

Actisense[®]

Award Winning NMEA Specialists

Your complete guide to building an NMEA 2000[®] network

Issue 1.1



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Who are the NMEA and What is NMEA 2000?



Who are the NMEA?

The NMEA stands for National Marine Electronics Association. In a nutshell, they're a not for profit organisation whose mission is to improve data communications between marine electronics manufacturers. Read more at www.nmea.org

What is NMEA 2000?

NMEA 2000 is an open standard designed by the NMEA to help them achieve their mission by standardising the messages and connector system used for devices in the marine industry. There is a common misconception that the term 'open standard' means freely available when in fact it means that the standard is available to buy at a reasonable cost from their [website](http://www.nmea.org). It is important to remember that the NMEA is not for profit (NFP) and the standards create an important source of income so that they can continue to exist.

The Network That CAN

NMEA 2000 is based on a system known as CAN which stands for 'Controller Area Network'. One of the reasons the NMEA chose this system over something like Ethernet (for example) which has a much wider bandwidth, and can support RADAR and video, is because CAN has the ability to guarantee message delivery even when the network is 100% loaded. An important feature when you consider that the network is likely to contain important GPS information.

DeviceNet

The NMEA adopted the 'DeviceNet' standard for the hardware (cables and connectors) that is used to create an NMEA 2000 network. The DeviceNet standard was already in use by the automotive and agricultural industries (to name a few) so it is a proven robust system and can withstand the harsh conditions of the marine environment.

Certification

There is a certification process in place for NMEA 2000. This helps the user to understand that if a device carries the NMEA 2000 logo they can rest assured that it is compatible with an NMEA 2000 network and any other 'NMEA 2000 Certified' device. Some common terms for the user to be aware of are 'CANbus approved' or 'NMEA 2000 Compatible' as these are unlikely to have gone through the NMEA 2000 certification process.

'NMEA 2000 Approved' is a term used for cables and connectors that meet the requirements for NMEA 2000 as they do not require the same certification process.



Minimum Network Requirements and Network Limitations

Minimum Network Requirements

The following are the essential components of any NMEA 2000 network:

- Power insertion point - fused.
- 2 x NMEA 2000 certified devices (at least 1x TX and 1x RX) and a means to connect them to the network. This can be via T-pieces or other products which will be discussed later.
- Termination resistors - Precisely 2, no more, no less.

Common Phrases

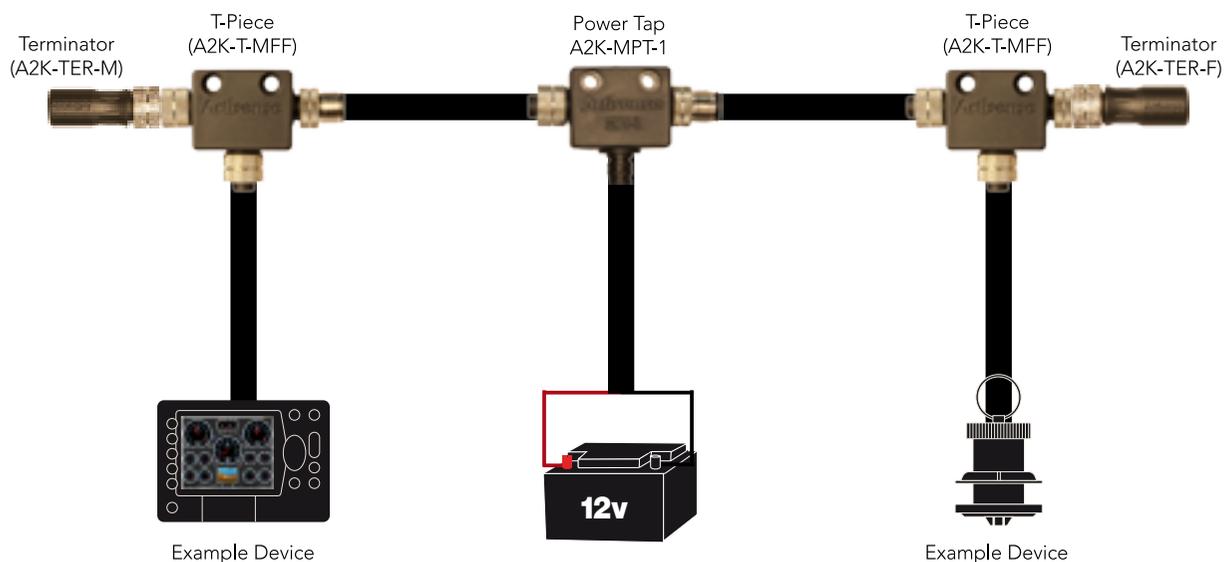
You will hear some common phrases used when discussing NMEA 2000 networks. Here's what they mean:

