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# USER MANUAL R500Ni

## INTELLIGENT AIS RECEIVER WITH WiFi

*SKU: 001-1047*

R500Ni-MA-v06r03  
2019-11-06  
ENGLISH



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## 1 R500NI INTELLIGENT AIS RECEIVER WITH WIFI



## 2 DOCUMENT

### 2.1 About This Manual

This Manual provides installation, operating Instructions and fault-finding procedures for the equipment to which it relates.

This manual may also be made available in electronic Portable Document Format (PDF). In PDF format, the following categories are all enabled as active hyperlink references: (1) The titles of each section; (2) document cross-references; (3) the table of contents.

This document may therefore be navigated quickly and effectively by using a mouse or other pointing device to activate each of these hyperlinks. This is a printer friendly document, designed to be printed 2-sided as a booklet with A5 pages on A4 stock paper.

Document name:	Date:	Details:	Author:
SLR350Ni-MA-v05r04	2017-12-19	First Released	JS, AA
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COMAR SYSTEMS  
Vittlefields Technology Centre  
Forest Road  
NEWPORT  
Isle of Wight  
PO30 4LY  
UNITED KINGDOM

tel: +44 (0)1983 828900




email: [sales@comarsystems.com](mailto:sales@comarsystems.com)

web: [www.comarsystems.com](http://www.comarsystems.com)

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## 4 GENERAL NOTICES

-  SAFETY: Make sure the power supply is switched off before you make any electrical connections to the unit.
-  INSTALLATION: This equipment must be installed in accordance with the instructions provided in this manual. Failure to do so could result in poor performance, personal injury and/or damage to your vessel and/or connected equipment.
-  CABLES: The supplied cables should only be cut, shortened or lengthened by an appropriate supplier.

In accordance with a policy of continual development and product improvement, hardware and software may be upgraded from time to time, and future versions of equipment may therefore not correspond exactly with this manual.

When necessary, upgrades to the product will be accompanied by updates or addenda to this manual. Information contained in this manual is liable to change without notice.

Comar Systems Ltd. disclaims any liability for consequences arising from omissions or inaccuracies in this manual and any other documentation provided with this product.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

# R500Ni

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## 5 INTRODUCTION

The R500Ni from Comar Systems is a compact, dual channel synthesized VHF AIS Receiver equipped with Ethernet, WiFi and USB Interfaces for land-based, shore side monitoring. It is designed to receive and decode all AIS transmissions from vessels fitted with Class 'A' or 'B' AIS transceivers, Aids to Navigation, and SART.

The R500Ni is based on the popular *Raspberry Pi™*<sup>3</sup> mini-computer and is optimised for coastal monitoring of AIS equipped marine traffic. The R500Ni is primarily intended for developers to implement within their own AIS monitoring networks. With compatible plotting software - for example, OpenCPN<sup>2</sup> - AIS data can be received from vessels within range of the antenna and displayed on a monitor in a visual representation.

Before operating the unit you should familiarise yourself with this user manual

The R500Ni is intended to be developed continually, therefore this manual should be considered as a guide

### 5.1 Parts List

On delivery, carefully inspect the contents of the packing case. Note any damage or any missing items. Ensure that the correct parts are included for your application.

Item:	Description:	No. included:	COMAR SKU Number:
1	R500Ni AIS Receiver - Unit	1	001-1047
2	Universal Power Supply	1	004-7128

