Intuicom®

Navigator II™
Multifunctional Wireless Data Transceiver

User Guide

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Table of Contents

Table of Figures

1 Product Overview

1.1 General Description

The **Intuicom Navigator II** wireless data transceiver enables wireless connectivity for up to three RS232 devices. An optional internal GPS receiver enables position and time to be included in the wireless data stream as well as be utilized locally. Discrete inputs and outputs enable remote sensing of states or switch closures as well as remote control.

A Navigator II can play many roles in a wireless network including a remote slave, a slave/repeater or a network master transceiver. Typical applications employ many Navigator II transceivers as slaves wirelessly transmitting data to and from connected RS232 devices back to a central location where the data is made available via IP sockets.

Figure 1-1: Intuicom Navigator II Front Panel

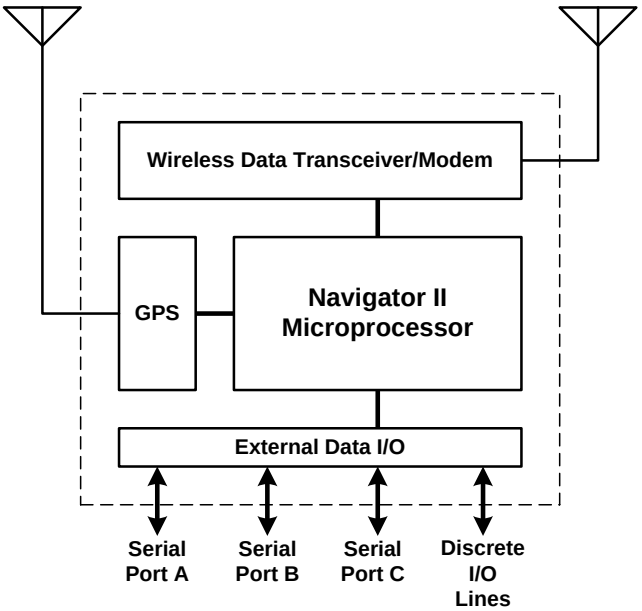


Figure 1-2: Navigator II Block Diagram

1.2 Features and Benefits

- Choice of license-free wireless bands. Intuicom Navigator II wireless data transceivers operate in the 900 Mhz and 2.4 Ghz ISM bands and do not require a FCC license (other special purpose/military bands including 225-400 Mhz available – contact Intuicom for more information regarding available bands).

- Exceptional wireless performance, range and bandwidth.

- Connectivity for up to three RS232 devices supporting interface baud rates from 1200 to 115,200 baud.

- Optional integrated GPS receiver for location-based applications. GPS PPS signal optionally available on Pin 1 of all ports.

- Discrete inputs and outputs for remote sensing and control (up to four inputs and three outputs with RS232 signal levels).

- Highly flexible and configurable features including: data buffering, I/O routing, data bursting (Intuicom Adaptive Multipoint), data port prioritization, remote diagnostics and configuration, and GPS data compression.

- Easy integration for remote devices with third party applications using Intuicom Nav-Link server software and standard IP sockets. Bi-directional wireless communication with remote serial devices attached to Navigator II units is made available on dedicated IP sockets at a central location.

- Ability to operate in different modes (roles) in a network including slave, slave/repeater, repeater, or master. Additionally DIRECT mode allows for two Navigator IIs to operate as peers and create a 3 port serial mux or a 2-port serial mux with the ability to receive a GPS data stream from the remote unit, or a 2-port serial mux with discrete inputs and outputs.

- Compact and ruggedized enclosure offering easy portability and mounting (waterproof enclosed units available).

- Ability to operate using different wireless (over the air) protocols to tailor performance to suit your specific application.

1.3 Common Applications

The Intuicom Navigator II can provide the key communications component to a wide variety of customer applications including:

- **Seismic monitoring** – Simultaneously returning real-time data from multiple seismometers in the field.
- **Weather network data collection** – Returning real-time weather data from multiple weather stations and data collectors in the field.
- **Structural monitoring** – Returning strain gauge and GPS data from structures such as bridges, dams and buildings.
- **Subsidence monitoring** – Streaming GPS data in real time to monitor the ground motion of a given geographic area.
- **Marine towed buoy array** – Buoy to ship communications returning GPS or other sensor information.
- **Automatic Vehicle Location (AVL) and Messaging** – Real-time location information from vehicles as well as bi-directional messaging to mobile data terminals.
- **Device remote control** – Remote control of power switching as well as remote state (discrete) monitoring.
- **SCADA** – Wireless communication with remotely located MTUs.
- **Wireless Serial Multiplexing** – Using a single radio link to create multiple, multiplexed serial-to-serial links.

1.4 Example Network Architecture

Figure 1-3 depicts one example of an Intuicom Navigator II network. In this application three Navigator II units are operating as slaves, each with two attached serial devices. An Intuicom Communicator II is operating as a repeater, and another Communicator II is operating as the network Master transceiver. Intuicom Nav-Link server software is installed on a PC attached to the Master transceiver and acts as the gateway between IP sockets and individual remote serial ports.

Note: *While Navigator II units can play any role in a Navigator II based wireless network, Intuicom Communicator II basic transceivers can only operate as repeaters or as the Master. Often times it is easier to have a single model of unit that can play any role in a network and thus be a potential spare for any network role.*

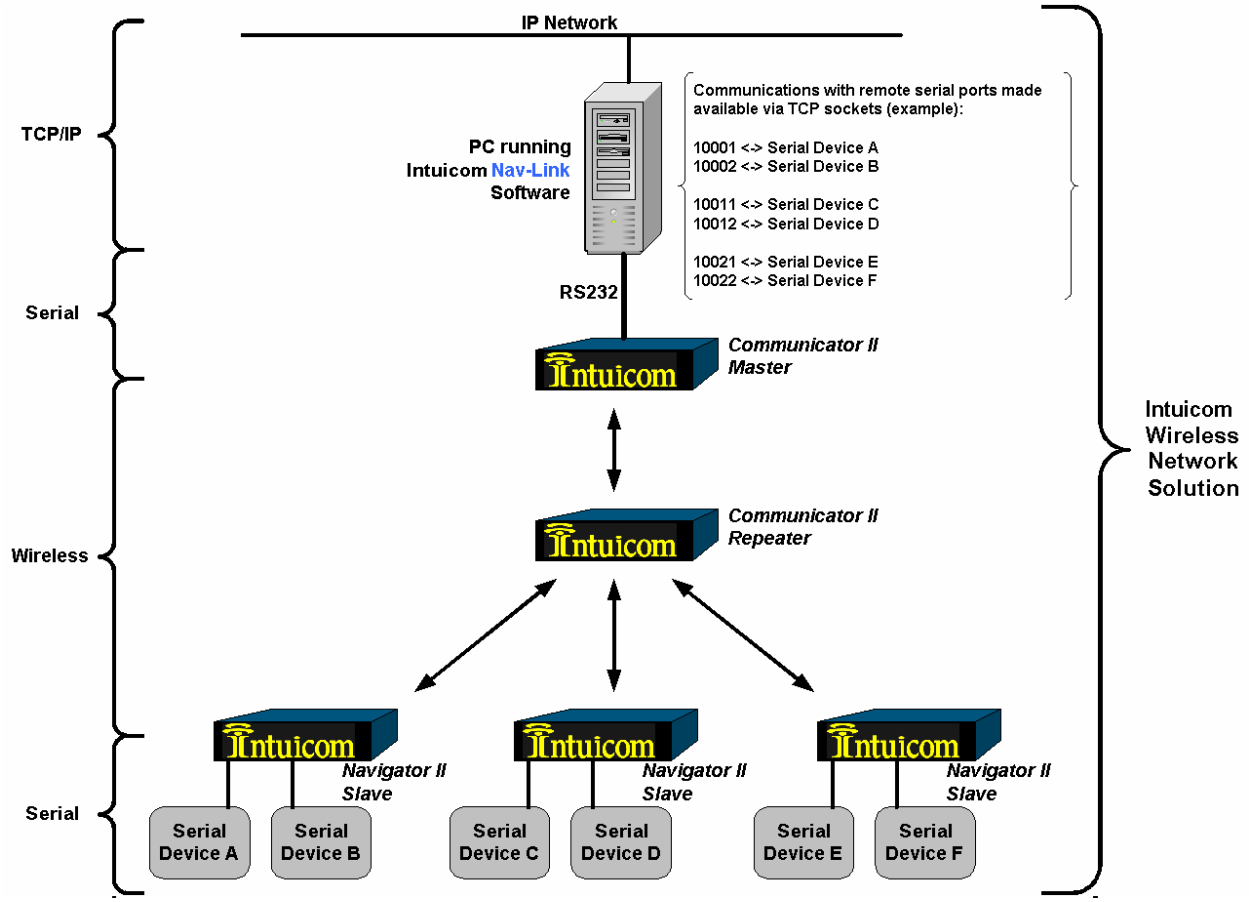


Figure 1-3: Example Intuicom Navigator II Network

2 Configuration

The Intuicom Navigator II is highly flexible and requires some degree configuration before use. Because the Navigator II can be configured for different roles in a wireless network, this section covers all configuration options in detail and highlights key configuration steps for specific network roles.

The Navigator II can operate in any of the following roles:

- As the **Network Master** – There must be one and only one Master transceiver in an Intuicom wireless network. The Network Master, along with Intuicom Nav-Link gateway software controls the wireless network and serves as the central gateway between the wired and wireless. When the Navigator II is operating as the Network master, Port A is dedicated for wireless diagnostics, Port B is dedicated for data, and Port C can output data from the optional integrated GPS receiver. An Intuicom Communicator II transceiver can also serve the role of the Network Master.

- As a **Network Slave** – A Network Slave is the most common role for a Navigator II. When operating as a Network Slave, the Navigator II can transfer data to and from devices attached to its serial port as well as to and from its integrated GPS receiver is one is installed.

- As a **Network Repeater** – When operating as a Network Repeater, the Navigator II is only utilizing its integrated wireless data transceiver to repeat signals from other slaves/repeaters/master, etc. An Intuicom Communicator II transceiver can also serve the role a Network Repeater.

- As a **Network Slave/Repeater** – A Navigator II has the ability to operate as a Network Slave and a Network Repeater simultaneously – both transferring data to and from locally attached serial devices as well as repeating signals for other units in a given network.

- In **Direct Mode** – Direct mode is a special mode allowing two Navigator II transceivers to communicate as peers, essentially creating a multiplexed wireless serial link mapping Port A of one of the Navigators to Port A of the other, and the same with Ports B and C. In addition, the state of the input discretes can be reflected via the discrete outputs of the other unit.

Commonly a network consists of one Network Master and many Network Slave Navigator II transceivers.

To make initial configuration easy and quick the Navigator II has a number of **Default Configuration Profiles** available that can be activated to automatically configure a majority of its settings and get the units to a known operational state. Intuicom suggests that one of the default configuration profiles be used as an initial step, and then the configuration of a unit be customized with individual configuration settings from that point.

The default configuration profiles can be used to configure the Navigator II as a **Network Master**, a **Network Slave** or a **Network Slave** employing Intuicom **Adaptive Multipoint**. A network can have only one Master. See **Section 2.5.8** for details of how to invoke a default configuration profile.

Note: The **Default Configuration Profiles** use default values for key configuration parameters that are used to separate wireless networks from one another. Intuicom suggests changing parameters such as Network ID (**Section 2.4.6**) and Frequency Key (**Section 2.4.4**) from the default values on all transceivers within a network to create a unique wireless network.

Figure 2-1 depicts a suggested process for configuring a Navigator II. This process is repeated for each Navigator II in a network.

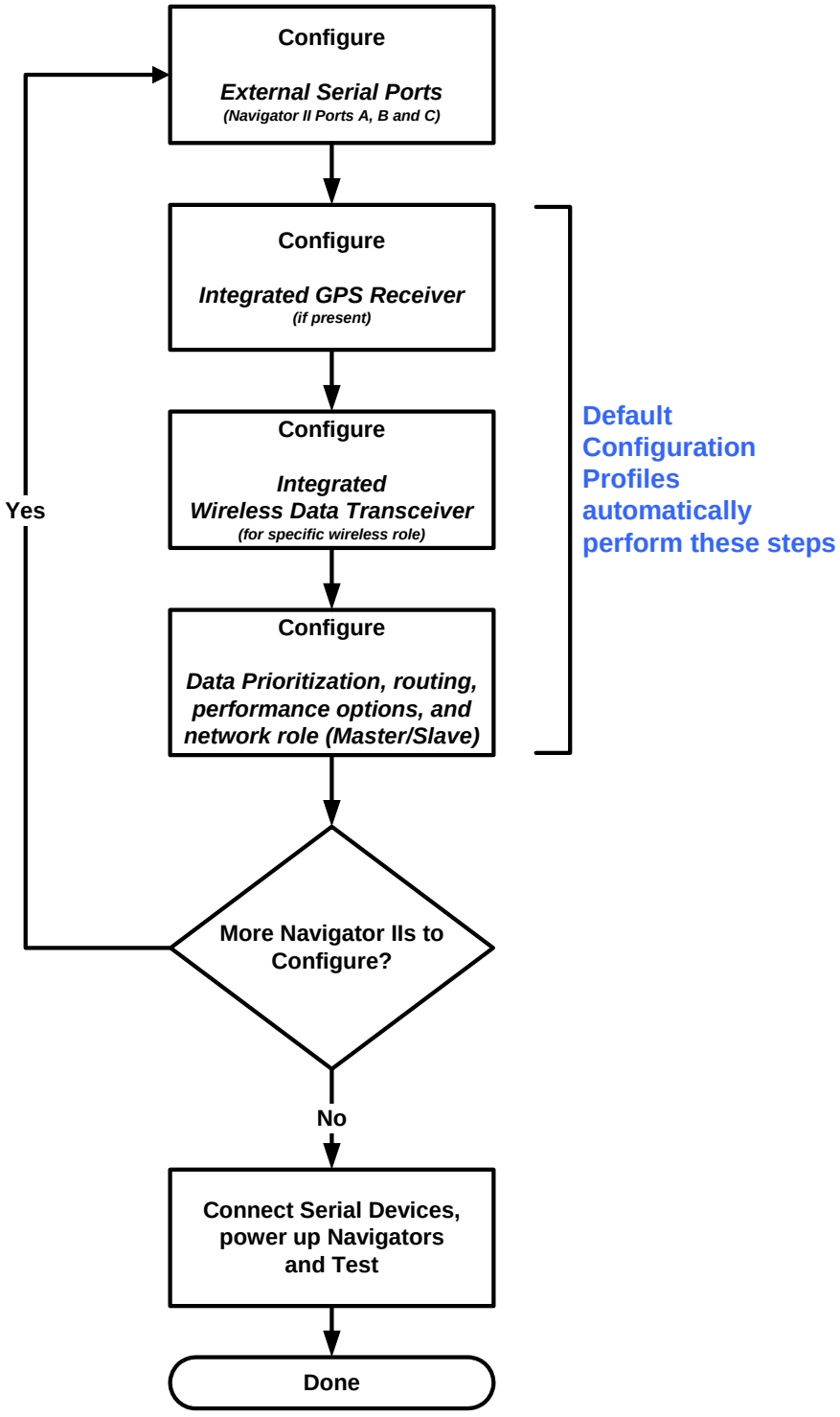


Figure 2-1: Navigator II Configuration Process Flowchart

2.1 Accessing the Navigator II Setup Menu

The Navigator II is configured via a serial connection using a terminal emulation program such as Windows HyperTerminal or Symantec ProComm. Interacting with the Setup menu is not platform specific; a terminal emulator on Unix/Linux, PalmOS, Pocket PC, etc. have been tested and work. Configure the terminal emulation application for:

Parameter	Setting
Baud Rate	19200
Data Bits	8
Parity	None
Stop Bits	1
Flow control	None

Table 2-1: Serial Settings to Access Setup Menu

The Navigator II Setup Menu is accessed by connecting a straight through serial cable (non-null) between the PC and Port B then pressing and holding the Setup Button for approximately three seconds or until the menu appears **Figure 2-3**. All three status LEDs will turn green once the setup menu has been activated.

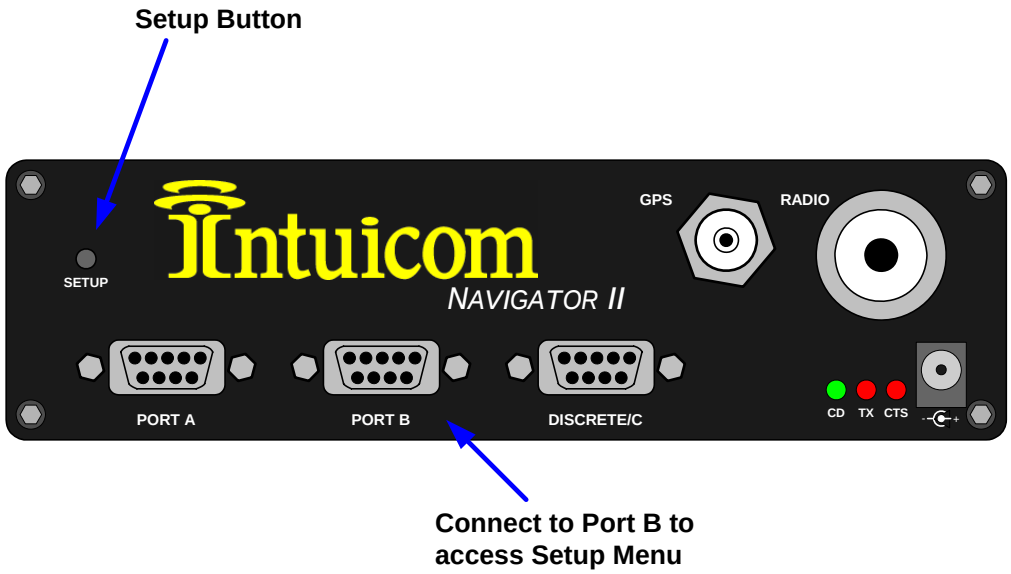


Figure 2-2: Setup Button and Setup Serial Port

To exit the Navigator II Setup Menu, press the **ESC** key (send and ESC sequence). Pressing the **ESC** key will always exit the current menu and return to the previous menu. It is recommended that when configuration is complete the **ESC** key be pressed a number of extra times to ensure that Setup Mode is fully exited. The unit returns to Run Mode when not in Setup Mode.

