

## MRF24J40 Radio Utility Driver Program

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For more detailed testing, engineers can use additional tools such a spectrum analyzer or the ZENA™ packet analyzer, Microchip's IEEE 802.15.4 sniffer program. For more details on the ZENA analyzer, see the "ZENA™ Wireless Network Analyzer User's Guide" (DS51606).

The MRF24J40 utility program source code and hex files are in the application note's compressed file. Additional reference material is listed in "References" on page 22.

### INTRODUCTION

The MRF24J40 Radio Utility Driver program provides design engineers a development and testing platform for the MRF24J40 IEEE 802.15.4™ 2.4-GHz RF transceiver. The program configures and runs tests of basic transceiver functionality such as transmission, reception sleep and Turbo mode, using a command-line and menu-driven user interface.

The MRF24J40 utility program can run on either the PICDEM™ Z or Explorer 16 development board, to which the MRF24J40 RF transceiver is attached. The board is connected to a PC's serial port and operated from a hyper terminal command window. For more details on the setup, see the section "Getting Started" on page 1.

### Supported Features

Table 1 gives the program's basic features.

**TABLE 1: MRF24J40 RADIO UTILITY DRIVER FEATURES**

Feature	Functionality
Sniffer/Packet Analysis	Functions as a sniffer or packet analyzer, when transceiver is programmed in Receive mode.
IEEE 802.15.4™ Specification Compliance	Transmits and receives packets compliant with the IEEE 802.15.4 specification.
All-Channel Energy Detection	Performs energy-detect scans on all channels.
Low-Power Testing	Enables testing of the MRF24J40 RF transceiver in Sleep mode.
End-to-End Testing	Provides Packet Error Rate (PER) and Ping Pong testing between two transceivers.

### GETTING STARTED

To set up the MRF24J40 RF transceiver:

1. Insert the MRF24J40 RF transceiver daughter card into the development board.
  - If using the PICDEM™ Z development board, see Figure 1 on page 2.
  - If using the Explorer 16 development board, see Figure 2 on page 3.
2. Plug in the power cord for the demonstration board that will hold the MRF24J40 RF transceiver.

3. Connect an RS-232-to-USB serial cable between the development board and the computer that will display the MRF24J40 utility program user interface.
4. Program the demonstration kit with the appropriate hex file.

First-time users of MPLAB® ICD 2, see the "MPLAB® ICD 2 User's Guide" (DS51331), Section 4.3.2, "Loading a Hex File."

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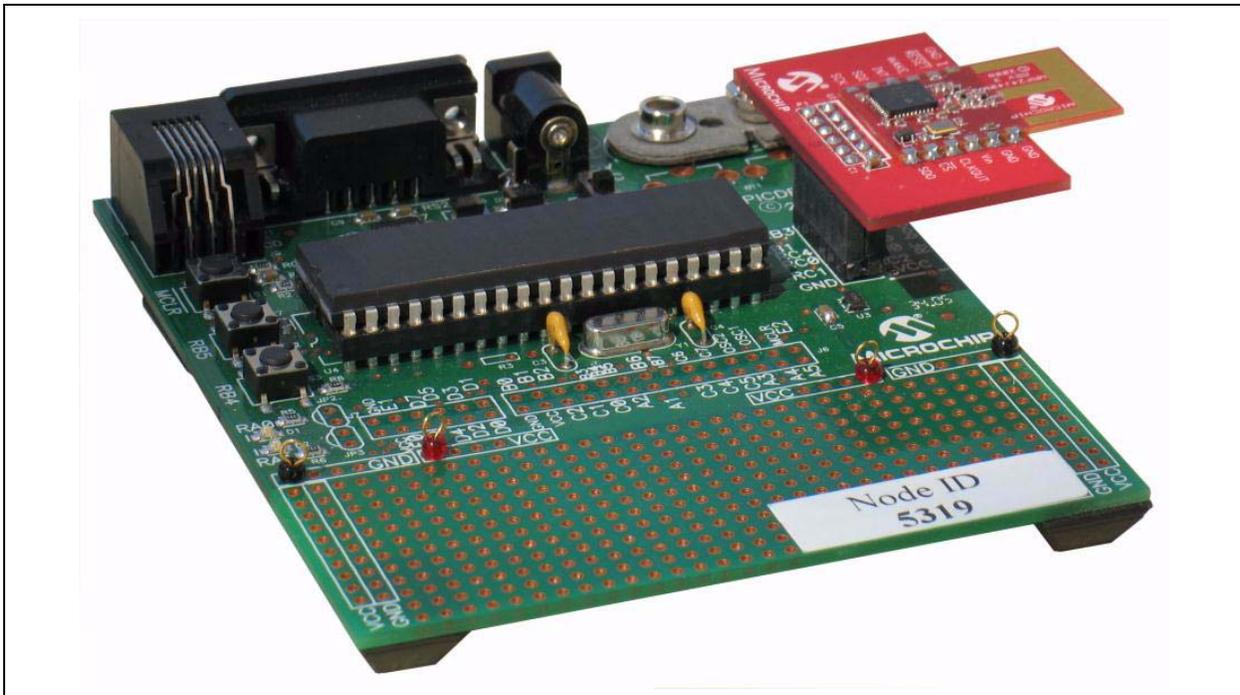
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## Using the PICDEM™ Z Board

The MRF24J40 RF transceiver daughter card's 12-pin connector (P1) can be used to connect to the PICDEM Z motherboard's J2 connector. That connection supplies 3.3V power, four-wire SPI, Reset, wake and interrupt connections to the MRF24J40 RF transceiver.

For the schematics of the MRF24J40 RF transceiver's daughter card, see Appendix C of the "PICDEM™ Z Demonstration Kit User's Guide" (DS51524).

**FIGURE 1: MRF24J40 RF TRANSCEIVER ON PICDEM™ Z DEVELOPMENT BOARD**

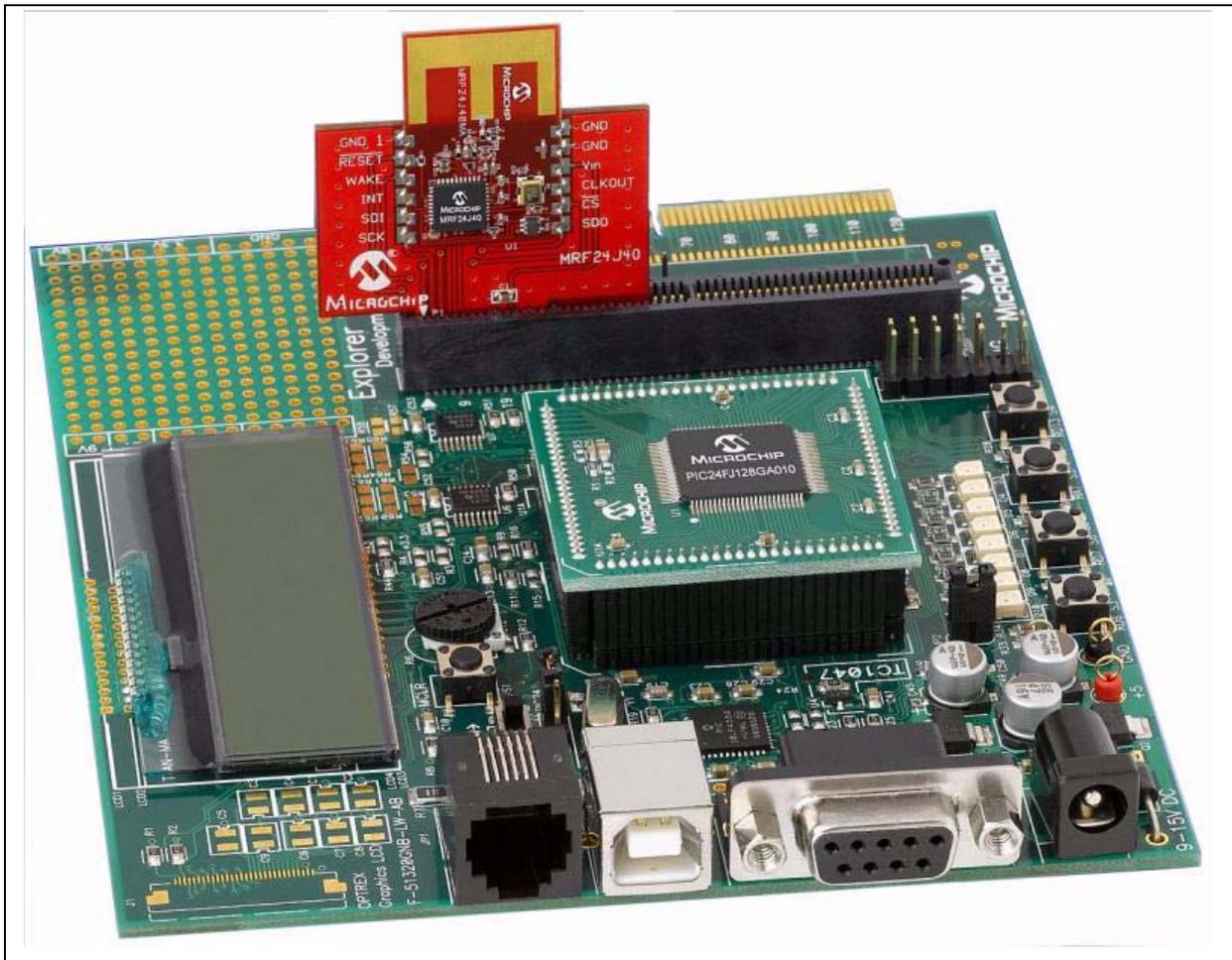


## Using the Explorer 16 Board

The MRF24J40 RF transceiver daughter card's 30-pin connector (P1), a PCB-edge connector, can be used to connect to Explorer 16 development board's PICtail™ Plus connector (J5 or J6). That connection supplies 3.3V power, four-wire SPI, Reset, wake and interrupt connections to the MRF24J40 RF transceiver.