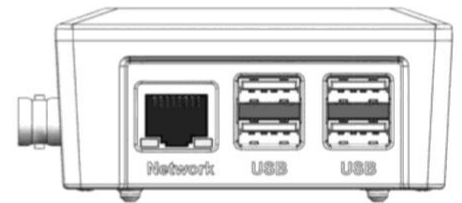
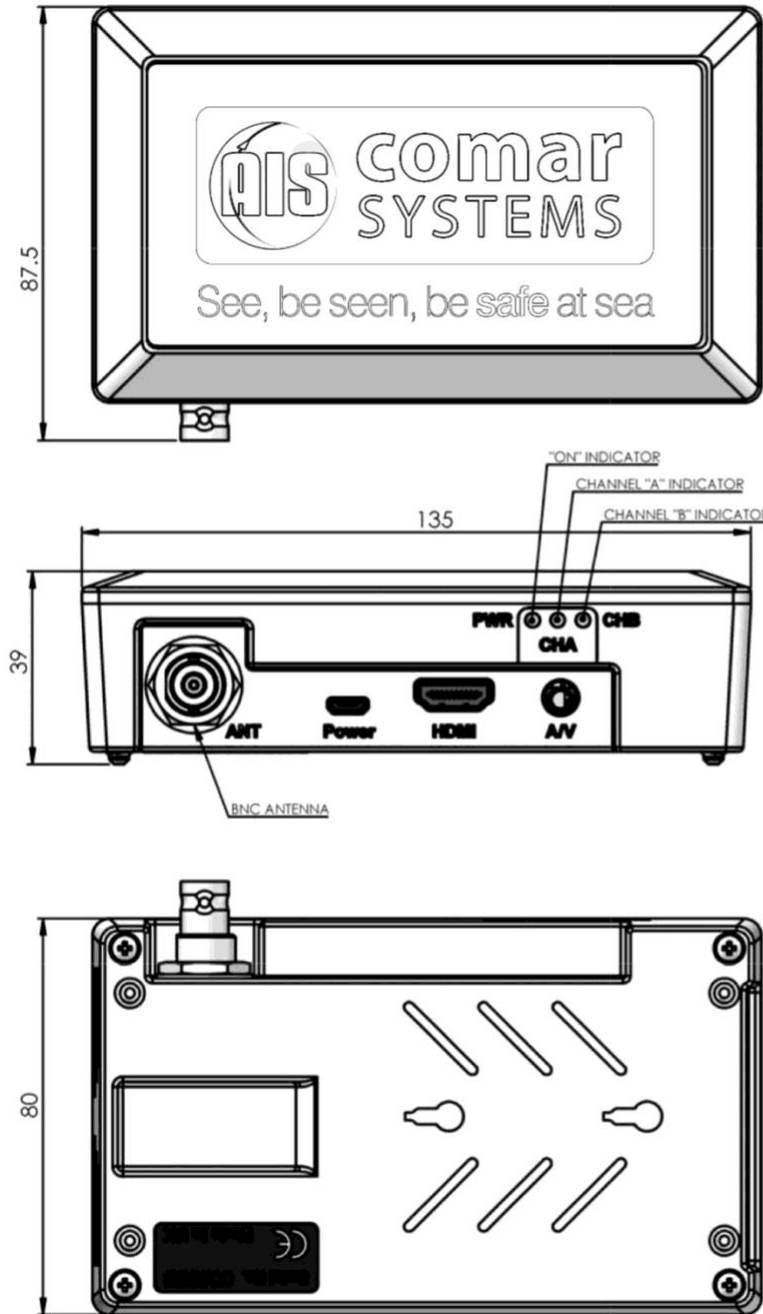
<sup>1</sup> For the latest information on Raspberry Pi™ computers and operating systems please refer to [raspberrypi.org](http://raspberrypi.org)

<sup>2</sup> OpenCPN: Open source Chart Plotter Navigation software. For the latest information on OpenCPN software please refer to [opencpn.org](http://opencpn.org)



## 6 MAJOR DIMENSIONS

All dimensions mm:



# R500Ni

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## 7 INSTALLATION

### 7.1 Mounting

Before starting installation select a suitable location. The R500Ni from COMAR SYSTEMS is intended to be used indoors as part of a land-based installation. It should be installed in a cool, dry place away from excessive vibration and shocks and can be mounted to a suitable bulkhead or shelf.

### 7.2 Power Supply

Fit the universal power supply<sup>3</sup> with the correct adaptor for your local power. Connect the Antenna & Ethernet cables first. Lastly, connect the power cable by plugging the micro-USB power jack into the micro-USB socket on the side of the R500Ni, see section 6 *MAJOR DIMENSIONS*. Provided that the unit is configured correctly, the receiver will immediately begin the boot process. Refer to section 8 *CONFIGURATION*.

