VX0850 PACKET RADIO USER'S MANUAL

Version 2.3

January 29, 2003

Stevens Water Monitoring Systems, Inc.
5465 SW Western Ave. Suite F
Beaverton OR 97005
Phone: 503-469-8000
Fax: 503-469-8100
www.stevenswater.com

TABLE OF CONTENTS

1 INTRODUCTION

The VX0850 Radio Controller is a compact, low power unit intended for use in remote locations as well as industrial environments. The unit provides a VHF/UHF packet radio communication link for the VX1100 Data Collection Platform. The VX0850 provides point to multi-point, digital repeating and advanced Reed-Solomon forward error correction (chance of undetected error 1 bit in 16 Million). Several VX0850's may be used together to form a network. The operation of VX0850 may be programmed either locally using a portable computer terminal or remotely over the communications link from other terminals in the network.

2 SPECIFICATIONS

This section describes the basic hardware and physical parameters of the VX0850.

2.1 MICROPROCESSOR AND MEMORY

- 16 Bit, 12 MHz CMOS Micro-controller.
- 64 Kilobyte CMOS EEPROM.
- 32 Kilobyte RAM, battery backed.
- 256 Bit EEPROM.

2.2 COMMUNICATIONS PORTS

- Bi-directional, serial RS-232-C (DB-9 Female DTE).
- Bi-directional, 1200 baud, modulated analog 300 to 3KHz telemetry port.
- VITEL bi-directional V-BUS.

2.3 POWER REQUIREMENTS

- 30mAmp with standard version 2.3 EEPROM.
- 13.8 VDC 1 Amp Max when Transmitting (5 Watt Transceiver).
- 240mWatts @ 12 VDC (nominal).

2.4 OPERATING TEMPERATURE RANGE

- -40 Degrees C to + 60 Degrees C.

2.5 MECHANICAL

- 11.5-inches wide x 1-inch high x 3.75-inches deep.

3 CONTROLS, INDICATORS AND CONNECTORS

3.1 RESET BUTTON

The **RESET Button** will initiate a system hardware reset. During reset, when the RESET Button is pressed, the **RUN** and **TX-ON** led will be illuminated. After reset,

when the RESET Button is released, the **RUN** led will be illuminated. Continued operation will be indicated by the **RUN** led being turned off and back on once every ten seconds.

3.2 RUN LED

The **RUN** led is illuminated by the processor. It is turned off and on for one second out of every ten to indicate that the software is running correctly.

3.3 CD LED

The **CD** led indicates that the data carrier has been detected on the telemetry channel. It is illuminated by the processor when the modem has detected and is demodulating the preamble bits at the beginning of a data block being received over the telemetry channel. It is turned off when the data carrier is no longer being received.

3.4 PACKET LED

The **PACKET** led indicates that the information in a data block is being decoded. It is illuminated when the VX0850 has synchronized onto a data block being received over the telemetry channel and is decoding the information contained in it. If that information is decoded correctly the led is left illuminated until the next time data carrier is detected. If the block cannot be decoded correctly the led is turned off. In this way the **PACKET** led gives the operator an indication of whether the last block received was decoded correctly or not regardless of when that reception may have occurred.

3.5 TX-ON LED

The **TX-ON** led is illuminated when the processor has turned on the transistor that pulls the key line (push to talk, PPT) to ground. This line is pulled to ground to key the transmitter.

3.6 COMMS LED

The **COMMS** Led is illuminated when either the telemetry or RS-232 communications port is active. When the VX0850 is connected to a VX1100 DCP via the V-Bus and the VX1100 is turned on, the **COMMS** Led will flash 5 times indicating good communication over the V-Bus.

3.7 OUT 1 LED

The **OUT 1** led is illuminated when STATUS 2 Bit one is high (Control Output 1). When this led is illuminated, the resistance between Pin1 and Pin 2 of J7 should drop to approximately one ohm. When this led is not illuminated this resistance should read infinite.

3.8 OUT 2 LED

The **OUT 2** led is illuminated when STATUS 2 Bit two is high (Control Output 2). When this led is illuminated, the resistance between Pin3 and Pin 4 of J7 should drop to approximately one ohm. When this led is not illuminated this resistance should read infinite.

3.9 ERROR LED

The **ERROR** Led is illuminated when either the software is performing internal tests initiated by commands received over the telemetry or RS-232 port, or when the tests performed return a failing value.