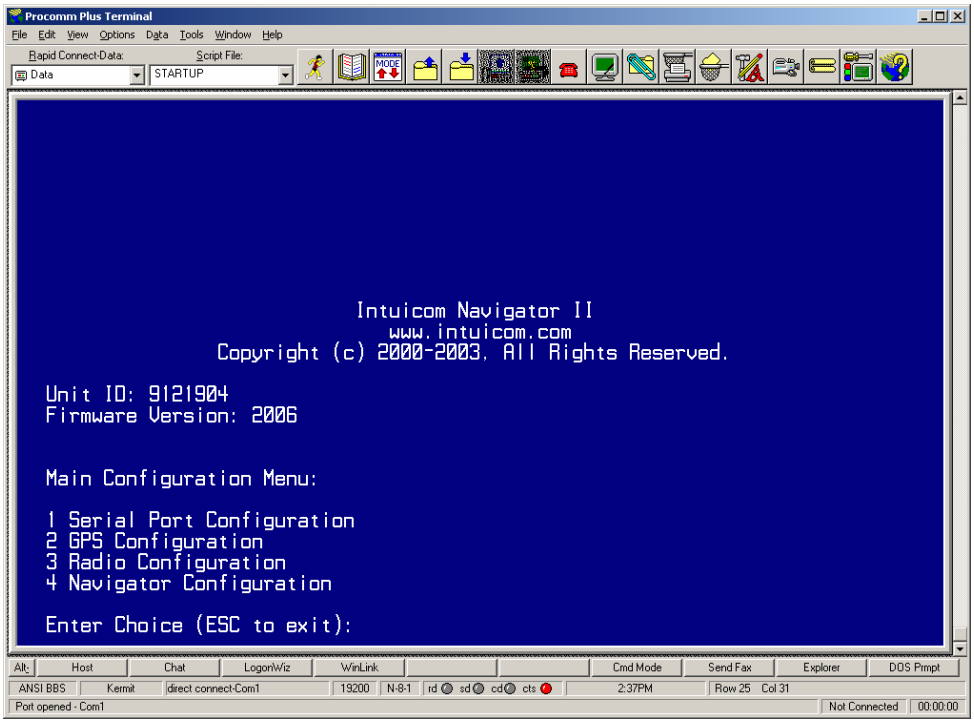


Figure 2-3: Navigator II Main Setup Menu

2.2 Serial Port Configuration

Option (**1**) from the Main Menu displays the Serial Port/Interface Configuration Menu shown in **Figure 2-4**. From this menu, select the interface to configure. Serial Ports A, B and C are available on the front panel of the unit. The baud rates for Ports A, B and C are not automatically configured when using Default Configuration Profiles.

Port C is a special port. If an optional integrated GPS receiver is present, Port C may be internally connected to the GPS secondary port for the purpose of transmitting DGPS corrections. When connected internally to the GPS, the configured baud rate must match that of the GPS secondary port. If communication with the internal GPS on its secondary port is not required, Serial Port C can be connected to the front panel using internal jumpers. If Port C is connected to the front panel it is configured and behaves like any other port.

Note: When Port C is connected to the front panel, two input and two output discrete I/O lines are disabled (as they are used for the serial interface). See **Section 7** for internal jumper settings required for Serial Port C redirection.

Note: When using DIRECT mode, Port C hardware flow-control should never be enabled.

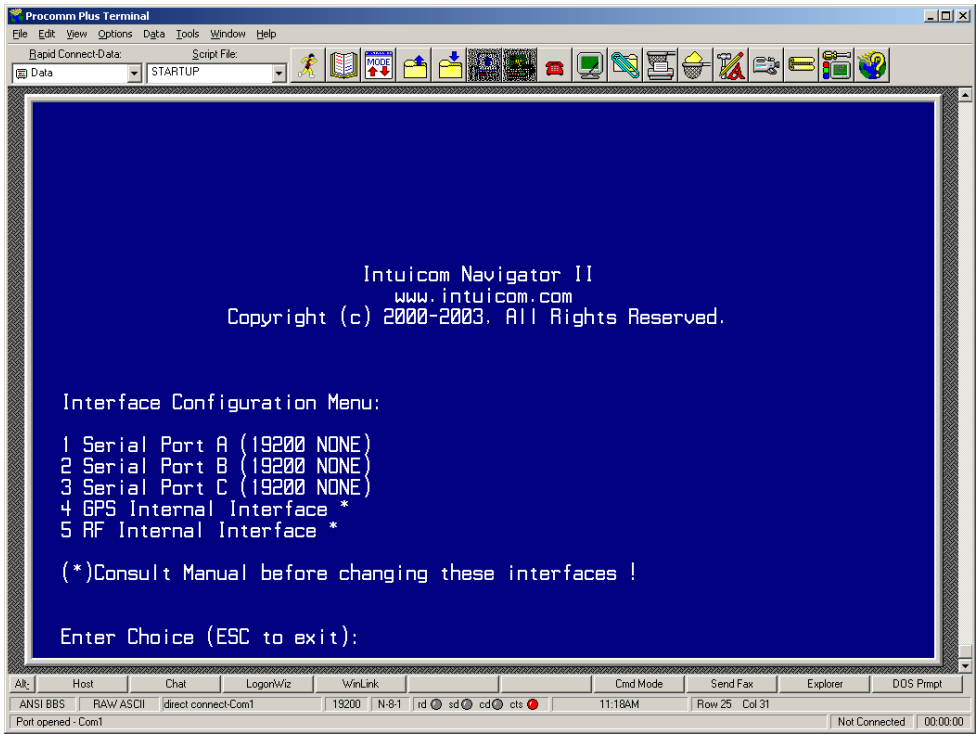


Figure 2-4: Serial Port Configuration Menu

Interface Configuration Menu Option (**4**) refers to the baud rate for the primary internal GPS interface, and is factory configured to match the GPS. If the internal GPS's primary port baud rate is changed (see **Section 2.3.2**), this baud rate must match. Note that the A12 GPS option does not support 38400 bps. If a Default Configuration Profile is selected, the GPS baud rate will be automatically configured.

Option (**5**) refers to the baud rate between the Navigator Microprocessor and the integrated Wireless Data Transceiver. The default baud rate for this interface is 115,200 bps with hardware flow control disabled. This baud rate must match the configured baud rate of the internal Wireless Data Transceiver (see **Section 2.4.2**). It is suggested that this baud rate never be changed, hardware flow control is automatically disabled when operating in Adaptive Multipoint Mode (see **Section 2.5.3**) for more information about Adaptive Multipoint). If a Default Configuration Profile is used, the baud rate and flow control settings will automatically be configured.

Figure 2-5 shows the configuration menu for an individual serial port. The current configuration is shown at the top of the menu with options below for changing baud rate and flow control.

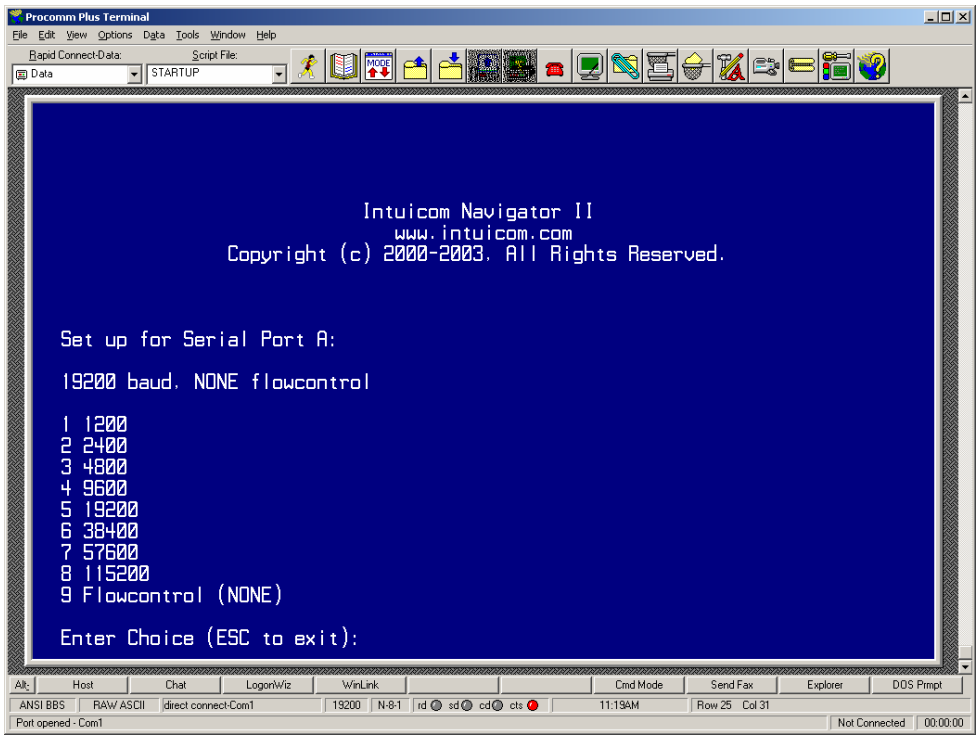


Figure 2-5: Serial Port A Configuration Menu

2.3 GPS Configuration

Main Menu Option (2) allows for configuration of the internal GPS receiver if one is installed. The type of installed GPS receiver is shown at the top of the menu. Configuration commands are specific to the type of receiver installed. The type of receiver installed is set at the factory - see **Section 2.5.5**.

The options for the type of internal GPS receiver include:

- Thales Navigation (Ashtech) A12
- CMC Superstar II
- Other (this option is intended for OEM users integrating another type of GPS receiver)

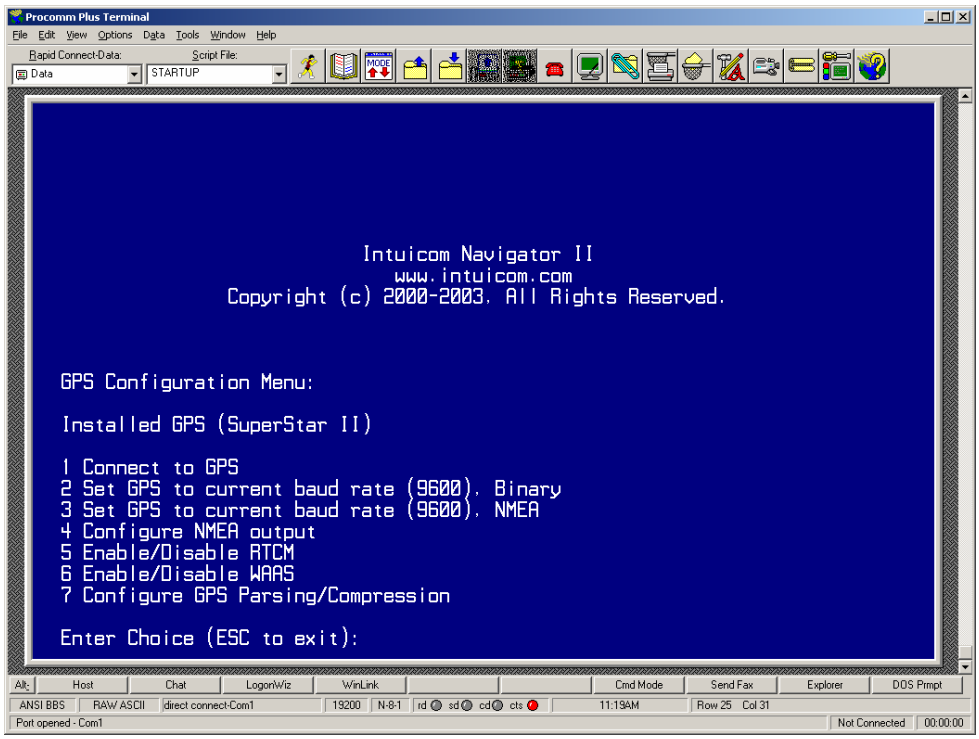


Figure 2-6: GPS Configuration Menu

2.3.1 Connect To GPS

This option connects the terminal session directly to the internal GPS allowing the user to directly see the current GPS output, and to send commands to the GPS. This option is useful when it is necessary to issue specific configuration commands to the GPS that are not provided in the setup menu and to verify correct GPS operation. Note that while the currently configured baud rate of the primary GPS interface may be different that the fixed setup baud rate (19,200 N81), communication is still possible. For example, the Navigator Microprocessor may be communicating with the GPS at 9600 baud while translating this baud rate to the setup session at 19,200. It is important to note that if a command is issued to change the GPS baud rate, the new baud rate will have to be matched in the Navigator II configuration (see **Section 2.2**).

2.3.2 Set GPS to Current Baud Rate (xxxx), Binary

This command forces the GPS to be set to the currently configured GPS Interface baud rate, and enables binary mode communications (if available). The currently configured GPS Interface baud rate is displayed in the option title (in **Figure 2-6** it is shown as 9600 Baud).

2.3.3 Set GPS to Current Baud Rate (xxxx), NMEA

This command forces the GPS to be set to the currently configured GPS Interface baud rate, and enables NMEA mode communications. The currently configured GPS Interface baud rate is displayed in the option title (in **Figure 2-6** it is shown as 9600 Baud).

2.3.4 Configure NMEA Output

This option allows the user to configure the NMEA output of the internal GPS receiver. A menu listing the available NMEA strings is shown. When a user selects a string the user is prompted for an update rate in seconds. If the string number is selected again, that string will be turned off, and if that string is selected again, no action will be taken regarding that NMEA string when the configuration is committed to the GPS. Configure any number and combination of strings and then select menu option (9) to commit the configuration changes to the GPS receiver.

Note the Period refers to the update rate for the selected NMEA string in seconds, i.e. a setting of 5 would instruct the GPS receiver to output that string every 5 seconds. Not all periods are supported.

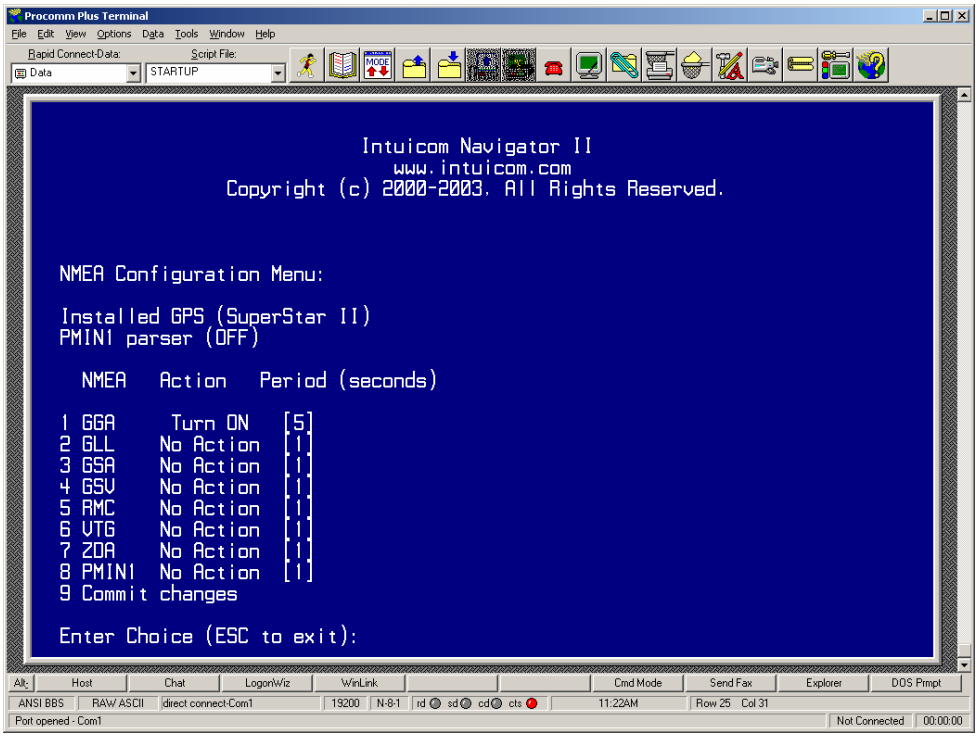


Figure 2-7: GPS NMEA Configuration Menu

After configuring the NMEA output, return to the GPS Configuration Menu and select "Connect to GPS" to confirm the correct output.

The $PMIN1 is a proprietary Intuicom NMEA string that combines the unique data from the $GPRMC and $GPGGA messages into a single string to save bandwidth by eliminating redundant data. The $PMIN1 string has the following format:

```
$PMIN1,9069800,231524.00,4001.1856,N,10512.9904,W,0.1,164.2,1604.1,170602,,*03
       |       |          |        |   |         |  |    |     |        |
       |       |          |        |   |         |  |    |     |        DDMMYY
       |       |          |        |   |         |  |    |     Altitude(m)
       |       |          |        |   |         |  |    Heading(degrees)
       |       |          |        |   |         |  Speed(knots)
       |       |          |        |   |         E/W – East or West
       |       |          |        |   Longitude
       |       |          |        N/S – North or South
       |       |          Latitude
       |       hhmmss.ss
       Unit ID
```

Figure 2-8: $PMIN1 NMEA String Data Format

2.3.5 Enable/Disable RTCM

This command enables of disables the acceptance of RTCM DGPS corrections for the GPS receiver. Note that in addition to enabling corrections, Port C must be configured to connect to the internal secondary GPS interface (see **Section 7.3** for internal jumper settings), and the baud rate must match that of the secondary GPS interface.

2.3.6 Enable/Disable WAAS

This command enables or disables the use of WAAS GPS corrections if supported on the internal GPS receiver. Note that only the A12 GPS option support WAAS corrections.

2.3.7 Configure GPS Parsing/Compression

The Configure GPS Parsing and Compression Configuration Menu allows the user to enable the parsing of NMEA data from the internal GPS receiver (thus verifying checksums) or any GPS receiver that may be attached to one of the external serial ports. NMEA parsing is a requirement to enable proprietary NMEA string such as $PMIN1.

Enabling the GPS parser only allows whole strings to be transmitted over the wireless link, thus any packet wirelessly transmitted will contain a complete NMEA string if it contains any GPS data at all.

Enabling GPS Data Compression saves wireless network bandwidth. Enabling GPS data compression on the internal GPS Interface will cause the Navigator II microprocessor to

compress NMEA messages $GPRMC and/or $GPGGA, and/or $PMIN1 before sending the data over the wireless link. Intuicom Nav-Link Server software running at the central site attached to the Network Master wireless data transceiver must be configured to decompress these messages and output the original NMEA string. GPS Data Compression is also available for GPS receivers attached to any of the external serial ports providing the external GPS receiver's output is limited to the NMEA GGA or RMC strings. See the ***Intuicom Nav-Link User Guide*** for more information about configuring GPS data de-compression.

