AN214896

Over-the-Air (OTA) Firmware Update Procedure for Bluetooth Low Energy (BLE) Devices

Associated Part Family: CYW20734, CYW20735

This application note describes procedures used to conduct the initial wired firmware downloads and subsequent over-the-air (OTA) firmware upgrades from a host laptop running a Bluetooth Simplified API (BSA) Linux® stack to Bluetooth Low Energy (BLE) or BLE2-based remotes. Contact your Cypress representative for access to BSA Linux components.

1 About This Document

1.1 Purpose and Audience

The document assumes that the user is familiar with using Cypress BlueTool™ software to download updates and perform upgrades on CYW20734 and CYW20735-equipped devices.

The document also covers the OTA process over a BLE link. BLE is a wireless personal area network (PAN) that adheres to the Bluetooth Special Interest Group (SIG) standards and is designed to support applications such as beacons, fitness and human interface devices (HIDs), healthcare, security, and home entertainment systems.

The document is intended for software and hardware engineers who develop and work with device updating firmware using OTA techniques and procedures.

1.2 Cypress Part Numbering Scheme

Cypress is converting the acquired IoT part numbers from Broadcom to the Cypress part numbering scheme. Due to this conversion, there is no change in form, fit, or function as a result of offering the device with Cypress part number marking. The table provides Cypress ordering part number that matches an existing IoT part number.

Table 1. Mapping Table for Part Number between Broadcom and Cypress

Broadcom Part Number	Cypress Part Number
BCM20734	CYW20734
BCM20735	CYW20735
BCM43569	CYW43569

1.3 Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use. For a more complete list of acronyms and other terms used in Cypress documents, go to: http://www.cypress.com/glossary.

1.4 References

The references in this section may be used in conjunction with this document.

Document (or Item) Name		Number	Source
Cypress Items			
[1]	*Single-Chip Bluetooth Transceiver for Wireless Input Devices*	20734-DS10x-R	Cypress Developer Community
[2]	*Single-Chip Bluetooth Transceiver for Wireless Input Devices*	20735-DS10x-R	Cypress Developer Community
[3]	*Over-The-Air Throughput Test Setup Using BlueTool Software*	BlueTool-AN20x-R	Cypress Developer Community
[4]	*Over-The-Air Throughput Test Setup Using BlueTool Software*	20704-AN20x-R	Cypress Developer Community
[5]	*Bluetooth Firmware Download*	43569-AN20x-R	Cypress Developer Community
[6]	*BTSP User's Guide*	–	Bundled with the BlueTool software package.
[7]	*Software for Exercising, Testing, Scripting, Debugging, and Programming Devices*	BlueTool-QSG1xx-R	Cypress Developer Community
[8]	*Hex Generator documentation provided as part of a release (ex 20735B0_SMK_Remote Playback_ADK)*	–	Cypress ADK provided in Cypress Developer Community
Other Items			
[9]	ActivePerl	–	www.activestate.com
[10]	*General information on Perl*	–	www.perl.org www.perl.oreilly.com
[11]	*Evoke Z, Evoke Reach, and Evoke Touch Remote Controllers by Universal Electronics®, Inc.*	–	http://www.uei.com/home

2 IoT Resources

Cypress provides a wealth of data at http://www.cypress.com/internet-things-iot to help you to select the right IoT device for your design, and quickly and effectively integrate the device into your design. Cypress provides customer access to a wide range of information, including technical documentation, schematic diagrams, product bill of materials, PCB layout information, and software updates. Customers can acquire technical documentation and software from the Cypress Support Community website (http://community.cypress.com/).

3 Introduction

An OTA device firmware upgrade is a bootload mechanism that uses a wireless link to update firmware on a target device. While some computers come with built-in Bluetooth connectivity, others require the use of a Bluetooth dongle. Dongles are USB network adapters that enable a computer to communicate with Bluetooth devices such as mobile phones, remotes, and headsets.

The procedures described herein include use of the Cypress CYW43569 dongle. The CYW43569 is a dual-band 2x2 MIMO combo chip (802.11a/b/g/n/ac and Bluetooth 4.1) aimed at media platforms such as digital televisions and over-the-top media boxes. It supports USB 2.0 or USB 3.0 access to both WiFi and Bluetooth and has integrated power amplifiers for both bands along with a separate Bluetooth low-noise amplifier (LNA) with customized WiFi and Bluetooth coexistence algorithms.

