NMEA Data Combiner

User Manual

Issue 1.03

- ❑ Multiple talker interface for use with the NMEA 0183 standard for serial-data networking of marine electronic devices / instruments

- ❑ Upgrade bridge for NMEA 2000 (CAN) standard by means of an internal CAN interface

- ❑ Personal computer (RS232) interface to NMEA 0183 and NMEA 2000 standards

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Contents

Important Notices

The **Actisense** NMEA Data Combiner (NDC) is intended for use in a marine environment, primarily for below deck use. If the unit is to be used in a more severe environment, such use may be considered misuse under the seller's warranty.

The **Actisense** NMEA Data Combiner (NDC) has been certified to comply with the European directive for Electro-Magnetic Compatibility (EN60945), and is appropriately CE marked. Operation of the unit should be in conjunction with appropriate CE approved shielded connectors and cabling used in accordance with the CE directive EN60945. Any EMC related issues should be reported to Active Research immediately to allow the company to rectify or resolve EMC related problems in accordance with its obligations under EN60945.

If the unit is connected such that compliance failure occurs beyond the company's control, the company shall not be held responsible for the compliance failure until suitable EMC guidelines for connection are seen to have been taken.

Notices

When using this document, keep the following in mind:

The products described in this manual and the specifications thereof may be changed without prior notice. To obtain up-to-date information and/or specifications, contact Active Research Limited or visit the **Actisense** website (www.actisense.com).

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Active Research Limited will not be held responsible for any damage to the user that may result from accidents or any other reasons during operation of the user's unit according to this document.

Foreword

Actisense recognises that instructions are often skipped, so we have aimed to write this document in an informative, yet direct manner that will aid the user. We have tried to cover all the points a typical user may need to know. Please read all sections before installing and using the **Actisense** NMEA Data Combiner product and its related software programs.

Introduction

The **Actisense** NMEA Data Combiner (NDC) product developed out of the requirement to solve two fundamental problems with the existing marine industry NMEA 0183 communications standard and the soon to be released NMEA 2000 standard.

In theory, the NMEA 0183 standard allows any suitably designed marine electronic device to share its gathered information with any other device on a vessel. Unfortunately, there is one very large drawback with this standard - only **one** device on a connected network can actually send data (a single talker), with multiple devices (determined by the current limit of the sending unit) listening to that data (multiple listeners).

If the vessel owner has an instrument that ideally requires the data output of two or more devices, for example a chart plotter, then the owner has no alternative but to settle on connecting only the most important device (that which supplies the most used information), usually the GPS unit.

What happens if the owner prefers the vessels gyro compass output to that of the GPS, or requires that the current depth be displayed on the plotted chart to help avoid the possible case of running the vessel aground on a shifting sand bank? The NMEA 0183 standard cannot supply an answer to those questions as it can handle **only one transmitting device.**

The second problem is that the soon to be released NMEA 2000 standard is not backward compatible with NMEA 0183 in any way whatsoever. It uses very different and incompatible information transfer ideas and cables. The NMEA 0183 standard is over 10 years old and no amount of compromise from the NMEA committee would have ever made NMEA 2000 compatible with the existing standard **and** allowed it to meet the greatly increased industry requirements of today.

These two elementary problems can be solved simply and easily with the **Actisense** NMEA Data Combiner's very flexible design approach.

By using the **Actisense** NMEA Data Combiner, all NMEA 0183 devices can share their information with each other (multiple talkers – multiple listeners) and any new NMEA 2000 device can listen to the NMEA 0183 information as if it was coming from another NMEA 2000 instrument (effectively making NMEA 0183 compatible with NMEA 2000). Refer to the **Features** section for details on NMEA 2000 functionality.

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General features

4 NMEA 0183 data input ports

Each NMEA 0183 input port has an "Inclusion List" that details all the NMEA sentences that are allowed to pass thought the NMEA Data Combiner (NDC) and out on the combined NMEA 0183 output. This allows the NDC to filter out all unwanted NMEA data and so reduce the loading on the NMEA combined output.

Each NMEA 0183 input port also has a priority level. This is set by default to the logical order that matches the port numbers, i.e. port 1 is the highest priority and port 4 the lowest.

An NMEA 0183 data combined output port

This output combines the input data into one standard NMEA output. As the inputs and the output are of the same baud rate, the combined input rate may exceed the output rate. The combiner contains special software to ensure that new data of the same type as older data, still in the buffer, will overwrite the older sentence. This ensures that the combiner cannot build up excess old data in the case where the output stream is fully loaded. Using a higher baud rate on this port will improve its' throughput, but may not be compatible with following equipment, if the baud rate on that equipment is fixed to 4800 baud (the NMEA standard).

A PC compatible RS-232 bi-directional port

A PC can use the RS-232 port to read all the NMEA data traversing through the NDC. This allows for the possibility of a "virtual cockpit" of instruments displaying all available data in any manner the user requires (available from a number of manufacturers).

All the above ports are re-configurable and offer various Baud rates to improve device connection compatibility with other NMEA 0183 instruments.

The NDC will be able to act as an NMEA 0183 to NMEA 2000 upgrade bridge, converting all NMEA 0183 data into standard NMEA 2000 packets that can be read by any suitably equipped device on the vessels NMEA 2000 CAN bus network. This ability will require a flash upgrade, as the NMEA 2000 standard is not yet finalised; please contact Active Research Limited / monitor the Actisense website for further information.

Software updates

The NDC's built-in software is held in "flash" memory, and so can be quickly and easily updated / "flashed" by using a simple Windows (95/98/ME and NT/2000) user interface program running on a connected PC.

It is our policy to provide these updates free on our website, www.actisense.com, so that your combiner can become more sophisticated with time, and should there be any bugs reported in the software, they can be promptly fixed without the unit coming out of commission. This upgrade can be performed with the unit completely in-situ, via a PC connected to the RS232 port.

Technical features

Fujitsu 16-bit high-speed micro-controller capable of 8 million instructions per second.

Flash ROM technology that supports automatic programming for quick and easy updates, 10,000 erase cycles and a 10-year Data Retention provides carefree user configuration.

Full-CAN interface that is compatible with the soon to be released NMEA 2000 marine communications standard. The NDC's built-in software will require flash upgrading when the NMEA committee finalise the new marine industry standard protocol.

On-board memory store allows buffering of short term NMEA data, allowing the unit to smooth short-term peaks in the NMEA data flow.

NMEA 0183 inputs are opto-isolated differential inputs to fully comply with the NMEA 0183 standard specification. This allows the inputs to work correctly with long cable runs and in a noisy environment. Typical operating voltage is 2.0V to 15V. The unit can withstand +/- 35V continuously, and can withstand +40V transients. The opto-isolators can protect any upstream equipment (chart plotter / PC / radar etc.) from up to 2000V of common mode voltage difference.

NMEA 0183 full-differential output driver. This can drive up to 20 typical NMEA 0183 device loads, with a 100mA (maximum) drive capability. The full-differential output ensures better quality communications and lower noise emissions on unshielded twisted pair cabling.

Full specification RS232 interface ensures that any marine electronic device that has an RS-232 port connected PC need miss no input NMEA data. Enables connection to a standard PC, allowing data to be read, and the unit to be freely updated via the supplied flash upgrade software.

Low Power Consumption that is typically 100-110mA at 12 volts and 50-60mA at 24 volts.

A diagnostic LED indicates the operation mode of the NDC, if any faults have been detected, or the peak loading currently on any one of the NMEA inputs.
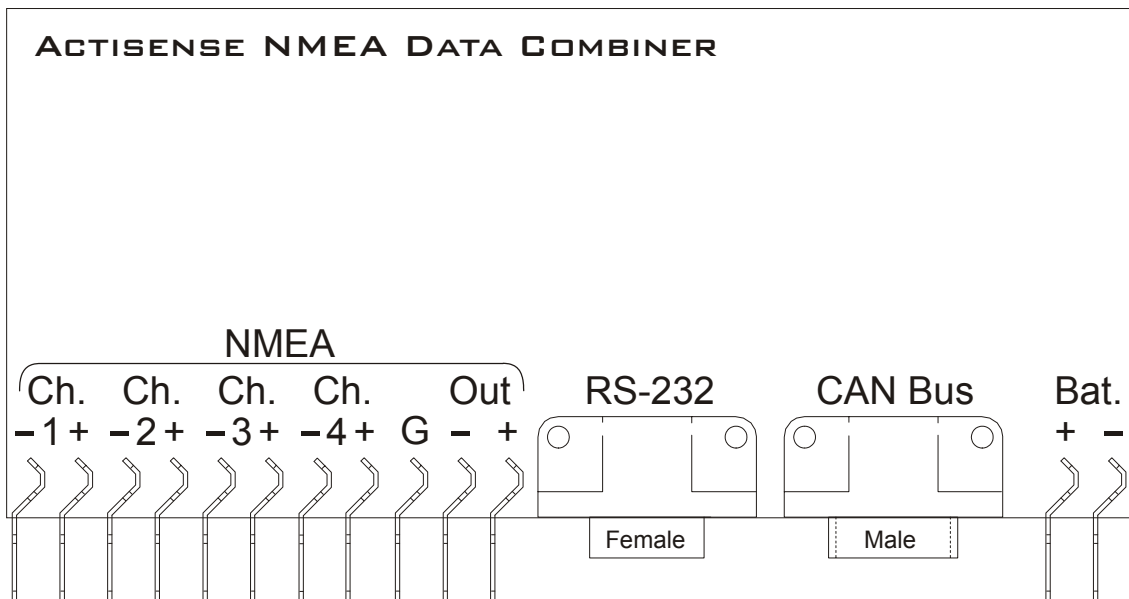
Connections

Figure 1 – External connections

The NMEA Data Combiner (NDC) has external connections for: -

1. Four NMEA 0183 inputs via male ¼ inch (6.35 mm) crimps.
   All NMEA 0183 inputs are of the differential opto-isolated type and use **Actisense** low current drain circuitry (2mA @ 2.0V) to conform in full with the NMEA 0183 marine electronic device network communication standard, and are flexible enough to interface to most fully and partially compliant devices.