3.10 RS-232 SERIAL PORT DTE

The **SERIAL PORT** Connector is the connection point for the serial RS-232-C packet port. This port is typically used to communicate with other devices in the immediate vicinity of the VX0850, such as a personal computer running set-up and display software. It can be connected to other long-range telemetry equipment or line drivers. The signals on this connector conform to the RS-232-C electrical standard.

4 VX0850 BOARD CONFIGURATION SETTINGS

The following items should have been removed at the factory: R69, R71, R82

4.1 POWER SUPPLY

The VX0850 board receives its +12VDC power through the supplied red and black power lead soldered onto the board. Color code:

Red +12VDC

Black Ground

4.2 POWER SELECT JUMPERS

The following jumpers must be installed for the VX0850 to work correctly:
Jumper J4 and J6 should be installed as shown below in Figure 1.

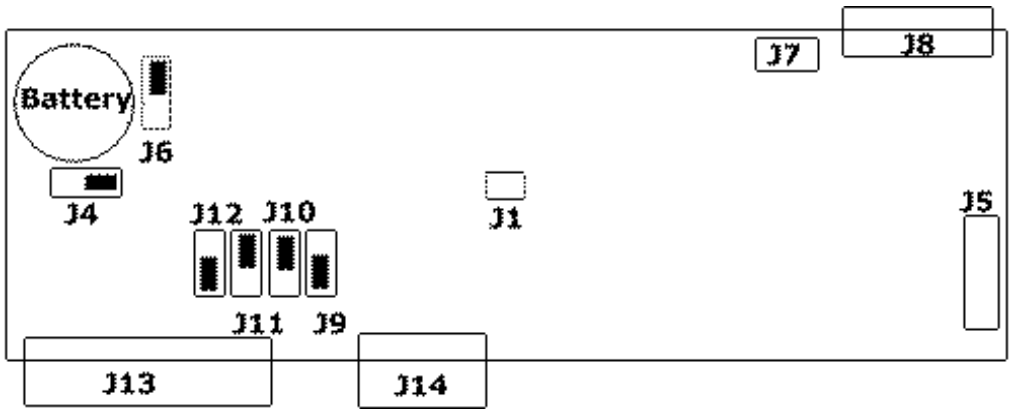

Figure 1. Power Jumpers

4.3 VX0850 V-BUS BOARD ADDRESS

The VX0850 boards V-Bus address is determined by jumpers J9 through J12. This address is module dependent, and all VX0850 boards will have the same address. Correct jumper settings are shown in Figure 1.

4.4 CONNECTOR PIN OUT

4.4.1 J5 – TELEMETRY INTERFACE

Pin 1	Audio OUT (TX Analog)
Pin 2	Key TX
Pin 3	TX/RX Power
Pin 4	+12VDC
Pin 5	Audio In (RX Analog)

4.4.2 J7 – CONTROL OUTPUT 1 & 2

Pin 1	Ground
Pin 2	Control OUT 1
Pin 3	Ground
Pin 4	Control OUT 2

4.4.3 J8 – MASTHEAD REMOTE RADIO INTERFACE

Pin 1	Ground
Pin 2	+12VDC
Pin 3	RX Analog Transformer Isolated with Pin 4
Pin 4	RX Analog Transformer Isolated with Pin 3
Pin 5	TX Analog Transformer Isolated with Pin 6
Pin 6	TX Analog Transformer Isolated with Pin 5
Pin 7	TX-KEY Transformer Isolated with Pin 8, Relay Driven
Pin 8	TX-KEY Transformer Isolated with Pin 7, Relay Driven

4.4.4 J14 – RS-232-C SERIAL PORT DTE

Pin 1		Not Used
Pin 2	(I)	RX Data
Pin 3	(O)	TX Data

Pin 4	(O)	Data Terminal Ready (DTR)
Pin 5		Ground
Pin 6	(I)	Data Set Ready (DSR)
Pin 7	(O)	Ready to Send (Not Used)
Pin 8	(I)	Clear to Send (Not Used)
Pin 9		Not Used

4.4.5 RS-232-C NULL MODEM CABLE PIN OUT

The RS-232-C Null Modem Cable allows communication with the VX0850 from either the controlling computer or a portable computer. The VX1100 RS-232 cable uses the same pin out; however, it uses two DB-9 Female connectors.