Backbone: The main trunk of cable that runs through the boat to form the network. T-pieces are connected along the network for devices to plug in to.

Instrument drop: The length of cable that connects an NMEA 2000 device to the backbone

PGN: Stands for 'Parameter Group Number'. The messages used by NMEA 2000 devices for sharing information.

The diagram below illustrates how an NMEA 2000 network is put together:



NMEA 2000 Network Limitations



Cable Type	Max Length	Max Amp	Power Pair	Data Pair
Per drop cable	6m			
Sum of all drop cables	78m			
Micro/Lite Backbone (Terminator to terminator)	100m	3	22 AWG	24 AWG
Mid backbone (Terminator to terminator)	250m	4	18 AWG	20 AWG
Mini/Heavy Backbone (Terminator to terminator)	250m	8	15 AWG	18 AWG

Actisense Starter Kits

Actisense can provide you with everything you need to get started with an NMEA 2000 network in a variety of flavours. Here's an outline of their contents. Each individual item will be discussed in more detail in future episodes, along with other items to complement your NMEA 2000 network.

The original Actisense starter Kit

- Power T-piece - Contains a twin pair of power cables for even power distribution across the NMEA 2000 network.
- 2x T-pieces - for extending the network from the power T-piece and connecting NMEA 2000 devices to the network.
- 2x termination resistors - To maintain signal integrity.
- 1x 2 metre cable - for extending the length of the backbone if needed or to connect an NMEA 2000 device to a T-piece. Fitted with overmoulded DeviceNet standard connectors to protect from water ingress.



RIB Starter Kit

- 1x 4-way T-piece - providing instrument drops for up to 3 devices (one port is used for power).
- 1x Micro power cord - can be plugged straight in to any available port on the 4-way T-piece to provide network power.
- 2x Termination resistors - To maintain signal integrity.
- Network can be extended by temporarily removing a termination resistor, plugging in additional T-pieces and replacing the termination resistor at the end of the backbone.



Small Boat Network

- Space for 4x instrument drops.
- Over moulded power cord attached.
- 2x Termination resistors built in.



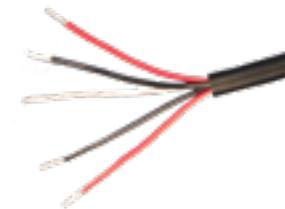
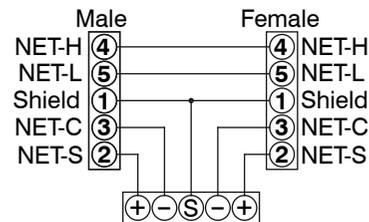
Powering and fusing the network

Power T-Piece

The Actisense power T-piece has a twin pair of power wires, one for each side of the T-piece. Both pairs must be connected to a 12/24 Volt power supply (via fuse panel) so that the electrical load can be distributed evenly.

When using 24V systems, a warning must be installed on the network to ensure anyone installing new devices is aware. This is because the NMEA 2000 specification doesn't officially support 24V but this level of power supply can be used if installed devices are capable of supporting it. All Actisense devices support 24V power supplies.