For the schematics of the MRF24J40 RF transceiver's daughter card, see Appendix C of the "PICDEM™ Z Demonstration Kit User's Guide" (DS51524). For the schematics of Explorer 16 development board, see the "Explorer 16 Development Board User's Guide" (DS51589).

**FIGURE 2: MRF24J40 RF TRANSCEIVER ON EXPLORER 16 DEVELOPMENT BOARD**



## Connecting to the Host PC

The PC displaying the MRF24J40 utility program's user interface connects to the development board through the PC's serial port. PCs with the Windows® XP or Windows NT® operating system can use the HyperTerminal program for communications to set up the user interface.

Other serial port communications can be used and open-source programs are available for downloading and use.

The required configuration settings for the serial port communication program are shown in Table 2.

**TABLE 2: SERIAL PORT SETTINGS**

Parameter	Setting
Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

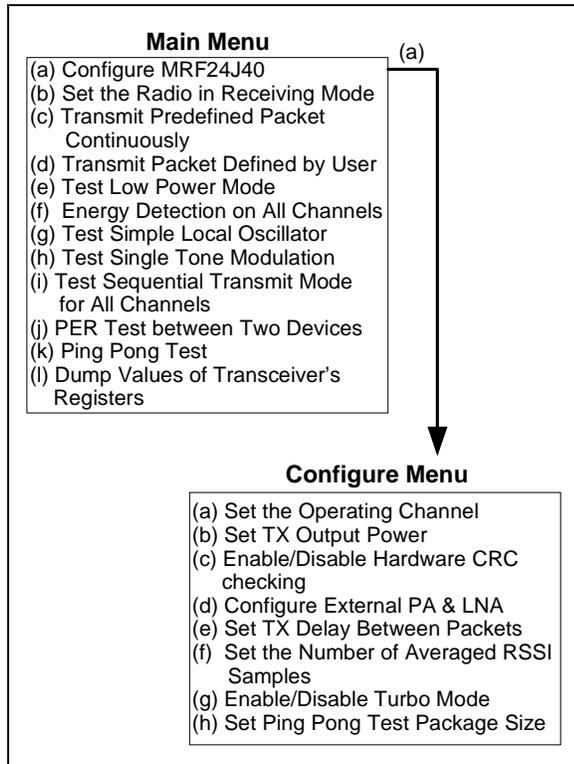
## USING THE DRIVER FIRMWARE

### Firmware Overview

The MRF24J40 utility program is operated through a menu displayed on the host computer, using a serial port communication application.

There are two major menus, shown in Figure 3.

**FIGURE 3: PRIMARY MENUS**



- The Main Menu primarily contains the test function commands
- The Configure Menu – accessed from the Main Menu – primarily configures the transceiver

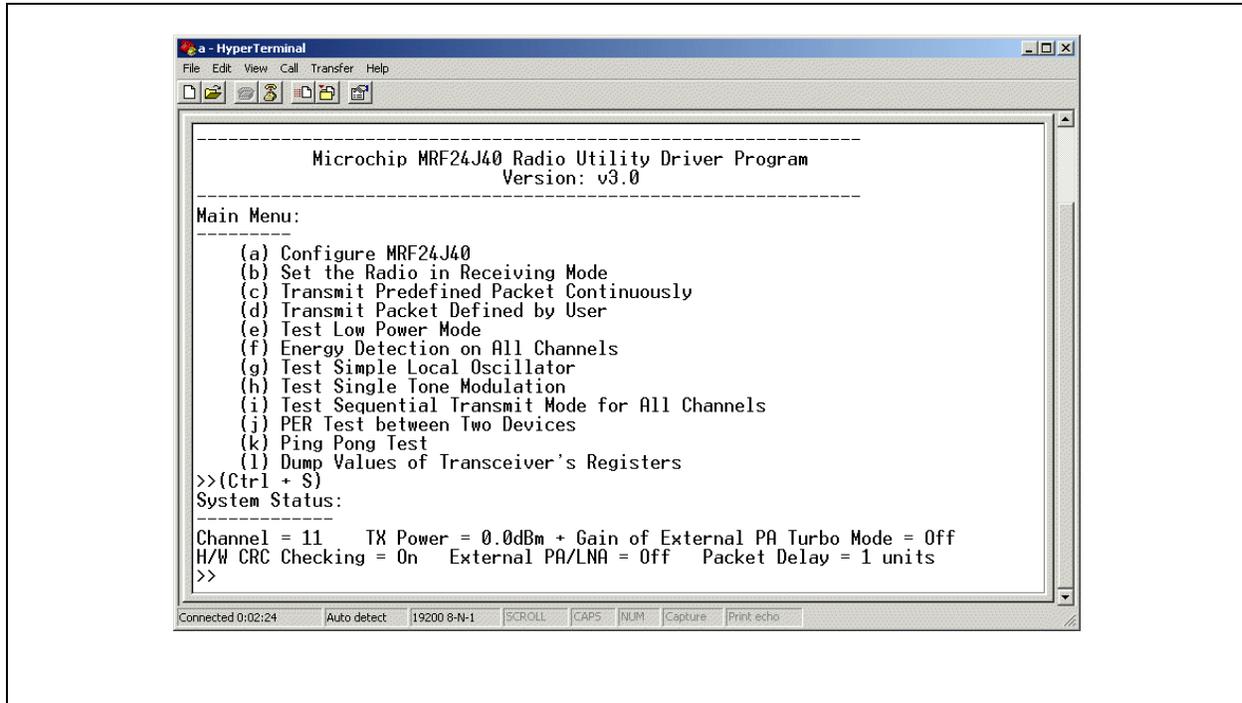
Hot keys can be used to navigate through the menus. See Table 3.

**TABLE 3: KEYBOARD HOT KEY COMMANDS**

Hot Key	Functionality
<Ctrl> + <z>	Exit and return to Main Menu. This hot key is used to stop/exit from any step.
<Ctrl> + <x>	Reset the transceiver and return configuration settings to their default values. This hot key can be used at any step.
<Ctrl> + <s>	Display the current system status and configuration values. The displayed configuration values are shown in Figure 4. This hot key can be used at any step in the program.
<Ctrl> + <t>	Continuously transmit predefined packet. This hot key can only be used from the Main Menu.
<Ctrl> + <r>	Set the radio in Receive mode (verbose). This hot key can only be used from the Main Menu.

Figure 4 displays the Main Menu and the status and configuration values displayed by the hot keys <Ctrl> + <s>.

FIGURE 4: MAIN MENU AND STATUS LINE



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## Process Overview

The sections “**Configuration Commands**” on page 7 and “**Test Function Commands**” on page 11 give the details of the MRF24J40 utility program’s commands. This section provides an overview of the sequence in which the commands are used.

**TABLE 4: FUNCTIONAL OVERVIEW**

Task (Optional Task)	Command	Details Page
<b>Transmitting</b>		
Set operating channel	Configure Menu (a)	7
Configure External PA/LNA	Configure Menu (d)	9
Program TX Output power	Configure Menu (b)	8
(Enable Turbo mode)	Configure Menu (g)	10
(If continuous transmission: Set inter-packet delay)	Configure Menu (e)	9
Set type of transmission: <ul style="list-style-type: none"><li>• Continuous</li><li>• Single packet</li><li>• (See “End-to-End Testing”)</li></ul>	Main Menu (c) Main Menu (d)	12 13
<b>Receiving</b>		
Set operating channel	Configure Menu (a)	7
Configure External PA/LNA	Configure Menu (d)	9
(Enable CRC checking)	Configure Menu (c)	7
Program RSSI samples	Configure Menu (f)	10
(Enable Turbo mode)	Configure Menu (g)	10
Enable receiving	Main Menu (b)	11
<b>End-to-End Testing</b>		
Set operating channel	Configure Menu (a)	7
Configure External PA/LNA	Configure Menu (d)	9
Program TX output power	Configure Menu (b)	8
(Enable Turbo mode)	Configure Menu (g)	10
(Enable CRC checking)	Configure Menu (c)	7
Initiate test: <ul style="list-style-type: none"><li>• Ping Pong test</li><li>• PER test</li></ul>	Main Menu (k) Main Menu (j)	21 20
<b>Other Tests</b>		
Sleep Mode: Enable, Wake-up	Main Menu (e)	14
Perform energy scan on all channels	Main Menu (f)	15
Test local oscillator	Main Menu (g)	16
Test single-tone modulation	Main Menu (h)	17
Sequential transmit on all channels	Main Menu (i)	19
Read transceiver’s registers	Main Menu (l)	22

## EXECUTING FIRMWARE COMMANDS

This section gives details about the commands issued by the Main and Configure menus. Its subsections include:

- **“Configuration Commands”** – The Main Menu command for accessing the Configure Menu and the Configure Menu commands
- **“Test Function Commands”** – The test and functional commands on the Main Menu

### Configuration Commands

The MRF24J40 RF transceiver is ready to operate, using the MRF24J40 utility program’s default values. Those values are shown in Table 5.

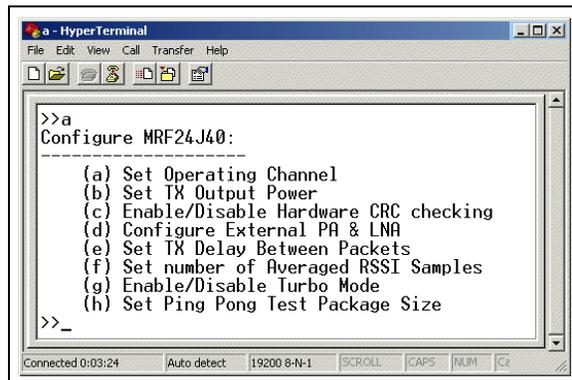
**TABLE 5: DEFAULT CONFIGURATION SETTINGS (1)**

Attribute	Setting
Channel	11
TX Output Power	0 dBm
Hardware CRC Checking	On
External PA and LNA	Off
TX Delay between Packets	1 unit
Number of averaged RSSI samples	1
Turbo Mode	Off
Ping Pong Test Package Size	100

**Note 1:** Resetting the MRF24J40 RF transceiver returns the settings to these default values.

If desired, the values can be reconfigured through the secondary, Configuration Menu displayed in Figure 5.

