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# **RN52 Bluetooth<sup>®</sup> Audio Evaluation Kit User's Guide**

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ISBN: 978-1-63276-021-0

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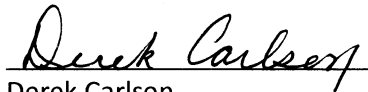
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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA



Derek Carlson  
VP Development Tools

16-July-2013

Date

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# RN52 BLUETOOTH AUDIO EVALUATION KIT USER'S GUIDE

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## Table of Contents

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<b>Preface</b> .....	<b>7</b>
<b>Chapter 1. Overview</b>	
1.1 Introduction .....	13
1.2 RN52 Evaluation Kit Features .....	13
1.3 RN52 Evaluation Kit Contents and Part Details .....	14
1.4 RN-52-EK Evaluation Board .....	15
1.5 RN52 Evaluation Kit Related Information Contents .....	17
<b>Chapter 2. Getting Started</b>	
2.1 Introduction .....	19
2.2 Hardware Requirements .....	19
2.3 Power Up the Board .....	20
2.4 Using the Evaluation Kit .....	20
<b>Chapter 3. Application Demonstrations</b>	
3.1 Audio Demonstration .....	27
3.2 HSP/HFP Demonstration .....	28
<b>Appendix A. RN52 Audio Evaluation Kits Schematics</b>	
A.1 Introduction .....	29
A.2 RN52 Evaluation Kits Schematic .....	29
A.3 RN52 Evaluation Kits PCB Layout and Assemble Drawings .....	31
A.4 RN52 Evaluation Kits Bill of Materials .....	34
A.5 RN52 Evaluation Kits Physical Dimensions .....	35
<b>Worldwide Sales and Service</b> .....	<b>37</b>

# RN52 Bluetooth Audio Evaluation Kit User's Guide

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## Preface

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### NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site ([www.microchip.com](http://www.microchip.com)) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXA”, where “XXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

## INTRODUCTION

This chapter contains general information that will be useful to know before using the Product Name. Items discussed in this chapter include:

- [Document Layout](#)
- [Conventions Used in this Guide](#)
- [Warranty Registration](#)
- [Recommended Reading](#)
- [The Microchip Web Site](#)
- [Development Systems Customer Change Notification Service](#)
- [Customer Support](#)
- [Document Revision History](#)

## DOCUMENT LAYOUT

This user's guide describes how to use the RN52 Bluetooth Audio Evaluation Kit. The document is organized as follows:

- **Chapter 1. “Overview”** – This chapter introduces the RN52 Bluetooth Audio Evaluation Kit and provides an overview of various features.
- **Chapter 2. “Getting Started”** – This chapter describes the hardware components and setup of the RN52 Bluetooth Audio Evaluation Kit.
- **Chapter 3. “Application Demonstrations”** – This chapter describes the application demonstrations of the RN52 Bluetooth Audio Evaluation Kit.
- **Appendix A. “RN52 Audio Evaluation Kits Schematics”** – This appendix includes a schematic of the RN-52-EK Evaluation Board, and the Bill of Materials.



# RN52 Bluetooth Audio Evaluation Kit User's Guide

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

Description	Represents	Examples
<b>Arial font:</b>		
Italic characters	Referenced books	<i>MPLAB<sup>®</sup> IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u><i>File&gt;Save</i></u>
Bold characters	A dialog button	Click <b>OK</b>
	A tab	Click the <b>Power</b> tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
<b>Courier New font:</b>		
Plain Courier New	Sample source code	#define START
	Filenames	autoexec.bat
	File paths	c:\mcc18\h
	Keywords	_asm, _endasm, static
	Command-line options	-Opa+, -Opa-
	Bit values	0, 1
	Constants	0xFF, 'A'
Italic Courier New	A variable argument	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets [ ]	Optional arguments	mcc18 [options] <i>file</i> [options]
Curly brackets and pipe character: {   }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses...	Replaces repeated text	var_name [, var_name...]
	Represents code supplied by user	void main (void) { ... }

## WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

## RECOMMENDED READING

This user's guide describes how to use the RN-52-EK Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

RN52 Bluetooth Audio Module Data Sheet (DS70005120)

PICDEM™ PIC18 Explorer Demonstration Board User's Guide (DS51721)

Explorer 16 Development Board User's Guide (DS51589)

Bluetooth Audio Module Command Reference User's Guide (DS50002154)

For more information, refer to the following sources:

- RN52/RN52N Class 2 Bluetooth Module Data Sheet
- Bluetooth Command Reference and Advanced Information User's Guide

# RN52 Bluetooth Audio Evaluation Kit User's Guide

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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The Development Systems product group categories are:

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- **Emulators** – The latest information on the Microchip MPLAB REAL ICE<sup>™</sup> in-circuit emulator.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 3.
- **MPLAB IDE** – The latest information on Microchip MPLAB IDE, the Windows<sup>®</sup> Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 device programmer and the PICKit<sup>™</sup> 3 development programmers.

## CUSTOMER SUPPORT

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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://support.microchip.com>

## DOCUMENT REVISION HISTORY

### Revision A (March 2014)

This is the initial released version of this document.