2. An NMEA (data combined) 0183 output via male ¼ inch (6.35 mm) crimps.
   The NMEA 0183 output comprises of three connections: '**+**', '**-**' and '**Ground**' and conforms in full to the NMEA 0183 standard. This allows the NDC to interface to various different devices that require any combination of these outputs.

3. An RS-232 input/output via a female 9-pin D-type connector.
   The bi-directional RS-232 port is designed for direct connection to a Personal Computer (PC) or other marine device capable of interfacing to an RS-232 port.

4. An NMEA 2000 CAN Bus input/output via a male 9-pin D-type connector.
   The NMEA 2000 port is designed to connect to the vessel's CAN Bus network by use of a conversion cable (supplied directly from **Actisense**).

5. Battery supply input via male ¼ inch (6.35 mm) crimps.

Note:
1. To complete the NMEA 0183 standard all device interconnection NMEA cables used should meet the two-conductor, shielded, twisted pair configuration specification.

2. Refer to the **Specifications** section for the full details on input/output specifications.
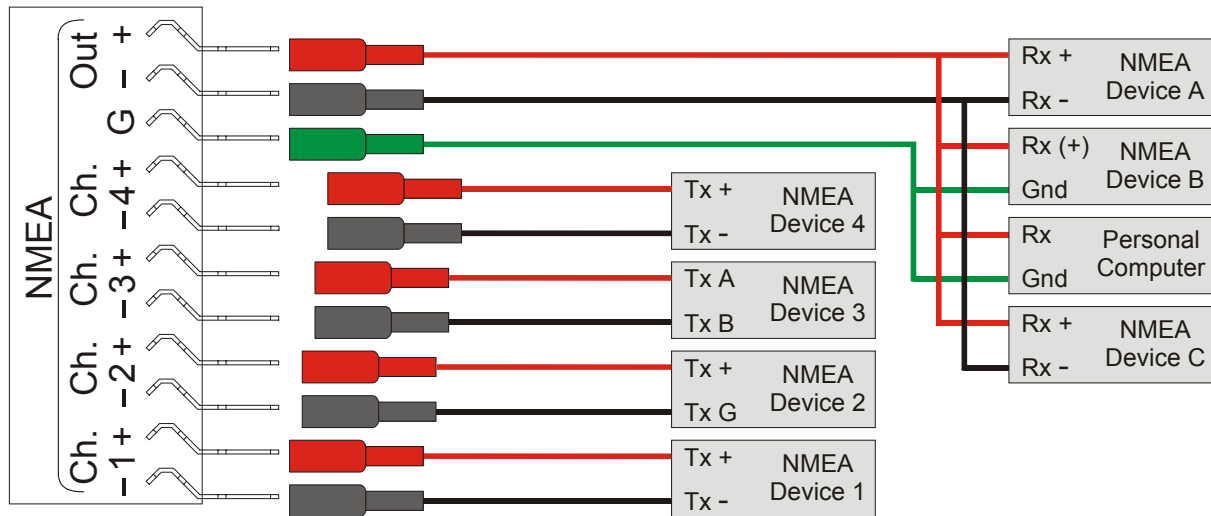
Connecting to NMEA devices

Figure 2 – NMEA 0183 connections

NMEA 0183 Inputs

The NMEA 0183 differential opto-isolated inputs are designed to handle a variety of NMEA 0183 device output specifications. Please determine (from device manufacturer's information) if the device(s) required to be connected to the **Actisense** NDC conforms in full to the NMEA 0183 network communication standard. If it does not, the flexible **Actisense** NDC inputs should still be capable of interfacing with the device, though this is not guaranteed. The diagram above shows a typical installation with both fully compliant NMEA devices with differential inputs/outputs, and non-differential output devices that output NMEA using the ground line as the "**NMEA -**" line.

NMEA Device's 1, 3 and 4: These devices conform in full to the NMEA 0183 standard. Devices 1 and 4 share the same connection ID's as the **Actisense** NDC, so connection is a simple matter of matching the ID's (refer to figure 2). Device 3 uses the RS485 convention connection ID's. Simply connect '**A**' to '**+**' and '**B**' to ' **-**' (refer to figure 2).

NMEA Device 2: This device does not conform completely to the NMEA 0183 standard. However, by connecting '**+**' to '**+**' and its '**G/Ground**' to the NDC "NMEA**-**" the NDC should be able to receive the NMEA data correctly.

NMEA 0183 Output

The NMEA 0183 buffered output is capable of driving up to 20 NMEA 0183 fully compliant listening devices, or a mixture of NMEA 0183 devices and a Personal Computer (PC) communication port.

NMEA Device's A and C: These devices conform in full to the NMEA 0183 standard and their connection ID's match that of the NDC.

Personal Computer: Whilst the RS-232 port is designed for connection to a PC, the NMEA 0183 output is also capable of being read by most PCs. Simply connect '**+**' to '**Rx**' and '**G**' to '**Gnd**' on a standard D-type (probably male) connector.

NMEA Device B: This device does not conform in full to the NMEA 0183 standard. However, by connecting '**-**' to '**-**' and '**G/Ground**' to '**Gnd**' the device should be able to receive the NMEA data correctly, though this is not guaranteed.
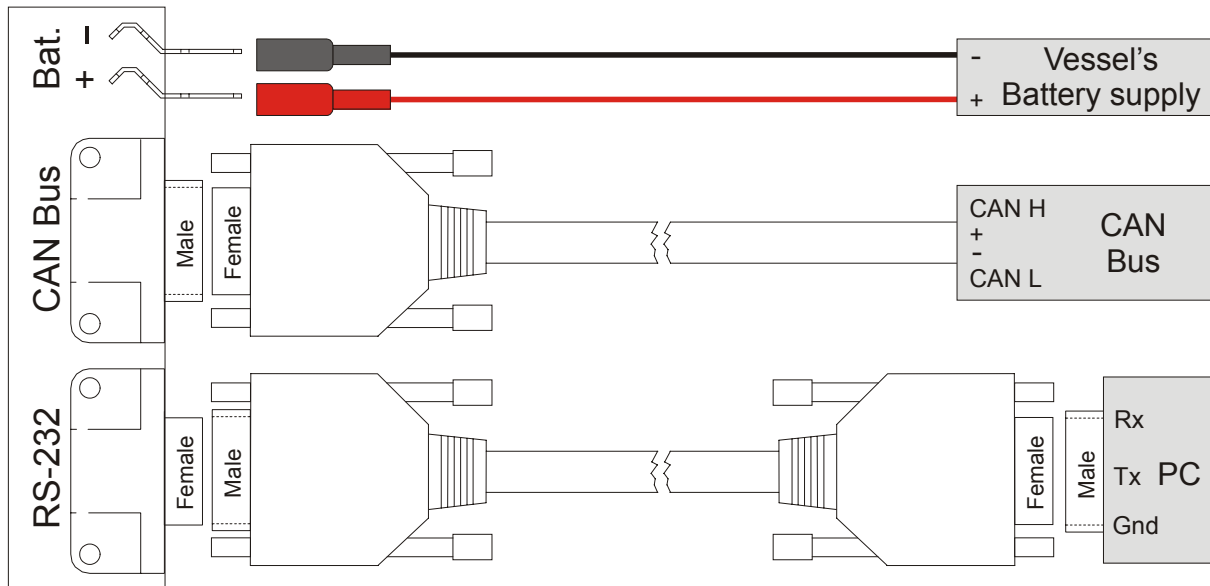
Connecting to a Personal Computer

Figure 3 – RS-232, CAN Bus and Battery connections

The RS-232 port can be connected to a PC communications port using an off-the-shelf computer one-to-one (**not** Null modem) extension cable (refer to figure 3). However, if the required cable length is not available or cost is a prohibitive factor, a cable conforming the following specification should be constructed instead:

1. A D-type male (plug) connector for the **Actisense** NDC end of the cable

2. A D-type female (socket) connector for the PC end of the cable

3. Minimum of 3 cores are required in a shielded cable. Higher quality cable will naturally yield higher performance / higher noise-to-signal ratio (NSR).