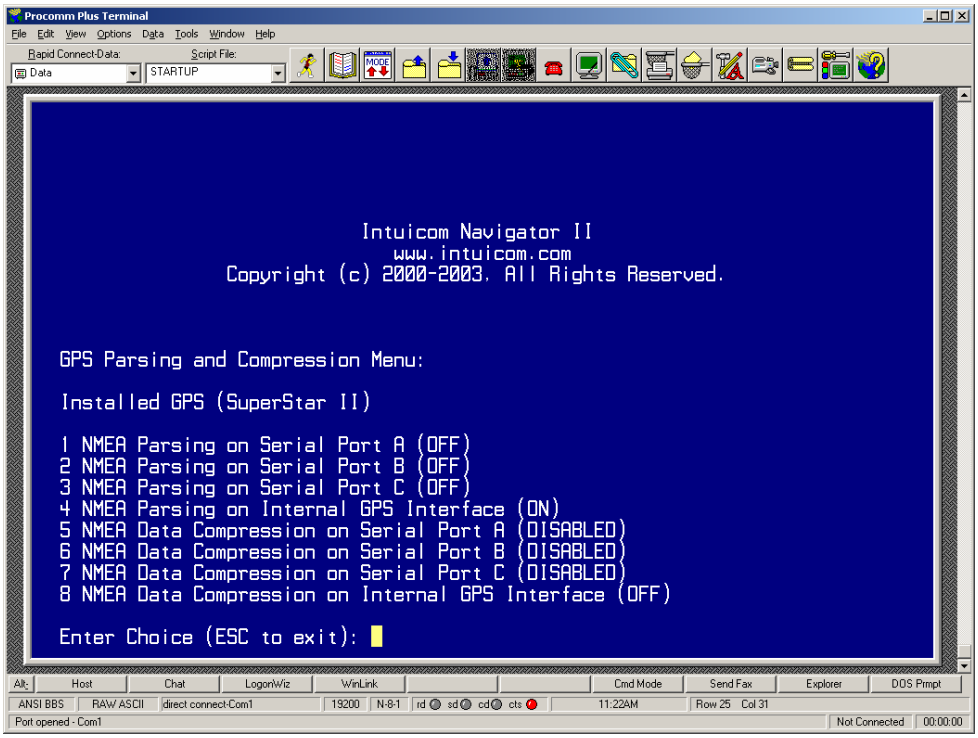


Figure 2-9: GPS Parsing and Compression Configuration Menu

2.4 Radio Configuration (Wireless Data Transceiver)

Main Menu Option (**3**) allows the user to configure the internal wireless data transceiver. Configuration of the Wireless Data Transceiver is key to the Navigator IIs operation and to what "role" it plays in a wireless network.

Because the wireless data transceiver core is uniform across Intuicom products, the ***Intuicom Communicator II User Guide*** is recommended for supplementary and supporting detail for the configuration of the modem.

When using the **Default Configuration Profiles**, configuration of the integrated wireless data transceiver is performed automatically. Use this menu option to fine-tune or customize these settings.

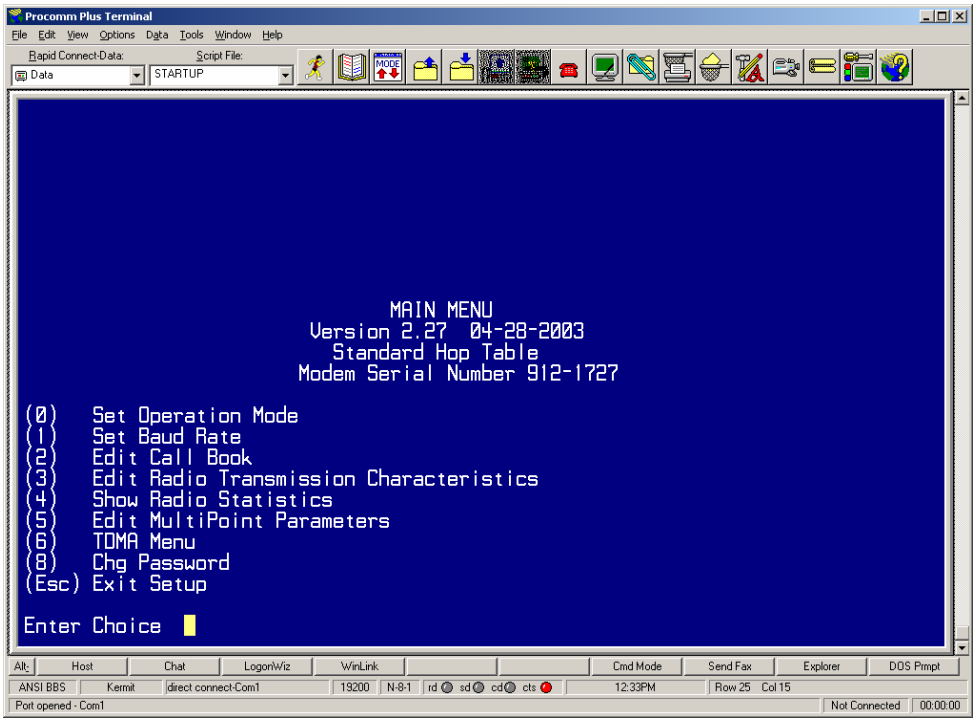


Figure 2-10: Wireless Data Transceiver Configuration Menu

2.4.1 Operation Mode

Depending upon the role chosen for a Navigator II's in the network, an operation mode must be selected for the wireless data transceiver. The most common role for a Navigator II is to operate as a slave with other Navigator IIs, thus the appropriate operation mode is "Point to Multipoint Slave". If the Navigator II is to operate as the master in a network, "Point to Multipoint Master" is the appropriate mode. For Navigator IIs operating as

repeaters or slave/repeaters, choose “Point to Multipoint Repeater”. For TDMA configuration and operation, refer to the ***Intuicom TDMA Design and Configuration Guide***.

2.4.2 Set Baud Rate

This menu configures the interface between the wireless data transceiver and the Navigator II microprocessor. It is suggested that all settings in this menu remain at their factory defaults specifically:

Baud Rate:	**115,200**
Data Parity:	**0**
MODBusRTU:	**0**
RS232/485:	**0**
Setup Port:	**3**
TurnOffDelay:	**0** TurnOnDelay: **0**
FlowControl:	**0**

2.4.3 Edit Call Book

The call book is a method of explicitly specifying the other transceivers with which this unit can communicate. Intuicom Wireless Networks generally use a Network ID to identify a group of transceivers that can communicate (Network ID parameters are located under the Edit Multipoint Parameters menu **Section 2.4.6**). Thus for most situations all call book entries are left blank 000-0000.

If the call book is utilized, the Network ID must be set to 255. List call book entries to specify which units, and through which repeaters, communication is possible.

2.4.4 Edit Radio Transmission Characteristics

When item (3) is selected in the Radio Configuration menu the screen in **Figure 2-11** appears, which allows the user to modify the radio transmission characteristics of the transceivers. As stated in the warning on the screen, these parameters are for the user who has a good understanding of the principles of radio data transmission. They should be changed only after consulting this manual.

Note: When operating in point-to-point mode the radio parameters set for the point-to-point master will override the settings for the point-to-point slave and repeater(s) in the link for all but RF Xmit Power, Slave Security, and Retry Time Out.

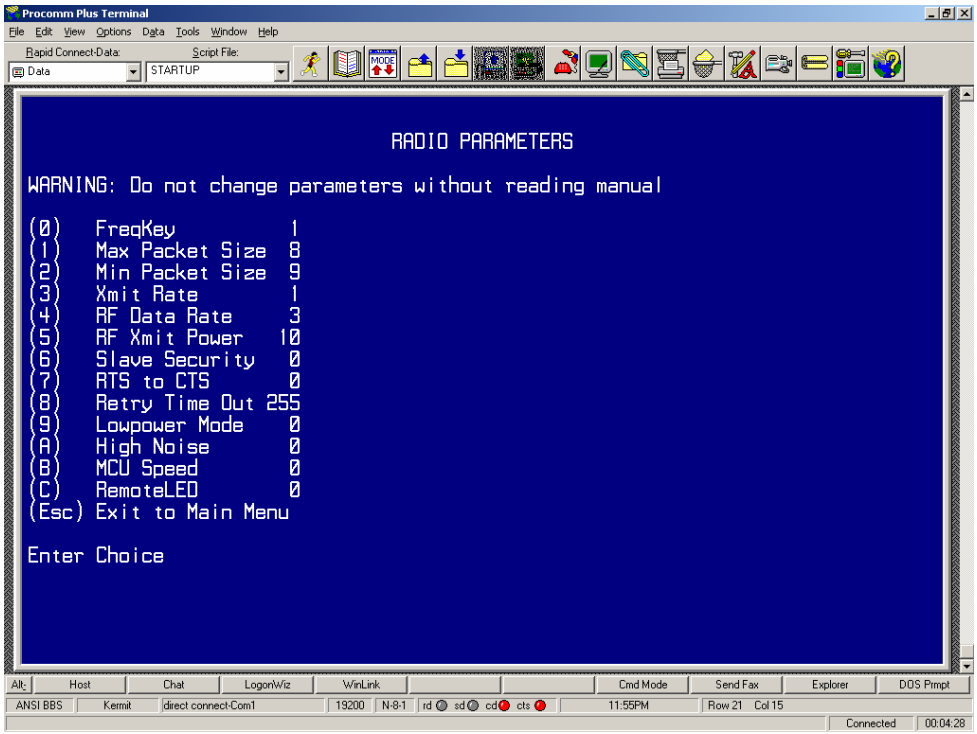


Figure 2-11: Radio Transmission Parameters

In addition to settings unique for a given wireless network, there are a number of settings that must not be changed from their default values for correct Navigator II operation.

FreqKey (Menu Option 0)

Selection (0) in the Radio Parameters menu allows the user to modify the hopping patterns of the transceivers to minimize the interference with other Communicator II transceivers in operation in the area. For instance, if there were 10 pairs of transceivers in operation within a factory or refinery, changing the Frequency Key would ensure that they would not jump onto the same frequencies at the same time for the same length of time.

There are 15 choices available for the Frequency Key (0-9 and A-E), representing 15 different pseudo-random patterns.

A selection of 'F' provides additional options to use different portions of the 902-928 MHz band.

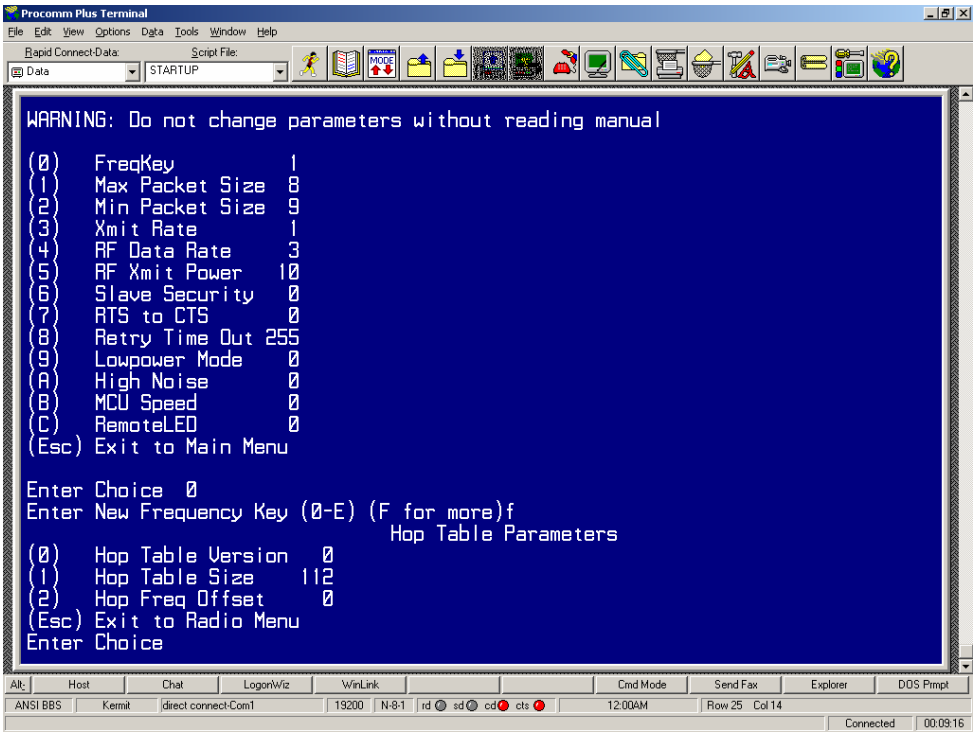


Figure 2-12: Hop Table Parameters

Hop Table Version allows the user to choose the portion of the band in which the transceiver will operate. These choices are show in the table below:

Selection	Name	Band
0	Standard	Full 902-928 MHz
1	Australia	915-928 MHz
2	International	902-928 MHz, 16 fewer frequencies than full US set
3	Taiwan	916-920 MHz
4	New Zealand	921-928 MHz
5	Notch	Uses 902-928 with center frequencies of 911-919 notched out
6	Brazil	902-915 MHz

Table 2-2: Frequency Bands 900 Mhz

Note: Do NOT use Freq Key 14 (D) with the Australia (915-928MHz) hop table

Hop Table Size allows the user to select, within a specified band,the number of frequencies to be used ranging from 50 to 112.

Hop Freq Offset is not functional in the 900 MHz spread spectrum transceiver.

Note: Irrespective of the Freq Key used, all transceivers in either point to point or point to multipoint networks must be set to identical Hop Tables and Table Size (number of frequencies).

Additional Frequency information for 2.4GHz transceivers

The Frequency Key for the 2.4GHz transceivers offers the ability to select more than just a different pseudo random hop table, but also the portion of the band that the transceiver will use. Because this feature offers the ability to select which portion of the spectrum will be used it is critical that all radios in a link, whether point-to-point or point to multipoint, use the same selections.

Frequency Key Selections 0-E provide 15 different pseudo random hop tables, similar to the 900 MHz transceiver. A selection of 'F' allows the user to set the Hop Table parameters. The user is then presented with 3 additional choices

Hop Table Version allows the user to determine which portion of the band to use:

Selection	Band Used
0	Entire band, 2.400 - 2.4835 GHz
1	Entire band, but offset frequencies from selection 0
2	Lower 1/3rd of band
3	Middle of band
4	Upper 1/3rd of band
5	2 outer 1/3rds of band, avoids the middle

Table 2-3: Frequency Band Selection 2.4 Ghz

Thus, setting one network up with selection 0 and the second network with selection 1 could set two networks up side by side using the entire band without collisions.

Hop Table Size allows the user to set the size (number of frequencies) of the hop table to use. The range available is from a minimum of 50 to a maximum of 80.

Hop Freq Offset allows the user to select a frequency offset, whereby the frequencies used are offset by 115.2 KHz from other frequency selections in the same portion of the band. For example, if 2 networks are operating side by side in the lower 1/3rd of the band using 50 frequencies, with one set to Frequency Offset of 0 and the other to Frequency Offset of 1, the frequencies used in the different hopping patterns will be offset by 115.2 KHz

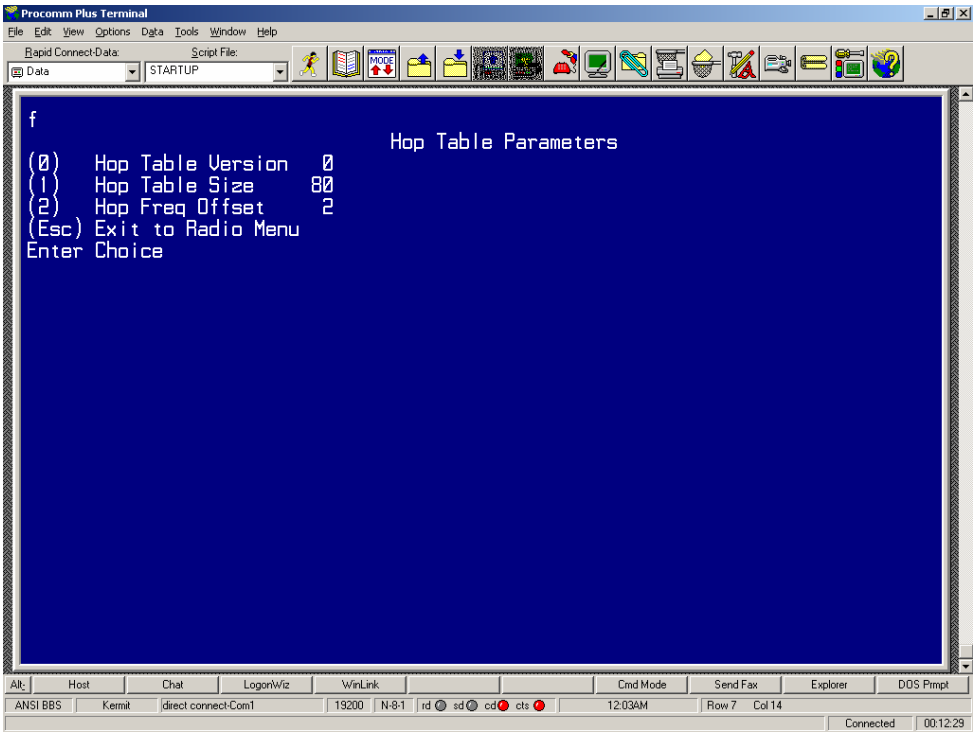


Figure 2-13: Frequency Key and Hop Table Options 2.4 Ghz

Max Packet Size and Min Packet Size (Menu Options 1,2)

Options (1) and (2) allow the user to designate the size of the packets (in bytes) used by the transceiver in its communication link. It should be noted that in Point to Point modes the Max and Min Packet Settings will not have any material impact on throughput unless 115.2 KBaud is desired. The settings for Min and Max Packet size **MUST** be the same for every wireless data transceiver in a given network.

The combination of Max and Min Packet Size Settings determines the allocation of the communication link from the Master to the Slave and vice versa. With a given Max Packet Setting the master will transmit up to that number of bytes on every hop. If fewer than that number of bytes is transmitted the balance is allocated to the slave's transmission, in addition to the quantity in the Min Packet Size Setting.

Packet size is determined by a combination of the setting entered by the user and the RF Data Rate. **Table 2-4**, **Table 2-5**, and **Table 2-6** provide the packet sizes for each different combination of settings.

