

First things first: What is NMEA2000 anyway?
NMEA2000 is often wrongly described as a "network for data transmission", which is probably mainly used in shipping industry. Experts would doubt this: this definition lags. The English-speaking area offers a different, much "warmer" definition: "NMEA2000 is a plug-and-play communication standard used for connecting marine sensors and display units within ships and boats."
They are talking about standards. Known in specialist jargon, experts would tend to call such standard as protocol.
However, back to the roots of NMEA2000 protocol: The Alma Mater of the NMEA2000 protocol underlies the SAE J1939. SAE shortly for Society of Automotive Engineers. SAE J1939 is a well-known and well-matured network protocol, describing the rules of communication between devices and sensors of vehicles. Nowadays there is hardly no vessel or vehicle to be found, which doesn't have the SAE J1939 variant implemented. After Robert Bosch GmbH added a time control function into the CAN-Bus protocol in the year 2000, the protocol got its high prevalence. From that angle, the NMEA 2000 protocol is a simple derivation of the open industrial SAE J1939 protocol. Terms like PGN, CAN bus, CAN-High, CAN-Low are therefore no inventions of the NMEA 2000 Association. The substantial roots of NMEA 2000 protocol interlinked deeply into SAE J1939 pedigree . The Robert Bosch GmbH published their CAN-protocol in 1980 already, that's nearly 40 years ago. SAE J1939 seems to be even older, therefore it appears safe to assume that the NMEA Association bet on an old player from the outset.

There is, however, a peculiarity in the NMEA2000 protocol worth to be mentioning. The NMEA 2000 devices don't have any hardcoded Node-addresses just like in the J1939, but they rather deal and trigger with among them automatically, which enables the ability of "plug-and-play".
So, what is NMEA2000 able to? You may integrate up to 50 devices into one physical NMEA2000 network. Devices and sensors can act as a transmitter and as a receiver. The transmission rates are hardcoded in all devices and allow 250 kbit/s over a theoretical distance of up to 200 meters. NMEA2000 devices are, as already mentioned, capable for "plug-and-play". Neither a configuration is needed, nor a central control unit required. Just plug and play, at least theoretically.

In order to operate an NMEA2000 protocol you need a physical layer, which is labeled as a Network in combination with OSI-Network Layer protocols.

This manual deals with the descriptions of NMEA2000 Network connectors and cables, but also with fundamental information for setting up a NMEA 2000 Network into your vessel.

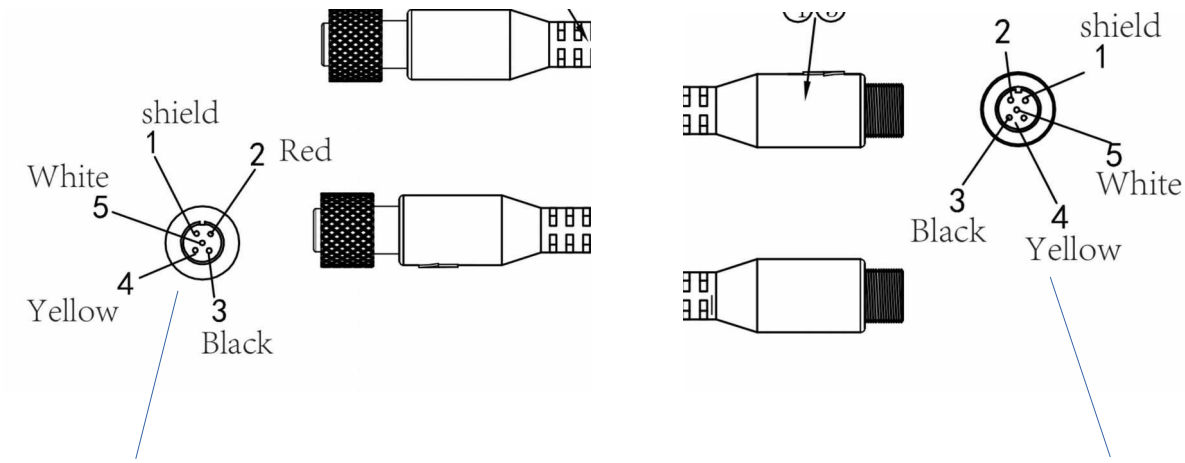
The technical design of the connectors and cables used in the implementation of device series of Simrad, Furuno, B&G, Lowrance etc. refers to the well-known DeviceNet standard, which is the state of the art in today's industry.