4. Cable shield should only be connected to the ground core (or D-type connector's shell if it is metal) at the computer end of the cable.
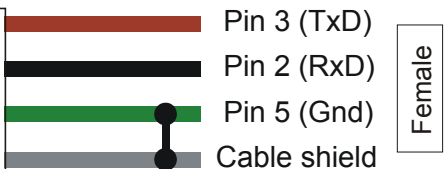

Figure 4 – RS-232 cable connections

Note:
1. Wire colours are for guidance only.

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Connecting to the CAN bus

The user supported method of connecting the **Actisense** NDC to the vessel's CAN bus network is with the directly supplied 9-pin D-type to NMEA 2000 converter cable. Please contact Active Research Limited (refer to **Contact Information** section) if you require such a converter cable.

Alternatively, if the supplied cable length is not suitable or cost is a prohibitive factor, a cable of the required length conforming the NMEA 2000 CAN bus specification should be purchased and one end modified to connect to a standard 9-pin D-type female (socket) connector (refer to figure 5).

The **Actisense** NDC connector end should be wired thus:

Female Connector

Pin 1 (CAN Power)	
Pin 5 (CAN Ground)	NMEA 2000
Pin 4 (CAN H)	CAN Bus cable
Pin 7 (CAN L)	

Figure 5 – CAN cable connections

Note:
1. Wire colours are an example only; actual colours vary between cable manufacturers.

Connecting to the battery supply

The **Actisense** NDC should be wired to the vessel's battery supply in the most direct manner possible to minimize interference from other electronic devices. The cable used should be of sufficient gauge to handle the power requirements of the **Actisense** NDC (refer to the **Specifications** sections).

Using the Control Centre

The **Actisense** NMEA Data Combiner hardware can be configured, monitored and tested by its own dedicated Control Centre program. This section provides a users guide to all the modes of operation possible with the Control Centre program.

This program is currently only available for Windows 95/98/ME and NT/2000 platforms, however, it has been proven possible to use the Control Centre on a Mac running Windows emulation software.
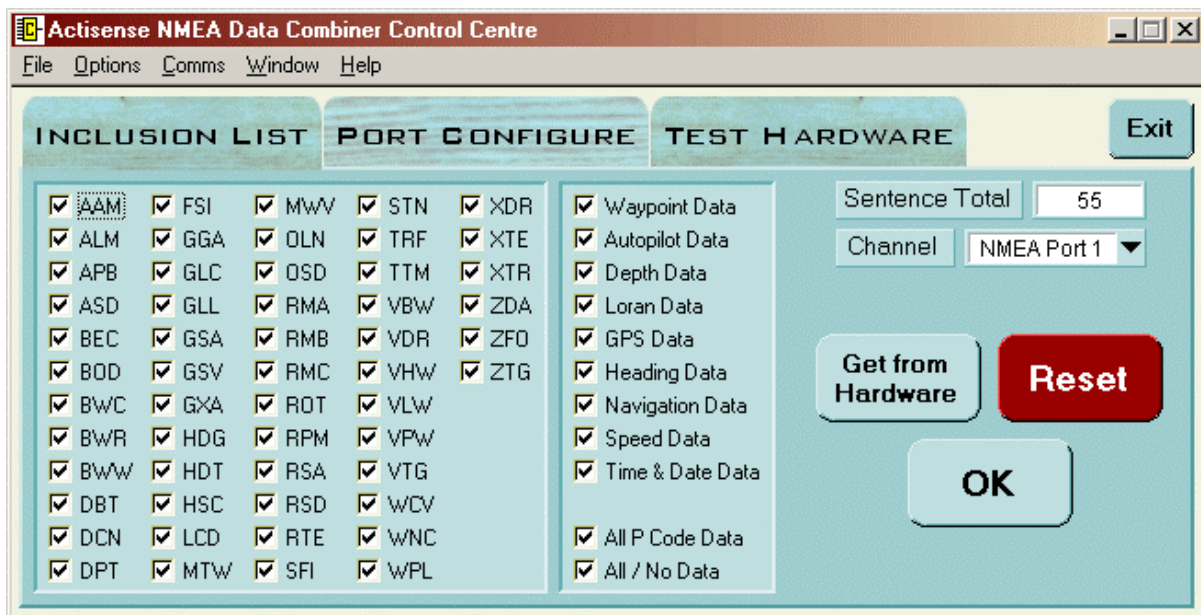
Main window

Figure 6 – Control Centre main window

The Control Centre main window allows the user access to all the NDC hardware configuration, monitor and test operations, and adjustment of the Control Centre programs actual appearance.

The Control Centre is capable of displaying a large array of data and information, and not all will be of interest to every user. Therefore, the user can select which information/status windows are shown and which are hidden. To meet user specific requirements, any shown windows can be repositioned on the screen by dragging them with the mouse. If when a window is dropped (the left mouse button is released after the drag operation) it is close enough to an adjacent windows edge it will snap that windows edge. This allows for easy and quick arrangement of the Control Centre's windows, and any changes to the programs appearance will be remembered for subsequent sessions.

Pull-down menus

The main window has five standard pull-down menus: -

File → Load / Save Configuration File: The Control Centre will automatically save its appearance and other settings to file "`ControlCentre.ini`" so that the same settings can be used in subsequent sessions. If the user requires more than one configuration set up (for different vessel installations) with unique Inclusion Lists and port configurations for example, then each set up can be saved and loaded back from here.

Note: Do not attempt to edit the "`ControlCentre.ini`" file by hand, as this will result in all configuration settings being lost.

File → Exit: Closes the Control Centre program. If the Inclusion Lists and/or the Port Configurations have been altered, but not yet transferred to the NDC hardware, the user will be asked to confirm the exit command (as all alterations will otherwise be lost when the program closes).

Options → Configure Inclusion Lists: Displays the Inclusion List configuration tab of the main window. Refer to the respective window sub-section below for details.

Options → Configure Ports: Displays the Port configuration tab of the main window. Refer to the respective window sub-section below for details.

Options → Test Hardware: Displays the Test hardware tab of the main window. Refer to the respective window sub-section below for details.

Comms → Comm Port 1-5: Selects the PC communications port that the NDC hardware is attached to. The baud rate will default to 38400 (the NDC hardware default). If received data errors are detected the Control Centre will attempt to match the NDC hardware's Baud rate.

Window → Control Centre Port Status: Displays the Control Centre's port status window. Refer to the respective window sub-section below for details.

Window → NDC Hardware Port Status: Displays the NDC hardware's port status window. Refer to the respective window sub-section below for details.

Window → NDC Hardware Connect Status: Displays the NDC hardware's connection status window. Refer to the respective window sub-section below for details.

Window → NDC Hardware Information: Displays the NDC hardware's information window. Refer to the respective window sub-section below for details.

Help → Control Centre Help: Displays the quick reference Control Centre help information (a cut-down context sensitive version of this document).

Help → About Control Centre: Displays the Control Centre's software version number and the **Actisense** / Active Research Limited contact information.

Control Tabs/Buttons

The main window has three control tabs (buttons) along its top: **Inclusion List**, **Port Configure** and **Test Hardware**. These tabs display all the associated information in the area below them (refer to figures 6 - 9) and act just like tabs in a filing cabinet (doing the same job as the items in the **Options** pull-down menu). Refer to the respective tab sub-sections below for more details.

The main window also has an **Exit** control button that closes the Control Centre program. As with the menu exit control, if the Inclusion Lists and/or the Port Configurations have been altered, but not yet transferred to the NDC hardware, the user will be asked to confirm the exit command.

Inclusion List configuration tab

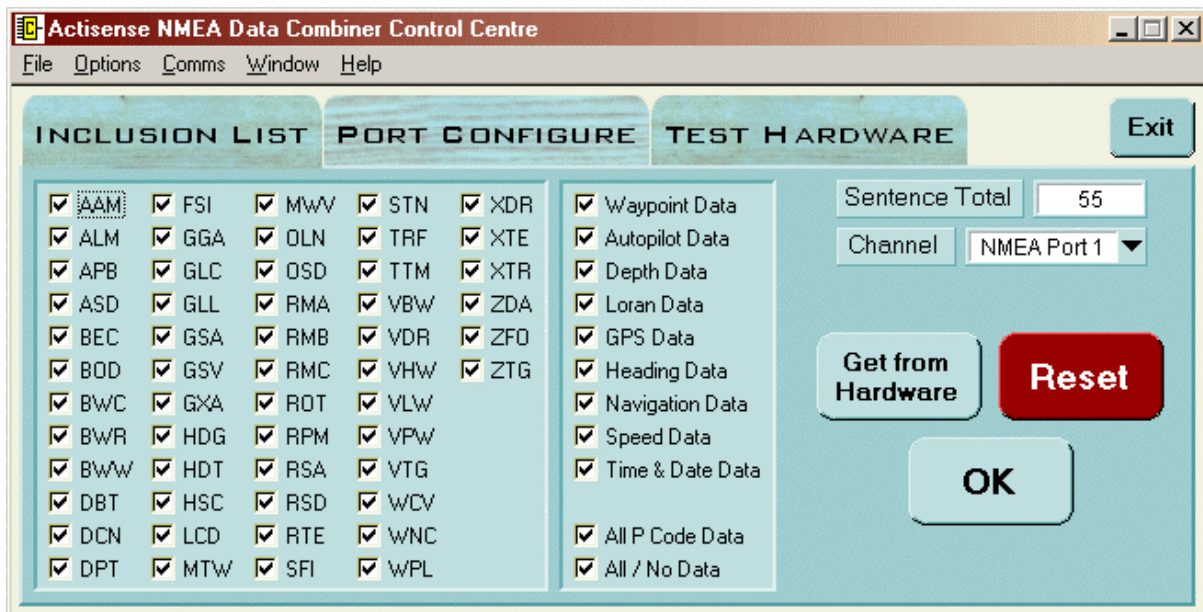**Figure 7 – Control Centre Inclusion List configuration tab**

The Inclusion List configuration tab of the main window allows the user to select which NMEA sentences are to be **included** in the onward data transmission from the NMEA Data Combiner. Each of the four NMEA input ports has its own Inclusion List, so that each can be tuned separately to match the NMEA device attached to that port.