Setting	Min Packet Size RF Data Rate = 2
0	16
1	21
2	26
3	32
4	37
5	42
6	48
7	53
8	58
9	64

Setting	Min Packet Size RF Data Rate = 3
0	8
1	12
2	16
3	20
4	24
5	28
6	32
7	36
8	40
9	44

Table 2-4: Min Packet Size Settings (Bytes)

Min Setting	Max Setting									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	15	36	58	79	100	121	143	164	185	206
1	20	42	63	84	105	127	148	169	190	212
2	26	47	68	90	111	132	153	175	196	217
3	31	52	74	95	116	137	159	180	201	222
4	36	58	79	100	121	143	164	185	206	228
5	42	63	84	105	127	148	169	190	212	233
6	47	68	90	111	132	153	175	196	217	238
7	52	74	95	116	137	159	180	201	222	244
8	58	79	100	121	143	164	185	206	228	249
9	63	84	95	127	148	169	190	212	233	254

Table 2-5: Max Packet Size Settings (Bytes) RF Data Rate 2

Min Setting	Max Setting									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	8	24	40	56	72	88	104	120	136	152
1	12	28	44	60	76	92	108	124	140	156
2	16	32	48	64	80	96	112	128	144	160
3	20	36	52	68	84	100	116	132	148	164
4	24	40	56	72	88	104	120	136	152	168
5	28	44	60	76	92	108	124	140	156	172
6	32	48	64	80	96	112	128	144	160	176
7	36	52	68	84	100	116	132	148	164	180
8	40	56	72	88	104	120	136	152	168	184
9	44	60	76	92	108	124	140	156	172	188

Table 2-6: Max Packet Size Settings (Bytes) RF Data Rate 3

Xmit Rate (Menu Option 3)

There are two settings for the Transmit Rate parameter. For normal operation the transceivers should be set at Transmit Rate 1. Transmit Rate 0 is useful to qualitatively gauge signal strength. When set to Transmit Rate 0 the transceivers will transmit data back and forth continuously, and the strength of the signal may be gauged by the Clear-to-Send LED. A solid red Clear-to-Send LED indicates a strong signal, the more intermittent the, the weaker the signal.

Because the transceivers transmit continuously when Transmit Rate is set to 0 (whether or not they have data to send) they use radio frequency spectrum unnecessarily. Therefore, in general, Transmit Rate 0 should be used only as a diagnostic tool and not for normal operation.

RF Data Rate (Menu Option 4)

The Communicator II has two settings for the RF Data Rate (not to be confused with the RS232 Baud Rate). Setting 2 should be used when the transceivers are close together and data throughput is to be optimized. Setting 2 must also be used when full throughput of 115.2 KBaud is necessary. Setting 3 should be used when the transceivers are farther away and a solid data link is preferred over data throughput. A setting of 3 is recommended for most applications.

Note: *When using the transceivers in Multipoint mode, the RF Data Rate setting must be identical for all units in the system. Any transceiver with a different RF Data Rate than the master transceiver will not establish a communication link.*

RF Xmit Power (Menu Option 5)

This option controls the RF transmit power of the transceiver. Settings range from 0 to 10 in approximately equal steps. Thus for 900 Mhz with 1 Watt maximum power, the steps are roughly 100 mW. For the 2.4 Ghz transceiver with 500 mW maximum transmit power, the steps are roughly 50 mW.

Slave Security (Menu Option 6)

The Navigator II does not support Slave Security because it does not support Operation Mode 6. The **ONLY** supported setting for Slave Security is 0.

RTS to CTS (Menu Option 7)

The Navigator II does not support RTS to CTS mode and the **ONLY** supported setting is 0 for disabled.

Retry Time Out (Menu Option 8)

The Retry Time Out parameter allows the user to determine when a slave will drop a connection to a master or repeater in multipoint mode. The default setting is 255, meaning that if one packet in 255 from the master is sent successfully to the slave it will maintain a link. The lowest setting is 8, at which a slave will drop a connection much more quickly.

The Retry Time Out parameter is useful when a multipoint system is used with a moving master or slaves. As the link gets weaker, a lower setting will allow a transceiver to more quickly drop the weak link and search for a stronger connection.

While intended primarily for multipoint systems, the Retry Time Out parameter may also be modified in point-to-point systems. In point-to-point mode the Retry Time Out should not be set to a value of less than 151.

Lowpower Mode (Menu Option 9)

The Lowpower Mode is an option that, when enabled, allows the transceiver to function as a multipoint slave while consuming less power. With a setting of 1 Lowpower Mode saves current consumption primarily by dimming the transceiver's LEDs.

Note that the Navigator II **ONLY** supports settings of 0 or 1 for Lowpower Mode.

High Noise (Menu Option A)

Use this menu to indicate if the transceiver will be operated in an environment with a high degree of radio noise and interference. With a setting of 1, the rejection of interference is improved, at the cost of reduced range and/or throughput.

MCU speed (Menu Option B)

Use this menu to set the speed of the processor (Micro Controller Unit) in the transceiver default setting, and the **ONLY** supported setting is 0 (low speed).

RemoteLED (Menu Option C)

For LED status to be displayed on the Navigator II front panel, this option **MUST** be set to 1. If set to 0, the transceiver will still operate but no status will be displayed.

2.4.5 Show Radio Statistics

Option (4) in the Radio Configuration menu allows the user to view data transmission statistics that have been gathered by the wireless data transceiver during the most recent session. This is of value when the user wishes to look at signal strength, noise levels, and the distance of the link between transceivers. Statistics are gathered during each data link and are reset when the next link begins.

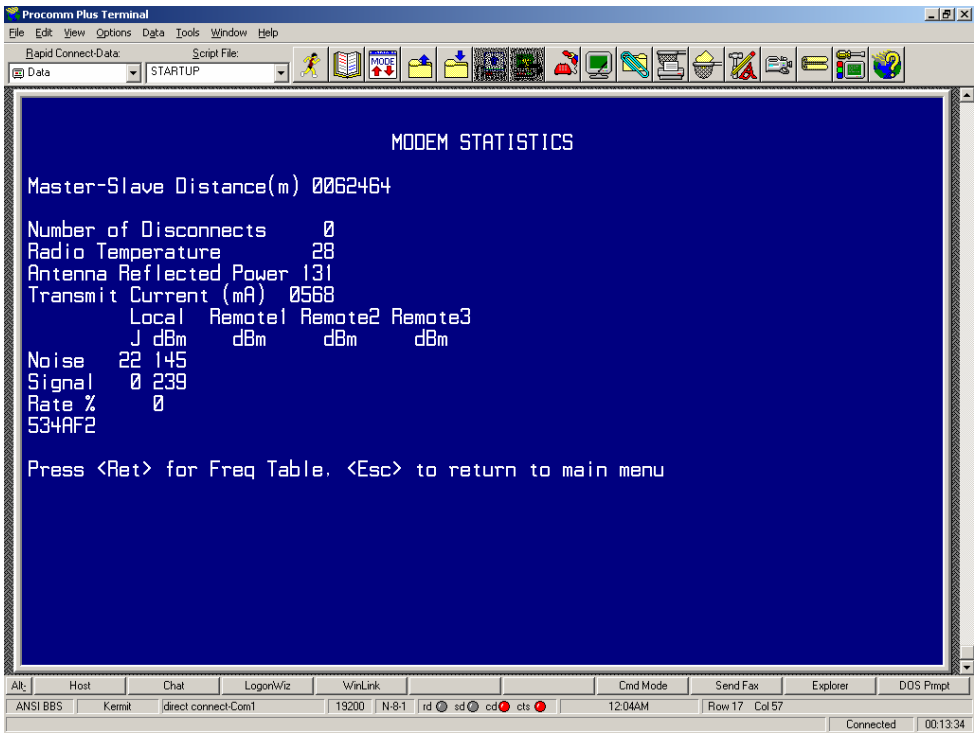


Figure 2-14: Radio Statistics Menu

Ideally, noise levels should be below 30, and the difference between the average signal level and average noise level should be 15 or more. High noise levels tend to indicate other sources of RF interference, while low signal levels indicate a weak link. The following sections provide information useful to the process of troubleshooting and improving radio links.

Average Noise Level

The average noise level indicates the level of background noise and interference at this modem and at each of the modems used as repeaters in the link. The number is an average of the noise levels measured at each frequency in the modems' frequency hop table. The individual measurement values at each frequency hop channel are shown in

the frequency table. The frequency table is accessed by pressing the ENTER key on the computer when the radio statistics menu is displayed.

Average noise levels will typically fall in the range of 15 to 30. Average noise levels significantly higher than this are an indication of a high level of interference that may degrade the performance of the link. High noise levels can often be improved with bandpass filters, antenna placement or antenna polarization. Please contact Intuicom for more information.

Average Signal Level

The average signal level indicates the level of received signal at this modem and at each of the modems used as repeaters in the link. For each of these, the signal source is the modem that transmits to it. The number is an average of the received signal levels measured at each frequency in the modem's frequency hop table. The individual measurement values at each frequency hop channel are shown in the frequency table. The frequency table is accessed by pressing the ENTER key on the computer when the radio statistics menu is displayed.

For a reliable link, the average signal level should be at least 15 higher than the average noise level reading.

Low Average Signal Levels can often be corrected with higher gain antennas, antenna placement, and use of repeaters or use of antenna amplifiers. Contact Intuicom for more information.

Overall Rcv Rate (%)

The Overall Rcv Rate measures the percentage of data packets that were successfully transmitted from the master to the slave on the first attempt without requiring retransmission. A number of 75 or higher indicates a robust link that will provide very good performance even at high data transmission rates. A number of 25 or lower indicates a weak or marginal link that will provide lower data throughput. An Overall Rcv Rate of 100% will provide approximately 100 Kbaud of bandwidth with an RF data rate of 3 (Radio Transmission Parameters Menu) and approximately 150 Kbaud of bandwidth with an RF Data Rate of 2. These numbers are reduced approximately 50% if there are one or more repeaters in the network.

Number of Disconnects

If, during the course of performing a link test, the link between the master and the slave is broken, and the radios lose carrier detect, the occurrence is recorded in the Number of Disconnects value. The value indicates the total number of disconnects that have occurred from the time the link test started until the radio was put into reset mode. Under

normal operating conditions, the number of disconnects should be 0. One or more disconnects may indicate a very weak link, the presence of severe interference problems or loss of dc power to any of the radios in the link.

Radio Temperature

The radio temperature value is the current operating temperature of the radio in degrees C (Celsius.) For proper operation, Intuicom Navigator II Wireless Data Transceivers must be in the range of –40° to 75°C.

Antenna Reflected Power

This value indicates the amount of transmit power reflected back at the transmitter from the transmission line and antenna. A high value (>20) of reflected power may indicate a poor antenna cable, antenna or cable connection.

Transmit Current

The current draw in milliamps of the integrated wireless data transceiver when transmitting.

2.4.6 Edit Multipoint Parameters

Number Repeaters (Menu Option 0)

In a Multipoint network it is critical for timing purposes to know whether or not there are repeaters in the network. Any transceiver that is used as a repeater essentially becomes a master to the slaves and other repeaters to which it is communicating. Therefore, the user must identify whether or not the network contains repeaters. This is done by assigning a value in parameter (0), Number Repeaters. The value should be 0 if there are no repeaters in the network and 1 if repeaters are present. This parameter must be set to the same value in all units in a Multipoint network (master, slaves, and repeater(s)).

Master Packet Repeat (Menu Option 1)

In point-to-point operation the transceivers acknowledge every data packet transmitted. In a point-to-multipoint network, the slaves do not acknowledge transmissions from a master to the slaves. This is to prevent system overload. If the slaves acknowledged all data transmissions from the master in a large point-to-multipoint system, then all system capacity would be spent having the master listen for acknowledgments from the slaves.

Because the transmission is not acknowledged by the slaves, 100% confidence does not exist that every slave has received every message from the master. To address this issue the user may modify option (1) Master Packet Repeat, assigning a value between 0 (the packet is transmitted once) to 9 (the packet is transmitted 10 times). For networks with solid RF links, this parameter would be set at the lower end of the scale (0-1). If the network has some weak or marginal links it would be set toward the higher values. If a slave receives a good packet from a master more than once it will discard the repeated packets received. In addition, once a multipoint repeater receives a good packet from the master it will discard any of the repeated packets. In turn, the repeater will send the packet out (to the next repeater or to the slaves) the number of times corresponding to *its* Master Packet Repeat setting. For more information on this, see the next section, **Master Packet Repeat in Multipoint Systems with Repeaters** for additional detail.

It is important to keep in mind that increasing the master packet repeat will not only increase the probability of a packet getting through, but will also increase latency in the system because each packet from the master or repeater is being sent more often. Therefore it is important to find the optimal mix between system robustness, throughput, and latency. In general a setting of 2 to 3 will work well for most systems.

Master Packet Repeat in Multipoint Systems with Repeaters

The Master Packet Repeat parameter must also be set in multipoint repeaters when they are used in a multipoint system. In a multipoint system a repeater looks like a master to a

slave. Therefore, the repeater will send the packet out the number of times corresponding to its Master Packet Repeat parameter. If this parameter is set improperly the reliability of the overall system may be compromised. For example, assume the master's Master Packet Repeat parameter is set to 3, and the link between the master and repeater is robust. Now assume that the repeater's Master Packet Repeat is set to 0, resulting in marginal communications between the repeater and the slaves with which it is communicating. The data communications between the master and those slaves communicating through the repeater will be marginal, because it is only as strong as the weakest link, which in this case is the link between the repeater and slaves.

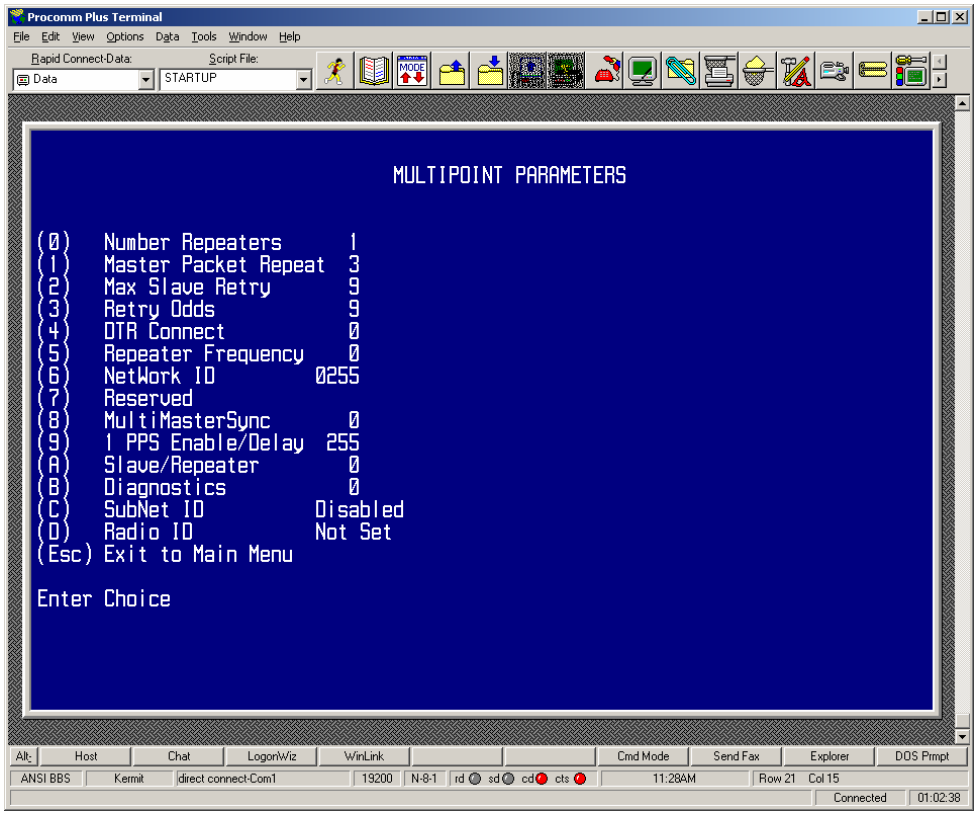


Figure 2-15: Multipoint Parameters

Max Slave Retry and Retry Odds (Menu Option 2,3)

While packets transmitted from the master to the slaves in a Multipoint network are not acknowledged, packets transmitted from slaves to the master are. However, it is possible that more than one slave will attempt to transmit to the master at the same time, and it is therefore important that a protocol exists to resolve contention for the master between slaves. This is addressed through parameters (2) Max Slave Retry and (3) Retry Odds. The Max Slave Retry setting defines how many times (0 to 9) the slave will attempt to retransmit a packet to the master before beginning to use a back-off algorithm. Once the

slave has unsuccessfully attempted to transmit the packet the number of times specified in Max Slave Retry it will attempt to transmit to the master on a random basis. The Retry Odds parameter determines the probability that the slave will attempt to retransmit the packet to the master; a low setting will assign low odds to the slave attempting to transmit and conversely a high setting will assign high odds. An example of how this parameter might be used would be when considering two different slaves in a Multipoint network, one close in with a strong RF link and the other far from the master with a weak link. It may be desirable to assign a higher Retry Odd to the slave with the weaker link to give it a better chance of competing with the closer slave for the master's attention.

When Retry Odds = 0 the slave will try to talk to the master the number of times specified in the Max Slave Retry parameter. If it is unsuccessful the slave will flash (purge) its RS232 input buffer.

DTR Connect (Menu Option 4)

The only supported options for DTR Connect mode supported by the Navigator II is 0 or 2. A setting of 0 is for normal operation and networks where bandwidth is not highly utilized. For the Navigator to use its Adaptive Multipoint Mode, this parameter must be set to 2. For more information about Intuicom Adaptive Multipoint, see **Section 2.5.3**.

Repeater Frequency (Menu Option 5)

The repeater's hopping pattern must also be set in a Multipoint network; this is accomplished with parameter (5) Repeater Frequency. Setting this parameter is in contrast with point-to-point mode where the repeater automatically uses the master's hopping pattern. The repeater may be programmed to either use the master's hopping pattern (selection 0) or its own (selection 1).

Please contact Intuicom for more information regarding Repeater Frequency.

NetWork ID (Menu Option 6)

Option (6) NetWork ID allows multipoint networks to be established without the use of the Call Book. If the NetWork ID is set to any value other than the default (255) and no higher than 4095 the slaves in the multipoint network will communicate with the first multipoint master or repeater heard with the same NetWork ID. When the NetWork ID is used multipoint masters and repeaters may be replaced without reprogramming all of the slaves in the network. In addition, this allows a slave to establish communications with different Masters (though not at the same time) without having the serial numbers in the Call Book. This is very useful in mobile multipoint applications.

MultiMaster Synch (Menu Option 8)

MultiMaster Synch is reserved for applications (either point to point or multipoint) with concentrations of Master units where it is necessary to reduce interference between the Masters. Please contact Intuicom for more information.

1 PPS Enable/Delay (Menu Option 9)

The Navigator II does not support the 1 PPS Enable/Delay Option. This option **MUST** remain set to the default value of 0.

Slave/Repeater (Menu Option A)

The Slave/Repeater mode allows a transceiver in a point-to-multipoint system to simultaneously act as a slave and a repeater. When in this mode a transceiver will repeat any packets sent from a master as well as send them out the RS232 port. Thus where 2 transceivers would be necessary previously (one to repeat and one to be a slave) only one is now needed.

To operate a transceiver as a multipoint slave/repeater you must set the operation mode to (7) Multipoint Repeater and then enable the slave/repeater option (setting of 1).

