NavLink 2 Wireless NMEA2000 Gateway

Developer's Guide

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Signature: ____ Date: ______________________

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1. Introduction

1.1 Purpose

This document provides a full Developer’s Guide to supporting the NavLink 2 wireless NMEA2000 Gateway in a Desktop type application or as part of an embedded hardware design.

1.2 Scope

The scope of this document is to give a developer all of the software protocol information they need to integrate and support the NavLink 2 Gateway in their applications or products.

1.3 Overview

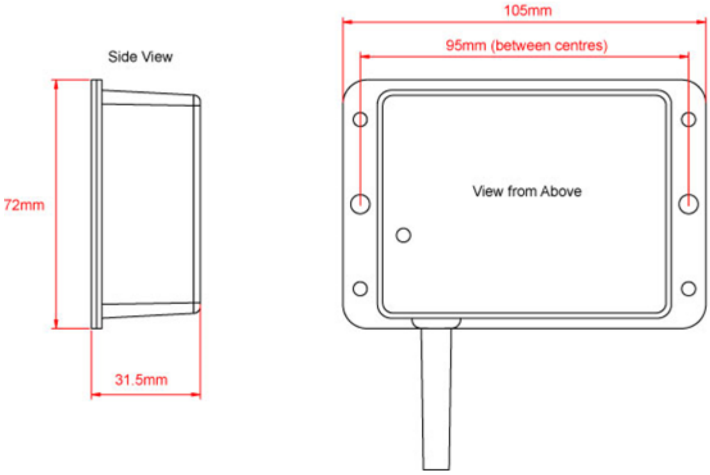
The NavLink 2 wireless NMEA2000 Gateway is designed to allow an Application Developer or Equipment Manufacturer to support bi-directional communication with an NMEA2000 network, through simple serial messages. Any individual or company that wishes to integrate NavLink 2 will need as a minimum the NMEA2000 Appendix A+B which is available from http://nmea.org for both NMEA members and non-members.

No special libraries are required to integrate NavLink 2.

2. General Information

2.1 Installation Information

The enclosure can be mounted using its two slotted 4mm wide fixing holes (see dimensions below). Use suitable screws/bolts (not supplied) to fix the converter to a flat surface or cable tie it to a cable loom or other solid object. Note - the unit may be installed in any orientation.

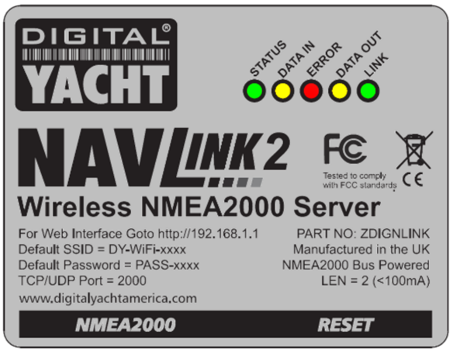


The NavLink 2 has an integral NMEA2000 drop cable, which is terminated with the standard NMEA 2000 Mini connector (male). Connection to a proprietary system like Raymarine’s SeaTalkNG or Simrad’s SimNet will require an adaptor cable – available from the respective manufacturer.

The NMEA2000 interface is fully isolated (power and data) and NavLink 2 takes its power from the NMEA2000 network (LEN=2).

2.2 LED Information

NavLink 2 has five indicator LEDs that show the status of the gateway.



When the unit powers up the "Status" LED will start flashing until either a wireless device connects to it (if in AP mode) or until it successfully joins another wireless network (if in STA mode).

If the gateway is initialised and on the NMEA2000 network, then the "Data In" LED will flash as N2K data is received, while the "Data Out" LED will flash as application data is received from a wireless device.

The Error LED will flash whenever error conditions occur such as; the application sends wrong commands to the gateway or if frame errors occur on the NMEA2000 networks. If you are regularly seeing the Error LED flash of stay on, please contact support@digitalyacht.co.uk

2.3 Changing Default Configuration

By default, NavLink 2 creates a wireless Access Point (hotspot) on-board your boat. The Name (SSID) of the Access Point will be "DY-WiFi-xxxx" where xxxx is the unique four digit code of your device.