Why is there a need for Inclusion Lists?

Each of the four NMEA input ports can transfer anything up to 480 bytes of data per second, making a total of 1920 bytes/second. The data combined output of the NDC is also forced (by the NMEA 0183 standard) to send a maximum of 480 bytes/second. It can be seen, that with a maximum of 1920 bytes being received and maximum of 480 bytes sent in a second, there exists the distinct possibility that some data may require removal to balance this equation. The **Actisense** NDC achieves this reduction in an intelligent manner with Inclusion Lists and Port Priorities.

Is some of the NMEA data really unnecessary?

Some NMEA instruments output a large number of sentences every period (usually 1-3 seconds), some of which are of absolutely no use to the average boat owner, and just clog up the NMEA network. Most GPS units are especially guilty of this and not all allow the user to reduce the number of unwanted sentences that are transmitted. Of those that do, the procedure can often be fiddly and time consuming.

The **Actisense** NDC can filter the incoming NMEA data to remove any sentences that are deemed unnecessary by the user.

For example, most GPS units automatically output the 'GSV' sentences (normally 2 but could be as many as 4), which give details of all the satellites that are currently in view. All of this information is of no use to 99% of users, but this alone can use up to 5% of the available NMEA bandwidth/capacity.

The **Actisense** NDC 'Inclusion List' default is to allow all sentences through. The user can modify these lists using a simple 'tick-the-box' panel from within the Control Centre.

How to change the Inclusion Lists

The Inclusion List configuration tab consists of two groups of sentence tick boxes and a box showing the total number of selected sentences, an NMEA channel selection pull-down list, and **Get from hardware, Reset** and **OK** control buttons (refer to figure 7).

> **Channel selection list:** determines which channel (port) has its inclusion list displayed for editing with the tick-boxes.

> **Left tick-box group:** has a separate tick box for every possible NMEA 0183 sentence and is intended for the advanced user to fine tune the selection to exactly what is required.

> **Right tick-box group:** has a tick box for each NMEA sentence collection and is primarily intended for the novice user who does not know which sentences contain what information. The NMEA sentence collections are designed for quick list configuration; each collection influences all the NMEA sentence tick boxes in the left group that contain the respective information.

The tick-box operation is straightforward: if the box is ticked, the corresponding NMEA sentence/collection will be transferred from the NDC input to the NDC combined output. Conversely, if the box is not ticked, any NMEA sentences of that type will be blocked from onward transmission.

Sentence Total: a tally of the number of NMEA sentences currently selected/enabled for the current channel/port is displayed in the top right corner.

Get from hardware: requests the current Inclusion List information (for all channels/ports) from the NDC hardware attached to the PC communications port. This will overwrite any current settings of the Control Centre Inclusion Lists; if the user requires that the current settings be remembered, the **File → Save Configuration file** main window menu option should be used before using this hardware read operation.

Reset: returns all channel/port Inclusion Lists to the factory default – all sentences are enabled on all channels/ports.

OK: finalises the Inclusion List editing operation. If any alterations to the list have occurred the Control Centre will now attempt to download the new settings to the attached **Actisense** NDC hardware. The **Flash Hardware** window will appear for the duration of the download and the details of the conversation can be viewed in the **NDC Hardware Connection Status** window.

Procedure

1. Remembering that the ports have a priority setting (that only has a effect during high loads), choose which device to connect to which channel/port. Place the most important device on channel 1 and so on. If the 'Inclusion Lists' are tuned to allow only the required data of each device through, then the port priorities will normally not come into operation (as the maximum output data rate will usually not be exceeded).

2. Starting with channel/port 1, place a tick next to all required NMEA sentences (using the individual tick boxes, the group tick boxes or a combination of both), by left clicking on the text or box with the mouse pointer.

3. Do the same for any other channel that you intend to use. Use the **Channel** selection list control to change the channel/port - left click on the controls down arrow to display the list and then select the required channel number. Any combination of channels can be used – for example, in a two-device set-up channel's 1 and 3, or 2 and 3 etc. could be used.

4. Once you are happy with the setting of all used channels, press the **OK** control button. If for some reason the Control Centre has not been able to detect the NDC hardware, it cannot start the data transfer process. If this happens check all cable connections, Control Centre communication settings (port number and Baud rate) and battery power to the NDC hardware (the diagnostic LED should be lit and either 'Green' or 'Amber').

5. When the Control Centre has detected the NDC hardware (the hardware information will be displayed in the **NDC Hardware Information** window), clicking the **OK** control button will start a transfer of the new Inclusion List data to the hardware. This process can be monitored on the **Flash Hardware** and **NDC Hardware Connection Status** windows.

6. The **Flash Hardware** window will display the success status of the transfer and then disappear. The full transfer conversation can be viewed on the **NDC Hardware Connection Status** window (for advanced users only).

Note:
1. The RS-232 port data and CAN bus data are unaffected by the NMEA Inclusion Lists and retains all received data – as these ports always have an excess transmit bandwidth/capacity.
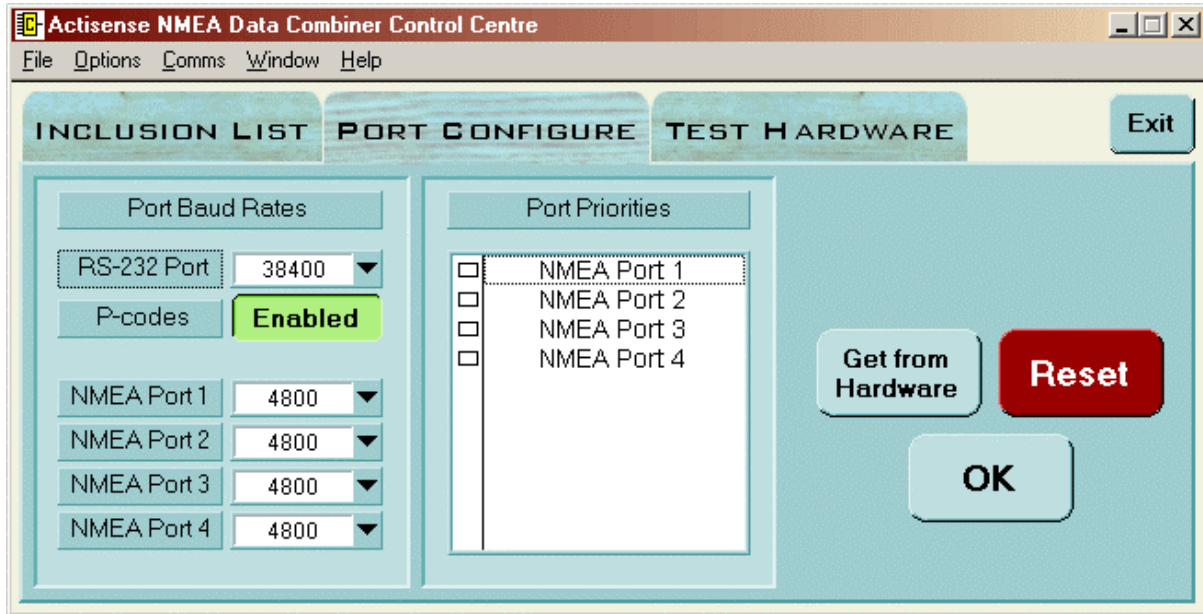
Port Configuration tab

Figure 8 – Control Centre Port Configuration tab

The Port configuration tab of the main window allows the user to determine the priority and Baud rates of the NMEA input ports of the NDC hardware, the Baud rate of the RS-232 port and if the NMEA proprietary ARL (P-codes) sentences are transmitted.

These P-codes are used by the Control Centre to determine the **NDC Hardware Port Status** and the original NMEA input port number the data (displayed in the **Control Centre Port Status** window) came from. As a result, the P-codes should always be enabled when using the NDC hardware with the Control Centre – otherwise the port status windows will be unable to operate. If however, the RS-232 port is connected to an electronic device (e.g. chart plotter) that cannot ignore the P-codes (as it should by default), then the P-codes can be disabled to aid compatibility.