The procedures address the configuration of CYW20734 and CYW20735-based Evoke™ remote controllers (see Reference [11] on page 2).

4 System Requirements

4.1 Host System Requirements

A personal computer running the Microsoft® Windows® operating system is required to use BlueTool. Cypress recommends running Windows XP; however, other versions of Windows are supported.

Note: BlueTool software is updated frequently, resulting in operational and other changes to the graphical user interface. Consequently, this document only contains selective references to using BlueTool. These instructions should remain the same for all BlueTool releases. If discrepancies exist between this document and the version of BlueTool you are using, contact your Cypress technical representative.

A Linux-based laptop running BSA software is also required. Contact your Cypress Field Applications Engineer (FAE) to obtain the BSA package.

4.2 Recommended Converter Board

The following board number is an example BCM9RS232_CONV (Rev 01).

4.3 Hex Generator

Cypress engineering teams support the hex generator that is available in the ADK as a zip file (see Reference [8] on page 2). Contact Cypress to request access to the 20735B0_hex_generator_manual.docx and hex_generator.bat. These files are located in */mpaf/apps/hidd/hex_generator* and are included in an ADK release for 20735B0 chips. For customers who received a prior ADK without /hex_generator folder (and the four files), these files can be provided by Cypress upon request.

5 CYW20734-Based BLE Evoke Remote Control

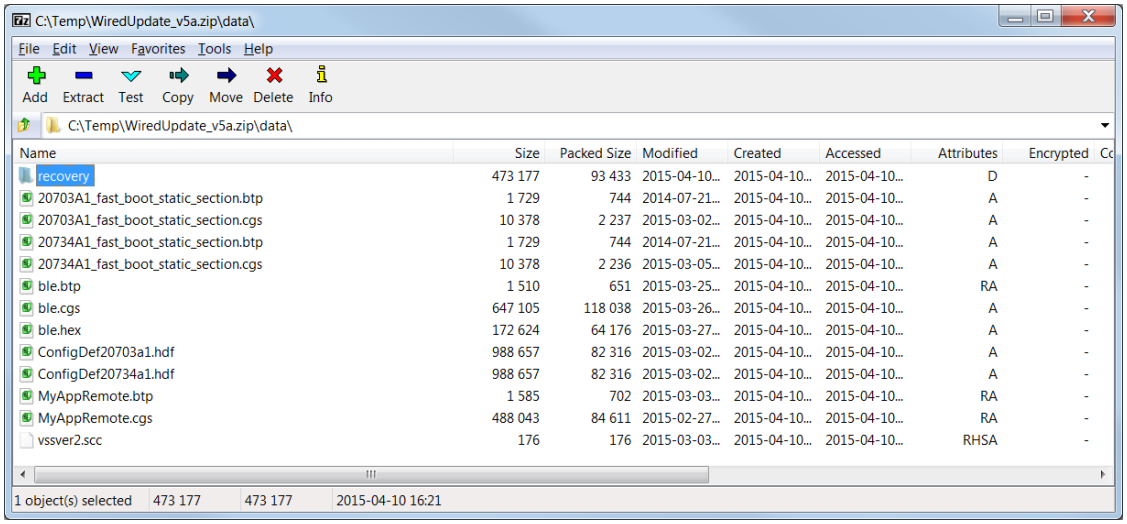
This section describes how to configure the CYW20734-based BLE Evoke Remote Control.

5.1 Firmware Update Installation

Start the firmware wired update installation. This is done using the *WiredUpdate* package.

