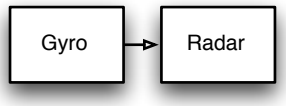
Introduction

The MiniPlex-2USB is an NMEA multiplexer that enables the connection of multiple NMEA 0183 instruments to each other and a computer. It is developed to solve a fundamental problem with the NMEA 0183 standard.

The NMEA 0183 standard defines a communication protocol that enables navigation instruments to exchange data with each other. A compass can send a bearing to a radar to enable a north-up display, a GPS can send cross-track information to an autopilot in order to steer a programmed course. The same GPS can also send information to the radar at the same time since the NMEA 0183 standard specifies that one device must be able to send data to up to four other devices. NMEA data is made up of short text messages with a strict format called sentences and are human-readable.

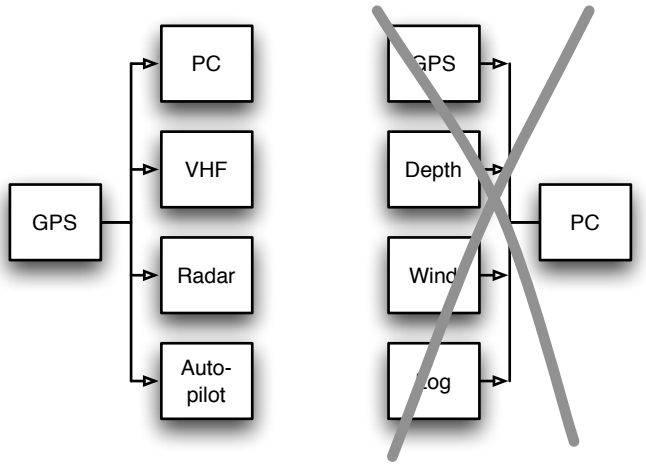
Talkers and Listeners

Communication using the NMEA 0183 protocol involves at least one device that sends NMEA sentences and another device that receives NMEA sentences. By convention, a sending device is called a talker while a receiving device is called a listener. The picture on the right shows such a minimal system: a gyrocompass sending heading sentences to a radar.



The NMEA 0183 standard specifies that a talker should have enough driving capability to talk to four listeners. This is as easy to achieve as telling a story to an audience of up to four people. The only requirement is to talk loud enough.

The picture left below shows such a situation.



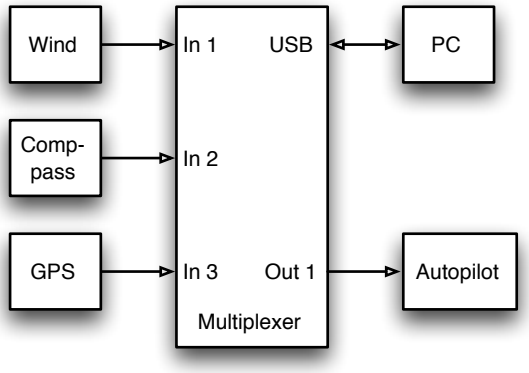
It gets complicated when several talkers must send data to one listener as shown in the picture on the right. Unless that listener has multiple inputs, this is not possible without help. Simply connecting talkers to one listener as shown is like four persons simultaneously telling you a different story. You can make neither head nor tail of it. In electronics terms: the outputs of the talkers will effectively short-circuit each other and the sentences they transmit will be corrupted. This is where a multiplexer offers the solution.

The Multiplexer

A multiplexer, sometimes called 'combiner', has multiple inputs, each acting as a single listener connected to a talker. It can also have several outputs that are able to talk to multiple listeners. A clever piece of software inside the multiplexer reads the NMEA sentences that are received on the listener ports simultaneously and stores them into queues. Another part of the software retrieves the sentences from the queues, one at a time, and sends them to the outputs of the multiplexer. This way, four incoming streams of sentences are combined into one single stream.

The picture below shows a typical setup with a multiplexer combining data from a wind instrument, a compass and a GPS. This data is forwarded to a PC and an autopilot using two different types of outputs: an NMEA talker port called 'Out1' a USB port. The multiplexer forwards the received NMEA sentences to the PC and the autopilot at the same time.