Why is there a need for Port Priorities?

Refer to '**Why is there a need for Inclusion Lists?**' for the detailed explanation for the need to potentially reduce the amount of data trying to be sent out of the combined output. If the Inclusion Lists cannot reduce the data rate below the 480 bytes/second maximum, then the port priority system comes into operation.

This system stipulates that all the data from the highest priority port will be passed through to the combined output. Then if any transmit capacity is left, the next lowest priority port's data is transferred until either no data remains (the usual case), or transmit capacity has reached its maximum of 480 bytes/second.

If the rate of data in to the NDC hardware continues at this very high level, then eventually some sentences (from the lowest priority channel first) will have to be dropped. If however, the rate drops below the maximum, then the sentence data will be sent at the next

opportunity. With the 'Inclusion Lists' set up correctly, data loss will be a very rare occurrence.

How to change the Port Priorities and Port Baud rates

The port configuration tab consists of a vertical port priority list, a Baud rate pull-down list for each NMEA/RS-232 port, the P-code enable toggle control, and **Get from hardware**, **Reset** and **OK** control buttons (refer to figure 8).

Port priority vertical list: utilises a simple priority system – the topmost item has the highest priority and the item at the bottom, the lowest.

NMEA/RS-232 Baud rate lists: selects the required baud rate for the appropriate port. Please note that the NMEA 0183 specification stipulates that the baud rate for NMEA data must be 4800 Baud. Therefore, any input NMEA port that has an NMEA device attached to it that cannot modify its Baud rate **must** remain at 4800 Baud (otherwise no data will be received). However, some NMEA devices (e.g. GPS units) do allow for the Baud rate to be increased to 9600 Baud. **Only** in this case can the baud rate of the appropriate port be changed to match that of the attached device.

P-code enable: toggles the enable/disable state of the P-code transmission on the RS-232 port.

Get from hardware: requests the current Port Configuration information (for all channels/ports) from the NDC hardware attached to the PC communications port. This will overwrite any current settings of the Control Centre's Port Configuration; if the user requires that the current settings be remembered, the **File → Save Configuration file** main window menu option should be used before using this hardware read operation.

Reset: returns all channel port configurations to the factory default – priorities match channel/port numbers (port 1 has highest priority and port 4 has the lowest), NMEA Baud rates are set to 4800 Baud, RS-232 Baud rate set to38400 Baud and the P-codes are enabled.

OK: finalises the port configuration editing operation. If any alterations to the port configuration settings have occurred the Control Centre will now attempt to download the new settings to the attached **Actisense** NDC hardware. The operation is very short in duration (less than one second).

Procedure
1. The RS-232 communication port defaults to 38400 Baud, which is more than capable of transferring the received data of all four NMEA input ports. When connected to a Personal Computer there should not be any reason to change this Baud rate. However, if it is required to connect the NDC hardware to an RS-232 compatible device that does not support the Baud rate of 38400, then the rate can be changed. Left click on the **RS-232 Port** controls down arrow to display the list and then select the required Baud rate number.

2. The proprietary NMEA P-code sentences sent by the NDC hardware are completely benign and cannot be understood by any other manufacturers device. The **Actisense** software programs (Control Centre and Flash Centre) use these

sentences to perform certain operations that enhance their control over the NDC hardware and are therefore important. There should not be any reason for requiring that these sentences be disabled. However, as **Actisense** believes in offering complete control over its products, it is possible to enable/disable these sentences by clicking on the **P-codes Enable/Disable** control.

3. As detailed above, the NMEA 0183 standard determines the Baud rate of 4800. If however to make the NMEA input compatible with special devices that offer a different Baud rate, the rate can be changed by left clicking on the **NMEA Port 1-4** pull-down lists.

4. To aid memory, it would be normal to keep the port priorities in the same order as the port numbers (i.e. port 1 has the highest priority and port 4 the lowest). However, if for some reason the port priorities require change and it is inconvenient to change the hardware crimp connections, the port priorities can be changed using the **Port priority list**.

5. Once all the changes have been preformed, press the **OK** control button to transfer the new port configuration data to the attached NDC hardware. As for the 'Inclusion List' data transfer, if the NDC hardware has not been detected, the Control Centre will not start the transfer. If this happens check all cable connections, Control Centre communication settings (port number and Baud rate) and battery power to the NDC hardware (the diagnostic LED should be lit and either 'Green' or 'Amber').

6. When the Control Centre has detected the NDC hardware (the hardware information will be displayed in the **NDC Hardware Information** window), clicking the **OK** control button will start a transfer of the new Port Configuration data to the hardware. This process can be monitored on the **Flash Hardware** and **NDC Hardware Connection Status** windows.

7. The **Flash Hardware** window will display the success status of the transfer and then disappear. The full transfer conversation can be viewed on the **NDC Hardware Connection Status** window (for advanced users only).

Note:
1. The RS-232 port data and CAN bus data are unaffected by the NMEA Inclusion Lists and retain all received data – as these ports always have an excess transmit bandwidth/capacity.

Flash Hardware window

Figure 9 – Control Centre Flash Hardware window

The Flash Hardware window is displayed for the duration of the Inclusion List or Port Configuration update operation. In the case of the Inclusion List, during this time a section of the Flash memory inside the NDC hardware is first erased/cleared and then re-programmed with the new data.

Please note that it is vital that during the programming stage of this process that the Control Centre and NDC hardware are not interrupted. Therefore, the following precautions are suggested: –

1. Ensure there are no programs active/running on the PC other than the Control Centre.

2. Check the RS-232 cable between the PC and the NDC hardware is secure.

3. Confirm that the battery supply to the NDC hardware is secure.

If the Flash hardware operation is interrupted, the Inclusion Lists or Port Configurations will become corrupted. The user should identify and then remove the reason for the previous interruption and then attempt to flash the hardware again – by returning to the **Inclusion List configuration tab** or **Port Configuration tab** and pressing the **OK** control button again.

The Flash Hardware window consists of four LED's that indicate the flash operations current status, a progress bar indicating percentage complete of current stage, and a flash program counter that indicates how many times the NDC hardware's Inclusion List has been re-programmed.

The **Success LED** will indicate the final outcome of the data transfer. If for some reason it does not light up green the **NDC Hardware Connection Status** will indicate a more detailed cause and the process should be performed again.

The following windows/tabs will only be of interest to the advanced user as they are not vital for the configuration of the NDC hardware. These windows are therefore hidden by default, and all novice users should advance to the **Using the Flash Centre** section.
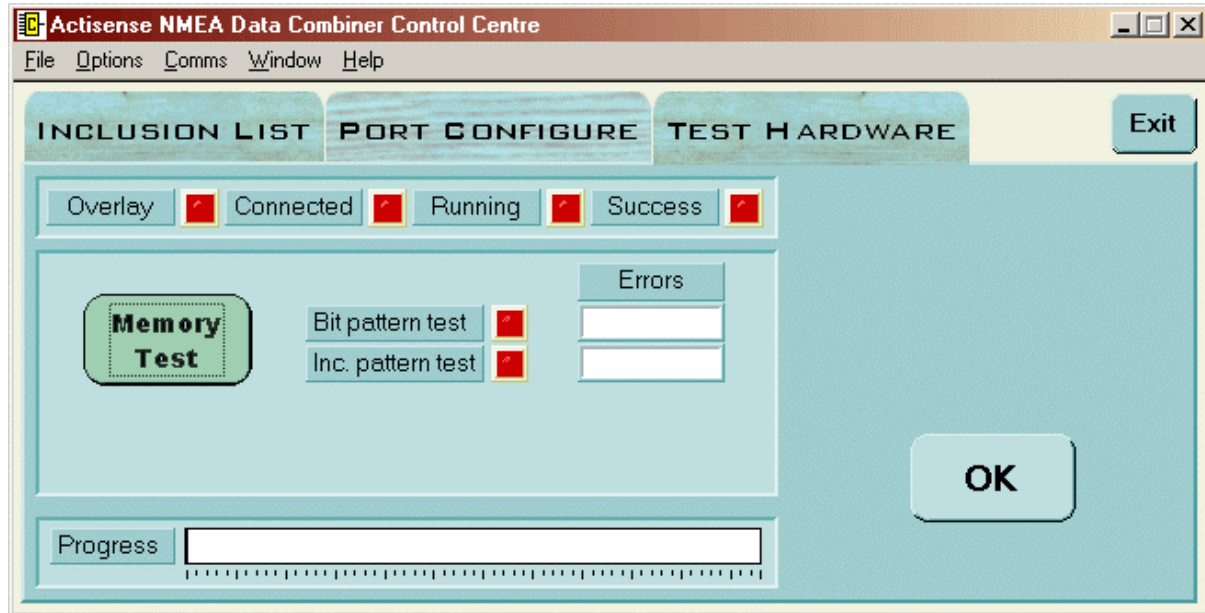
Test Hardware tab

Figure 10 – Control Centre Test Hardware tab

The Test Hardware tab of the main window enables the advanced user to test the NDC hardware's RAM. This operation will only require completion when the hardware is suspected of being faulty and at the request of an **Actisense** support team member.