The illustration below details the internal wiring of the Actisense power T-piece. Note the pair of positive and negative pins on each side.



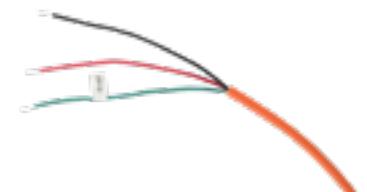
Micro Power Cable

This cable is designed for small installations that will be used with the RIB Starter Kit so it only has a single pair of power wires. The Micro Power Cable has a Micro DeviceNet connector so that it can be easily plugged in to the most suitable port on the 4-way T-piece provided.

The Micro Power Cable should never be used on larger installations.

Small Boat Network

The power cord for the Small Boat Network is over moulded to the case of a 4-way T-piece to prevent water ingress. Power is available to all 4 ports once the pair of bare wires is connected to a 12V or 24V power supply.

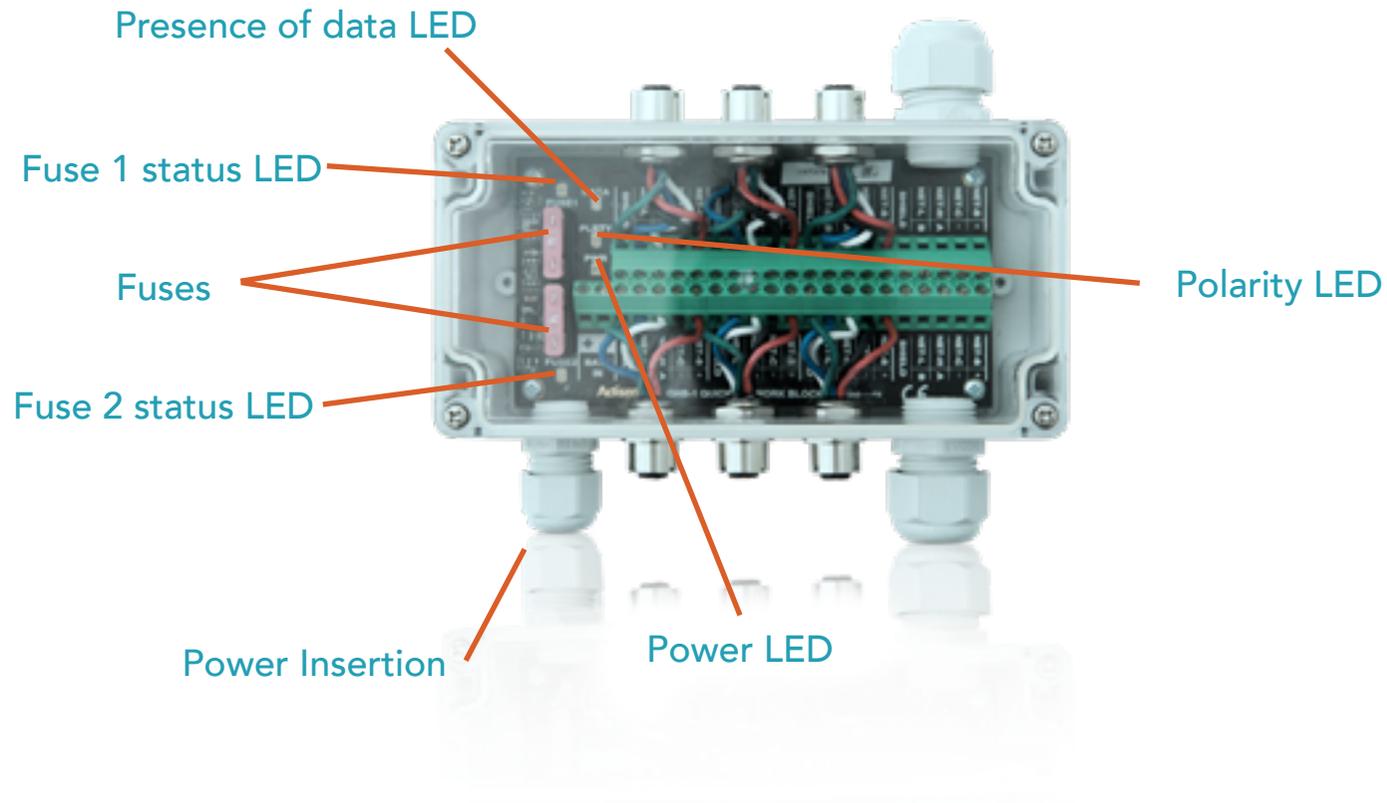




Quick Network Block

The Actisense Quick Network Block (QNB) provides a versatile and easy to install solution for any NMEA 2000, large or small. This section illustrates how the QNB can be used for providing power to your network and the added benefits of its features. Other benefits will be shown later in this document. (See ["The Quick Network Block"](#) on page 13)

Note: The QNB will not regulate the voltage that is being provided to the network.



T-Pieces and Termination Resistors

Micro T-Pieces

T-pieces can be connected directly to the Power T or you can use a length of NMEA 2000 approved cabling to extend the backbone and join the T-piece to the end of the cable. The instrument drop must be connected at right angles to the backbone so it is clear what is the backbone and what is an instrument drop.

Micro 4-Way T-Pieces

The photos on the right illustrate the different T-piece options available from Actisense. They are shown in actual size (if this PDF has been printed to A4 size) and demonstrate the space saving that the 4-way T-piece can provide.



Termination Resistors

At each end of the backbone a termination resistor must be installed. Each termination resistor is 120 Ohms and is connected in parallel across the data pair of wires when plugged in to NMEA 2000 approved cables and connectors. This provides a total of 60 Ohms resistance across the network and is essential to data integrity.

Connecting Devices and Extending the backbone

Trunk and Drop Cable

If the length of cable required between T-pieces/devices is known, pre-assembled cables can be used for extending the backbone or plugging in devices to the network. This option saves a lot of time not having to cut the cable and wire a connector to it yourself. Actisense NMEA 2000 approved cabling is available in the following sizes:

- 0.25m
- 0.5m
- 1m
- 2m
- 3m
- 4m
- 5m
- 6m (maximum length that can be used for an instrument drop as defined by the NMEA 2000 specification)
- 8m
- 10m



Bulk Cable

If customised lengths of cable are needed, or lengths of cable greater than 10 metres, bulk cable is available in 100 metre reels. This can be used together with Actisense field fit connectors.