**FIGURE 5: CONFIGURATION MENU**



### CONFIGURE MRF24J40

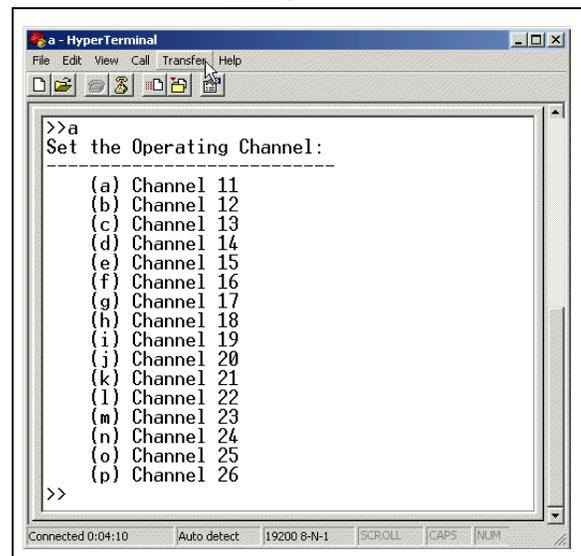
This Main Menu command displays the Configuration Menu, shown in Figure 5.

### SET OPERATING CHANNEL

This Configuration Menu option, shown in Figure 6, enables the selection of one of the 16 operating channels available in the 2.4-GHz range. The default operating channel is 11.

When a channel is selected, the current system status displays at the bottom of the screen. Check the Channel = value to confirm the setting.

**FIGURE 6: OPERATING CHANNEL MENU**



**Note:** For details on finding the channel with the least noise, see **“Energy Detection on All Channels”** on page 15.

## SET TX OUTPUT POWER

This Configuration Menu option sets the transceiver's output power. The default transmitting output power is 0 dBm.

This parameter is configured with a two-tier menu:

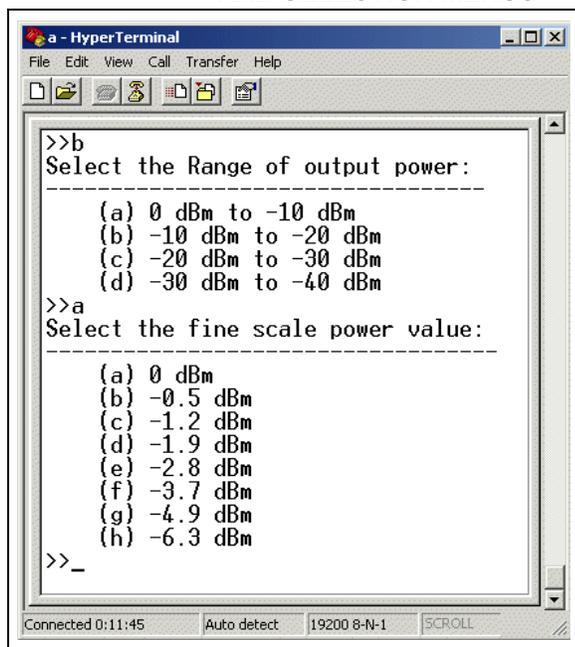
- The first menu *designates the range* from which the output power value will be chosen.
- The second menu *specifies the output power value* by indicating the value to be added to the beginning value of the previous menu's range.

See Table 6

**TABLE 6: TX OUTPUT POWER MENUS – OUTPUT COMPUTATION**

	Option from Range Menu	Option from Fine-Scale Menu	Output
Process	x dBm to y dBm	z dBm	x + z dBm
Example	(b)-10 to -20 dBm	(b)0.5 dBm	-10.5 dBm

**FIGURE 7: OUTPUT POWER RANGE AND SELECTION MENUS**



The two-tier menus enable the values shown in Table 7.

**TABLE 7: OUTPUT POWER VALUES**

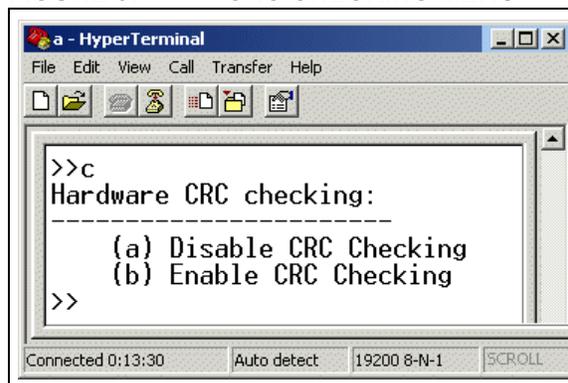
Range	Values			
0 to -10 dBm	0 dBm	0.5 dBm	1.2 dBm	1.9 dBm
	2.8 dBm	3.7 dBm	4.9 dBm	6.3 dBm
-10 to -20 dBm	10 dBm	10.5 dBm	11.2 dBm	11.9 dBm
	12.8 dBm	13.7 dBm	14.9 dBm	16.3 dBm
-20 to -30 dBm	20 dBm	20.5 dBm	21.2 dBm	21.9 dBm
	22.8 dBm	23.7 dBm	24.9 dBm	26.3 dBm
-30 to -40 dBm	30 dBm	30.5 dBm	31.2 dBm	31.9 dBm
	32.8 dBm	33.7 dBm	34.9 dBm	36.3 dBm

When the Tx output power value is programmed, the current system status displays on the screen. Check the TX Power = value to confirm the setting.

## ENABLE/DISABLE HARDWARE CRC CHECKING

This Configuration Menu option, as shown in Figure 8, enables or disables a Cyclic Redundancy Check (CRC) of incoming packets. If CRC checking is enabled, incoming packets with incorrect CRC will be discarded by the Medium Access Layer (MAC). If CRC checking is disabled, even CRC-incorrect packets will be passed to the host layer.

**FIGURE 8: CRC CHECKING MENU**



By default, this feature is turned on.

When this parameter is set, the current system status displays at the bottom of the screen. Check the status line's H/W CRC Checking value to confirm the change.

## CONFIGURE EXTERNAL PA AND LNA

This Configuration Menu option enables or disables an external Power Amplifier (PA) and Low Noise Amplifier (LNA). The configuration of those amplifiers is done through the MRF24J40 RF transceiver's general purpose digital I/O (GPIOx) pins. (For more information, see **section 4.2 "External PA/LNA Control"** of the *MRF24J40 Data Sheet* (DS39776).)

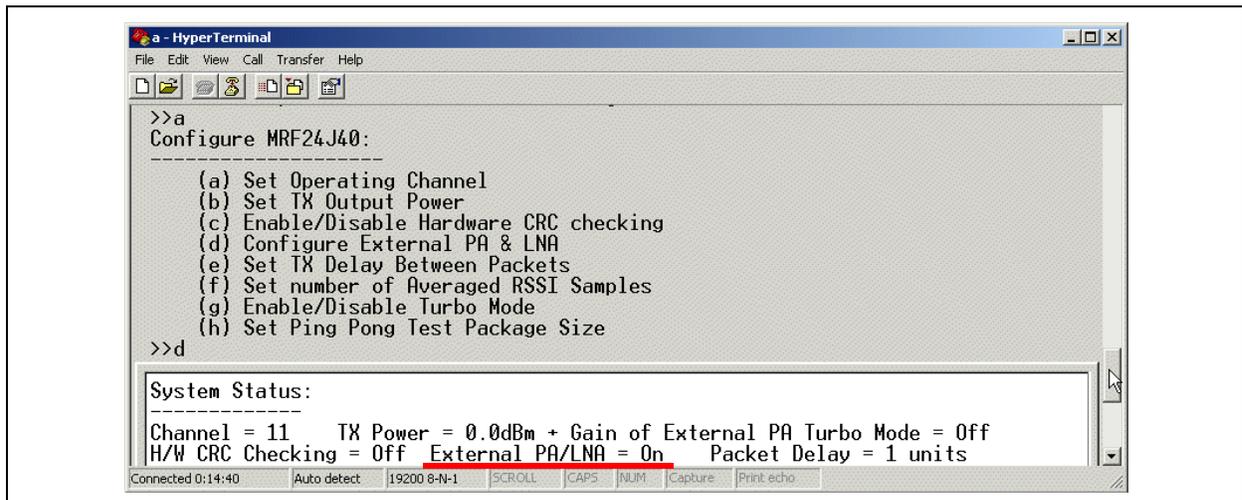
By default external PA and LNA option is disabled.

When the External PA and LAN are enabled, the current system status displays on the screen, as shown in Figure 9. Check the **External PA/LNA** value to confirm the setting.

**Note:** Do not enable PA/LNA on the MRF24J40MA module. The module's GPIO pins are grounded, doing that will drive the pins to ground.

The external PA and LNA can subsequently be disabled by resetting the MRF24J40 RF transceiver – which returns the configuration to its default values. To do this, press the hot keys <Ctrl> + <x>.