The USB connection to the PC is actually bi-directional: the PC acts as a listener and a talker at the same time. It receives NMEA sentences from the instruments to be processed by navigation software on the PC. This software can generate NMEA sentences to control an autopilot. These sentences are sent to the multiplexer and forwarded to the autopilot. They can be combined with the sentences received from the other navigation instruments.



The MiniPlex-2USB

The MiniPlex-2USB is a multiplexer with four NMEA inputs (listener-ports), two NMEA outputs (talker-ports) and one USB port to connect to a computer. The multiplexer combines NMEA data that is received on the listener ports **In1** to **In4** and sends this data to talker ports **Out1** and **Out2** and to the USB port. This USB port is also used to send data from a computer to the multiplexer to be forwarded to **Out1**, as well as to send commands to configure the multiplexer.

Every NMEA input on the MiniPlex is galvanically isolated, sometimes called opto-isolation because of the use of opto-couplers for isolation. An opto-coupler is a small device that transports information by means of light instead of electricity.

A galvanically isolated input prevents unwanted currents to flow between instruments and the multiplexer. These currents can damage equipment or interfere with radio signals and should therefore be avoided. Galvanically isolated inputs are required by the NMEA standard.

The USB port of the MiniPlex is also galvanically isolated, which isolates the computer from the navigation network and protects it against potential damage caused by ground loops or voltage spikes.

Both NMEA outputs can drive up to four listeners each. Flexible routing options allow you to specify which NMEA sentences are sent to these outputs.

Besides the basic functionality of combining NMEA data from multiple sources, the MiniPlex offers a range of features to manage NMEA data like Sentence Filtering and Routing, Input Priority with automatic switchover, testing of data integrity, Talker ID modification and SeaTalk® to NMEA translation.

The MiniPlex can seamlessly be integrated into an existing Raymarine SeaTalk network when SeaTalk mode is enabled. This mode changes one NMEA listener port into a SeaTalk input. When connected to a Raymarine SeaTalk network, the multiplexer will translate SeaTalk data into NMEA sentences and combine these with NMEA sentences that are received on the other listener ports. Only one SeaTalk input is needed since the SeaTalk bus is a single-cable system that connects all instruments together through one single cable. SeaTalk to NMEA translation in the MiniPlex works only one-way. No NMEA sentences are converted into SeaTalk, the multiplexer just listens on the SeaTalk bus.

Connections

NMEA Signals

Although the NMEA 0183 standard very clearly specifies the signal names, voltage levels and connection methods, the reality is far from this ideal world.

The most important property of an NMEA port is that the connections or wires are labelled 'A' and 'B' and that it uses a differential signalling scheme. This means that data is transmitted on both wires, but in 'opposite direction'. Both wires are driven between 5V and 0V and opposite of each other. This means when A is 5V, then B is 0V and vice versa. The advantage of this signalling scheme is that it is very insensitive to electrical interference. NMEA 'A' and 'B' are often labelled as NMEA '+' and '-' respectively. When connecting devices, simply connect NMEA 'A' to NMEA 'A' or NMEA '+' and NMEA 'B' to NMEA 'B' or NMEA '-'.

Things get complicated when manufacturers don't follow the NMEA 0183 standard, which is very often the case. Many devices have an NMEA port, which is really an RS-232 port. The only resemblance with the NMEA standard is the format of the data transmitted. Electrically, they are an entirely different world. The used signal names differ wildly and often lead to confusion. When a device has a listener port with connections 'Data In' and 'Data Return' it is not clear whether this input is galvanically isolated or 'Data Return' is simply another name for 'Signal ground'

As opposed to the NMEA standard, many devices use a single-ended signalling scheme where data is transmitted on one signal wire while a power/signal ground presents the return path for data. Single ended devices often have connections named as TX and Gnd (transmit and ground) on the talker port and RX and Gnd (receive and ground) on the listener port. Also used are Data Out, Data In and Signal Ground. Mix these with 'standard' NMEA connections and confusion is imminent!

In general it is safe to connect a single ended talker port to a differential listener port. Connecting a differential talker port to a single ended listener port however is less obvious. When NMEA 'B' of a talker port is connected to the signal ground of a listener port, the 'B' signal is effectively short-circuited to ground. A properly designed talker port can handle this abuse but it will result in fairly high currents in long cables, which in turn leads to severe interference on SSB radios and possibly on VHF radios too. In the worst case, the talker port will be destroyed.

