BM77 PICtail™/PICtail Plus Board User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

ISBN: 978-1-63277-717-1

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Object of Declaration: BM77 PICtail™/PICtail Plus Board

EU Declaration of Conformity

Manufacturer: Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, Arizona, 85224-6199
USA

This declaration of conformity is issued by the manufacturer.

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.

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

Derek Carlson
VP Development Tools

12-Sep-14
Date

NOTES:

Table of Contents

NOTES:

Preface

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 website (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 "DSXXXXXXXXA", where "XXXXXXXX" 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 online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the BM77 PICtail™/PICtail Plus Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

DOCUMENT LAYOUT

This document describes how the BM77 PICtail/PICtail Plus Board enables the designer to evaluate and demonstrate the capabilities of the BM77 Dual Mode Bluetooth® RF Module. The document is organized as follows:

- **Chapter 1. "Overview"**– This chapter describes the BM77 PICtail/PICtail Plus Board.
- **Chapter 2. "Getting Started"** – This chapter describes how to establish Bluetooth serial data connections using the BM77 PICtail Board, demonstrates how serial data is transmitted from the BM77 PICtail Board (via PC Chat) to an iOS device using Bluetooth Low Energy (BLE) connection, and provides an overview on how to configure the BM77 module on the BM77 PICtail/PICtail Plus Board using a PIC® MCU through the PICtail interface.
- **Appendix A. "BM77 Module PIN Assignment"** - This appendix shows the pin-out for BM77 and describes the pins of the module.
- **Appendix B. "Schematics"** - This appendix shows the BM77 PICtail/PICtail Plus Board schematics.
- **Appendix C. "Questions and Answers"** - This appendix lists the most common questions and answers when using the BM77 module.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
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
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
`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 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) { ... }`
Notes	A Note presents information that we want to re-emphasize, either to help you avoid a common pitfall or to make you aware of operating differences between some device family members. A Note can be in a box, or when used in a table or figure, it is located at the bottom of the table or figure.	**Note:** This is a standard note box. **CAUTION** **This is a caution note.** **Note 1:** This is a note used in a table.

RECOMMENDED READING

This user's guide describes how to use BM77 PICtail/PICtail Plus Board. Other useful documents are listed below. The following Microchip document(s) are recommended as supplemental reference resources:

BM77SPPx3MC2 Bluetooth® 4.0 Dual Mode Module Data Sheet
This document provides the technical specifications for the BM77 module and is available for download from the Microchip website at www.microchip.com.

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events; and listings of Microchip sales offices, distributors and factory representatives

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip website at www.microchip.com, click on Customer The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools
- **Emulators** – The latest information on the Microchip MPLAB® REAL ICE™ in-circuit emulator
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 3
- **MPLAB X IDE** – The latest information on Microchip MPLAB X IDE, the Windows® Integrated Development Environment for development systems tools
- **Programmers** – The latest information on Microchip programmers including the PICkit™ 3 development programmer

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- 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 website at:

http://www.microchip.com/support.

REVISION HISTORY

Revision A (August 2015)

This is the initial release of this document.

Chapter 1. Overview

1.1 INTRODUCTION

This document describes the hardware and software for the BM77 PICtail™/PICtail Plus Board.

The BM77 PICtail/PICtail Plus Board enables the designer to evaluate and demonstrate the capabilities of the BM77 Dual Mode Bluetooth® RF Module. The evaluation board includes an integrated configuration and programming interface for plug-and-play capability. It also includes on-board connection and data-status LEDs enabling rapid prototyping and fast time to market.

In addition to BM77 PICtail/PICtail Plus Board hardware, several software applications are provided to demonstrate Bluetooth data connections to the on-board BM77 module and optionally configure the BM77 module.

The demonstration software application consists of the following SmartPhone APPS:

- Android™ Chat Application using Serial Port Profile (SPP)
- iOS Bluetooth Terminal (BLETR)
- BT Chat Tool

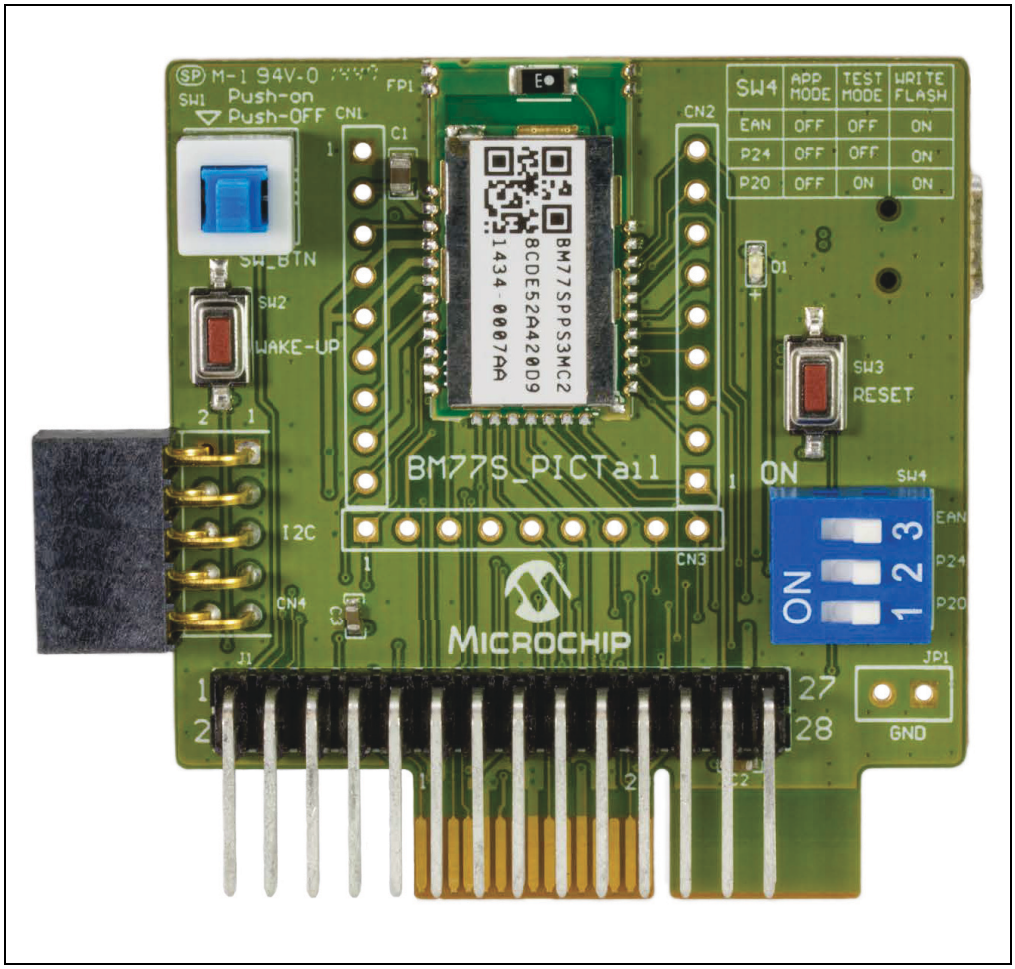
The configuration software consists of the following components:

- BM77 Configuration Library
- BM77 Configuration User Interface (UI) Tool
- BM77 Electrically-Erasable Programmable Read-Only Memory (EEPROM) Table Utility

1.2 BM77 PICtail™ BOARD DESCRIPTION

The BM77 PICtail™ Board provides rapid prototyping and developing for Bluetooth data applications for Classic SPP or Bluetooth Low Energy. Refer to Figure 1-1. It can be powered via USB host or through the Microchip PICtail Plus interface. The BM77 PICtail Board utilizes the BM77 module, a fully certified Bluetooth 4.0 dual mode RF module supporting Bluetooth Classic SPP and Bluetooth Low Energy (BTLE), providing Bluetooth serial data connections. The BM77 PICtail Board provides a MCP2200 USB-UART converter for issuing commands to control or configure the BM77 modules for any specific requirement based on the application. The USB-UART converter provides the flexibility to interface to a host PC, a PC terminal utility to drive both classic SPP and BTLE data connections. The BM77 PICtail Board also provides Microchip PICtail Plus and PICtail interfaces to interface with the Microchip PIC® microcontrollers (MCU) using Microchip development tools such as the Explorer 16 Development Board (DM240001) or the PIC18 Explorer Board (DM183032).

FIGURE 1-1: BM77 PICtail™/PICtail PLUS BOARD



1.3 BOARD FEATURES

The BM77 PICtail board has the following features:

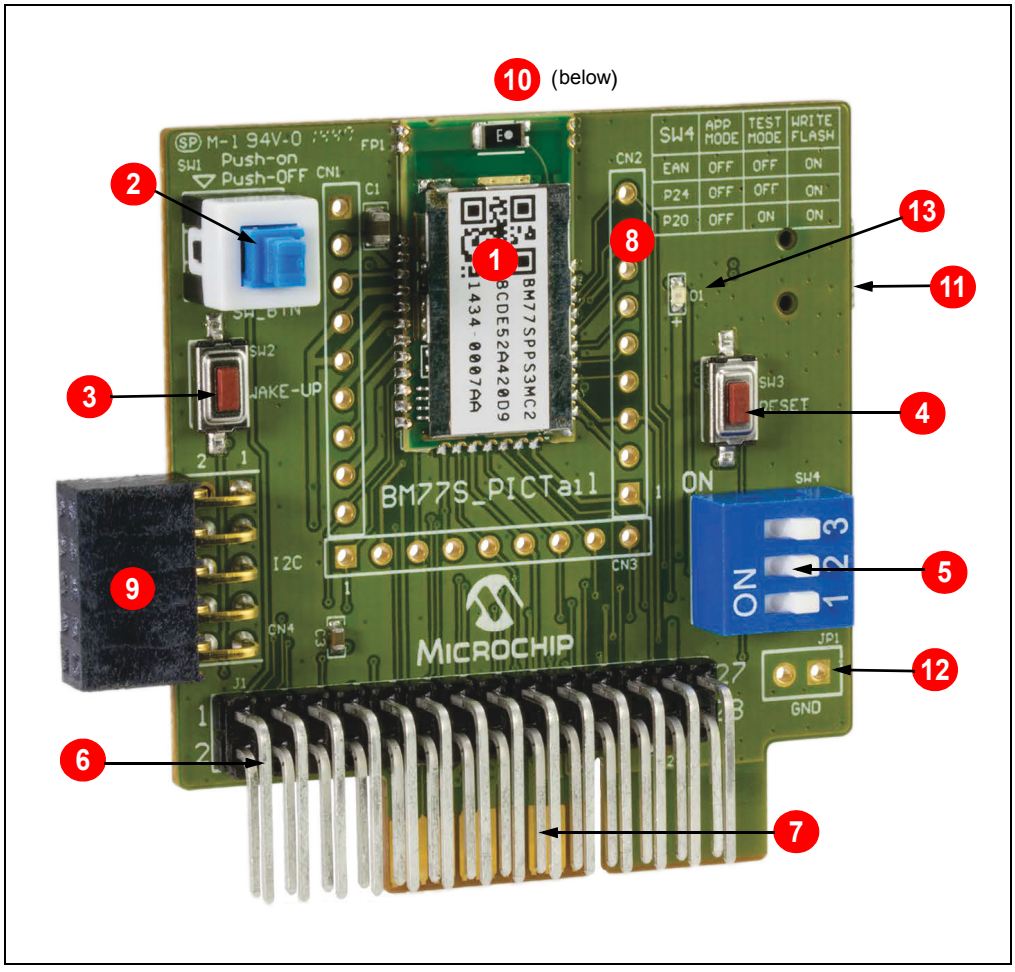
- Fully certified on-board Bluetooth 3.0 + EDR and Bluetooth 4.0 stack
- Class 2 transmitter, +2 dBm typical
- Transparent serial data connection over Bluetooth Classic SPP and Bluetooth Low-Energy transparent serial data service
- Automatic configuration mode for quick setup (default)
- Manual configuration mode for the MCU to access the configuration settings
- Configuration settings stored in internal EEPROM on BM77
- On-board Dual In-line Package (DIP) switch block to set operating modes
- PICtail Plus and PICtail interfaces to fully access BM77 pins using the external PIC MCU
- Embedded MCP2200 USB-UART converter to enable application mode and programming interface to update firmware and configuration settings

1.4 INTERFACE DESCRIPTION

The following are the description of the BM77 PICtail board in its default configuration as represented in Figure 1-2:

1. Bluetooth Module, BM77 (FP1)
2. Button to SW_BTN pin (SW1); press the button down to turn ON BM77
3. Wake up button to wake up the module from shutdown state (SW2)
4. Reset button for BM77 Bluetooth module (SW3)
5. Mode Switch (SW4); refer to Table 1-1 and Table 1-2
6. PICtail interface; right angle pins (J1)
7. PICtail Plus interface; edge connector (J2)
8. Header that brings out BM77 pins (CN2)
9. I2C expansion port (CN4)
10. Microchip MCP2200 chip; USB/UART serial converter (U3)
11. Mini-B USB connector (P1)
12. Ground (GND) test points (JP1)
13. Status LED (D1)

FIGURE 1-2: BM77 PICtail™/PICtail PLUS BOARD CONFIGURATION



1.4.1 Mode Definition and Mode Switch Settings

Table 1-1 and Table 1-2 show the mode definitions and the mode switch settings of the module.

TABLE 1-1: MODE DEFINITIONS

Mode	Switch Number	1	2	3
	**Pin Name**	P20	P24	EAN
	ON	Low	Low	High
	Function	EEPROM/Test mode High = Disable/Application Low = Enable/Test mode	Flash Write High = Disable Low = Enable	Boot to Flash or ROM Application High = ROM Low = Flash

TABLE 1-2: MODE SWITCH SETTINGS

Mode	Switch	PIN Definition
Write Flash		1 = P20: Low 2 = P24: Low 3 = EAN: High
EEPROM/Test		1 = P20: Low 2 = P24: High 3 = EAN: Low
Application (default)		1 = P20: High 2 = P24: High 3 = EAN: Low

1.5 USB-UART SERIAL INTERFACE

The BM77 PICtail Board consists of an USB-UART converter enabling flexible interface to the host PC, a PC terminal utility and Smartphone APPs to drive both classic SPP and BTLE data connections. The Universal Asynchronous Receiver/Transmitter (UART) port on the BM77 is exposed through an MCP2200 USB-UART serial converter for interfacing easily with a host PC.

Connecting the mini-B USB receptacle (P1) on the BM77 PICtail Board to the USB port on a PC enumerates the BM77 PICtail Board as a Composite Device Class (CDC) USB device for serial communication. A dedicated COM port is assigned on the host PC for serial communication with the BM77 on the BM77 PICtail Board after the MCP2200 is enumerated. A PC terminal utility or application opens the assigned COM port and connects to the UART port on BM77 for serial data transfer or to configure and control BM77. If the MCP2200 does *not* enumerate, ensure that the MCP2200 drivers are downloaded and manually installed from www.microchip.com/MCP2200.

1.6 PICtail PLUS AND PICtail INTERFACE

Using the PICtail Plus (J2) or PICtail (J1) interface, the board can be plugged into any standard Microchip development board such as the Explorer 16 Development Board (DM240001) or the PIC18 Explorer Board (DM183032) that supports the PICtail Plus or PICtail connection interface.

The PICtail interface provides access to the UART port and the General Purpose Input Output (GPIO) pins on the BM77 PICtail/PICtail Plus Board. The PICtail interface is used to configure the BM77 by updating the Bluetooth parameters on the internal EEPROM, updating the BM77 firmware on the internal flash, and entering BM77 into application mode. In application mode, pairing procedure is performed on the BM77 after establishing a Bluetooth connection for SPP or BLE data transfer.

Figure 1-3 and Figure 1-4 show the pin mapping for the PICtail Plus 30-pin interface and the PICtail 28-pin interface.