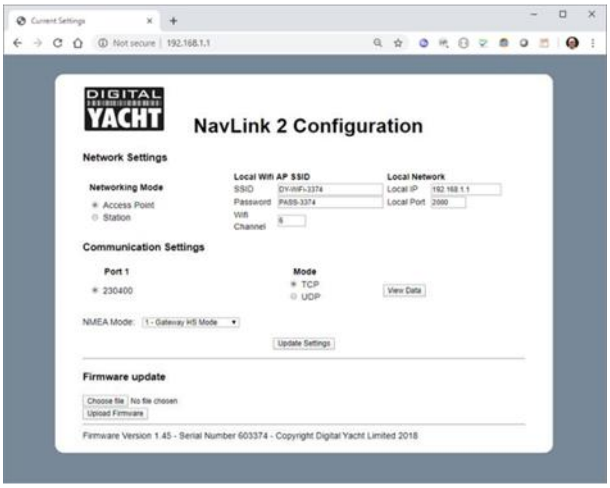
To connect to the NavLink2 you will need to scan for wireless networks, find and select it in the network list and then when prompted, enter the default WPA2 password, which is "PASS-xxxx", where xxxx is the same, unique four digit code that is in the hotspot name.

As soon as a wireless connection is established, the Status LED will stop flashing and stay permanently ON, whilst the wireless device is connected.

The NavLink2 has a built-in web interface that can be used to configure the unit and display the data that it is sending to apps. Any device, connected to NavLink2, can access its web interface by typing…

http://192.168.1.1 or http://dy-wifi.local

…in to its browser's address bar, which should bring up the web page shown below.



NavLink 2 Configuration

Network Settings

Networking Mode
● Access Point
○ Station

Local Wifi AP SSID
SSID: DY-WiFi-3374
Password: PASS-3374
Wifi Channel: 6

Local Network
Local IP: 192.168.1.1
Local Port: 2000

Communication Settings

Port 1
● 230400

Mode
● TCP
○ UDP

NMEA Mode: 1 - Gateway HS Mode

Firmware update

No file chosen

Firmware Version 1.45 - Serial Number 603374 - Copyright Digital Yacht Limited 2018

By default, NavLink 2 is operating in the Mode 1 "High Speed Gateway", where it converts NMEA 2000 data in to NMEA 0183 data. For apps that only support wireless NMEA 0183 data, then no changes are required and NavLink 2 should work perfectly with your app in TCP or UDP mode.

For developers that want to start or already support reading NMEA 2000 data, then you need to set the NavLink 2 to be in Mode 15 “RAW data mode”. Select this mode from the drop down menu and click “Update Settings”. NavLink 2 will now reboot and when it boots back up, will be in our “RAW” NMEA 2000 mode.

NavLink 2 retains its mode in non-volatile memory, so it should not be necessary to ever change mode again.

3. Operation

The following description of operation, is only applicable when the gateway is in “RAW data” mode.

3.1 Power Up

When the gateway powers up for the first time, or after a factory reset, it will send out a Boot Loader text string….

$PDGY,TEXT,Digital_Yacht_NavLink 2_v2.22_#AB-181018-12345_Mode:15 CR LF

Which identifies the model, firmware version, serial number and mode.

Then it will wait for the application to configure and initialise it. At this stage even though the gateway is physically connected to the NMEA2000 network, it is “Off Bus” (inactive) and no NMEA2000 communication is taking place.

To tell the application that it is powered up but “Off Bus”, the gateway outputs an “I’m Alive” message every second, which is the Network Status Message (see 4.3) but with null data values…

$PDGY,000000,,,,,, CR LF

By default just the mandatory TX and RX PGNs are enabled and the first task for the application is to send the required TX and RX PGN lists to the gateway (see 4.5 and 4.6), which will store them in Non-Volatile memory.

The TX and RX PGN lists are retained by the gateway after a power cycle, so it is not necessary for the application to set these every time it is run.

Before any NMEA2000 communication can take place, the gateway must be initialised, which causes it to go “On Bus” i.e. negotiate a CAN Address.

The gateway is designed to operate as autonomously from the application as possible and once initialised it will handle all the normal NMEA2000 network management tasks automatically. Negotiating a CAN Address, maintaining a list of active devices on the network, responding to requests from other devices, etc. are all handled with no input from the application.

3.2 Normal Operation

Once the TX and RX PGN lists are configured, the application must initialise the gateway by sending it the Initialisation Sentence (see 4.7). This causes the gateway to go “On Bus” and the N2K LED will now illuminate and flash as data is received.