### 7.3 Antenna Installation

A VHF antenna for receiving AIS signals is not included in this package. The minimum requirements of an antenna suitable for AIS are:

- Marine VHF band reception (for maximum performance, centred at 162 MHz)
- Having a gain of 3 dB or more
- Omnidirectional

Shore based reception is governed by local terrain, however an open view to the sea with an antenna mounted in the clear, at a height of approximately 20 metres will achieve a reception range of 25 nautical miles or more. A higher gain antenna can be used on shore to further increase the coverage. COMAR SYSTEMS has a range of antennas available; we recommend the AV200 unit with ground plane for use with the R500Ni.

**TIP: The higher the antenna is located, the greater the range.**

Mount the antenna with a relatively clear view of the horizon. Large obstructions that might shade the antenna should be avoided. Try to maintain a short RF cable run, preferably 10 m or less for the RG-58 cable type or 20 m for the RG-213 type.

Normally an omni-directional antenna is recommended; however a directional antenna such as a 3 element Yagi can be used to greatly increase performance in one particular direction.

In order to protect the antenna installation from the elements and avoid water ingress, please apply waterproof sealant to both the RF connector and at the point where the sub-assemblies connect to the main body.

<sup>3</sup> In the unlikely event of power supply failure it is possible to use any micro-USB plug pack capable of delivering 1.2 A of power, e.g. a phone or a tablet charger.

## 8 CONFIGURATION

This manual is intended to instruct in the installation of open source software on the Comar R500Ni. Third party proprietary networked implementations of the R500Ni are outside the scope of this manual. The micro computer embedded in the R500Ni is a *Raspberry Pi 3™* unit.

### 8.1 Installing Open Source Software

The R500Ni is shipped without software and can be installed with any operating system that works on the Raspberry Pi 3™ micro computer. Full information and additional details can be found on the Raspberry Foundation website: <https://www.raspberrypi.org/>

The R500Ni can run a number of operating systems and these are listed and explained on the official Raspberry Foundation website. Comar Systems recommend using *Raspbian*, the official operating system (OS) for the Raspberry Pi, which is a Linux based OS. The following information is based on the assumption that you will be using Raspbian. It is an open source operating system and can be freely downloadable from the internet.

The examples in this section are based on the Raspbian OS. This section describes examples of how to download and install software to receive data from the R500Ni in two stages:

1. To be able to view the data as a NMEA feed
2. To install OpenCPN charting software to view the position of vessels in a charting application

OpenCPN is an open source application. Refer to the OpenCPN website: [opencpn.org](http://opencpn.org)

### 8.2 Requirements

You will need the following:

1. The Comar R500Ni and power supply
2. A MicroSD data storage card. Comar recommends a high quality branded card of at least 8 GB capacity
3. USB Mouse and keyboard or USB Bluetooth
4. A monitor with an HDMI4 connection
5. A connection to the internet, either using Wi-Fi or ethernet via the RJ45 port. Comar always recommends using a direct cable connection via the RJ45 port while installing the system software
6. A VHF antenna to connect to the BNC connection of the R500Ni. Comar recommends the AV200 antenna for receiving AIS data transmitted from marine traffic
7. A computer (PC or Mac) connected to the internet

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## 8.3 Installing the Raspbian OS

Raspbian is the official Operating System for the Raspberry Pi Foundation. You have two options to install Raspbian on an SD card:

1. The New Out Of Box Software (NOOBS) option
2. Installing an SD image directly

We recommend the NOOBS option.

- To install the Raspbian OS, follow this easy guide for both options:  
<https://www.raspberrypi.org/learning/software-guide/quickstart/>

There are two versions of the operating system:

1. A full operating system with graphical user interface and networking
2. A 'lite' version with no graphical user interface and reduced functionality.

The instructions below are based on installing the full GUI version of Raspbian.

Once you have installed the operating system you will want to get access to the AIS data from the inbuilt AIS receiver. The AIS data is a NMEA stream on the internal serial port and once set up it can be viewed, stored or transferred to an application or other device.