Note: Intuicom Adaptive Multipoint is not available when the unit is operating as a slave/repeater. Adaptive Multipoint must be disabled and DTR Connect mode (see above) set to 0 on any unit operating as a slave/repeater.

Diagnostics (Menu Option B)

This option, when enabled, provides diagnostics data over a multipoint network simultaneously with the application data when the Navigator II is operating in Master Mode (see **Section2.5.1**). Proper use of diagnostics requires the following:

1. Diagnostics must be enabled on the master (set to 1) and the Navigator Configured to operate in Master mode.
2. A second serial port (or computer) to run the diagnostics software
3. Diagnostics software, available through Intuicom.

Please contact Intuicom if you are interested in using the diagnostics feature in your network.

Subnet ID (Menu Option C)

In a point-to-multipoint network where the Network ID is used (instead of the Call Book) when a slave is initially powered it will connect with the first repeater or master that it hears with the same Network ID. Likewise, a repeater in the network, when initially powered up, will connect to the first master or repeater that it hears with the same Network ID.

In typical applications this approach works very well, however there are scenarios where you want to force communications to follow a specific path. For example, you may want to ensure that two repeaters in the system are communicating in series instead of in parallel, or it may be desirable to force slaves to communicate to specific repeaters for load balancing purposes.

There are two components to the Subnet ID:

> **Rcv Subnet ID**. This setting identifies who a repeater or slave will listen to.
> **Xmit Subnet ID**. This setting identifies the sub network this device transmits on, and in turn which devices will listen to it. *The Xmit Subnet ID parameter is relevant for multipoint repeaters only.*

To disable the Subnet ID both Rcv Subnet ID and Xmit Subnet ID should be set to 'F'.

***Note**: The Subnet ID settings are irrelevant for the Master.*

***Note**: The Master always transmits on Subnet ID=0, regardless of the setting. To force communications directly through the Master the Slave or Repeater's Rcv SubnetID must be set to 0.*

***Note**: The Subnet ID works only in Multipoint Networks using NetworkID.*

***Note**: In typical multipoint networks the Freq Key must be at the same setting for all transceivers. If the SubnetID is used the sub network may be set to a different Freq Key.*
***Note**: If both Rcv SubnetID and Xmit SubnetID are set to 0 the SubnetID will show **Roaming** in the menu. This setting will allow a mobile slave to roam from subnet to subnet within a network.*

Figure 2-16 below depicts a point-to-multipoint network in which the Subnet ID is used to force communications along specific paths. In this example Repeater1 *must* talk directly to the Master, and Repeater2 *must* talk directly to Repeater1. Communications for Slaves 1, 2, and 3 are forced along the direction of the solid lines, and Slave4 may link to the first master or repeater it hears.

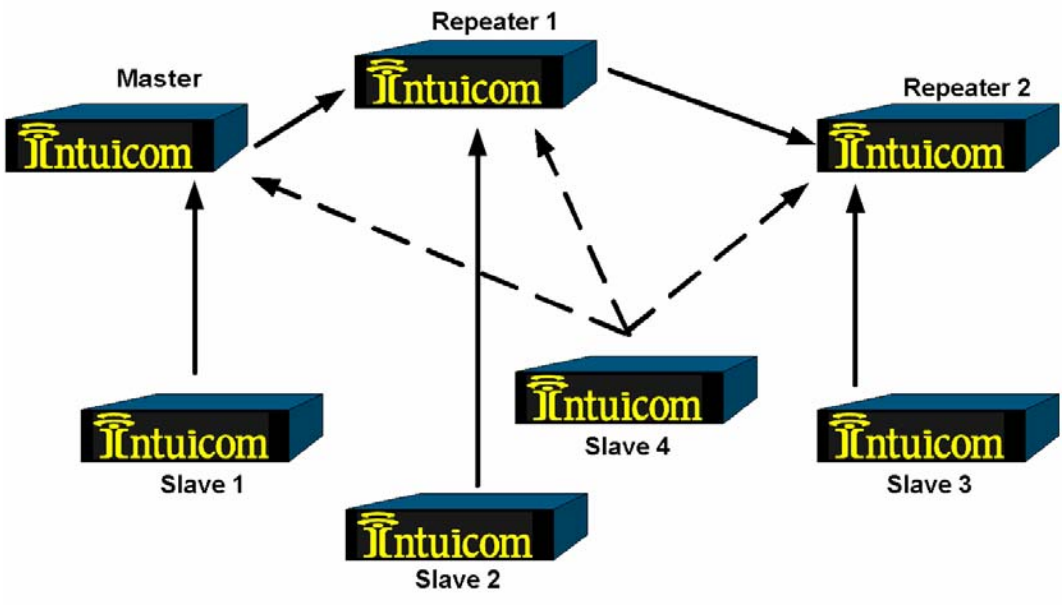


Figure 2-16: Multipoint Subnet Diagram

Transceiver	Rcv SubnetID	Xmit SubnetID	Notes
Master	NA	NA	May be set to anything
Repeater1	0	1	0 forces it to link only to the Master
Repeater2	1	2	Rcv SubnetID=1 forces communication through Repeater1 (Repeater1 transmits on SubnetID 1)
Slave1	0	NA	Rcv SubnetID=0 forces communication through the Master
Slave2	1	NA	Rcv SubnetID=1 forces communication through Repeater1
Slave3	2	NA	Rcv SubnetID=2 forces communication through Repeater2
Slave4	F	F	Setting of FF allows the Slave to link with the first Master or Repeater it hears with the correct NetworkID

Table 2-7: Subnet ID Settings for example Multipoint Subnet Diagram

***Note**: If you set the Rcv Subnet ID to '0', the modem (other than a master) will communicate only with a master. If you set both Subnet IDs to 'FF', the modem will communicate with any other modem in the same sub-network. Other than that, you can set any value for these settings.*

Radio ID (Menu Option D)

Option (D) allows a transceiver to be designated with an arbitrary, user selectable, 4 digit number which identifies the transceiver in the diagnostics mode.

2.4.7 TDMA Menu

The TDMA Menu contains parameters for controlling operation in TDMA mode. Refer to the ***Intuicom TDMA Design and Configuration Guide*** or contact Intuicom for more information about TDMA.

2.4.8 Chg Password

Setting a password allows the Wireless Data Transceiver's configuration to be locked. It is recommended that a password ***never*** be set.

CAUTION: If the password is forgotten, the unit will have to be physically returned to Intuicom for the password to be reset. It is recommended that a password ***never*** be set.

To enable the Password feature choose (8) from the menu. You will be prompted with

```
New PW? (<esc> to exit)
```

To back out of the process and not enable the password, hit escape. To set a password, type in **4 characters**. At any point in the process you can cancel by hitting the escape key. Once the 4 characters have been entered you will be prompted with:

```
<Enter> to accept,<esc> to quit
```

At this point if you wish to accept the password entered and enable the feature, press the enter key. The password that you have chosen is displayed on the line above (please note that the password is case sensitive). To quit the process and not enable the password press ESC.

Changing a Password

Once the password feature has been enabled it is possible to change to a new password. To enter a new password select (8) from the Main Menu. You will be prompted with "Enter Security Code" to enter the current password. Once the password has been entered correctly (it **is** case sensitive) you will be prompted to enter the new password. At any point this process may be cancelled by pressing escape.

Disabling a Password

The process to disable the password is similar to the process to change the password. However, when prompted to enter the new password the following procedure needs to be followed:

1. Hold down the Alt key and type 0255
2. Release the Alt key
3. Repeat this step 3 more times (hold Alt and type 0255 a total of 4 times).

2.5 Navigator Configuration

The Navigator Configuration menu allows the user to configure important settings affecting the operation of the unit including its role (Master, Slave, etc), serial data routing, data prioritization and performance settings as well as settings for the Discrete input and output lines. Additionally, the Default Configuration Profiles are accessible from this menu. **Figure 2-17** shows the Navigator Configuration Menu options.

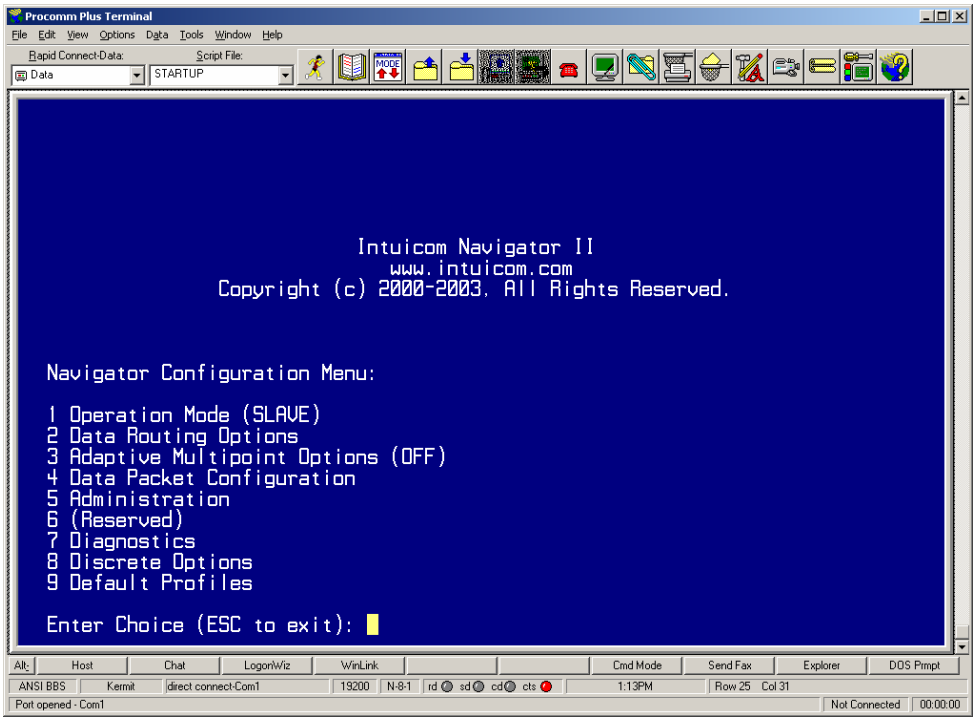


Figure 2-17: Navigator II Configuration Menu

2.5.1 Operation Mode (Slave/Master/Direct)

Option (**1**) controls the Data Operation Mode. The Data Operation Mode is similar to the Wireless Role (wireless operation mode **Section 2.4.1**), and the two settings should be considered together.

Slave

The Network Slave mode is the most common. Slave mode indicates that data can be transferred to and from any attached serial devices and/or the internal GPS receiver. In Slave mode, data is usually exchanged with TCP ports hosted by Intuicom Nav-Link server at a central or Master site.

Master

Master mode is useful when the unit is to be used as a wireless Network Master and only needs to interact with Nav-Link server software on a single serial port. When in Master mode, Port B is mapped directly to the internal wireless data transceiver.

Master mode is also useful in a basic multipoint wireless network where the Navigator II needs to behave as a transparent slave (i.e. not multiplex data from multiple serial ports).

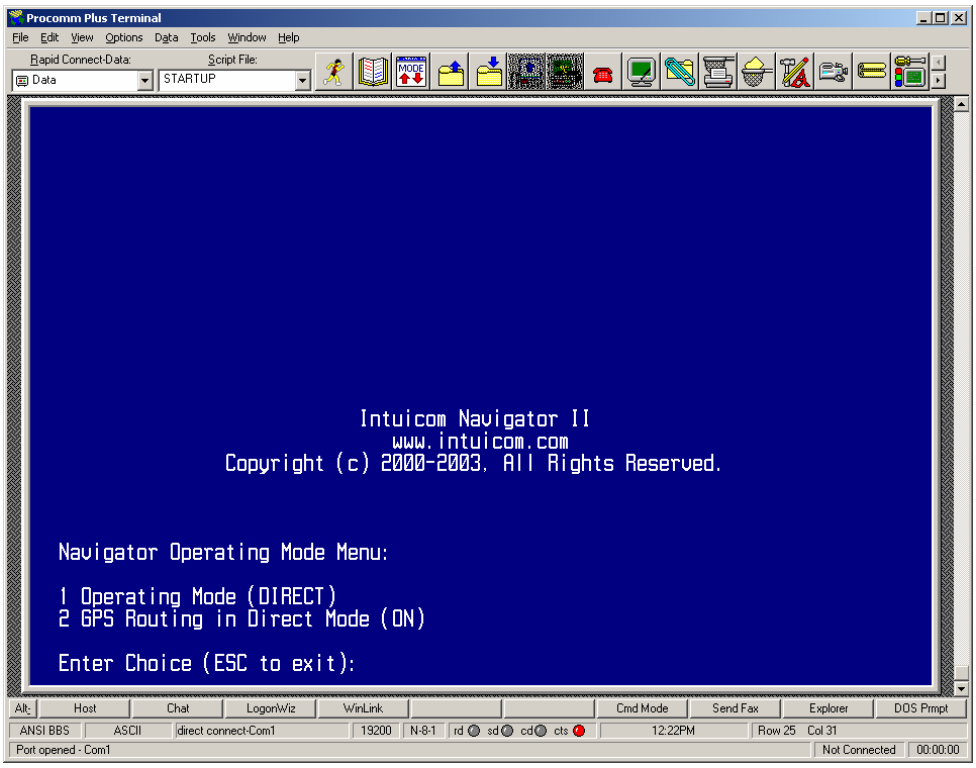
In Master mode, Port A is mapped directly to the wireless data transceiver's diagnostics port for real-time wireless diagnostics functionality when the wireless data transceiver is operating as a Point-to-Multipoint Master. Please contact Intuicom, Inc. for more information regarding real-time diagnostics.

If GPS data routing to Port C is enabled, data from the internal GPS receiver will be output on Port C while the unit is operating as a Network Master.

Direct

Direct mode allows two Navigator II units to operate in a peer-to-peer fashion. Each Navigator II must have their wireless data transceivers configured to talk to each other either as a Point-to-Multipoint Master and Slave, or as a Point-to-Point Master and Slave.

Once wirelessly connected, Port A on one unit is mapped directly to Port A on the other unit, the same is true for Ports B and C. The discrete lines are also mapped. Each units input discretes are reflected as the peer units output discretes (note that only the first three discrete lines are mapped because only three output discretes exist).



Note: Port C can be used for either serial data or discretes, but not both at the same time. Hardware flow-control on Port C is not supported in Direct mode.

2.5.2 Data Routing Options

Data routing allows the user to control the flow of data from the internal GPS receiver, if one is present. A copy of the data generated by the GPS receiver can be sent to the local serial ports (Port A, Port B, or Port C). The user can also choose whether to send the GPS data over the wireless link as well. If Port C is configured to be attached to the GPS secondary port, data routing to Port C should not be turned on. Any combination of routing options can be selected.

Note: If GPS data is routed to Ports A, B, or C, bi-directional communication between this slave and the Master site/Nav-Link TCP Port is still possible. The locally attached serial device may need to be able to parse a mixture of GPS data and data from the central site.

Note: Data transmitted by an external serial device on any of the local serial ports (A, B, or C) is not sent back to the GPS receiver; as stated above, it is transmitted over the wireless link to the master. Bi-directional communications with the integrated GPS receiver is possible either through the setup menu (see **Section 2.3.1**) or from a Nav-Link mapped TCP port.

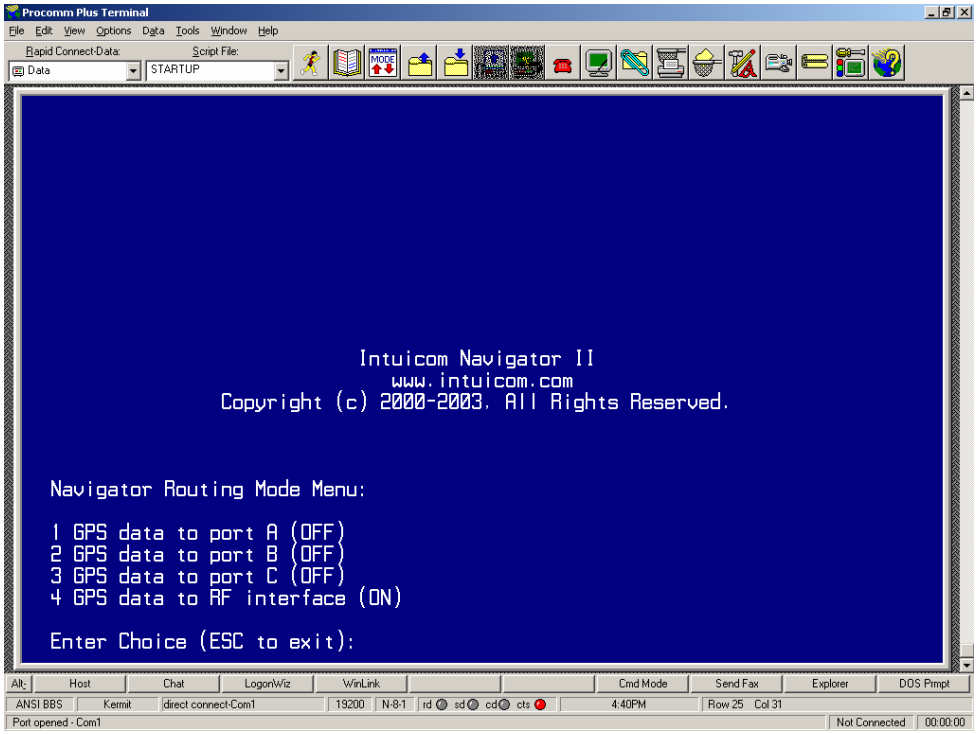


Figure 2-18: Navigator Configuration Data Routing Options

2.5.3 Adaptive Multipoint Options (On/Off)

Menu option (**3**) allows the user to configure the behavior of Intuicom Adaptive Multipoint. When enabled, Adaptive Multipoint allows the Navigator II microprocessor to closely control the integrated wireless data transceiver to achieve higher performance and to conserve wireless network bandwidth. Adaptive Multipoint ***requires*** the integrated wireless data transceiver operate as a Point-to-Multipoint slave.

Specifically, Intuicom Adaptive Multipoint (AMP) waits until a packet of data is ready to be transmitted and then requests that the wireless data transceiver get the attention of the Master wireless data transceiver to send the packet of data in a burst. AMP employs three key configurable techniques:

1. Allows data to accumulate for a configured period of time before forming a packet to lower overhead.

2. Once a packet is formed, wait a random amount of time before attempting to transmit the data (the maximum amount of random time is configurable) to reduce collisions on the wireless network and improve bandwidth efficiency.

3. Configure a timeout such that if the data could not be transmitted over the wireless link in a configured amount of time, either because of network congestion or because of a weak link, the buffer is flushed. This is useful when transmitting real-time position data from the integrated GPS.