Field Fit Connectors

Field Fit Connectors

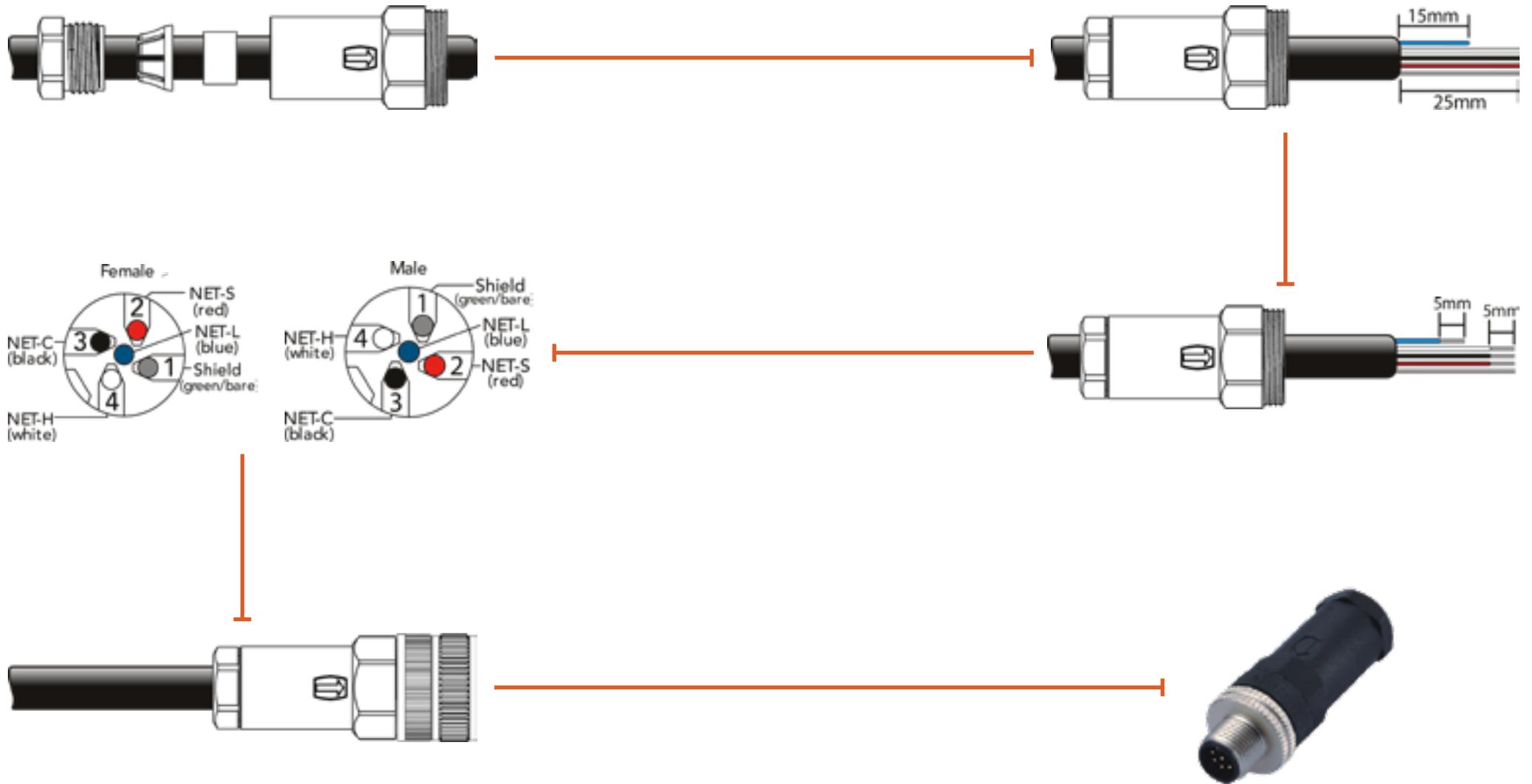
When bulk cable is used a connector will need to be wired to the ends so that the cable can be plugged in to the network or a device. Follow our five steps to field fit installation success on the next page that illustrates the best method for installing field fit connectors, including which colour wires connect to which pins. The NMEA 2000 wiring colour system is standardised so the colours and pin numbers will be the same for any wire and connector combination that uses the same DeviceNet standard.

Actisense field fit connectors are available as straight or right angled options and in male and female variants to suit any installation requirement.



Note the plastic sleeve that covers the centre pin. This is to prevent the bare wires that extrude from the other 4 pins making contact with the copper and creating a short. Not all field fit connectors have this plastic sleeve.

5 Steps to Field Fit Installation Success

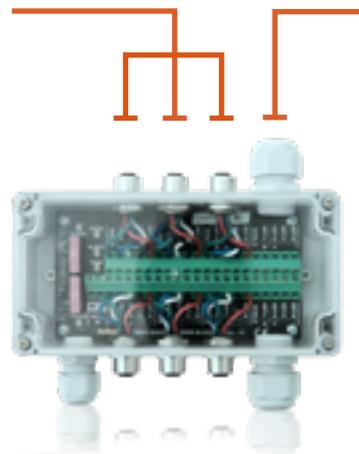


The Quick Network Block

At a Glance

The next page provides a more detailed overview of the Quick Network Block. Please refer to [“Powering and fusing the network”](#) on page 7 for full details of the power insertion features of the Quick Network Block.