All PGNs received that are in the gateway’s currently configured RX PGN list will be passed through to the application using the RX PGN Sentence (see 4.1). The PGN number, priority, source and destination Addresses, time stamp and the PGN payload (encoded in base64) are all included in the sentence, so that the application has full visibility of what the data is, where it has come from, it’s priority and relative timing.

Every second, the gateway will also send a Network Status Sentence that provides the application with additional information about the status of the NMEA2000 network (see 4.3).

If the application wishes to transmit a PGN on to the network, it must send a TX PGN sentence (see 4.2) to the gateway. The gateway will check that the requested PGN to be transmitted is in its TX PGN List, and if it is, it will place the PGN in its transmit queue and send at the first opportunity. If the PGN is not in the TX PGN list or the gateway is unable to complete this transmission it will send a NACK sentence back to the application with the reason for non-transmission (see 4.9).

3.3 Application Closes or Restarts

If the application closes for any reason and communication with the NavLink 2 gateway is lost, the gateway will continue to stay in whatever state it was in before i.e. “On Bus” or Off Bus”.

If it is “On Bus” then it continues to send out the Heartbeat PGN 126993 and responds to any network management PGNs.

When the application runs again and opens the virtual serial port connection to the NavLink 2 gateway, it will immediately start to receive the Network Status Sentence from the gateway, with null data if “Off Bus” or with the status of the NMEA2000 network if “On Bus”. Also, if the gateway is “On Bus” it will immediately start to send the application RX PGN Sentences, without the application having to re-initialise it.

4. NavLink 2 Serial Data Protocol

The gateway will be connected wirelessly to a mobile device and in order for NavLink 2 to communicate with an application running on that wireless device, a number of Proprietary NMEA0183 sentences have been defined.

Sentences that only contain ASCII characters start with a **$** symbol and sentences that include the binary PGN data start with a **!** symbol.

All PGN numbers are in decimal format and to reduce serial data bandwidth, all binary PGN data is encoded in base64.

4.1 RX PGN Sentence

For each RX PGN received from the NMEA2000 network, the gateway will generate a mixed ASCII and Base64 (PGN payload) sentence in the following format…

!PDGY,<pgn#>,p,src,dst,timer,<pgn_data> CR LF

Key

<pgn#>	=	NMEA2000 PGN number between 0 and 999999
p	=	Priority 0-7 with 0 being highest and 7 lowest
src	=	Source Address of the device sending the PGN between 0-251
dst	=	Destination Address of the device receiving the PGN between 0-255 (255 = global)
timer	=	internal timer of the gateway in milliseconds 0-999999
<pgn_data>	=	The binary payload of the PGN encoded in Base64

4.2 TX PGN Sentence

For each TX PGN the application wishes to send on the NMEA2000 network, the app will send a mixed ASCII and Base64 (PGN payload) sentence in the following format…

!PDGY,<pgn#>,dst,<pgn_data> CR LF

Key

<pgn#>	=	NMEA2000 PGN number between 0 and 999999
dst	=	Destination Address of the device sending the PGN between 0-255
<pgn_data>	=	The binary payload of the PGN encoded in Base64

If for any reason the requested PGN was not transmitted a NAK would be sent to the app with the reason for the TX PGN request being rejected. Typical examples would be if the TX PGN was not in the TX List or if the application tries to send a PGN at an update rate faster than the rate recommended in the NMEA2000 specification.

Any rejected TX PGNs, will increment the NavLink 2's PGN rejection count by one. It is recommended that during app development, developers check the Network Status Message (see section 4.3) and ensure that their app is not creating any rejected PGNs

4.3 Network Status Sentence

To provide the application with useful data about the NMEA2000 network, the gateway generates the following ASCII sentence (at 1Hz)….

$PDGY,000000,29,12,7,12345678,12,31 CR LF

```
             ^  ^  ^   ^      ^  ^
             1  2  3   4      5  6
```

Key

Field 1	=	Bus Load between 0-99%
Field 2	=	Frame Errors (not currently supported)
Field 3	=	Number of Devices Live on network
Field 4	=	Network Uptime in seconds
Field 5	=	Gateway's CAN address
Field 6	=	Number of Rejected TX PGN Requests

NOTE - A PGN number 000000 is used to identify this special network status data, which under normal circumstances would never be seen on an NMEA2000 network

The number of devices on the network is useful to monitor for changes in the network status, although all applications would benefit from maintaining their own NMEA2000 Device List. A change in the number of devices can be the trigger for your application to query the devices on the network.