To use the AIS receiver you have to enable the serial port and set the communication parameters. This applies to all uses of the R500Ni; see below.

## 8.4 Enabling the Serial Port

In the later *Jessie*s releases the GPIO serial port is disabled by default. In order to enable it, you will need to edit config.txt using the terminal emulator on the toolbar, as follows:

Once you have Raspbian running on Raspberry Pi, go to Menu → Accessories → Terminal, and type:

```
sudo nano /boot/config.txt
```

A text editor will open. Move the cursor to the end of the file and add this line:

```
enable_uart=1
```

This will also lock the cpu core frequency for you so there's nothing else you need to do.

(The full command for locking the CPU core frequency is: `core_freq=250` which you add to the same file as well).

```
core_freq=250
```

Save the file by pressing Ctrl+X, say Yes and press enter. Reboot for the changes to take effect.

Now type:

```
sudo reboot
```

This will restart the system.

Once the R500Ni is back up and running, check the status of the serial port.

Go to Menu → Accessories → Terminal, and type:

```
$ ls -l /dev
```

- NOTE: Use lower case 'L' not '1' or any other character

You should see the serial port *ttyS0* with the alias of *serial0* displayed part way down the list:

```
crw-rw-r-- 1 root root    10,  58 May 28 12:14 rfdm
lrwxrwxrwx 1 root root      5 May 28 12:14 serial0 -> ttyS0
lrwxrwxrwx 1 root root      7 May 28 12:14 serial1 -> ttyAMA0
drwxrwxrwt 2 root root    40 May 28 12:15 shm
```

The next step is to disable the remote console which by default uses the internal serial port *ttyS0* which is also the same serial port the AIS receiver uses in the R500Ni. To do this, type:

```
$ sudo systemctl stop serial-getty@ttyS0.service
```

```
$ sudo systemctl disable serial-getty@ttyS0.service
```

You also need to remove the console from the *cmdline.txt*. You edit this with the following line:

```
$ sudo nano /boot/cmdline.txt
```

You will then see a response similar to this:

```
dwc_otg.lpm_enable=0 console=serial0,115200 console=tty1 root=/dev/mmcblk0p2
rootfstype=ext4 elevator=deadline fsck.repair=yes root wait
```

Remove the text:

```
console=serial0,115200
```

The code should now look something like this:

```
dwc_otg.lpm_enable=0 console=tty1 root=/dev/mmcblk0p2 rootfstype=ext4 elevator=deadline
fsck.repair=yes root wait
```

Save the file by pressing **Ctrl+X**, use option *Yes* and press *Enter*. Reboot for changes to take effect.

```
$ sudo reboot
```

Finally you need to set the speed and enable the port *ttyS0* for the AIS stream.

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## 8.4.1 Setting and testing the serial port to receive AIS data

First, set the serial port to the Baud rate of 38400:

```
$ stty -F /dev/ttyS0 38400
```

Make sure that the AIS antenna is connected. You should now be receiving AIS data on the internal serial port. Check that the red LEDs on the side of the R500Ni are flashing; these indicate data being received.