FIGURE 1-3: PIN MAPPING FOR THE PICtail™ PLUS 30-PIN INTERFACE

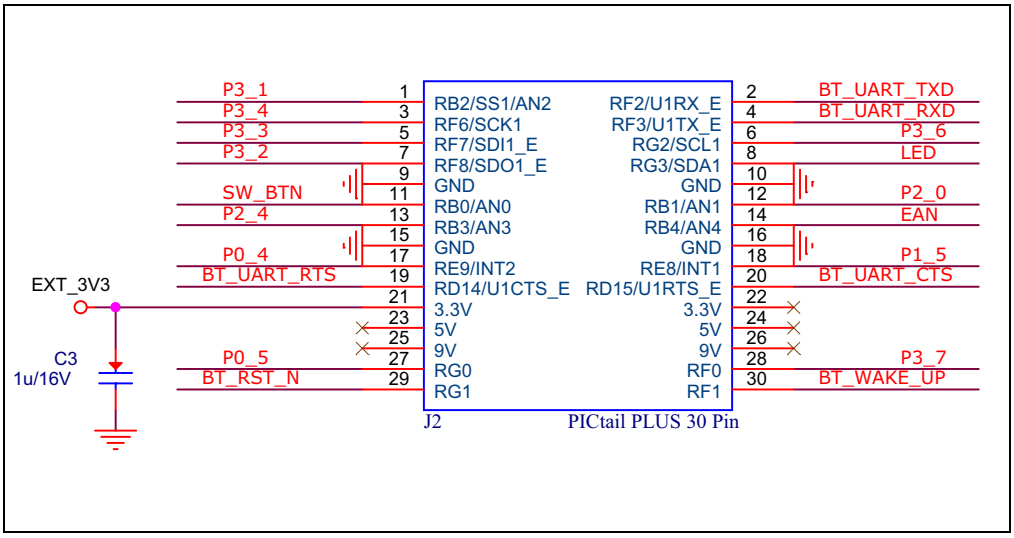
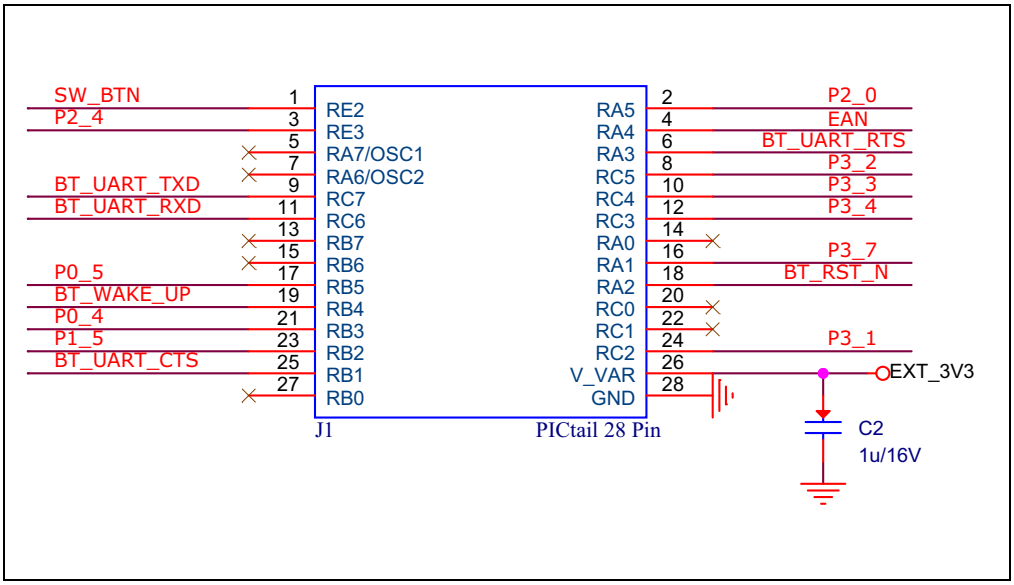


FIGURE 1-4: PIN MAPPING FOR THE PICtail™ 28-PIN INTERFACE



The BM77 PICtail Board can be inserted into the PICtail Plus/PICtail interface header on Microchip development tools as shown in Figure 1-5 and Figure 1-6.

Note: Ensure that the BM77 module on the board is facing the PIC PIM while inserting the BM77 PICtail Board into either of the PICtail headers.

FIGURE 1-5: BM77 PICtail™ BOARD INSERTED INTO PICtail PLUS INTERFACE

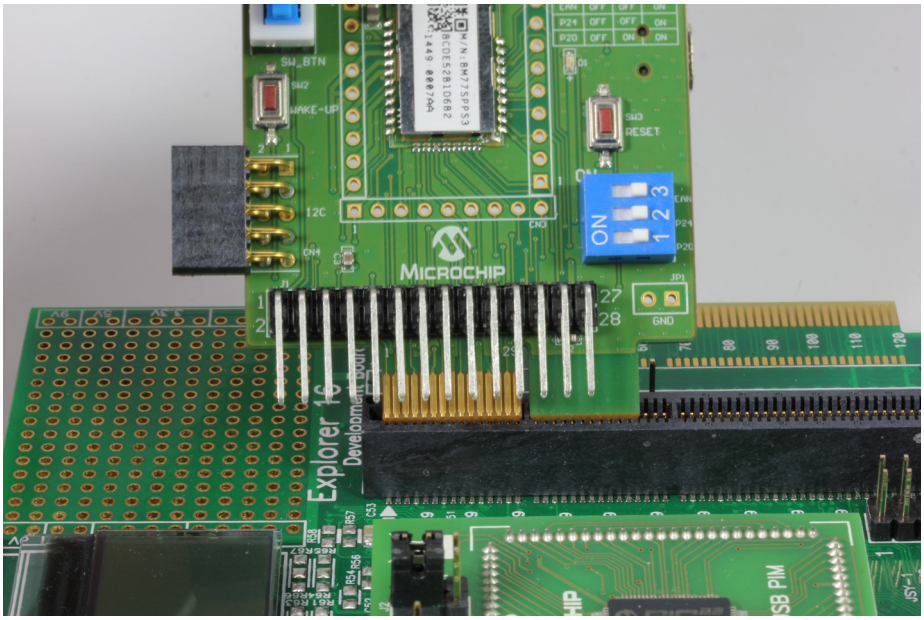
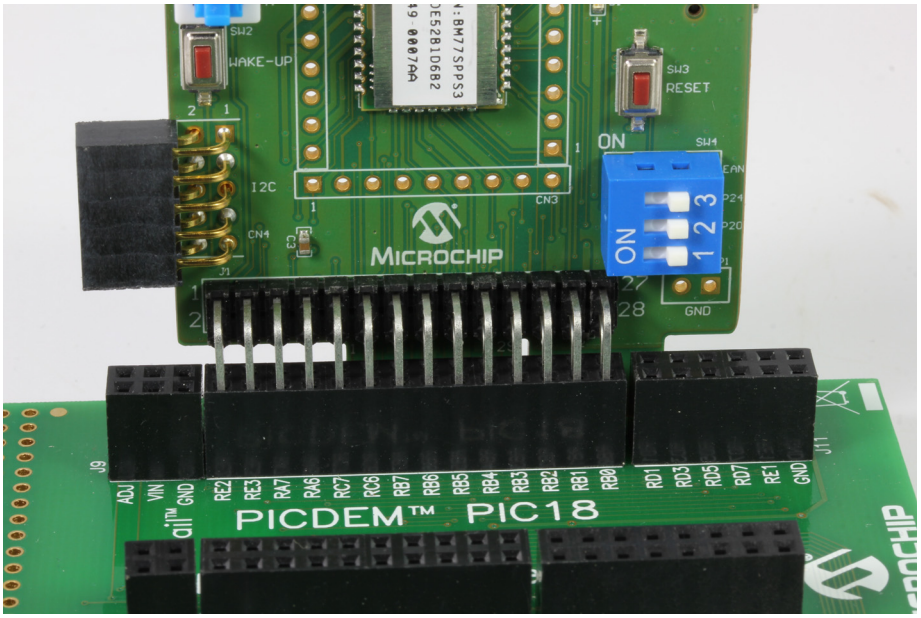


FIGURE 1-6: BM77 PICtail™ BOARD INSERTED INTO PICtail INTERFACE



Chapter 2. Getting Started

2.1 INTRODUCTION

This chapter describes how to establish Bluetooth® serial data connections using the BM77 PICtail™ Board over the USB-UART MCP2200 interface (P1). The purpose of the exercise is to demonstrate the basic data capabilities of the BM77 module, and its interoperability with other Bluetooth devices. Note that in all these demonstrations, the BM77 is a Bluetooth slave device, waiting for a connection initiated by the Bluetooth master device.

This chapter discussed the following topics:

- Hardware Requirements
- Software Requirements
- Using BM77 PICtail Board in USB-UART Serial Interface Mode
- Using BM77 PICtail Board in PICtail Interface Mode

2.2 HARDWARE REQUIREMENTS

The following hardware applications are required to demonstrate the BM77 PICtail:

- BM77 PICtail Board, (Part#BM77-PICtail) available for purchase on www.microchipdirect.com
- Bluetooth-enabled Smartphone or Tablet
  - Android™ device running Android 4.3 or later
  - iOS: iPhone® 4S or later, iPad®3 or later, must support Bluetooth Low Energy
- Windows® Host PC with USB port
- Bluetooth adapter supporting 2.0+EDR or later

2.3 SOFTWARE REQUIREMENTS

The following software applications are required to demonstrate the BM77 PICtail:

- Bluetooth (BT) Chat Tool, `BT Chat v004.exe` file available for download from www.microchip.com/bm-77-pictail under "PC ChatTool"
- Android BtChat APP, `BtChat_V1.0.3.apk` file available for download from www.microchip.com/bm-77-pictail under "BM77 Android App Demo"
- iOS Terminal "BLETR", available on Apple® AppStore (iOS)
- MCP2200 driver for Windows, available from www.microchip.com/MCP2200
- PC terminal emulator such TeraTerm or CoolTerm

2.4 USING BM77 PICtail BOARD IN USB-UART SERIAL INTERFACE MODE

This section discusses the following topics:

- how to exercise the BM77 module using the USB-UART serial interface on the BM77 PICtail Board,
- how to establish the Bluetooth Classic and Bluetooth Low Energy data connections,
- how to transfer data on the BM77 module through the USB-UART serial interface that is demonstrated via PC utility and Smartphone applications.

2.4.1 Bluetooth® SPP Connection to Android Smartphone/Tablet

In this demonstration, a Bluetooth SPP data connection is established between the BT Chat Tool and the Smartphone application via the BM77 PICtail Board. For the SPP demonstration, an Android 4.3 or later Smartphone or tablet is required.

As illustrated in Figure 2-1, the host PC runs a BT Chat Tool application, transferring serial data over a COM port (USB virtual COM port) to the BM77 PICtail Board. The serial data is transmitted over a Bluetooth connection to the remote Bluetooth device, which is the Android BT Chat APP.

FIGURE 2-1: BLUETOOTH® SPP CONNECTION TO SMARTPHONE

To establish a connection, perform the following steps:

1. Ensure that the BM77 PICtail Board is unplugged from the PICtail interface of a Microchip development board.
2. Verify that SW4 switches are set to application mode as specified in Table 1-2.
3. Ensure that SW1 button is in the ON position (pushed down).
4. Use a mini-B USB cable and connect the BM77 PICtail Board mini-B USB receptacle (P1) to a host PC USB port to power up the BM77 PICtail Board. Refer to Figure 2-2. The blue connection LED1 (D1) indicates the connection state as follows:

- **Stand-by** State - The LED1 on BM77 PICtail Board blinks once at a time
- **Pairing, Connected** State - The LED1 blinks twice at a time.

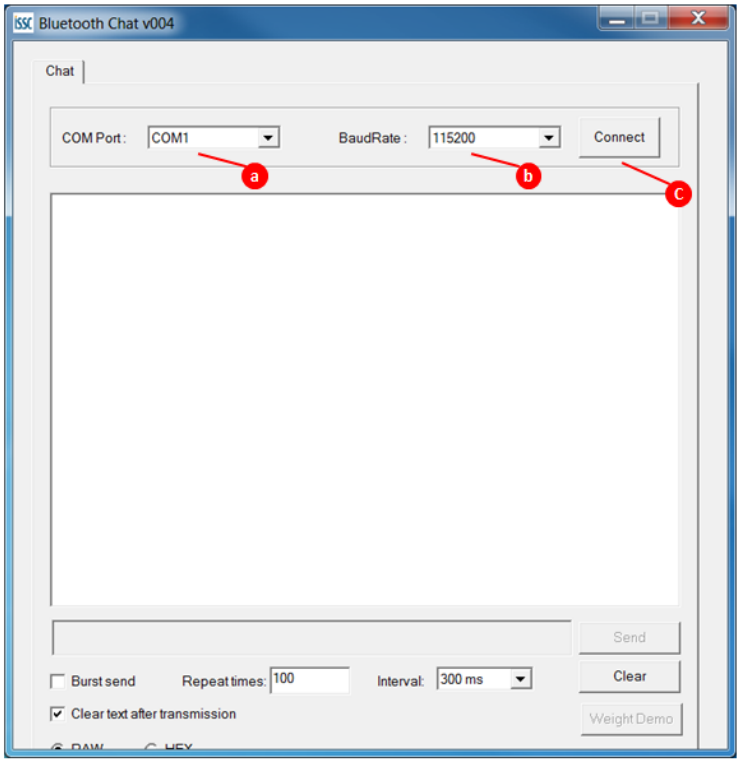
FIGURE 2-2: CONNECT THE BM77 PICtail™ BOARD TO A HOST PC USB PORT

5. Ensure that the Virtual COM port is created.

> **Note:** A virtual COM port must be created when the BM77 PICtail Board is connected to a PC. If a virtual COM port is *not* detected in the Device Manager port list, download and install the Microchip MCP2200 driver from www.microchip.com/MCP2200.