It makes no difference if there is a connection cable, a device connection cable or a T-piece, there is basically in use just the same M12, 5 pin component.

[Abb.1]

Despite all of them distinguish among each other in types of coloring, materials and quality, they are all compatible to each other in relation to the type of connection. In a nutshell: In NMEA2000 standard manufacturers may use their own designs, as long as they comply with given technical specifications.

This is the usual pin allocation in NMEA 2000 network components using the DeviceNet standard.
[Abb.2]



Female PIN	Funktion	Male PIN
1	Shield/Braid	1
2	Power 12VDC +	2
3	GND	3
4	CAN HIGH	4
5	CAN LOW	5

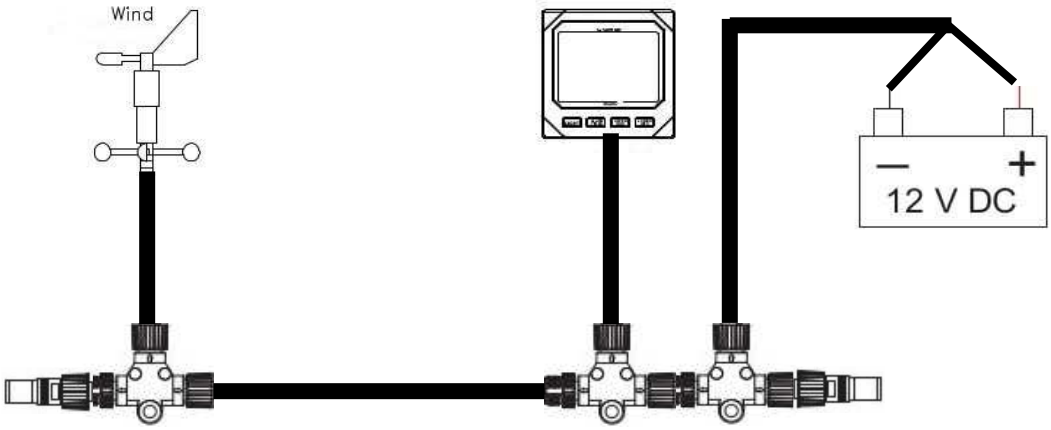
* Color designation is not mandatory for manufacturers and may vary

A few limited exceptions: Raymarine and its proprietary cable system for use in NMEA2000 networks. Products with SeaTalk-NG can also be used in NMEA2000 networks with DeviceNet system when applying an adapter connector and vice versa.

The structure of a NMEA2000 networks behooves simple rules. The main component of a NMEA2000 Network is a Backbone. This is where all devices are connected then. A Backbone may have a theoretical length of 200 meters and can carry theoretical up to 50 devices or sensors. It should be noted that each device and each conductor leads to voltage drop and we have to be careful on this point, more info further down. Each device should be connected with the Backbone using a T-piece or a multiconnector. Each Backbone should be terminated with some plug-in terminators at both ends, to assure optimal operation. The last component needed to finish the set up is a power resource which is also connected to the Backbone using a power cable.