To enable AMP, set option (1), Streaming Mode, to **On**. Setting AMP to **On** will automatically configure the integrated wireless transceiver for AMP. The best way to enable AMP is to use a Default Configuration Profile (see **Section 2.5.8**)– this assures that all associated configuration settings will be changed correctly.

Note: Enabling AMP automatically disables flow control between the Navigator II microprocessor and the wireless data transceiver. If AMP is disabled, this flow control will need to be manually re-enabled, see **Section 2.2**.

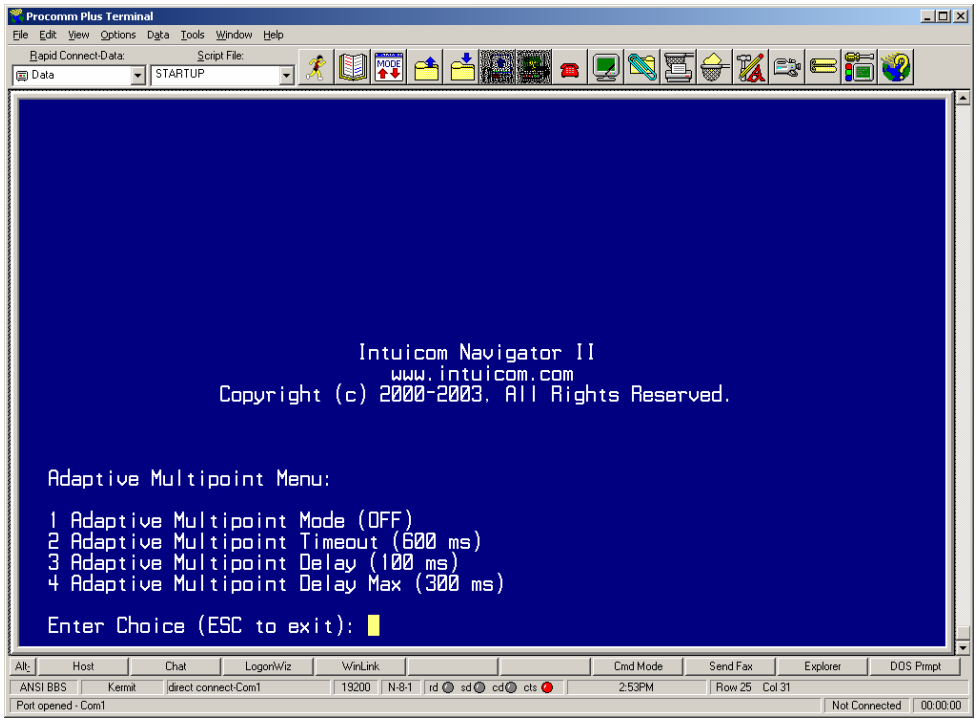


Figure 2-19: Navigator Configuration Menu Adaptive Multipoint Options

Once AMP is enabled, configure the three controlling time parameters:

Streaming Mode Timeout

Streaming Mode Timeout value in milliseconds. The setting should be greater than the setting for **Streaming Mode Delay Max**. A setting of **0** will disable the timeout, and cause the wireless data transceiver to continue to attempt to send the packet in the buffer.

Streaming Mode Delay

Streaming Mode Delay value in milliseconds. The baud rate setting of the local serial ports should be considered in this setting. If the local baud rates are slow, a higher setting for this parameter will result in fewer packets and less overhead.

Streaming Mode Delay Max

Streaming Mode Delay Max value in milliseconds. This parameter constrains the random delay in sending data to the wireless data transceiver for transmission over the wireless link. With data that is highly synchronous across multiple slave Navigator II units, this setting can reduce collisions and improve overall data throughput

2.5.4 Data Packet Configuration

The settings for Data Packet Configuration control the formulation of a data packet to be transmitted over the wireless link, and how much of that packet is dedicated to data from different sources.

The prioritization of the data for each port can be totally dynamic, forming a packet of data on a first come first serve basis from data transmitted on the local serial ports (Ports A, B and C) and the integrated GPS receiver, if present.

Data prioritization can also be explicitly configured reserving minimum amounts of bandwidth (bytes in a packet) for specific ports and setting a priority order for filling space in a packet. Multiple quick passes of the internal buffers are made when generating a packet and ports with a higher priority will have the first opportunity to fill any extra space in a packet up to the maximum packet size. In all cases, a maximum packet size must be set. The default maximum packet size is 512 bytes. The largest value possible for the maximum packet size is 1011 bytes.

If using TDMA mode, be sure that the Max Packet Size is smaller that the configured TDMA Slave Data Packet Size for the TDMA network by 11 bytes. See the ***Intuicom TDMA Design and Configuration Guide*** for more information about TDMA mode.

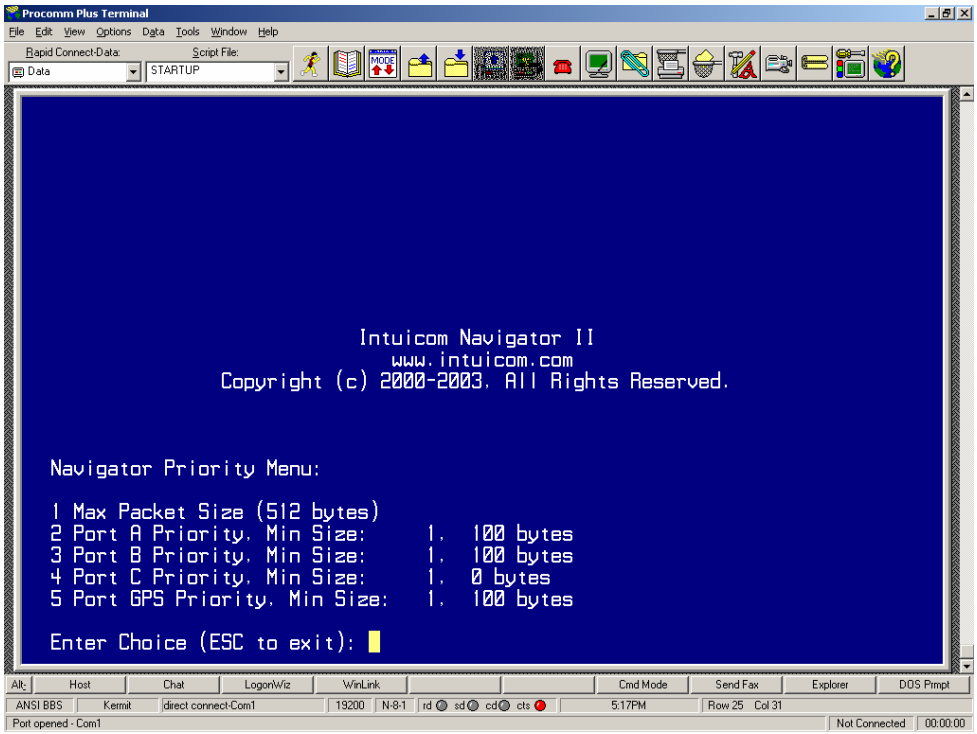


Figure 2-20: Navigator Configuration Menu Data Prioritization

Prioritization is configured by first setting the maximum packet size, option (**1**), in bytes. This packet size should be set with consideration for the number of slaves in the wireless network which need to transmit data simultaneously, as well as the latency sensitivity of the data or application.

Configure the prioritization for the individual ports by selecting the port, entering a priority (1-4), and setting a minimum number of reserved bytes in the packet. A setting of 0 allows this port to be dynamically allocated on a best-effort basis.

Note: The selection of minimum number of bytes to reserve in a packet for a given port is constrained by the maximum packet size and the existing setting for the other ports. If necessary reduce the number of bytes allocated to another port before configuring the selected port.

2.5.5 Administration

The Administration Menu, Option 5, provides a number of administrative setup parameters and utilities.

Change GPS Type (xxxx)

This option configures the type of internal GPS receiver installed. The options include:

- Thales (Ashtech) **A12** WAAS Capable Receiver
- CMC Electronics (Novatel) **Superstar II**
- **Other** (for OEM configurations)
- None

The type of installed GPS receiver is factory set and should not be changed.

Upgrade Firmware

This option allows the Navigator II firmware to be upgraded. This option launches the firmware loader program. Before selecting this option, be ready to invoke the Intuicom Firmware Upgrade Utility running on a PC to complete the upgrade. Refer to the Firmware Upgrade Utility instructions for more information regarding performing a firmware upgrade.

CAUTION: Care should be taken with this option not to instruct the loader program to erase the current firmware unless ready to perform an upgrade.

Spectrum Tool Data Stream Conduit

The integrated 900 Mhz wireless data transceiver can be used as a simple spectrum analyzer in its band and this option provides a way to make the spectrum data stream available to the Intuicom Spectrum Tool application. Select this option, and then close the terminal emulation program in use and start the Intuicom Spectrum Tool, select the appropriate COM/Serial port and click CONNECT. When done using the Intuicom Spectrum Tool, power cycle the unit and re-enter the setup menu as normal.

Reset Unit to Defaults

This option will reset all Navigator II settings to factory default. The radio configuration parameters for the integrated wireless data transceiver are not set however. Use the **Default Configuration Profiles** to set the integrated wireless transceiver to a known state.

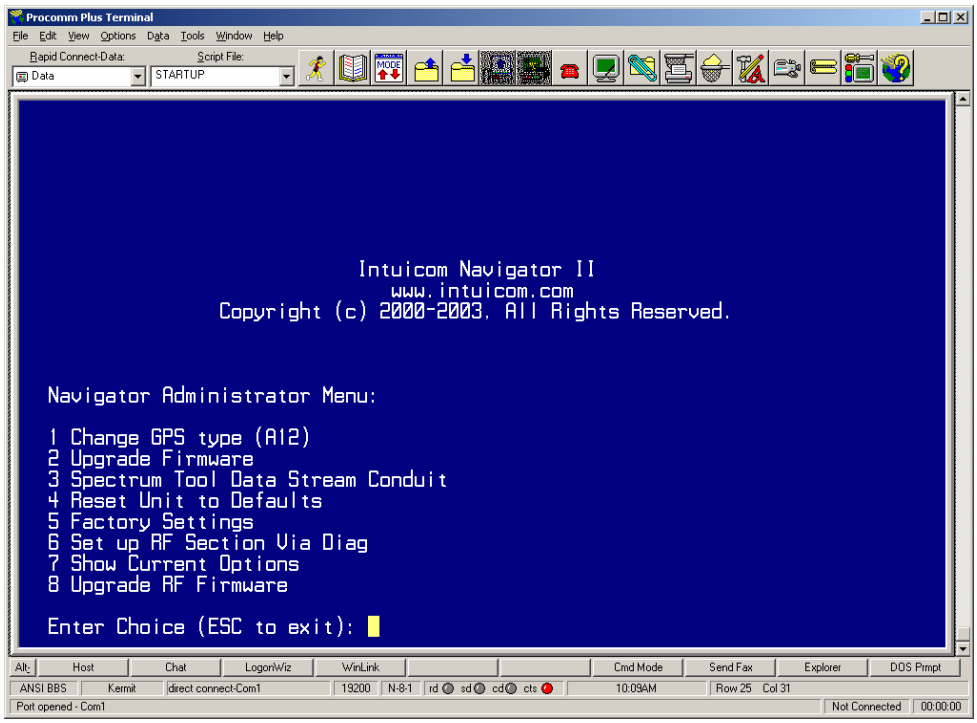


Figure 2-21: Navigator Configuration Menu Administrative Options

Factory Settings

The Factory Settings option is reserved for factory turning and diagnostics and is not user accessible.

Setup RF Section Via Diag

This option allows “backdoor” access to the setup menu of the integrated wireless data transceiver. It is generally not necessary to use this option but it is helpful in a few configurations such as when the integrated wireless transceiver is set to only allow setup access through the DIAG port (See **Section 2.4.2**).

Show Current Options

This option displays the installed and activated Navigator II firmware options. Options for a Navigator II include:

- Enabling the serial ports (Ports A, B and C) for data.
- Input and output Discretes
- Optional integrated GPS

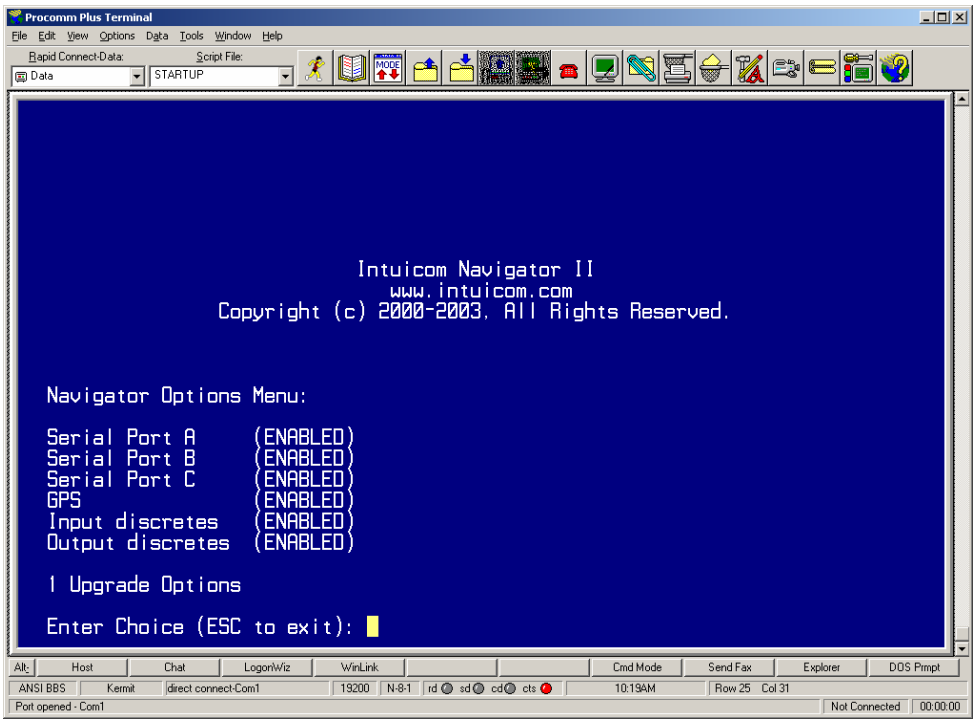


Figure 2-22: Navigator II Installed Firmware Options

Upgrade RF Firmware

This option is for use with an external Firmware upgrade utility for the integrated wireless data transceiver. This option connects directly to the integrated wireless transceiver for upgrading its firmware via an external application. After this option is selected, close the terminal application being used and start the firmware upgrade utility. After the integrated wireless transceiver's firmware has been upgraded, the Navigator II will have to be power cycled before the setup menu can be accessed again.

2.5.6 Diagnostics

The Diagnostics menu selection, Option 7, displays accumulated information about the amount of data in bytes that has passed in and out of each port and as a aggregate of all ports. Additionally, the number of times the wireless data transceiver has disconnected its wireless link, because of a weak link, or when switching between repeaters, is displayed. These values are reset with every power cycle of the Navigator II.

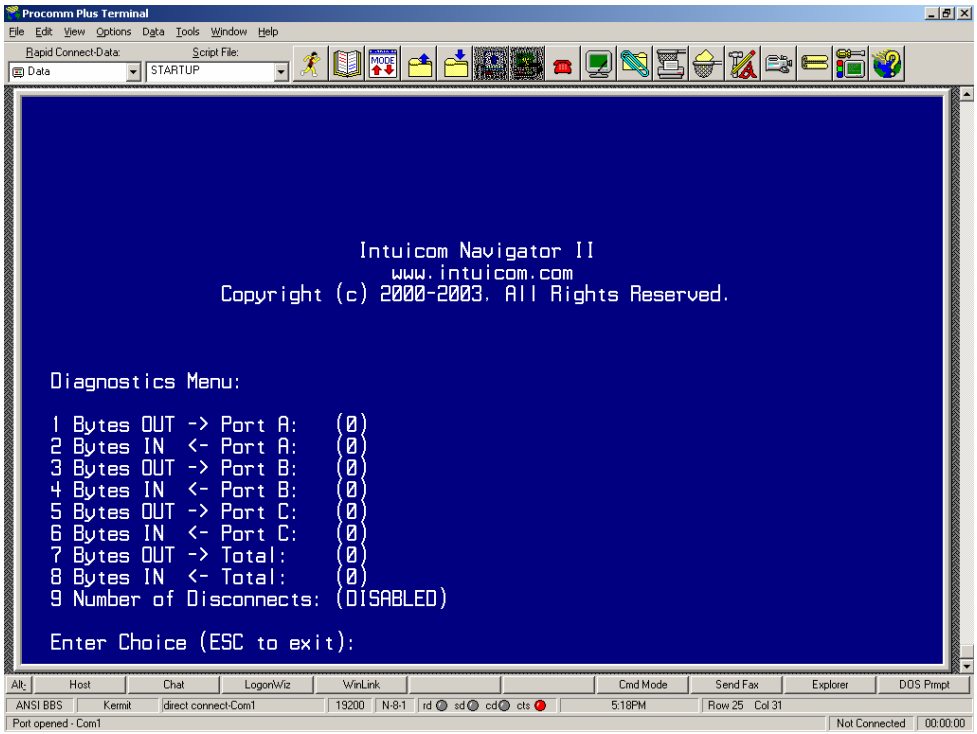


Figure 2-23: Navigator Configuration Menu Diagnostics

2.5.7 Discrete Options

The Discrete Options menu allows the user to both see the current state of input discrete lines and set the default, power-up state of the output discrete lines. Selecting the corresponding menu item will toggle the default power-up state of a given discrete output.

Navigator discrete I/O lines are RS232 polarity and signal level lines with ESD protection. Input lines can be grounded for one state or driven high (+5V - +15V) for another. All signals reference the ground pin on the discrete port.

Discrete output lines are controlled remotely by sending the selected Navigator a discrete control command specifying the output discrete, new state, and duration for state change.

See ***Intuicom Nav-Link documentation User Guide*** for Navigator II discrete command packet formats.

In addition to setting the default power-on-state for output discretes, the user has the option of using one of the output discretes (Discrete Output 1) as an external indication of whether the integrated wireless transceiver is currently linked with a Network Master or Repeater. Menu Option (4) toggles this feature on or off.