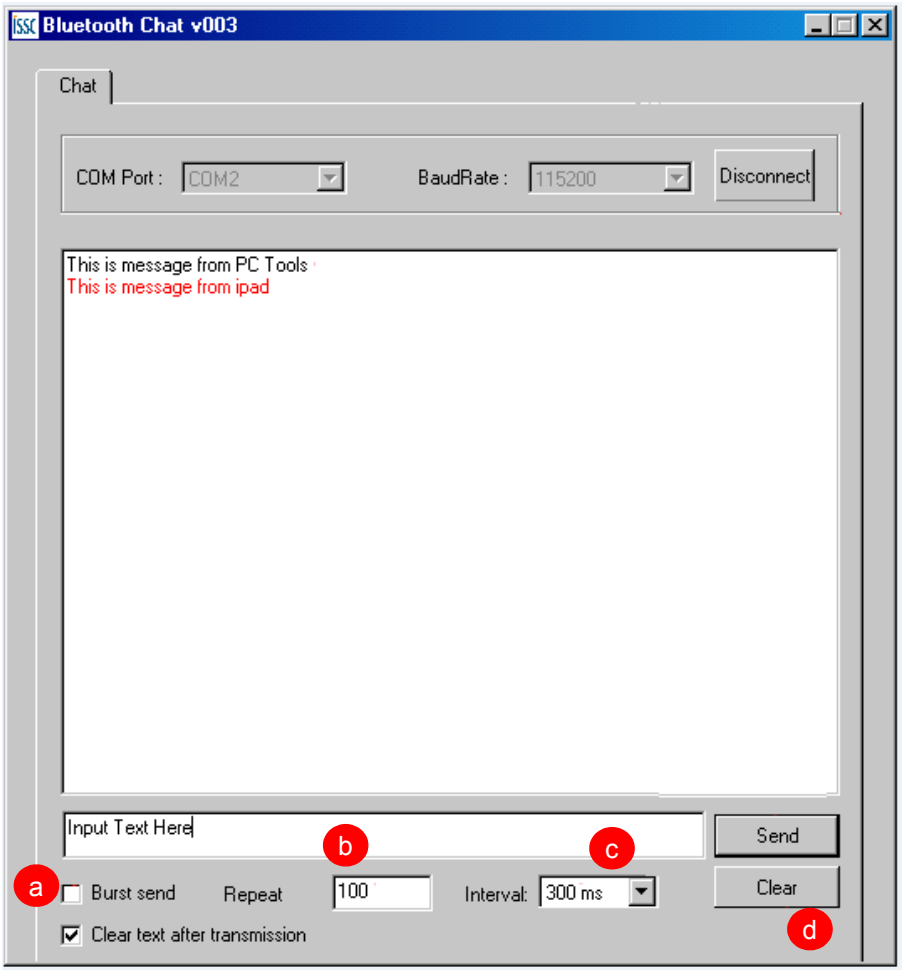
6. Run the `BT Chat v004.exe` file on the host PC and ensure that the COM Port is connected. The steps to connect to the COM Port are represented in Figure 2-3:
   a. Select the COM Port assigned to the BM77 PICtail Board
   b. Ensure that the default Baud Rate is 115200
   c. Click **Connect** button

FIGURE 2-3: CONNECT TO COM PORT



7. The **Connect** button changes into a **Disconnect** button once Step 6 is completed. Use the “Input” field to enter the characters to transmit. Click **Send** to transmit text to Smartphone over the BM77 PICtail Board Bluetooth connection. The BT Chat tool settings are represented in Figure 2-4:
   a. Select the “Burst send” check box to enable sending the text repeatedly from this tool.
   b. Input a value into the “Repeat” field to set the number of times allowed to resend the text.
   c. Select the desired value from the “Interval” drop-down list to set the time interval between two successive sent attempts.
   d. Press the **Clear** button to delete the text on the screen, if required.

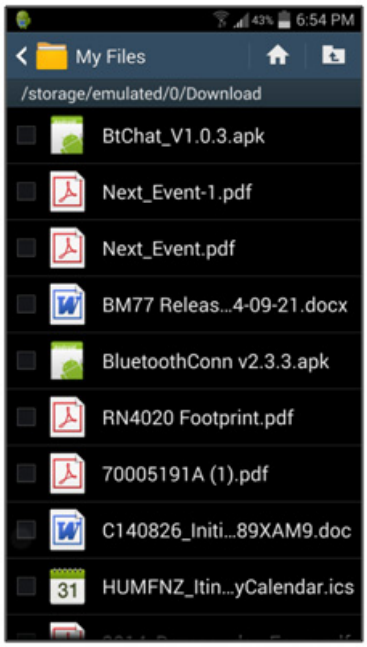
FIGURE 2-4: BT CHAT TOOL SETTING



Note: Black texts are sent from PC tool (BM77 PICtail Board) to Smartphone. Red texts are sent from Smartphone to the PC tool (BM77 PICtail Board).

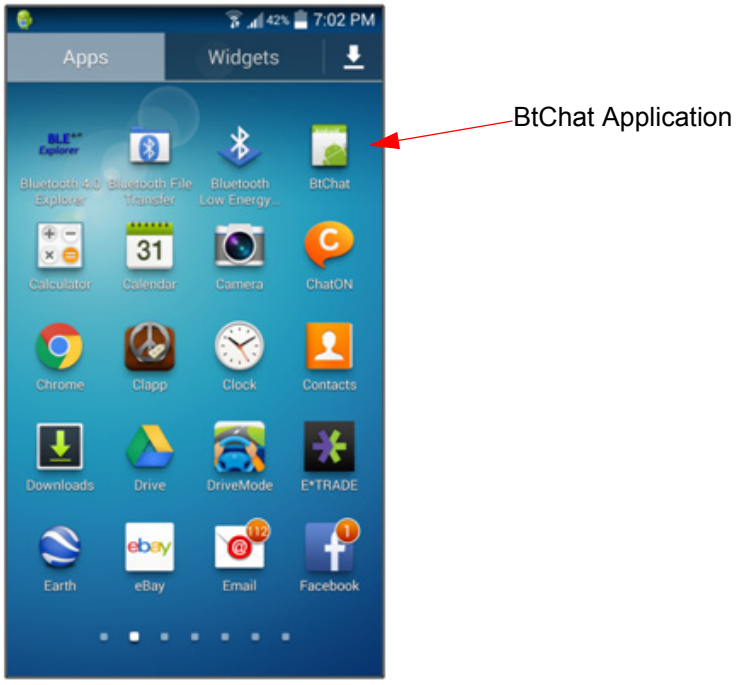
8. Install the Android Bluetooth Chat application into the Android device by copying or downloading the `BTChat_V1.0.3.apk` file. The `.apk` file can be copied into the Android device by using an SD Card to transfer the file, or by plugging Android device into the host PC where the Android device mounts as an external USB drive. Note that Android Media Transfer Protocol (MTP) is required on host. Once the `.apk` file is copied into the Android device, perform the following instructions:
   a. Select the downloaded file. Click to open file to install from Android File Manager "My Files" App. If necessary, enable the "Unknown Sources" from the Device Security settings of the phone to allow the installation. Refer to Figure 2-5.

FIGURE 2-5: INSTALL THE ANDROID BLUETOOTH CHAT APPLICATION



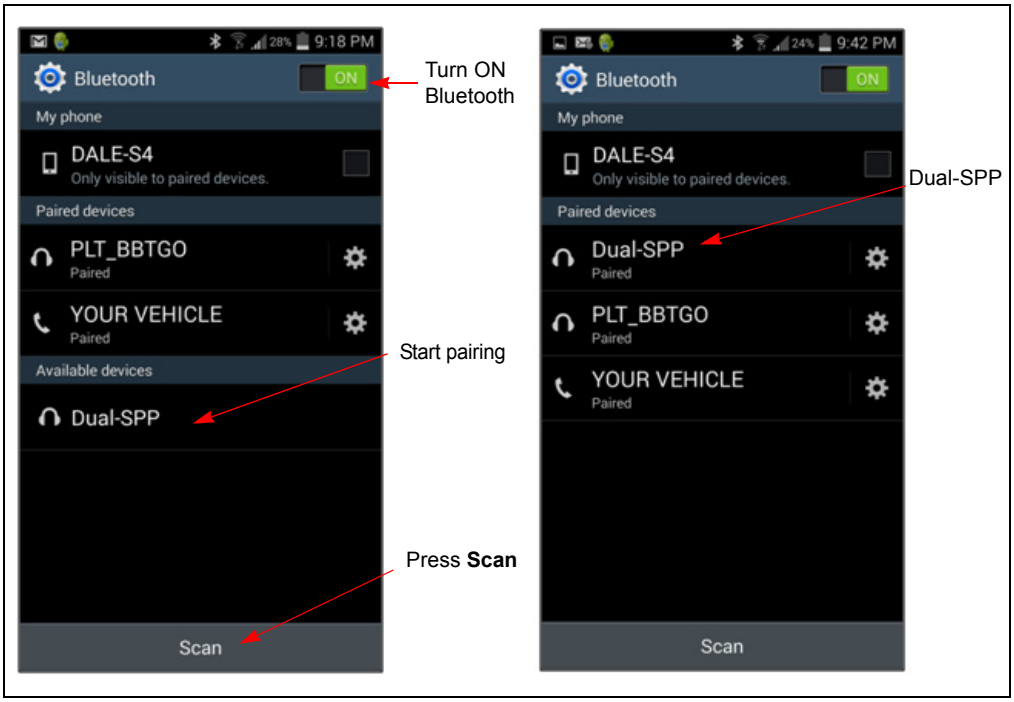
b. The BtChat APP displays in Application view after successful installation. Refer to Figure 2-6.

FIGURE 2-6: BTCHAT APP ON ANDROID



9. To pair the BM77 PICtail Board with the Android Device, open the *Settings > Bluetooth* page on the Android device and then set to **ON** to turn ON Bluetooth as shown in the left image of Figure 2-7. Press **Scan** to initiate the Bluetooth Device scan, find the BM77 PICtail Board device named Dual-SPP and then select to start the pairing process. Once paired, the Dual-SPP (BM77 PICtail Board) device is listed in the paired device list as shown in the right image of Figure 2-7.

FIGURE 2-7: PAIR BM77 PICtail™ BOARD WITH THE ANDROID DEVICE

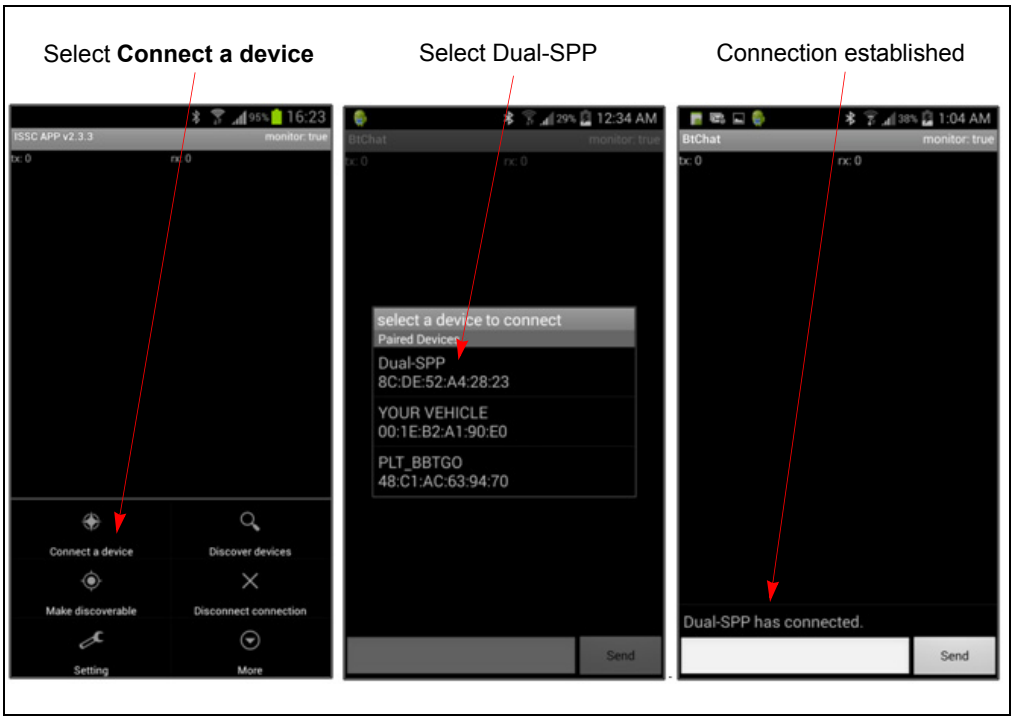


10. Launch the BtChat APP on the Android Device to display the BtChat APP main window. To open BtChat menu options, use the menu button of the phone. Select the **Setting** button to open the APP setting view. To show the received text in the APP, select the "Show Rx Text" check box. Press the **Back** button of the phone to return to the main window. Refer to Figure 2-8.

FIGURE 2-8: SET BTCHAT APP

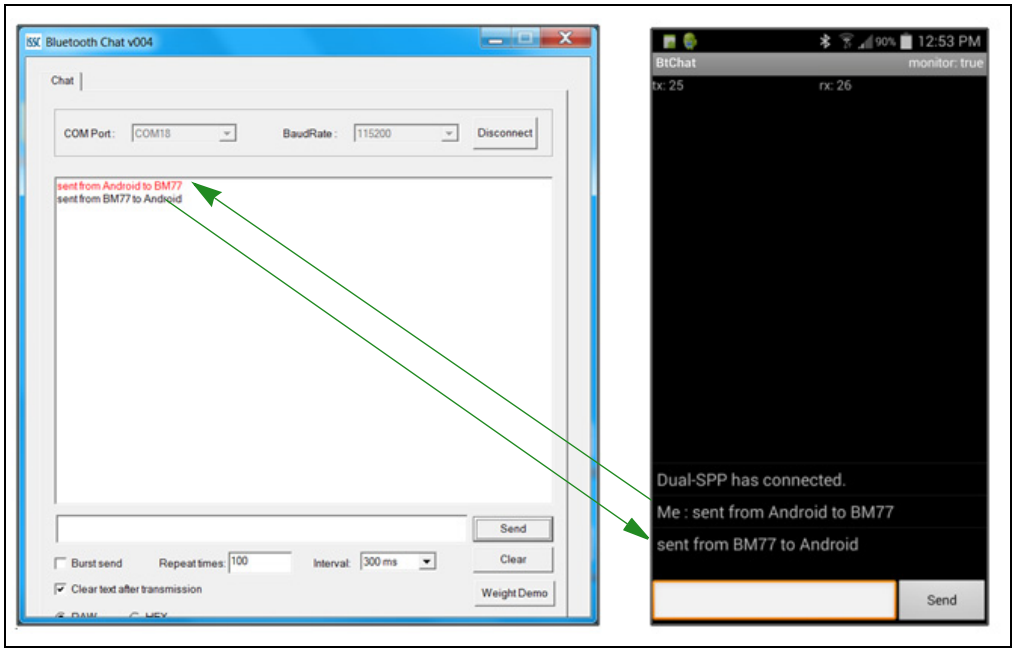
11. To set up a Bluetooth SPP connection to the BM77 PICtail device, go to the BtChat APP main window, press the menu button of the phone to open the BtChat menu options and then select the **Connect a device** button to open the paired device list. Select the Dual-SPP device to open the SPP connection to the BM77 PICtail Board. A status message displays in the main window when a connection is established. Refer to Figure 2-9.

FIGURE 2-9: SET UP THE BLUETOOTH SPP CONNECTION



12. To transfer data from the BM77 to the Android Device via Bluetooth SPP connection, launch the BT Chat Tool on the host PC and set the correct COM port corresponding to the BM77 PICtail Board as described in Figure 2-3.
    a. Enter text into Android BtChat APP to send it to the BT Chat Tool on the PC. Click **Send** to transmit the text entered to BM77 that is connected to the BT Chat Tool. Text received on the BT Chat Tool window displays in red.
    b. Enter text into the BT Chat Tool to send it to the BM77 PICtail Board. Click **Send** to transmit text to the Android BtChat APP. Text is received in Android BtChat APP. Refer to Figure 2-10.

FIGURE 2-10: DATA TRANSFER FROM BM77 TO ANDROID DEVICE

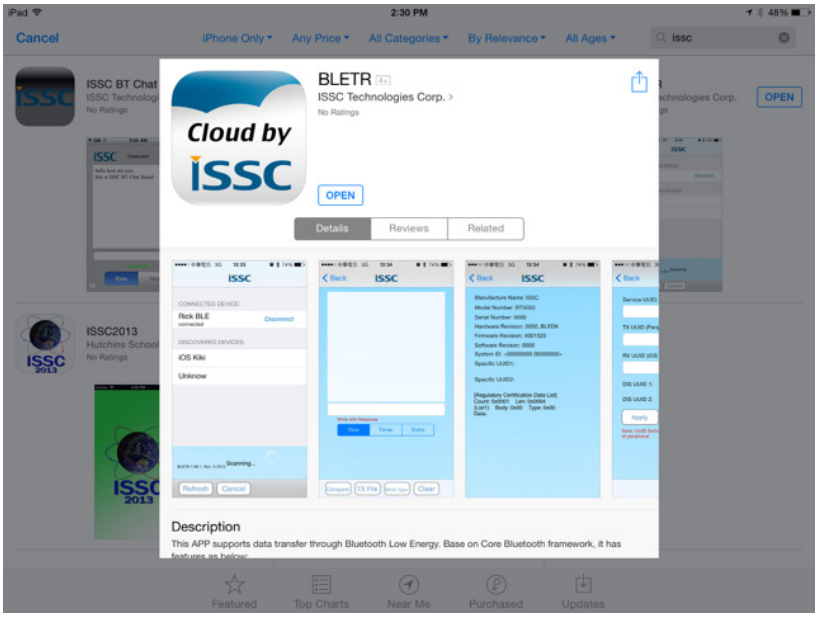


2.4.2 Bluetooth Low Energy Data Connection to iOS Device

This demonstration shows how serial data is transmitted from the BM77 PICtail Board (via PC Chat) to an iOS device using Bluetooth Low Energy (BLE) connection. This demonstration uses ISSC BLETR APP to establish connection with the BM77 PICtail Board. BLETR can be downloaded from APP Store and ensure to disable the "iPad only" filter as this is an iPhone APP. A key feature of the BM77 module is the transparent serial data connection from BM77 UART to an iOS device over Bluetooth Low Energy connection.