**FIGURE 9: PA AND LNA MENU**

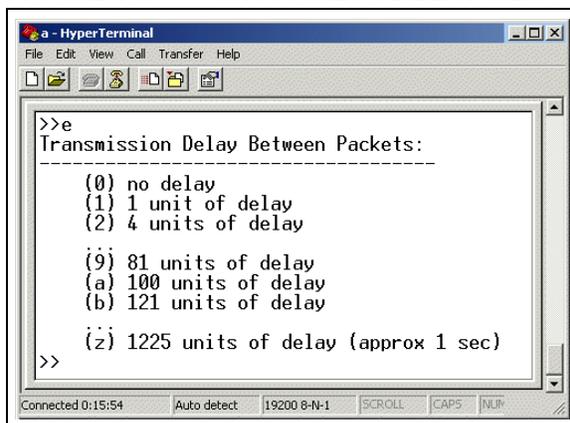


## SET TX DELAY BETWEEN PACKETS

This Configuration Menu option, shown in Figure 10, determines the size of the inter-packet delay between continuously transmitted TX packets. (To have the transmitting MRF24J40 RF transceiver send these packets, select Main Menu option (c) **Transmit Pre-defined Packet Continuously**.)

The size of the delay can be set with the PC's number or letter keys – numbers configuring no delay to a 81-unit delay and letters setting a delay of 100 to 1,225 units. (See Table 8.)

**FIGURE 10: TX PACKETS DELAY MENU**



**TABLE 8: TX PACKET DELAY MENU – DELAY CONFIGURATION**

Key Type	Value	Example
Number	$n = n^2$	$9 = 81$
Letter	$a = 10 = 10^2$	$a = 100$
	$b = 11 = 11^2$	$b = 121$
	•	•
	•	•
	$z = 35 = 35^2$	$z = 1,225$

By default, the delay is one unit – the equivalent being:

- PICDEM Z board – 2 ms
- Explorer 16 board – 4 ms

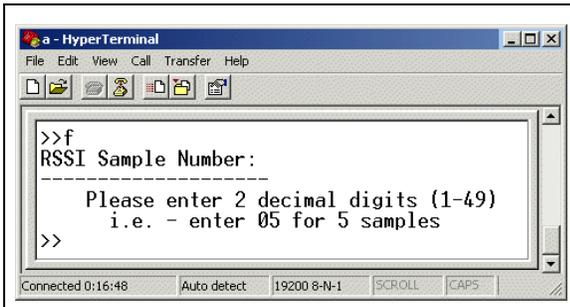
When the packet delay value is configured, the current system status displays on the screen. Check the **Packet Delay** value to confirm the setting.

## SET NUMBER OF AVERAGED RSSI SAMPLES

The Received Signal Strength Indicator (RSSI) measures the signal quality of a received packet. Using an RSSI measurement that is averaged over multiple readings provides a more accurate value than a single-reading RSSI.

This Configuration Menu option, shown in Figure 11, sets the number of RSSI samples to be averaged. The resulting measurement are displayed on the screen by using the Main Menu option (a) **Set the Radio in Receiving Mode**. (See “Set the Radio in Receiving Mode” on page 11.)

**FIGURE 11: RSSI SAMPLE MENU**



By default, the sample size is one.

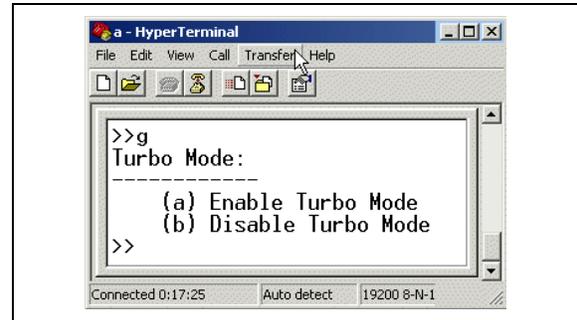
## ENABLE/DISABLE TURBO MODE

The MRF24J40 RF transceiver has a Turbo mode that transmits and receives data at 625 kbps – two and a half times the normal rate for proprietary protocols.

This Configuration Menu option, shown in Figure 12, enables or disables that mode.

**Note:** ZENA packet analyzer cannot capture packets transmitted in Turbo mode.

**FIGURE 12: TURBO MODE MENU**



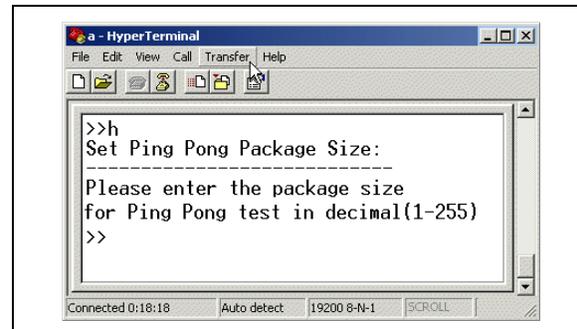
By default the Turbo mode is disabled.

When the mode is enabled or disabled, the current system status displays on the screen. Check the Turbo Mode value to confirm the setting.

## SET PING PONG TEST PACKAGE SIZE

This Configuration Menu option, shown in Figure 13, sets the number of ping pong packets exchanged between the transmitting and receiving transceivers. (For more details about ping pong tests, see “Ping Pong Test” on page 21.)

**FIGURE 13: PING PONG MENU**



Type one to three digits and press <Enter>.

The default value of this parameter is 100.

## Test Function Commands

Test activation and other functional commands are issued through the Main Menu, shown in Figure 14. To display this menu from anywhere in the firmware interface, press <Ctrl> + <z>.

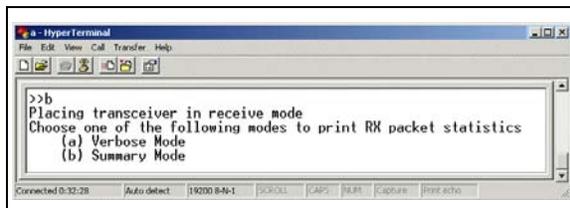
**FIGURE 14: MAIN MENU**



## SET THE RADIO IN RECEIVING MODE

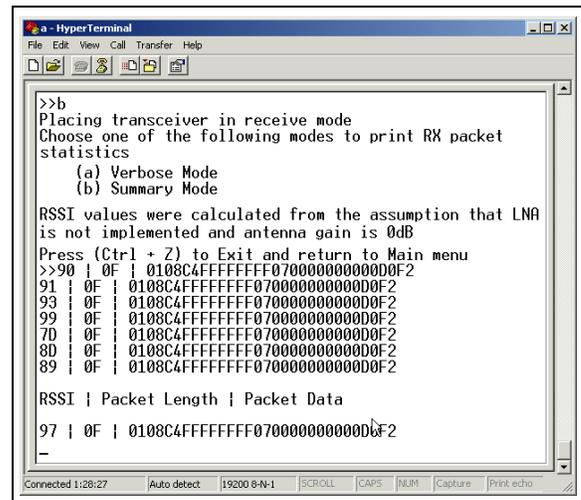
This Main Menu option displays a received packet's statistics on the screen. Two display modes are available, as shown in Figure 15:

**FIGURE 15: SET RADIO TO RECEIVE**

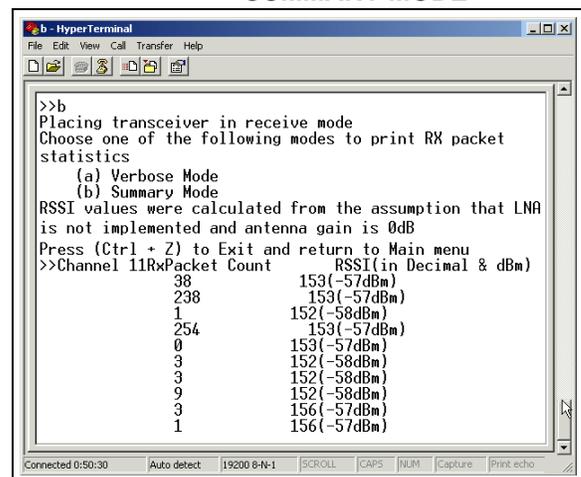


- Verbose mode – Displays all of the packet data (See Figure 16.)
- Summary mode – Displays statistics accumulated and printed for every second (See Figure 17.)

**FIGURE 16: RADIO IN RECEIVING MENU – VERBOSE MODE**



**FIGURE 17: RADIO IN RECEIVING MENU – SUMMARY MODE**



When you select one of the options, the received data is displayed. To take the transceiver out of Receiving mode, press <Ctrl> + <z> – which also redisplay the Main Menu.

Before executing the command on the receiving transceiver, ensure that you have executed one of the “transmit packet” commands on the transmitting transceiver.

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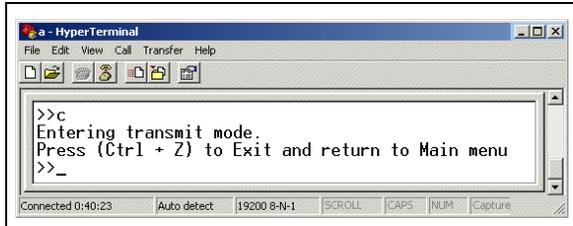
## TRANSMIT PREDEFINED PACKET CONTINUOUSLY

This Main Menu option, shown in Figure 18, continuously transmits a predefined packet until <Ctrl> + <z> (Exit and Return to Main Menu) is pressed.

The predefined packet is:

```
01 08 C4 FF FF FF FF 07 00 00 00 00 00
```

**FIGURE 18: TRANSMIT PREDEFINED PACKET MENU**



Before executing this command:

1. Review the transmitting transceiver's configuration values. (Most of these values can be displayed by pressing <Ctrl> + <s>.)

The default configuration value are shown in "Configuration Commands" on page 7.

2. If some parameters need to be changed:
  - Display the Main Menu (by pressing <Ctrl> + <z>) and select **(a) Configure MRF24J40**. The Configure Menu, shown in Figure 5, appears.
  - Edit the desired parameter(s).
  - Return to the Main Menu (<Ctrl> + <z>).

