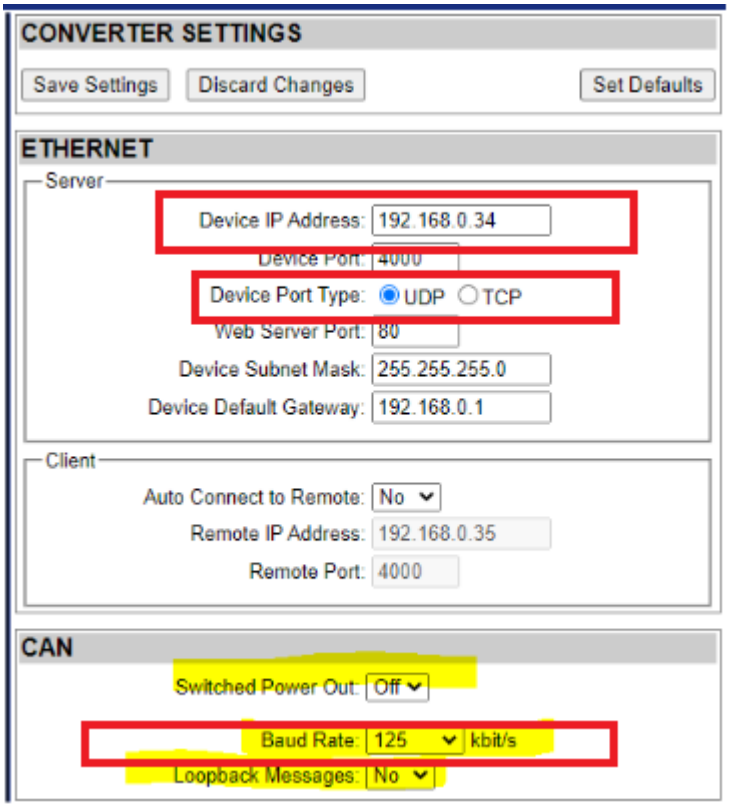
2. Tap and hold the Ethernet connection and then tap Properties
    a. IP Address: 192.168.0.100
    Subnet Mask: 255.255.255.0
    Default Gateway:192.168.0.100
    Select Use the following DNS server addresses:
    Preferred DNS server: blank
    Alternate DNS server> blank



3. At this point your CAN to ETH adapter should be connected to the system. If you are using 2 adapters, connect one at a time to configure them as out of the box adapters have the same static IP address.
4. Open up a browser and type in address 192.168.0.34



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



Device Port Type: TCP
Baud Rate: 125

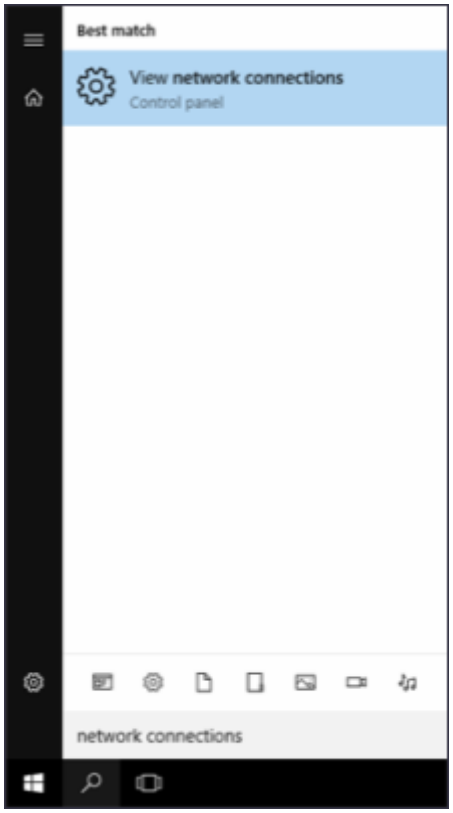
6. If you are using two CAN to ETH devices please convert the second adapter to have IP address following the steps above.
   192.168.88.35

Setting up a Static IP address on the Trimble VERSO 12 display for Eth to CAN adapter

The Trimble VERSO 12 display,CAN to Eth adapter, the two GNSS receivers 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.

To change the IP address of the Trimble VERSO 12:

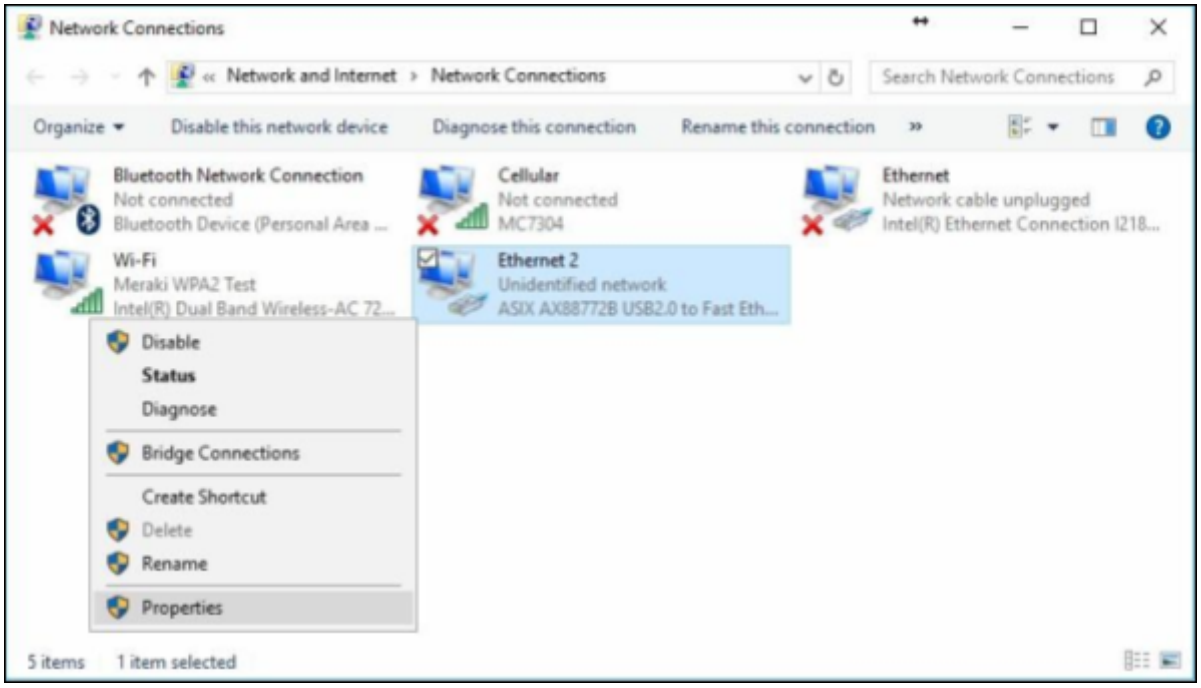
1. From the Windows Start menu, enter Network connections into the Search field. Tap the View Network connections link when it appears:



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

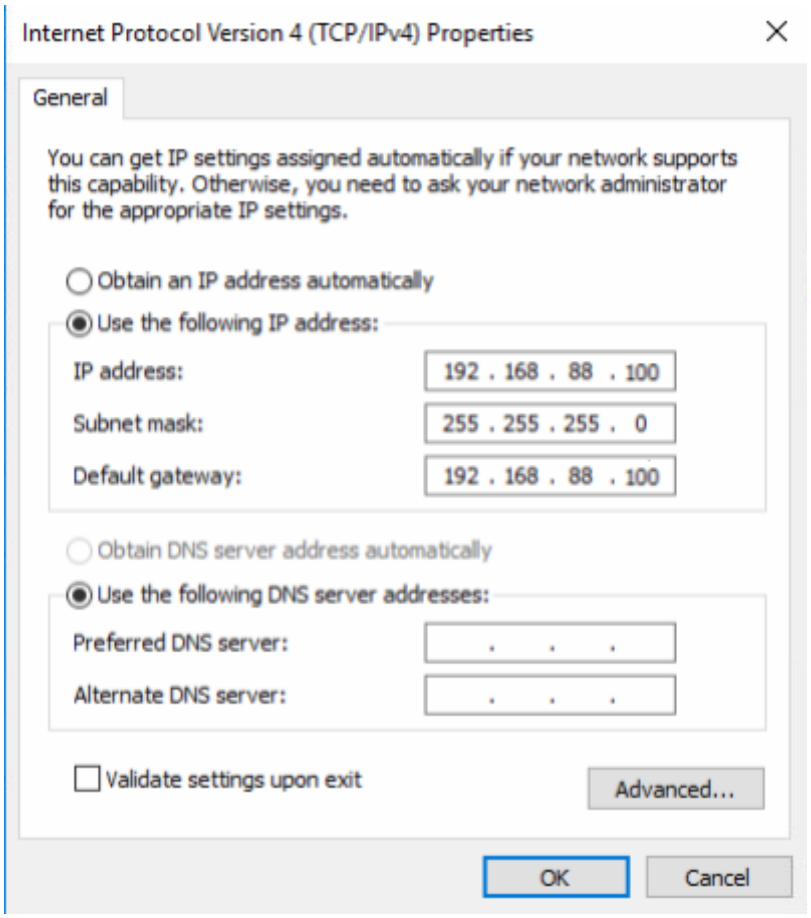
   NOTE – In some cases this may display as Thinkpad USB 3.0 Ethernet Adapter, ASIX AX88772B USB2.0 to Fast Ethernet Adapter, or similar.

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

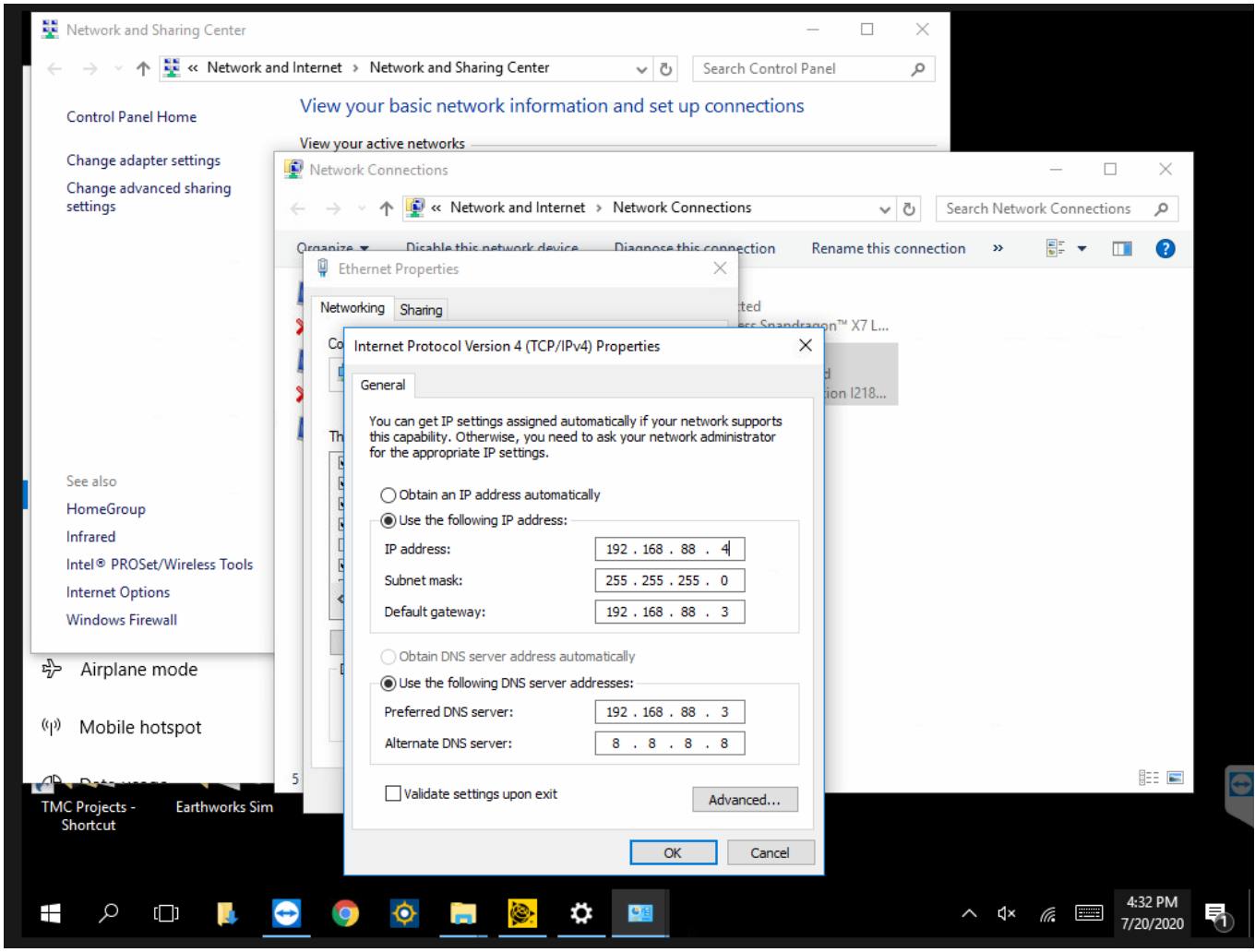


4. Select Use the following IP address if SNM 94x is NOT used:
   IP Address: 192.168.88.100
   Subnet Mask: 255.255.255.0
   Default Gateway:192.168.88.100
   Select Use the following DNS server addresses:
   Preferred DNS server: blank

Alternate DNS server> blank



5. Select Use the following IP address if SNM 94x is used:
   IP Address: 192.168.88.4
   Subnet Mask: 255.255.255.0
   Default Gateway:192.168.88.3
   Select Use the following DNS server addresses:
   Preferred DNS server: 192.168.88.3
   Alternate DNS server> 8.8.8.8



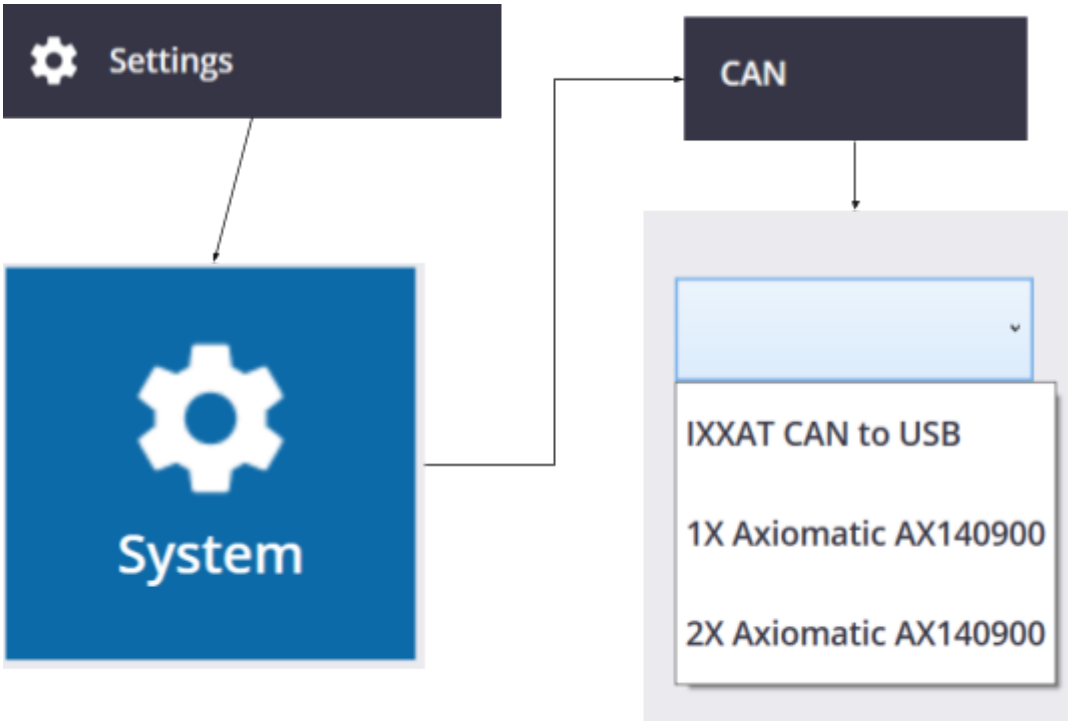
NOTE – By default, the SNM94x is set up to use this static IP address.

6. Tap OK then close the Properties window.

Setting up a Groundworks Software

With the hardware all configured, the Groundworks software must be configured to match the existing configuration.

1. Open up Groundworks executable
2. Create a machine profile and user profile and login
3. Select Setting → System → CAN
4. From the drop down menu select
    a. 1 X Axiomatic AX140900 if using one CAN to ETH adapter
    b. 2 X Axiomatic AX140900 if using two CAN to ETH adapter



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

- VERSO 12 touch display
- JB900 Junction Box
- TS900 Dual-Axis Tilt sensor
- CLD900 sensor
- CRD900 and CDD900
- sensors AC900 sensor
- FRD900
- sensor BR900
- sensor

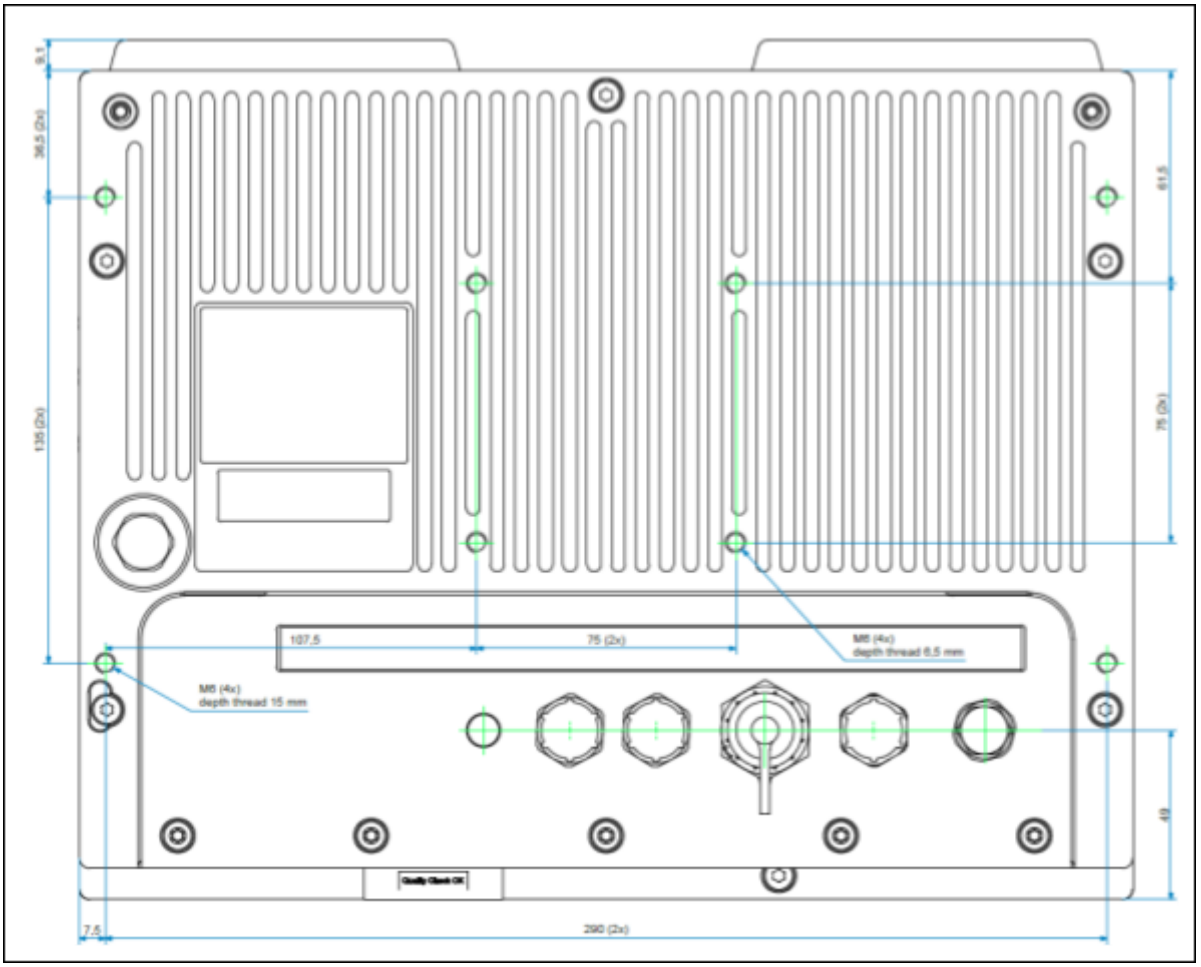
  Electronic Box
- M12 Proximity Switch
- M18 Proximity Switch
- M30 Proximity Switch
- Whisker Switch
- Pressure sensors
- IO900 I/O Box
- GNSS dual-antenna mounting bracket
- TBE900 sensor