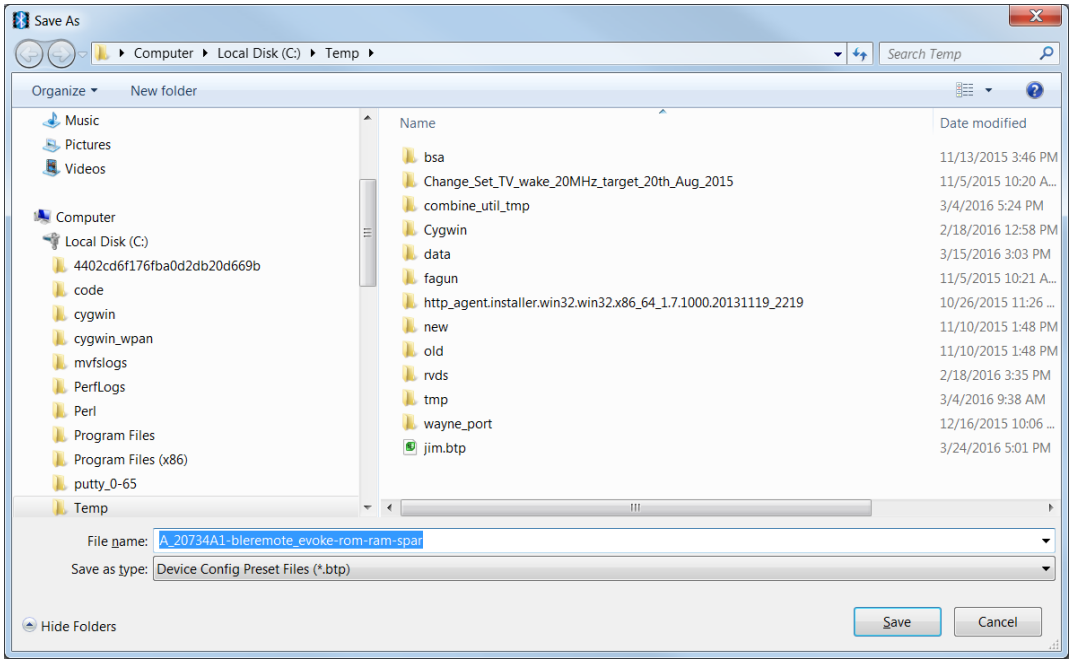
Note: Due to a bug in the ROM, the CYW20734 only checks a specific serial flash location for a valid static section. Thus, the initial firmware download into the remote must be done using the WiredUpdate package to work around this limitation. You will need Bluetool, *WiredUpdate_v5a.zip, and read_sflash.zip).* The WiredUpdate package includes instructions on how to execute the WiredUpdate package.

1. Unzip the WiredUpdate_v5a.zip file to a directory on your C drive. These files will be executed from the command prompt. The following shows a resulting unzipped directory.



2. Use the following example file name *A_20734A1-bleremote_evoke-rom-ram-spar.cgs* to conduct the firmware download using the Cypress BlueTool user interface.
3. From the Cypress Bluetool user interface, within the Device configuration field, select **20734 EEPROM Serial Flash** and click **Export.**

   Once Export is selected, an interface appears as shown in the example below:

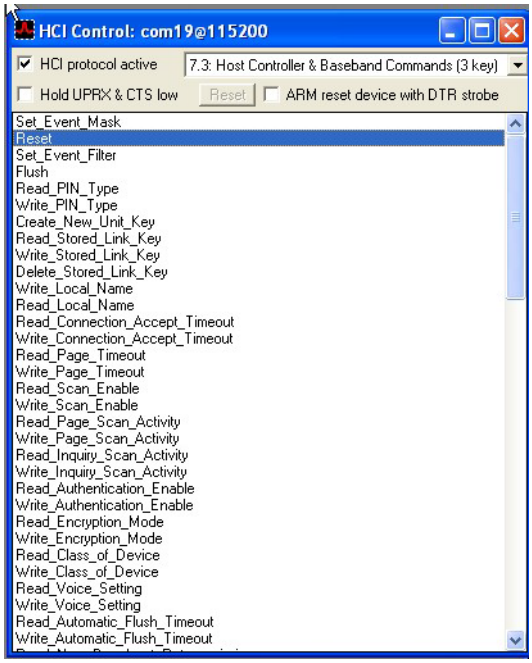


4. Type in the example file name **A_20734A1-bleremote_evoke-rom-ram-spar** in the File name field using the same format as shown in the user interface screen, then click **Save**, then the file name that appears in this example is saved.
5. The example above shows a download to C:\temp. In this case, simply move the file from this directory to the WiredUpdate directory. Open the .btp file and check to ensure that ConfigDSLocation = 16384 (=0x4000).
6. In the WiredUpdate directory, copy both the .cgs file and .btp file to the data subfolder of the *WiredUpdate* folder.

Example: The files *MyAppRemote.btp* and *MyAppRemote.cgs* above show representative examples. Once the

.cgs file is compiled, then the .btp file is created using the same name.