You will need the Gateway's CAN Address so that your application can know which addressed PGNs are being sent to it and ignore addressed PGNs with a different destination address.

"Rejected TX PGN Requests" counter increments by 1 each time the application tries to transmit a PGN at a rate faster than the default/recommended update rate as defined by the NMEA2000 Appendix B. For instance, if the application tries to send compass heading at 12Hz the count will increase by two every second as the default/recommended update rate is 10Hz.

The Network Status Sentence is output at 1Hz and the gateway always outputs this Status message even when not on the bus. In this "Off Bus" situation the gateway outputs the sentence below, as an "I'm Alive" type message so the application knows the gateway is powered up but not initialised…

$PDGY,000000,,,,,, CR LF

4.4 Factory Reset Sentence

To reset the gateway to factory defaults, the app will send an ASCII sentence in the following format…

$PDGY,N2NET_RESET CR LF

A successful factory reset clears all settings, configurations and the TX/RX Lists and generates an ACK sentence back to the app.

4.5 Set RX PGN List Sentence

To set the RX PGN List that the gateway will store and use, the app will send an ASCII sentence in the following format…

$PDGY,RX_LIST, PGN1,PGN2,PGN3,PGN4…….PGNn CR LF

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app.

4.6 Set TX PGN List Sentence

To set the TX PGN List that the gateway will store and use, the app will send an ASCII sentence in the following format…

$PDGY,TX_LIST,PGN1,PGN2,PGN3,PGN4…….PGNn CR LF

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app.

4.7 Show TX and RX Lists

To get the latest TX and RX lists being used by NavLink 2, the app will send an ASCII sentence in the following format…

$PDGY,SHOW_LISTS CR LF

The gateway responds by sending a list of the RX and TX PGNs in this format in ascending order…

$PDGY,ShowRXTable,PGN1,PGN2 and $PDGY,ShowTXTable,PGN1,PGN2

4.8 Initialisation Sentence

To Initialise the gateway (must be done before gateway goes on bus), the app will send an ASCII sentence in the following format…

$PDGY,N2NET_INIT,<mode> CR LF

Initialises the gateway and enables it to go on to the NMEA2000 network. Any setup/configuration of the Gateway, including TX and RX PGN lists must be done before the initialisation sentence is sent.

If the gateway's TX/RX PGN list is blank (default) just the mandatory TX and RX PGNs are enabled but if the TX/RX lists have PGNs in them, the gateway will use these lists when queried by another network device.

The <mode> field is used to tell the gateway to go in to a particular operating mode. Currently only two modes are defined "NORMAL" and "ALL".

4.9 Offline Sentence

To make the gateway go "Off Bus" so that the application can change its settings, the app will send an ASCII sentence in the following format…

$PDGY,N2NET_OFFLINE CR LF

On receiving this command the NavLink 2 goes "Off Bus" and reboots.

4.10 Gateway Setup Sentence (Not currently Implemented)

To setup the gateway with any required configuration settings, the app will send an ASCII sentence in the following format…

$PDGY,N2NET_SETUP,instance,address,baud,checksum, tbd,tbd CR LF

Key

Instance	=	Integer 0-9
Address	=	Integer 001-255
Baud	=	Integer 4800-230400
Checksum	=	A = enabled V = disabled and default = disabled

4.11 Command Mode Sentence

When there is a lot of NMEA 2000 streaming through, it is sometimes desirable to stop this so you can see the commands being sent and the ACKs or NAKs.

NavLink 2 has a special “Command” mode where the display of received NMEA 2000 PGNs is stopped and you just see the commands sent and received by the app. To enter command mode, send an ASCII sentence in the following format…

$PDGY,CMD CR LF

And then to exit command mode, send an ASCII sentence in the following format…

$PDGY,EXIT CR LF

4.12 TX Limit On/Off Command Sentence

In some situations, it is necessary to send particular PGNs at a faster rate that the NMEA 2000 specification recommends, such as when you have multiple instances and each instance needs to transmit the same PGN at the recommended update rate. To allow for this situation you can set the NavLink 2’s TX Limit restriction to OFF, by sending an ASCII sentence in the following format…

$PDGY,TX_LIMIT,OFF CR LF

And then to turn the TX Limit ON again, send an ASCII sentence in the following format…

$PDGY,TX_LIMIT,ON CR LF

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app.