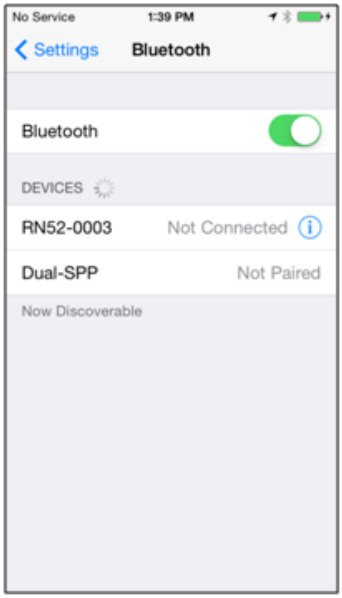
1. Download and install "ISSC BLETR" APP from Apple AppStore (iOS) using an iPhone 4S or later, iPad3 or later devices. Refer to Figure 2-11.

FIGURE 2-11: ISSC BLETR APP



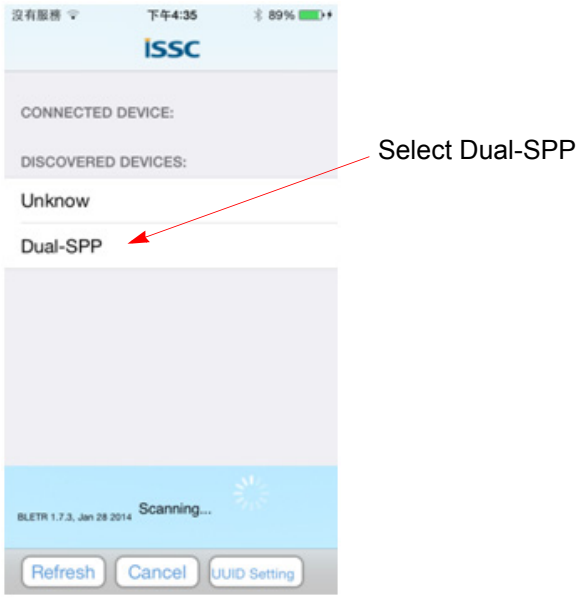
2. Go to *Settings > General > Bluetooth* Page. Turn ON the **Bluetooth**. Refer to Figure 2-12.

FIGURE 2-12: TURN ON BLUETOOTH



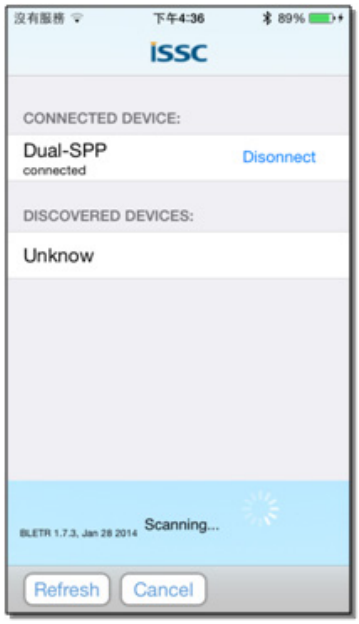
3. Launch the ISSC BLETR APP to scan for the Bluetooth Low Energy (BTLE) peripheral devices. If the device is not displaying on the list, press the **Refresh** or **Scan** button to restart the BTLE peripheral scan. Find the Dual-SPP device and then select to start a connection to the BM77 PICtail Board. Refer to Figure 2-13.

FIGURE 2-13: SCAN FOR BTLE DEVICES



4. BLETR displays the status of the Dual-SPP device as connected after a successful connection. Refer to Figure 2-14.

FIGURE 2-14: DUAL-SPP CONNECTED



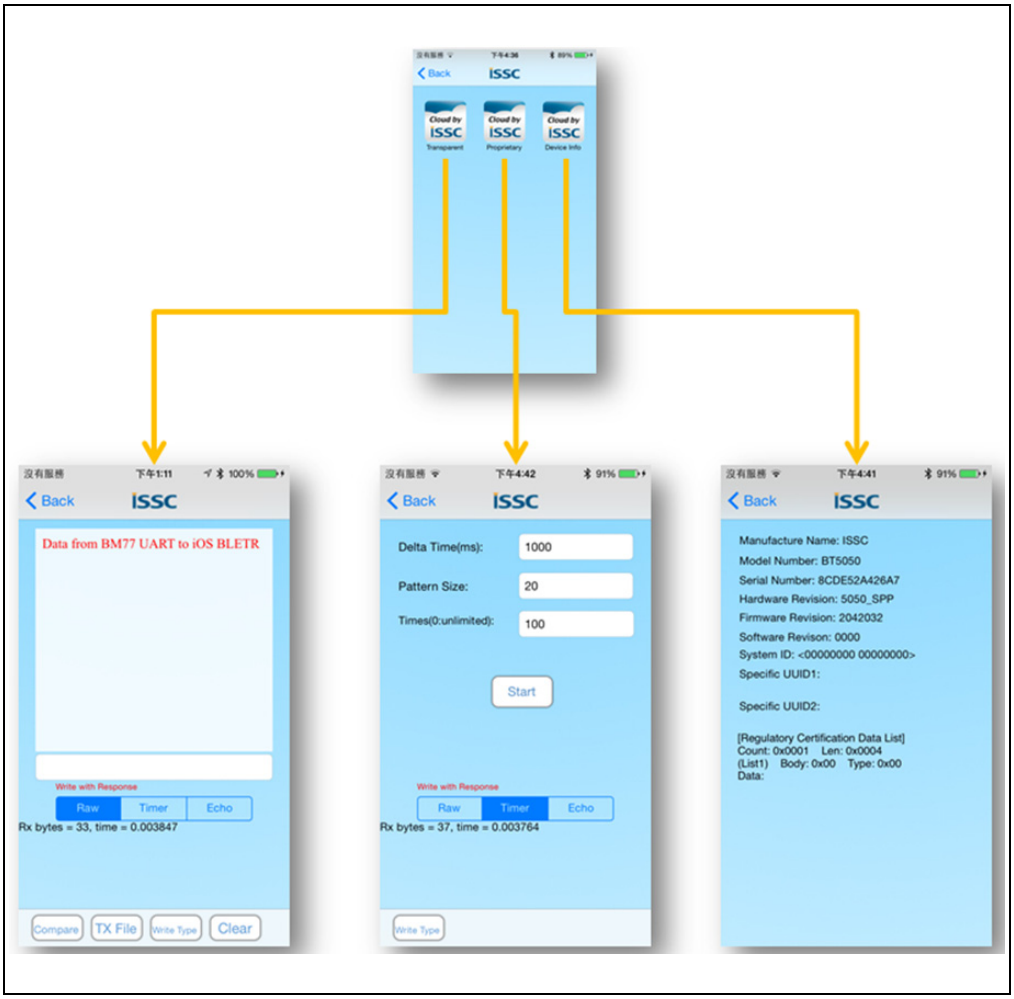
5. Select the connected Dual-SPP device to display the top level view. Refer to Figure 2-15.

The top level view displays the following three options when connected to a BM77 PICtail Board as shown in Figure 2-16:

- **Transparent** - This view enables to display the received data, send data, and activate features.
- **Proprietary** - This view sets the Bluetooth Low Energy connection parameters.
- **Device Info** - This view displays the settings for Bluetooth Low Energy Device Information Service.

FIGURE 2-15: ISSC BLETR APP TOP LEVEL VIEW

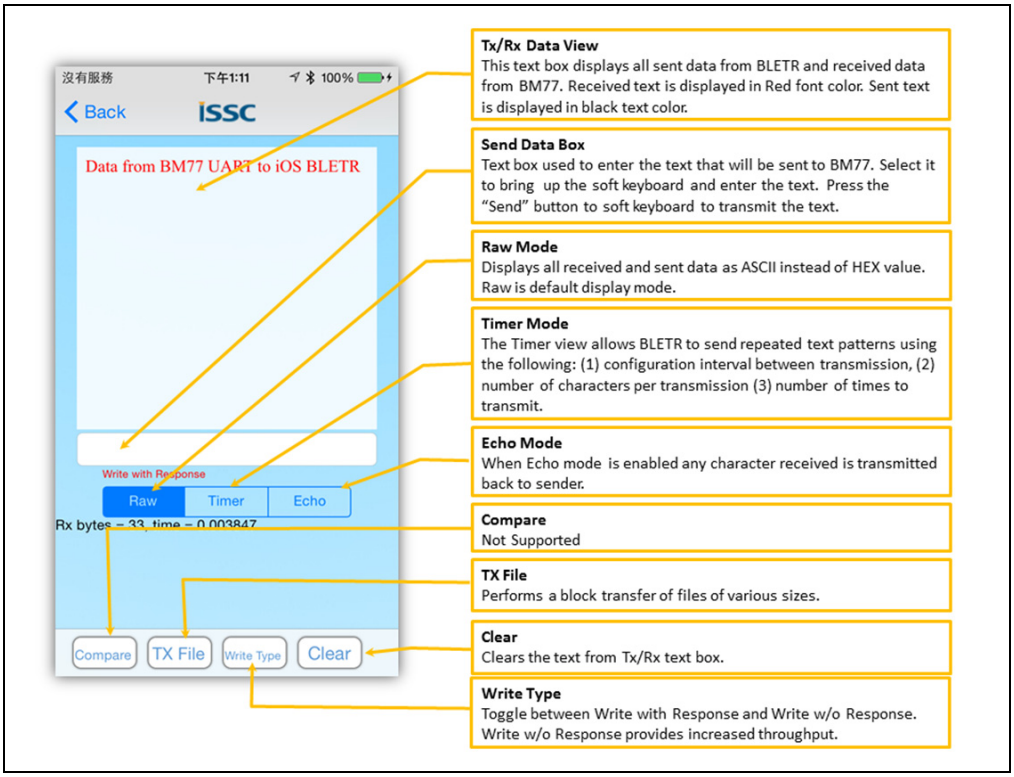
FIGURE 2-16: ISSC BLETR APP OPTIONS



2.4.2.1 TRANSPARENT DATA VIEW

The Transparent data view enables to display received data, send data, and activate features. Selecting **Transparent** button opens the transparent serial data view as shown in Figure 2-17. The default mode is Raw mode (ASCII) where the received data characters displays in red font in the large text box.

FIGURE 2-17: DATA MODE TRANSFER

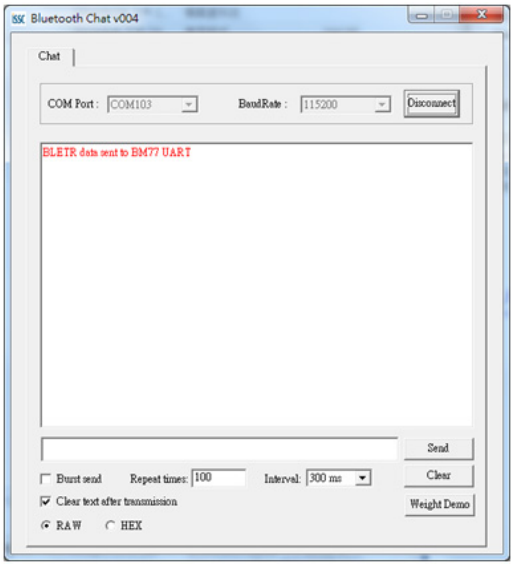


Select the input text box to send data from BLETR iOS device to the BM77. The soft keyboard displays that enables the user to enter text in the input text box. Click **Send** to transmit text to the BM77 over BLE connection. Refer to Figure 2-18.

FIGURE 2-18: SOFT KEYBOARD

The text is received via the BM77 UART after clicking **Send** and displays in the BT Chat Tool window on the PC as shown in Figure 2-19.

FIGURE 2-19: TEXT RECEIVED VIA THE BM77 UART

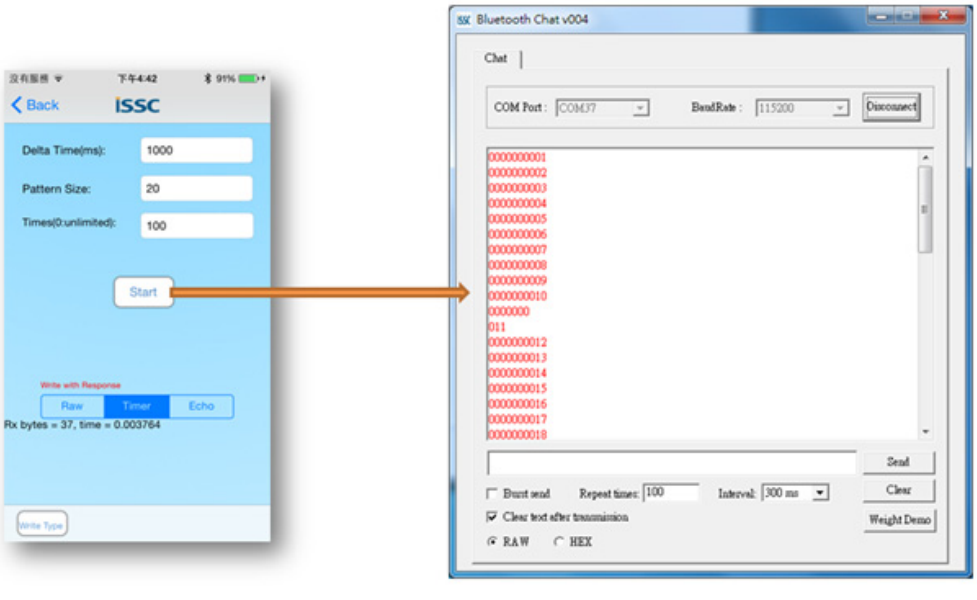


Timer Feature

In addition to the Raw mode (ASCII), the Transparent data view also includes the Timer and Echo features, refer to Figure 2-17. The Timer feature enables the BLETR to send a repeated test pattern to BT Chat Tool for throughput and data transfer test. Figure 2-20 shows an example of the Timer test feature.

BLETR is configured to transmit a 100 test blocks of 20 characters in every 1000 ms. BT Chat Tool on PC receives the test pattern data and displays it in red text. The line break indicates a Bluetooth Low Energy packet break, which means that a transmitted test block is fragmented into multiple BLE packets. Clicking the **Start** button initiates the data transfer.