# RN52 Bluetooth Audio Evaluation Kit User's Guide

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## Chapter 1. Overview

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### 1.1 INTRODUCTION

This user's guide describes the hardware and software setup for the RN52 Bluetooth® Audio Evaluation Kit. This kit contains the hardware needed to evaluate the RN52 Bluetooth audio module. The RN52 module is mounted to an evaluation board that demonstrates the module's key features. The evaluation board contains:

- Dual-channel audio output and input
- Easy access to GPIO pins
- Built-in amplifier for stereo audio output
- 6 push buttons to control audio playback
- Status LEDs
- Connections for the programmer and UART interfaces

The RN52 supports the following Bluetooth profiles:

- A2DP stereo audio (Sink mode with support for Sub-Band Coding (SBC), Advanced Audio Coding (AAC) and aptX® codecs)
- AVRCP media player remote control
- HFP/HSP for accepting a phone call with 3-way calling and caller-ID support
- Support for Clear Voice Capture® (cVc) voice enhancement through HFP/HSP
- SPP (allows the module to receive serial data over the UART)
- iAP profile discovery for iOS devices

The evaluation kit can be used to configure and program the Bluetooth module using the command interface, create connections, and transfer data. The command interface is made up of simple ASCII commands. For more details, refer to the “*RN52 Bluetooth Audio Module Data Sheet*”, “*Bluetooth Audio Module Command Reference User's Guide*”, and “*Bluetooth Command Reference and Advanced Information User's Guide*”.

For data sheet and other details related to RN52 module, refer to the Microchip web site at <http://www.microchip.com>.

This chapter discusses the following topics:

- [RN52 Evaluation Kit Features](#)
- [RN52 Evaluation Kit Contents and Part Details](#)
- [RN-52-EK Evaluation Board](#)
- [RN52 Evaluation Kit Related Information Contents](#)

### 1.2 RN52 EVALUATION KIT FEATURES

#### 1.2.1 RN52 Evaluation Board Features

The RN52 Evaluation Board has the following features:

- Fully qualified Bluetooth version 3.0 module, fully compatible with Bluetooth version 2.1 + Enhanced Data Rate (EDR), 1.2, and 1.1
- Backwards-compatibility with Bluetooth version 2.0, 1.2, and 1.1
- Software configurable through commands over UART console interface

# RN52 Bluetooth Audio Evaluation Kit User's Guide

- Dedicated GPIO pins enable MCUs to access control and status functions efficiently
- Embedded RN-52 module with postage-stamp size form factor of 13.5 x 26.0 x 2.7 mm
- Embedded Bluetooth stack profiles: A2DP, AVRCP, HFP/HSP, and SPP
- Dual-channel, differential audio input and output for highest quality audio
- Supports iAP profile to discover iOS devices and apps (requires a special firmware build)
- Integrated amplifier for driving 16  $\Omega$  speakers
- UART (SPP) data connection interfaces
- External audio CODECs supported via S/PDIF and I2S interface
- Castellated SMT pads for easy and reliable PCB mounting
- Environmentally friendly, RoHS compliant
- Certifications: FCC, IC, and CE
- Bluetooth SIG certified

## 1.3 RN52 EVALUATION KIT CONTENTS AND PART DETAILS

The evaluation kit includes the hardware required to connect the evaluation board to the host computer. See [Table 1-1](#). To evaluate the module on the evaluation board, the user needs a computer with a USB port running the Microsoft Windows or Mac OS-X operating system.

**Note:** Prior to the evaluation, install the FTDI driver for the USB cable. If the drivers are not automatically installed, download and install the FTDI drivers from the Microchip web site at <http://ww1.microchip.com/downloads/en/DeviceDoc/FTDI-Drivers.zip> for FTDI Chipset Drivers.

Depending on the development kit ordered, the package contains the following:

- **RN-52-EK Board** - Contains the Bluetooth module and connectors. Supports Standard application firmware (A2DP/AVRCP/SPP) master and slave
- **Mini-USB cable** - Links user's computer to the evaluation board
- **Stereo mini-speakers** - Rechargeable battery-powered speakers