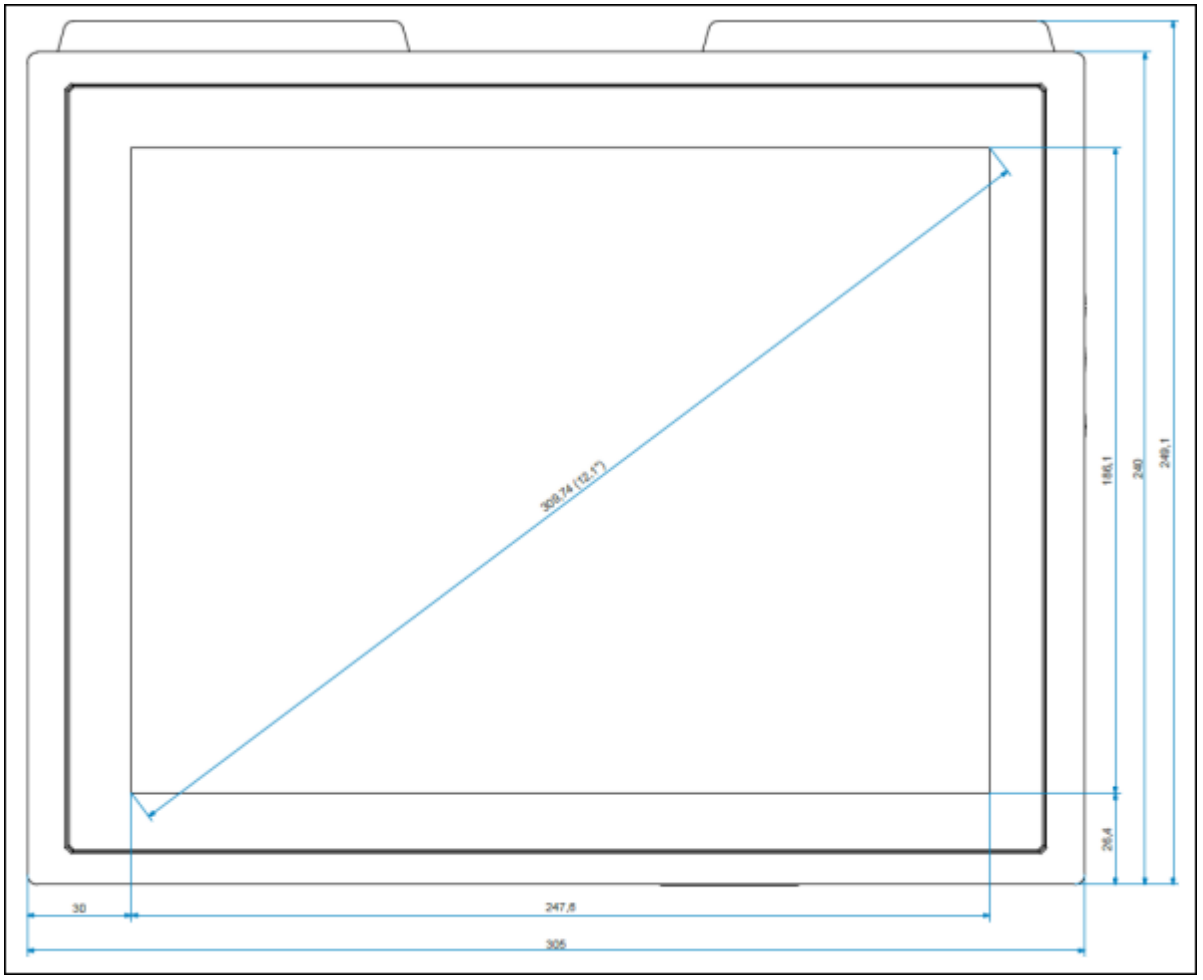
This chapter shows detailed drawings of the system components.

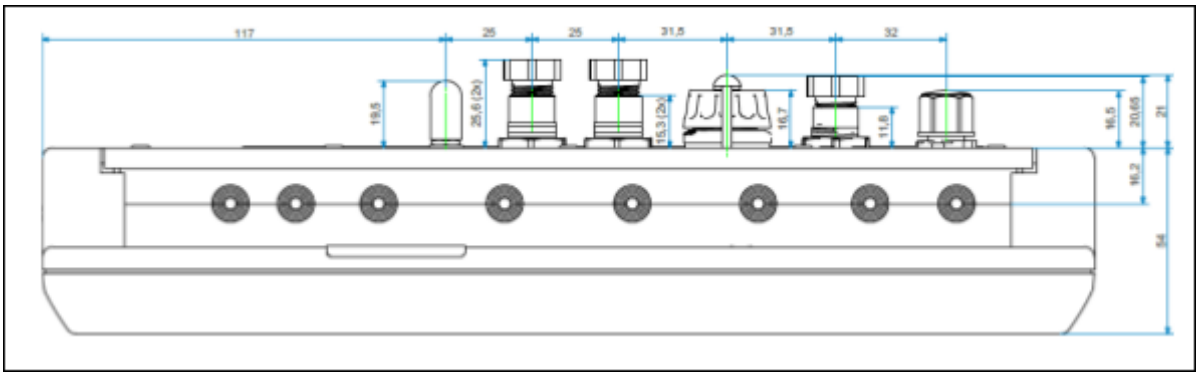
NOTE – All units are in mm unless otherwise noted.