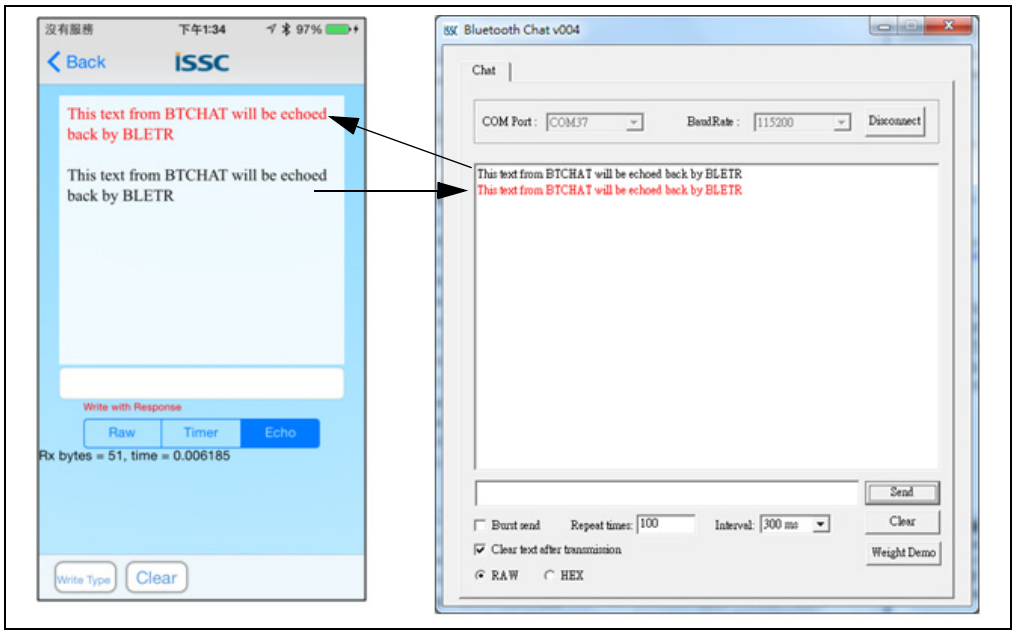
FIGURE 2-20: TIMER TEST FEATURE



Echo Feature

The Echo feature is an optional function for the Transparent data view. If Echo is enabled, any data received by BLETR is echoed back to the sender. Figure 2-21 shows text sent from BT Chat Tool (PC) being echoed to BLETR when the Echo mode is enabled.

FIGURE 2-21: ECHO FEATURE



TX File Feature

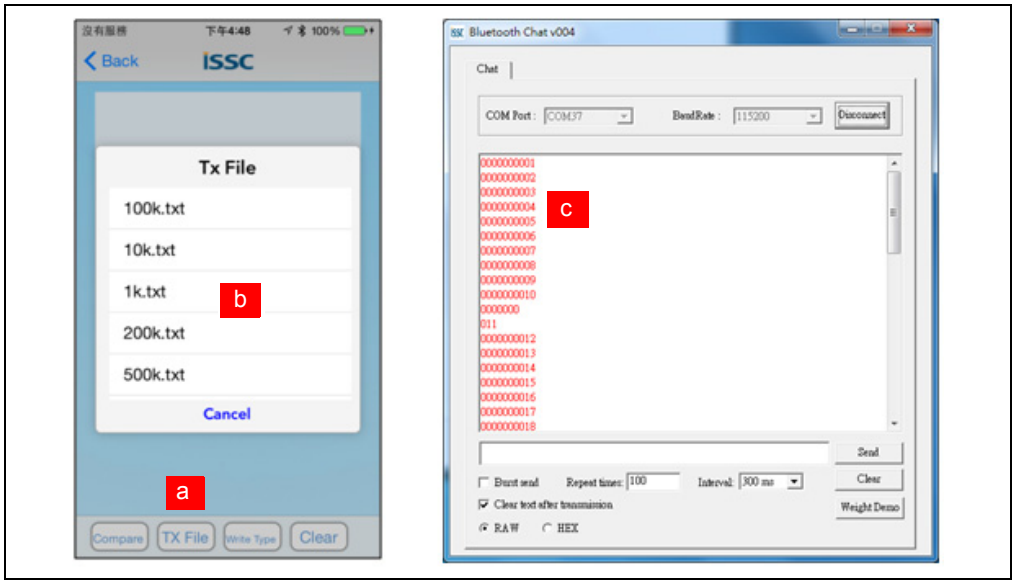
Another test feature similar to the Timer feature is the TX File transfer. The TX File function transfers files that is embedded in the BLETR APP to the BM77. The steps to use this feature are represented in Figure 2-22:

a. Click the **TX File** button to open a dialog box with the list of file sizes to transmit.

b. Select the file size to send.

c. Observe the file received on BT Chat Tool.

FIGURE 2-22: TX FILE FEATURE



2.4.2.2 PROPRIETARY DATA VIEW

The Proprietary data view demonstrates the capability to remotely change the Bluetooth Low Energy connection parameters via BLETR application. These parameters only affect Bluetooth Low Energy connections.

- **Max Interval** - communication time interval (ms) between BM77 and BLE Central device.
- **Connection Timeout** - determines the timeout (ms) between data exchanges before a connection is considered lost without risking disconnection.
- **Latency** - number of peripheral (BM77) connection events allowed to be skipped.
- BLE name used to advertise Peripheral name to scan Central devices. To change device name, type new name in the text box and click **Change Name** to apply the change. Refer to Figure 2-23.

FIGURE 2-23: CHANGE DEVICE NAME

2.4.2.3 DEVICE INFORMATION VIEW

The Device Information view displays the characteristics associated with Device Information service. The Device Information service is available to all Bluetooth 4.0 Low Energy hosts that access the BM77 PICtail Board. It provides the identification information about the BM77 BLE peripheral device. Refer to Figure 2-24.

FIGURE 2-24: DEVICE INFORMATION

2.5 USING BM77 PICtail BOARD IN PICtail INTERFACE MODE

This section provides an overview of tools that are used to configure the BM77 module on the BM77 PICtail/PICtail Plus Board using a PIC MCU through the PICtail interface. The BM77 Configuration UI Tool or BM77 UI Tool is used to edit the Bluetooth parameters stored in the EEPROM configuration file.

The BM77 EEPROM Table Utility as described in **Section 2.5.2 "BM77 EEPROM Table Utility"** is used to convert the EEPROM configuration file into an EEPROM structure file, which can be read by the PIC library running PIC MCU. The EEPROM structure file can be imported by the BM77 Configuration Library demo workspace to program the Bluetooth parameters into the BM77 module through the PICtail interface over UART.

2.5.1 BM77 Configuration User Interface (UI) Tool

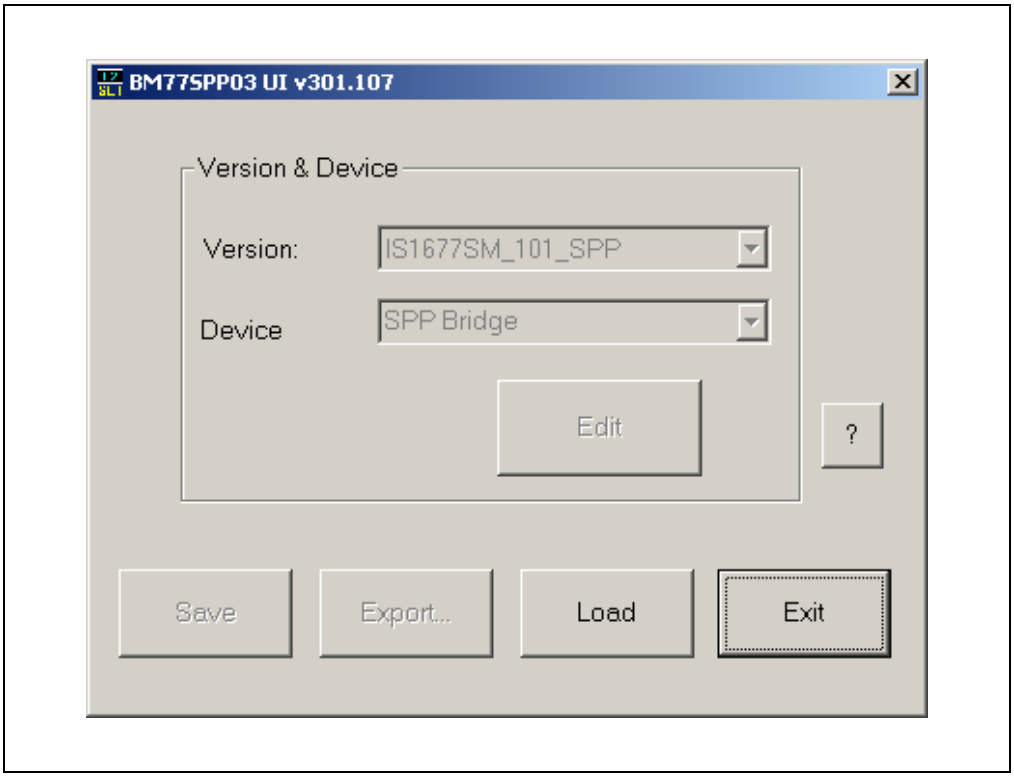
BM77 module provides the ability to update and configure various Bluetooth configuration parameters. The BM77 UI Tool is an easy-to-use PC application enabling the user to update the various Bluetooth parameters available that are saved into the EEPROM configuration file. The Bluetooth parameters saved in the EEPROM configuration file can be downloaded into the BM77 module using the BM77 Configuration Library as described in **Section 2.5.3 "BM77 Configuration Library"**.

Note:	The tools and utilities can be downloaded from the BM77 PICtail web page at www.microchip.com.

To configure the BM77 UI Tool, perform the following steps:

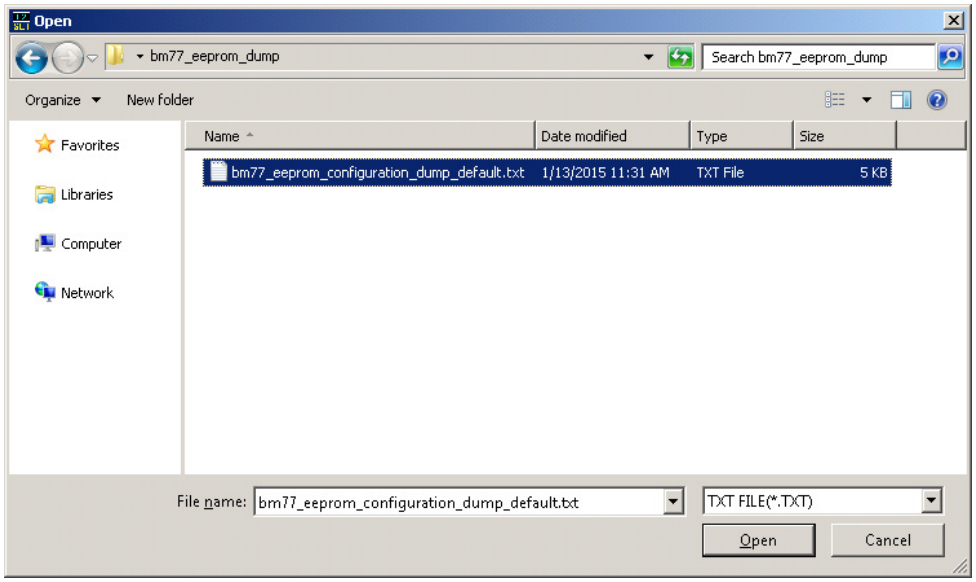
1. Download the BM77 UI Tool into a Windows PC and run the application.
2. Click **Load** button to import the default EEPROM configuration file `bm77_eeprom_configuration_dump_default.txt` provided with the application. Refer to Figure 2-25.

FIGURE 2-25: BM77 UI TOOL



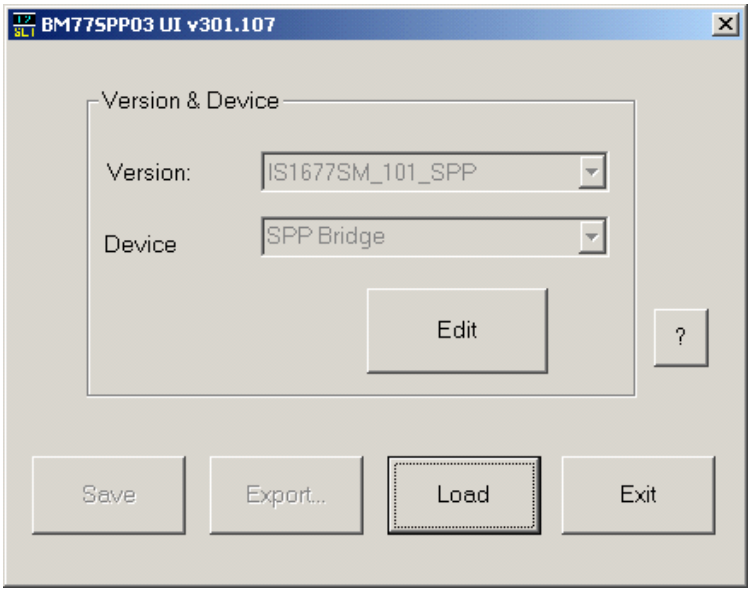
3. Browse to import the default EEPROM configuration file and click **Open** button. Refer to Figure 2-26.

FIGURE 2-26: OPEN EEPROM CONFIGURATION FILE



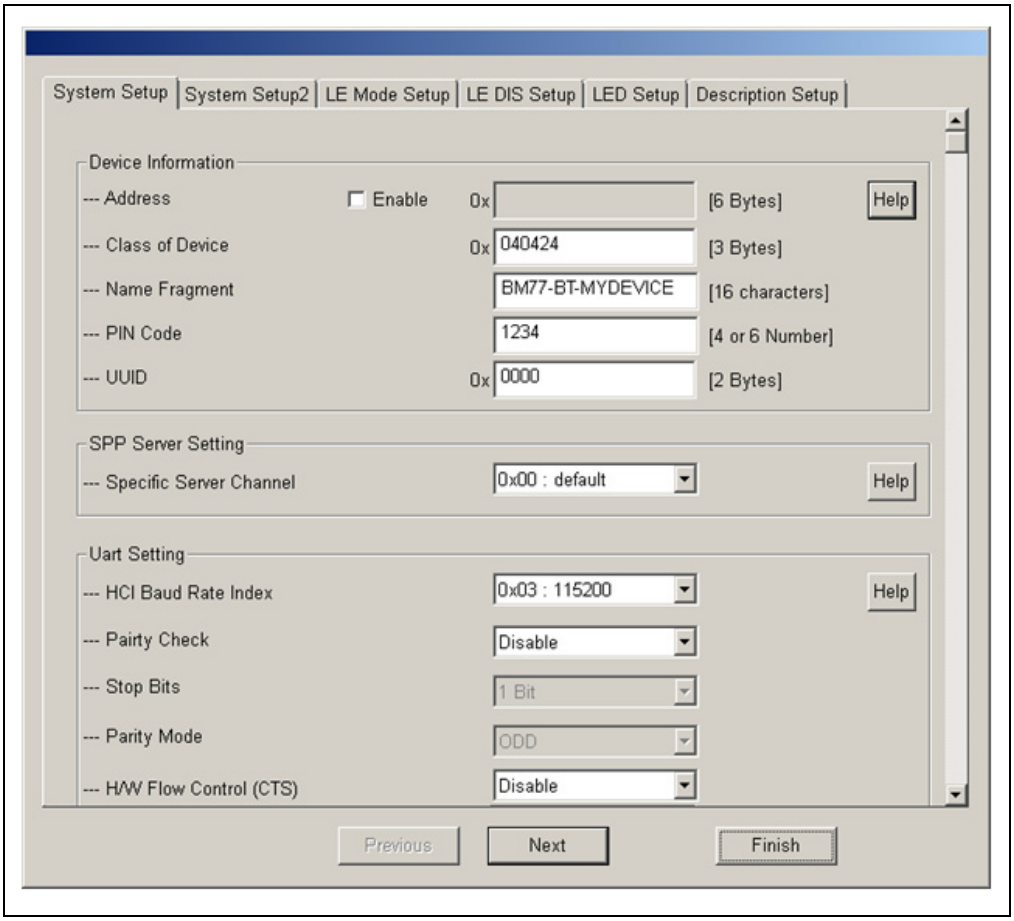
4. Click **Edit** button after the default EEPROM configuration file is imported into the BM77 UI Tool. Refer to Figure 2-27.