Figure 2. RTU 0850 Cable Assembly

5 PACKET FORMATS AND USAGE

The VX0850 data telemetry protocols are based on peer to peer, packet switching techniques. Information is transferred through the network in the form of packets. A packet is composed of Header/Control Fields, Routing Fields, and Information Fields as illustrated in the following figure:

Header/ Control	**Routing Fields**	**Information**

The Header/Control Fields contain information such as the type of packet, (data, time, command), it's priority, and the length of the routing and information fields. The Routing Fields contain the source and destination path specifies. The Information Field contains the actual information being transferred between the terminals.

5.1 PACKET TYPES

There are several packet types used by the VX0850. The different packet types are used to invoke different activities within the terminal units that receive the packet or through which it passes.

5.1.1 COMMANDS AND COMMAND RESPONSES

Command packets are used to send commands through the network to a terminal. Typical commands sent through the system to a terminal are:

- Send/Get Configuration Parameters
- Get System Status
- Perform System Tests

Command response packets are generated in response to command packets. They contain confirmation of the command's execution as well as any supplementary information produced by that execution (for example the response associated with a system test). Command responses are always routed back to the unit that issued the command.

5.1.2 DATA PACKETS

Data packets are used to transfer data through the system. Each data packet can contain multiple data points. Each data point has three pieces of information associated with it; the ID of the device that generated the value, the sample time of the value, and the value itself.

5.1.3 TIME PACKETS

Time packets are used to synchronize the internal clocks of all devices in the VX0850 Network. Time Packets differ from Data and Command Packets in that any device that receives a Time Packet, even if the packet path does not specify that devices unit ID number, will compare the time in the Time Packet with its own clock and correct it if necessary. This eliminates having to send a Time Packet to every device. For instance, in a VX0850 system where radio communication links are used, a single time packet transmission to one VX0850 may be all that is required to synchronize the entire network.

5.2 PACKET ROUTING

Each packet moving though the communications network must follow a specific path to get from its source to its intended destination. The path is defined by a series of path specifies with each specifier indicating the station number (UID), in-port, and out-port for each terminal through which the packet must pass to reach it's destination. The routing fields contain these path specifies and some control information for determining where on the path a specific packet is situated.

The first number in the Routing Fields is the UID of the terminal that originated the packet. The last number is the UID of the terminal that the packet is destined for. The intermediate UID's identify the terminals the packet must pass through to reach its destination. A pointer in the Header/Control Field is used to keep track of the current location of the packet. The receiving terminal can use this information to determine the source of the packet and the path it took to reach its destination.

5.2.1 UNIT IDENTIFICATION (UID) NUMBERS

Each terminal in a VX0850 communications system is assigned a unique identification number in the range from 0 to 65535. This number is referred to as the Unit Identification Number (UID). When assigned, the UID is programmed into a non-volatile memory in the terminal controller module and is used as the terminal address for all communications network activity.

5.2.2 IN-PORTS AND OUT-PORTS

In-ports and Out-ports are used to designate the physical port at the terminal through which the packet is transferred. The in-port is the port through which the packet enters the terminal and the out-port is the port through which the packet leaves the terminal. There are currently three ports defined for use in the VX0850 terminal:

1 The Telemetry (radio) port.
4 The Console (Serial RS-232-C) port.
0 A logical port indicating the source or destination termination.

The termination port indicates that this terminal is the initial source or the final destination of the packet. For example, the source specifier for a terminal originating a data packet will have an in-port specifier of 0. Similarly, a sensor interrogation command routed to a VX0850 will have a destination out-port specifier of 0.

5.2.3 CREATING A PATH SPECIFIER

A path is specified by indicating the station number, in-port, and out-port of each terminal a packet must pass through to go from it's source to it's destination. For example, a data packet created by a VX0850 with UID = 1001, sent through another VX0850 with UID = 1002 over the telemetry channel to a VX0850 with UID = 1003 and then out the last VX0850's console port to the central computer would have it's path specified as follows:

Terminal UID	In-Port	Out-Port
1001	0	1
1002	1	1
1003	1	4
0	4	0

This path would commonly be displayed in the following format:

1001:0/1 1002:1/1 1003:1/4 0:4/0

Similarly the path used to send a command from the central computer to the VX0850 to read a sensor would have the path:

0:0/1 1003:4/1 1002:1/1 1001:1/0

6 OPERATORS TERMINAL UNIT (OTU) PROGRAM

The Operators Terminal Unit is a DOS based utility that allows a user to access the VX0850 internal configuration settings and test the VX0850. It also allows the user to remotely test and configure other VX0850's using the radio network.