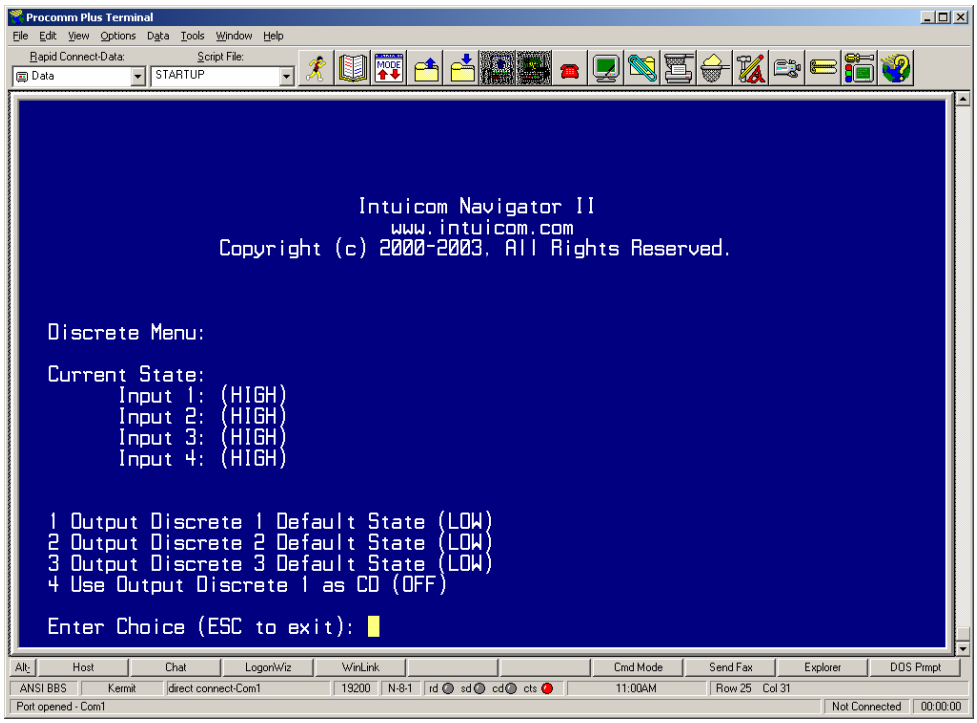


Figure 2-24: Navigator Configuration Discrete Options

2.5.8 Default Configuration Profiles

Navigator Configuration Menu Option (**9**), **Default Configuration Profiles** provide a quick way to setup a Navigator II. The Profiles are a good way to bring the Navigator II to a known state of configuration, further customization of the setup can begin from there if necessary. Selecting a Default Configuration Profile will automatically configure all the necessary parameters of the Navigator II including the GPS and integrated wireless transceiver. Three Default Configuration Profiles are available:

- Configure the unit as a Network Master
- Configure the unit as a Network Slave
- Configure the unit as a Network Slave with Adaptive Multipoint Enabled

A Navigator II configured as a Network Slave from the Default Configuration Profiles menu will communicate with a Navigator II configured as a Network Master from the Default Configuration Profiles.

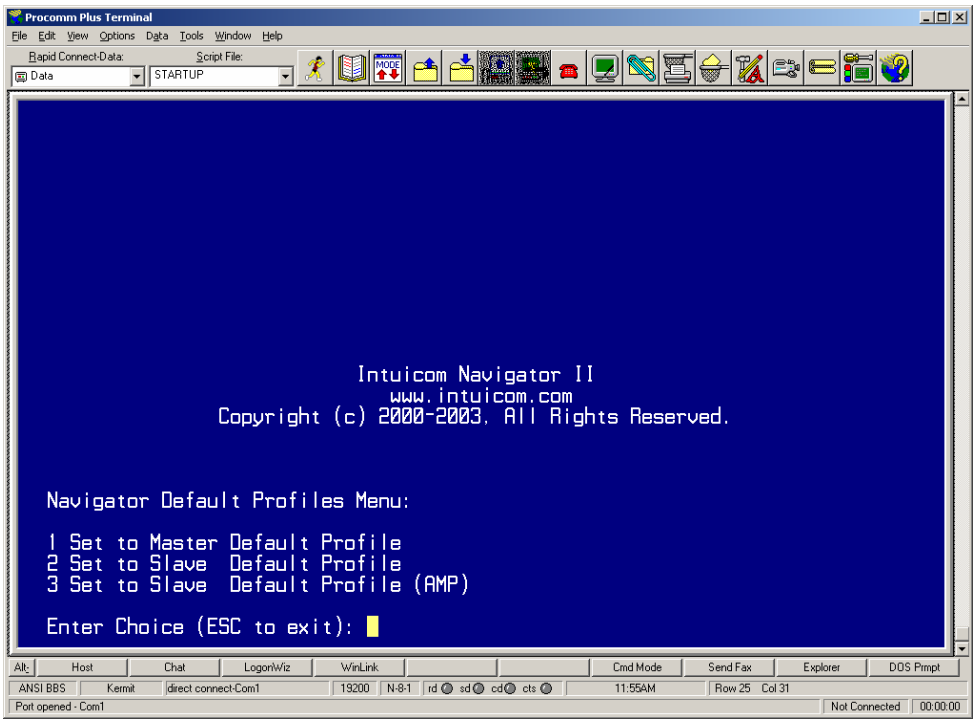


Figure 2-25: Default Configuration Profiles Menu

A common network configuration is to have many Navigator II units operating as Network Slaves, communicating with an Intuicom Communicator II operating as a repeater or Network Master. Because an Intuicom Communicator II basic transceiver does not support automatic configuration via Default Configuration Profiles, it must be configured manually.

The following configuration parameters should be used to configure an Intuicom Communicator II as a Network Master:

Configuration Parameter	Value
Menu 0	
Operating Mode	2 (Point to Multipoint Master)
Menu 3	
Frequency Key	11
Max Packet Size	8
Min Packet Size	9
Xmit Rate	1
Retry Time Out	255
MCU Speed	0
Menu 5	
Number Repeaters	1
Master Packet Repeat	3
Max Slave Retry	9
Retry Odds	9
DTR Connect	0
Repeater Frequency	0
Network ID	3283
MultiMasterSync	0
1 PPS Enable/Delay	255
Slave/Repeater	0
Diagnostics	0
Subnet ID	Disabled (disable with F, F)
Radio ID	Not Set

Table 2-8: Communicator II Configuration Settings to match Navigator II Default Configuration Profile(s)

Note: Configuration Profiles use arbitrary default values for key parameters that are used to separate wireless network from one another. It is suggested that the Default Configuration Profiles be used as a starting point when designing, testing, or troubleshooting a network and then key parameters (Frequency Key, Hop Table, Network Number, Min and Max Packet Sizes) be changed to unique values for your application.

2.6 Key steps for Configuration as Network Slave

Configuring a Navigator II as a slave involves two key steps:

1. Configuring the integrated wireless data transceiver to operate as a slave in a Point-to-Multipoint or TDMA wireless network.

2. Configuring the Navigator II to operate in Slave mode.

Other configuration options are determined by the requirements of the application such as external port baud rates, internal GPS configuration, data routing, and Adaptive Multipoint.

Note that by using a Default Configuration Profile, the Navigator II can be automatically configured as a Network Slave using default settings.

2.7 Key steps for Configuration as Network Master

When a Navigator II operates as a master, its primary purpose is to interface the data stream from the wireless network to Intuicom Nav-Link server running on a PC platform. In addition to this primary purpose, a few additional features are available such as a data feed of wireless diagnostics on Port A when operating in Point-to-Multipoint wireless operation mode. Additionally, if an optional GPS receiver is installed, a local serial GPS data stream is available on Port C. Configuring a Navigator II to operating as a Master involves two key steps:

1. Configuring the integrated wireless data transceiver to operate as a master in a Point-to-Multipoint or TDMA wireless network and confirming the baud rate as 115,200 baud with hardware flow control (RTS) enabled.

2. Configuring the Navigator II to operate in Master mode and configuring the Port B baud rate to 115,200 baud with hardware flow control enabled.

Note that by using a Default Configuration Profile, a Navigator II can be automatically configured to operate as a Network Master using default settings, providing a quick way to get a network up and running.

2.8 Specific steps for Configuration in Direct Mode

Direct mode allows two Navigator II units to operate peer-to-peer, multiplexing the Port A, B and C data streams as well as discrete states between the two units. With only two Navigator IIs operating in Direct mode, the wireless data transceiver configuration is not critical as long as the two units can communicate (i.e. Point-to-Point, Point-to-Multipoint, or TDMA mode will all work). Intuicom recommends operating the wireless data transceivers in Point-to-Point mode with one unit as a Point-to-Point master and the other unit as a Point-to-Point slave.

Direct mode also supports an architecture where one Navigator II operates as a "Master" and two or more Navigators operate as "Slaves". With this configuration in Direct mode, all "Slaves's" Port As will be mapped to the "Master's" Port A, and anything transmitted on the "Master's" Port A will be broadcast to each of the "Slave's" Port A. The same is true for Port B and C. In this configuration the discrete lines are not functional. For this configuration to operate, the "Master" Navigator II must have its wireless data transceiver configured to operate as a Point-to-Multipoint master, and the "Slave" Navigator IIs must have their wireless data transceivers configured to operate as Point-to-Multipoint slaves.

GPS Data is not transferred when operating in Direct Mode.

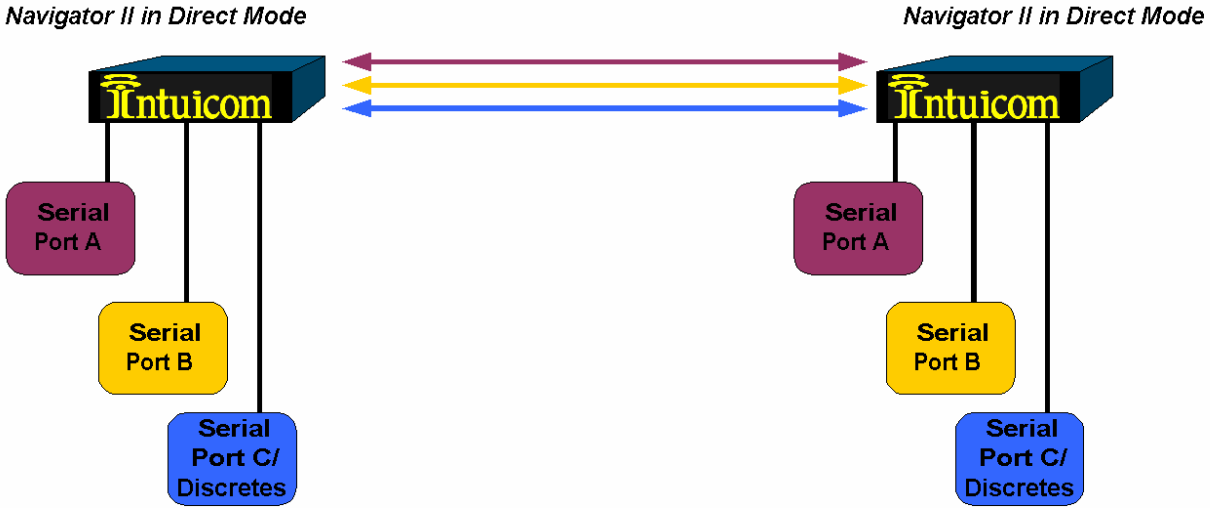


Figure 2-26: Two Navigator II units operating in Direct Mode

3 Operation

3.1 Physical Setup

Each unit installed in the field requires the following for operation:

Power - Connect power (+6-30 VDC for 900 Mhz units and +9.5-30 VDC for 2.4 Ghz units) to the connector (2.1 x 5.5mm center pin positive). Be sure to use a regulated, clean power source, and confirm the power source is capable of delivering enough current to run the unit.

RF Data Transceiver Antenna – Connect an appropriate antenna cable and antenna. The connector on the Navigator is **N-type female**. The antenna cable length should be as short as possible to avoid power loss. Be sure to use tested, high quality, low-loss antenna cables in good condition. Poor cables can be difficult to troubleshoot.

GPS Receiver Connection – If utilizing an internal GPS receiver, connect a GPS antenna cable and antenna. The connector on the Navigator is **TNC female**. The antenna cable length should be as short as possible to avoid power loss. Be sure to use tested, high quality, low-loss antenna cable in good condition. Poor cables can be difficult to troubleshoot. The GPS antenna connector is biased with +5VDC (+3.3VDC for Thales A12 GPS receiver) for active GPS antennas.

Note that placing the GPS antenna near some other antenna with high power RF radiation may affect the GPS receiver's ability to correctly produce position data.

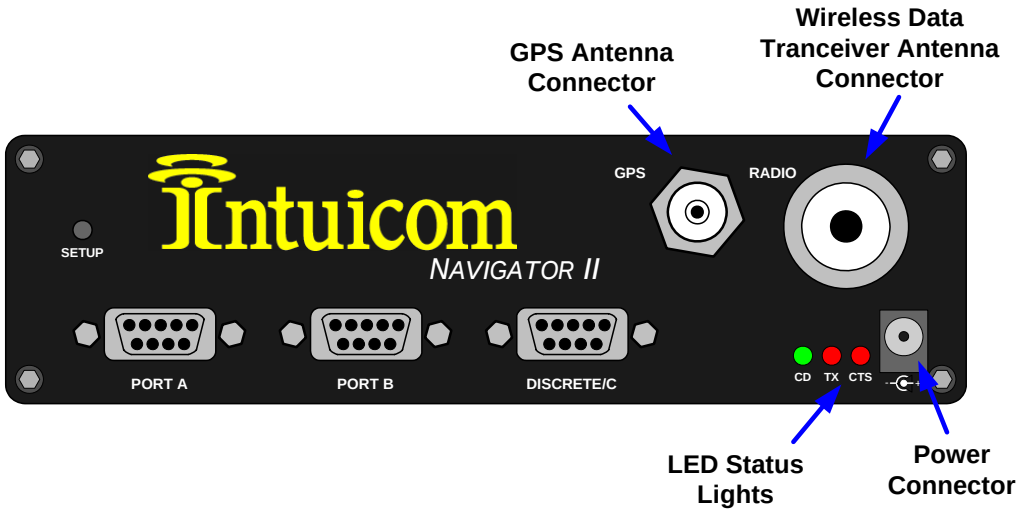


Figure 3-1: Navigator II Antenna and Power Connectors

External Serial Devices – Connect any serial devices to the unit using the DB9 connector(s) on the front of the unit. Confirm the pinout for transmit, receive, ground, and hardware flow control (RTS, CTS) for each port. The Navigator II behaves as a DCE device.

Note that a DB9 F-F Gender changer may be required when using Port C for serial data.

Mounting – Securely mount the Navigator II so as to eliminate vibration, impact, cable friction and movement. Enclose the unit to prevent exposure. An optional mounting bracket is available to aid in this process (P/N: **FIP1-MNTPLT**).

3.2 Front Panel LEDs

The LEDs located on the Navigator II front panel provide important information on the operation of the integrated wireless data transceiver. Compare the status of the unit's LEDs with the table below to aid you in the troubleshooting process.

Condition	Master			Slave			Repeater		
	CD	TR	CTS	CD	TR	CTS	CD	TR	CTS
Powered, disconnected	SR	SR	SR	SR	O	BR	SR	O	BR
Connected, no repeater, sending sparse data	SG	IF	IF	SG	IF	IF			
Master calling slave through repeater	SR	SD	SR	SR	O	BR	SR	O	BR
Master connected to repeater, not to slave	FO	SD	SR	SR	O	BR	SR	SD	SR
Repeater connected to slave	SG	IF	IF	SG	IF	IF	SG	IF	IF
Mode 6, disconnected	SR	O	BR	SR	O	BR			
Setup Mode	SG	SG	SG	SG	SG	SG	SG	SG	SG

Table 3-1: LED Status in Point-to-Point Mode

Condition	Master			Slave			Repeater		
	CD	TR	CTS	CD	TR	CTS	CD	TR	CTS
Powered, disconnected	SR	SD	O	SR	O	BR	SR	O	BR
Repeater and slave connected to master, no data	SR	SD	O	SG	O	SR*	SG	SD	SR*
Repeater & slave connected to master, master sending data to slave	SR	SD	O	SG	O	SR*	SG	SD	SR*
Repeater & slave connected to master, slave sending data to master	SG-SR	SD	IF	SG	IF	SR*	SG	SR	SR*

Table 3-2: LED Status in Point-to-Multipoint Mode

LEDs	
CD	Carrier Detect
TR	Transmit
CTS	Clear to Send

LED Status	
BR	Blinking Red
FO	Flashing Orange
IF	Intermittent Flashing Red
O	Off
SD	Solid Red, Dim
SG	Solid Green, Bright
SR	Solid Red, Bright

Table 3-3: LED Status Legend

3.3 End-to-End Data Integration using Nav-Link

In an operational Navigator II wireless network, third party applications make TCP socket connections to Intuicom Nav-Link server in order to communicate with remote serial devices.

After the Navigator II units, Master transceiver and any repeaters are configured, Intuicom Nav-Link server must be configured accordingly. Nav-Link is configured to communicate with the Master transceiver via a serial cable at a specified baud rate and to map remote serial ports to TCP ports. Nav-Link is configured by modifying the Nav-Link config.xml file. Refer to the ***Nav-Link User Guide*** for detailed information about configuring Nav-Link.

A configuration might be as straight forward as a vehicle tracking application making a single TCP socket connection to a socket streaming GPS position data from all remote Navigator II units in a network.

Another application might involve a seismic data collection application that makes a dozen parallel TCP connection to sockets dedicated to individual remote seismometers streaming seismic data.