4.13 NMEA Mode Command Sentence

The NavLink 2 gateway supports a number of different NMEA operating modes. These can be configured by the internal DIP switches or by sending a serial command.

This NMEA Mode serial command is only actioned if the DIP switches are in the 0000 (all off) position. To set the NavLink 2’s NMEA Mode, send an ASCII sentence in the following format…

$PDGY, N2NET_MODE,n CR LF

Where n = 0 to 15 depending on the required mode – see NavLink 2 manual for details of the supported modes.

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app or if a mode was selected that is no currently supported, NavLink 2 will generate a NAK message.

4.14 Get NMEA Names Command Sentence (Not currently Implemented)

To make it easier for an application to maintain an NMEA 2000 device list, the NavLink 2 gateway automatically maintains a device list with the CAN Address and NMEA Name of every device on the network. To get this list from the NavLink 2 Gateway, the app needs to send an ASCII sentence in the following format…

$PDGY,GET_N2NET_NAME CR LF

If received and actioned correctly, NavLink 2 will generate a series of sentences (one for each device) in the following format…

$PDGY,N2NET_NAME,ADDR,NAME

The first sentence that is transmitted is the NavLink 2's own Address and Name, followed by the rest of the devices in ascending Address order.

4.15 BLACKLIST Command Sentences

The NavLink 2 gateway normally passes through all data from any device on the network, but in some situations, such as when there are duplicate data sources or a device is outputting wrong data or data not available value it is desirable to "Blacklist" a device.

You can blacklist up to a maximum of 10 different devices and up to 3 different PGNs for each device. You can blacklist specific PGNs or all PGNs from that device, by sending NavLink 2 an ASCII sentence in the following format…

$PDGY,BLACKLIST,address,PGN1,PGN2,PGN3 CR LF

Where the address = 0 to 251 and the PGN1, PGN2, PGN3, etc, is the PGN number in decimal format of the PGN you do not want NavLink 2 to pass through. If you want to blacklist all of the PGNs from a device you send the following command…

$PDGY,BLACKLIST,address,1 CR LF

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app or if the maximum number of Blacklists has been reached or the address is outside the range 0 to 251, NavLink 2 will generate a NAK message.

If you wish to clear all of the Blacklist rules in the NavLink 2 memory, send this command…

$PDGY,RESET_BLACKLIST CR LF

If received and actioned correctly, NavLink 2 will generate an ACK message back to the app.

4.16 ACK Sentence

To tell the application that the last received sentence was successfully actioned, the N2Net gateway will send an ASCII sentence in the following format…

$PDGY,ACK,message CR LF

Where “message” is the command that was successfully actioned. Below is a list of currently generated ACK messages;

```
$PDGY,ACK,N2NET_RESET
$PDGY,ACK,RX_LIST
$PDGY,ACK,TX_LIST
$PDGY,ACK,N2NET_INIT,ALL
$PDGY,ACK,N2NET_INIT,NORMAL
$PDGY,ACK,PROD_CONFIG_SAVED
$PDGY,ACK,TX_LIMIT,ON             (or OFF)
$PDGY,ACK,N2NET_MODE
$PDGY,ACK,BLACKLIST_ITEM_SAVED
$PDGY,ACK,RESET_BLACKLIST
```

4.17 NAK Sentence

To tell the application that the last received sentence was not actioned, the N2Net gateway will send an ASCII sentence in the following format…

$PDGY,NAK,error_text CR LF

The NAK sentence includes the associated Error Text that the application will display i.e. “Error - PGN not in TX List”. The currently generated NAK messages are;

```
$PDGY,NAK,ALREADY_INITIALISED
$PDGY,NAK,PGN_NOT_IN_TX_LIST
$PDGY,NAK,NOT_INITIALISED_YET
$PDGY,NAK,SERIAL_NUMBER_NOT_PROGRAMMED
$PDGY,NAK,SERIAL_NUMBER_IS_INCORRECT
$PDGY,NAK,TX_RATE_TOO_HIGH
$PDGY,NAK,FRAME_SIZE_ERROR
$PDGY,NAK,PACKET_SIZE_ERROR
$PDGY,NAK,UNKNOWN_PGN
$PDGY,NAK,WRONG_MODE
$PDGY,NAK,BLACKLIST_IS_FULL
$PDGY,NAK,ADDRESS_BETWEEN_0_AND_251
```

The serial number NAK messages are only generated in response to special commands used during production and should never be seen in normal operation.