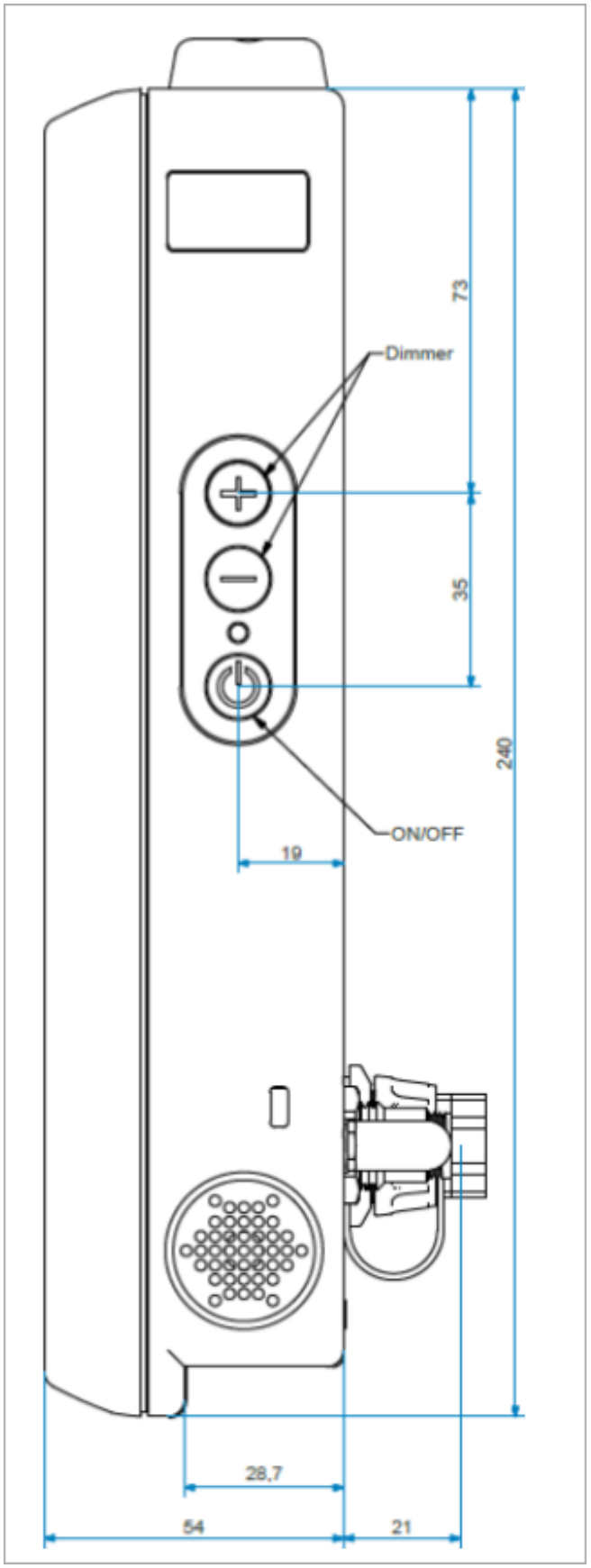
VERSO 12 touch display

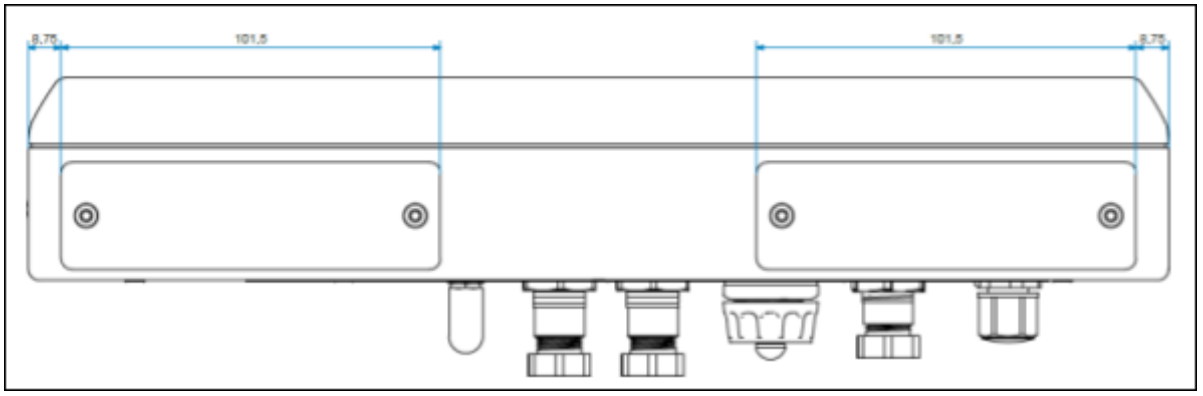
P/Ns TABV12-00 and TABV12-10



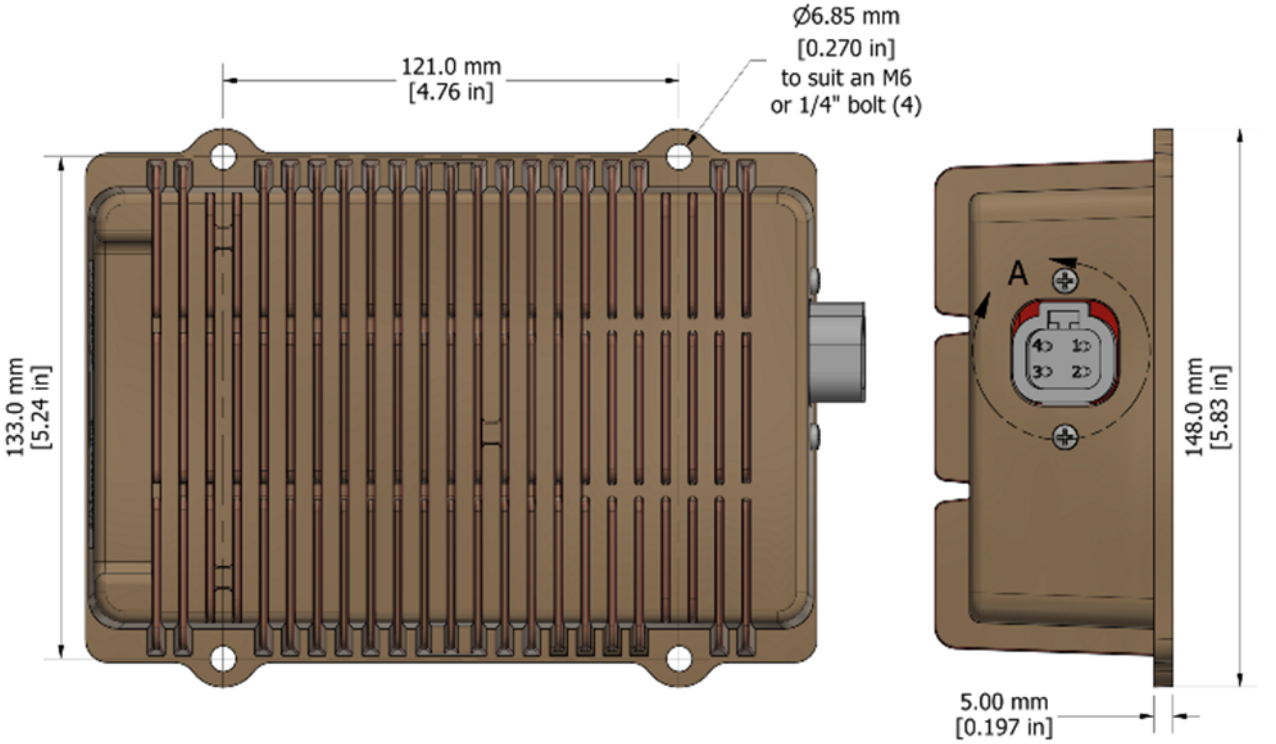

309,74 (12,1")
186,1
240
249,1
26,4
30
247,6
305

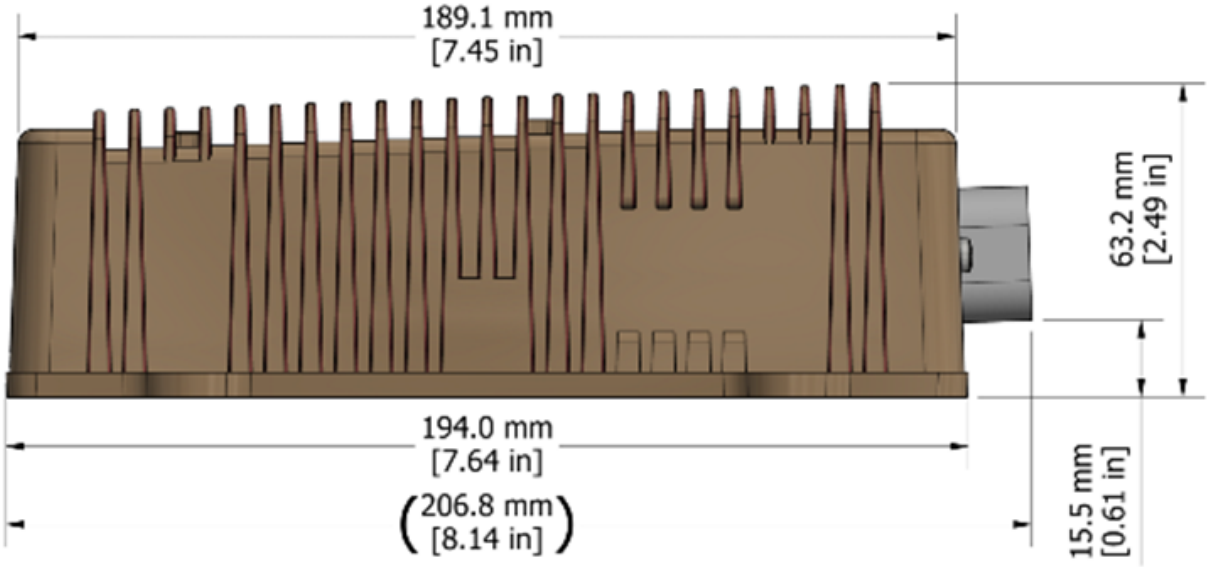

117
25
25
31,5
31,5
32
19,5
25,6 (2x)
15,3 (2x)
16,7
11,6
16,5
20,65
21
16,2
54


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

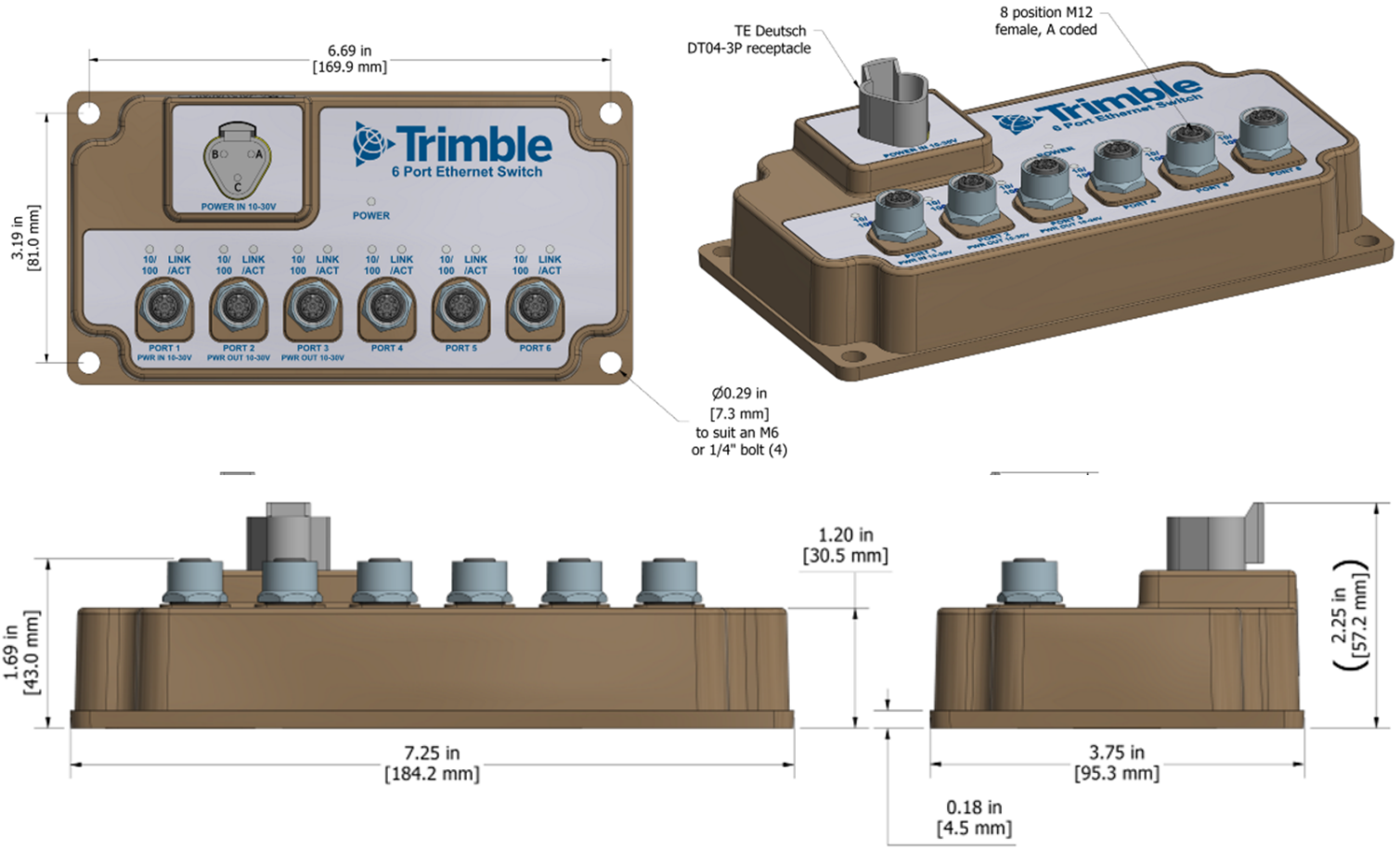

8.75
101.5
101.5
8.75

Power Conditioner

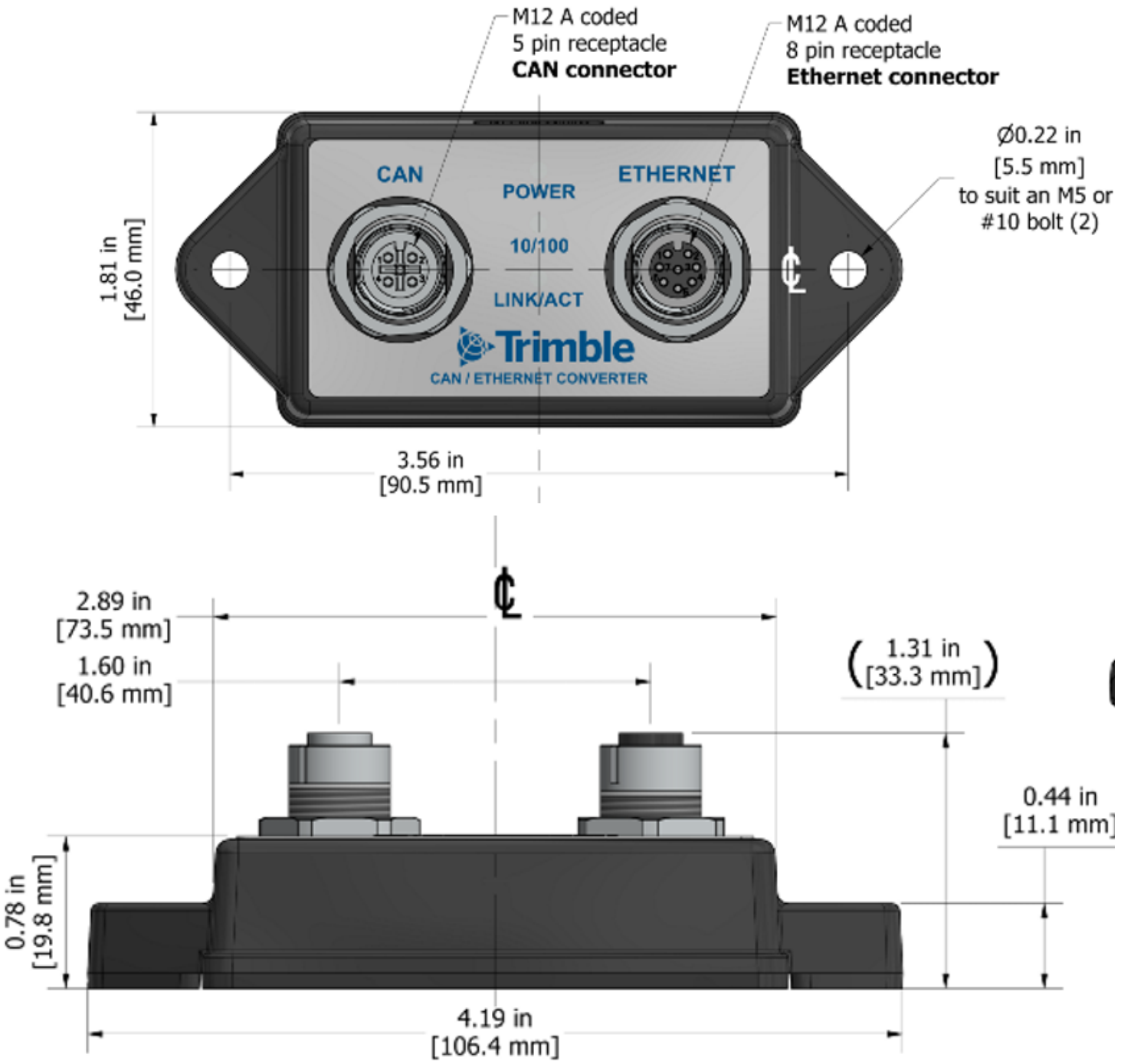




ETH Switch

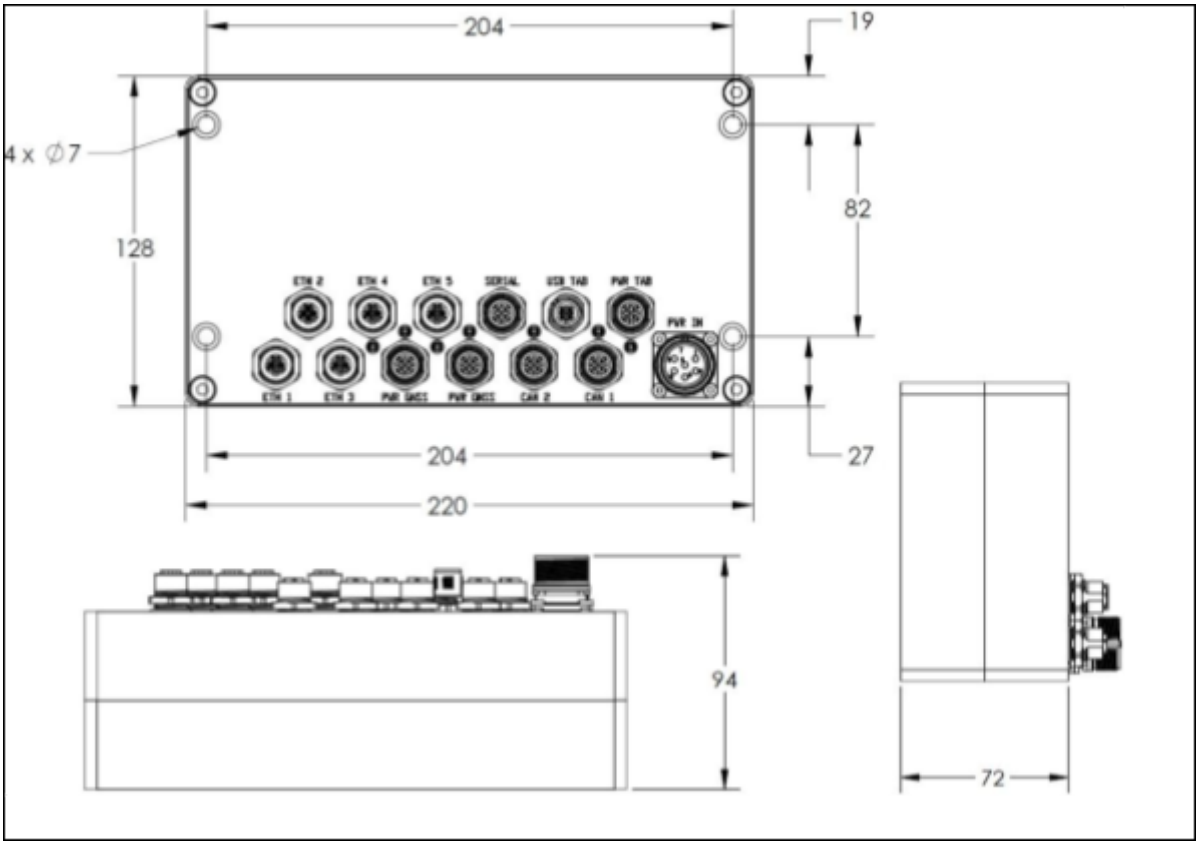

6.69 in
[169.9 mm]
3.19 in
[81.0 mm]
Trimble
6 Port Ethernet Switch
POWER IN 10-30V
POWER
10/100 LINK/ACT
PORT 1
PWR IN 10-30V
PORT 2
PWR OUT 10-30V
PORT 3
PWR OUT 10-30V
PORT 4
PORT 5
PORT 6
TE Deutsch
DT04-3P receptacle
8 position M12
female, A coded
Ø0.29 in
[7.3 mm]
to suit an M6
or 1/4" bolt (4)
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]