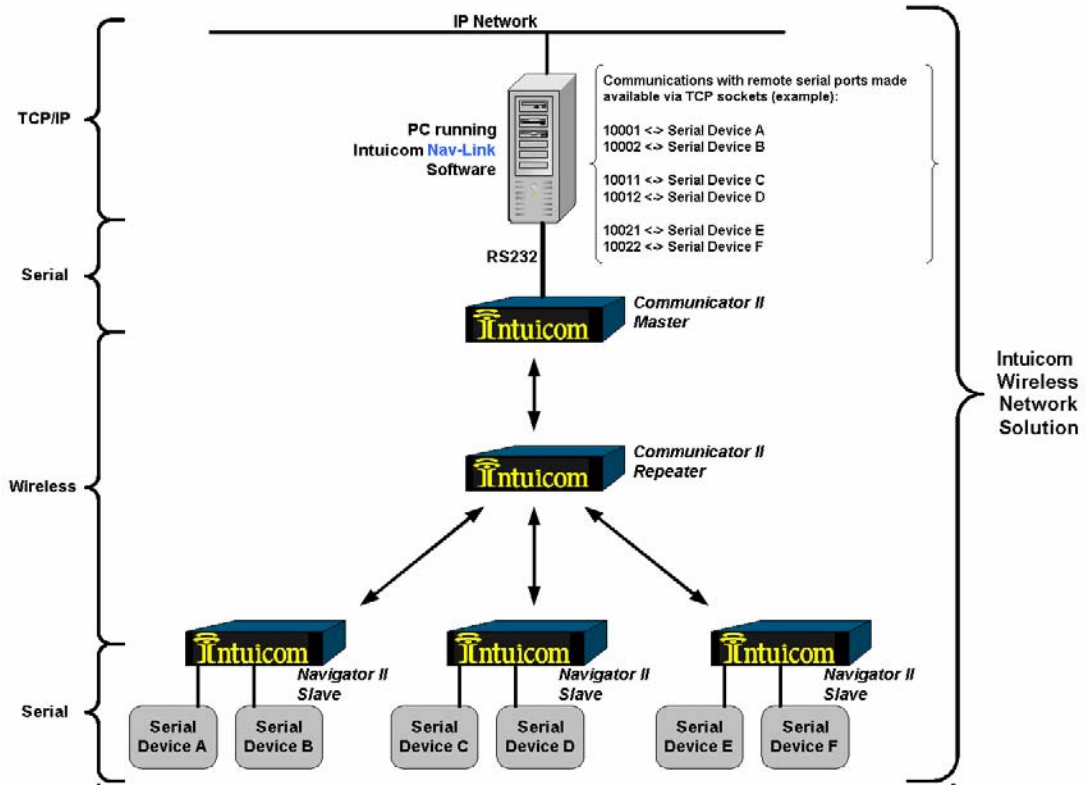


Figure 3-2: Example End-to-End network with Nav-Link

4 Navigator II Setup Menu Tree

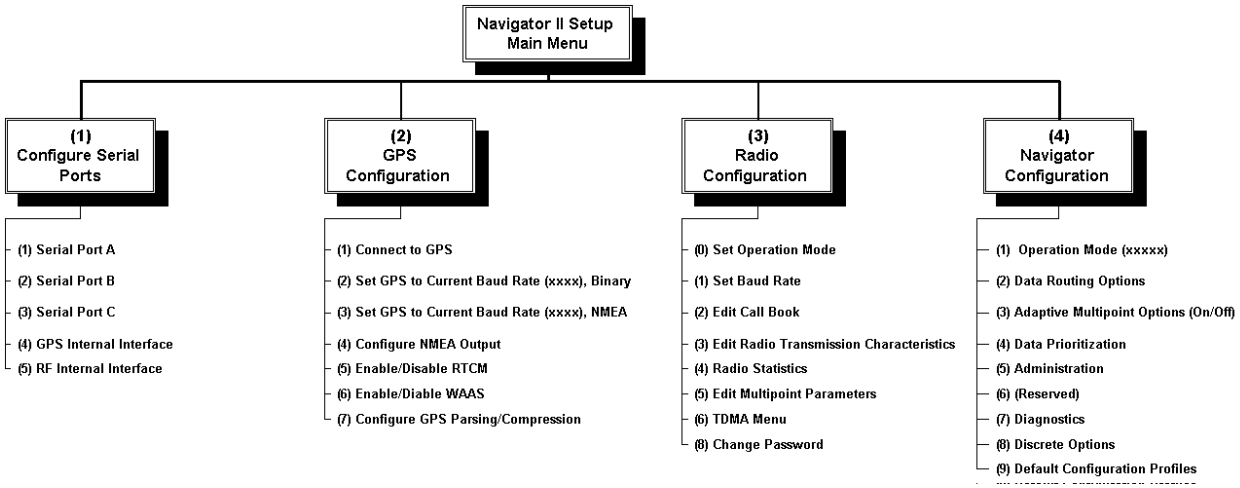


Figure 4-1: Navigator II Setup Menu Tree

5 Navigator II Specifications

5.1 General

Specification	Value	
Enclosure	Extruded aluminum with rubber bumpers	
Size	53mm x 167mm x 143 mm - H x W x L	
Weight	795 grams	
Temperature Operating Environment	-40 to +75 C non-condensing	
Connectors/Signals		
Wireless Data Transceiver	N-Type Female	
GPS	TNC Female	
RS232 Data	3 - DB9 5-wire serial	
Discrete	4 - Inputs, 3 - Outputs available on DB9 (3rd serial port not available when using all discretes)	
GPS PPS	Available on pin 1 of each DB9	
Input Voltage	6-30 VDC 900 Mhz 9.5-30 VDC 2.4 Ghz 9.5 – 14 VDC 225-400 Mhz	
Average Power Consumption (900 Mhz) @ 12VDC – Full RF Transmit Power	**GPS**	**No GPS**
Transmit	272 mA	266 mA
Receive	136 mA	114 mA
Idle	121 mA	98 mA

5.2 Wireless Data Transceiver

Specification	Wireless Transceiver Option		
	900 Mhz	**2.4 Ghz**	**225-400 Mhz [1]**
FCC ID	KNY-6231812519 Canada: IC:2329B-DGR09RAS	KNY209228624168 Canada: 2329391130A	N/A
Frequency Range	902-928 Mhz	2400-24835 Mhz	225-400 Mhz
Operating Modes	Adaptive Multipoint, TDMA, Point-to-Point, Store-and-forward repeater		
Transmitter			
Output Power	1 Watt	500 mW	4 Watt
Range, Line of Sight	60 Miles	60 Miles	60+ Miles
Modulation	Spread Spectrum GFSK, 120 kBs – 170 kBs		
Occupied Bandwidth	230 kHz		
Receiver			
Sensitivity	-108 dBm at 10^{-6} raw BER		
Selectivity	40 dB at fc± 230 kHz, 60 dB at fc ± 460 kHz		
Data Transmission			
Error Detection	32 Bit CRC, resend on error		
Data Encryption	Substitution, dynamic key		
Link Throughput [2]	115 Kbps		

[1] Available only to military customers

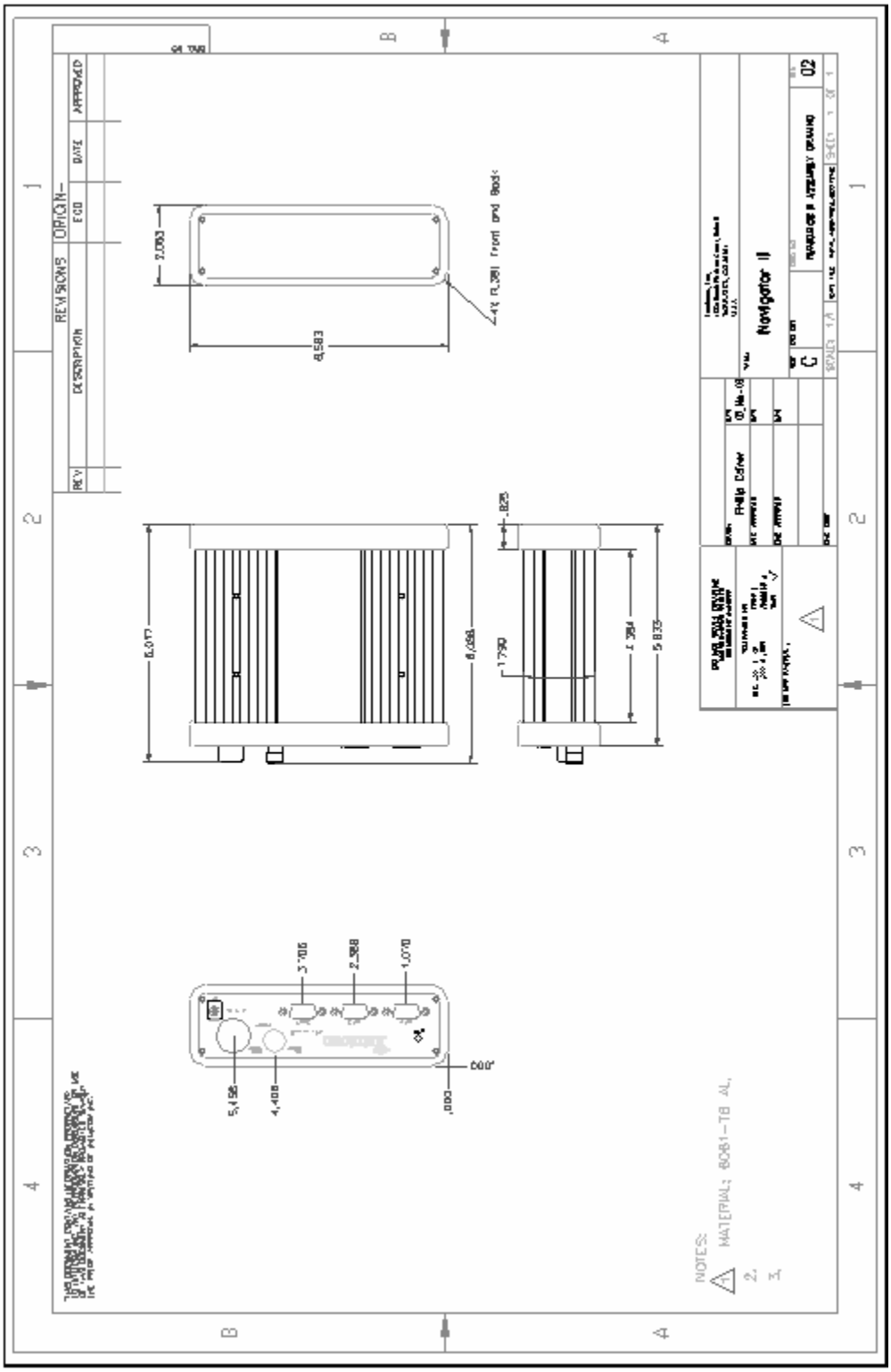
[2] Uncompressed throughput assuming 75% frequency availability

5.3 GPS Receiver Options

Specification	GPS Receiver Option	
	CMC Superstar II	**Thales A12 (WAAS)**
Channels	12 "all-in-view"	10+2 SBAS Config
Frequency	L1 C/A code and carrier	L1 C/A code
Update Rate	1 Hz	1 Hz
PPS	Yes	Yes
Speed	1000 Knots (514 m/s)	
Altitude	60,000 Ft. (18,288 m)	
Position Accuracy [(1)]		
Autonomous Horiz. CEP	< 5 m	3 m
DGPS Horiz. CEP	1 m	< 1 m
WAAS/EGNOS Horiz. CEP	n/a	1 m
Acquisition Time		
Hot Start	15 sec	< 10 sec
Warm Start	45 sec	< 45 sec
Cold Start	120 sec	< 150 sec
Reacquisition Time		
Total SV blockage <20 sec	1 sec	1-2 sec
Communications		
Standard NMEA Output	GGA, GSV, GSA, RMC, VTG, GLL, ZDA	
DGPS Input	RTCM-104 Message 1,2,9	RTCM-104 v2.2 Messages 1,3,9

[(1)] Accuracies based on tests in low multipath environment with clear sky conditions; accuracies may degrade in high multipath environments

6 Navigator II Mechanical Drawing



7 Cable Pinouts, Jumper Settings

7.1 Pinout Serial Ports A and B (DB9 Female)

Pin Number	Signal Name/Alternate	Direction
1	No Connection / GPS PPS	Output
2	TXD	Output
3	RXD	Input
4	No Connection	
5	Signal Ground	
6	No Connection (or power input)	
7	CTS	Input
8	RTS	Output
9	No Connection/+5V/+Vin	Output

Table 7-1: Serial Port A and B Pinout

7.2 Pinout Serial Port C/Discrete (DB9 Male)

Pin Number	Signal Name/Alternate	Direction
1	Discrete In 1 / GPS PPS	Input/Output
2	Discrete Out 1 / Port C TXD	Output
3	Discrete In 4 / Port C RXD	Input
4	Discrete In 3	Input
5	Signal/Power Ground	
6	Discrete Out 3	Output
7	Discrete In 2 / Port C CTS	Input
8	Discrete Out 2 / Port C RTS	Output
9	+5V/+Vin	Output/Input or Output

Table 7-2: Serial Port C/Discrete Pinout

7.3 Jumper settings

Jumper Bank(s)	Closed Pins	Function
J6	1-2, 3-5, 9-7, 11-12	GPS Secondary Port, All discretes enabled
	3-4, 9-10	Port C Enabled
J8 (Port C/Discrete)	1-2, (3-4)	+5VDC Pin 9 or (+Vin Pin 9)
	5-6, (7-8)	GPS PPS Pin 1 or (Input Discrete 1)
J10, J11 (Ports A and B)	1-2, (3-4)	+5VDC Pin 9 or (+Vin Pin 9)
	5-6	Enable GPS PPS Pin 1

Table 7-3: Jumper Settings

8 Antennas and Accessories

Part Number	Description
Data Antennas	
EAN0900NH	Whip Stub Antenna - 900 MHz, Half Wave, with N type male connector
EAN0900WB	12 inch omnidirectional antenna - 890-940 MHz 3 dB open coil with bracket mount with radials. No cable included.
EAN0905WB	33 inch omnidirectional antenna - 890-940 MHz 5 dB elevated feed gain with female N type connector. Includes bracket mount. No ground plane required. No cable included
MFB-9385	48 inch omnidirectional antenna in fiberglass housing: 896-940 MHz, 5 dB, N-type connector, no cable
MFB-9387	96 inch omnidirectional antenna in fiberglass housing: 896-940 MHz, 5 dB, N-type connector, no cable
GPS Antennas	
MP 1330FW	1575 MHz marine grade antenna, 26.5 dB gain, 5-26 VDC
MP 1372FW	Lightweight Survey Antenna. L1 frequency band, 13 dB amplification, TNC female connector. No cable included.
Dual Mode Antennas	
MM-MAG3-925/1575	Dual Mode Antenna - Mobile Mark high gain magnetic mount dual band 900 MHz/GPS antenna w/ 10 ft. cable with male N type RF connector and male TNC GPS connector
MM-SM3-925/1575	Dual Mode Antenna - Mobile Mark high gain surface mount dual band 900 MHz/GPS antenna w/ 10 ft. cable with male N type RF connector and male TNC GPS connector.
RF Filters	
EBF900	Cavity Band Pass Filter 902-928 MHz. Provides 20dB interference rejection at frequencies above 932 MHz and below 897 MHz, with less than 1.5dB insertion loss.
Mounting Bracket	
FIP1-MNTPLT	Navigator II flush mounting plate kit with set of bolt/washer kit.

Table 8-1: Navigator II Accessories

9 FCC Notification

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.

This device must be operated as supplied by Intuicom, Inc. Any changes or modifications made to the device without the express written approval of Intuicom, Inc. may void the user's authority to operate the device.

CAUTION: Intuicom Navigator II Models with 902-928 Mhz wireless transceivers have a maximum transmitted output power of 955 mW, models with 2400-2485 Mhz wireless transceivers have a maximum transmitted output power of 500 mW. It is recommended that the transmit antenna be kept at least 23 cm away from nearby persons to satisfy FCC RF exposure requirements.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

10 Warranty

LIMITED WARRANTY TO END-USERS

Intuicom, Inc.
1880 South Flatiron Ct., Suite R
BOULDER, CO 80301

A. Standard Limited Warranty for Software Products. For Products that include a software license, INTUICOM makes a limited warranty to the End User that the software will perform substantially in accordance with the accompanying written materials and that the transfer media on which the Product is provided will be free from defects in materials or workmanship under normal use and service for a period of ninety (90) days from the date of delivery (the "Limited Warranty") pursuant to the software license included with the Product. The software license specifically disclaims all other warranties relating to the Products, including any and all other warranties with respect to the performance of the Products.

B. Hardware and Other Equipment Manufactured By Intuicom. Hardware products manufactured by INTUICOM include a limited warranty for defects in materials or workmanship under normal use and service for a period of one (1) year from the date of delivery. Intuicom, at its sole discretion, will repair or replace hardware covered under this limited warranty. Cables, antennas or other accessories manufactured by INTUICOM include a limited warranty for defects in materials or workmanship under normal use and service for a period of ninety (90) days from the date of delivery. Repairs not covered under this limited warranty will be billed as set forth in INTUICOM's current Hardware Service Policy and Instructions.

C. Hardware Manufactured By Others. INTUICOM makes no warranties whatsoever with respect to Hardware manufactured by third parties. Customers shall look only to the original manufacturer of the Hardware, pursuant to the terms of any manufacturer warranty for any alleged defects and indemnifies and holds INTUICOM harmless from and against any claims by any party related directly or indirectly to any defects in the Hardware, and functional failure, improper operation, failure to operate according to specifications or any other matter related to the Hardware. INTUICOM shall not be liable or responsible for the failure of the Manufacturer to perform under or honor any warranty with respect to the Hardware. Customer acknowledges and agrees that Customer shall have the risk of any loss, damage or functional failure related to the HARDWARE and shall have the responsibility for maintaining the proper operation of the HARDWARE and complying with all maintenance guidelines and specifications from the Manufacturer and all other conditions to receiving warranty coverage from the Manufacturer.

D. No Other Warranty. EXCEPT FOR THE EXPRESS STANDARD LIMITED WARRANTY REFERENCED ABOVE, INTUICOM GRANTS NO OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING THE PRODUCTS, THEIR FITNESS FOR ANY PURPOSE, THEIR QUALITY, THEIR MERCHANTABILITY OR OTHERWISE. INTUICOM DOES NOT MAKE BY VIRTUE OF THIS AGREEMENT OR ANY PRODUCT ORDER, AND HEREBY EXPRESSLY DISCLAIMS, ANY OTHER REPRESENTATION OR WARRANTY OF ANY KIND WITH RESPECT TO THE PRODUCTS.

E. Limitation of Liability. IN NO EVENT WILL INTUICOM BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, INCIDENTAL, BUSINESS INTERUPTION, CATESTROHPIC, PUNITIVE OR OTHER DAMAGES WHICH MAY BE CLAIMED TO ARISE IN CONECTION WITH ITS PRODUCTS, REGARDLESS OF THE LEGAL THEORY BEHIND SUCH CLAIMS, WHETHER IN TORT, CONTRACT OR UNDER ANY APPLICABLE STATUTORY OR REGULATORY LAWS, RULES, REGULATIONS, EXECUTIVE OR ADMINISTRATIVE ORDERS OR DECLARATIONS OR OTHERWISE, EVEN IF INTUICOM HAS BEEN ADVISED OR OTHERWISE HAS KNOWLEDGE OF THE POSSIBILITY OF SUCH DAMAGES AND TAKES NO ACTION TO PREVENT OR MINIMIZE SUCH DAMAGES. IN THE EVENT THAT REGARLDESS OF THE WARRANTY DISCLAIMERS AND HOLD HARMLESS PROVISIONS INCLUDED ABOVE INTUICOM IS SOMEHOW HELD LIABLE OR RESPONSIBLE FOR ANY DAMAGE OR INJURY, INTUICOM'S LIABILITY FOR ANY DAMAGES SHALL NOT EXCEED THE PROFIT REALIZED BY INTUICOM ON THE SALE OR PROVISION OF THE HARDWARE TO THE CUSTOMER.