7. Remove the batteries from the remote control.
   a. Connect an RS-232 converter board to the download cable of the remote control.
   b. Connect an RS-232 cable between your PC's COM 1 and the converter board.
8. Run Bluetool. From the Bluetool menus, select **Transport>HCI Control**
9. Select **COM 1** (or the COM port you used to connect to the PC) and check the **HCI protocol active** check box in the HCI Control window.
10. Slide the SW1 switch on the RS-232 board to the off position and then back to the on position.
11. Uncheck the **HCI protocol active** check box and then recheck the box **HCI protocol active** check box in the HCI Control window.
12. From the Bluetool HCI Control window:
    a. Reset the CYW20734 Evoke remote control by selecting **7.3 Host Controller & Baseband Commands (3 key)** from the drop-down Command list.
    b. Double-click **Reset** to reset the device (the reset status will be available in the log window).



   c. Ensure the reset progress is successful by checking the log window. It should display “Success” status as shown below:

```
07:39.447  com19  <c  Reset
                  HCI Command Complete Event
           com19@115200
    [0E 04]: 01 03 0C 00
    event = 0xE (14, "Command Complete")
    Num_HCI_Command_Packets = 0x1 (1)
    Command_Opcode = 0xC03 (3075, "Reset")
    Status = 0x0 (0, "Success")
```

13. Open a DOS window and navigate to the *WiredUpdate* directory.
    a. Example: Type **prog com1 A_20734A1-bleremote_evoke-rom-ram-spar 20734000AAAA**
    – This example entry programs 20734000AAAA as the BD address into a CYW20734 Evoke remote.

Note: Be sure to use your own BD address in above step. After the download completes, you can verify using Bluetool to see this BD address by power cycling the remote, and performing a reset from Bluetool.

14. Create a *.hex* image to be downloaded via OTA from BSA:
    a. To distinguish firmware downloaded via OTA from firmware downloaded via a wired update, change *ADV_LOCAL_NAME* from the default name of *BrcmLeRC-* to another name such as *TestLeRC-* in the *\bleremote_evoke\version.h* file.
    b. Recompile and generate a *.cgs* file.
    c. From the Cypress BlueTool interface, select **20734 EEPROM Serial Flash (4k pages)** in the Device configuration field.
    d. Set the DS location to **0x00004000**
    e. Uncheck **Include static section** and locate the .cgs file that was just built.
    f. From the Cypress BlueTool interface shown above, select **File>Generate Burn Image**, to generate and save the *.hex* file.
    g. Copy the *.hex* file to the path of the BSA server on the Linux laptop (/<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build/x86, to be generated in the following step), and remove the RS-232 cable between your PC's COM 1 and the converter board (for example BCM9RS232_CONV (Rev 01).
15. Install the appropriate BSA into the Linux laptop and perform the OTA firmware upgrade. Use the steps presented below. In this example, *bsa0106_01.48.00-binary_<optional ID>_20150422eng1.tar.gz* is used for the CYW20734 Evoke remote).
16. Plug the Cypress43569 USB dongle into a Linux laptop and enter the following commands to set up BSA:
    tar -xvf bsa<tab>.tar.gz

    cd /<bsa_release_name>/3rdparty/embedded/brcm/linux/btusb

    make

    rmmod btusb

    insmod btusb.ko

    cd /<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build

    make -f Makefile.all clean

    make -f Makefile.all all ENABLE_BLE_FWDL=TRUE
17. On Linux laptop, open four terminal windows with root privileges and change directory using the following command:
    /<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build/x86
18. Type in the following commands on each of the four terminals to start bsa_server, app_manager, app_ble, and app_hh:
    terminal #1: **rm -rf bt*xml** followed by **./bsa_server -b btsnoop.txt**

    terminal #2: **../../../app_manager/build/x86/app_manager**

    terminal #3: **../../../app_ble/build/x86/app_ble**

    terminal #4: **../../../app_hh/build/x86/app_hh**
19. Pair and connect to the remote from app_hh terminal.
    a. Select **option 4: BLE Discovery**.
    b. Press the **Pairing** key on the remote.
    c. Once the app_hh terminal displays *Discovery complete*, select **6**, then **1**, then the device with your BD address (such as Dev: 0), then **7 Open (Encryption+Authentication+Authorization)**.
    d. Press any key on the remote to make sure that the key report appears in the app_hh terminal (terminal 4).
20. From app_ble terminal, select **option 10 or 11=> Connect to Server** (this is either option 10 or option 11, depending on your BSA version).
    a. Select 0: Device from XML database (already paired)
    b. Select the device number with your BD address (such as Dev: 0)
    c. Select the Index number from BLE CLIENT LIST (such as Index: 0)