The configuration for the delay between each packet (inter-packet delay) may need to be changed from its default value (1 unit). If a second transceiver is using the MRF24J40 utility program as a receiver/sniffer, the transmitting transceiver's use of the default value may be too short. The second transceiver may not be able to display the continuously received packets. This particularly can be the case when using high-speed communications such as the ZENA™ Packet Analyzer.

Figure 19 shows a second transceiver using the ZENA analyzer to monitor a message sent with this command.

If a second transceiver is using the MRF24J40 utility program as a sniffer/analyzer, see "Set the Radio in Receiving Mode" on page 11.

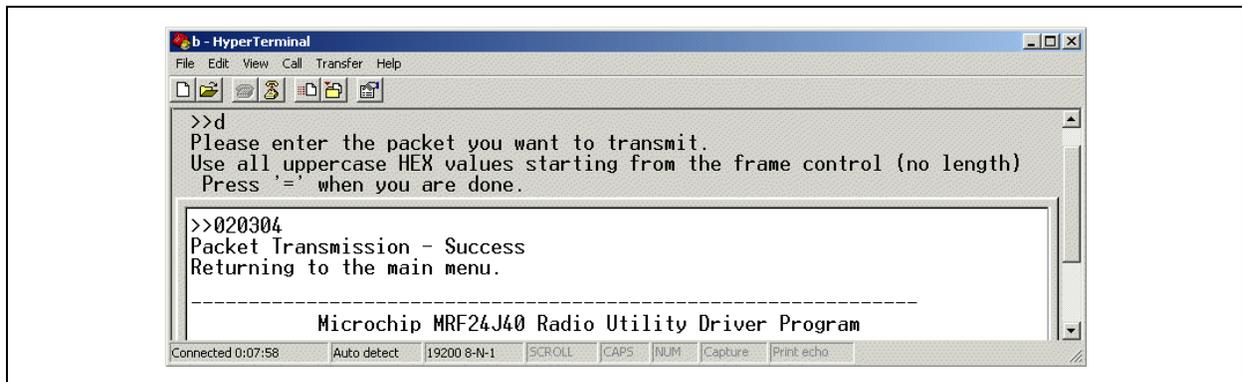
**FIGURE 19: TRANSMITTING MODE USING THE ZENA™ SOFTWARE DISPLAY**

Frame	Time(us)	Len	MAC Frame Control	Seq Num	Dest PAID	Dest Addr	Payload	FCS
00126	+331264 =44094064	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -10 0x6A OK
00127	+329744 =44423808	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -08 0x6B OK
00128	+338352 =44762160	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -10 0x6A OK
00129	+320880 =45083040	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -10 0x69 OK
00130	+336496 =45419536	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -08 0x6A OK
00131	+320576 =45740112	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -12 0x6A OK
00132	+330640 =46070752	15	Type Sec Pend ACK IPAN DATA N N N N	0xC4	0xFFFF	0xFFFF	0x07 0x00 0x00 0x00 0x00 0x00	RSSI Corr CRC -10 0x69 OK

## TRANSMIT PACKET DEFINED BY USER

This Main Menu option, shown in Figure 20, enables transmission of a user-defined packet that conforms to IEEE 802.15.4™ specifications.

FIGURE 20: TRANSMIT DEFINED PACKET MENU



After the menu appears:

1. Type the *hexadecimal* values to be transmitted—capitalizing all letters.
2. Send the entered data by pressing <=> (the “equals” key).

The MRF24J40 utility program automatically checks if the packet conforms to the IEEE 802.15.4 format.

- If the format is correct:
  - The message is sent.
  - The following message appears: Packet Transmission - Success.
  - The Main Menu reappears.
- If the format is incorrect, an error message is displayed.

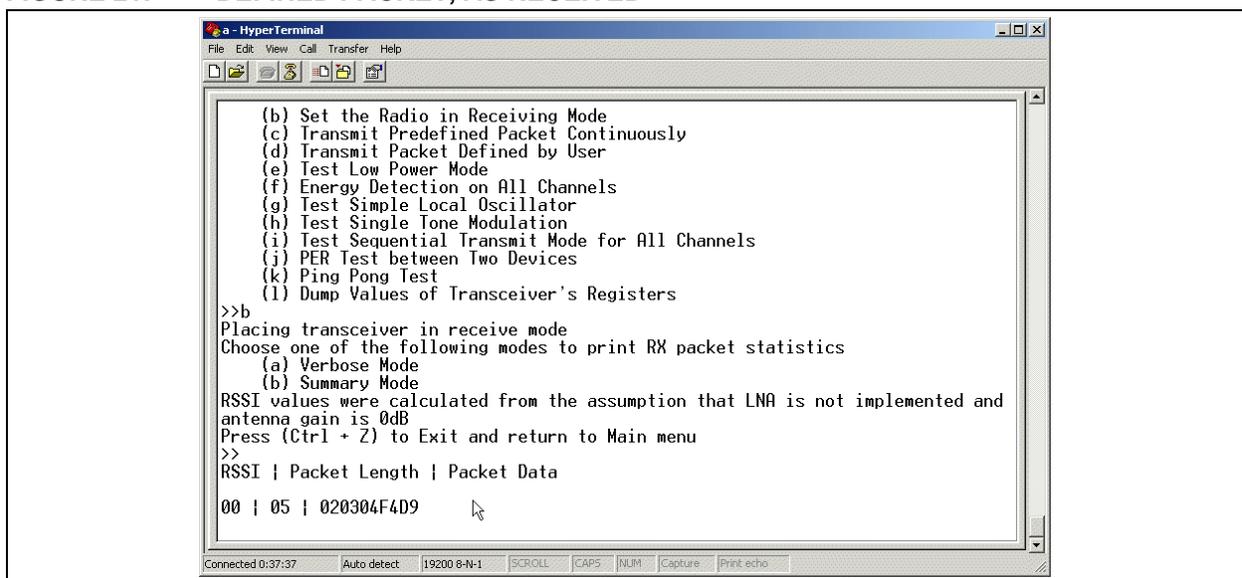
3. If an error message appears:

- Double-check your message and retype it.
- Repeat steps 1 and 2.

The user-defined packet is transmitted only once. To transmit the same packet multiple times, re-execute the **(d) Transmit Packet Defined by User** option as many times as desired.

Figure 21 shows how the packet — sent in Figure 20 — appears on a second transceiver whose MRF24J40 utility program has been set in Receive mode.

FIGURE 21: DEFINED PACKET, AS RECEIVED



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## TEST LOW-POWER MODE

This Main Menu option can:

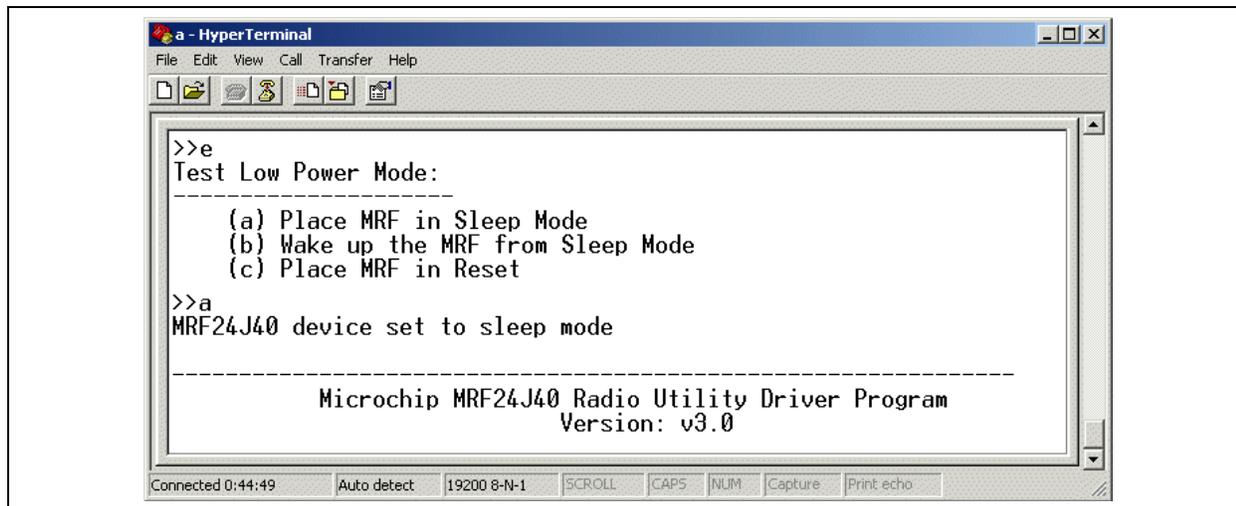
- Put the MRF24J40 RF transceiver in Sleep mode
- Wake the transceiver from Sleep mode
- Reset the transceiver

The Sleep mode enables designers to measure the MRF24J40 RF transceiver's Sleep current.

Figure 22 shows the option menu and the prompt that appears when the transceiver is put into Sleep mode.

To bring the transceiver out of Sleep mode, use option **(b) Wake up the MRF from Sleep Mode** or reset the transceiver. Resetting the transceiver returns all configuration settings to their default values.

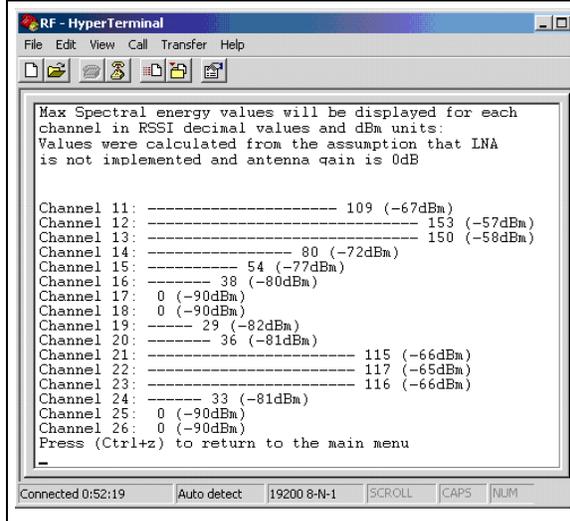
**FIGURE 22: TEST LOW-POWER MODE MENU**



## ENERGY DETECTION ON ALL CHANNELS

This Main Menu option, shown in Figure 23, scans the energy levels on all the 2.4-GHz IEEE 802.15.4 channels. For more accuracy, the RSSI reading from the MRF24J40 RF transceiver is averaged over 200 samples.