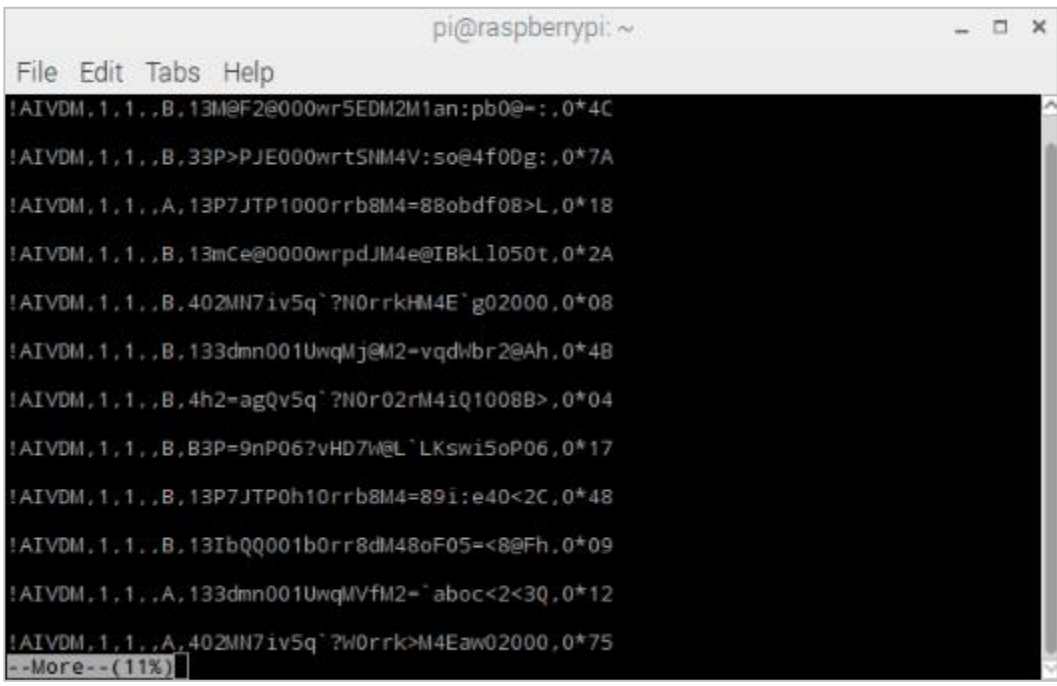
To check that the data sentences being received are formatted correctly you will need to examine the data. This can be done either on the screen or by redirecting it to a file as follows:

```
$ cat /dev/ttyS0 > ./test.txt
```

This command line will put all the data received into a file named `./test.txt` which can then be viewed:

```
$ more ./test.txt
```

You will see something like this formatted AIS data:



```
pi@raspberrypi: ~  
File Edit Tabs Help  
!AIVDM,1,1,,B,13M@F2@000wr5EDM2M1an:pb0@-:,0*4C  
!AIVDM,1,1,,B,33P>PJE000wrt5NM4V:so@4f0Dg:,0*7A  
!AIVDM,1,1,,A,13P7JTP1000rrb8M4=88obdf08>L,0*18  
!AIVDM,1,1,,B,13mCe@0000wrpdJM4e@IBkL1050t,0*2A  
!AIVDM,1,1,,B,402MN7iv5q`?N0rrkHM4E`g02000,0*08  
!AIVDM,1,1,,B,133dmn001UwqMj@M2=vsqdwbr2@Ah,0*4B  
!AIVDM,1,1,,B,4h2=agQv5q`?N0r02rM4iQ1008B>,0*04  
!AIVDM,1,1,,B,B3P=9nP06?vHD7W@L`LKswi5oP06,0*17  
!AIVDM,1,1,,B,13P7JTP0h10rrb8M4=89i:e40<2C,0*48  
!AIVDM,1,1,,B,13IbQQ001b0rr8dM48oF05=<8@Fh,0*09  
!AIVDM,1,1,,A,133dmn001UwqMvfm2= `aboc<2<3Q,0*12  
!AIVDM,1,1,,A,402MN7iv5q`?W0rrk>M4Eaw02000,0*75  
--More-- (11%)
```

If strange characters are displayed or data sentences are not formatted correctly then the Baud rate settings may need checking for the serial port. In this case, repeat the procedure for setting up the serial port.

## 8.5 Installing OpenCPN

OpenCPN works on Raspberry Pi 3™ model which is embedded in the Comar R500Ni. There are three options for installing OpenCPN:

### 8.5.1 Option 1: A complete installation including the Raspbian OS

If you feel lazy you can use OpenPlotter, a complete marine Operating System for Raspberry Pi with the Raspbian OS, OpenCPN and plugins installed and extra tools ready to use. OpenPlotter can be installed with 'NOOBS' (New Out Of Box Software) by following this online guide:

[https://sailoog.gitbooks.io/openplotter-documentation/content/en/getting\\_started.html](https://sailoog.gitbooks.io/openplotter-documentation/content/en/getting_started.html)

### 8.5.2 Option 2: Installing OpenCPN after installing the Raspbian OS

You can install OpenCPN by adding an Ubuntu PPA (Personal Packages Archives) to your system's Software Sources. To do this, first install the Raspbian OS as described previously and enable the serial port, checking that AIS data is being received on the serial port, as described previously. Then add OpenCPN in the next steps.