d. Select Direct connection = 1
e. Select option 29 => Upgrade FW by LE, then enter *.hex* file name that was previously copied over.
f. Select the Index number from BLE CLIENT LIST (such as Index: 0).

Note: Do steps d, e, and f without pausing, and the BSA should start downloading the OTA firmware and finish with an *OTA FW DL: Success* message. Otherwise, the connection may be closed and the OTA firmware update will not start.

5.2 Verify OTA Firmware Download

Once the firmware upgrade completes:

1. Power cycle the Evoke remote.
2. Reconnect the remote to your PC using an RS-232 cable and the BCM9RS232_CONV (Rev 01) converter board.
3. Connect remote to Bluetool and verify that the HCI reset was successful.
   a. Uncheck **HCI protocol active** or exit this window.
4. From a DOS window:
   a. Unzip *read_sflash.zip* into a target directory.
   b. Change into that directory and type **perl read_sflash.pl > log.txt**. This dumps out the content of magic numbers at locations *0x1FF4-0x1FFB*, and DS2 offset at locations *0x1FFC-0x1FFF*.
   c. Check the results to examine from the 5th byte onward for eight (8) consecutive bytes to see the magic numbers: 0xAA, 0x55, 0xF0, 0x0F, 0x68, 0xE5, 0x97, 0xD2. Check to ensure DS2 offset is populated.
   d. Remove the RS-232 cable from the RS-232 converter board BCM9RS232_CONV (Rev 01) from your PC.

Note: DS2 offset is expressed in little endian. So if the four bytes are 00, 20, 02, 00, then the DS2 offset address is 0x00022000. This verifies that the OTA firmware download has successfully written the magic numbers and DS2 offset to the correct locations.

5. Power cycle the remote:
   a. type **Ctrl-C** to exit the bsa_server, then re-start bsa_server, app_manager, app_ble, and app_hh as described previously, and try to re-pair the remote with the BSA by following the same pairing procedure.
   b. Once BSA has completed discovery, double check that your remote's BD address and local name are correct. Once successfully paired, type any keys on the remote to ensure the reports show up in the app_hh terminal. This completes the verification of OTA firmware download.

5.3 Second OTA Firmware Download (Optional)

Note: Repeat step 14 on p. 9 and step 20 on p. 10 to perform a hex image generation and initiate an OTA firmware download.

You may want to perform a second OTA firmware download. This step is optional and involves repeating the procedures described in Firmware Update Installation on page 3. To do so:

1. Change the device local name again to a unique name.
2. Recompile and regenerate a *.hex* image and copy it to the path of the defined BSA server.
3. After this second OTA firmware download is completed:
   a. Check the magic numbers described in Verify OTA Firmware Download on page 7 and the DS2 offset will return to all 0xFF by running the same perl script.
   b. Re-pair the remote with the defined BSA, with BSA discovering the newly downloaded firmware of your updated device local name and the identical BD address.