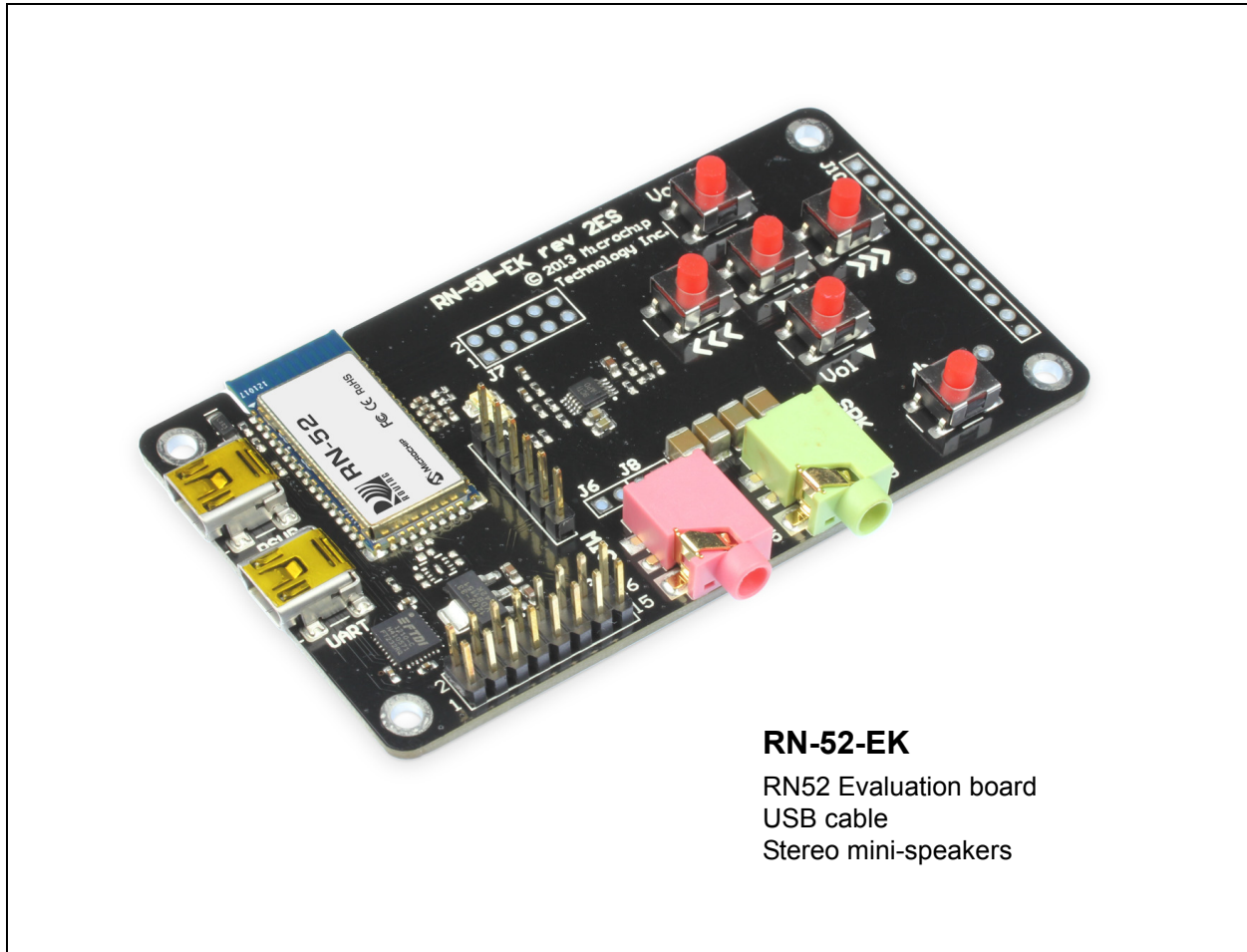
[Table 1-1](#) lists the part number of RN-52-EK Evaluation Kit.

**TABLE 1-1: RN52 EVALUATION KIT PART DETAILS**

Description	Part Number
RN52 Evaluation board	RN-52-EK
Mini-USB cable	—
Duo Rechargeable Mini-Speaker Set (includes Universal 3.5mm Audio Plug and USB cable)	—
Hands Free Clip on Mini Lapel Microphone	—

Figure 1-1 illustrates the RN-52-EK evaluation kit contents.

**FIGURE 1-1: EVALUATION KIT CONTENTS**



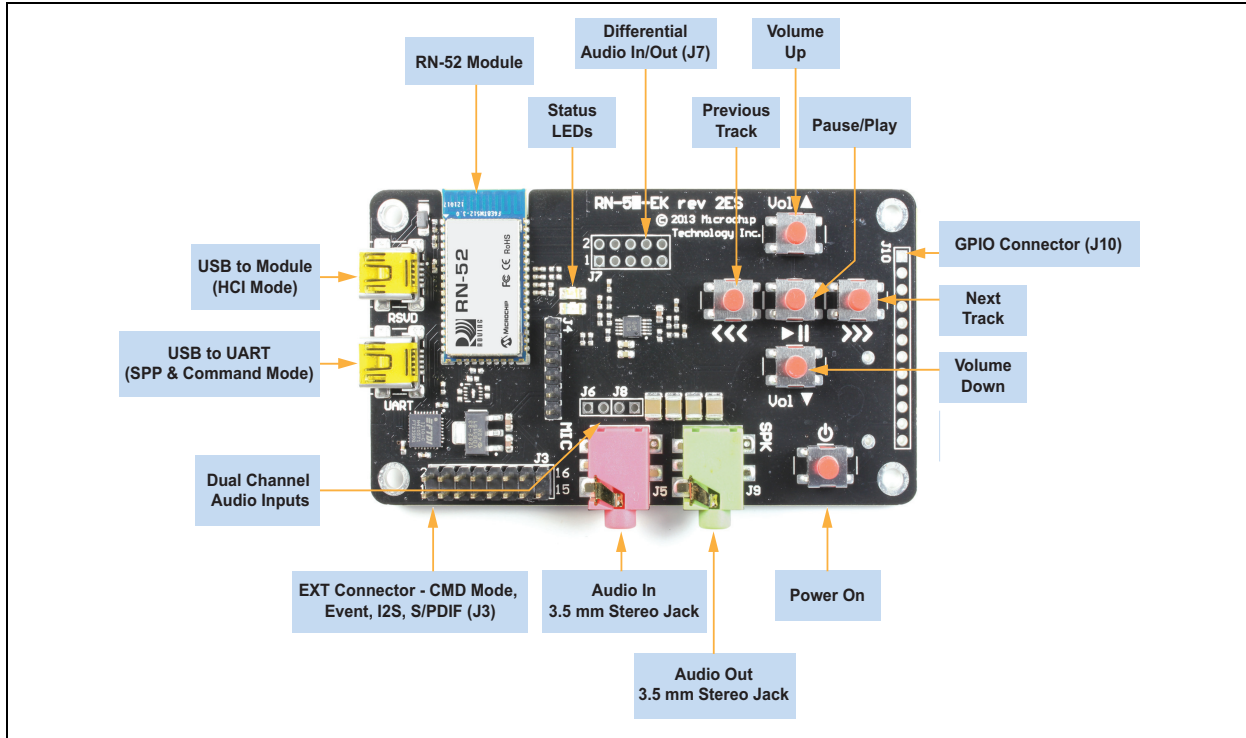
## 1.4 RN-52-EK EVALUATION BOARD

RN52 Audio Evaluation Board contains the following components as shown in [Figure 1-2](#) which describes the evaluation board's interfaces and connectors. [Table 1-2](#) describes the various components of the evaluation board.