**FIGURE 23: ENERGY DETECTION MENU**



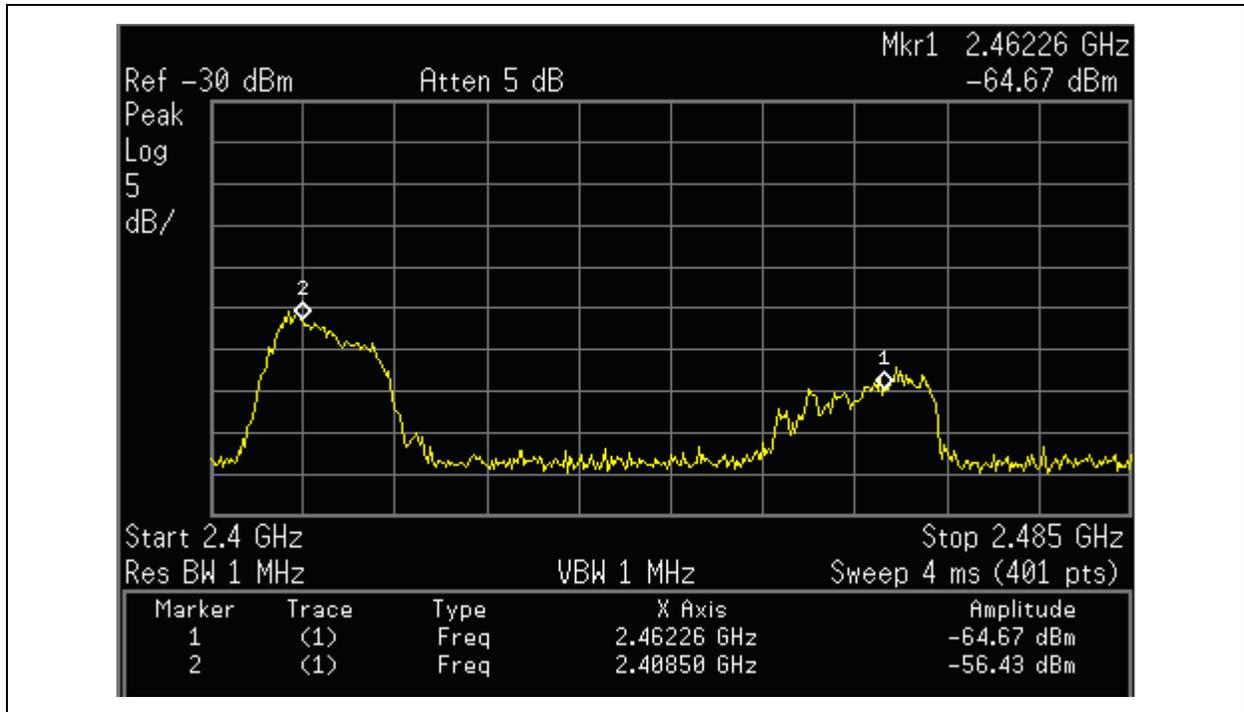
Use this option — before selecting your operating channel — to find the least-occupied channel. This will be particularly helpful with tests like the Packet Error Rate (PER) test between two devices.

This test is comparable with that done by a spectrum analyzer. (See Figure 24.)

In order to correlate Figure 23 and Figure 24:

- Equivalent antennas must be used and the comparison must incorporate cable loss. (For Figure 24, the whip antenna has 1 dBi gain and 0.3 dB cable loss.)
- The sweeping time of ISM bands must be the same.
- The spectrum analyzer must have the appropriate resolution bandwidth.
- If the board has a high-gain low-noise amplifier (LNA), the values in Figure 23 must be adjusted accordingly.

**FIGURE 24: ENERGY DETECTION TEST ON A SPECTRUM ANALYZER**



# AN1192

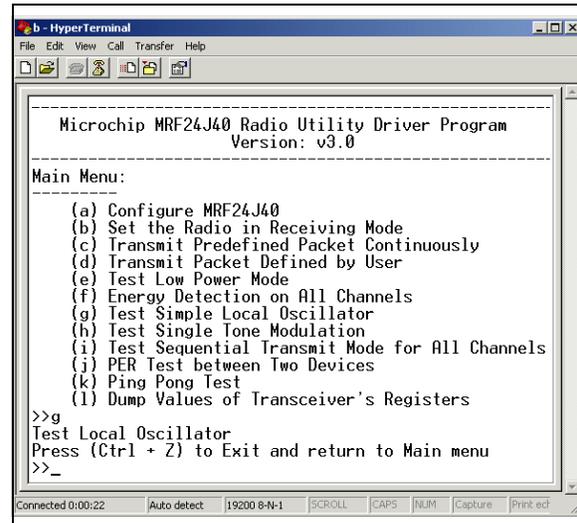
## TEST SIMPLE LOCAL OSCILLATOR

This Main Menu option, shown in Figure 25, can be used to check the frequency and output level of a local oscillator for a specific channel.

This command enables the local oscillator to start running without any modulation.

To end the test and return to the Main Menu, press <Ctrl> + <z>.

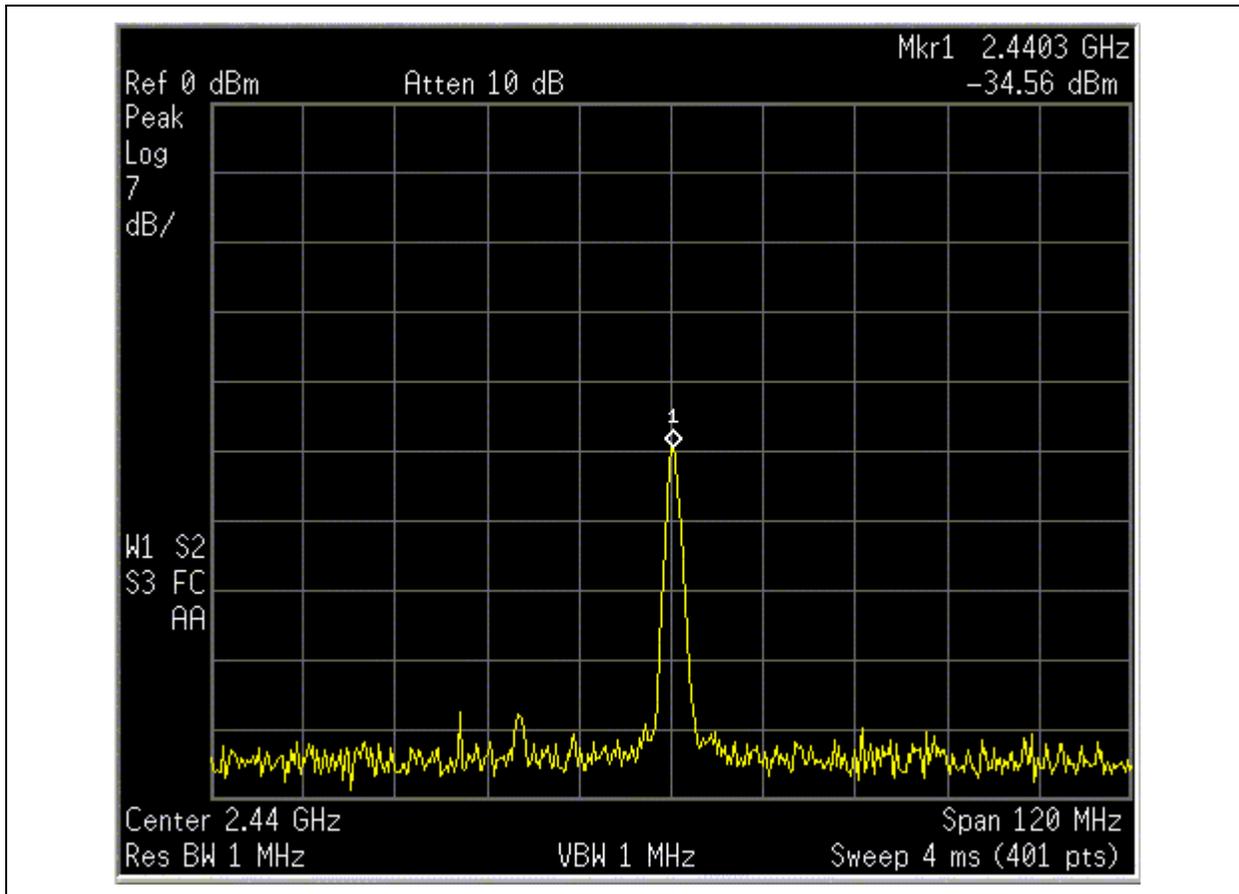
**FIGURE 25: TEST LOCAL OSCILLATOR MENU**



Before executing this test, select the required channel.

Figure 26 shows a comparable test by a spectrum analyzer.

**FIGURE 26: OSCILLATOR LEAKAGE TEST ON A SPECTRUM ANALYZER**



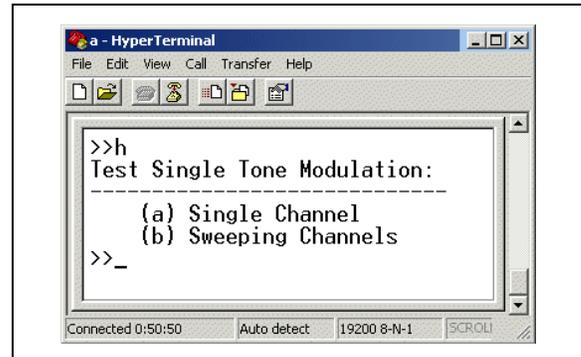
## TEST SINGLE TONE MODULATION

This Main Menu option, shown in Figure 27, allows users to tune RF circuits and to see a Continuous Wave (CW) signal as the transceiver's output. This single-tone modulation test can be done for a single channel (the first option) or for all the channels, one after another.