CAN to ETH Adapter



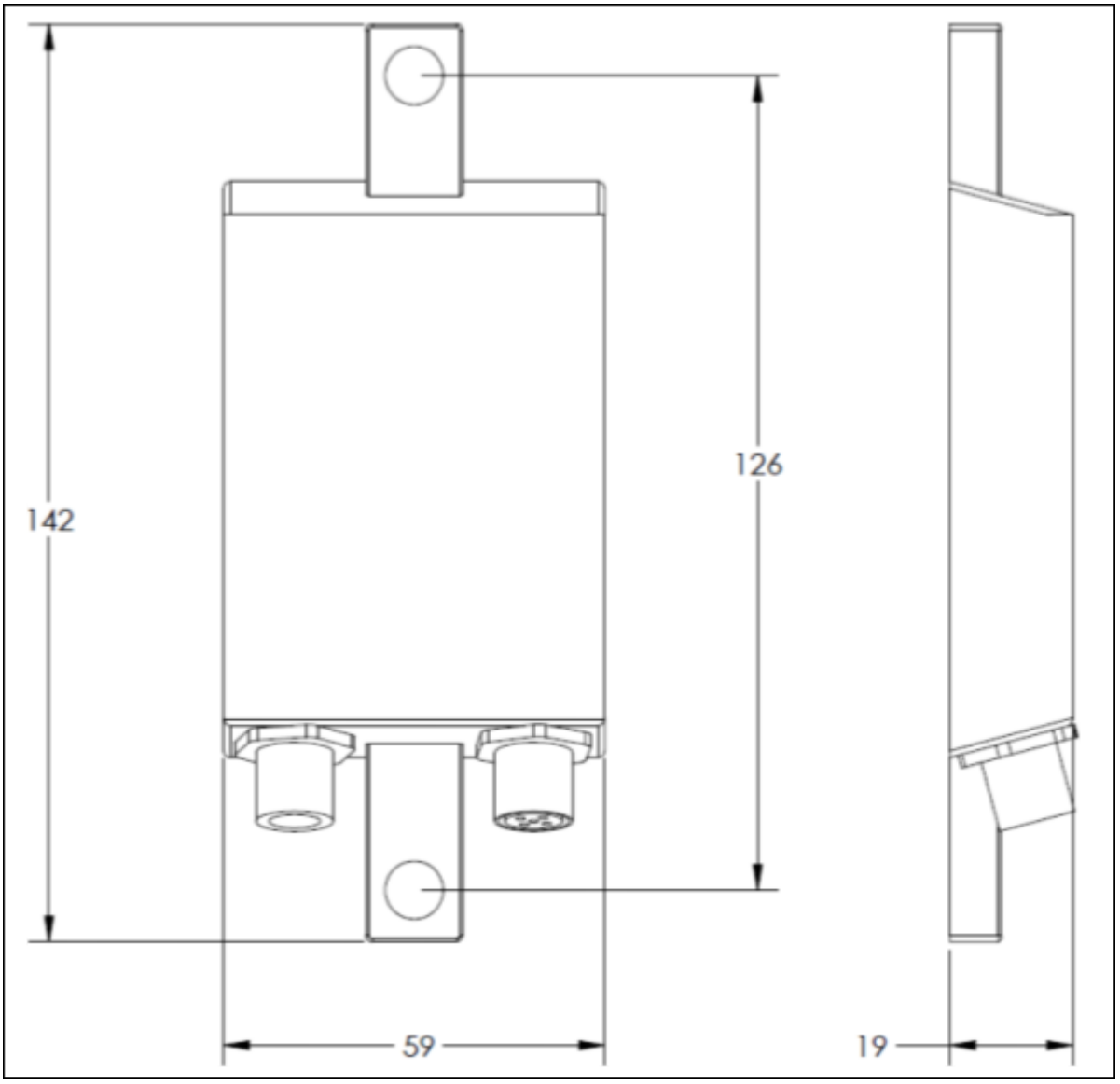
JB900 Junction Box

P/N 92299-75



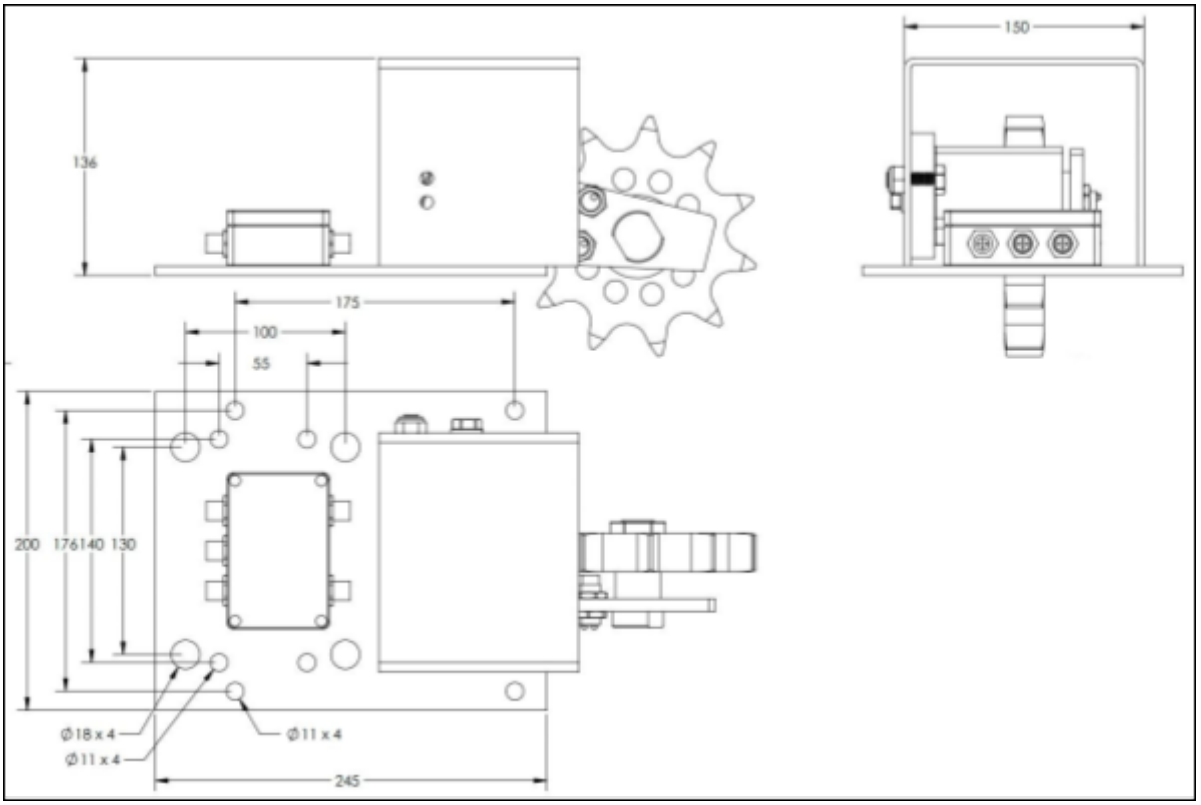
TS900 Dual-Axis Tilt sensor

P/N 92303-10

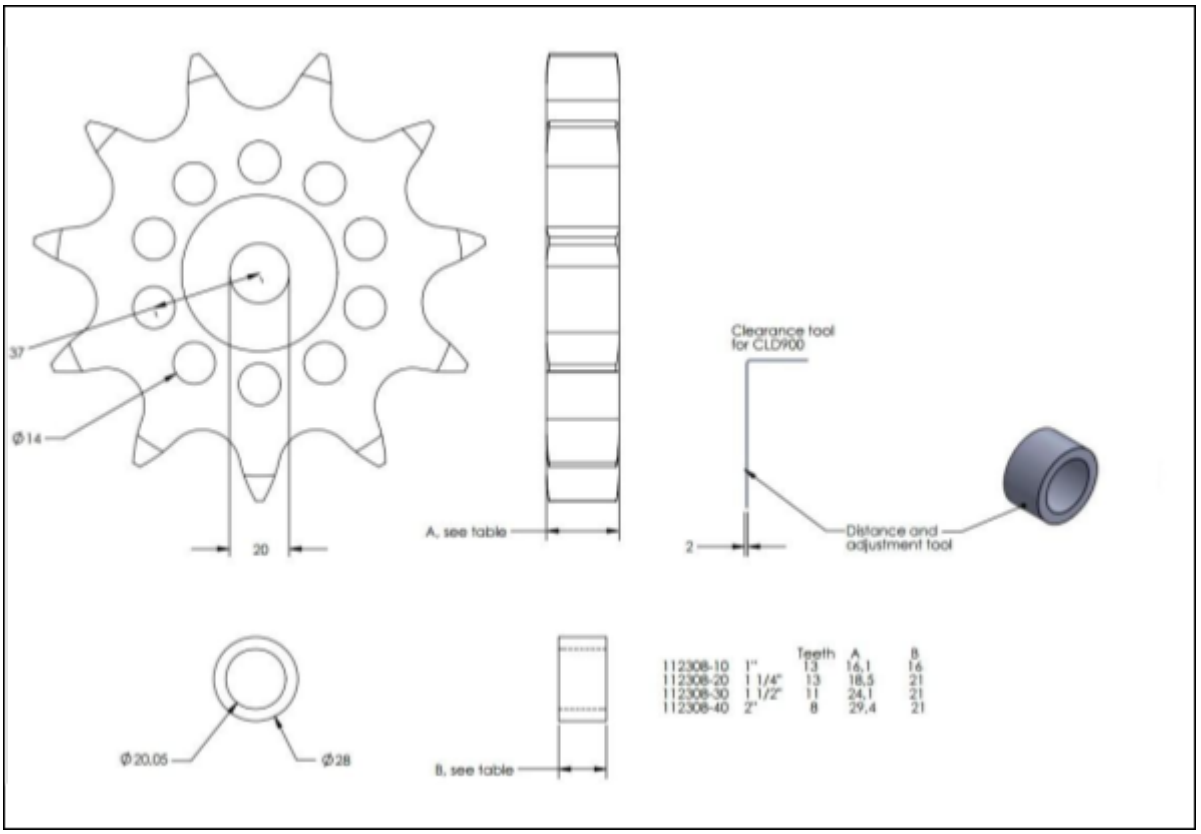


CLD900 sensor

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

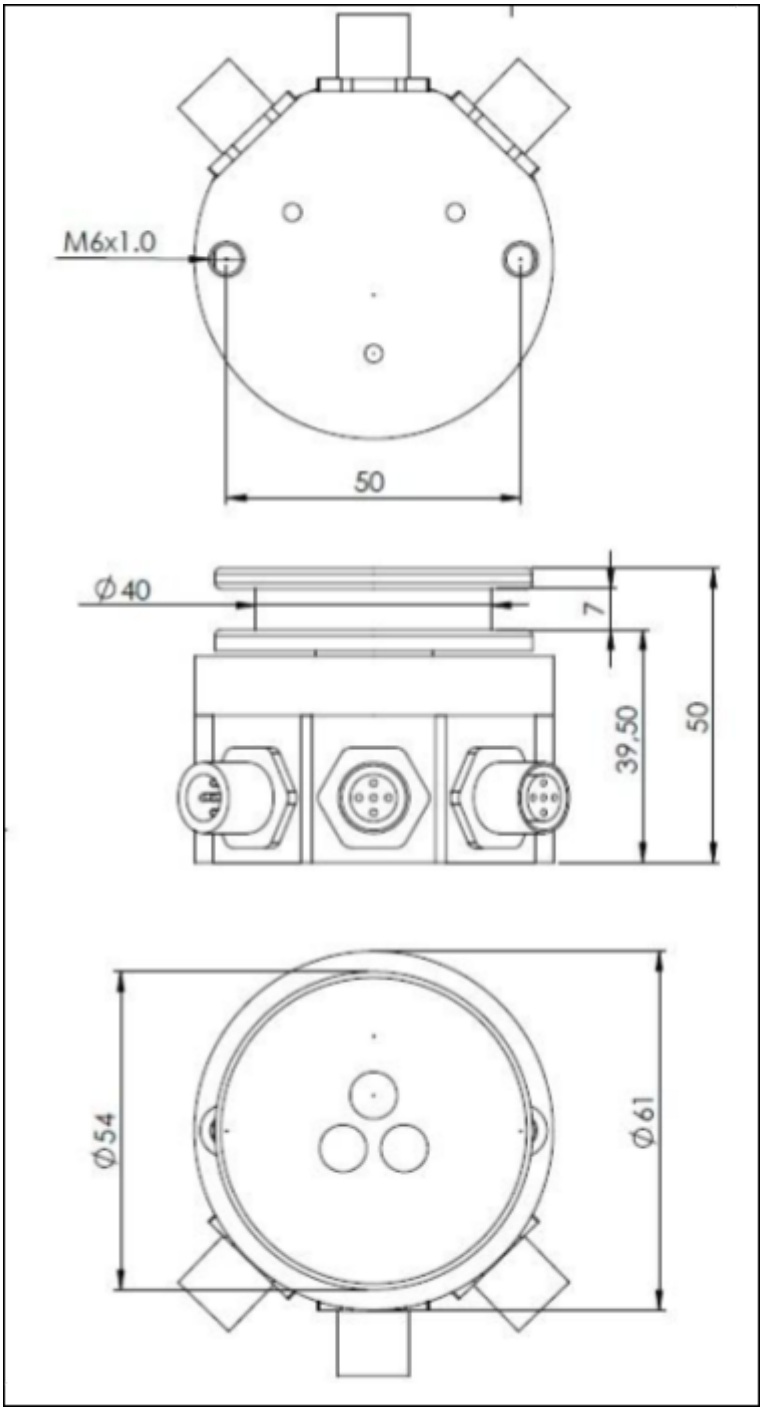


P/Ns 112308-10, -20, -30, -40 (Sprockets only)



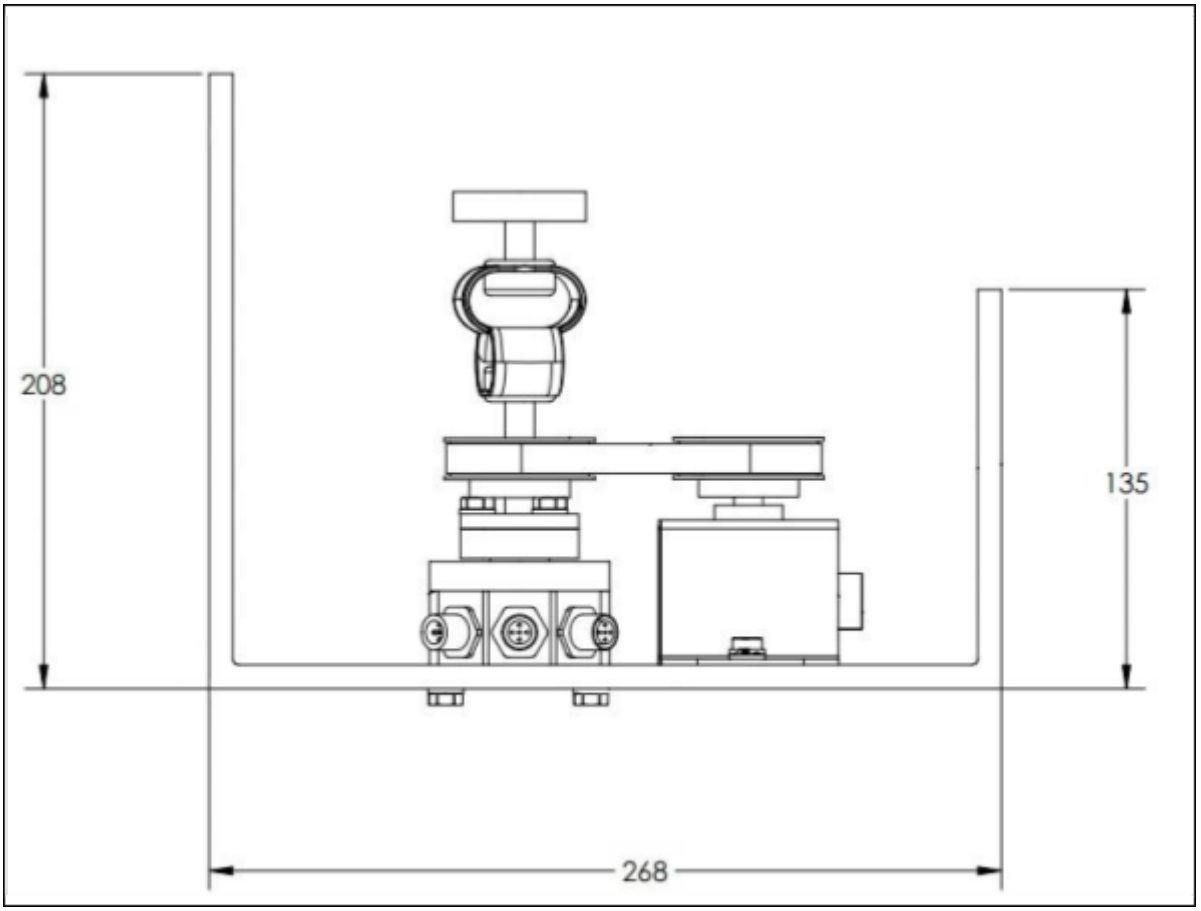
CRD900 and CDD900 sensors

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



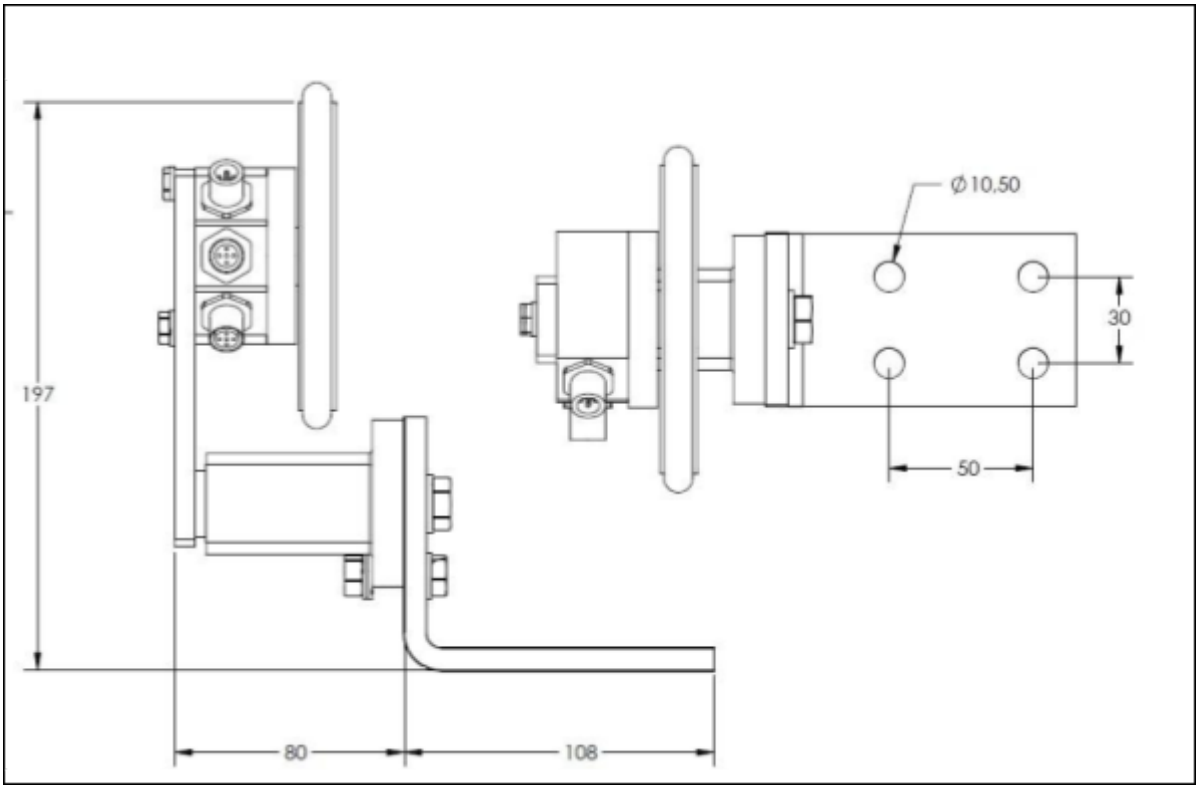
AC900 sensor

P/N 98499



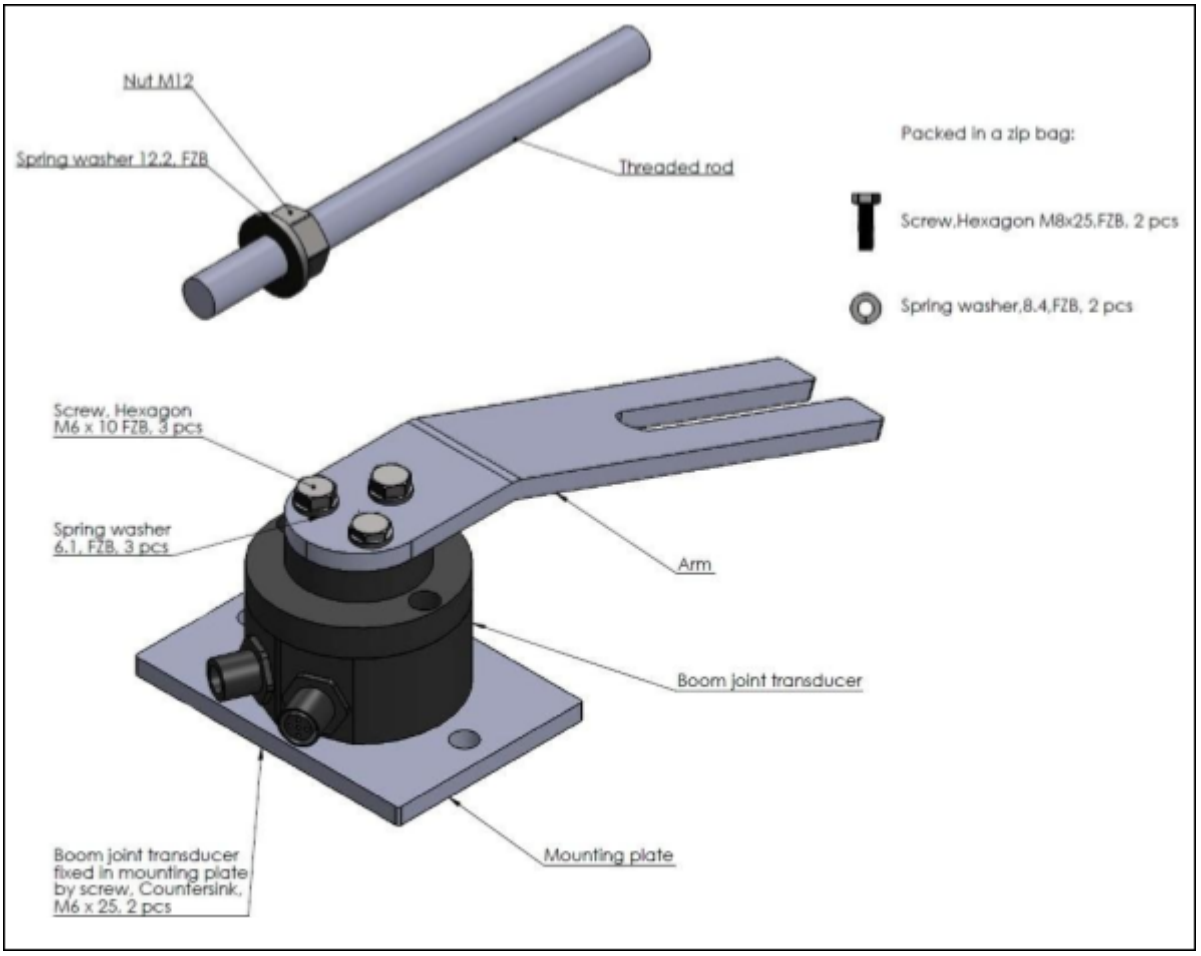
FRD900 sensor

P/N 98498



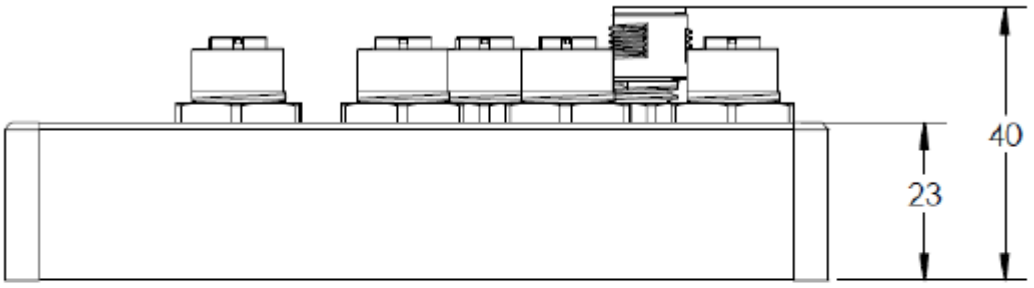
BR900 sensor

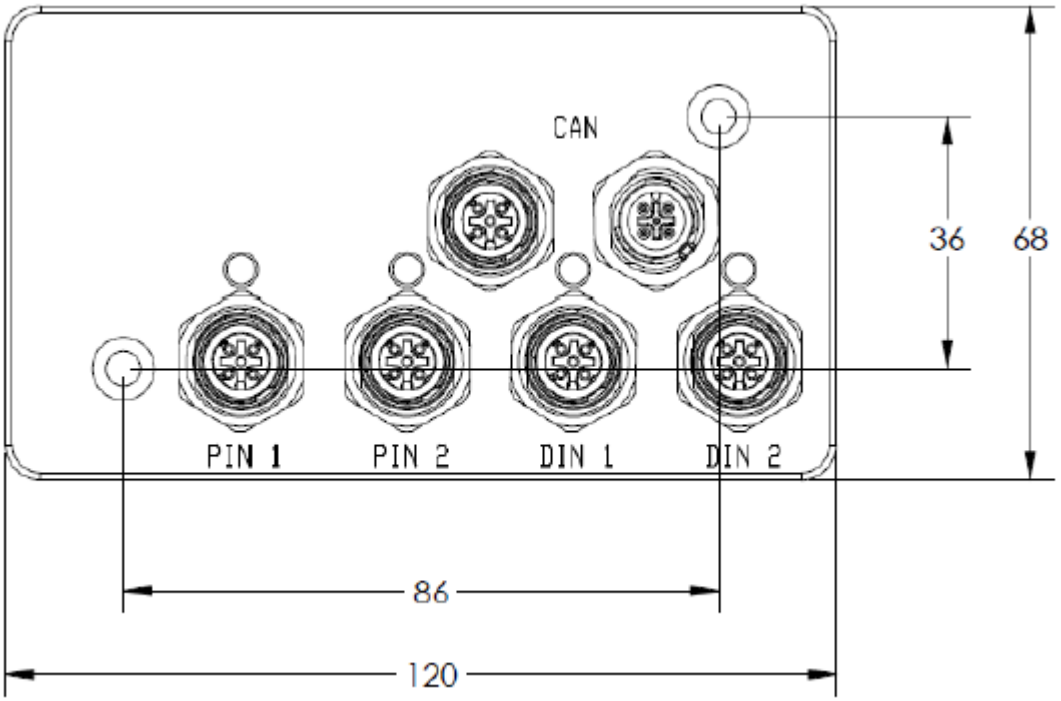
P/N 103103



Electronic Box

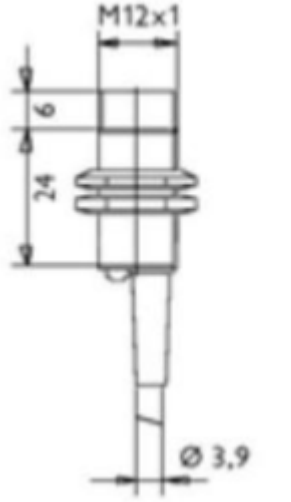
P/N 92314-50 (CLD900 and PSD900 and Energy box)





M12 Proximity Switch

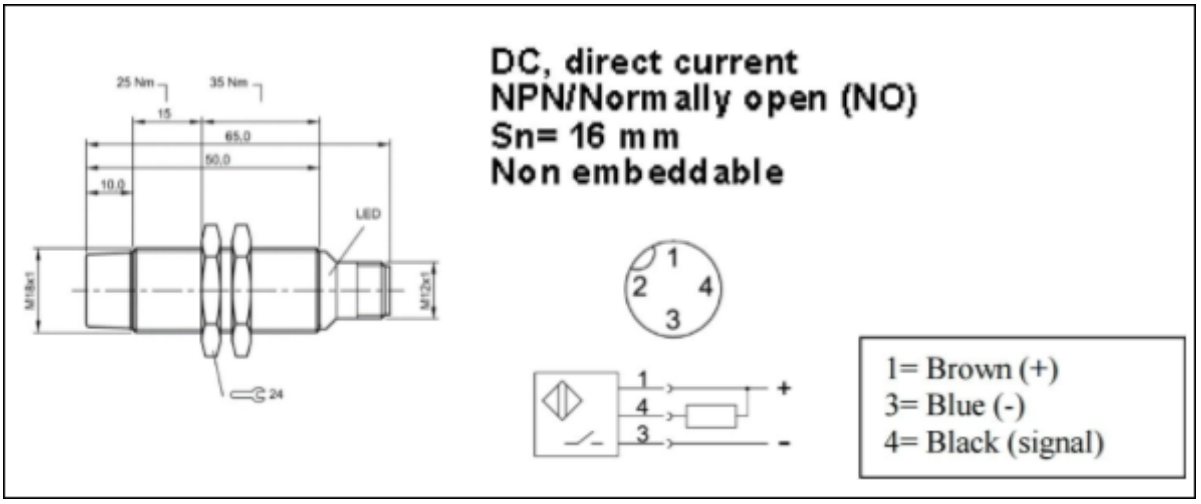
P/N: 92314-20 (CLD900 and PSD900)