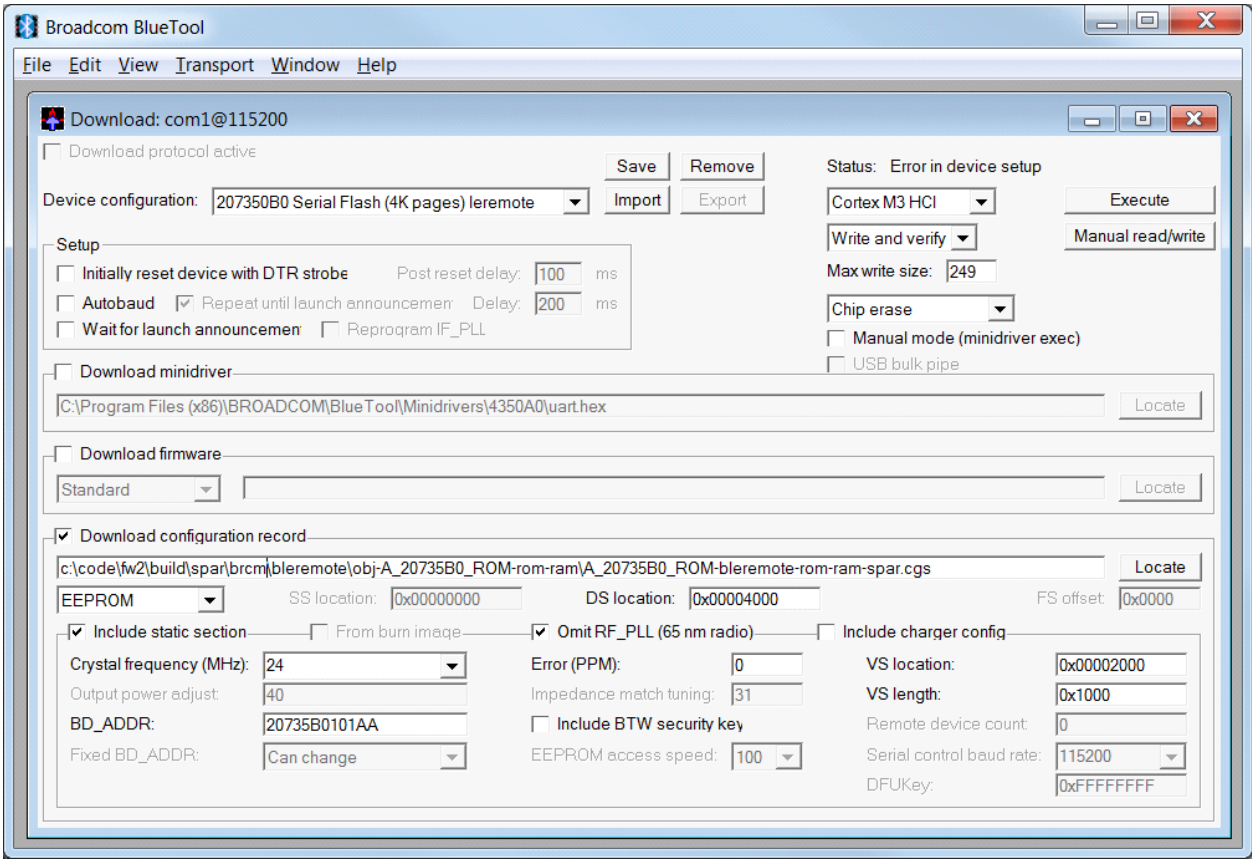
6 CYW20735-Based BLE Evoke Remote Control

This section describes how to configure the CYW20735-based BLE Evoke Remote Control.

6.1 Firmware Update Installation

1. In the directory *\fw2\build\spar\brcm\bleremote\makefile.mk*, comment out the line below and recompile.
   #C_FLAGS += -DBLE2_ENABLE
2. Install the hex generator utility.
   a. You must update the CYW20735 firmware using this utility due to the need to add required patches. This utility and instruction manual are available in ADK under (adk)\mpaf\apps\hidd\hex_generator. Please read 20735B0_hex_generator_manual.docs for information on how to install and download firmware using this utility.
3. Create a *.hex* image to be downloaded via OTA from BSA.
   a. To distinguish firmware downloaded via OTA from the firmware downloaded via BlueTool, change dev_local_name from the default of *BLE Remote* to a name such as *BLE Test* in *\fw2\build\spar\brcm\bleremote\wiced_bt_bleremote_cfg.c file*.
   b. Recompile and generate a *.cgs* file.
   c. From the Cypress BlueTool interface, select **20735B0 Serial Flash (4k pages) leremote** in the Device configuration field.
   d. Set the DS location to **0x00004000**
   e. Uncheck **Include static section** and locate the *.cgs* file that was just built.
   f. From the Cypress BlueTool interface, select **File>Generate Burn Image**, to generate and save the *.hex* file.
   g. Copy the *.hex* file to the path of the BSA server on the Linux laptop (/<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build/x86, to be generated in the following step), and remove the RS-232 cable between your PC's COM 1 and the converter board (BCM9RS232_CONV Rev 01).

   The 207350B0 Serial Flash (4k pages) leremote screen is shown below.