The Test Hardware tab consists of four stage-status LED's (**Overlay**, **Connected**, **Running** and **Success**), an LED and associated 'Number of Errors' text box for each of the memory tests, a progress bar indicating progress of current stage, and the **Memory Test** and **OK** control buttons.

> **Memory Test:** initiates the memory test. The test currently underway is indicated by the associated test LED and any accrued error count is displayed in the 'Number of Errors' box.
>
> Once the memory test has completed, the NDC hardware will be reset and restarted.
>
> **OK:** resets the Test Hardware settings to allow for another test to be started by the **Memory Test** control button (if so desired).

If the test indicates a RAM error and all connections to the NDC hardware are proven correct, the user should consult the **Troubleshooting guide**.
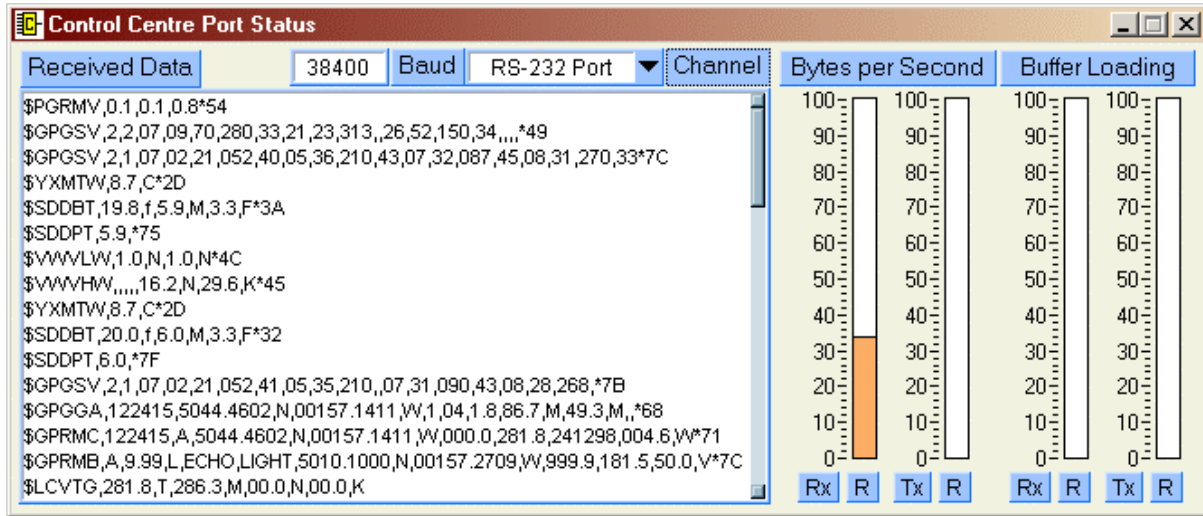
Control Centre Port Status window

Figure 11 – Control Centre Port Status window

The Control Centre status window displays all information relating to the communications port open between the Control Centre and the NDC hardware. This includes data received (from the NDC hardware) and data sent (to the NDC hardware), and the bytes-per-second transfer rate / buffer loading rate for both directions of the communications port.

This data is valuable in monitoring the performance of the NDC hardware, and as a diagnostic tool for pinpointing a port overload condition (this is when the maximum data transfer rate of a port is trying to be exceeded, and data is being lost as a result).
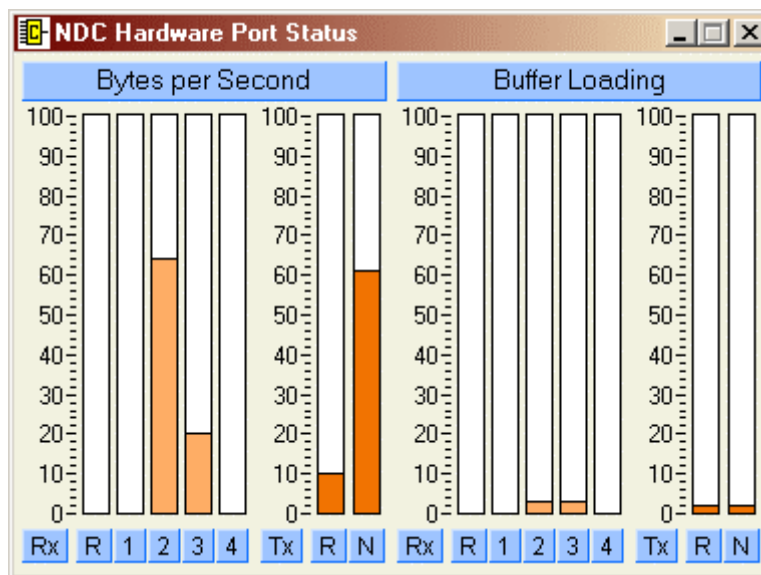
NDC Hardware Port Status window

Figure 12 – NDC Hardware Port Status window

The NDC hardware status window, like the **Control Centre Port Status** window, displays bytes-per-second transfer rates and buffer loading rates for a number of ports. However, these values relate to the ports on the NDC hardware – the four NMEA input ports, NMEA combined output port and the RS-232 input/output port.

This data is also valuable in monitoring the performance of the NDC hardware, and as a diagnostic tool for pinpointing an overload condition (refer to **Control Centre Port Status** for more details).

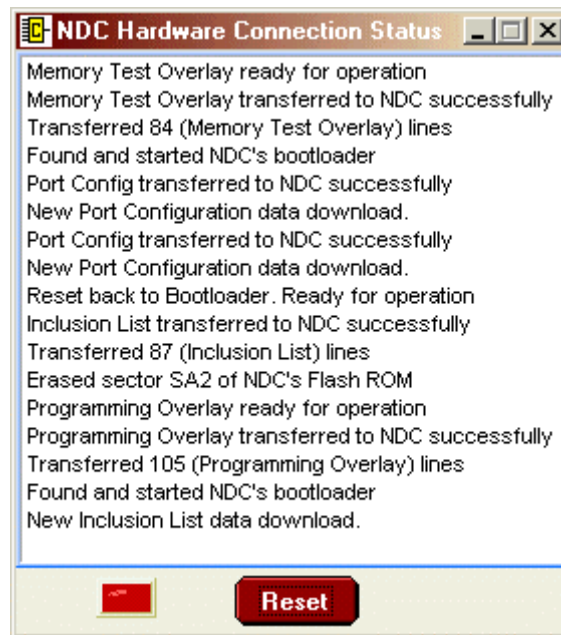## NDC Hardware Connection Status window

Figure 13 – NDC Hardware Connection Status window

The NDC hardware connection status window displays all information related to the connection status between the Control Centre and the NDC hardware. This includes all handshaking and data transfer information required for flash programming the NDC hardware during Inclusion List and Port configuration data updates.
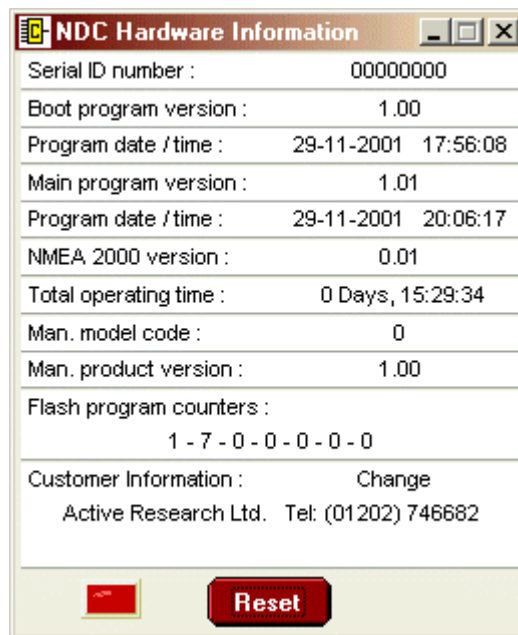
NDC hardware information window

Figure 14 – NDC Hardware Information window

The NDC hardware information window displays the information received from the NDC hardware after being requested by the Control Centre. This information Includes: -

1. The hardware Serial ID number – the unique serial identification number give to each NDC. This number is used to identify each NDC unit in our records.

2. The bootloader and main program software version numbers, and the program creation dates and times both of these.

3. The NMEA 2000 version currently supported by the NDC hardware. This will initially be "0.01", indicating that the NMEA 2000 specification is not currently available, as it is yet to be released. Once the NMEA committee finalise the standard, work will begin on providing a Flash update to expand the hardware's abilities to include NMEA 2000. Please visit the **Actisense** website for up to date information on this subject.