6.1 INSTALL OPERATORS TERMINAL UNIT (OTU)

Install OTU by inserting the floppy disk into drive a: or b: as appropriate. For this example it is assumed that drive a: is the one that OTU will be installed from. Type "a:\install" and follow the directions.

6.2 CONFIGURE OPERATORS TERMINAL UNIT

1) Start Operators Terminal Unit by typing "**OTU15**" for the color version or by typing "**OTUM15**" for the monochrome version. Select **SETUP** from the menu. Select **MISC** from the drop down menu. Ensure that the following items are correctly selected, if not press **<Enter>** to edit the entries:

   a) Comm Port should be set to the serial port that will be used to talk to the VX0850.
   b) Baud Rate should be set at 9600 baud.
   c) Data Bits should be set for 8.
   d) Stop Bits should be set for 1.
   e) OTU ID should be set to 0.

2) After configuring OTU if necessary press **<ESC>** and answer "**Y**" to save the changes. Press **<ESC>** again to reach the main menu. Next, select **COMMS** from the menu, and then **COMMS PARAMS** from the drop down menu. Ensure that the following items are configured as follows, if not press **<Enter>** to edit the entries:

COMMS PARAMS	
Serial Port	9600
Access Level	0
General Password	0

RF PORT	
1st Preamble Duration	50 MS
2nd Preamble Duration	50 MS
Max Short Packet Length	100 Bytes
Squelch	OFF

TIMMED EVENTS / TX DEFAULTS	
Transmit Format	16 bit CAL
PKT Path(s)	00000000

3) After configuring OTU if necessary press **<ESC>** and answer "**K**" to keep the changes. Press **<ESC>** again to reach the main menu. Select **DEVICE**, press **<ENTER>** and then select **ANALOG IN**. Enter "**8**" when asked for the device number. Ensure that the following items are configured as follows, if not press **<ENTER>** to edit the entries:

DEVICE CALIBRATION	
Multiplier Value	15677
Divisor Value	10000
Base Value	0

PERIODIC DATA	
Report Changes	65535

REPORT METHODS	
Transmit zero's	Enabled

PROBLEM DATA	
Warning Report	65535
Alarm Report Changes	65535

4) After configuring OTU if necessary press **<ESC>** and answer "**K**" to keep the changes. Press **<ESC>** again to reach the main menu. Select **FILE** from the menu and then select **SAVE ALL CONFIG** from the drop down menu. Enter a file name, (i.e. "default.cfg") to save this default setup. **NOTE:** The file name cannot exceed the DOS imposed 8-character limit. All configurations should be saved with the .cfg suffix.

5) At this time exit OTU by selecting **QUIT** and pressing **<ENTER>**.

6.3 CONFIGURE VX0850 UID AND COMMS PARAMS.

The following item will be needed to perform this task:

- Computer with the OTU software installed.
- Serial null modem cable as described in section 4.4.5.
- VX0850(s) to configure.
- +12VDC power source.

1) Connect the VX0850 to the +12VDC power source observing the correct polarity and that the **RUN** led illuminates and then flashes after approximately 10 seconds. Connect the VX0850 to the computer using the serial null modem cable.

2) If the computer is not running, turn it on and then start OTU by using "**otum15.exe**" for monochrome or "**otu15.exe**" for color. Select **COMMS** from the menu, then select **UID** from the drop down menu and then press **<ENTER>** to edit the UID that is to be assigned to the connected VX0850. After the correct number is entered press **<ESC>** and answer with a "**Y**" to keep and send changes. In the Command Response Window there should be a message stating that the command received good. Again press **<ENTER>,** enter all 0's and then press **<ESC>** and answer with "**K**" to keep the changes locally. Select **GET** from the menu and press **<ENTER>** to EXECUTE the command. The UID displayed should change from all 0's to the UID that was assigned the VX0850.

3) If the UID the VX0850 responded with is correct then select **QUIT** from the menu and continue to the next section. If the UID the VX0850 responded with was incorrect, repeat steps 1 and 2 again to verify that there is a problem with the VX0850. If the Command Response Window shows a communication error, check to ensure that:

   a) the VX0850 is powered.
   b) the serial cable is correct with the pin-out in section 4.4.5.
   c) that the cable is connected to the VX0850.
   d) the computer's COM PORT as was indicated to the OTU program in its setup in section 6.2

4) Correct any deficiencies and redo steps 1 and 2. If there is still a problem, consult a technical representative and explain the nature of the problem.