FIGURE 2-27: EDIT BM77 UI TOOL



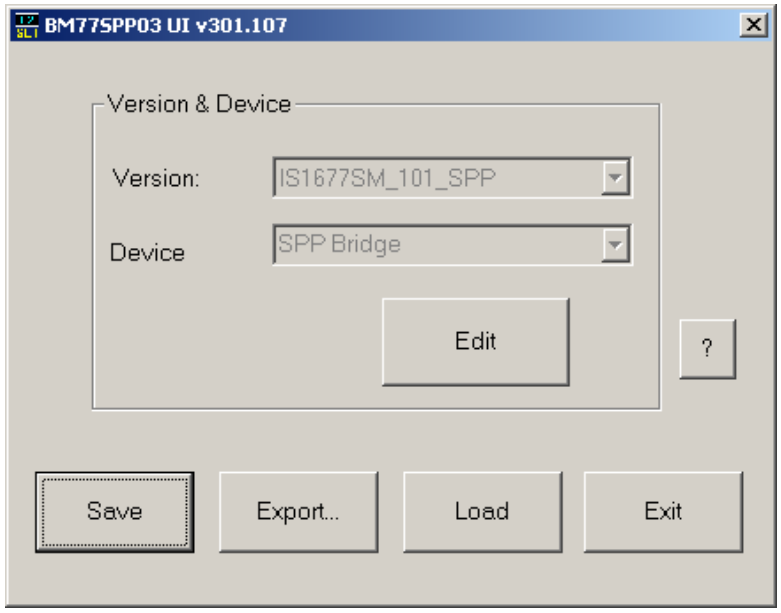
5. The BM77 UI Tool opens the Bluetooth configuration window with various tabs to configure various available parameters as shown in Figure 2-28. To configure the Bluetooth parameters desired for the specific application, click **Help** button for each parameter. If the configuration is completed, click **Finish** button.

FIGURE 2-28: BLUETOOTH CONFIGURATION WINDOW



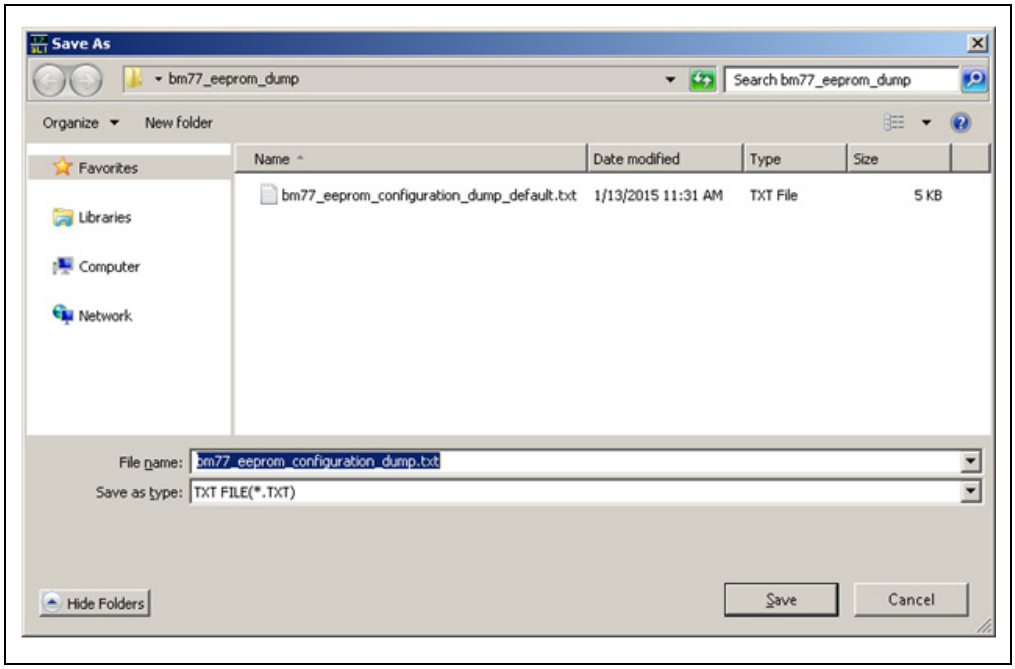
6. Click **Save** button to save the updated EEPROM configuration file. Refer to Figure 2-29.

FIGURE 2-29: SAVE EEPROM CONFIGURATION FILE



The new EEPROM configuration file is different from the default EEPROM configuration file due to the updates on the Bluetooth parameters using the BM77 UI Tool. Refer to Figure 2-30.

FIGURE 2-30: UPDATED EEPROM CONFIGURATION FILE



2.5.2 BM77 EEPROM Table Utility

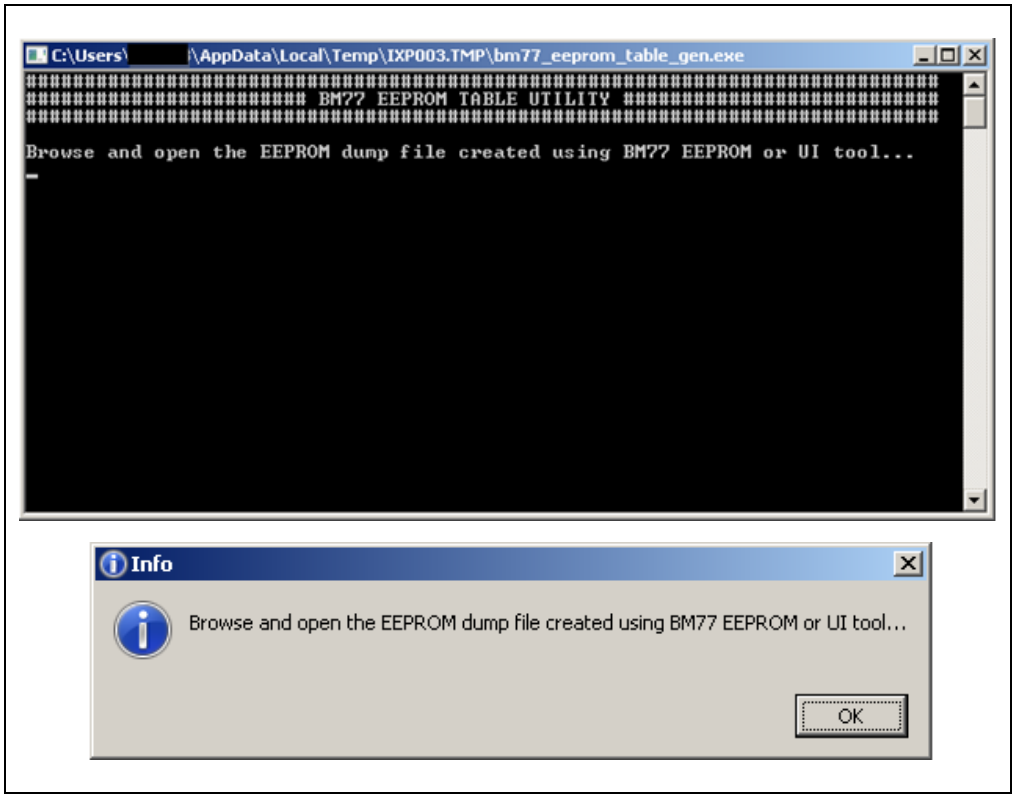
The BM77 EEPROM Table Utility is used to create a file with an EEPROM table structure from the EEPROM configuration file that is created by the BM77 Configuration User Interface (UI) Tool. For more information on the BM77 tool, refer to **Section 2.5.1 "BM77 Configuration User Interface (UI) Tool"**.

The EEPROM table structure file can be imported into BM77 Configuration Library MPLAB workspace. Using this EEPROM table file, all EEPROM parameters on the BM77 can be updated.

To install the BM77 EEPROM Table Utility, use the BM77 Configuration Library Installer:

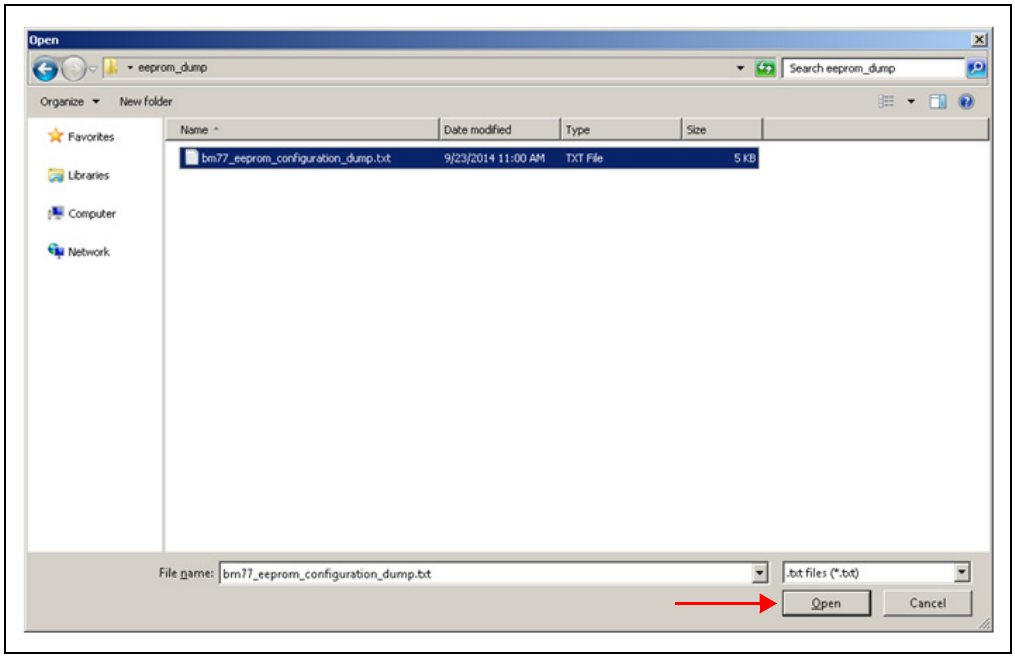
1. Execute the `bm77_eeprom_table_utility.exe` in the bm77_eeprom_table_utility directory.
2. Browse and open the EEPROM configuration file created in **Section 2.5.1 "BM77 Configuration User Interface (UI) Tool"**. Click **OK** button on the message dialog box.The message displays on the command window as shown in Figure 2-31.

FIGURE 2-31: OPEN THE EEPROM FILE



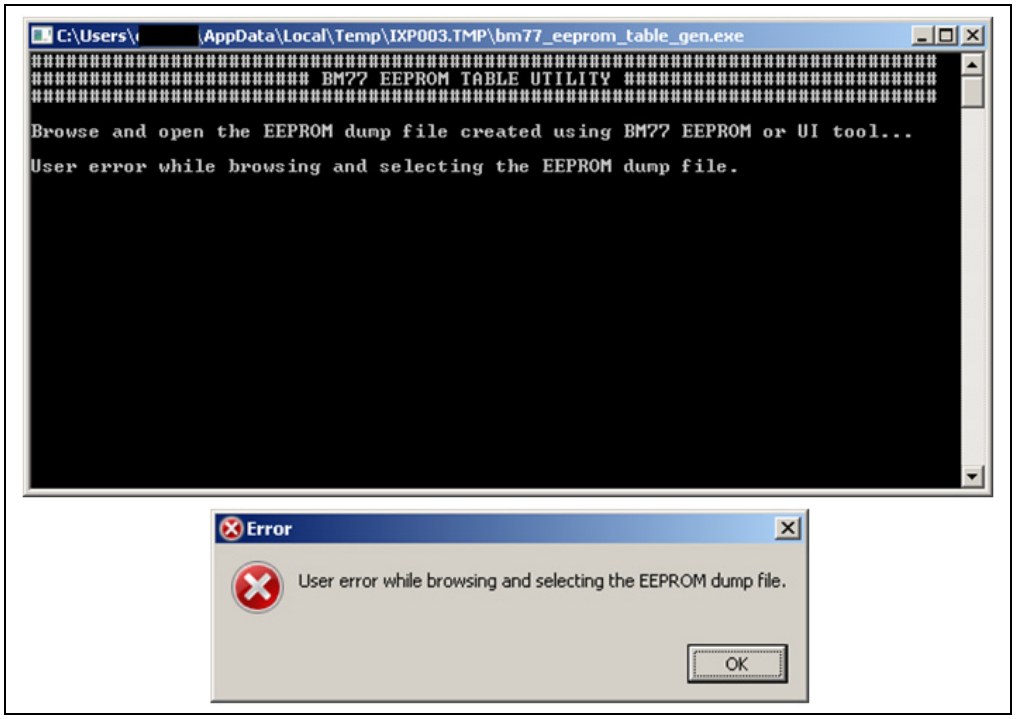
3. A File Browser dialog box opens for the user to browse. Click **Open** button to open the EEPROM configuration file as shown in Figure 2-32.

FIGURE 2-32: FILE BROWSER DIALOG BOX



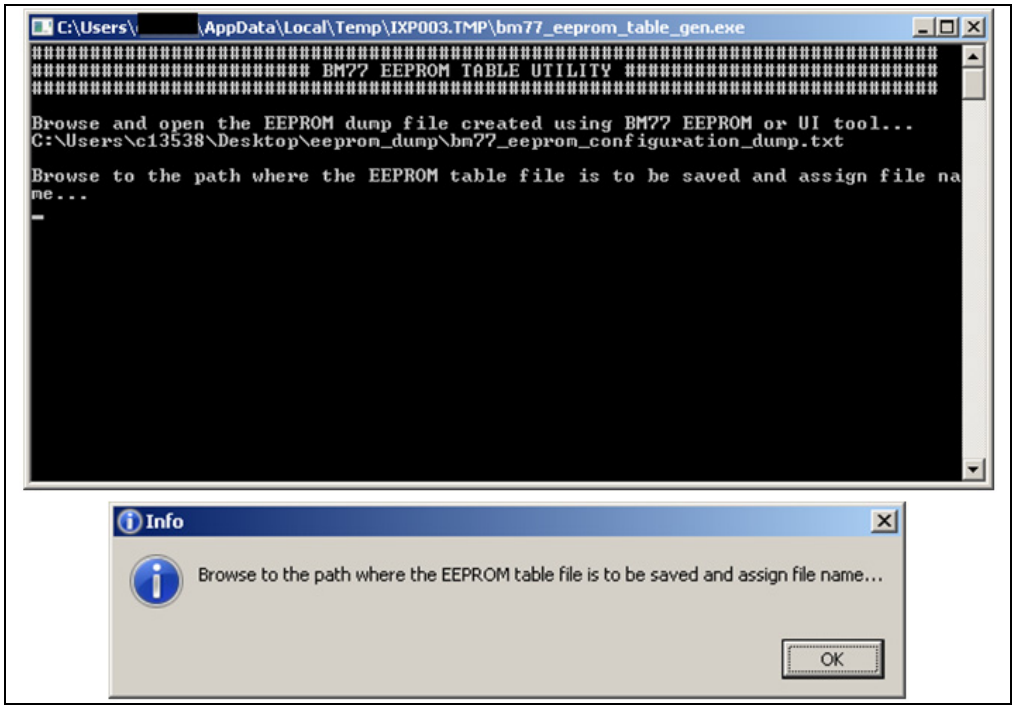
4. In Step 2, if the user clicks the **Cancel** button and does not browse and open the EEPROM dump file, an error is displays on the command window. A message dialog box opens to indicate the error. Click **OK** button on the message dialog box to close the application and restart if desired. Refer to Figure 2-33.