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

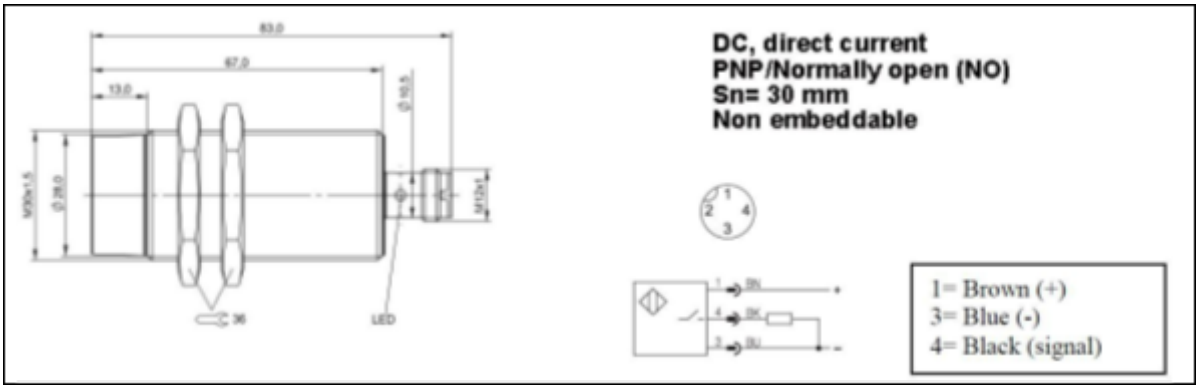
M18 Proximity Switch

P/N: 98445



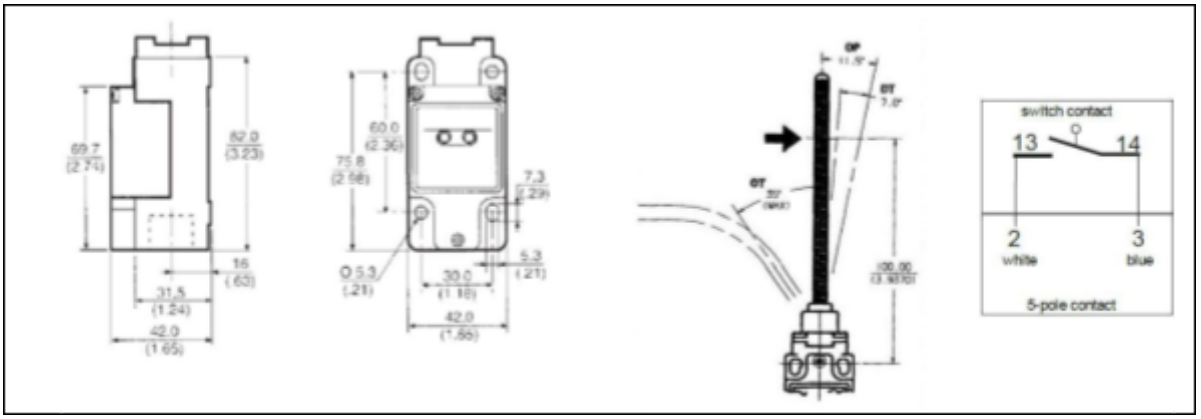
M30 Proximity Switch

P/N: 98446



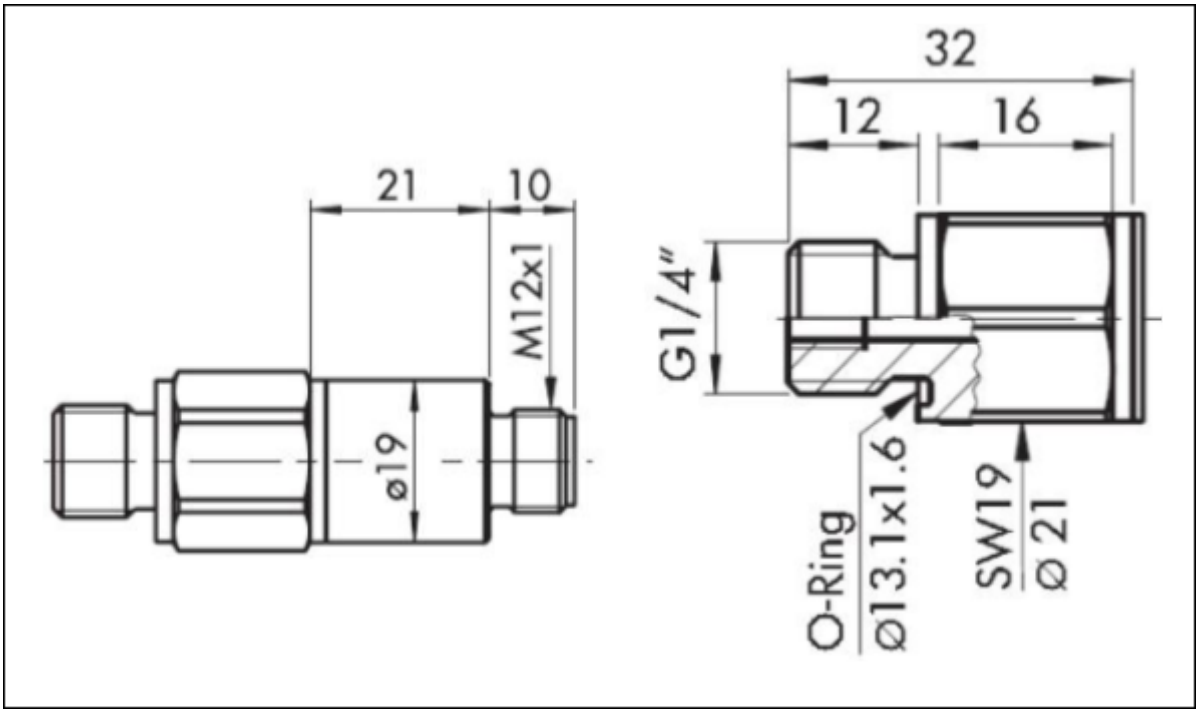
Whisker Switch

P/N: 98497



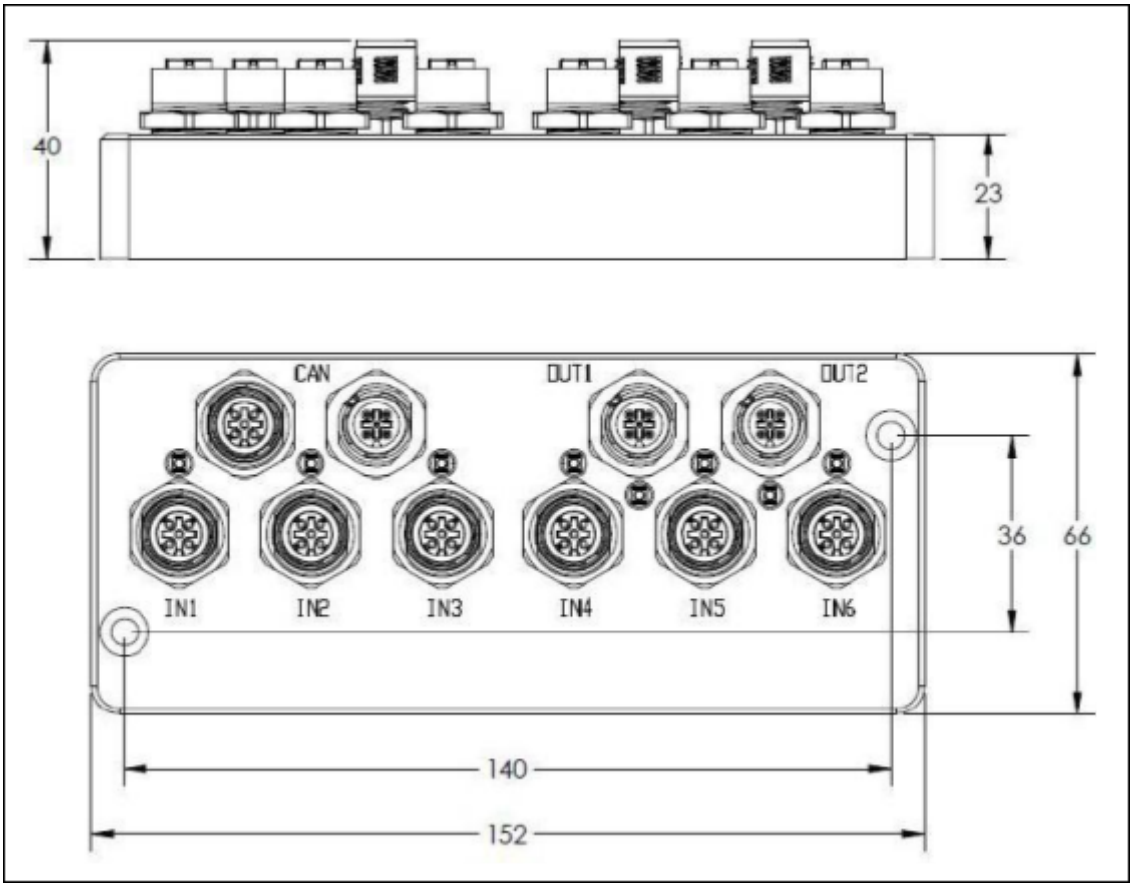
Pressure sensors

P/N: 98494 and 98495



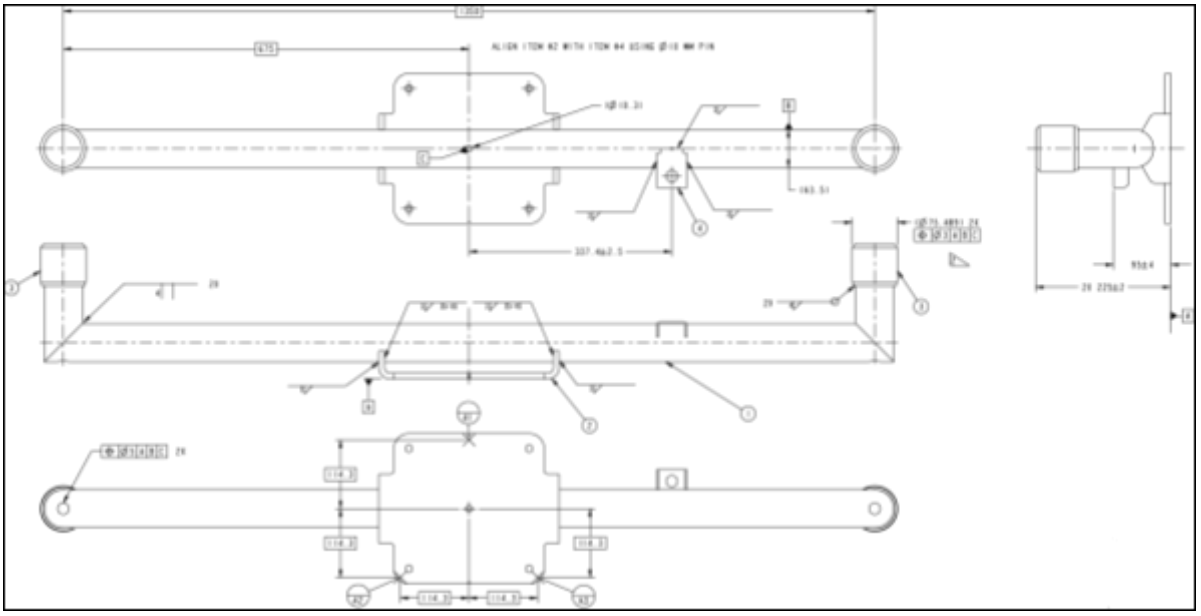
IO900 I/O Box

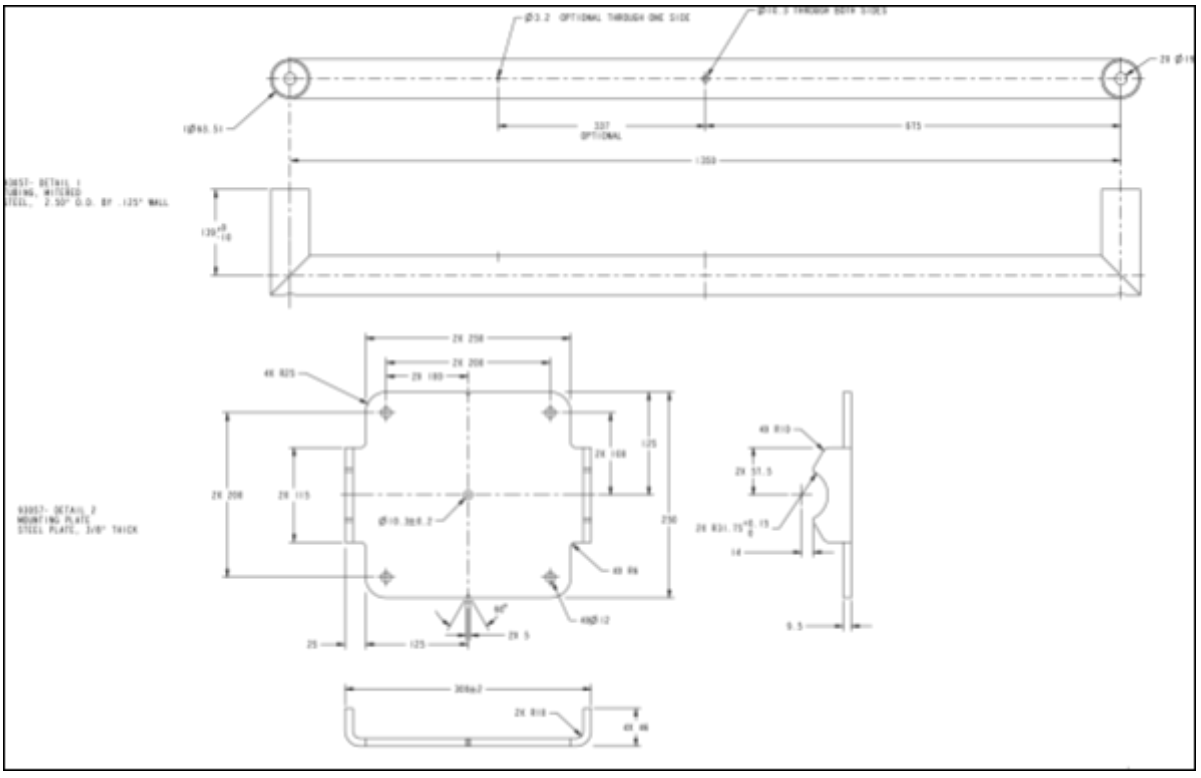
P/N: 92311-75



GNSS dual-antenna mounting bracket

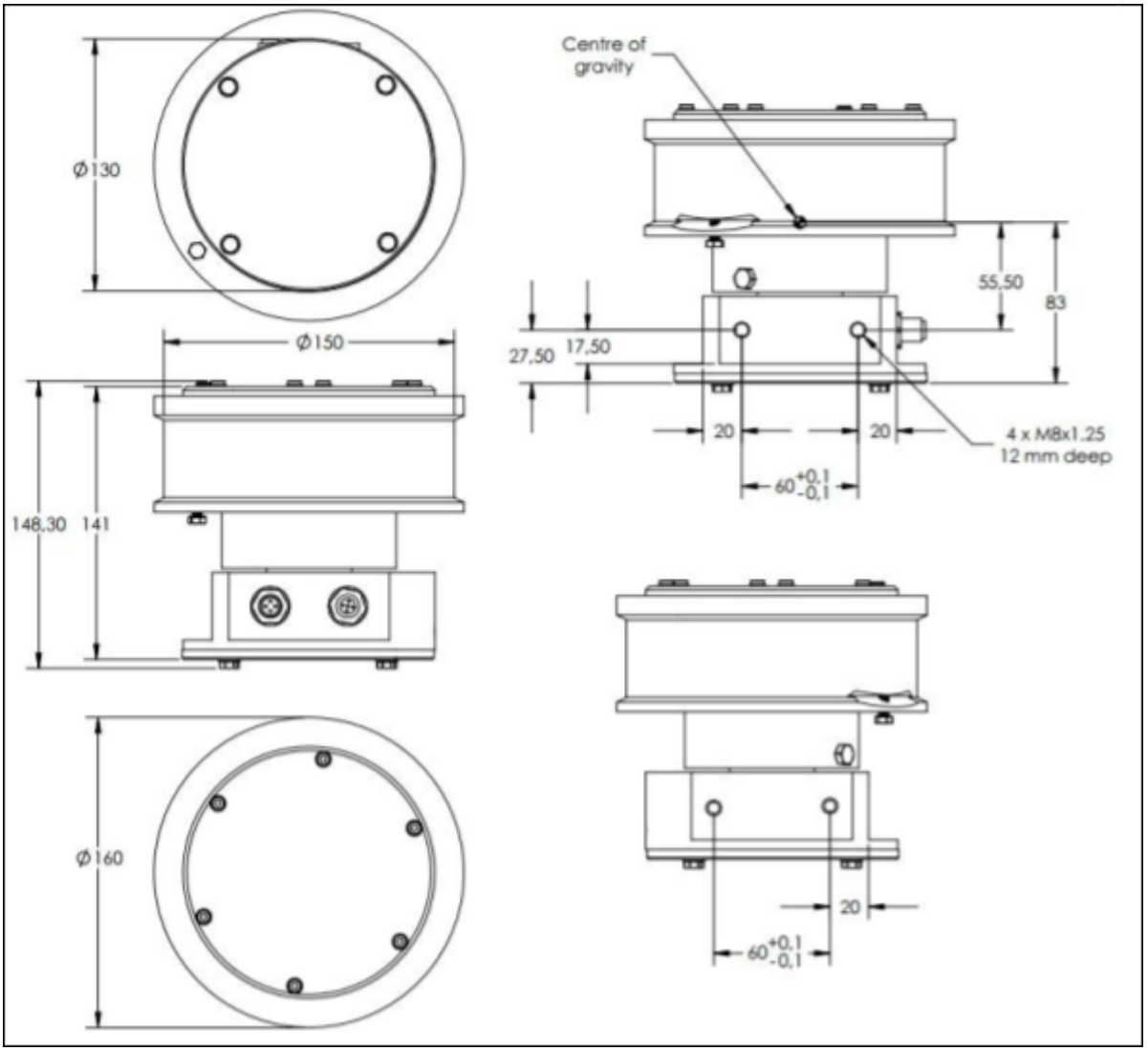
P/N 93057





TBE900 sensor

P/N 98496



9

Cables and Connectors

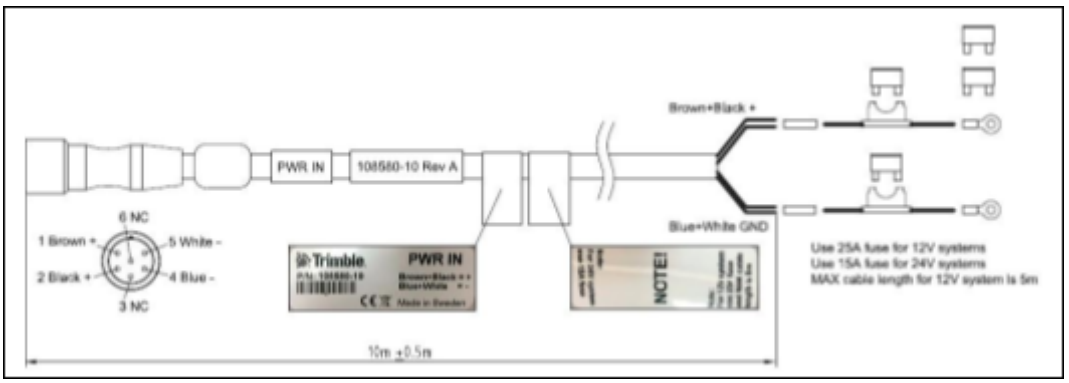
- Groundworks system cables
- Mounting loose M12 connectors

This chapter describes the system cables and connectors for the Groundworks system.