5) After completing the above section successfully, select **FILE** from the menu, then **LOAD ALL CONFIG** from the drop down menu and press **<ENTER>**. Enter the name of the file that was saved in section 6.2 step 4. If the file name is unknown press **<ESC>** and then select **DOS SHELL** from the drop down menu. If the file was saved as stated in section 6.2 step 4 then type at the dos prompt "**DIR *.CFG**" and press **<ENTER>**. This should produce a listing of all saved configuration files. Make a note of which file is to be loaded and repeat this section from **LOAD ALL CONFIG**. If there are no configuration files, type **EXIT** and return to OTU and go to section 6.2 step 3 and complete a default configuration.

6) After successfully loading a configuration file select **SEND ALL CONFIG** from the drop down menu and answer "**Y**" to send the configuration to the VX0850. In the Command Response window there should be a message Awaiting 100 Command Responses. During the next two minutes this number of awaiting command responses should decrease.

6.4 VERIFY VX0850 OPERATION (PERFORMANCE TEST)

The following items are needed to perform this test:

- (2) VX0850's with Radios.
- Computer with Operator Terminal Unit software.
- (2) +12VDC Power Sources.
- VX1100 with V-Bus Cable.
- Serial Null Modem Cable.
- Ohm meter.

Test each VX0850 for proper operations. **NOTE:** The Telemetry Interface and radio will be tested last as part of the end to end test.

Connect the VX0850's to their radios and power sources. Connect the VX0850 to the computer using the serial null modem cable. Using OTU either assign the VX0850 a UID (see section 6.3) or check the existing one and write down the UID for later use.

6.4.1 ROM, RAM, BATTERY, CLOCK TEST (ALL OF THE ABOVE)

Select **TEST** from the main menu and press **<ENTER>**. Select **ALL OF THE ABOVE** and wait for the results of the test to be displayed.

ROM Test This test calculates a checksum from the date in the VX0850 EPROM. It then compares it to the expected checksum, which is stored in the EPROM. A failed ROM Test is a serious error and the controller module should be replaced.

RAM Test This test runs through the entire RAM and writes a test value to each of the addresses in turn. A failure will result if a value read back is not the same value that was written. A failed RAM Test is a serious error and the controller module should be replaced.

Battery Test This test performs a read of the battery sensor while keying the transmitter so that the battery voltage is measured under maximum load. This test will fail if the battery voltage is less than 12 volts.

Clock Test The clock test takes about 20 seconds. During that time, the number of pulses on each of the two VX0850 internal clocks are counted and compared. The result is converted to a value approximating the clock drift that could occur in one day. A value of more than 1 minute per day will result in a failure and the controller module should be replaced.

6.4.2 LED TEST

Press <ENTER> and select LED. Observe the front panel of the VX0850 and watch the LEDs illuminate in the following order: PACKET, CD, TX-ON, ERROR. The result of the test will be displayed.

Description: The LED test causes the following VX0850 LEDs to be turned on and off: PACKET, CD, TX-ON, ERROR. The failure of a led to light indicates a hardware failure and the controller module should be replaced.

6.4.3 WATCHDOG TEST

Press <ENTER> and select WATCHDOG. The result of the test will be displayed.

Description: This test is used to verify that the VX0850's internal watchdog timer is working. When the test is started the ERROR led will be turned on for approximately 5 seconds. Within 20 seconds of the command being executed, the VX0850 must reset. Failure of this test is a serious error and the controller module should be replaced.

6.4.4 TRANSMIT TEST

Press **<ENTER>** and select **TRANSMIT**. The result of the test will be displayed.
NOTE: Sometimes OTU does not recognize the returned command indicating the test was successful or times out shortly before it's received. This test may be skipped as the telemetry interface and radio will be tested later in the test procedure.

Description: This option does not actually perform a test but is used in the process of testing the telemetry port. This test will key the transmitter causing the **TX-ON** LED to be illuminated and the carrier to be transmitted for 20 seconds. When the test is complete the **ERROR** LEDs will be turned off. The controller module should be replaced if this test fails to run.

6.4.5 CONTROL OUTPUT TEST

Press <ESC> to return to the main menu. Select DEVICE and press <ENTER>. Press <ENTER> again and select STATUS I/O and then enter "2".

To test Control OUT-1 select WRITE, then select RAW from the dropdown menu and enter "1". Press <ENTER> and answer "Y". Observe the OUT 1 led light up. Check the resistance between pin 1 and 2 of J7, the resistance should be approximately one ohm.