Figure 28 shows how the **Single Channel** test appears on a spectrum analyzer. Figure 29 shows how the **Sweeping Channels** test appears on an analyzer.

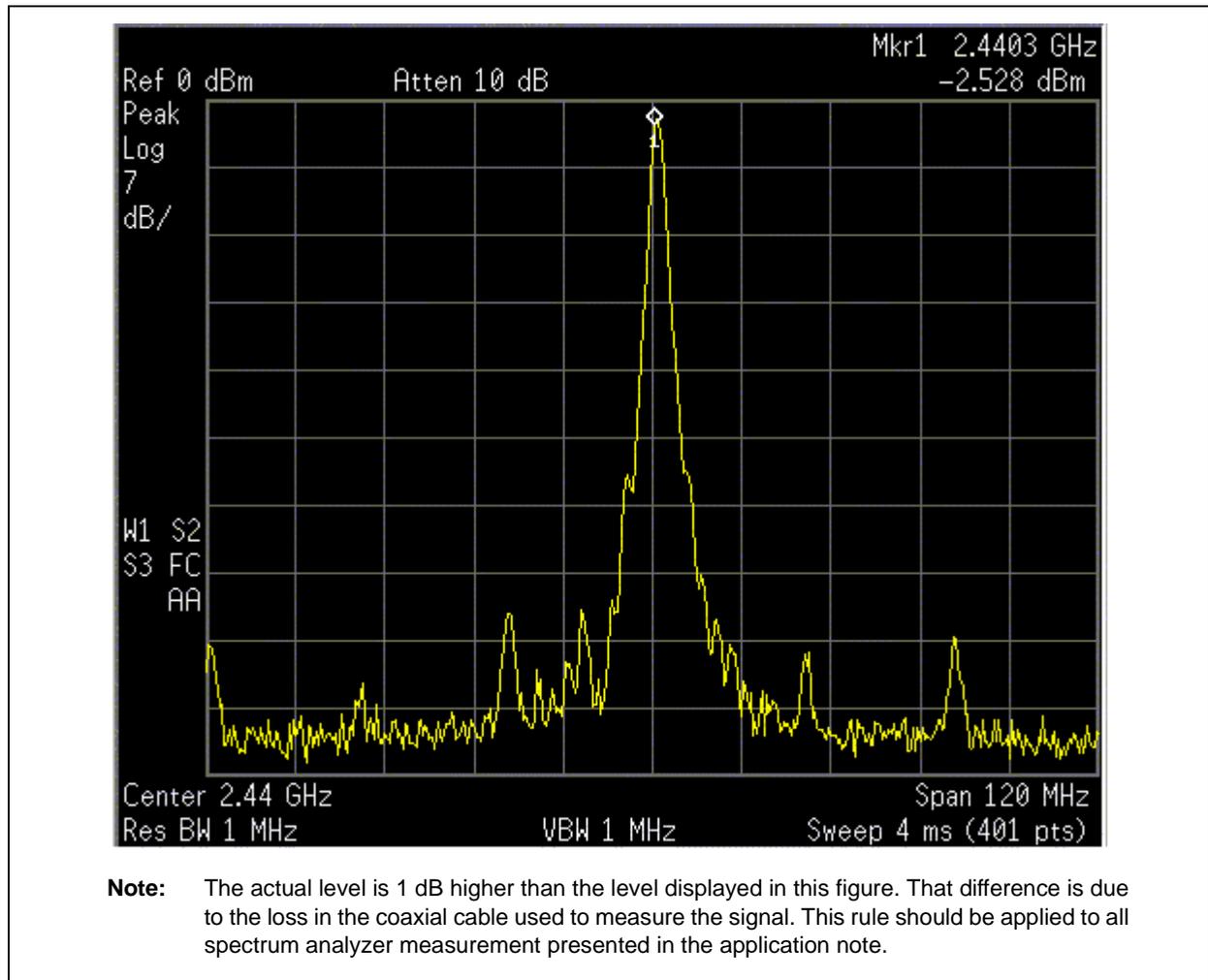
To end the test and return to the Main Menu, press <Ctrl> + <z>.

**FIGURE 27: SINGLE-TONE TEST MODULATION MENU**

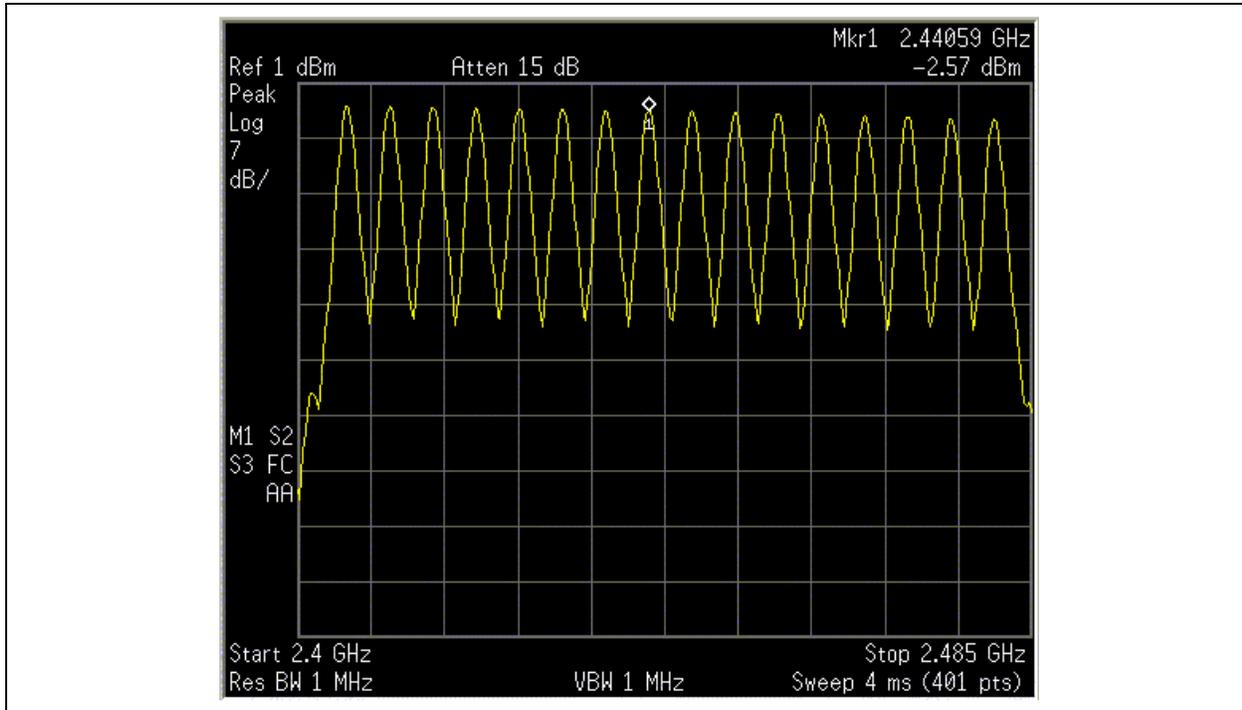


This **Sweeping Channels** option of this function also can be used to characterize the antenna gain on all the channels. To do this, a good omni-directional antenna should be connected to the spectrum analyzer.

**FIGURE 28: SINGLE-CHANNEL TONE TEST ON A SPECTRUM ANALYZER**



**FIGURE 29: SWEEPING-CHANNELS TONE TEST ON A SPECTRUM ANALYZER**



## TEST SEQUENTIAL TRANSMIT MODE FOR ALL CHANNELS

This Main Menu option, shown in Figure 30, is equivalent to using the **Transmit Predefined Packet Continuously** option's test – except that the continuous transmission sweeps from channel 11 through 26.

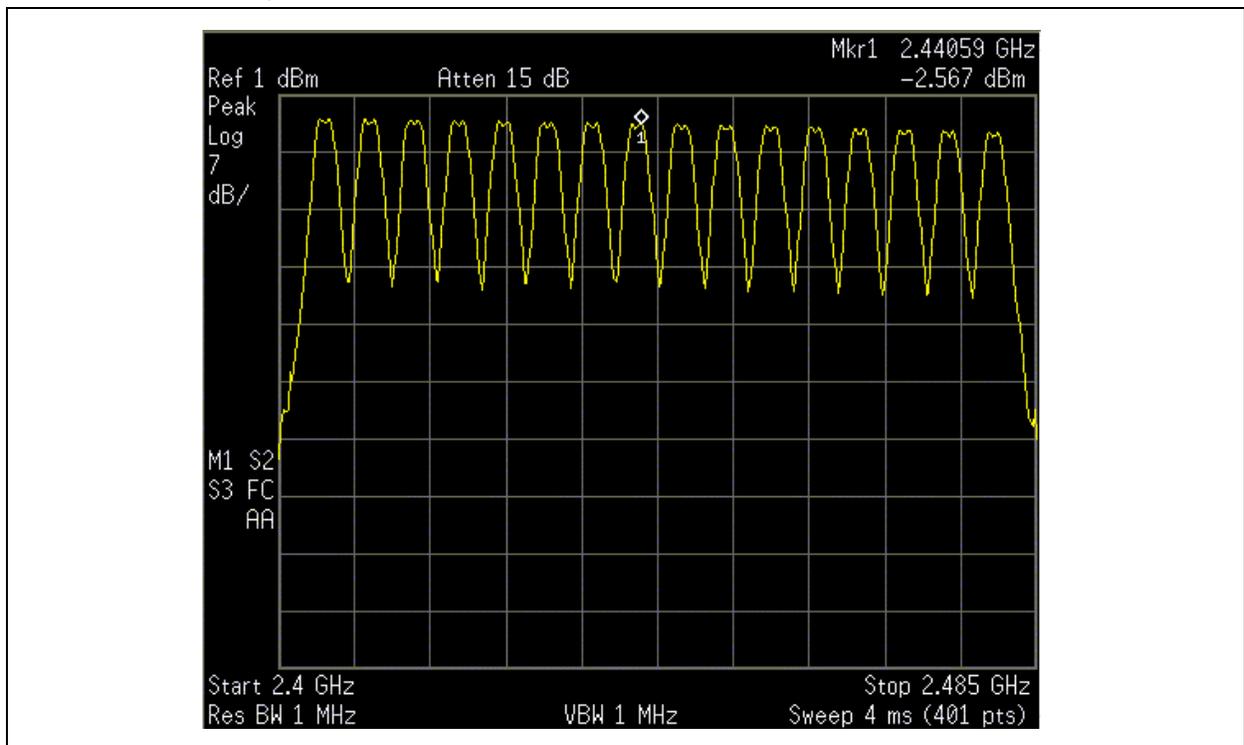
**FIGURE 30: TEST SEQUENTIAL TRANSMIT, ALL CHANNELS MENU**