4. The Total time that the NDC hardware has been operating for since new.

5. The Manufacturers Model (0 = NDC) and product codes (hardware revision number).

6. The flash program counters for each sector of the hardware's Flash ROM.

7. Customer details (as known at time of despatch/initial program at factory).
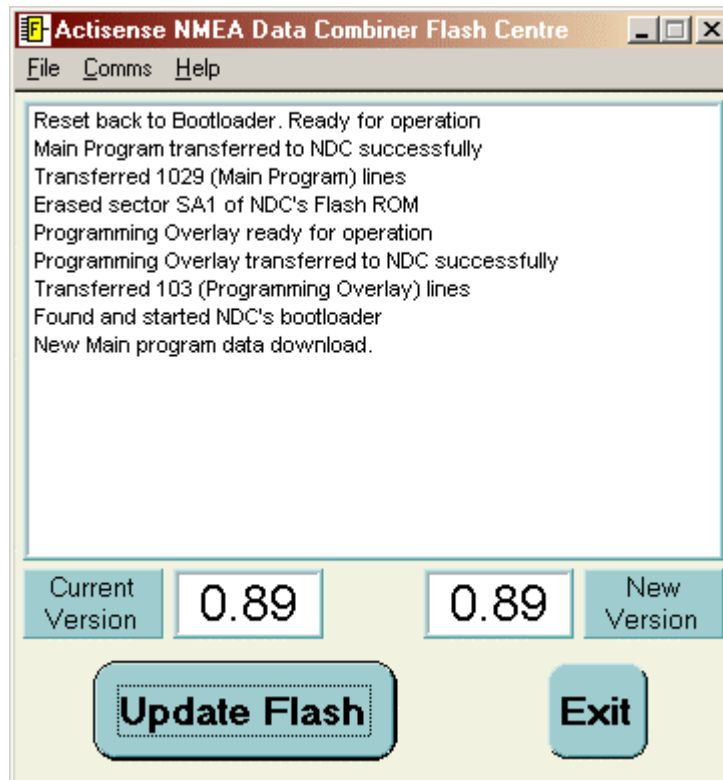
Using the Flash Centre

Figure 15 – Flash Centre main window

The Flash Centre main window has a very simple look, as the **Actisense** NDC main program flash update process has been completely automated for a trouble-free operation.

The NDC hardware should be connected to the PC communications port and a battery supply as per the instructions in the **Connecting to a Personal Computer** section and Figure 3 (RS-232, CAN Bus and Battery connections).

Pull-down menus

The main window has three standard pull-down menus: -

File → Exit: Closes the Flash Centre program.

Comms → Comm Port 1-5: Selects the PC communications port that the NDC hardware is attached to (via the extension cable).

Comms → Baud rate 19200-115200: Selects the PC communications port Baud rate to match that of the NDC hardware attached to the port. The baud rate will default to 38400 (the NDC hardware default). If received data errors are detected the Flash Centre will attempt to match the NDC hardware's Baud rate.

Help → **Flash Centre Help:** Displays the quick reference Flash Centre help information (a cut-down context sensitive version of this document).

Help → **About Flash Centre:** Displays the Flash Centre's software version number and the **Actisense** / Active Research Limited contact information.

Control Buttons and Text Displays

The Flash Centre main window consists of the **Hardware Connection Status** text box (identical that in the **NDC Hardware Connection Status** window of the Control Centre), **Current Version** and **New Version** text boxes, the update progress bar, and the **Update Flash** and **Exit** control buttons.

Connection Status: displays all handshaking and data transfer information required for flash programming the NDC hardware during the main program update.

Current Version: displays the main program version currently resident in the NDC hardware's Flash ROM. This is received from the NDC hardware when the Flash Centre detects the hardware's presence and requests the hardware information.

New Version: displays the main program version that the Flash Centre can upgrade the NDC hardware to. This number must be greater than the **Current Version** for an update to be required (and allowed) by the Flash Centre.

Figure 16 – Flash Centre "Hardware already up to date" message

If the **New Version** is older or equal to the **Current Version**, then the Flash Centre will block all attempts to update the NDC hardware – as there is nothing to be gained, and perhaps a reduction in functionality and performance.

Update Flash: initiates the flash update of the NDC hardware's main program. If the NDC hardware has not been detected, the Flash Centre requests a confirmation from the user.

Figure 17 – Flash Centre "Hardware not detected" message

As the message explains, if the diagnostic LED is lit and 'Green' in colour, check all cable connections, Flash Centre communication settings (port number and Baud rate) and battery power to the NDC hardware. Press the **Cancel** button. Once the problem has been found the **Current Version** box will display the hardware's version number and the **Update Flash** control button can be pressed.

If however, the diagnostic LED is lit and 'Red' in colour **AND** there was an interruption to a previous attempt to update the hardware's main program with the Flash Centre, reset the NDC hardware (by removing the battery power, waiting 5 seconds and then reconnecting the battery power), and press the **Continue** button.
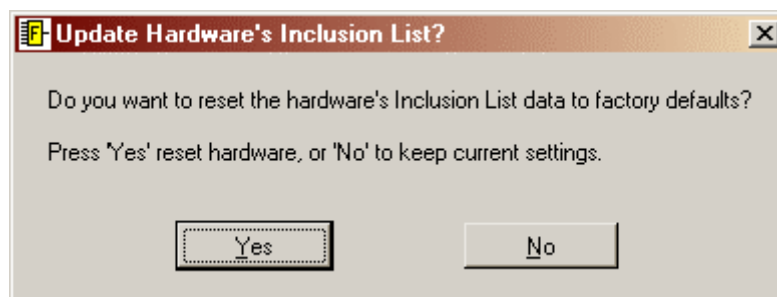

Figure 18 – Flash Centre "Update Hardware's Inclusion List" message

The final message displayed (or only message if there are no problems) asks the user if they require that the NDC hardware's Inclusion List be reset back to factory defaults, or kept as is. The normal answer is **No**, keep the current settings, but if the user would like to take this opportunity to reset the Inclusion Lists then select **Yes**.

The Inclusion Lists can also be reset back to the factory defaults by using the Control Centre (refer to **How to change the Inclusion Lists** section).
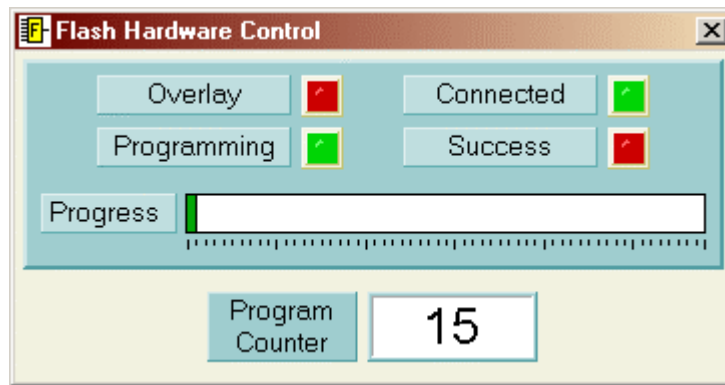
Figure 19 – Flash Centre Flash Hardware window

Once started the **Flash Hardware** window will be displayed and the progress indicated by the four-stage status LED's and the progress bar. The **Hardware Information Status** box will display the relevant information during the process.

The user is not required to interact with the process during the update. Once complete the NDC hardware will be automatically reset and the new **Current Version** number will be displayed (which now matches the **New Version** number).

Exit: once the flash process is complete (indicated in the text box and on the progress bar), the user can exit from the Flash Centre by press the 'Exit' control button. The 'Exit' button is not active during the flash process.

Please note that it is vital that during this process the Flash Centre and NDC hardware are not interrupted. Therefore, the following precautions are suggested: –

1. Ensure there are no programs active/running on the PC other than the Flash Centre.

2. Check the RS-232 cable between the PC and the NDC hardware is secure.

3. Confirm that the battery supply to the NDC hardware is secure.

If the Flash Centre operation is interrupted, the main NDC program will become corrupted. The user should identify and then remove the reason for the previous interruption and then attempt to flash the hardware again – by following the on-screen messages carefully.

Troubleshooting guide

This guide will concentrate on all relevant troubleshooting issues above simple cable connection faults. Therefore, the cables between the NDC hardware and any other device should be checked as a matter of course before continuing with this guide.

Diagnostic LED

The NDC hardware supports a tri-colour diagnostic LED that can indicate the current operating mode of the hardware and if any error has been detected during the self-test initiation process. Table 1 details what each LED colour represents and if any user interaction is required: -

LED Colour / Flash Count	Mode / Error condition	Required user response
Red, No flashing	Start-up mode, No error	No response required. A normal operation mode that should last for 1.5 seconds. Any longer indicates an error with the main program.
Amber, No flashing	Initialise and self-test mode, No error	No response required. A normal operation mode that follows after the Start-up mode and should last for approximately 1 second.
Green, No flashing	Normal and no data mode, No error	No response required. A normal operation mode that follows the Initialise and self-test mode. Indicates that no error was detected during the self-test operation. Also indicates that no data is currently being received by the NDC hardware.
Green, Flashing (1-10 per second)	Normal and data Rx mode, No error	No response required. A normal operation mode that indicates that data is currently being received (on at least one channel) by the NDC hardware.
	Error conditions.	If the error persists the NDC unit should be returned to **Actisense** (refer to the **Contact Information** section).
Amber, Flashing (Once every 4 seconds)	Error trap mode, EEPROM memory error	An error with the EEPROM memory has been detected during the self-test mode. Reset the NDC hardware.
Amber, Flashing (Twice every 4 seconds)	Error trap mode, RAM memory error	An error with the RAM memory has been detected during the self-test mode. Reset the NDC hardware.
Amber, Flashing (Thrice every 4 seconds)	Error trap mode, EEPROM memory error	An error with the EEPROM memory has been detected during the self-test mode. Reset the NDC hardware.