Repeat again except enter "0" and check resistance again, the resistance should read infinite.

To test Control OUT-2 select WRITE, then select RAW from the dropdown menu and enter "10". Press <ENTER> and answer "Y". Observe the OUT 2 led light up. Check the resistance between pin 3 and 4 of J7, the resistance should be approximately one ohm. Repeat again except enter "0" and check resistance again, the resistance should read infinite.

To test both Control OUT-1 & Control OUT-2 select WRITE, then select RAW from the dropdown menu and enter "11". Press <ENTER> and answer "Y". Observe the OUT 1 led light up. Check the resistance between pin 1 and 2 and 3 and 4 of J7, the resistance should be approximately one ohm. Repeat again except enter "0" and check resistance again, the resistance should read infinite.

The OUT 1 led is illuminated when STATUS 2 Bit one is high (Control Output 1). When this led is illuminated, the resistance between Pin1 and Pin 2 of J7 should drop to approximately one ohm. When this led is not illuminated this resistance should read infinite.

The OUT 2 led is illuminated when STATUS 2 Bit two is high (Control Output 2). When this led is illuminated, the resistance between Pin3 and Pin 4 of J7 should drop to approximately one ohm. When this led is not illuminated this resistance should read infinite.

7 VX1100 SETUP FOR USE WITH VX0850

The following items are needed to configure the VX1100 for use with the VX0850:

- Computer with the Communications software installed.
- Serial null modem cable as described in section 4.4.5, with dual female plugs.
- VX1100(s) to configure.
- +12VDC power source.

1) If the computer is not running, turn it on and then start the communications package. Ensure that the COM Port settings are:

- Data Bits: 8
- Stop Bits: 1
- Parity: N
- Baud Rate: 9600

2) Connect the VX1100 to the +12VDC power source ensuring correct polarity of the connection. Connect the serial null modem cable to the VX1100 and to the computer's COM Port as selected in the communications program. Turn on the VX1100.

7.1 VX1100 CONFIGURATION

1) Log onto the VX1100 by pressing <ESC> or <ENTER> until the logon prompt (Enter Password ?>_) is shown in the communications program. Enter "1111" as pass code. **NOTE:** If the VX1100 has already been configured, enter the appropriate pass code, the pass code shown is the default code when the unit is shipped from the factory.

2) Select **SYSTEM SETUP** and then select **VX0850 SETUP** from the menu. For the VX1100 to report through the VX0850 the VX0850 Flag must be set to **ON**, this can be changed by selecting the menu item "VX0850 Flag" which will then toggle ON & OFF.

3) Enter the path length that the reports will take back to the central computer. Refer to section 5.2.3 for more information on creating path specifiers. **NOTE:** The maximum number of path specifiers is 10. The following example require a path length of 4:

Node	UID
VX1100	= 400
VX0850 (1)	= 401
VX0850 (2)	= 1
Computer	= 0

4) Enter path specifiers as required. The previous example would require the following path specifiers:

Node	Path Specifier #	Path Specifier
VX1100	1	00400:0/4
VX0850 (1)	2	00401:4/1
VX0850 (2)	3	00001:1/4
Computer	4	00000:4/0

NOTE: When entering the path specifiers into the VX1100, remember that the path is entered from the VX1100 to the central computer. The path information provides the routing information that the VX1100 needs to send a report through the VX0850 radio network.

5) Log off the VX1100 by pressing **<ESC>** twice and selecting "**Logoff"** from the main menu.

7.2 VX1100 & VX0850 END TO END TEST

1) Place the VX0850's approximately 1 meter apart. Select one and attach the VX1100 via the V-Bus ribbon cable. Apply power to all units. Turn on the VX1100 and observe the COMMS light on the VX0850 blink five (5) times.

2) Setup the VX1100 using section 7. Either use existing UID's or those provided in the example below:

Example:
Path Length = 4
Path Specifiers:

Node	Node #	Path Specifier #	Path Specifier
VX1100	0	1	00400:0/4
VX0850 (1)	1	2	00401:4/1
VX0850 (2)	2	3	00001:1/4
Computer	3	4	00000:4/0

3) Log into VX1100 and choose the SYTEM SETUP menu. Then choose the menu SETUP VX0850.

4) Select the Get UID menu item. Enter node number 2 to select VX0850(2) that is connected to the computer.

5) A successful test will result in the GET UID number of Node 2 being displayed correctly (i.e. 00001).