FIGURE 2-33: ERROR MESSAGE - OPENING THE EEPROM FILE



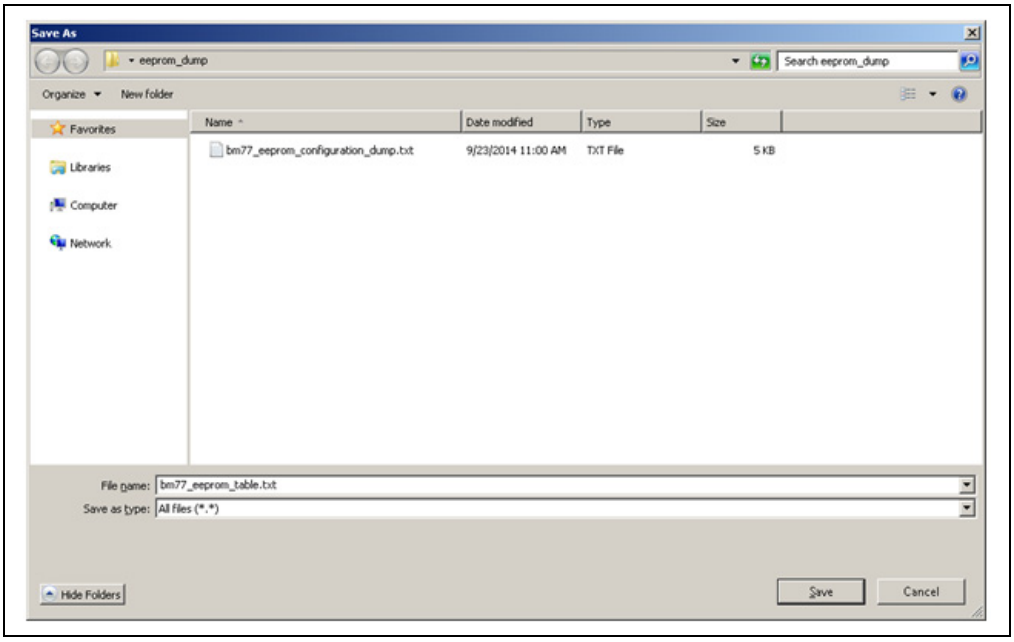
5. Browse, assign a name, and then save the EEPROM table file to be used by the BM77 Configuration Library. Click **OK** button on the message dialog box. Refer to Figure 2-34.

FIGURE 2-34: BROWSE, ASSIGN FILE NAME AND SAVE FILE



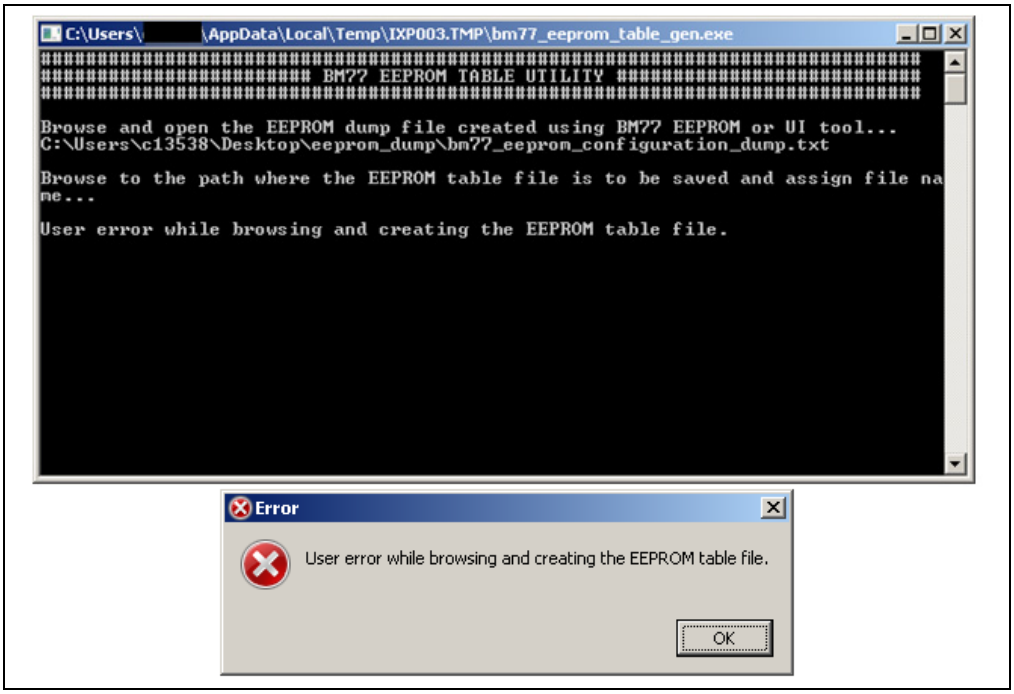
6. A File Browser dialog box opens for the user to browse, assign a name and save the EEPROM table file to be used by the BM77 Configuration Library. Type in a file name and click **Save** button to save the EEPROM table file. Refer to Figure 2-35. The file path is indicated on the command window and the application proceeds to the next step.

FIGURE 2-35: FILE BROWSER DIALOG BOX TO BROWSE AND SAVE THE EEPROM TABLE FILE



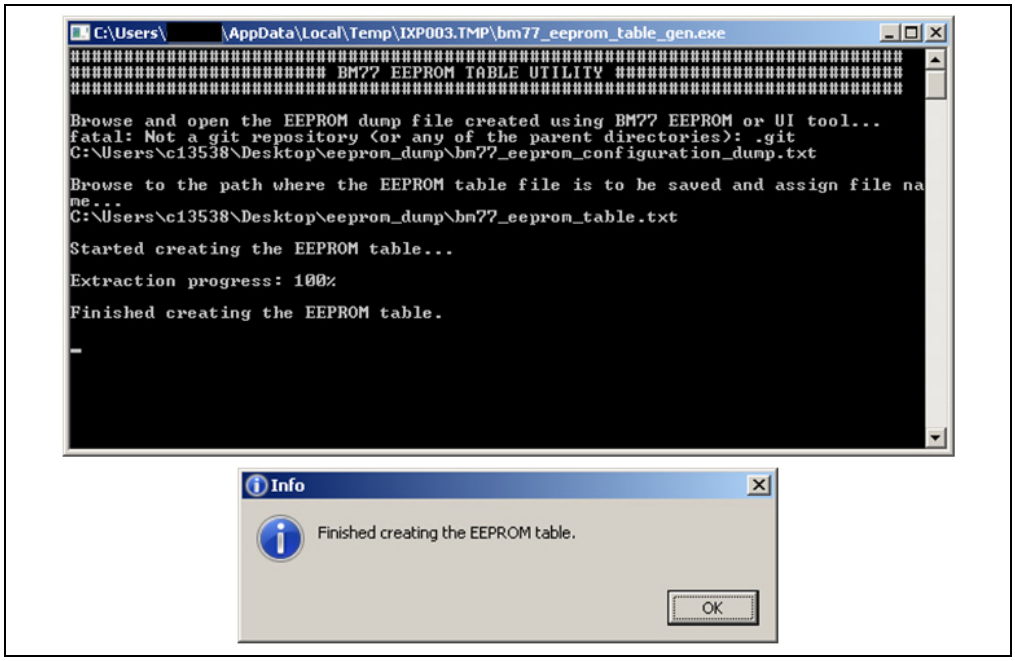
If the user chooses to click **Cancel** button and not to browse and open the EEPROM file, an error message displays on the command window. A message dialog box opens to indicate the error. Refer to Figure 2-36. Click **OK** button on the message dialog box to close the application and restart if desired.

FIGURE 2-36: ERROR MESSAGE - SAVING THE EEPROM TABLE FILE



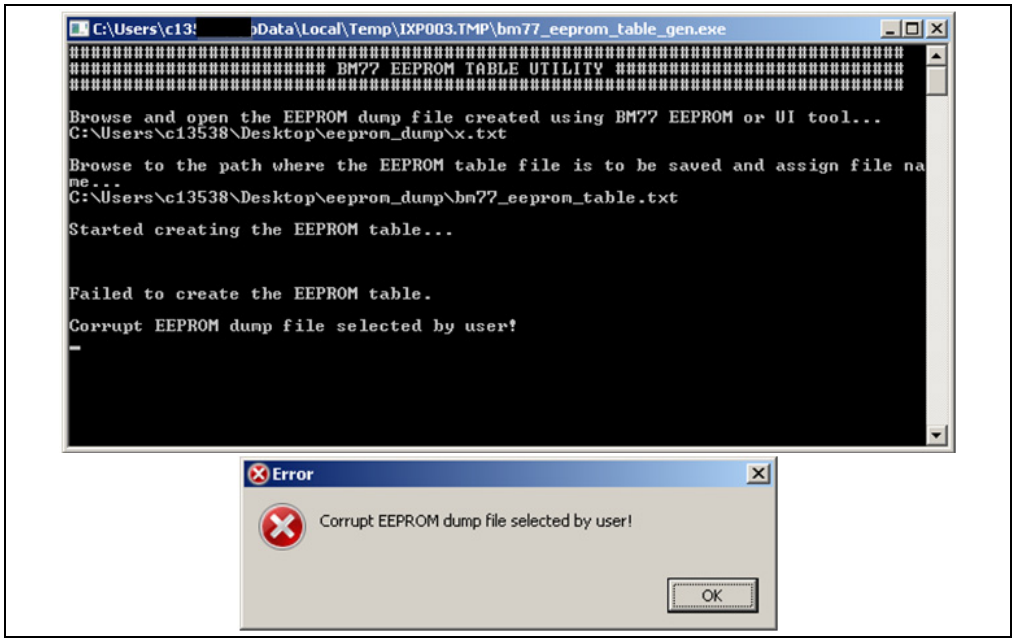
7. The application creates the EEPROM table structure file. The progress is shown on the command window. Refer to Figure 2-37. The EEPROM table is created in the file that the user selects in Step 6. A message displays on the command window and a message dialog box opens after an EEPROM table file `bm77_eeprom_table.txt` is successfully created. Click **OK** button on the message dialog box to proceed to the next step.

FIGURE 2-37: MESSAGE SHOWING THE PROGRESS AND COMPLETION OF THE EEPROM TABLE CREATION



If the EEPROM configuration file that the user selects in Step 3 is corrupted, an error displays in the command window followed by an error dialog box. Refer to Figure 2-38. Click **OK** button on the error dialog box and restart the application using a good EEPROM configuration file.

FIGURE 2-38: ERROR DUE TO CORRUPTED EEPROM FILE



8. Copy the EEPROM table file created by the utility into the BM77 Configuration Library workspace folder. Import the EEPROM table file into the workspace to configure BM77 with the EEPROM table. For an example on how to import and use the EEPROM table, refer to the `bm77_configure_demo.X` workspace installed as part of the PIC configuration library.

2.5.3 BM77 Configuration Library

The BM77 Configuration Library provides a set of functions to create command protocol packets to perform the following fiunctions:

- Update the System, the Bluetooth Classic and Low-Energy configuration parameters of BM77
- Set/get the EEPROM configuration parameters
- Bulk write of EEPROM configuration
- Perform pairing procedure with BM77
- Configure a subset of parameters in application mode on BM77
- Put the BM77 into different operating modes

The BM77 Configuration Library Installer is available on the BM77-PICtail webpage at www.microchip.com/bm-77-pictail. To install the BM77 Configuration Library along with BM77 Configure Demo MPLAB workspace and BM77 EEPROM Table Utility, download the BM77 Configuration Library Installer into a Windows PC, open the installer application and then follow the installer instructions. The `readme.txt` provides an overview of the components installed and available documentation.

The BM77 uses the UART interface for configuration and data transfer. If the BM77 is paired and connected, and the SPP profile is active, the data transferred is raw by nature. The BM77 Configuration and Events are defined as Command and Response protocol packets. Command packet is sent to BM77 over UART to update a parameter. Response packet is received from BM77 over UART for the command issued. The BM77 also sends Event packets over UART when a defined event occurs. For more information on the available functions in the BM77 configuration library, refer to the `BM77ConfigLibraryHelp.chm` file.

The BM77 configures a demo that showcases a proof-of-concept example on how to interface with the BM77 PICtail/PICtail Plus Board with a PIC microcontroller (MCU). In this demonstration, the BM77 module on the BM77 PICtail is configured through the PIC MCU. A Bluetooth device can be paired and connected to the BM77 module after configuring the BM77. Data can be transferred to and from the BM77 module once connected.

To start the demo, perform the following steps:

1. Set a few Bluetooth parameters using the EEPROM mode to access and update the parameters on the EEPROM.
2. The demo initiates the application mode and the BM77 module enters the Configure mode. In Configure mode, the demo gains access and reupdates some of the Bluetooth parameters to show an example of the application mode functions usage.
3. The BM77 waits for the Pairing procedure after exiting the Configure mode. If the connecting Bluetooth device initiates the Pairing procedure, the BM77 performs pairing by prompting the user for a passkey or confirmation as required. Once the pairing is complete where the Bluetooth device is connected to the BM77 and the SPP is active with an emulated serial cable, the connection is enabled. The demo enables the data transfer over UART between the BM77 and the connected Bluetooth device.
4. The debug UART is used to perform the pairing procedure and for data transfer to and from the BM77 when connected.

The `EEPROM_BULK_WRITE` preprocessor directive enables bulk write of the EEPROM instead of the default function that configures each EEPROM parameter. Using `EEPROM_BULK_WRITE`, the EEPROM table file included in `BM77_EEPROM_TABLE` is created using the BM77 EEPROM Table Utility through `bm77_eeprom_table_utility.exe` found in `bm77_eeprom_table_utility` folder. Refer to **Section 2.5.2 "BM77 EEPROM Table Utility"**.

The BM77 configure demo performs the following functions:

- **Configuration** - Sets and gets a few BM77 EEPROM configuration parameters or performs bulk write of EEPROM based on selected option and invokes functions in the Configure mode.
- **Pairing procedure** - Performs pairing based on the Pairing mode selected. If Just Works mode is selected, the pairing requires no user intervention. If Passkey Entry mode or Passkey Yes/No Confirm mode is selected, user intervention is required. In this demo, the debug UART port is used to enter passkey or yes/no confirmation. If Passkey Entry mode is selected, the program prompts the user to enter the entry key on the debug UART port. In this case, enter the 6-digit passkey and press <Enter>. If Passkey Yes/No Confirm mode is selected, the program prompts the user to enter the yes/no confirmation on the debug UART port by entering a <y> or <n> response, and then press <Enter>.
- **Data Connection** - Once the pairing procedure completes successfully and the Bluetooth device connects to BM77, the debug UART is used to transfer data to and from the BM77.

The BM77 PICtail uses the UART interface and GPIO ports to configure, control and transfer data to the PIC MCU. For more information on the UART configuration, refer to the *BM77SPPx3MC2 Bluetooth® 4.0 Dual Mode Module Data Sheet* available for download from http://www.microchip.com/products/BM77.

The following are examples of supported hardware combinations in the BM77 Configure Demo MPLAB workspace:

- **MPLAB PIC32 Configuration**
  - Explorer 16 Development Board (DM240001)
  - PIC32MX795F512L Plug-In Module (MA320003)
  - BM77 PICtail/PICtail Plus Board (BM-77-PICTAIL)
- **MPLAB PIC24 Configuration**
  - Explorer 16 Development Board (DM240001)
  - PIC24FJ128GA010 Plug-In Module (MA240011)
  - BM77 PICtail/PICtail Plus Board (BM-77-PICTAIL)
- **MPLAB PIC18 Configuration**
  - PIC18 Explorer Board (DM183032)
  - PIC18F87J11 Plug-In Module (MA180020)
  - BM77 PICtail/PICtail Plus Board (BM-77-PICTAIL)

The steps described in **Section 2.4.1 “Bluetooth® SPP Connection to Android Smartphone/Tablet”** and **Section 2.4.2 “Bluetooth Low Energy Data Connection to iOS Device”** in using the BTChat APP on Android device and the ISSC BLETR APP, can be used to pair, connect, and transfer data to the BM77 PICtail Board, with the exception that the BM77 PICtail Board is interfaced to a PIC MCU over the PICtail interface and then transfer data through the PICtail interface and not the USB-UART MCP2200 interface.