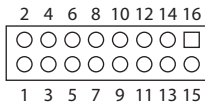


# RN52 Bluetooth Audio Evaluation Kit User's Guide

FIGURE 1-2: RN-52-EK EVALUATION BOARD

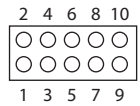


**EXT Connector - CMD Mode, Event, I2S, S/PDIF (J3)**



Pin	Description
1	UART_TX
2	VBUS
3	UART_RX
4	AIO0
5	GPIO9
6	GND
7	GND
8	I2S_IN
9	GND
10	I2S_OUT
11	GND
12	I2S_SYNC
13	GND
14	I2S_CLK
15	GND
16	3.3 V

**Differential Audio In/Out (J7)**



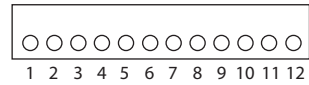
Pin	Description
1	SPKR_R-
2	MIC_L+
3	SPKR_L-
4	MIC_R+
5	SPKR_R+
6	MIC_L-
7	SPKR_L+
8	MIC_R-
9	GND
10	MIC_BIAS

**MIC Right (J6)**



Pin	Description
1	MIC_R
2	GND

**GPIO Connector (J10)**



Pin	Description
1	GND
2	GPIO2
3	GPIO4
4	BTN_VOLUP
5	BTN_NEXT
6	BTN_PLAY
7	BTN_PREVIOUS
8	BTN_VOLDOWN
9	GPIO7
10	GPIO6
11	PWREN
12	3.3 V

**MIC Left (J8)**



Pin	Description
1	MIC_L
2	GND

**TABLE 1-2: RN52 AUDIO EVALUATION KIT HARDWARE**

Hardware Component	Description
RN-52	Bluetooth® v3.0 module
USB to UART (UART)	USB to UART serial bridge for command and SPP modes
USB to Module (RSVD)	USB interface to RN-52 module for DFU, HCI, and other modes
Power On	Switch to turn on the RN-52 module. Power to the RN-52-EK is provided through USB to UART serial bridge.
Audio Out	Audio 3.5 mm jack for audio playback
Audio In	Audio 3.5 mm jack for microphone input
Status LEDs	Red and Blue LEDs show the pairing/connection status
Play/Pause Button	Button to play or pause the audio playback
Previous Track Button	Button to skip track backwards
Next Track Button	Button to skip track forwards
Volume Up Button	Button to increase volume
Volume Down Button	Button to decrease volume
J3 Connection Header	Provides access to GPIOs, UART, and I2S. Controls switch to command mode over GPIO9.
J7 Connection Header	Provides access to analogue audio interface
J10 Connection Header	Provides access to GPIOs used for player control buttons, power enable pin and other GPIOs
J6 Connection Header	Provides access to microphone-right input
J8 Connection Header	Provides access to microphone-left input

## 1.5 RN52 EVALUATION KIT RELATED INFORMATION CONTENTS

For more details on software and other documentation, refer to the Microchip web site at <http://www.microchip.com/RN-52-EK>.

**Note:** All the factory-shipped RN modules are available with firmware version and profile details. For more information on RN module links, refer to “*Bluetooth Audio Module Command Reference User’s Guide and Bluetooth Command Reference and Advanced Information User’s Guide*” from the Microchip web site <http://www.microchip.com>.

# RN52 Bluetooth Audio Evaluation Kit User's Guide

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## Chapter 2. Getting Started

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### 2.1 INTRODUCTION

This chapter describes how the RN52 Audio Evaluation Kit board works using the ASCII command set. Certain hardware and software/utilities are essential to support the evaluation/development of demo applications. This chapter discusses the following topics:

- Hardware Requirements
- Software/Utility Requirements
- Module Configuration

### 2.2 HARDWARE REQUIREMENTS

Along with an USB cable RN-52-EK boards are required for evaluation hardware setup and to run the firmware/demo applications.

#### 2.2.1 Hardware Setup

To setup the evaluation hardware, perform the following steps:

1. Connect the mini-USB cable to your computer's USB port and to the evaluation board's UART (USB-UART bridge) connector. This connection provides power to the board, and provides a virtual serial data port connection to the command console and in SPP mode.
2. Prior to the evaluation, install the FTDI driver for the USB cable.

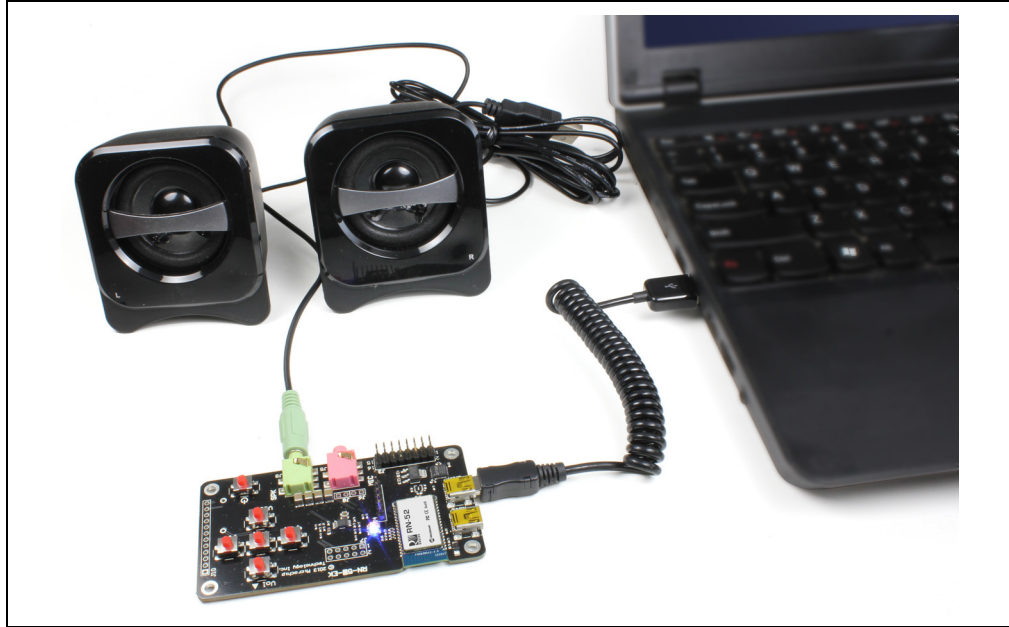
**Note:** If the drivers are not automatically installed, download and install the FTDI drivers from the Microchip web site at <http://ww1.microchip.com/downloads/en/DeviceDoc/FTDI-Drivers.zip> for FTDI Chipset Drivers.

3. Note down the assigned computer COM port to which the RN-52-EK is attached through the cable connected.
4. Connect the portable mini-speaker 3.5 mm to the stereo audio out connector (J9).

[Figure 2-1](#) shows the completed hardware setup for the evaluation board.

# RN52 Bluetooth Audio Evaluation Kit User's Guide

FIGURE 2-1: CONNECTED HARDWARE SETUP



## 2.3 POWER UP THE BOARD

To power-up the board, connect the board to a power source via USB, and then press and hold the evaluation board's power-on button until the speakers issue a two-tone alert. The RN52 evaluation board's status LEDs give user a visual confirmation that the board is powered up and operating. See [Table 2-1](#).

TABLE 2-1: RN52 AUDIO EVALUATION BOARD STATUS LEDS

LED	Status	Description
Blue and red	Flashing	The RN52 module is discoverable
Blue only	Flashing	The module is connectable
Red only	Flashing	The module is connected

## 2.4 USING THE EVALUATION KIT

This section of the user's guide assumes that users have a basic working knowledge of Bluetooth operation and communications. To configure the Bluetooth devices, a Bluetooth-enabled PC (either built-in or using a USB Bluetooth dongle) is required. Only one device can be configured at a time. Once programmed and configured, device settings are saved (independent of power down) until they are explicitly changed or the factory defaults are restored.

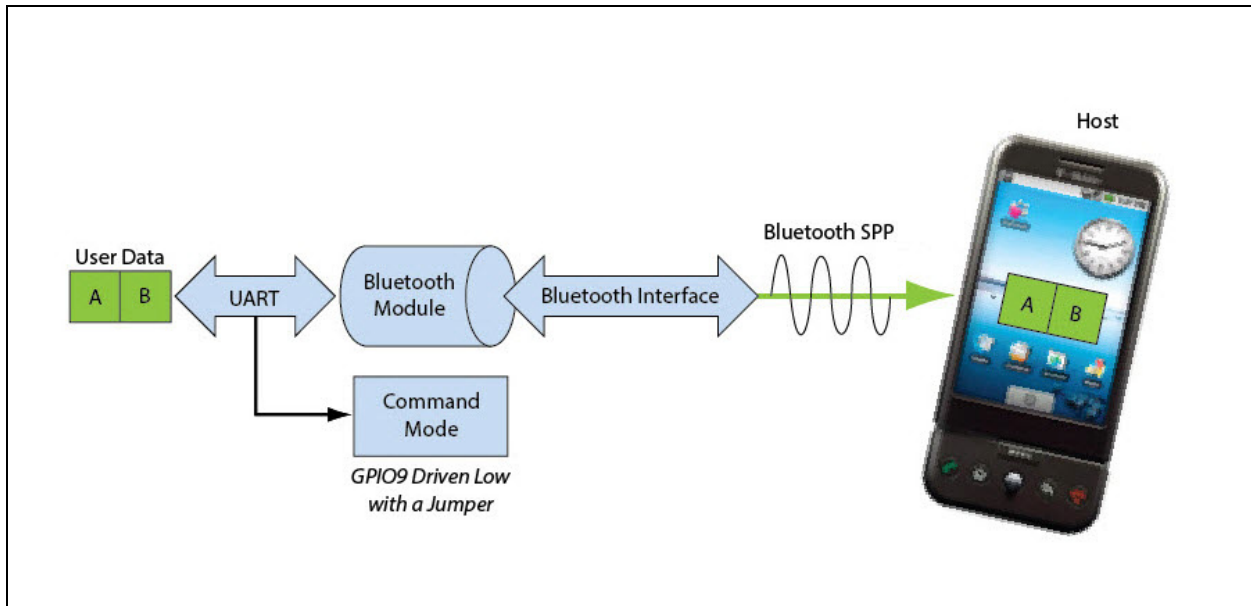
The RN52 uses simple ASCII commands sent over UART interface to: *set* commands to configure the Bluetooth module and *get* commands to echo the current configuration. Configuration settings modified with the *set* command do not take effect until the module has been rebooted, even though the *get* command may show otherwise.

**Note:** For detailed information on the ASCII commands used to configure the Bluetooth module, refer to the “*Bluetooth Command Reference and Advanced Information User's Guide*”.

## 2.4.1 Command Mode vs. Data Mode

The Bluetooth device operates in two modes: Data mode (default) and Command mode. While in Data mode, the module is essentially a data pipe. When the module receives data from SPP Bluetooth connections, it strips the Bluetooth headers and trailers and passes the user data to the UART Receive (RX) line. When data is written to the UART Transmit (TX) line, the module constructs the Bluetooth packet and sends it out over to the Bluetooth SPP. Thus, the entire process of sending/receiving data to the host is transparent to the end microprocessor. Figure 2-2 illustrates the Bluetooth communication pipe.

FIGURE 2-2: DATA & COMMAND MODES



The default configuration for the Bluetooth device is:

- Bluetooth Slave mode
- Keyboard Default Authentication mode (no pin code required)
- Serial port 115,200 Kbps baud rate, 8 bits, no parity, one stop bit
- Serial port flow control enabled
- Low-Power mode off

The device can be configured by putting it into Command mode and sending ASCII commands over a serial port. Once the configuration parameters are changed, the parameters persist until it is changed. Otherwise, a Factory Reset is performed.

**Note:** User can only configure the Bluetooth audio module locally using host computer's serial port. The module *cannot* be configured remotely over the Bluetooth link.

Terminal emulator application/program on PC is required to complete the setup.

**Note:** Depending on the operating system, the users can opt to use either the TeraTerm (Windows OS) or CoolTerm (Mac OS-X) terminal emulator programs.

# RN52 Bluetooth Audio Evaluation Kit User's Guide

## 2.4.2 Configure the Module Using the UART

Setup the RN-52-EK hardware as described in **Section 2.2.1 “Hardware Setup”**. With the Bluetooth device connected and powered on, run a terminal emulator and open the COM port to which the RN-52-EK link cable is connected. Configure the virtual COM port connected to the RN-52-EK USB interface with the default settings (115,200 Kbps baud, no parity, 8 bits, 1 stop bit). The terminal emulator's communication settings should be the default serial port settings.

Command mode can be switched through the UART interface via the USB connector at any time when the device does NOT have a Bluetooth connection, as well as under certain conditions. If the device is in configuration mode and a connection occurs, the device exits configuration mode and data passes back and forth from the remote device.

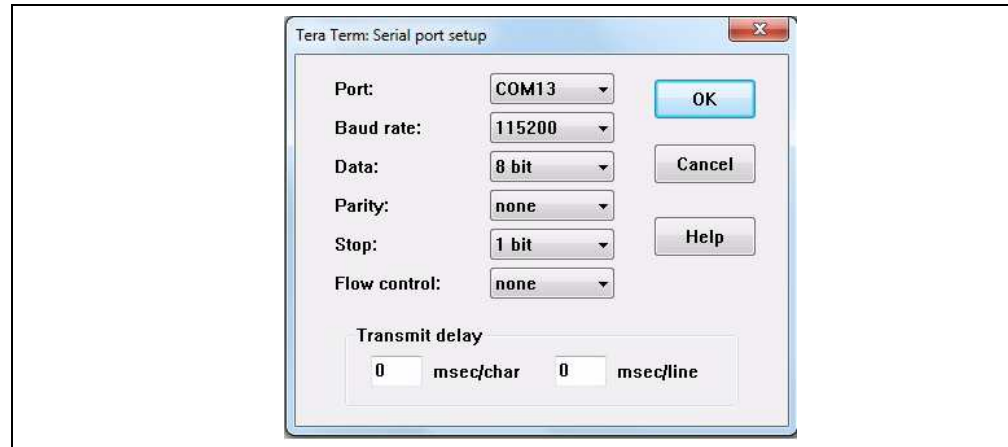
**Note:** Local configuration can be used at any time when the device does NOT have a Bluetooth connection, as well as under certain conditions. If the device is in Configuration mode and a connection occurs, the device exits Configuration mode and data passes back and forth from the remote device.

## 2.4.3 Enter Command Mode

The RN52 module enters Command mode when GPIO09 goes low. The RN52 module leaves command mode and enters data mode when GPIO09 goes high. With the RN-52-EK evaluation board, use a jumper to switch between command and data modes.

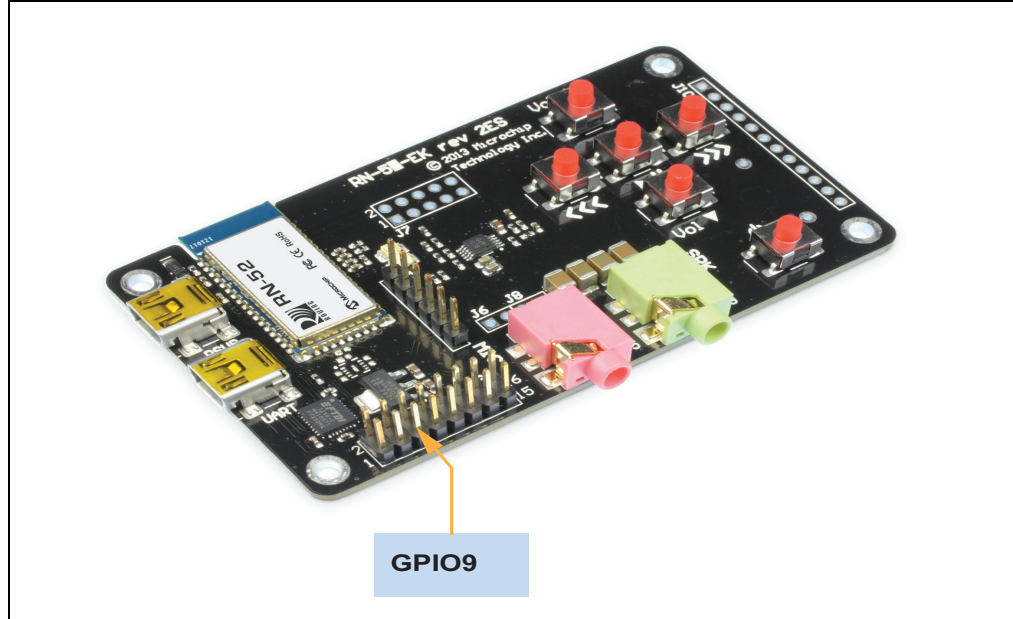
Launch a terminal emulator and specify the adapter's default settings. [Figure 2-3](#) shows the serial port settings dialog box for TeraTerm (open this dialog box by choosing *Setup > Serial Port*).

**FIGURE 2-3: SERIAL PORT SETTINGS IN TERATERM**



To place the module on the RN-52-EK evaluation board into Command mode, connect a jumper to header pins 5 (GPIO9) and 6 (GND) on J3. Refer to [Figure 2-4](#) and its Connector-Pin details. After entering Command mode, the module sends `CMD` to the UART as acknowledgement.

**FIGURE 2-4: GPIO9 LOCATION**

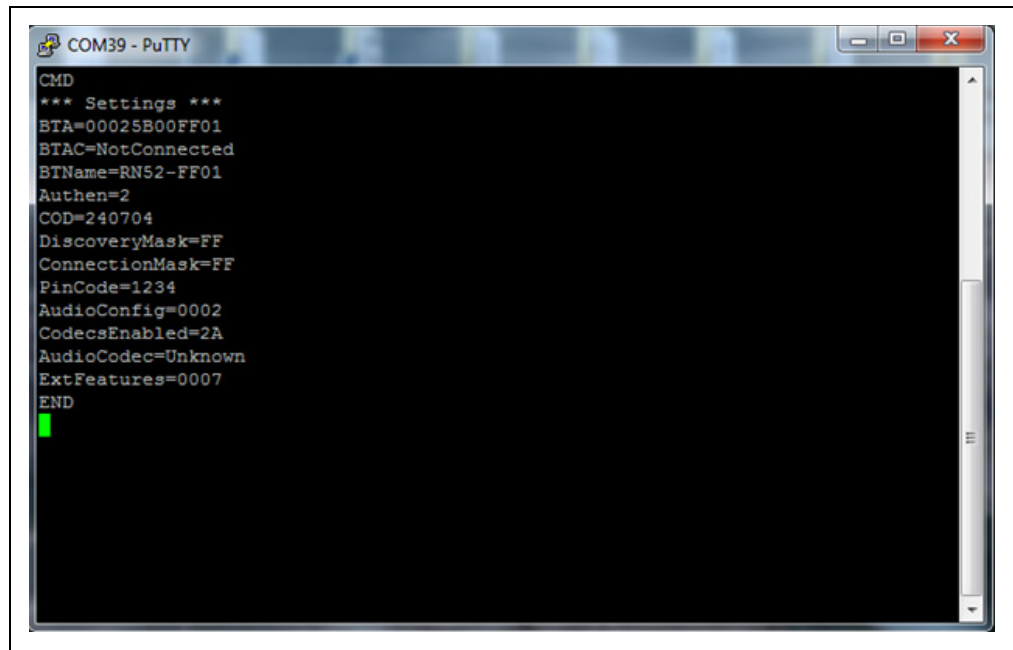


Type the following commands into the Tera Term console:

```
+ // Turn on local echo
v // Display the firmware version
d // Display the current settings
q // Show the connection status
```

To switch into Data mode, remove the jumper from header pins 5 (GPIO9) and 6 (GND) on J3. When leaving Command mode, the module sends `END` to the UART. [Figure 2-5](#) shows the Tera Term console after performing these actions.

**FIGURE 2-5: COMMAND MODE ACTIONS IN A SERIAL TERMINAL EMULATOR**





# RN52 Bluetooth Audio Evaluation Kit User's Guide

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## 2.4.4 Making a Bluetooth Connection

By default, the Bluetooth adapter acts as a slave and the PC is the master. Connect to the Bluetooth adapter using the computer's Bluetooth device manager, which varies depending on the operating system. Regardless of the operating system, the process is the same: Discovery, Pairing, and Connecting.

### 2.4.4.1 DISCOVERY

When the RN-52-EK is turned on, the Blue and Red LED should blink and the adapter should be discoverable. Open the host PC's Bluetooth device manager and choose to add a new device. The Bluetooth device manager's icon is located at the bottom right corner on the host's computer screen in the taskbar for Windows; and at the upper right corner for Mac OS-X. The Bluetooth device manager displays a list of discoverable Bluetooth devices. The board displays as **RN52-XXXX**, where XXXX is the last 4-digits of the module's MAC address.

### 2.4.4.2 PAIRING

The module supports the following pairing methods:

- Legacy Pairing using PIN code
- Secure Simple Pairing (SSP)
  - Just Works
  - Numeric Comparison using Yes/No Keyboard IO

The RN-52 module can be configured through command console to use either of the above pairing methods.

To pair with the module, double click its name in the Bluetooth device scan list. The default authentication mode is Just Works which requires no user interaction. The link key is generated, stored and a connection gets established. For subsequent connections, the stored link keys are compared and the connection is established. The module's firmware automatically stores up to 8 pairings from remote hosts in a first in, first out fashion.

If the remote Bluetooth device does not require authentication, a connection can occur without the pairing process. However, the Bluetooth specification requires that if either device involved in the pairing process requires authentication, the other device must participate to ensure a secure link. Microchip modules default to Just Works mode and do not require authentication.

In numeric comparison using yes/no keyboard IO mode, the user is shown a 6-digit number on both the module console and the pairing device display. The user has to verify that the numbers match or do not match on both devices by entering yes or no. A command is provided to enter yes or no on the module command console.

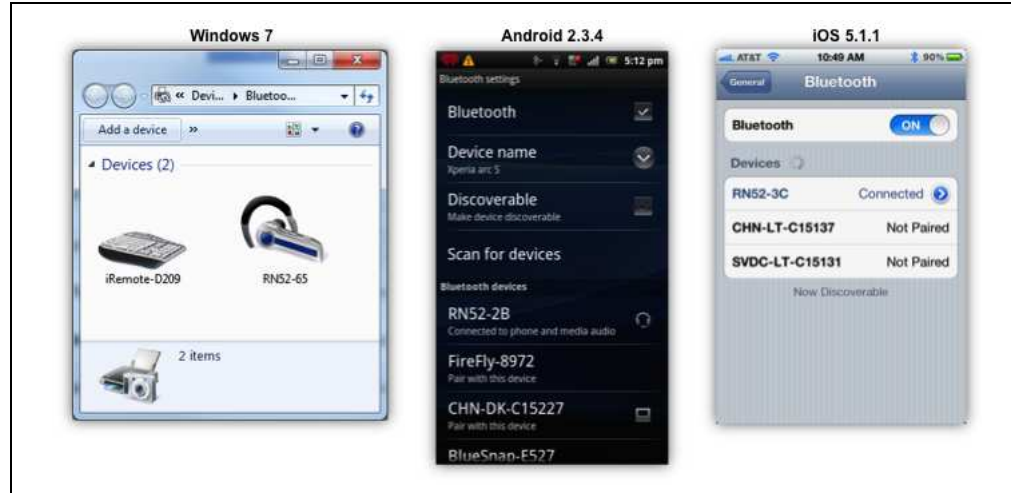
In legacy pairing mode, the pairing device requests a 4-digit fixed PIN for authentication. In this case, use the module's default PIN code, 1234, as the pass key. After entering the PIN code, the Bluetooth devices are compared. If a match is found, a link key is generated and stored. Usually, but not always, the remote device stores the link key. For subsequent connections, the devices compare link keys. If correct, there is no need to re-enter the PIN code. The PIN code can be set as desired using command console.

To remove the stored link key on the remote device, you typically "unpair" or remove the device from the Bluetooth manager. The pairing information can be reset by executing the reset Paired Device List (PDL) on the command console. You can change the PIN code to remove the link key on the Bluetooth adapter, forcing a new pin code exchange to occur upon subsequent connection attempts.

Figure 2-6 shows examples of Bluetooth devices discovered list and pair/connect interfaces.

**Note:** For detailed information on the pairing mode commands, refer to the “*Bluetooth Command Reference and Advanced Information User’s Guide*”.

**FIGURE 2-6: PAIRING/CONNECTING WITH THE BLUETOOTH® ADAPTER**



### 2.4.4.3 CONNECTING

If the pairing with the device is successful, the module can connect to the device. Click connect using the pair/connect interface to establish a connection.

Once connected, the module enables Advanced Audio Distribution Profile (A2DP) for audio playback and Audio Video Remote Control Profile (AVRCP) for player control.

Additionally, a Serial Port Profile (SPP) link can be established by opening the virtual COM port available on the RN52 module from a PC over its Bluetooth device.

When connecting to a PC using SPP, after the Bluetooth device manager completes pairing/connecting, it issues a message that the Bluetooth device is installed on COM port X where the specific COM port is unique to the user’s computer. After connecting successfully, the data can be transmitted and received on the Bluetooth COM port link in Data mode.

In some cases, the Bluetooth device manager creates two COM ports. In this situation, use the incoming port to wait for the module to initiate a connection. Open the outgoing port to establish a connection to the module.