To end the test and return to the Main Menu, press <Ctrl> + <z>.

Figure 31 shows how this test looks on a spectrum analyzer.

**FIGURE 31: SEQUENTIAL TRANSMIT TEST ON A SPECTRUM ANALYZER**



# AN1192

## PER TEST BETWEEN TWO DEVICES

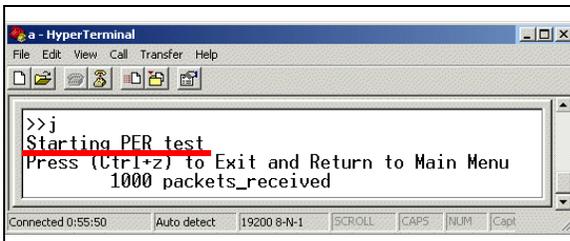
This Main Menu option performs a test of the packet-error rate (PER) between two devices. This is a one-iteration test with a predetermined number of packets.

The IEEE 802.15.4 specification defines a reliable link as having a PER less than 1%.

This test requires two MRF24J40 RF transceivers – each one running the MRF24J40 utility program and set to the same operating channel. After the command is executed from Unit 1:

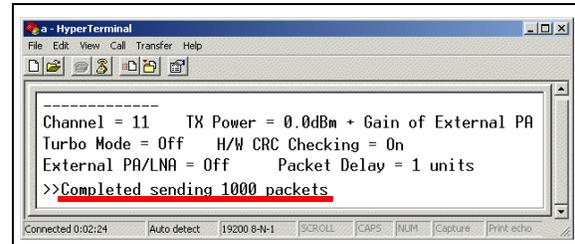
1. Unit 1 sends a message to Unit 2 for it to transmit 1,000 packets and, as shown by underlined prompt line in Figure 32, reports that the test has commenced.

**FIGURE 32: PER TEST – UNIT 1**



2. Unit 2 sends the packets and, as shown by the underlined prompt line in Figure 33, reports that the packets have been sent.

**FIGURE 33: PER TEST – UNIT 2**



3. As shown in Figure 32, Unit 1 reports how many packets were received.

If desired, this test can be repeated with the units at different distances – to determine the devices' coverage.

## PING PONG TEST

This Main Menu option tests for compliance to the European standard for blocking and desensitization. It measures the capability of a device to receive a signal without degradation due to unwanted signals at other frequencies.

The wanted signal's degradation of its Packet Error Rate (PER) must be less than 1% or the Bit Error Rate (BER) less than 0.1%.

The test requires two MRF24J40 RF transceivers – each one running the MRF24J40 utility program. Prior to initiating the test, both transceivers must be configured for the same operating channel (see “**Set Operating Channel!**” on page 7) and the same test-package size (see “**Set Ping Pong Test Package Size!**” on page 10).

A signal generator also will be needed. The generator's antenna should have at least 0 db gain.

To perform the test:

1. On Unit 1, select the Main Menu option **(k) Ping Pong Test** and select that menu's option **(a) Receive Ping Pong Test**.
2. On Unit 2, activate the command and select the option **(b) Start Ping Pong Test**.

Unit 2 transmits the designated number of packets to Unit 1 (see right-hand dialog box in Figure 34). Unit 1 (the left dialog box) reports the number of received packets and transmits the specified number of packets to Unit 2.

The process continues until stopped.

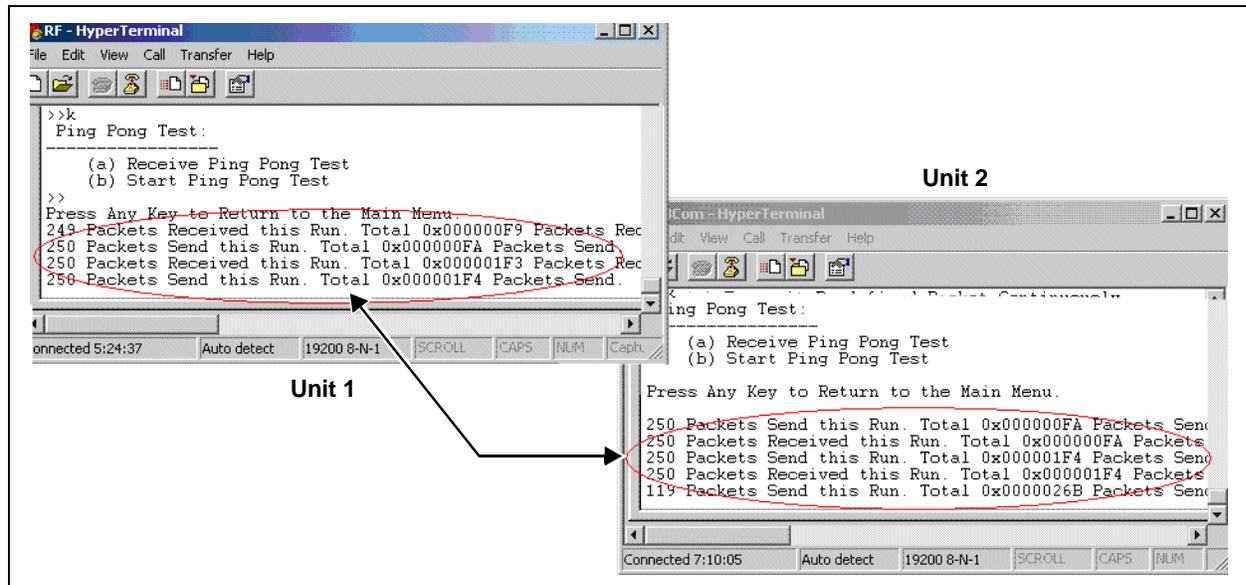
3. While the packets are being exchanged, activate a signal generator and modify its frequency setting.

Use the signal generator to sweep a bandwidth large enough to create interference signals for the two transceivers.

4. Watch the two dialog boxes and record the number of lost packets.
5. To end the test and return to the Main Menu, press <Ctrl> + <z>.

If desired, this test can be repeated with the units at different distances – to determine the devices' coverage.

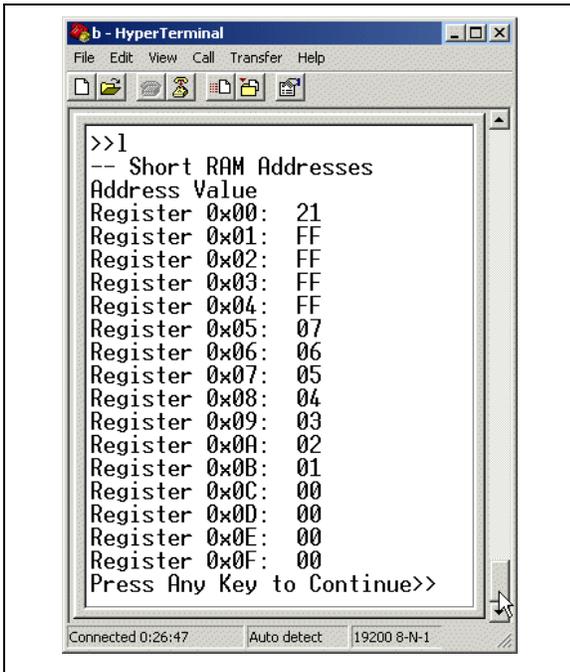
**FIGURE 34: PING PONG TEST**



## DUMP VALUES OF TRANSCEIVER'S REGISTERS

This Main Menu option, shown in Figure 35, reads the transceiver's eight-bit register values – used for setting the MAC and baseband modes. For more information, see *MRF24J40 Data Sheet* (DS39776).

**FIGURE 35: DUMP REGISTERS**



After the command is executed, the first screen of registers appears. To view the next screen of register values, press any key.

After the last screen of registers appears, the Main Menu displays automatically.

## REFERENCES

*"Explorer 16 Development Board User's Guide"* (DS51589), Microchip Technology Inc.

*"MPLAB<sup>®</sup> ICD 2 User's Guide"* (DS51331), Microchip Technology Inc.

*"MRF24J40 Data Sheet"* (DS39776), Microchip Technology Inc.

*"PICDEM<sup>™</sup> Z Demonstration Kit User's Guide"* (DS51524), Microchip Technology Inc.

*"ZENA<sup>™</sup> Wireless Network Analyzer User's Guide"* (DS51606), Microchip Technology Inc.

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