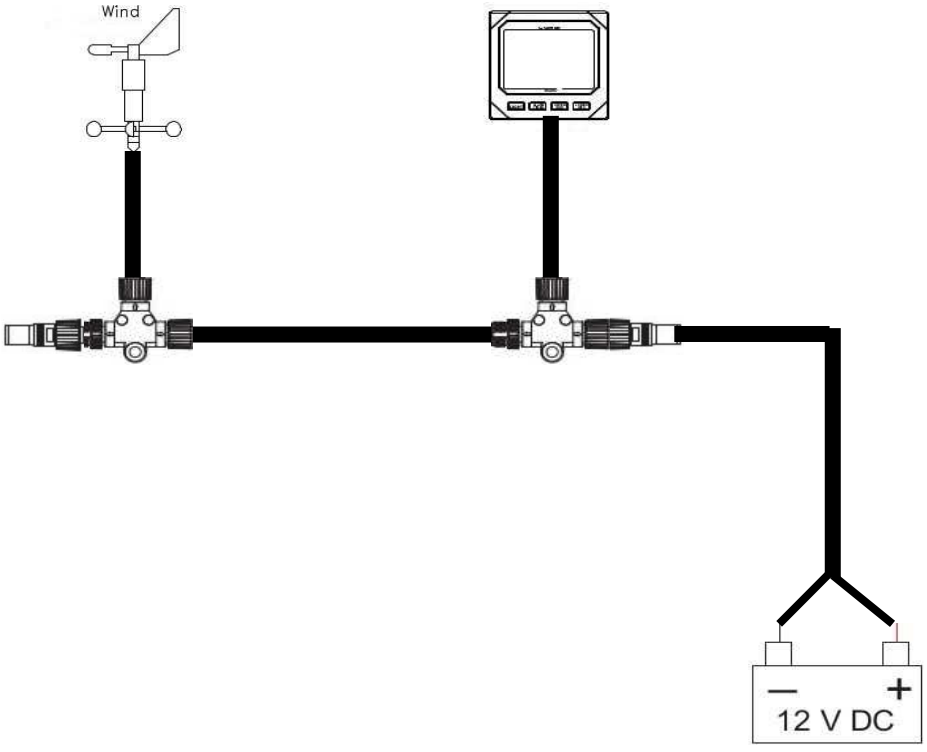
Important notice!
The power supply of the NMEA2000 bus should be used for supplying the sensors only, which are mostly embedded in closed shells and have no dedicated outputs for connections to the vehicles power system. Furthermore, a little current is needed to activate some small circuits of some “bigger" NMEA2000 capable devices. These circuits are responsible for data transmission and mostly have a galvanic isolation which separates them from the main power system. Some milliamps are needed to activate this circuits and these get the needed power via drop cable from NMEA2000 Backbone.
Please notify, that the NMEA2000 network serves as a data transmission line primarily and does NOT present a power system for the all another "big" devices. That’s why the NMEA2000 bus must be connected using the power cable including a small 4A to max. 5A safety fuse. Rem. 5A max.!
All other devices, i.e plotters, radar, VHF, autopilots require their own power supply from the main power source on board. You will find a manual enclosed to ach device in most cases. Please refer to them when setting up one of them.

An example of a minimal NMEA2000 network:



*the fuse is not marked here, but is mandatory

An example of an optimized minimal NMEA 2000 network:
A power cable including an integrated terminal resistor is used. Therefore, a third T-piece is obsolete, and you will gain extra space for your installations.



A Backbone, just like mentioned before, can reach up to 200 meters. It is not relevant how many T-pieces are used as long the voltage drop on the entire Backbone, from one end to another, does not exceed 3V. Please assure to switch on all connected devices and sensors when measuring any voltage. If the voltage drop exceeds 3V, some devices may not be provided with enough power. In this case it's advisable to divide your Backbone using the so-called power blockers into partial network segments to avoid any failures. Each segment must be provided with its own power cable and safety fuse then. The voltage drop must not exceed 3V in that segment either. Therefore, it is advisable to place the T-piece connected to the power cable right in the middle of the Backbone, if possible. The voltage drop will be halved, by assuming that the power cable is relatively short enough. Always consider the length of your power cable, drop cables and any power consumers used when you concern to determine any voltage drops. It is not advisable to rely only on calculations made using some equations. To many junction points, some unsufficient pin plating and bad soldering/screw joints could increase the gap between theoretical values with real values. We recommend using a simple multimeter and control any calculations value in real environment. When using drop cables, please notify that they must not reach more than 5 to 6 meters or the length of the backbone itself. Although the transmission rate of the backbone bus amounts 250 kbit/s, longer drop cables could compromise the signal transmission quality.

You may achieve a compact and space-saving installation by using a so-called multiporter.

This multiporter is not only a distributor with 5 ports, it is more a complete NMEA2000 network fitted with integrated switcheable terminal resistors, power connector and status indicators.
You can find out more about this product inside the dedicated manual you can find on www.technospark.de

As previously said, well-known companies like Simrad, Furuno, Lowrance, Raymarine etc. use NMEA2000 protocols for a long time now, long before about NMEA2000 marketing flushed the market.
Several manufacturers used different names, i.e Simnet with different connectors, but the NMEA2000 protocol was already ticking inside. That's why it is possible to connect even well-aged devices with out any further efforts using some hardware adapters. The construction principle is always the same: two signal carrying wires lead into the same in NMEA2000 network (CAN Low, and CAN High), another two wires are dedicated for power supply (often signed as "+", "-" or "12VDC+" , "GND").

In the following an example of how to connect an older Simrad AP25 autopilot to NMEA2000 Network: