Bluetooth Audio Module
Command Reference User’s Guide

MODULES SUPPORTED:
RN52-I/RM

RN-BT-AUDIO-UG Version 2.0r 3/20/13

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Chapter 1. Introduction

1.1 OVERVIEW

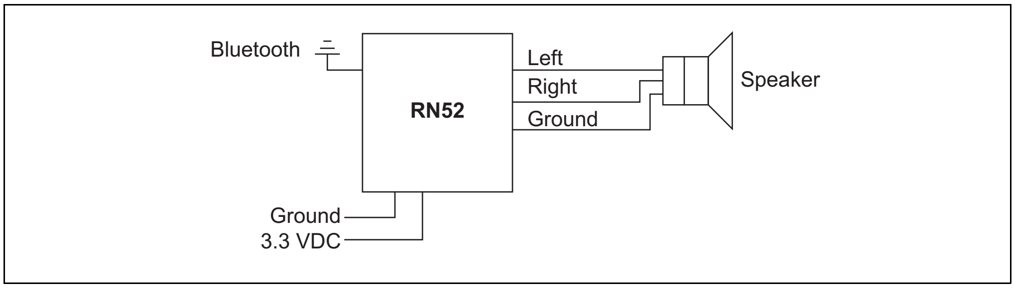
This document contains the software command reference and advanced configuration settings for Roving Networks Bluetooth audio modules. Commands and settings that are specific to a single product or product family are identified as such in the document.

NOTICE TO CUSTOMERS

The commands and applications described in this document apply to Roving Networks Bluetooth *audio modules*, e.g., the RN52. They do not apply to Roving Networks Bluetooth data modules such as the RN41, or RN42. For data module configuration information, refer to the *Bluetooth Data Module Command Reference & Advanced Information User's Guide*.

Roving Networks Bluetooth audio modules, such as the RN52, allow you to stream audio over the Bluetooth link from a source (such as a smartphone) to speakers, a PC, or other Bluetooth-enabled hardware. In it's simplest configuration, e.g., controlling remote speakers, the module only requires five signals to stream audio (left/right speaker, two grounds, and power). See Figure 1-1.

FIGURE 1-1: BLUETOOTH AUDIO MODULE CONNECTED TO WIRELESS SPEAKERS



This document assumes that you have a working knowledge of Bluetooth operation and communications. To configure Roving Networks modules you need a Bluetooth-enabled smartphone or PC (either built-in or using a USB Bluetooth dongle). You can only configure one device at a time. Once configured, device settings are saved (independent of power down) until they are explicitly changed or the factory defaults are restored.

1.2 AUDIO & DATA BLUETOOTH PROFILES

The audio module supports several Bluetooth profiles, as described in Table 1-1. Upon power-up, the module is configured as a slave and is ready to pair and connect. The A2DP/AVRCP profile is enabled and connected to the SBC CODEC and analog I/O.

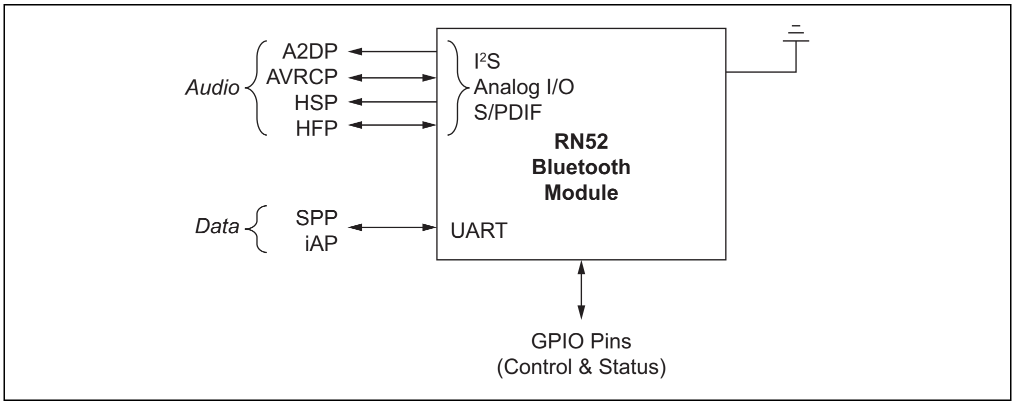
Bluetooth master devices can discover and use the profiles listed in Table 1-1. You configure each profile to be discoverable by using ASCII commands in command mode over the data interface. The module can enable multiple profile connections simultaneously, and broadcasts the profiles it has available. When you pair the module with a smartphone, the smartphone decides which profile connection(s) to use.

TABLE 1-1: SUPPORTED BLUETOOTH PROFILES

Profile	Type	Comments
A2DP	Audio	The advanced audio distribution profile (A2DP) defines how high quality audio (stereo or mono) can be streamed from one device to another over a Bluetooth connection.
AVRCP	Audio	The audio-video remote control profile provides a standard interface to control audio/video equipment such as TVs and hi-fidelity equipment. This profile is dependent on and used with the A2DP profile.
HFP	Audio	The hands free profile (HFP) is commonly used in car hands-free kits to communicate with mobile phones in the vehicle.
HSP	Audio	The headset profile provides support for using Bluetooth headsets with mobile phones. This profile is dependent on and used with the HFP profile.
SPP	Data	SPP defines a virtual serial port between two Bluetooth-enabled devices. SPP emulates a bidirectional serial link.
iAP	Data	The module natively supports iPod Accessory Protocol (iAP) data connections and directly manages authentication with the MFI authentication chip (not included).

Figure 1-2 shows a block diagram of the RN52 with Bluetooth audio and data profiles, and GPIO pins.

FIGURE 1-2: RN52 PROFILE CONNECTION BLOCK DIAGRAM



1.3 AUDIO SETTINGS

You control the module's settings through the UART interface using a simple ASCII command language. For example, you can change the audio routing and/or profile. Set commands configure the module and get commands echo the current configuration. Because the module reads the configuration into RAM once at boot time, configuration settings modified with the set command do not take effect until the module has been rebooted (unless otherwise noted), even though the get command may show otherwise. Some example commands are:

```
SK,08       // Set the connection profile to HFP
GA          // Display the authentication mode
GP          // Display the pin code
+           // Turn on local echo
V           // Display the firmware version
D           // Display the current settings
Q           // Show the connection status
```

1.4 MAKING A BLUETOOTH CONNECTION

By default, the Bluetooth module acts as a slave and the PC or smartphone is the master. You connect to the Bluetooth module using the Bluetooth device manager, which varies depending on your smartphone or computer's operating system. In all cases, the process is the same:

- *Discovery*—In the discovery phase, the Bluetooth module broadcasts its name, profile support, and MAC address. It is ready for other devices to pair with it. Discovery is only availoable in slave mode.
- *Pairing*—During pairing, the Bluetooth module and the Bluetooth master validate the pin code. If the pin code validates successfully, they exchange security keys and a channel hopping pseudo-random sequence. Successful pairing results in the module and master establishing link keys.
- *Connecting*—Before connecting, the Bluetooth devices must have paired successfully. The master initiates a connection, the master and slave validate the link keys, and a Bluetooth link is established.

The following sections describe these processes in detail.

1.4.1 Discovery

Upon power up, the module is discoverable. See Figure 1-3 for Bluetooth device scanning examples. Bluetooth devices, such as smartphones and PCs, can discover the module.

- *Discovery using a smartphone*—Touch the **Settings** icon. For iOS devices, touch **Bluetooth**; for Android devices, touch **Wireless & networks** and then **Bluetooth**. The device discovers the module and displays it as **RN52-***XXXX*, where *XXXX* is the last 4 digits of the module's MAC address. The module displays in the available devices list as **Not Paired.**
- *Discovery using a PC*—Open your PC's Bluetooth device manager and choose to add a new device. The Bluetooth device manager's icon is located in the bottom right corner of your screen in the taskbar for Windows and in the upper right corner for Mac OS-X. The Bluetooth device manager displays a list of discoverable Bluetooth devices. The module displays as **RN52-***XXXX*, where *XXXX* is the last 4 digits of the module's MAC address. The module's label also shows the MAC address.

1.4.2 Pairing

To pair with the module, double-click its name in the Bluetooth device list. The module’s firmware automatically stores up to 8 pairings from remote hosts in a first in, first out fashion. The default authentication mode is keyboard I/O (no pin code required).

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. Roving Networks modules default to SPP open or keyboard I/O mode and do NOT require authentication.

Most PCs do not support keyboard I/O mode and, therefore, require authentication. In this case, use the module’s default pin code, 1234, as the pass key. After you enter the pin code, the Bluetooth devices compare them. If they match, 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 they are correct, you do not need to re-enter the pin code.

To remove the stored link key on the remote device, you typically “unpair” or remove the device from the Bluetooth manager. 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.

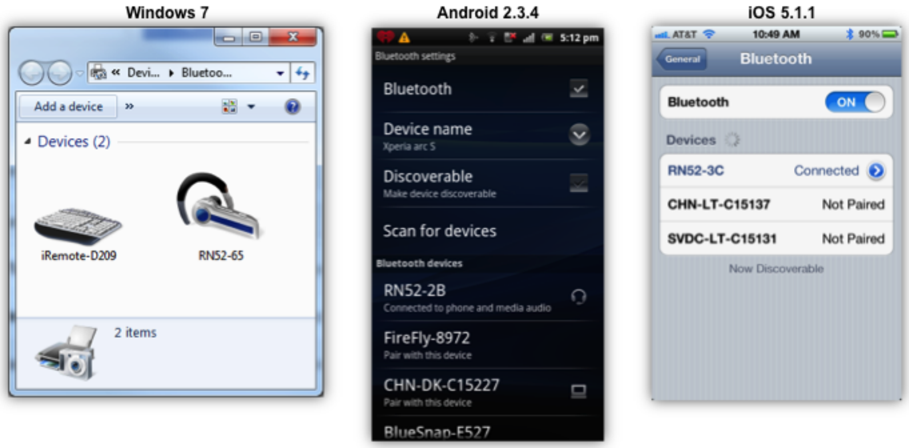
The module may use simple secure pairing (SPP) when it attempts to pair with devices that support the Bluetooth specification version 2.1 + EDR. SSP does not require the user to remember the pin code, but it asks to confirm a 6-digit number if the device has a display capability.

Note: Keyboard I/O mode prompts the host to acknowledge a 6-digit number. Because there is no way to display this number on an embedded device, the module always replies with *Yes*, thereby creating a successful pairing. This mode is useful for Android devices with operating system 2.3 and higher.

When you connect to a PC using SPP to exchange data, after the Bluetooth device manager completes pairing, it issues a message that the Bluetooth device is installed on COM*X* where COM*X* is unique to your computer. This connection is bidirectional. 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.

Figure 1-3 shows some pairing/connecting examples on several platforms.

FIGURE 1-3: PAIRING/CONNECTING WITH THE BLUETOOTH MODULE



1.4.3 Connecting

To establish a Bluetooth connection on a PC, open the module's COM port from your application or a terminal emulator. The module remains connected until you close the COM port or remove power from it.

Once connected, the module is in audio mode, allowing audio (A2DP) to flow from the source to the sink.

While sending and receiving audio, the module can transfer and receive data over its UART. Additionally, you configure the module over the UART by placing the module into command mode and sending ASCII commands. Command mode is independent of the audio function; e.g., the module can play audio as it is going in and out of command mode.

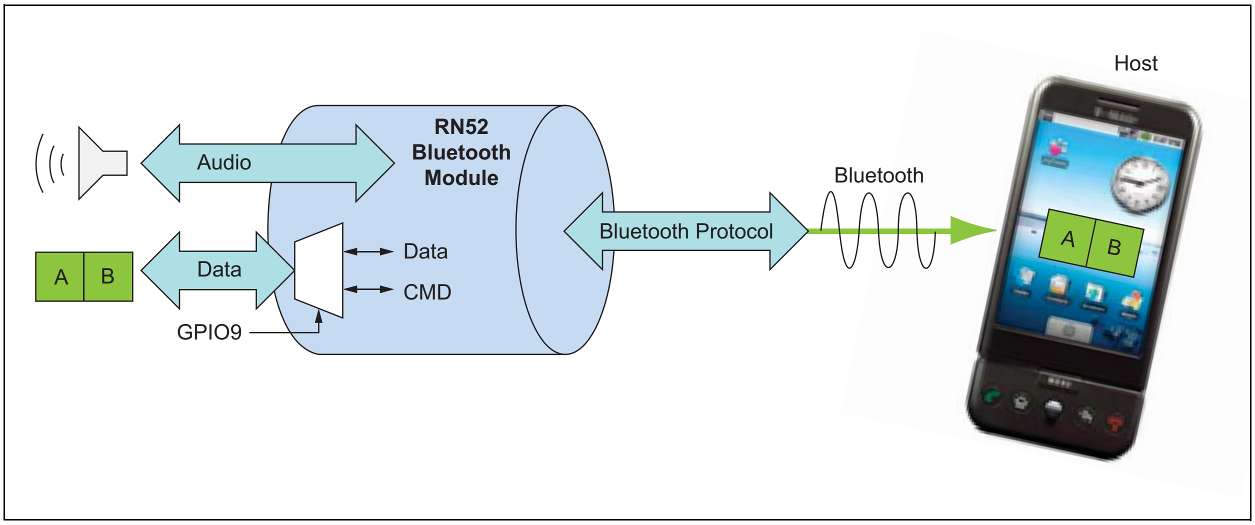
Note: Only one master can connect to a slave device at a time. As a master, the device can make multiple connections, but only in a point-to-point, serialized manner. Roving Networks modules do not currently support multi-point master mode.

1.5 COMMAND MODE VS. DATA MODE

The RN52 UART has two modes: data mode (default) and command mode. While in data mode and connected over Bluetooth (SPP or iAP), the module is essentially a data pipe. When the module receives data over the wireless Bluetooth connection, it strips the Bluetooth headers and trailers and passes the user data to the UART. When data is written to the UART, the module constructs the Bluetooth packet protocol and sends it out over the Bluetooth connection. Thus, the entire process of sending/receiving data to the host is transparent to the end microprocessor. See Figure 1-4.

Note: The audio stream is unaffected when the module enters/leaves command mode.

FIGURE 1-4: DATA & COMMAND MODES



NOTICE

You can only configure the Bluetooth audio module locally using your computer's serial port. You *cannot* configure the module remotely over the Bluetooth link.

1.5.1 Default Configuration & Serial Port Settings

Table 1-2 shows the default configuration for the Bluetooth module:

TABLE 1-2: DEFAULT CONFIGURATION & SERIAL PORT SETTINGS

Option	Setting
Bluetooth mode	Slave
Bluetooth pin code (for legacy pairing modes)	1234
Baud rate	115,200 Kbps
Bits	8
Parity	None
Stop bits	1
Flow control	Disabled

1.5.2 Configuring the Module over the UART

Connect the module to your computer. For example, if you are using the RN-52-EK evaluation board, connect it to your computer using a USB cable. With the Bluetooth module connected and powered on, run a terminal emulator and open the COM port to which the cable is connected. The terminal emulator's communication settings should match the Bluetooth module's default serial port settings.

Note: You can use local configuration 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.

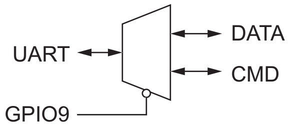
When you are finished configuring, reset the device, which causes the device to exit configuration mode and allows data to pass normally.

1.5.3 Command Mode & GPIO9

Launch a terminal emulator and specify the module's default settings (see Table 1-2).

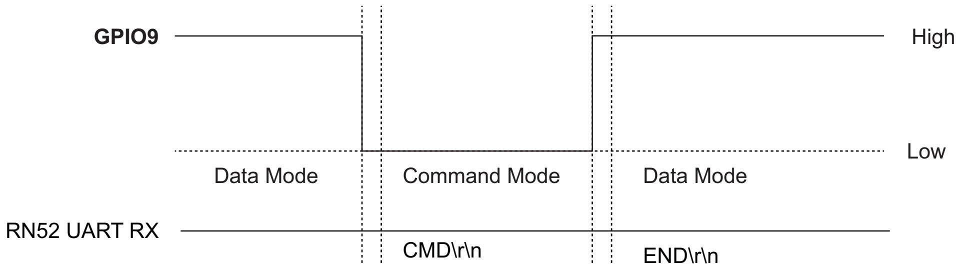
The module monitors GPIO9 as an input to determine whether data traversing the UART should be routed to the active Bluetooth SPP connection or to the command console. When you hold GPIO9 low, the UART enters command mode. The module returns the string CMD to the UART console to indicate that the module is in command mode. Figure 1-5 shows a logical diagram of the GPIO9 function.

FIGURE 1-5: GPIO9 CONTROLLING COMMAND MODE



In command mode, the module routes all data entering the UART to the command console. In the command console, you configure the module and query its status using ASCII commands. See Figure 1-6.

FIGURE 1-6: PULLING GPIO9 LOW ROUTES UART TRAFFIC TO THE COMMAND CONSOLE

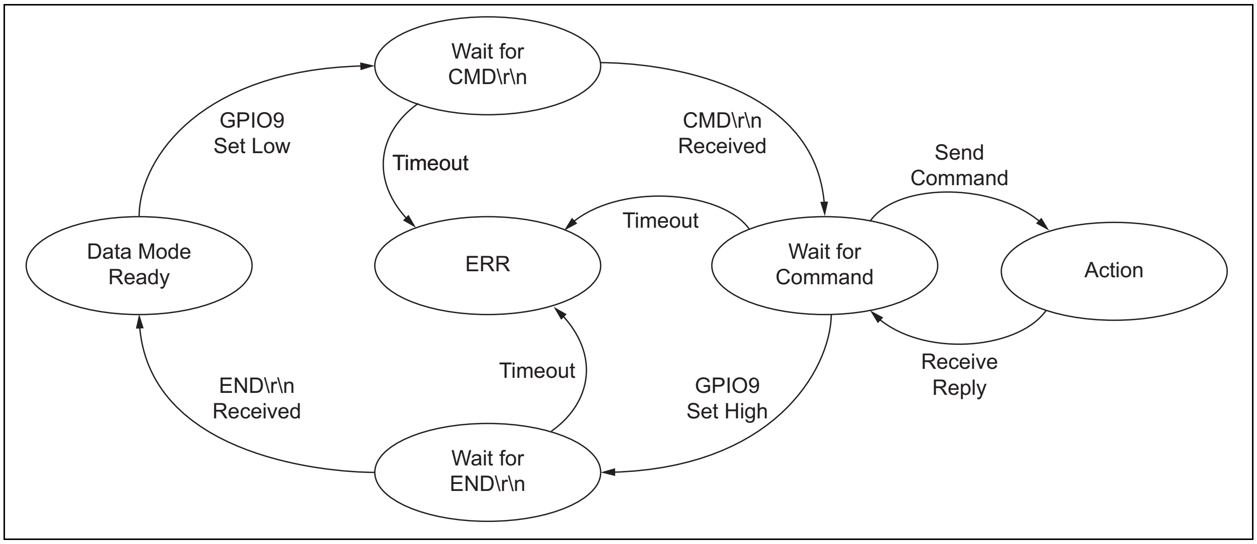


For applications in which a microcontroller controls GPIO9 and sends commands over the UART, the microcontroller should monitor the UART RX line for the following strings immediately after driving GPIO9:

- `CMD\r\n`
- `END\r\n`

Use the state diagram shown in Figure 1-7 as a guideline when designing code to monitor GPIO9 and command states.

FIGURE 1-7: STATE DIAGRAM FOR ENTERING & EXITING COMMAND MODE

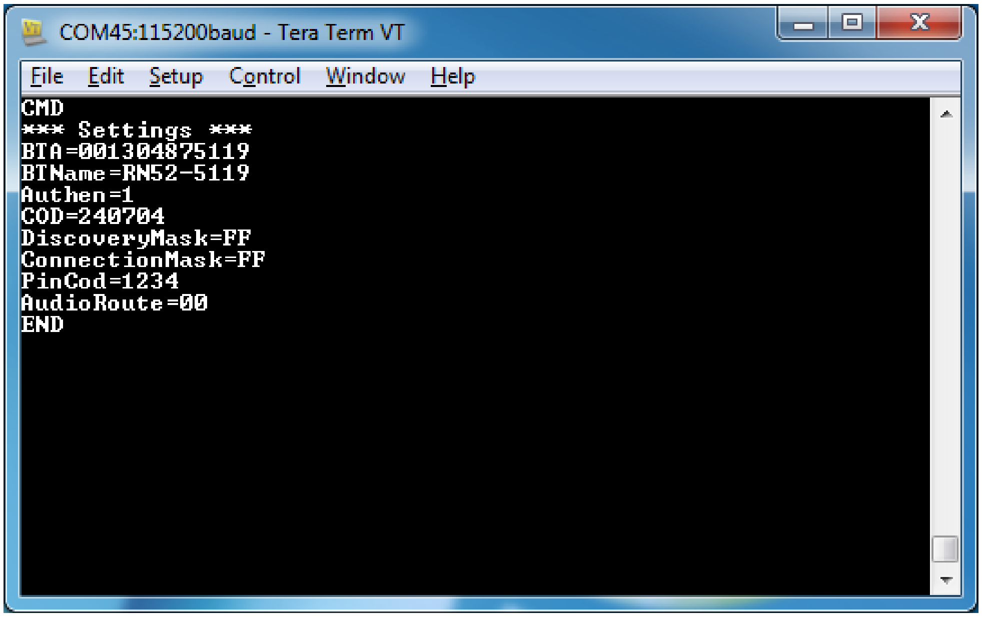


While in command mode, the device accepts ASCII bytes as commands. When you enter a valid command, the module returns `AOK`. It returns `ERR` for an invalid command and `?` for unrecognized commands. Type `h` <cr> to see a list of commands.

A quick check to confirm that you are in command mode is to type the `D` <cr> command after entering command mode. This command shows the a summary of the module's current settings, such as the Bluetooth name, device class, and serial port settings. See Figure 1-8.

To return to data mode, drive GPIO9 high. When leaving command mode the module sends `END` to the UART.

FIGURE 1-8: VIEW CURRENT SETTINGS



```
CMD
*** Settings ***
BTA=001304875119
BTName=RN52-5119
Authen=1
COD=240704
DiscoveryMask=FF
ConnectionMask=FF
PinCod=1234
AudioRoute=00
END
```

1.6 GPIO PINS

The Bluetooth audio module has 11 GPIO pins. Several of these pins are reserved for specific functions during bootup and runtime. As a demonstration, the RN-52-EK board uses various GPIO pins to control the board's audio playback. Table 1-3 describes the GPIO pins for the standard RN52 module and Table 1-4 describes the RN-52-EK GPIO pin demo function.

TABLE 1-3: RN52 STANDARD GPIO PIN ASSIGNMENTS & FUNCTIONS

GPIO Pin	Function	Use	Direction	Default
GPIO2 (Event Register)	Toggles from high to low for 100 ms to indicate that the module's state has changed. A microcontroller can enter command mode and poll the state register using the Q action command. Reserved. Not available for use at runtime.	Runtime, Reserved	Output	High
GPIO3 (DFU Mode)	This pin enters device firmware update (DFU) mode at bootup if a USB device powers VBUS. GPIO3 requires 47 kΩ to ground and 22 kΩ to the USB VBUS signal if the USB VBUS is supplying power to the main board.	Bootup, Configuration	Input	Low
GPIO4	Factory reset mode. To reset the module to the factory defaults, GPIO4 should be high on power-up and then toggle low, high, low, high with a 1 second wait between the transitions.	Bootup, Configuration	Input	Low
GPIO5	Programmable I/O.	Runtime, Configuration	I/O	High
GPIO6	Programmable I/O.	Runtime, Configuration	I/O	High
GPIO7	Driving this pin low sets the UART baud rate to 9,600. By default the pin is high with a baud rate of 115,200.	Bootup, Configuration	Input	High
GPIO9	When you drive this signal low, the module's UART goes into command mode. If this signal floats high, the UART is in data mode. Reserved. Not available for use at runtime.	Runtime, Reserved	Input	High
GPIO10	Programmable I/O.	Runtime, Configuration	I/O	High
GPIO11	Programmable I/O.	Runtime, Configuration	I/O	High
GPIO12	Programmable I/O.	Runtime, Configuration	I/O	High
GPIO13	Programmable I/O.	Runtime, Configuration	I/O	High

TABLE 1-4: RN-52-EK (DEMO) GPIO PIN ASSIGNMENTS & FUNCTIONS

GPIO Pin	RN-52-EK Demo Function	Use	Direction	Default
GPIO2 (Event Register)	Toggles from high to low for 100 ms to indicate that the module's state has changed. A microcontroller can enter command mode and poll the state register using the `Q` action command. Reserved. Not available for use at runtime.	Runtime, Reserved	Output	High
GPIO3 (DFU Mode)	This pin enters device firmware update (DFU) mode at bootup if a USB device powers VBUS. GPIO3 requires 47 kΩ to ground and 22 kΩ to the USB VBUS signal if the USB VBUS is supplying power to the main board.	Bootup, Configuration	Input	Low
GPIO4	Factory reset mode. To reset the module to the factory defaults, GPIO4 should be high on power-up and then toggle low, high, low, high with a 1 second wait between the transitions.	Bootup, Configuration	Input	Low
GPIO5	The module uses this signal for the volume up button. Low is active.	Runtime, Configuration	Input	High
GPIO6	Input/output at runtime.	Runtime, Configuration	I/O	High
GPIO7	Driving this pin low sets the UART baud rate to 9,600. By default the pin is high with a baud rate of 115,200.	Bootup, Configuration	Input	High
GPIO9	When you drive this signal low, the module's UART goes into command mode. If this signal floats high, the UART is in data mode. Reserved. Not available for use at runtime.	Runtime, Reserved	Input	High
GPIO10	The module uses this signal for the volume down button. Low is active.	Runtime, Configuration	Input	High
GPIO11	The module uses this signal for the previous track button. Low is active.	Runtime, Configuration	Input	High
GPIO12	The module uses this signal for the next track button. Low is active.	Runtime, Configuration	Input	High
GPIO13	The module uses this signal for the play/pause button. Low is active.	Runtime, Configuration	Input	High

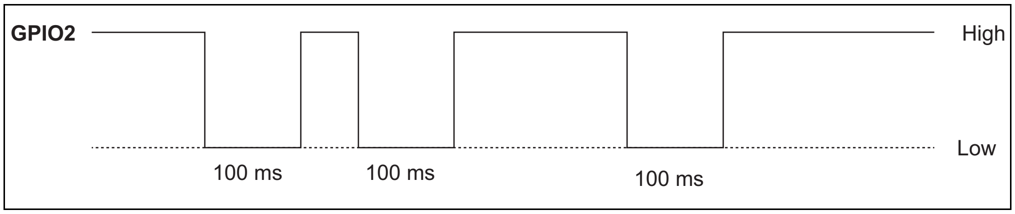
1.6.1 Using GPIO2 to Monitor the Event or Status Register

The module contains an event or status register, which you can read to determine status changes. Status changes include changes to profile connections or voice call connections. You access the register with the `Q` command. When you issue this command, the module responds with an encoded 2-byte stream of ASCII hex data terminated by the `\r\n` characters. See "Q" on page 26 for more information on using the `Q` command.

The module drives GPIO2 as an output to notify an external microcontroller of an event or status change. The microcontroller should enter command mode and issue the `Q` command and parse the response to retrieve the current status.

The module holds GPIO2 low for 100 ms to indicate a change or event has occured. If a new event occurs, the register's data is overwritten with the new event information. Some bits are cleared when you read the data. See "Q" on page 26 for details. Figure 1-9 illustrates three event notifications.

FIGURE 1-9: GPIO2 EVENT NOTIFICATION



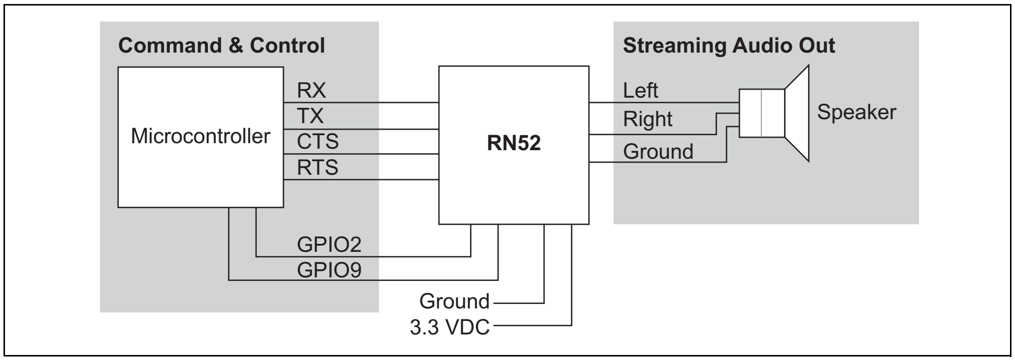
1.7 CONNECTING WITH A MICROCONTROLLER

Figure 1-10 shows a simple schematic in which a microcontroller controls the RN52 module. This schematic shows the bare minimum configuration required for the microcontroller to perform the following functions:

- Configure and control the module
- Get module's status information (see "Q" on page 26 for more details)
- Stream audio over the Bluetooth link

For a more complex example of how to control the RN52, refer to the RN-52-EK schematic (Figure 1-13 on page 18).

FIGURE 1-10: CONNECTING THE RN52 TO A MICROCONTROLLER

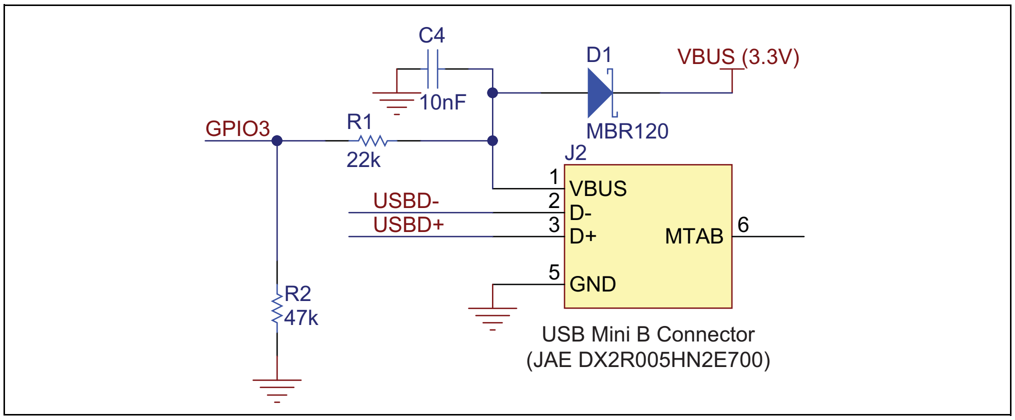


1.8 DEVICE FIRMWARE UPDATES

The module supports the device firmware update (DFU) mode in which you use the module's USB interface to update the firmware. Implementing the DFU feature is recommended highly because firmware updates offer new features and enhance the module's functionality. Follow the reference design shown in Figure 1-11 to support this mode.

Note: A 47 KΩ pull-down resistor (R2 in Figure 1-11) is required on GPIO3 even if you do not use the USB for DFU.

FIGURE 1-11: USB DFU PORT & GPIO3 SCHEMATIC



When you connect an external USB host into the DFU port and power VBUS, the module enters DFU mode when you reboot or power it. If your board is not powered by VBUS, you do not need to include the C4 and D1 to VBUS inputs on the voltage regulator. See Figure 1-13 for a more complete design.

1.9 STATUS LEDS

The module can drive status LEDs that give you a visual confirmation that the module or board is powered up and operating. Table 1-5 describes the status LEDs.

TABLE 1-5: STATUS LED FUNCTIONS

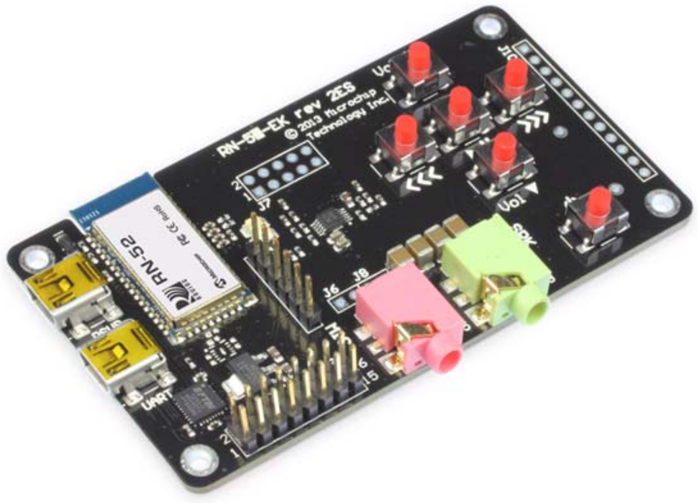
Blue LED	Red LED	Description
Flashing	Flashing	The RN52 module is discoverable.
Off	Flashing	The module is connected.
Flashing	Off	The module is connectable.

1.10 EVALUATION BOARDS & REFERENCE DESIGNS

Roving Networks provides a variety of evaluation kits and reference designs for evaluation and prototyping. The RN-52-EK evaluation kit is a prototyping platform for the RN52 module. The board contains buttons to control audio playback (volume up/down, next/previous track, pause/play) and connections for plugging in external speakers.

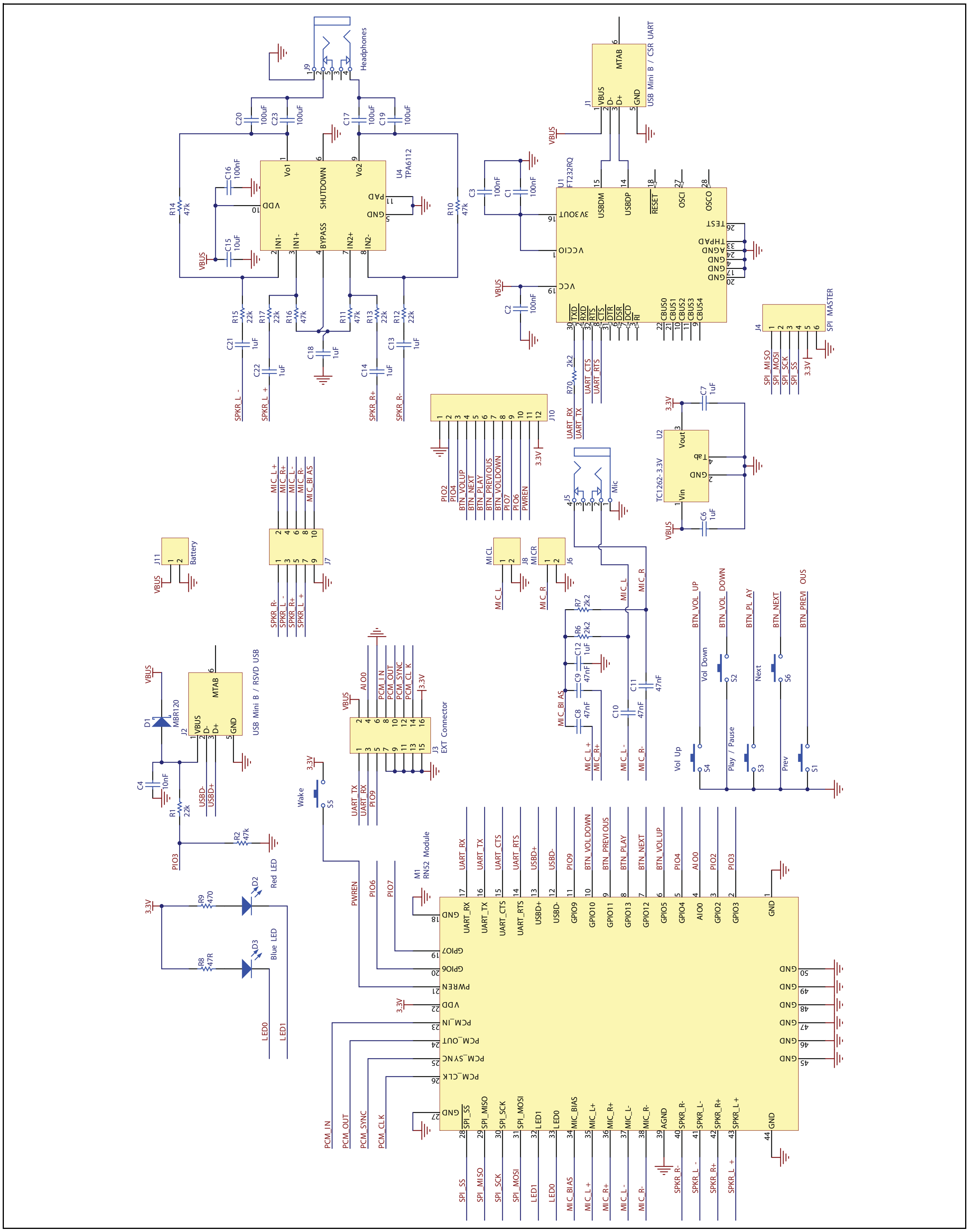
The board has the flexibility to connect directly to PCs via a standard USB interface or to embedded processors through the TTL UART interface. The status LEDs, switches, and signal headers enable rapid prototyping and integration into existing systems. Figure 1-12 and Figure 1-13 show the board and schematic, respectively.

FIGURE 1-12: RN-52-EK EVALUATION KIT



For more information on available evaluation boards and reference designs, refer to the Roving Networks (http://www.rovingnetworks.com) or Microchip (http://www.microchip.com) web sites.

FIGURE 1-13: RN-52-EK SCHEMATIC



Chapter 2. Command Reference

Roving Networks Bluetooth modules support a variety of commands for configuration. This section describes these commands in detail and provides examples.

NOTICE TO CUSTOMERS

The commands and applications described in this document apply to Roving Networks Bluetooth *audio modules*, e.g., the RN52. They do not apply to Roving Networks Bluetooth data modules such as the RN41 or RN42. For data module configuration information, refer to the *Bluetooth Data Module Command Reference & Advanced Information User's Guide*.

2.1 COMMAND SYNTAX

To issue commands to the module, you send a keyword followed by optional parameters via the UART.

- All commands are one or two characters and can be upper or lower case.
- Delimit command arguments with a comma.
- Commands use decimal input, except where noted.
- Text data, such as the Bluetooth name and pin code, is case sensitive.

There are three general command categories, as shown in Table 2-1.

TABLE 2-1: COMMAND TYPES

Command Type	Description
Set commands	Store information to flash memory. Changes take effect after a power cycle or reboot.
Get commands	Retrieve and display the stored information.
Action commands	Perform actions such as controlling the audio playback, performing inquiries, connecting, etc.

Set commands only take effect AFTER reboot, except where noted. Get and action commands take effect immediately.

Each command terminates with the carriage return (\r).

2.2 SET COMMANDS

Set commands specify configuration settings and take effect after power cycling or rebooting. Commands are not case sensitive. All commands respond with `AOK,`<*optional message*>\r\n for success or `ERR,`<*optional message*>\r\n if the command fails.

2.2.1 S|,<*value*>

This command sets the routing for the audio output, where <*value*> is a value shown in Table 2-2.

TABLE 2-2: AUDIO ROUTING VALUES

Value	Description
00	Analog output (default).
01	Set the output for I^2S. See Table 2-3 for the I^2S settings the RN52 interface supports.
02	Set the output for S/PDIF.

TABLE 2-3: RN52 I^2S SETTINGS

Parameter	Value
Configuration	Master mode.
Supported sample rates	Variable.
Sample width	24 bits.
Synchronous data	Data is right channel with word select (WS) high. The SD data MSB occurs in the second SCLK period.
Justification	Left justified.

Default: 00

Example: `S|,02` // Set the audio output to S/PDIF

2.2.2 S-,<*string*>

This command sets the module's normalized name where <*string*> is a prefix of up to 15 alphanumeric characters. The module's name is set to <*string*>-*XXXX*, where *XXXX* is the last four digits of the module's MAC address.

This setting is useful for situations in which you want to set up multiple modules with simular but unique identifiers.

Default: RN52

Example: `S-,MCHIP` // Set module's name to MCHIP-*XXXX*

2.2.3 SA,<*value*>

The set authentication command forces authentication when a remote device attempts to connect, where <*value*> is a decimal value shown in Table 2-4. Regardless of this setting, if a remote device forces authentication, this device responds with the stored pin code. Once a remote device has exchanged pin codes with this device, a link key is stored for future use. The device stores up to 8 keys automatically and permanently in flash memory, in a first in, first out fashion.

TABLE 2-4: SET AUTHENTICATION VALUES

Value	Description
0	Open. Authentication is not required. The device accepts pin code mode.
1	SSP keyboard I/O mode (default). If this option is set, the remote host receives a prompt; reply yes to pair. Optional does not force this mode but accepts it if the host requires (e.g., Droid 3.3+). The host posts a message asking for confirmation; the module always responds yes.
2	SSP “just works” mode. You can use this mode with Droid devices if the application connects using unsecure mode (which was the default on Droid version 3.3). This mode also works with new PC stacks.
4	Pin code. Forces pin code mode, which requires the host device to enter a pin code that matches the stored pin code.

> **Note:** Modes 0 and 4 are legacy modes that do not support SSP (Bluetooth version 2.0).

Default: 1 // Keyboard mode

Example: `SA,4` // Set to pin code mode

2.2.4 SC,<*24-bit hex value*>

This command sets the service class field in the class of device (COD), where <*24-bit hex value*> represents the COD. Bluetooth master devices use the COD when scanning for available devices to determine whether a device in a given class offers the type of service that they want.

The service class consists of the most significant 11 bits in the COD. This command sets the MSW to create the 24-bit device class number. The inquiring device interprets the service class to determine the service. A complete listing of available Bluetooth service classes is available on the Bluetooth SIG web site (https://www.bluetooth.org/apps/content).

The default COD, 240704, represents the following device:

- Service class: rendering, audio
- Major device class: wearable
- Minor device class: wrist watch

Default: 240704

Example: `SC,240710` // Service class: rendering, audio
// Major device class: wearable
// Minor device class: helmet

2.2.5 SD,<*8-bit hex value*>

This command sets the discovery mask, where <*8-bit hex value*> represents the profiles enabled for discovery. The Bluetooth profiles are represented by an 8-bit hex value as shown in Table 2-5.

TABLE 2-5: BLUETOOTH PROFILE BITMASK VALUES

Bit Position	Value	Profile
0	01	iAP
1	02	SPP
2	04	A2DP
3	08	HFP

Default: FF

Example: `SD,01` // Set the discovery profile to iAP

2.2.6 SF,1

This command sets all module parameters to the factory defaults. The changes do not take effect until you reboot the module.

> **Note:** When performing a factory reset using a microcontroller, send the `SF,1` command, wait for 20 ms, send the `R,1` command, and wait for the module to return `reboot`. Then, drive GPIO9 high to exit command mode.

Example: `SF,1` // Invoke factory defaults

`R,1` // Reboot

2.2.7 SK,<*8-bit hex value*>

This command sets the connection mask where <*8-bit hex value*> represents the profiles enabled for connection. The Bluetooth profiles are represented by an 8-bit hex value as shown in Table 2-6.

TABLE 2-6: BLUETOOTH PROFILE BITMASK VALUES

Bit Position	Value	Profile
0	01	iAP
1	02	SPP
2	04	A2DP
3	08	HFP

Default: FF

Example: `SK,08` // Set the connection profile to HFP

2.2.8 SN,<*string*>

This command sets the device name, where <*string*> is up to 20 alphanumeric characters.

Default: RN52-*XXXX*, where *XXXX* is the last 4 digits of the module's MAC address. When you set the name, the -*XXXX* is not appended to <*string*>.

Example: `SN,MyDevice` // Set the device name to "MyDevice"

2.2.9 SP,<*string*>

This command sets the security pin code, where <*string*> is up to 20 alphanumeric characters. Each time the device pairs successfully, it saves the Bluetooth address. The device can store up to eight addresses on a first in first out basis. Using this command also erases all stored pairings. You can use the same value that is already set.

You cannot erase the pin code, however, you can overwrite the default pin code.

Default: 1234

Example: `SP,0123` // Set pin code to 0123

2.3 GET COMMANDS

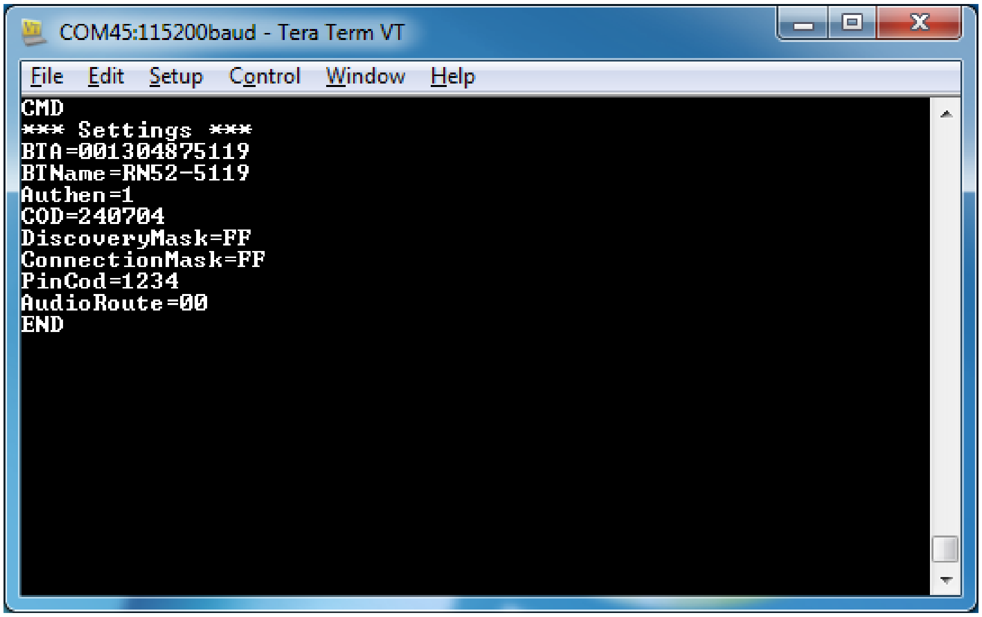
Get commands retrieve and display the device's stored information. These commands do not have a keyword or character and do not take any parameters, except as noted. Commands are not case sensitive. All commands respond with `AOK,`<*optional message*>\r\n for success or `ERR,`<*optional message*>\r\n if the command fails.

2.3.1 D

This command displays basic settings such as the address, name, UART settings, security, pin code, bonding, and remote address. Figure 2-1 shows an example of the output.

Example: `D` // Display basic settings

FIGURE 2-1: DISPLAY COMMAND EXAMPLE OUTPUT


COM45:115200baud - Tera Term VT
File Edit Setup Control Window Help

```
CMD
*** Settings ***
BTA=001304875119
BTName=RN52-5119
Authen=1
COD=240704
DiscoveryMask=FF
ConnectionMask=FF
PinCod=1234
AudioRoute=00
END
```

2.3.2 G<*command*>

This command displays the stored settings for a set command, where <*command*> is the second character of a set command.

Example:	`GA`	// Display the authentication mode
	`GP`	// Display the pin code

2.3.3 H

The help command displays a list of commands and their basic syntax.

Example:	`H`	// Display help

2.3.4 V

This command displays the firmware version.

Example:	`V`	// Show the firmware version

2.4 ACTION COMMANDS

Action commands perform actions such as audio playback, inquiries, connecting, and entering/exiting command mode. Commands are not case sensitive.

2.4.1 +

This command toggles the local echo on and off. If you send the `+` command in command mode, all typed characters are echoed to the output. Typing `+` a second time turns local echo off.

Default:	Off	
Example:	`+`	// Turn local echo on

2.4.2 @,<*flag*>

This command toggles whether the module is discoverable, where <*flag*> is 1 (discoverable) or 0 (not discoverable).

Example:	`@,1`	// Make the module discoverable

2.4.3 A,<*telephone number*>

This command initiates a voice call to a telephone, where <*telephone number*> is a decimal telephone number up to 25 digits. The module returns an error (`ERR`) if the call status is not idle.

Example:	`A,14083955300`	// Call 1 (408) 395-5300

2.4.4 AV+

This command increases the volume.

2.4.5 AV-

This command reduces the volume.

2.4.6 AT+

This command plays the next track by sending an AVRCP volume previous track command to the host.

2.4.7 AT-

This command plays the previous track by sending an AVRCP volume previous track command to the host.

2.4.8 AP

This command pauses or starts playback by sending an AVRCP volume pause/play command to the host.

2.4.9 B

The module attempts to reconnect the Bluetooth profiles specified in the connection mask to the most recently paired device. See “SK,<8-bit hex value>” on page 22.

Use the `Q` command to retrieve the Bluetooth profile connection status in byte 0 (bits 0 - 3). The module returns an error if it has not been previously connected or if the connection mask is set to 00 (meaning the module is not connectable).

2.4.10 C

This command instructs the module to accept an incoming voice call. You use the `Q` command to retrieve the call status (bits 8 - 10) value. The module returns an error (`ERR`) if the call status is not set to incoming calls.

Example: `C` // Accept incoming call

2.4.11 E

This command terminates an active call or rejects an incoming call. The module returns an error (`ERR`) if the call status is not an incoming call or active call.

Example: `E` // Terminate call

2.4.12 HV,<*value*>

This command sends a volume adjustment command to the telephone to adjust the voice call volume and synchronize the volume levels. <*value*> is the level in decimal integers from 0 - 15, and conforms to the HFP specification version 1.8 4.28.2.

Example: `HV,8` // Set volume to level 8

2.4.13 K,<*8-bit hex value*>

This command disconnects the currently active connection, where <*8-bit hex value*> represents the profile to disconnect**.** The characters `KILL`<cr><lf> are echoed to the local UART once the connection is broken. The Bluetooth profiles are represented by an 8-bit hex value as shown in Table 2-7.

TABLE 2-7: BLUETOOTH PROFILE BITMASK VALUES

Bit Position	Value	Profile
0	01	iAP
1	02	SPP
2	04	A2DP
3	08	HFP

Example: `K,01` // Disconnect the iAP profile

2.4.14 M,<*flag*>

This command controls the hold/mute function for the current telephone call, where <*flag*> is 0 or 1. If <*flag*> is 1, the module mutes the call; if <*flag*> is 0, the call is unmuted.

Example: `M,1` // Mute the call

2.4.15 Q

This command queries the current connection status in the event/status register. It returns an encoded byte stream of ASCII hex values terminated by \r\n to describe the status of the currently connected profile(s). The module drives GPIO2 low for 100 ms to notify attached equipment that the event/status register has been changed. See "Using GPIO2 to Monitor the Event or Status Register" on page 14 for more information.

Byte 0 of the byte stream indicates which profiles are connected as shown Table 2-8.

TABLE 2-8: BYTE 0 BIT FORMAT

Bit	Description
0	iAP wireless active connection to remote device.
1	SPP active connection to remote device.
2	A2DP active connection to remote device.
3	HFP/HSP active connection to remote device.
4 - 7	Reserved.

Table 2-9 describes the bits in byte 1. Note that:

- The connection state values (bits 0 - 3) only change when the module's status changes.
- The event bits (4 - 6) in byte 0 are cleared when you issue the `Q` command.

TABLE 2-9: BYTE 1 BIT FORMAT

Bit	Description
0 - 3	These bits indicate the connection state. See Table 2-3 for a listing of the possible states.
4	HFP audio volume level change from audio gateway (phone). Use the `Y,0` command to retreive the volume level. The module clears this bit when you read the event/status register qith the `Q` command.
5	HFP audio microphone level change from audio gateway (phone). Use the `Y,1` command to retreive the volume level. The module clears this bit when you read the event/status register qith the `Q` command.
6 - 7	Reserved.

Table 2-3 describes the connection states in bits 0 - 3 of byte 1.

TABLE 2-10: BYTE 1 CONNECTION STATES

Value	State	Description
0	Limbo	Logically off, but physically on.
1	Connectable	The module is connectable, page scanning.
2	Connectable and discoverable	The module is connectable and discoverable, page and inquiry scanning.
3	Connected	The module is connected to an audio gateway.
4	Outgoing call established	The connected audio gateway has an outgoing call in progress.
5	Incoming call established	The connected audio gateway has an active call in progress and the audio is in the headset.
6	Active call	The connected audio gateway has an active call in progress and the audio is in the headset.
7	Test mode	The headset is in test mode.
8	Three-way call waiting	The connected audio gateway has an active call and a second call on hold.
9	Three-way call on hold	The conneted audio gateway has an active call and a second call on hold.
10	Three-way call multi-call	The connected audio gateway has an active call and a second call on hold.
11	Incoming call on hold	The connected audio gateway has an incoming call on hold.
12	Active call	The connected audio gateway has an active call and the audio is in the handset.
13	Audio streaming	The headset is streaming A2DP audio.
14	Low battery	The system has a low battery.

Example: `0C16\r\n`

\\ Indicates that the A2DP and HFP
\\ profiles are connected, the call status is
\\ active, and that an audio mute/hold
\\ event was received from the phone.

2.4.16 R,1

This command forces a complete device reboot (similar to a power cycle). After you send this command, the module responds `reboot`.

> **Note:** When performing a factory reset using a microcontroller, send the `R,1` command and then wait for the module to return `reboot`. Then, drive GPIO9 high to exit command mode.

Example: `R,1` // Reboot the device

2.4.17 Y,<*flag*>

This command returns either the last speaker (<*flag*> = 0) or microphone level (<*flag*> = 1) as a 0 - 15 decimal value sent from the audio gateway in response to bits 14 and 15 in the event status register.

Example: `Y,0` // Returns the speaker volume

Appendix A. Command Quick Reference Guide

This section provides a quick reference of the firmware commands as well as the factory defaults. Table A-1 provides an overview of the set commands.

TABLE A-1: SET COMMANDS

Command	Description	Factory Settings
`S|,`*<hex value>*	Audio output routing.	00 (analog output)
`S-,`*<string>*	Sets the normalized name.	RN52
`SA,`<0,1,2,4>	Authentication enable/disable.	1 (SPP keyboard I/O)
`SC,`*<hex value>*	Service class.	240704
`SD,`*<hex value>*	Discovery profile mask.	FF
`SF,1`	Factory defaults.	N/A
`SK,`*<hex value>*	Connection profile mask.	FF
`SN,`*<string>*	Device name.	RN52-*XXXX*
`SP,`*<string>*	Pin code.	1234

Table A-2 describes the get (or display) commands.

TABLE A-2: GET (DISPLAY) COMMANDS

Command	Description
`D`	Basic settings.
`G`*<command>*	Displays setting for the set command indicated by <*command*>.
`H`	Display help.
`V`	Display the firmware version.

Table A-3 describes the action commands.

TABLE A-3: ACTION COMMANDS

Command	Description
`+`	Toggle the local echo of RX characters in command mode.
`@,`*<flag>*	Toggle whether the module is discoverable.
`A,`*<telephone number>*	Initial a voice call to <*telephone number*>.
`AV+`	Increase the volume (AVRCP command).
`AV-`	Decrease the volume (AVRCP command).
`AT+`	Play the next track (AVRCP command).
`AT-`	Play the previous track (AVRCP command).
`AP`	Pause or start playback (AVRCP command).
`B`	Reconnect Bluetooth profiles to the mnost recently paired and connected device.
`C`	Accept an incoming voice call.
`E`	Terminate an active call or reject an incoming call.
`HV,`*<value>*	The module sends a volume adjustment command to the telephone.
`K,`*<hex value>*	Kill the currently active connection.
`M,`*<flag>*	Toggle the on hold/mute function.
`Q`	Query the current connection status.
`R,1`	Reboot.
`Y,`*<flag>*	Return either the last speaker or microphone level.

NOTES:

Appendix B. Firmware Revision History

The following sections provide the firmware revision history.

B.1 VERSION 1.05

- First release.

NOTES:

Appendix C. Document Information

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User’s Guide*
	Emphasized text	...is the *only* 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	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** 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>
Courier New font:		
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	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly braces 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)`
		`{ ...`
		`}`

RECOMMENDED READING

This user's guide describes how to configure Roving Networks Bluetooth modules. The module-specific data sheets contain current information on the module specifications. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

RN52 Bluetooth Audio Module Data Sheet

This document provides the technical specifications for the RN52 module.

RN-52-EK Evaluation Kit User's Guide

This document describes how to use the RN-52-EK evaluation kit and provides an audio demonstration.

To obtain any of these documents, visit the Microchip web site at www.microchip.com.

DOCUMENT REVISION HISTORY

Version 2.0 (March 2013)

Added more details on the module's audio operation.

Version 1.0 (January 2013)

This is the initial released version of the document.