Instrument drops



Backbone connections

Labels are the same for both sides and for both variants of QNB-1.

See the next page for more information on the different variants available.

Panel mounted wire connectors are available as a stand alone product for creating through bulkhead connections. They can also be used to replace the connectors in the QNB if needed.

Blanking plugs are also available to protect any unused panel mounted wire connectors from water splashes.



Wire Colour	Connects to
Red	NET-S
Black	NET-C
White	NET-H
Blue	NET-L
Bare/green	Shield



Detailed Overview

The Actisense Quick Network Block (QNB) provides a simple 'network in a box' solution. It can be used in areas of high instrument density when devices are up to 12 metres apart from each other (6 metre drop from device to QNB per device). Another popular use for the QNB is with engineers that have a need to create a small NMEA 2000 test environment on a workbench (for example).

Raymarine SeaTalkNG Solution

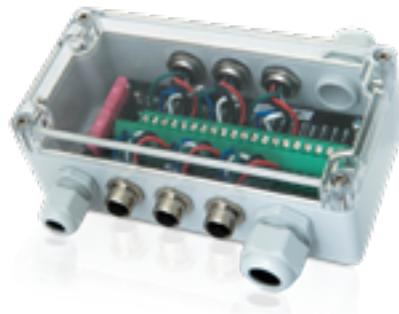
A less obvious benefit to the QNB is the ability to mix and match DeviceNet standard connectors with Raymarine SeaTalkNG (STNG) connectors. As STNG uses exactly the same data as NMEA 2000 but chooses not to use the DeviceNet standard for its connector system, adapter cables are needed to change the connector type when installing STNG devices on NMEA 2000 networks, or vice versa.

STNG cables can be stripped back and wired directly to the terminals inside either variant of the QNB-1, which means that you can mix and match STNG with DeviceNet. The wiring colours inside STNG cables are the same as DeviceNet cables.

Removing the connectors from the PMW variant is not advised as the QNB-1 will lose its watertight integrity. Instead, we recommend simply connecting an STNG backbone cable through one or both of the backbone glands to enable the mix & matching options described above.

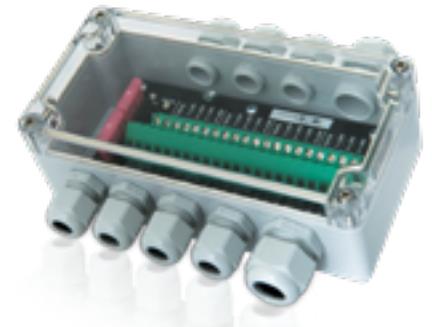
Panel Mounted Wire connector option (PMW)

The PMW option is the simplest to install as all the connectors are pre-wired and provide plug & play connectivity. The backbone should always be installed through the glands provided that are furthest from the power insertion point.



Glanded option

A glanded option of the QNB is available for more customised installations using Actisense bulk cable. A rubber, self-tightening seal inside each gland clamps around the cable when it is installed and the screw is tightened.



Network Diagnosis



No matter how robust a network is, how simple it is to install, or how well it has been documented and managed there will invariably be issues that need tackling at some point. This episode will help to identify some good places to start when diagnosing an NMEA 2000 network.

Adequate Power Supply & Termination Resistance

- Test voltage at entry point

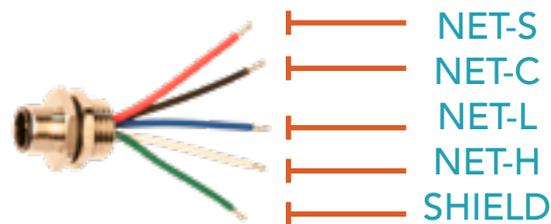
Ensuring the network is receiving a power supply is always the best place to start. As some devices may be powered by the network, knowing that these devices are working is a quick win for this test. The power at the entry point should not exceed 14V from a 12V supply.