To program/debug the BM77 Configure Demo MPLAB workspace, perform the following steps:

1. Plug the PIC Plug-In-Module (PIM) into the relevant Explorer Development Board based on the hardware combination selected for evaluation.

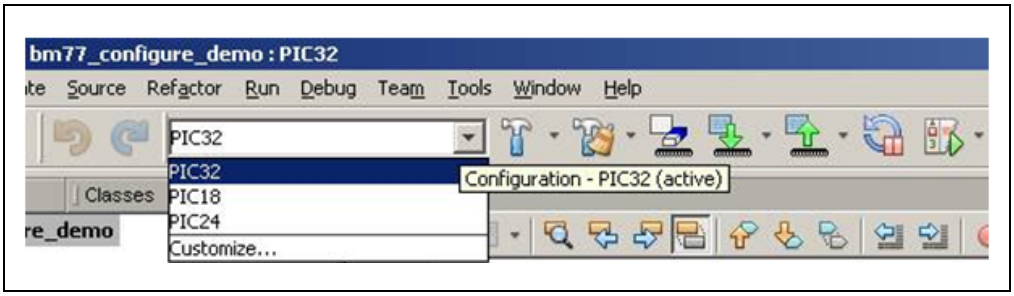
Note:	If using PIC32MX795F512L PIM, ensure that on jumpers J1 and J2 on the PIM, pins 2 and 3 are connected using a jumper to select the CAN configuration and all jumpers on J9 and J10 on the PIM are not connected.

2. Plug the BM77 PICtail/PICtail Plus Board into the Explorer Development Board with the BM77 module facing towards the PIC PIM as shown in Figure 1-5 or Figure 1-6 based on the hardware combination used.
3. [Optional] A debug UART port can be connected to a PC terminal emulator program.

Note:	Using the Explorer 16 Development Board, a debug UART is available on the DB9 UART serial connector P1. If using the PIC18 Explorer Board, the debug UART must be manually tapped from pins RG1/TX2 and RG2/RX2 on J5 header using an external wiring.

4. Provide power through the 9V power input port available on the Explorer Development Board.
5. Program the PIC32 with the `bm77_configure_demo_xc32.hex` or the PIC24 with the `bm77_configure_demo_xc16.hex` or the PIC18 with the `bm77_configure_demo_xc8.hex` in the “precompiled_hex” sub-directory.
6. Alternately, open the `bm77_configure_demo.X` MPLABX workspace using the MPLABX IDE to compile and program or enter Debug mode and then select any of the following workspace configurations (PIC32, PIC24, or PIC18) based on the specified hardware combination as shown in Figure 2-39.

FIGURE 2-39: SELECTED WORKSPACE CONFIGURATION



To run the BM77 Configure Demo MPLAB workspace after setting up the hardware combination and programming the PIC, perform the following the steps:

1. Observe the BM77 configuration by inserting break points in the workspace or optionally use the debug UART.
2. On BM77 web page, click on the BM77 Android App Demo to download the Android APK file (`BtChat_V1.0.3.apk`).
3. Open the BtChat APP installed by the `BtChat_V1.0.3` and scan for the Bluetooth devices on the Android device.
4. Select the BM77 device in the scan list and click to pair and connect.
5. The application uses Just Works pairing by default. If using the Passkey Entry or Passkey Yes/No Confirm mode, provide the passkey or confirmation using the debug UART port.
6. Once connected, the data can be transmitted from BM77 through the debug UART port to the BtChat APP over the Bluetooth link. Enable "Show Rx Text" option in the BtChat APP settings. The BtChat APP sends data back to the BM77 that is later received through the debug UART.

Alternately, any suitable Bluetooth SPP Data Terminal application can be used to transfer data back and forth by following the steps described in this demonstration.

Appendix A. BM77 Module PIN Assignment

A.1 BM77 MODULE PIN ASSIGNMENT

Figure A-1 shows the pinout for BM77 module.

FIGURE A-1: BM77SPP03 MODULE PIN ASSIGNMENT

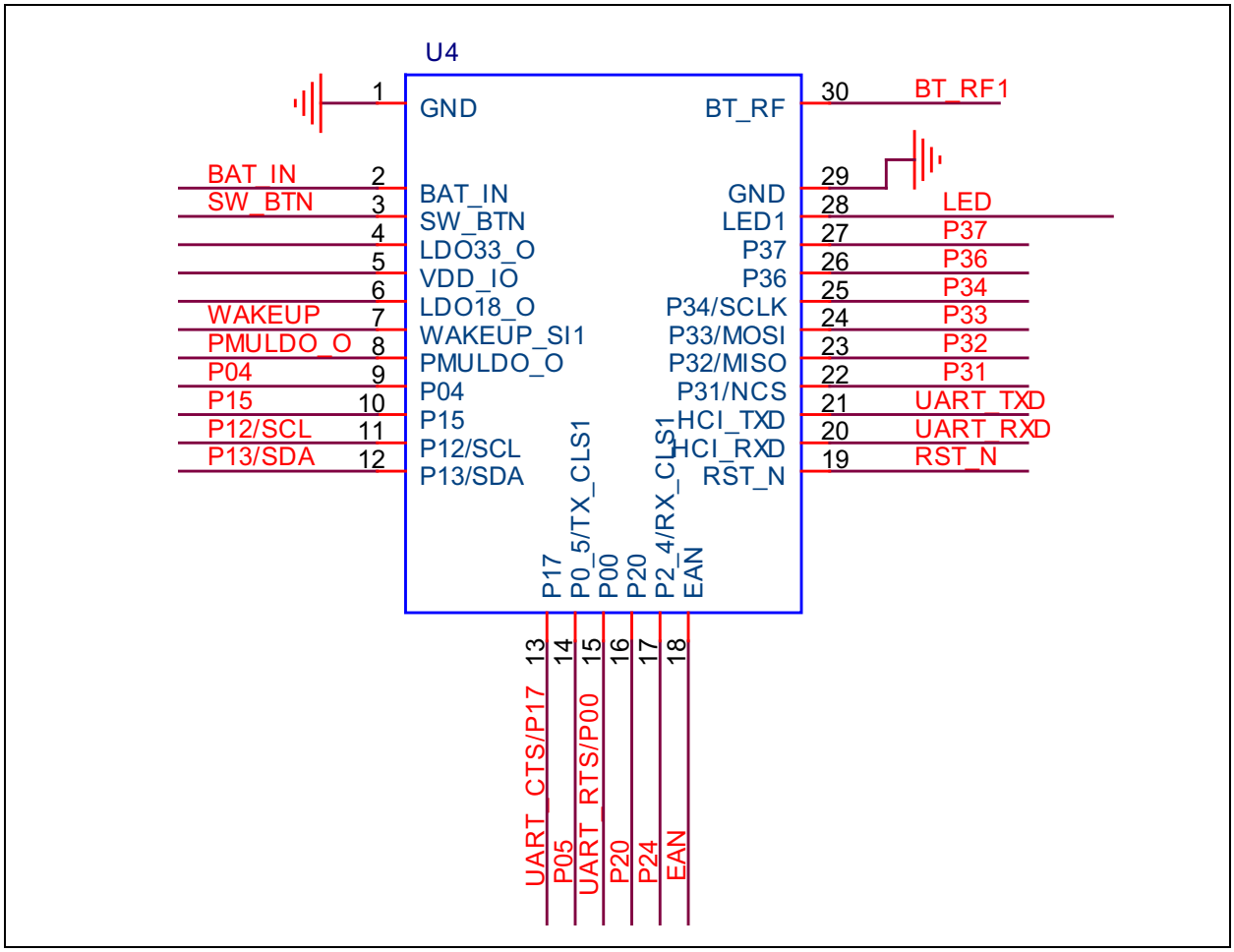


Table A-1 describes the pins for BM77 module.

TABLE A-1: BM77 MODULE PIN DESCRIPTION

PIN	Type	Name	Description
1	P	GND	Ground
2	P	BAT_IN	4.2~3.3V Power input
3	I	SW_BTN	Input for software button H: Power On L: Power Off
4	P	LDO33_O	3V3 LDO output
5	P	VDD_IO	Main power supply

TABLE A-1: BM77 MODULE PIN DESCRIPTION (CONTINUED)

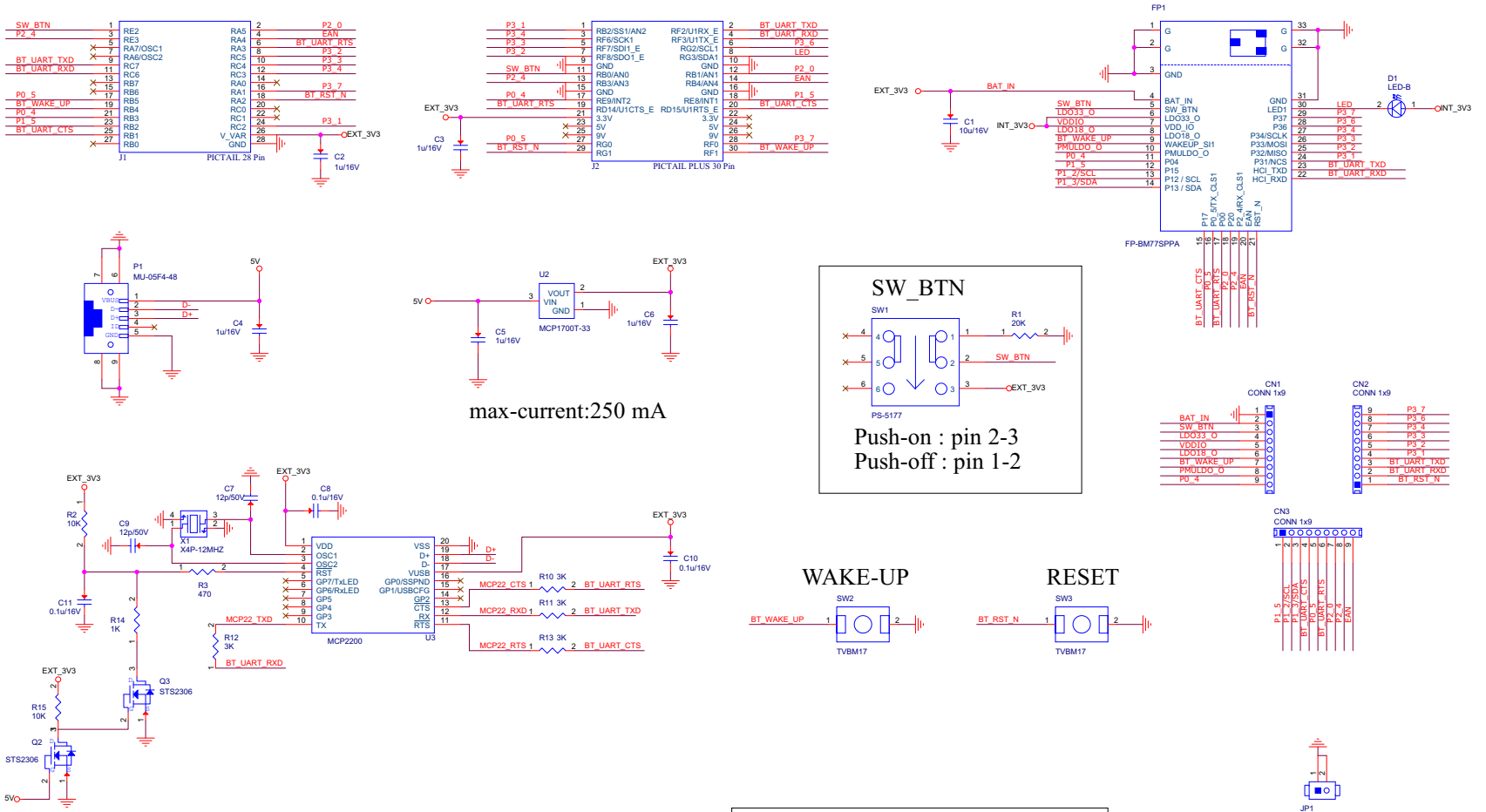
PIN	Type	Name	Description
6	P	LDO18_O	LDO18 output
7	I	WAKEUP	Wakes BM77 from Shutdown state (Active-Low) Valid only while BM77 is in Shutdown state
8	P	PMULDO_O	Power management unit output
9	O	P04	UART_TX_IND: H: BM77 indicates that UART data is transmitted out after a certain timing. (Setting by EEPROM, default 5 ms) L: Otherwise. STATUS_IND_2: BM77 State indication, refer to P15
10	O	P15	STATUS_IND: Bluetooth link status indication P15/P04: HH - Power default value and Shutdown state P15/P04: HL - Access state P15/P04: LL - Link state without UART_TXD P15/P04: LH - Link state with UART_TXD
11	N/A	P12/SCL	I2C_SCL, Reserved
12	N/A	P13/SDA	I2C_SDA, Reserved
13	I	P17	- UART_CTS: - Configurable Functional GPIO
14	I/O	P05	Configurable Functional GPIO
15	O	P00	- UART_RTS - Configurable Functional GPIO
16	I	P20	System configuration, refer to P2_4. (No drive under APP mode)
17	I	P24	Boot mode selection. (No drive under APP Mode) P2_0/P2_4: HH - Application LL - Boot mode LH - HCI UART mode for testing and system configuration
18	I	EAN	ROM/Flash selection. (No drive under APP Mode) H: ROM code L: Flash code
19	I	RST_N	External reset input (Active-Low), Clock period 62.5n at least
20	I	HCI_RXD	UART_RXD
21	O	HCI_TXD	UART_TXD
22	I/O	P31	Configurable Functional GPIO
23	I	P32	Configurable Functional GPIO
24	I	P33	Configurable Functional GPIO
25	I	P34	Configurable Functional GPIO
26	O	P36	Reserved
27	I/O	P37	Configurable Functional GPIO
28	O	LED1	LED1 driver
29	P	GND	Ground
30	RI/O	BT_RF	RF Port

Appendix B. Schematics

B.1 BM77 PICtail™/PICtail Plus BOARD SCHEMATICS

Figure B-1 shows the BM77 PICtail/PICtail Plus Board schematics.

FIGURE B-1: BM77 PICTAIL™/PICTAIL PLUS BOARD SCHEMATICS



SW4	APP MODE	TEST MODE	WRITE FLASH
EAN	OFF	OFF	ON
P24	OFF	OFF	ON
P20	OFF	ON	ON

Appendix C. Questions and Answers

C.1 QUESTIONS AND ANSWERS

1. **Is the BM77 Module Data Sheet available?**

   Yes. The BM77 data sheet is available for download from the Microchip web site at www.microchip.com/BM77.

2. **When I connect the BM77 PICtail board to the host PC, the COM port does not appear.**

   Try to unplug the USB cable and plug it back to the PC. Check if the MCP2200 drivers are installed. Otherwise, download and install the MCP2200 drivers.

3. **What is the maximum supported Baud Rate of BM77 UART?**

   The maximum baud rate is 921600 used with 16 MHz crystal.

4. **How do you change Bluetooth parameters such as name, Device Info, COD, rate, inquiry and page scan windows?**

   The configuration settings are accessed using the UI Tool software utility. The configuration settings can be updated on the BM77 using the BM77 Configuration Library. Contact your Microchip representative to request additional configuration tools including BM77 UI tool and other documentation for BM77.

5. **What is default security mode for SPP?**

   Simple Secure Pairing (SSP)/Just Works mode.

6. **Is there an Android™ BTLE demonstration application?**

   At this time, Android support for dual mode Bluetooth devices, such as the BM77, is limited to Bluetooth Classic SPP data service.

7. **Is the source code for iOS and Android APP available?**

   Contact your Microchip representative to request the source code packages for the Smartphone Apps.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

07/14/15