Once you have Raspbian running on Raspberry Pi, go to: Menu → Accessories → Terminal, and type:

```
$ sudo nano /etc/apt/sources.list
```

A text editor will open. Move the cursor to the end and add this line:

```
$ deb http://ppa.launchpad.net/opencpn/opencpn/ubuntu/ trusty main
```

Save the file pressing Ctrl+X, say Yes and press enter. Now type:

```
$ sudo apt-key adv --keyserver keyserver.ubuntu.com --recv-keys C865EB40
```

and press enter. Now be sure you have an Internet connection and type:

```
$ sudo apt-get update
```

The Software sources will be updated and finally you will have to type:

```
$ sudo apt-get install opencpn
```

Confirm install with Y and hit enter.

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## 8.5.3 Configure the OpenCPN

Start OpenCPN from the GUI.

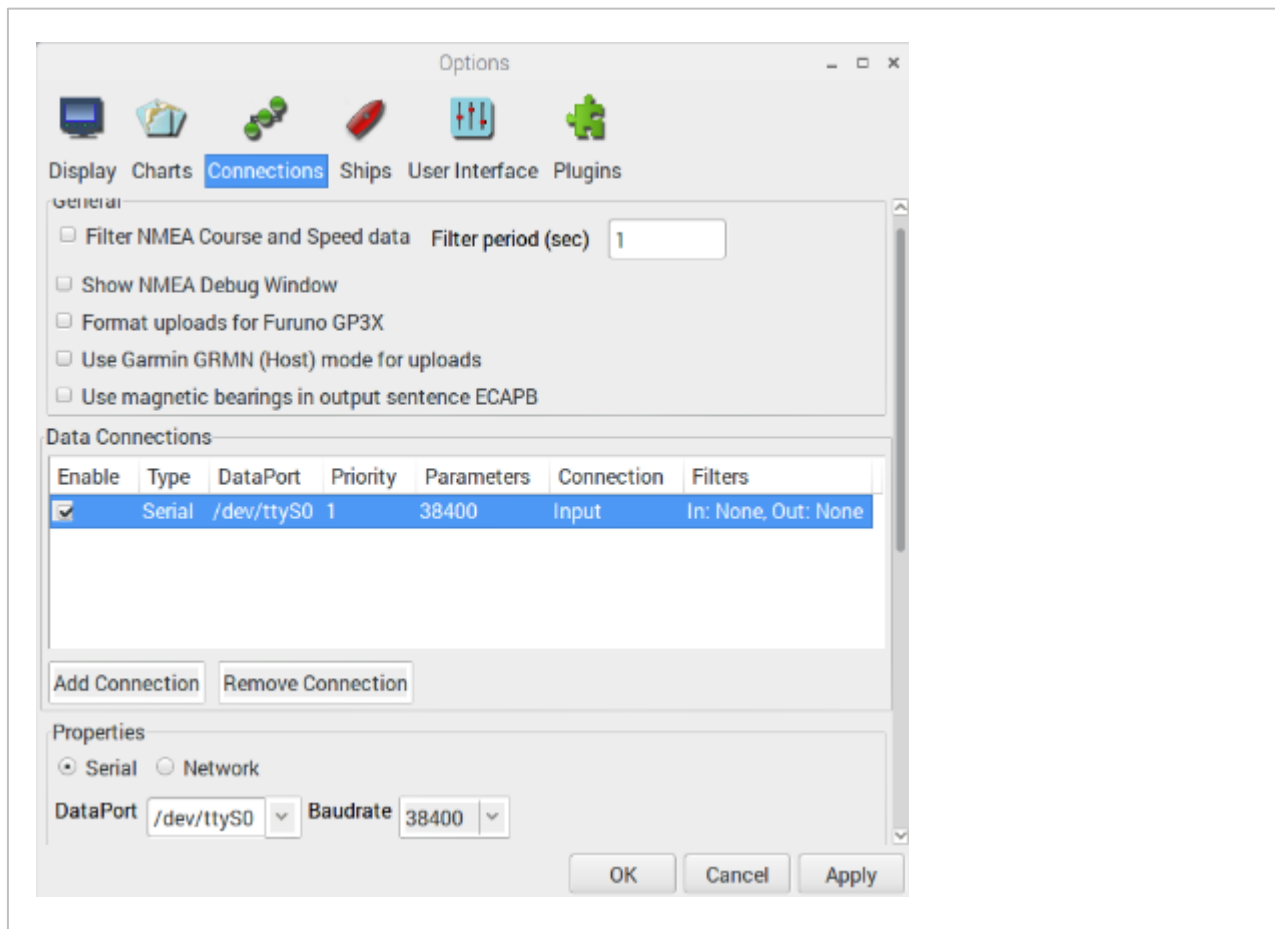
On the menu -> option -> connections

Add a connection ->Serial

Set Baud Rate 38400

Select Port /dev/ttyS0

Click the *Apply* button and the setup is complete.





## 8.5.4 Option 3: Installing OpenCPN with all available plugins

Once you have Raspbian running on Raspberry Pi, go to Menu → Accessories → Terminal, and type:

```
$ sudo apt-get install opencpn*
```

If you get an error doing this, you will have to install the plugins individually by typing:

```
$ sudo apt-get install opencpn-plugin-watchdog
```

```
$ sudo apt-get install opencpn-plugin-statusbar
```

If a new version of OpenCPN is released, just type:

```
$ sudo apt-get update
```

```
$ sudo apt-get install opencpn
```

You should now be up and running with the R500Ni displaying NMEA data either from the serial port or on a visual chart plot.

## 9 FAULT FINDING

### 9.1 Power LED not illuminating

Check the power supply and that the unit is connected to a 5 V dc power source capable of providing an operating current of 1.2 A minimum