Groundworks system cables

Power Cable JB900

P/N 108580-10

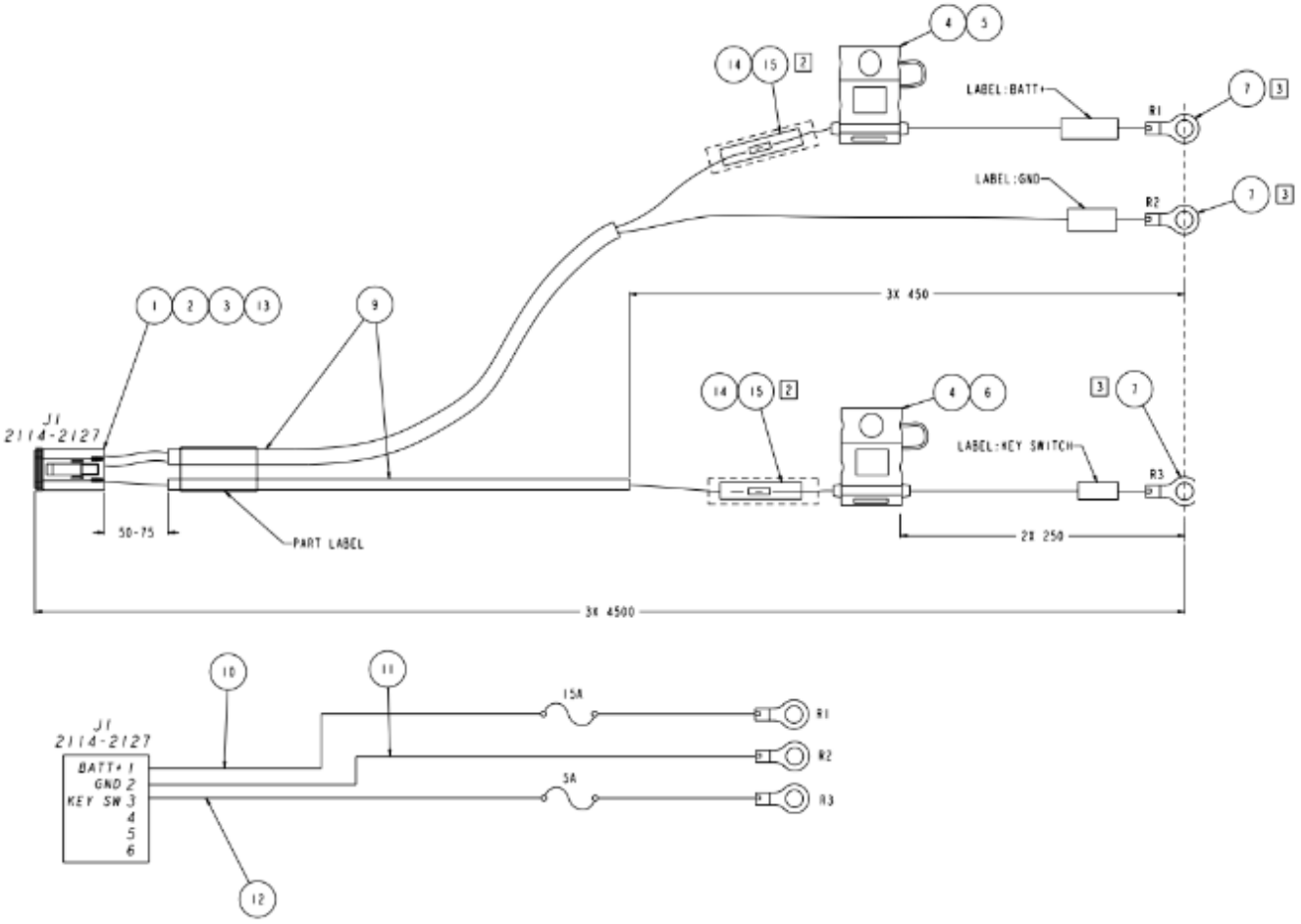


NOTE – The power cable is labeled showing that the brown and black wires should be connected to the 10.5 to 30 V DC terminal and the blue and white wires should be connected to the GND terminal. The cable is shipped with fuses that need to be connected in line with the wires, and they should be attached 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.