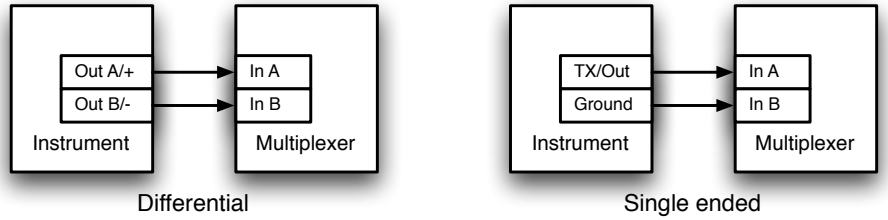
To overcome this problem, the MiniPlex multiplexers provide a Com terminal on each talker port in addition to the 'A' and 'B' terminals. This 'Com' terminal is similar to a signal ground. To connect a talker port of the MiniPlex to a differential NMEA listener port, use the 'A' and 'B' terminals. Use the 'A' and 'Com' terminals to connect to a single-ended or RS-232 listener port.

NMEA Listener Ports/Inputs

The multiplexer has four listener ports, **In 1** to **In 4**. Each listener port should be connected to one instrument only. These inputs are completely floating and galvanically isolated from the multiplexer, as specified in the NMEA 0183 standard.

Connect the **A** and **B** terminals of the listener port on the multiplexer to the **A** and **B** terminals of the talker port on the instrument. These terminals may also be labelled as **Data+** and **Data-**, **TX+** and **TX-** , **Out+** and **Out–** or **ve+** and **ve-**.

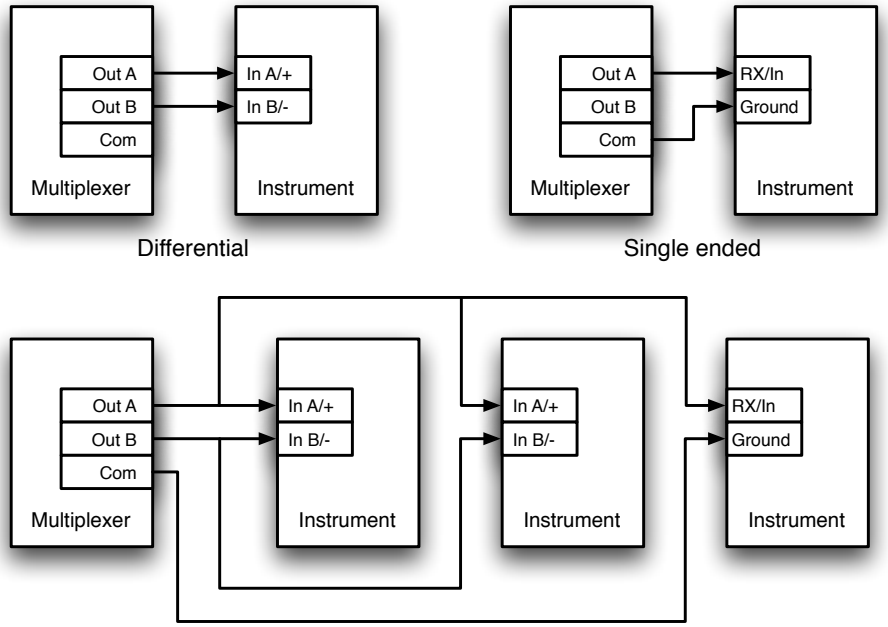
Some instruments have single ended talker ports, with only one data terminal. Connect this terminal to the **A** terminal on the multiplexer, and connect the ground of the instrument to the **B** terminal on the multiplexer. The instrument's data ground is often combined with its power supply ground.



NMEA Talker Ports/Outputs

Both talker ports can be connected to up to four instruments. Connect the **A** and **B** terminals of the talker port on the multiplexer to the **A** and **B** terminals of the listener port(s) on the instrument(s). These terminals may also be labelled as **Data+** and **Data-**, **RX+** and **RX-** , **Out+** and **Out–** or **ve+** and **ve-**.