4. Install the appropriate BSA into the Linux laptop and perform the OTA firmware upgrade. Use the steps presented below. In this example, *bsa0107_00.19.00.tgz* is used for the CYW20735 Evoke remote).
5. Plug the CYW43569 USB dongle into a Linux laptop and enter the following commands to set up BSA:

   tar -xvf bsa<tab>.tgz

   cd /<bsa_release_name>/3rdparty/embedded/brcm/linux/btusb

   make

   rmmod btusb

   nsmod btusb.ko

   cd /<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build

   make -f Makefile.all clean

   make -f Makefile.all all ENABLE_BLE_FWDL=TRUE ENABLE_BLE2_BRCM=TRUE
6. Follow the same procedure as described in CYW20734-Based BLE Evoke Remote Control on page 3 (steps 17 through 20) to complete the BSA app launch, pairing, and OTA firmware upgrade.
7. On Linux laptop, open four terminal windows with root privileges and change directory using the following command:

   /<bsa_release_name>/3rdparty/embedded/bsa_examples/linux/server/build/x86
8. Type in the following commands on each of the four terminals to start bsa_server, app_manager, app_ble, and app_hh:

   terminal #1: **rm -rf bt*xml** followed by **./bsa_server -b btsnoop.txt**

   terminal #2: **../../../app_manager/build/x86/app_manager**

   terminal #3: **../../../app_ble/build/x86/app_ble**

   terminal #4: **../../../app_hh/build/x86/app_hh**

9. Pair and connect to the remote from app_hh terminal.
   a. Select **option 4: BLE Discovery**.
   b. Press the **Pairing** key on the remote.
   c. Once the app_hh terminal displays *Discovery complete*, select **6**, then **1**, then the device with your BD address (such as Dev: 0), then **7 Open (Encryption+Authentication+Authorization)**.
   d. Press any key on the remote to make sure that the key report appears in the app_hh terminal (terminal 4).
10. From app_ble terminal, select **option 10 or 11=> Connect to Server** (this is either option 10 or option 11, depending on your BSA version).
   a. Select 0: Device from XML database (already paired)
   b. Select the device number with your BD address (such as Dev: 0)
   c. Select the Index number from BLE CLIENT LIST (such as Index: 0)
   d. Select Direct connection = 1
   e. Select option 29 => Upgrade FW by LE, then enter *.hex* file name that was previously copied over.
   f. Select the Index number from BLE CLIENT LIST (such as Index: 0).

6.2 Verify OTA Firmware Download

Verify the OTA firmware download following the same procedure as described in Verify OTA Firmware Download on page 7.

6.3 Second OTA Firmware Download (Optional)

You may want to perform a second OTA firmware download (see Second OTA Firmware Download (Optional) on page 7.

7 CYW20735-Based BLE2 Evoke Remote Control

This section describes how to configure the CYW20735-based BLE2 Evoke Remote Control.

1. In the directory *\fw2\build\spar\brcm\bleremote\makefile.mk*, enable the line below and recompile.
   C_FLAGS += -DBLE2_ENABLE
2. Install the hex generator utility (see CYW20735-Based BLE Evoke Remote Control on page 8).
3. Create a *.hex* image to be downloaded via OTA from BSA (see CYW20735-Based BLE Evoke Remote Control on page 8).
4. Install the appropriate BSA into Linux laptop and perform OTA firmware upgrade: Follow the steps below (in this case, *bsa0107_00.19.00.tgz* is used for the CYW20735 Evoke remote).
   a. This procedure is the same as described in CYW20735-Based BLE Evoke Remote Control on page 8, with one additional step required for BLE2-based pairing. After starting the bsa_server, app_manager, app_ble, and app_hh, and before the pairing step, go to the app_ble terminal to select **option 50 => BLE2 Control**, and select **1** to enable it.

7.1 Verify OTA Firmware Download

Verify the OTA firmware download following the same procedure as described in Verify OTA Firmware Download on page 7.

7.2 Second OTA Firmware Download (Optional)

You may want to perform a second OTA firmware download (see Second OTA Firmware Download (Optional) on page 7.

Document History Page

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Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	–	–	03/28/2016	Initial release
*A	5450876	UTSV	09/28/2016	Updated in Cypress template
*B	5787406	AESATMP9	06/27/2017	Updated logo and copyright.

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Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

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