Check that the micro-USB cable is correctly connected and that the cable and socket are not damaged.

### 9.2 Channel Indicators A & B do not flash

Check that the VHF antenna is correctly connected

Check that the antenna is correctly positioned, i.e. at a direct line of sight to nearby vessels

Check that the antenna body and cable connectors are free of corrosion and moisture

# R500Ni

## 10 SPECIFICATION

10.1 Physical	
Weight:	600 g
Dimensions:	L 130 x W 105 x H 46 mm
Mounting:	2 holes in chassis back
Connections:	Power: Micro USB Antenna: BNC Connector (50Ω antenna impedance) Ethernet: RJ45 USB: Type 'B' x4
Finish:	Black plastic

10.2 Electrical and Electronic	
Power supply:	5 V dc nominal
Operating Current:	900 mA (minimum) to 1200 mA (typical)
Onboard micro computer:	Raspberry Pi 3™ (see footnote) <sup>6</sup>

10.3 Operational	
Output Format:	ITU / NMEA 0183
Output Message:	VDM
AIS Receiver Frequency Range:	Channel A 161.975 MHz
	Channel B 162.025 MHz
Channel Spacing:	25 KHz
Sensitivity:	> -112dBm @ 20% MER
Demodulation:	GMSK
3x LED Indicators:	Green: Power
	Red: Channel A Receiving
	Red: Channel B Receiving
WiFi Band:	2.4 GHz (802.11n)
WiFi Security:	WPA, WPA-PSK, WPA2 & WPS
Network:	Must be DHCP enabled

<sup>6</sup> For the latest information and specifications on Raspberry Pi™ micro computers and operating systems please refer to [raspberrypi.org](http://raspberrypi.org)

## 10.4 Environmental

Operating Temperature:	-15°C to +55°C
Operating Humidity:	Up to 93%
Storage Temperature:	-20°C to +70°C
Ingress Protection:	IP20

## 10.5 Additional Information

If spare parts are required then please contact either your supplier or COMAR SYSTEMS. COMAR SYSTEMS reserves the right to make changes to its products and specifications without notice.