Some instruments have single ended listener ports, with only one data terminal. Connect this terminal to the **A** terminal on the multiplexer, and leave the **B** terminal on the multiplexer unconnected. Connect the ground of the instrument to the **Com** terminal on the multiplexer. The instrument's data ground is often combined with its power supply ground.

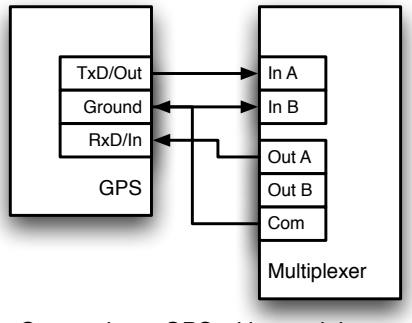


Multiple differential and
single ended listeners

The shield terminals on the multiplexer (**Shld**) can be connected to the screen/shield of the cable if available. This should always be done on one end of the cable only, preferably on the end that is connected to a talker port.

Combining Ports

It is sometimes necessary to combine a listener and talker port of the multiplexer to connect to an instrument. One of the most commonly used combinations is the connection of a GPS to the multiplexer. While some GPS receivers have properly designed NMEA ports, many only have an RS-232 port which is single ended with three terminals: TxD (data out), RxD (data in) and Ground. The picture below shows how to connect such a GPS to the multiplexer.



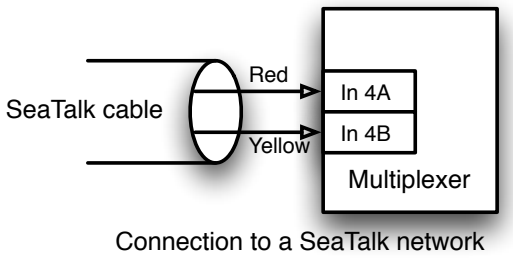
Connecting a GPS with a serial port
to the multiplexer

SeaTalk

SeaTalk® is a proprietary protocol developed by Raymarine®. This protocol is used for communication between Raymarine navigation instruments like the ST40, ST50 and ST60 series.

To be able to use these instruments with commonly available navigation programs or to feed their data into other non-Raymarine instruments, the SeaTalk data needs to be translated into NMEA. Even Raymarine's own navigation software, Raytech Navigator, needs this translation.

The MiniPlex can be directly connected to a SeaTalk network. It will translate all SeaTalk data required for navigation into NMEA sentences. Input **In 4** can be set to SeaTalk mode (**SeaTalk -> NMEA**) and should be connected as shown below:



Connection to a SeaTalk network

Note that the **red** and **yellow** wires are used! The screen of the SeaTalk cable is not connected to the multiplexer.

USB port

The USB port connects the multiplexer to a computer or a USB hub with the supplied cable. The supplied driver provides a virtual COM port to allow navigation software to communicate with the multiplexer. The USB port is bi-directional: the multiplexer sends NMEA data to the computer and the computer can also send NMEA data back to the multiplexer. This data can be routed to **NMEA Out 1** and **NMEA Out2**.

The USB port is galvanically isolated from the multiplexer to prevent ground loops and excessive currents that could otherwise destroy the multiplexer or the USB port of the connected computer.

The USB connection supports flow control, which is needed when waypoints and routes are sent from the computer to a GPS through the multiplexer. While normal NMEA sentences are sent at regular intervals, waypoints and routes are sent 'in one go' without any pause between these NMEA sentences. This fills up the queue in the multiplexer almost immediately after which the multiplexer discards the remaining waypoints and routes. The GPS now only receives a few waypoints and partial routes.

Flow control prevents this from happening. When the queue in the multiplexer is almost filled, the multiplexer signals the computer to stop sending data. When the queue is sufficiently emptied, the multiplexer signals the computer to continue. This requires a special setting in your navigation software, which is mostly called 'Flow Control'. This setting can mostly be found in the port settings of your software. Set the Flow Control to Hardware or CTS/RTS. This Hardware flow control is virtualized over the USB connection. Do not use Xon/Xoff flow controls since this uses special characters instead of a (virtual) signal. These characters are not part of the NMEA standard and therefore ignored by the multiplexer.

Power Supply

The multiplexer must be powered from an externally supplied DC voltage from 8 to 35V. The power supply connection is protected against reversed polarity.