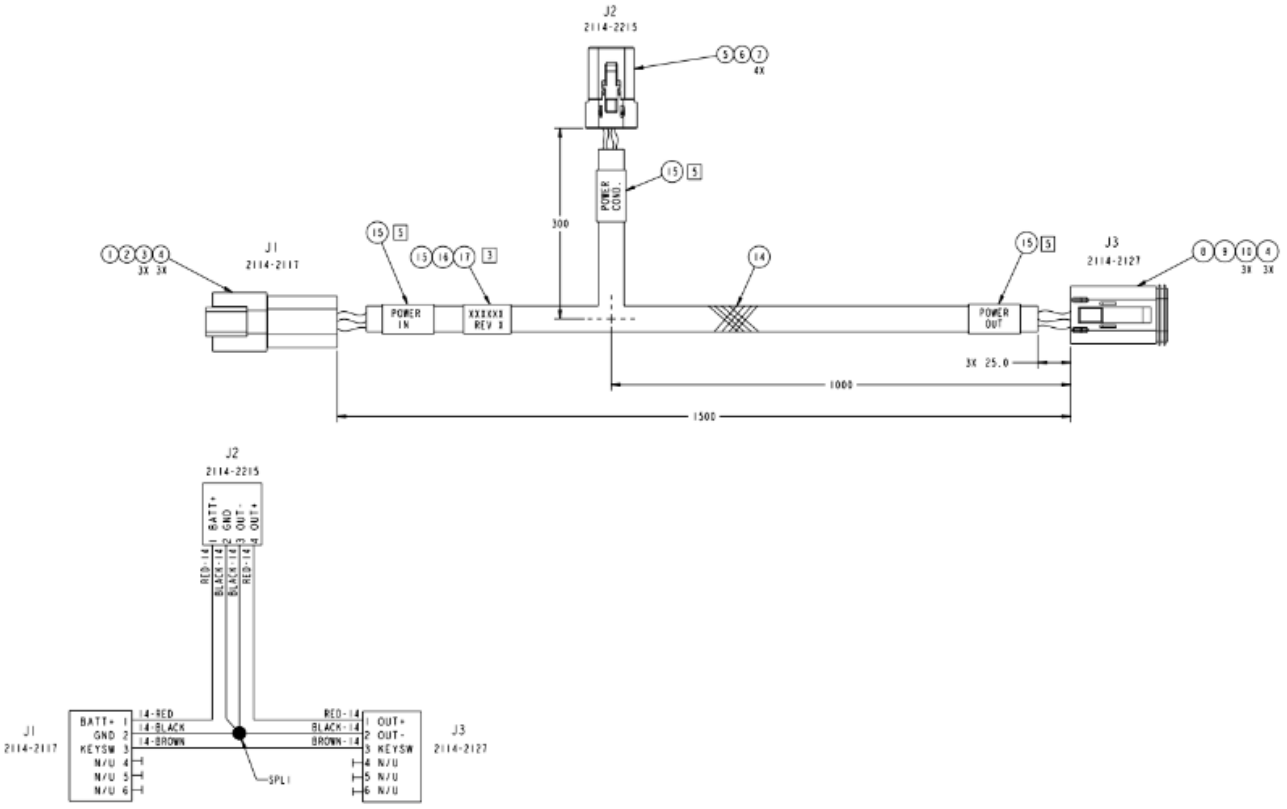
Power Cable

P/N 150411-045



Cable TMC, Power

P/N 130021

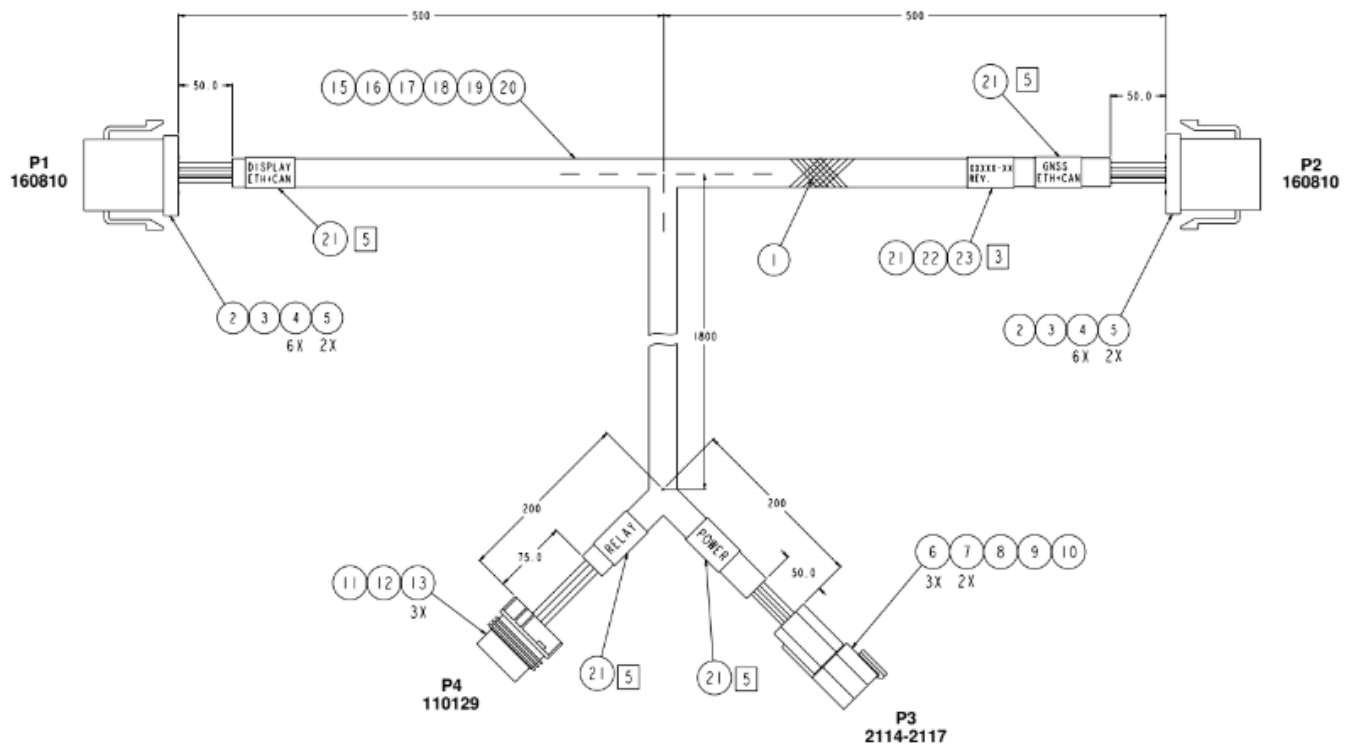


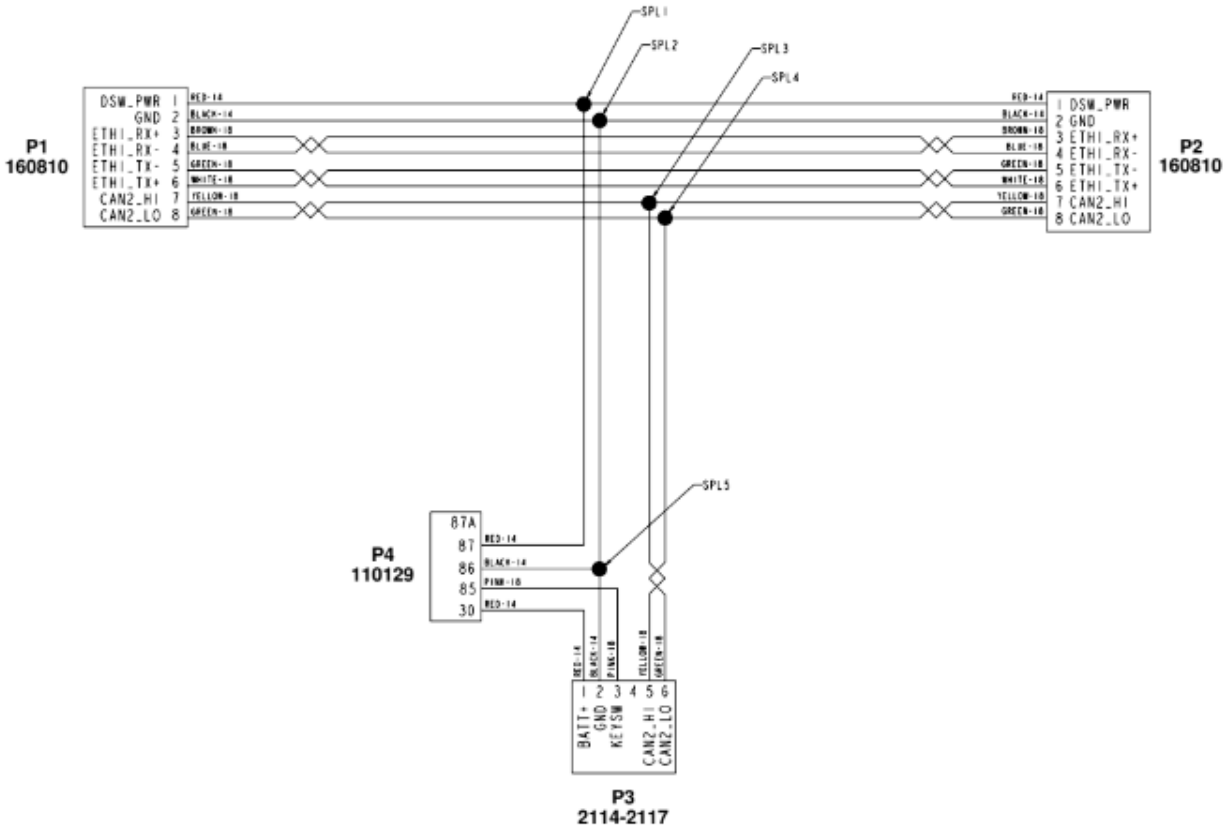
Relay 24V

P/N 109333-24

Cable Harness

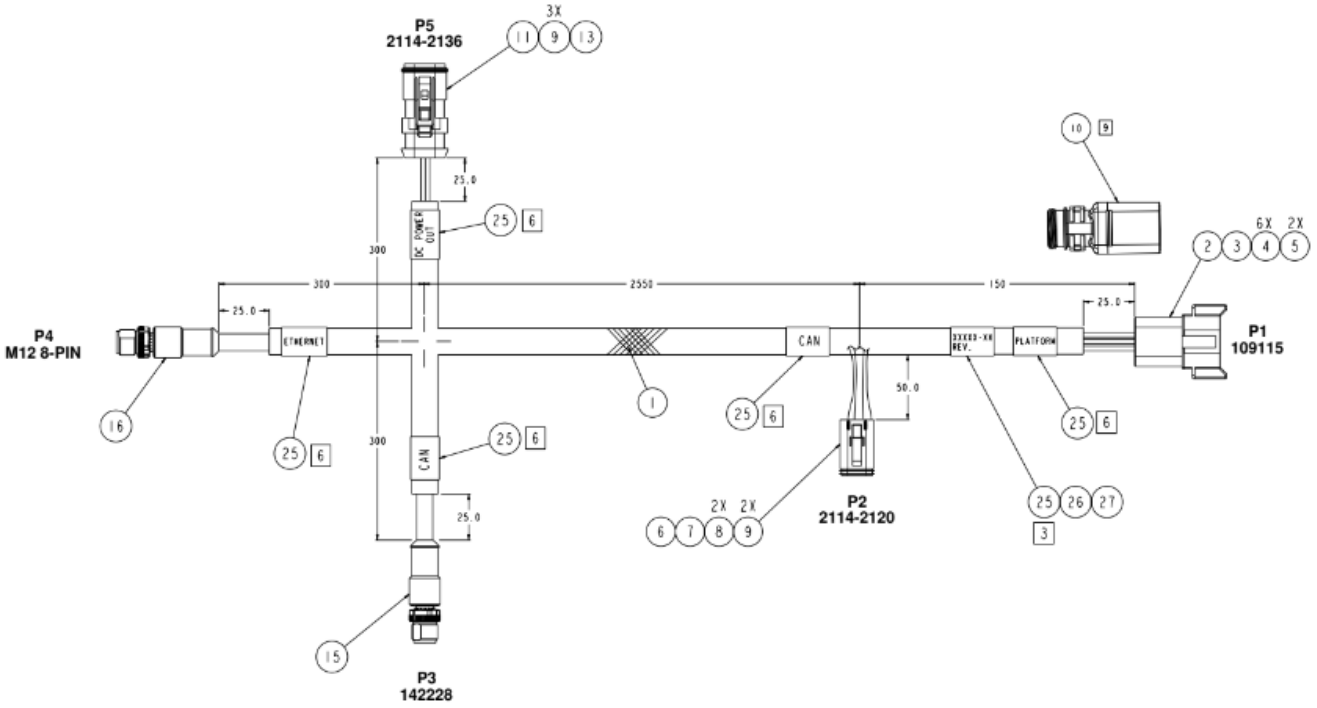
P/N 160702-030

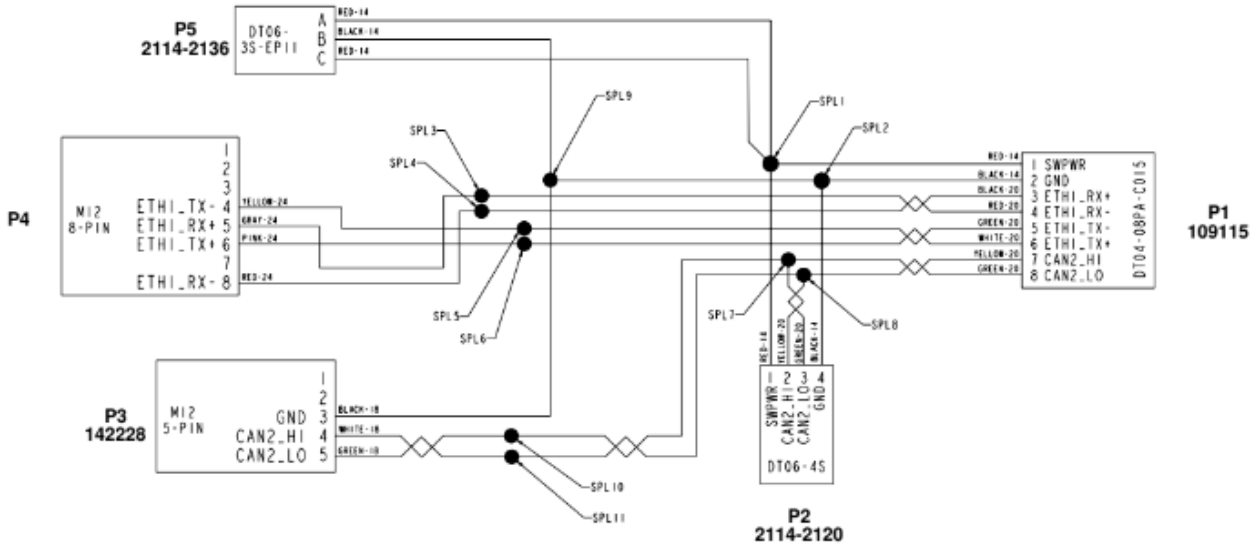




CAN/ETH/Power 3 m

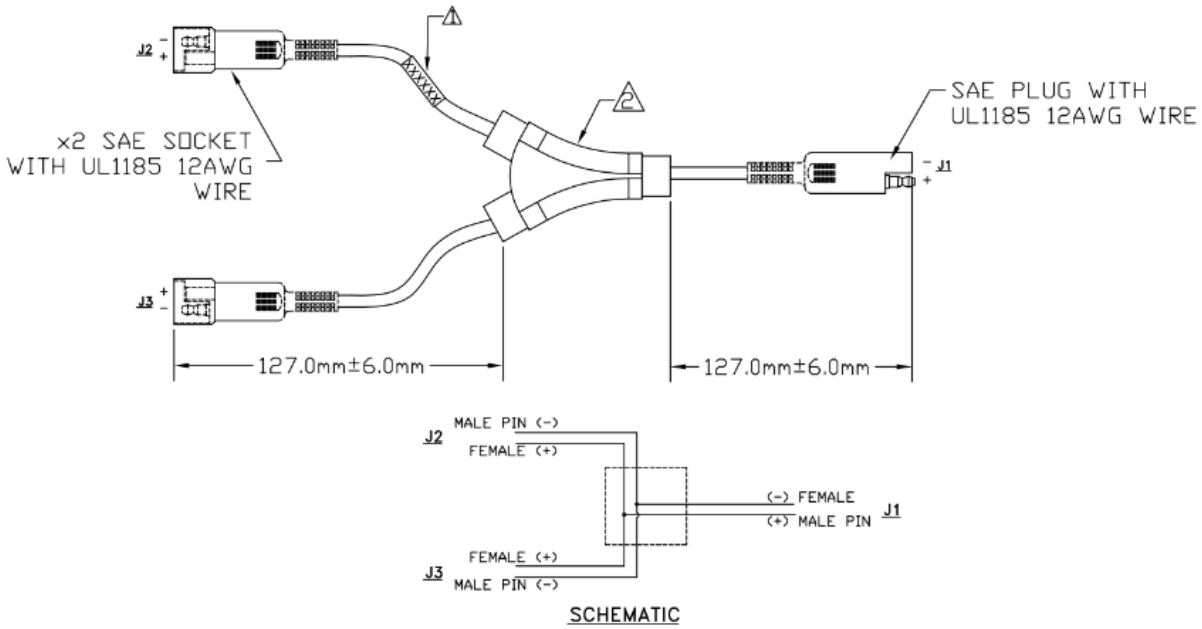
P/N 128403-030





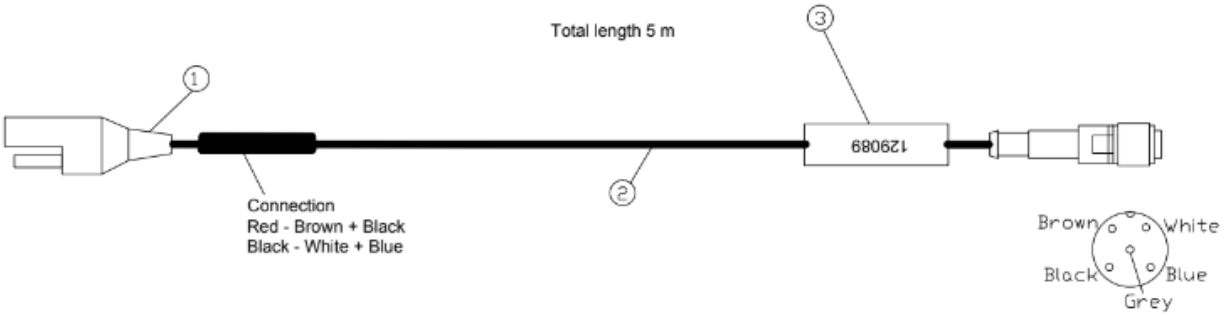
SAE Splitter

P/N 89073-00



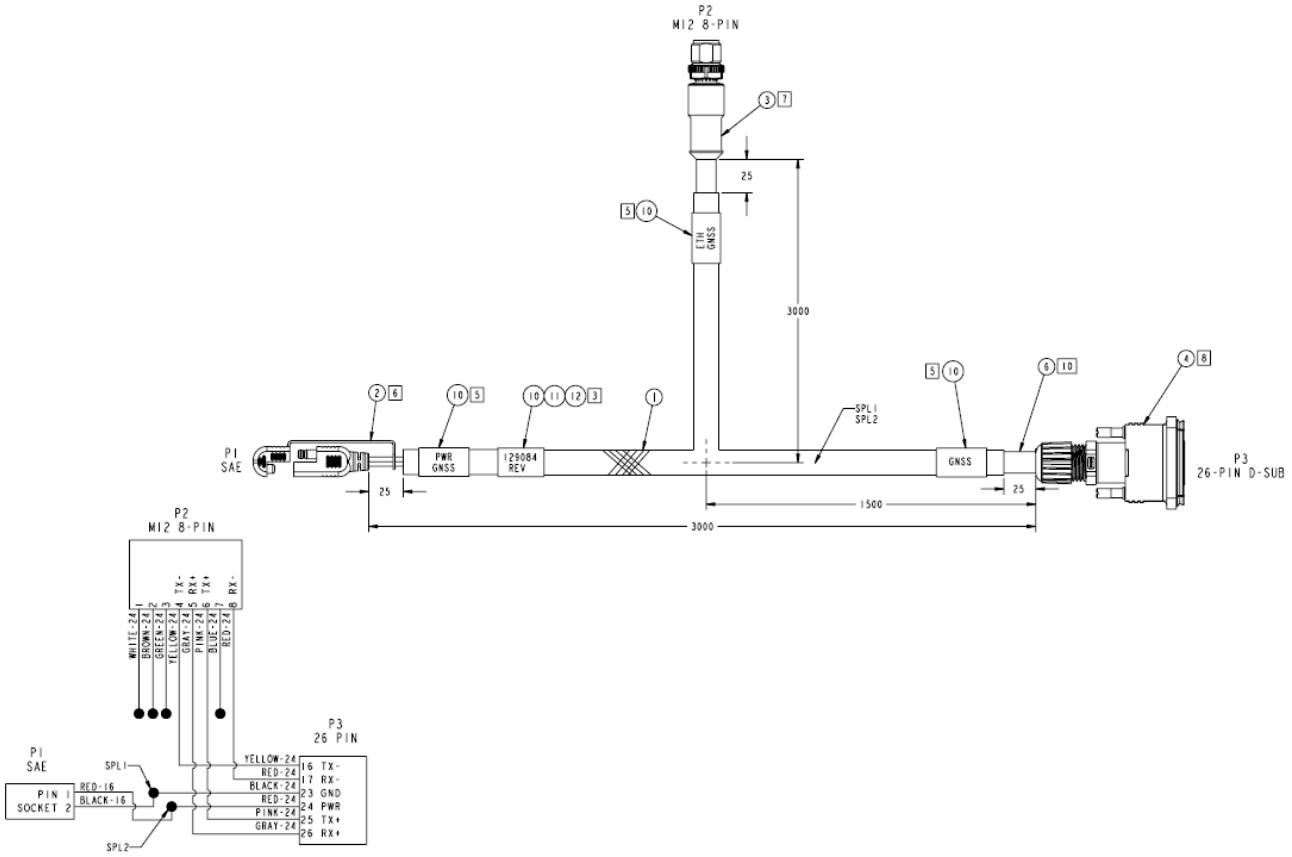
Power for the VERSO12

P/N 129089



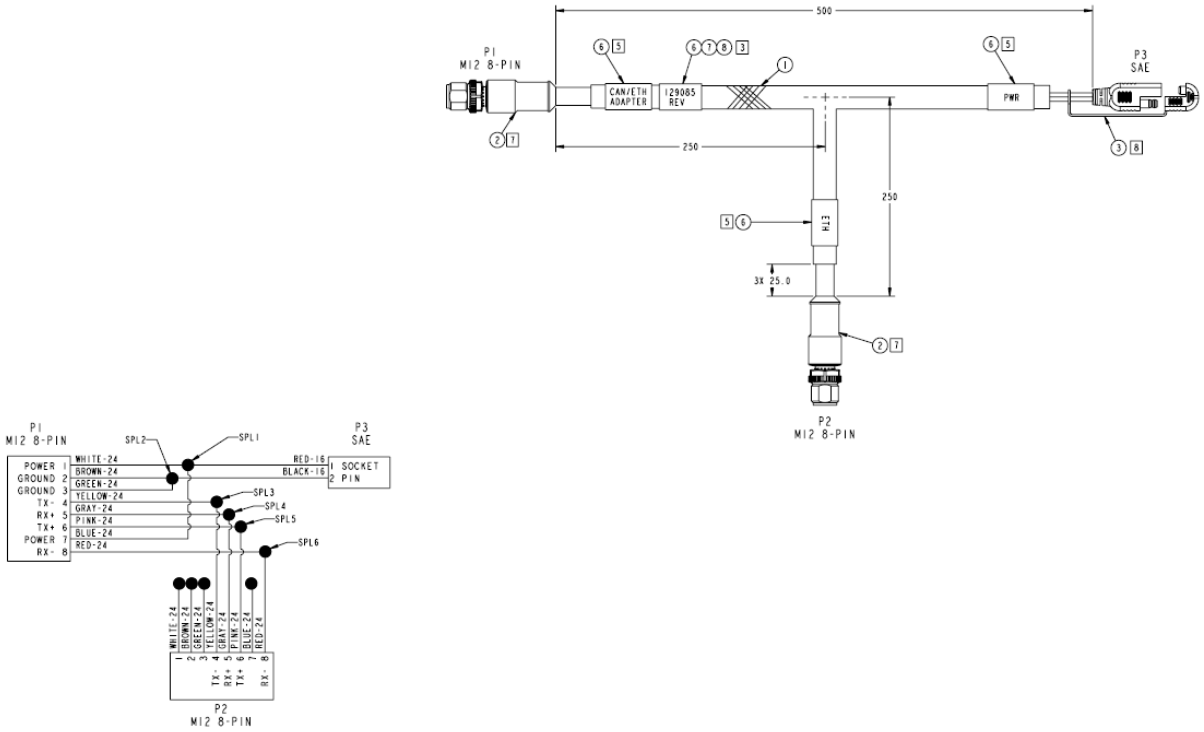
Power and signal cable for GNSS

P/N 129084



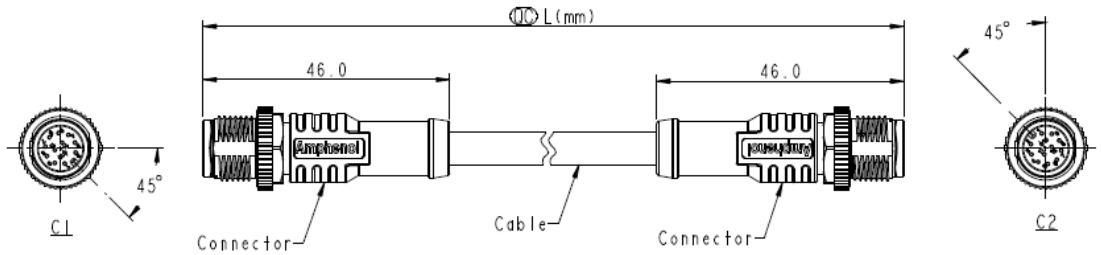
Power and signal cable for CAN to ETH adapter

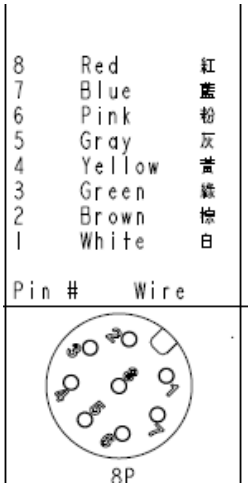
P/N 129085



Ethernet M12 8 pin A coded cable for Signal/Power

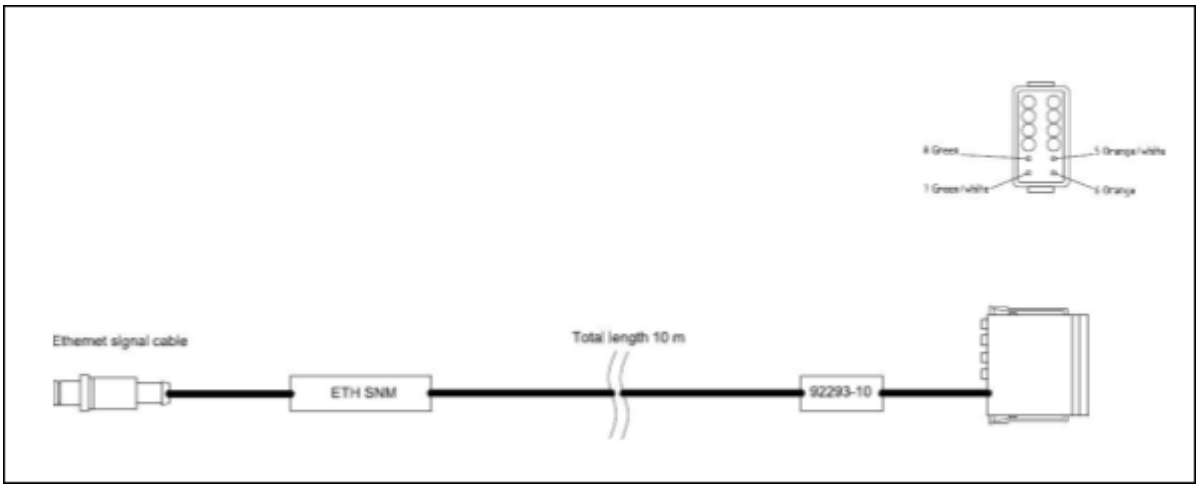
P/N 128965





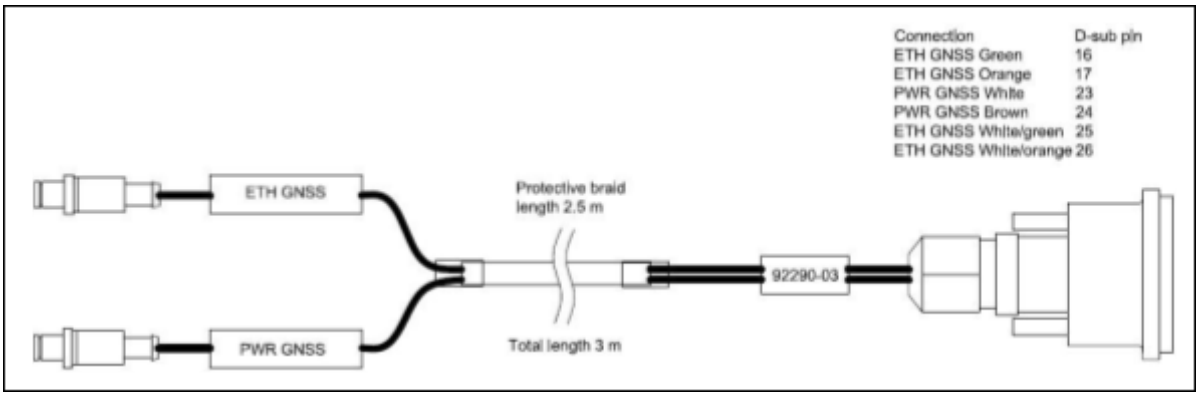
Ethernet (M12) to SNM94x (Deutsch Brown) cable

P/N 92293-10

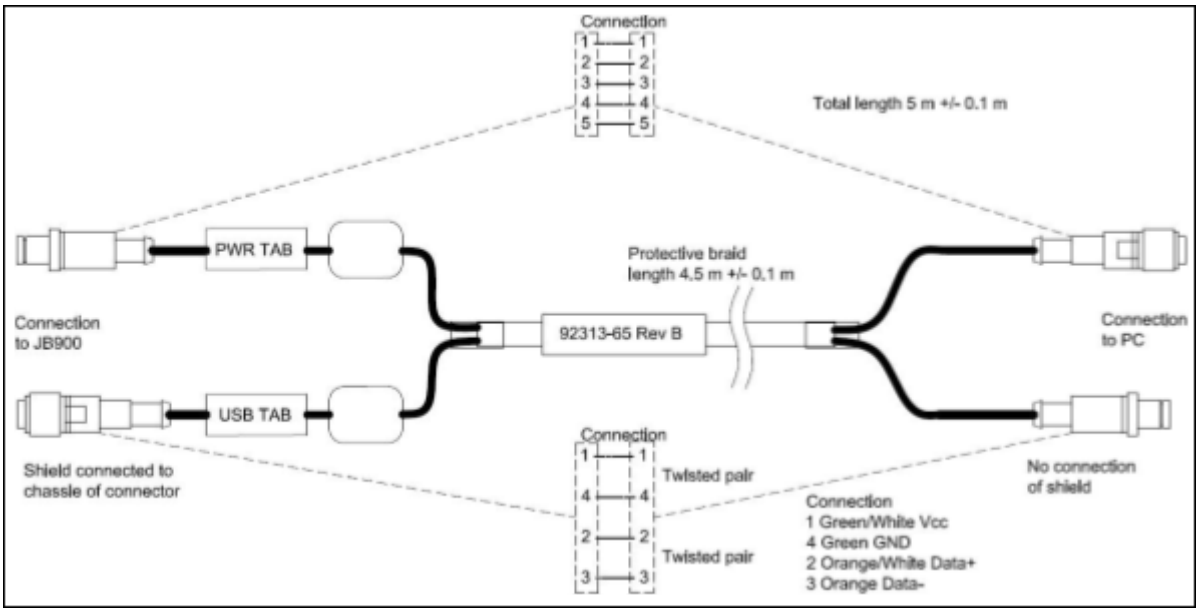


JB900 Ethernet and Power (M12) to GNSS receiver (DB26) cable

P/N 92290-03

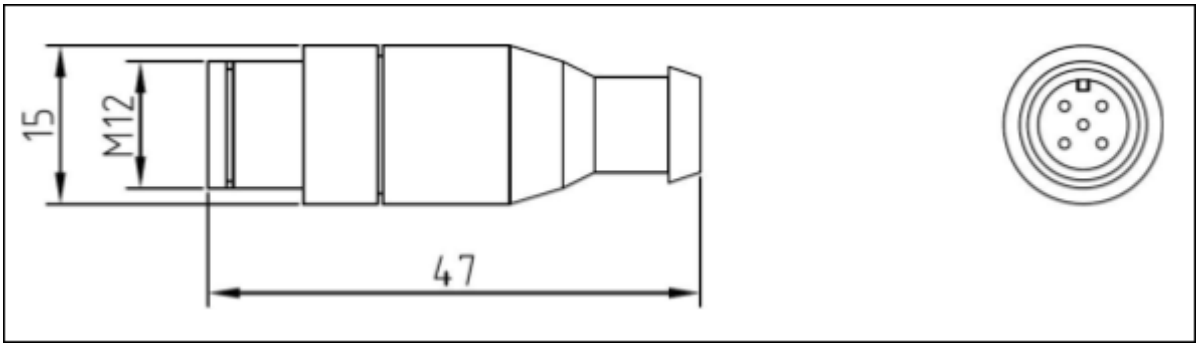


P/N 92313-65



CAN termination plug

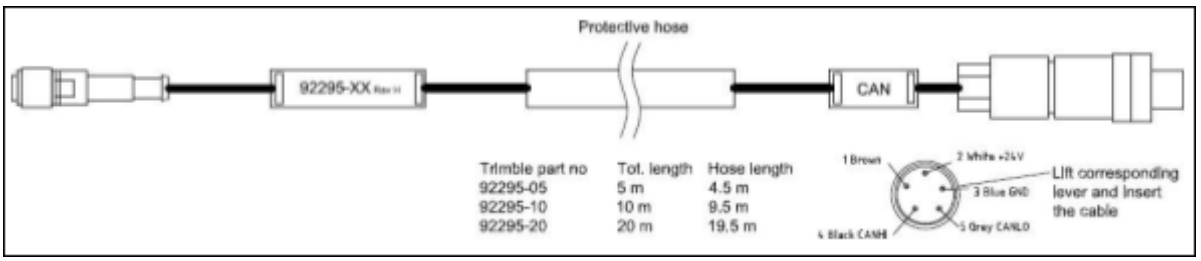
P/N 92312



NOTE – For last sensor in CAN chain.