- Test voltage at network extremities

With network devices using up some of the supplied power and impedance from cabling also dropping the voltage, it is important to know that the voltage at the end of each backbone leg is adequate. Temporarily remove a termination resistor from the end of the network and use a voltmeter to measure across the NET-S and NET-C pins. The measured value should be at least 9V. The diagrams below will help you find these pins when using Actisense connectors.



An Actisense Panel Mounted Wire (PMW) connector is a great tool for plugging in to a spare T-piece to quickly identify the correct pins via the wiring colours. It is recommended that each wire from the PMW is terminated inside a terminal block prior to plugging it in to the network as voltage may be present across the NET-S and NET-C pins.





- Check for the correct termination resistance

Turn off network power and check resistance across NET-H and NET-L terminals of any T-piece on the network. The measured resistance should read 60 Ohms.

If 120 Ohms is measured, only one termination resistor is installed. A second resistor will need to be installed at the opposite end of the network to the one that is already present.

If 40 Ohms is observed, there are 3 termination resistors installed on the network so 1 will need to be removed. If it's not obvious where the third resistor is, check for any devices on the network with installed termination resistors and ensure they are switched off.

Network devices with termination resistors installed do not achieve NMEA 2000 certification as this practice can cause confusion on the network.

Digging Deeper

If issues remain when the correct power and resistance have been proved on the network, further investigation will be required.

- Half split method

Disconnect one half of the backbone and move the termination resistor to the new, temporary end of the network. If the issue remains you have narrowed it down to the half of the network that is still powered and active. If the issue does not remain it is in the half of the network that has been disconnected. Keep performing this half split method until you are able to narrow it down to a single device, if possible. Don't forget to move the termination resistor each time to ensure the network is correctly terminated.

Once the issue has been narrowed down, try swapping out t-pieces or cabling with ones that are known to be good. If Field Fit Connectors have been used, check the wiring connections inside to ensure that they are correct and firmly secured in place.

If possible, check the wiring inside the device is properly and securely terminated, ensuring to observe anti-static precautions if exposing internal electronics. It is always best to check that this is ok with the device manufacturer before performing this step to ensure you do not void any warranty.

If an issue still remains you now know there is a problem with the device and it's time to contact the manufacturer of that device.



Checking availability and accuracy of data on the network

- Actisense NMEA 2000 to PC Gateway (NGT-1)

To be able to see all of the data on the NMEA 2000 network and analyse it, you will need to be able to send it to a PC. NMEA 2000 data can not be read by a PC without the use of a gateway, like the NGT-1.

There are two options of NGT-1 available:

USB option (NGT-1-USB):

This is the easiest to connect to a PC as it can be plugged straight in to your PC's USB port. The NGT-1 will be powered and active once the USB drivers have been successfully installed. Depending on your OS settings this should happen automatically if you have a working internet connection. If the USB drivers do not install automatically, the same USB drivers are available on the CD provided with the product or from the NGT-1 downloads page on the Actisense website.

ISO option (NGT-1-ISO)

The ISO option is for users that prefer a serial connection to their PC, instead of USB. It has bare wires on the PC side for connecting to a serial (RS232) port. The ISO option is powered by the NMEA 2000 network.

The default baud rate for both options of NGT-1 is 115200 which can be changed using NMEA Reader.

- NMEA Reader

NMEA Reader is software that lets you see all of the data being sent to your PC from the NMEA 2000 network via the NGT-1. There are also options for configuring Actisense devices. NMEA Reader is freely available to download from the Actisense website.

- Actisense Toolkit

Toolkit is new software from Actisense that is currently used for configuring the Engine Monitoring Unit (EMU-1) from Actisense. It will soon support configuration of all configurable Actisense products and will replace NMEA Reader when the 'Data View' feature has been added.

For more information on how to use the NGT-1, NMEA Reader or Toolkit, please refer to the manual at actisense.com