Table 1 – Diagnostic LED colours

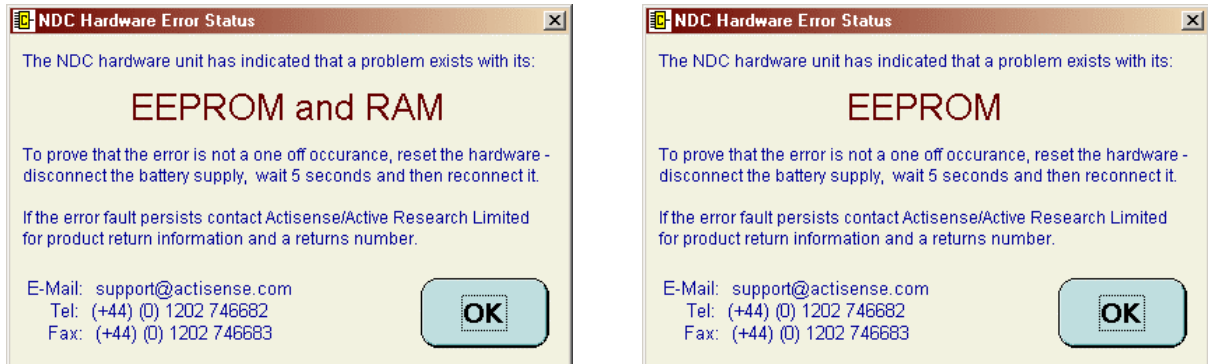## Control Centre Error Status window

Figure 20 – Control Centre Error Status window

The Control Centre will display any error information received from the NDC hardware in a window like those in Figure 20. If this window is displayed, follow the message instructions carefully and then contact **Actisense** / Active Research Limited.
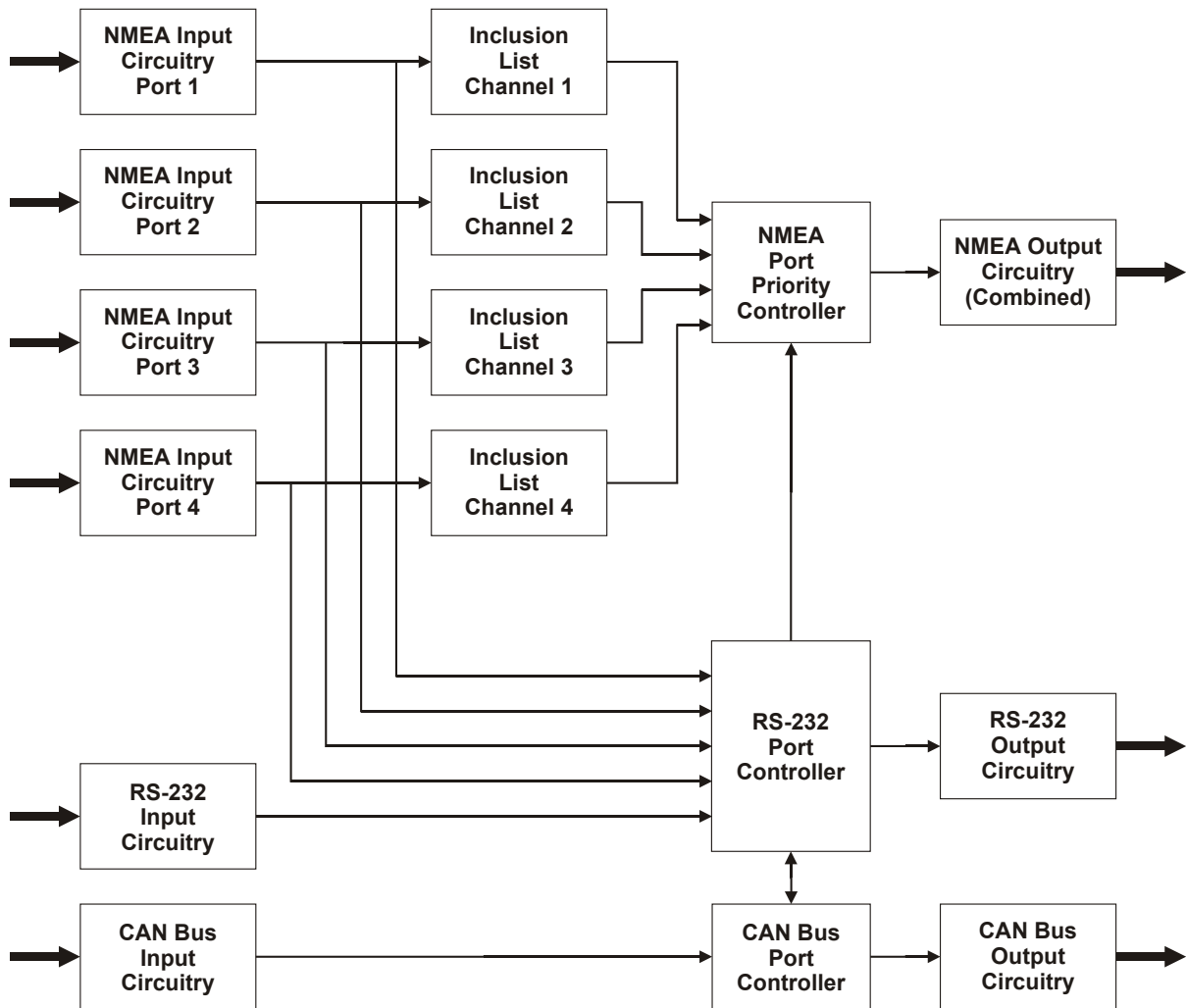
Block Diagram

Figure 21 – NMEA Data Combiner Block Diagram

Specifications

Symbol	Parameter	Conditions	Min.	Max.	Unit
Supply					
V_B	Supply voltage		7	28	V
I_B	Supply current	Supply voltage = 12v	100	110	mA
		Supply voltage = 24v	50	60	mA
NMEA					
$V_{NMEA\ I}$	Input voltage between +/-	Logical '1'/stop bit	-15.0	0.5	V
		Logical '0'/start bit	4.0	15.0	V
$I_{NMEA\ I}$	Input current	Maximum is under +35v overload condition	2.0	30	mA
$V_{NMEA\ ID}$	Differential input voltage	Required level for NMEA to be detected	1.8	2.0	V
$V_{NMEA\ O}$	Output voltage between +/- and ground (see note 1)	Logical '1'/stop bit	0.0	0.5	V
		Logical '0'/start bit	4.8	5.2	V
$I_{NMEA\ O}$	Output current (see note 1)		15.0	40	mA
$I_{NMEA\ SC}$	Output short circuit current.		35	250	mA
B_{NMEA}	Baud rate (see note 2)		2.4	9.6	kbit/sec
$t_{NMEA\ PD}$	Data propagation delay		1.0	100	ms
RS-232					
$V_{RS232\ IR}$	Input voltage range		-15	+15	V
$V_{RS232\ IT}$	Input voltage threshold	LOW	0.8	1.2	V
		HIGH	1.7	2.8	V
$V_{RS232\ O}$	Output voltage swing	Loaded with $3\kappa\Omega$ to Ground	±5	±9	V
$R_{RS232\ O}$	Output resistance	$V_{RS232\ O}$ = ±2V	300		Ohms
$I_{RS232\ SC}$	Output short circuit current (Infinite duration)			±18	mA
B_{RS232}	Baud rate		19.2	115.2	kbit/sec
$t_{RS232\ PD}$	Data propagation delay		1.0	100	ms

Symbol	Parameter	Conditions	Min.	Max.	Unit
CAN Bus					
$V_{CAN\ P}$	Supply voltage for CAN Bus circuitry (see note 3)		7	28	V
$I_{CAN\ P}$	Supply current for CAN Bus circuitry (see note 3)	Dominant bit (CANH/L)	-	70	mA
		Recessive bit (CANH/L)	-	18	mA
$V_{CAN\ HL}$	CANH, CANL input/output voltage		-8	+18	V
$R_{CAN\ I}$	CANH, CANL input resistance		5	25	kΩ
$C_{CAN\ I}$	CANH, CANL input capacitance		-	20	pF
$I_{CAN\ SCH}$	CANH short circuit current	CANH = -5V	-105	-120	mA
$I_{CAN\ SCL}$	CANL short circuit current	CANL = 18V	-	-160	mA
General					
T_A	Ambient temperature		-40	+80	°C

Table 2 – NDC specifications

All specifications are taken with reference to an ambient temperature (T_A) of +25°C.

Note:
1. NMEA output is RS-485 compatible.

2. NMEA 0183 stipulates the use of 4800 Baud (factory default). However, to maximise compatibility with other standards, the baud rate is selectable between values shown.

3. The Can Bus circuitry is power directly from the CAN Bus to conform to the NMEA 2000 standard specification of galvanic isolation.

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