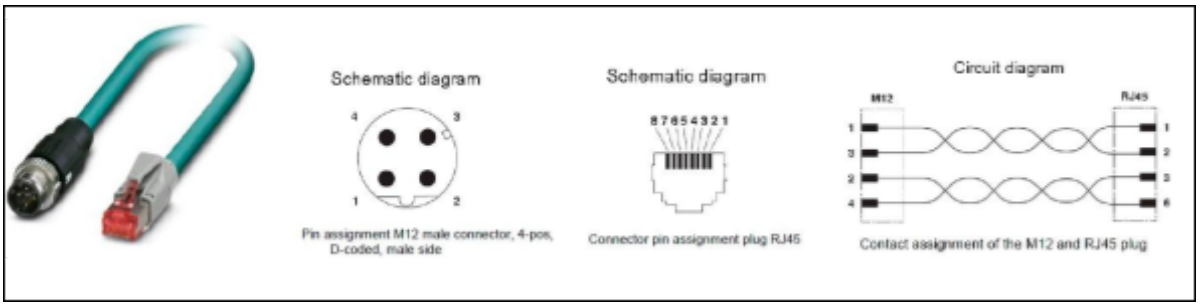
CAN cable

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



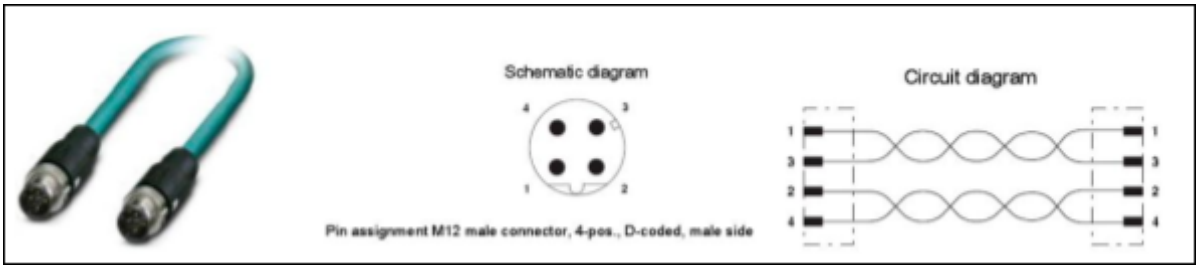
M12 to RJ45 Ethernet cable

P/N 103097



M12 to M12 Ethernet cable

P/N 98904 and 98904-10



Mounting loose 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.

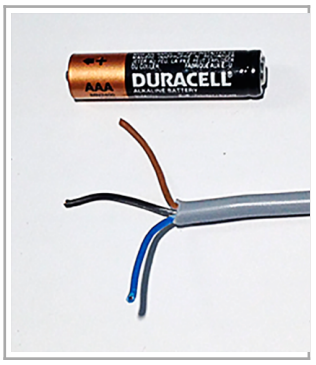
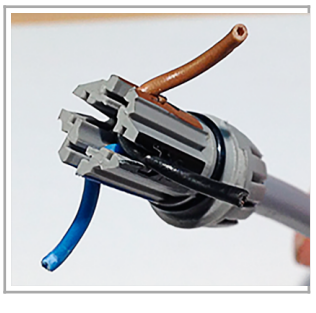
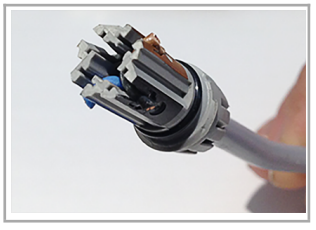
CAN cable wire	Goes to ... of male M12 connector for Whisker Switch sensor (P/N 98497)
White (Signal)	Pin 2 / White (Signal)
Blue (GND)	Pin 3 / Blue (GND)

Tools needed:

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

Connector type 1

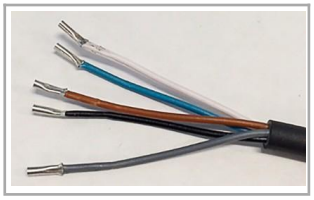
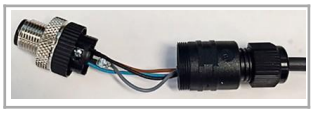


Step	Description	
1	Expose about 4 cm of the wire.	
2	Insert wires through cap and self-splicing insert. Press cable sleeve into self-splicing insert.	
3	Bend and insert color-coded wires into corresponding colored slots.	
4	Clip the ends of the wires nearly flush with the outside of the insert.	

Step	Description	
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		

Step	Description	
	wires are held tightly in place.	
5	Screw the three pieces of the connector together.	

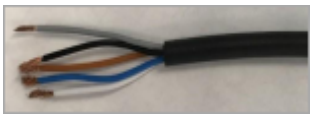
Connector type 3



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

- VERSO 12 touch display
- JB900 Junction Box
- TS900 Dual-Axis Tilt sensor
- BR900 Boom Rotation sensor
- CLD900 Chain Link Drive sensor
- CDD900, CRD900, AC900, and FRD900 sensors
- TBE900 Telescopic Boom Extension sensor
- Electronic Box
- M12 Proximity Switch
- M18 Proximity Switch
- M30 Proximity Switch
- Whisker Switch
- Pressure sensors
- IO900 I/O Box

This chapter details the specifications of the system components for the Groundworks system.

VERSO 12 touch display

P/Ns: TABV12-00 and TABV12-10

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	8 GB DDR 3
Storage	CFast 128 GB
Processor	Intel® Core™ i5 4300U
WLAN	Dual-band WLAN 802.11 ac
WWAN	Sierra Wireless MC7354 [LTE / DC-HSPA+ / HSPA+ / HSPA / UMTS (WCDMA)] *Not available for TABV12-00*
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 x 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 fem 1 × Type A female
Bluetooth	Yes, Bluetooth v4.2
Ethernet	1 × M12 4-pin connector, D-coded fem
External Cellular Antenna	1 × SMA female connector *Not available for TABV12-00*

JB900 Junction Box

P/N 92299-75

Supply Voltage	12 to 32 V DC (10.5 V DC for 5 minutes MAX) 12 V DC system MAX 21 A, Fuse 25 A 24 V DC system MAX 10 A, Fuse 10 A
Power Output	13 V DC 65 W, Fuse 5 A GNSS (x2) 2 A at 12 – 32 V DC, Fuse 2 A CAN (x2) .5 A at 24 V DC, Fuse .75 A PoE (x2) .6 A at 54 V DC, Fuse 0.75 A (802.3at Type 2)
USB Ports	USB to VERSO 12 (connected to USB Hub) USB to Serial Converter (connected to USB Hub)
USB Hub	USB to Ethernet Converter (connected to Ethernet Switch)
CAN Port	CANopen/CAN J1939 Port (x2) USB to CAN Converter (connected to USB Hub)
Ethernet Ports	Ethernet Port (x5) (PoE on Ethernet Port 4 and 5)
Ethernet Switch	6-Port Ethernet Switch
Operating Temperature	-40 to +65 °C
Storage Temperature	-40 to +85 °C
Housing	Machined Aluminum
Mounting	4 x M6 screws
IP Rating	IP67

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 (x2) (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 x 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 (x2) (CAN input/output)
Housing	Steel housing, zinc plated
Mounting	2 x 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 (x2) (CAN Input / Output) M12 4-pin (x2) (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 x 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 (x2) (CAN input/output) M12 4-pin (x1) (Digital inputs)
Digital Inputs	2
Digital Input Type	Active High
Housing	Steel housing, zinc plated
Mounting	2 x 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 (x2) (CAN input/output)
Mechanical error	± 12 mm only when changing direction
Electrical error	± 2 mm
Housing	Aluminum
Mounting	2 x 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, CLD900, and Energy Box

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 (x2) (CAN input/output) M12 4-pin (x2) (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 x 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

Whisker Switch

P/N: 98497

Mechanical life	Up to 15 million operations
Operating temperature range	-25 °C to +85 °C
Storage temperature range	-40 °C to +85 °C
Vibration (Actuator not fitted)	10 g conforming to IEC 68-2-6
Shock (Actuator not fitted)	50 g conforming to IEC 68-2-27
	Terminal marking to EN50013
IP Rating	IP66

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

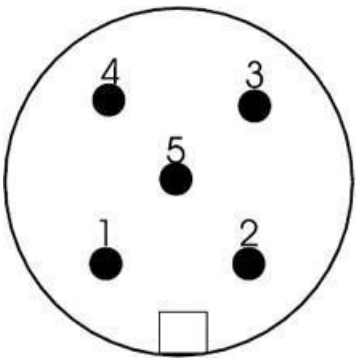
Pinout Diagrams

- CAN In/Out Ports for AC900, BR900, CDD900, CLD900, CRD900, Electronic Box, FRD900, IO900, PSD900, Pressure Sensors, TBE900, and TS900
- M18 and M30 Proximity Switch
- Whisker Switch

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

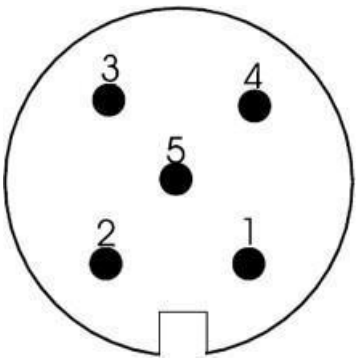
CAN In/Out Ports for AC900, BR900, CDD900, CLD900, CRD900, Electronic Box, FRD900, IO900, PSD900, Pressure Sensors, TBE900, and TS900

CAN input (A-coded male)

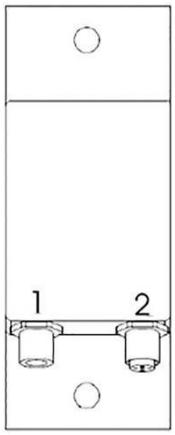


Pin	Signal
1	Not used
2	+ 24 V
3	GND
4	CAN Hi
5	CAN Lo

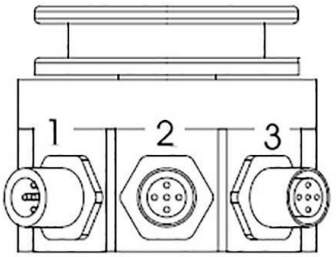
CAN output (A-coded female)



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



Pin	Signal
1	CAN In
2	CAN Out

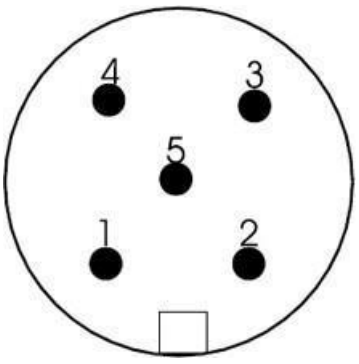


Pin	Signal
1	CAN In
2	CAN Out
3	Digital Input

Digital Input/Output Ports for IO900

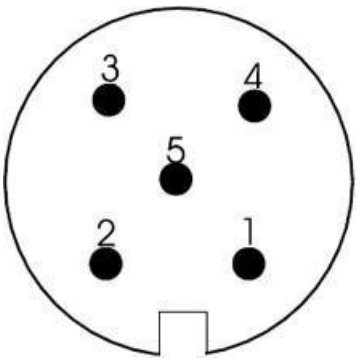
NOTE – Digital input pinout also applies to AC900, CDD900, CLD900, CRD900, Electronic Box, FRD900, and PSD900.

Input 1 to 6



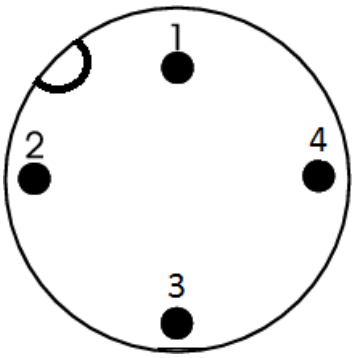
Pin	Signal
1	+ 24 V
2	Signal 1 active low
3	GND
4	Signal 2 active high
5	Not used

Output 1 to 2



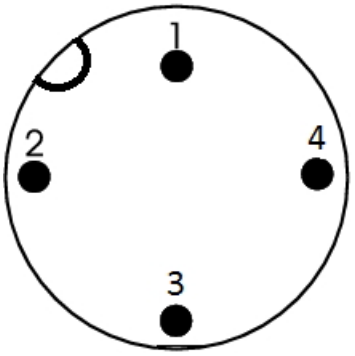
Pin	Signal
1	Common
2	Not used
3	Not used
4	Normally open
5	Normally closed

M18 and M30 Proximity Switch



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

Whisker Switch



Pin	Signal
1	Not used
2	Signal
3	GND
4	Not used

12

Accessories

- VERSO 12 accessories
- CAN cable accessories
- CDD900 sensor accessories
- CRD900 sensor accessories
- FRD900 sensor accessories
- AC900 sensor accessories
- Brackets

This chapter describes the available Groundworks Machine Control System accessories.

VERSO 12 accessories

Spare backplate

P/N 115405



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 98498



Wheel kit for the FRD900 depth sensor

P/N 98907



AC900 sensor accessories

Cog belt for the AC900 sensor

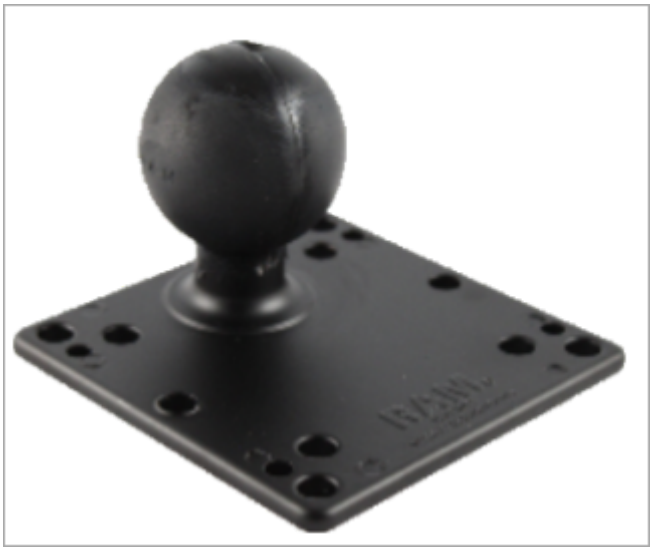
P/N 98905



Brackets

RAM mounting plates

P/N 105108 – RAM D plate

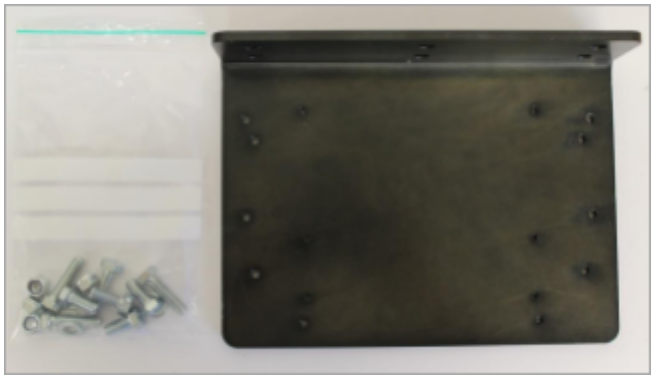


P/N 105109 – Medium length D arm



Universal mounting plate for JB900/IO900/SNM94x/SPS receivers

P/N 105501-10



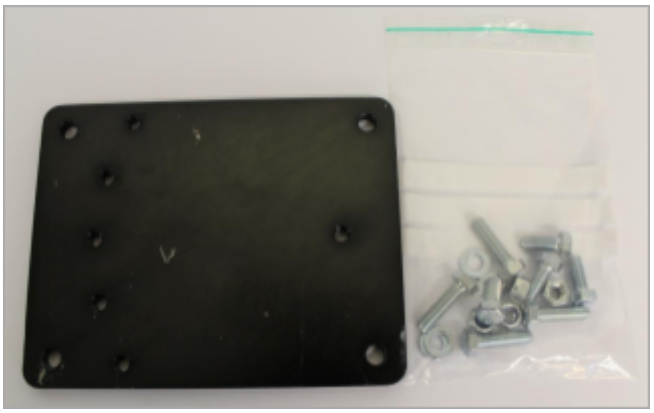
IO900/PSD900 mounting plate

P/N 105501-20



TS900 mounting plate

P/N105501-30



CRD900 mounting plate

P/N 105501-40



CDD900 mounting plate

P/N 105501-50



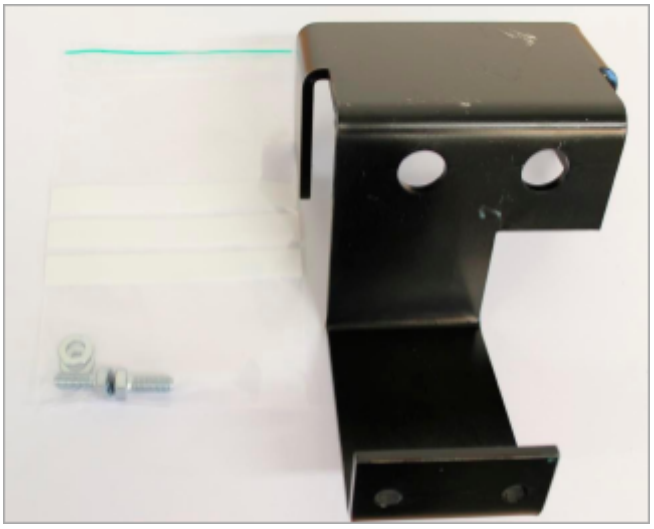
Wire attachment

P/N 105501-60



Dual Proximity Switch mounting plate for Epiroc

P/N 105501-70



Assorted hardware for Groundworks sensors

P/N105501-99



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