## 11 SAFETY AND SECURITY

Please observe the following procedures to ensure safety of personnel installing and operating the equipment:

1. Ensure all power to the unit is disconnected and locked-out during installation, maintenance and removal procedures
2. Ensure power is disconnected and locked-out in the event of mechanical damage to the unit, rendering internal parts accessible to personnel
3. Only the electrical power of the specified voltage should be connected to the unit
4. The panel to which the unit is mounted should be designed to provide adequate mechanical support. This minimises the possibility of damage or injury caused under mechanical shock conditions
5. Care should be taken to ensure the fixings used to mount the unit to the panel are correctly fitted and retain their mechanical integrity over time

## 12 LIMITED WARRANTY

COMAR SYSTEMS LTD. warrants this product to be free from defects in materials and manufacture for one year from the date of purchase. Comar Systems Ltd will, at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts and labour. The customer is, however, responsible for any transportation costs incurred in returning the unit to Comar Systems Ltd.

This warranty does not cover failures due to abuse, misuse, accident or unauthorised alteration or repairs.

Changes or modifications not made by Comar Systems or an authorised repairer will: (1) Void the warranty issued by Comar Systems (2) Void the user's authority to operate the equipment.

The above does not affect the statutory rights of the consumer.

**Note: Every effort has been made to ensure that all information contained in this manual is accurate at the time of going to press. We therefore cannot take any responsibility for the content and advise that you take normal steps to ensure that the information is at its most current when you are reading this manual.**

## 13 APPENDIX 1 – BACKGROUND TO AIS

The marine Automatic Identification System (AIS) is a location and vessel information reporting system. It allows vessels equipped with AIS to automatically and dynamically share and regularly update their position, speed, course and other information such as vessel identity with similarly equipped vessels or shore installations. Position is derived from the Global Positioning System (GPS) and communication uses Very High Frequency (VHF) digital transmissions.

There are a number of types of AIS device as follows:

- Class ‘A’ transceivers. These are designed to be fitted to large vessels such as cargo ships and large passenger vessels. Class ‘A’ transceivers transmit at a high RF signal power and therefore can be received by more distant vessels. They also transmit more frequently. Class ‘A’ transceivers are mandatory on all vessels over 300 gross tonnes on international voyages and certain types of passenger vessels under SOLAS regulations.
- Class ‘B’ transceivers. Similar to Class ‘A’ transceivers in many ways, but due to the less stringent performance requirements they are normally available at lower cost. Class ‘B’ transceivers transmit at a lower power and at a lower reporting rate than Class ‘A’ transceivers.
- AIS base stations. AIS base stations are used by Vessel Traffic Systems to monitor and control the transmissions of AIS transceivers.
- Aids to Navigation (AtoN) transceivers. AtoNs are transceivers mounted on buoys or other hazards to shipping which transmit details of their location to the surrounding vessels.
- AIS receivers. AIS receivers will generally receive transmissions from Class ‘A’ transceivers, Class ‘B’ transceivers, AtoNs and AIS base stations but do not transmit any kind of AIS (or other) information.

Information transmitted from vessels fitted with AIS transponders may (but not always) include:

Name of Vessel	Call sign	Type of vessel
Speed over the ground (SoG)	Course over the ground (CoG)	Heading
Position	Navigational status	Vessel Dimensions
MMSI Number	IMO Number	Draft
Rate of Turn	Size of vessel	Status
Destination	ETA	Cargo



COMAR SYSTEMS  
Vittlefields Technology Centre  
Forest Road  
NEWPORT  
Isle of Wight  
PO30 4LY  
UNITED KINGDOM

tel: +44 (0)1983 828900

email: [sales@comarsystems.com](mailto:sales@comarsystems.com)

web: [www.comarsystems.com](http://www.comarsystems.com)