

# Low Power Modes

## BL654 Module

Application Note

v1.1

### 1 INTRODUCTION

The BL654 module has three power modes:

- **Run** - The normal operation of the module when the application is running and not waiting for events.
- **Standby Doze** -The module is placed in Standby Doze when there are no pending events, and the smartBASIC application reaches the WAITEVENT statement. The module wakes from Standby Doze if any registered event is triggered.
- **Deep Sleep** - Deep Sleep is the lowest power mode, and the module can only exit it through a system reset. It is achieved through the smartBASIC function `SystemStateSet(0)`.

This guide demonstrates how to load a smartBASIC application in order to test the power consumption of the two low power modes: Standby Doze and Deep Sleep.

### 2 REQUIREMENTS

- Laird DVK-BL654 (455-00001 or 455-00002)
- Micro USB to USB (Type-A) Cable – provided with devkit
- UwTerminalX v1.10a or later (found at <https://github.com/LairdCP/UwTerminalX>)
- `lp.low.power.deep.sleep.sb` application (found in the [BL654 GitHub repository](#))
- Current measuring digital multimeter (DMM)

### 3 DEVELOPMENT KIT SETUP

To set up the DVK-BL654 development kit, complete the following steps:

1. Configure the board to the following settings (shown in [Figure 1](#))
  - DC/USB power source switch (SW4) – in position USB (default)
  - VCC\_1V8/VCC\_3V3 switch (SW5) – in position VCC\_3V3 (default)
  - CR2033/VCC\_3V3/1V8 switch (SW6) – in position VCC\_3V3/1V8 (default)
  - Switch SW7 is in middle position for Normal Voltage mode operation (default)
  - Jumper J7 removed, cut solderbridge SB1
  - Jumper J26, J37, J45, J39 removed to disconnect LED's D1, D2, D3, D4
  - SW11 in left position
2. To measure the current consumption of the module, connect the current measuring DMM to J7 on the development kit ([Figure 1](#)).

**Note:** After the test is complete, remember to replace the jumper on J7.

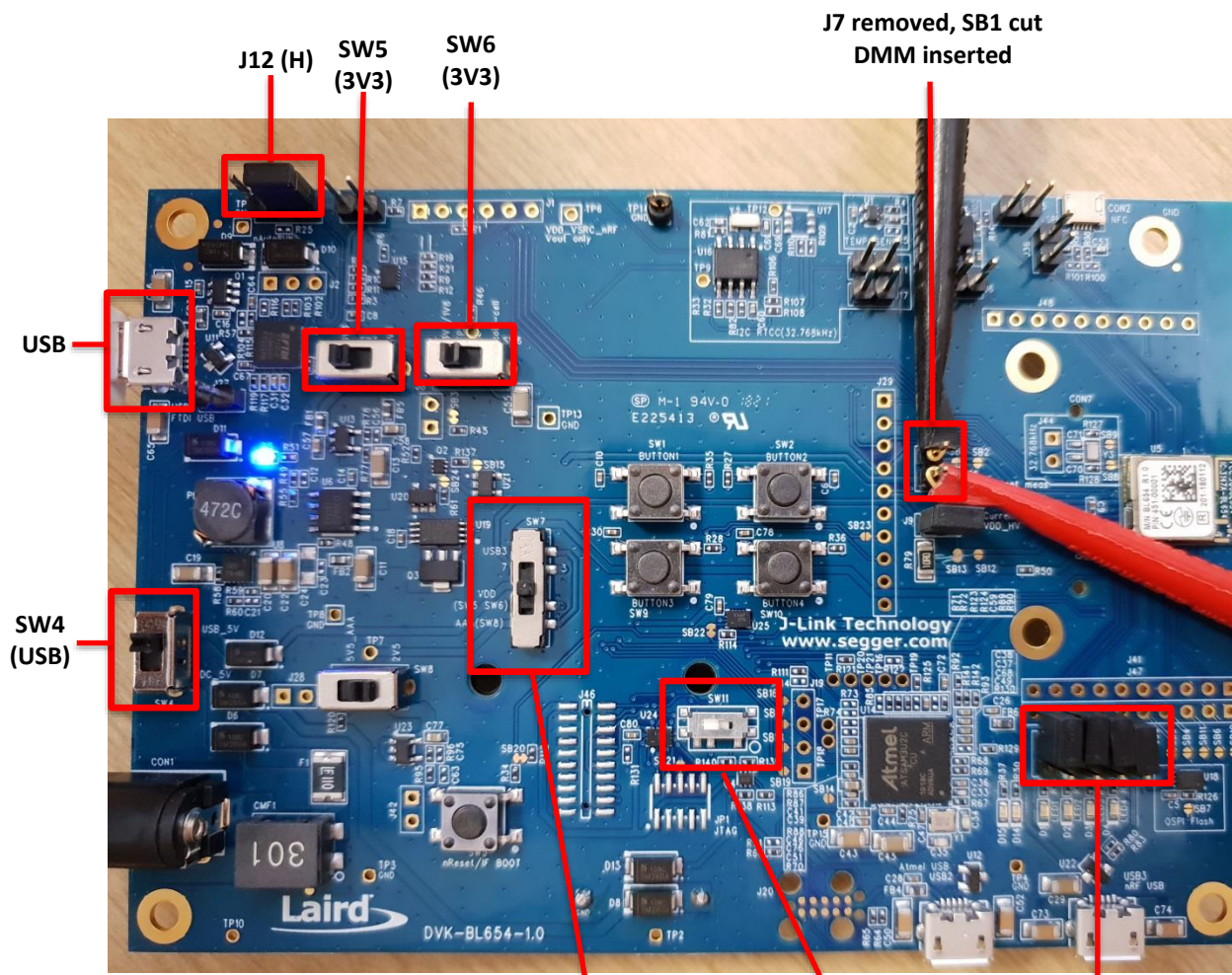


Figure 1: BL654 development board

SW7 middle position SW11 left position J26, J37, J45, J39 removed

3. Connect the DVK-BL654 to your PC via the included USB-A to USB Micro cable.
4. Ensure that the current measuring DMM is connected to J7 before the development kit is powered up (or else the board will not be powered).
5. Follow the on screen prompts. Windows may prompt you to install FTDI drivers (found at <http://www.ftdichip.com/FTDrivers.htm>).
6. Ensure that the Windows Device Manager displays a new virtual COM port for the USB to Serial adapter.
7. Launch UwTerminalX.
8. From the Config tab in Device drop-down menu, select **BL654** to populate the baud, parity, stop bits, data bits, and handshaking settings. If “BL654” is not selectable, set the configuration as shown in [Figure 2](#).
9. In the Port dropdown, select the COM port associated with your DVK-BL654. At the top of the screen, click **OK**.

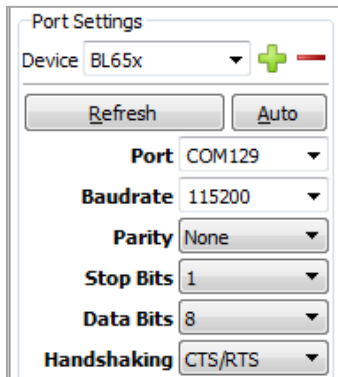


Figure 2: Setting connection parameters

10. To return the BL654 to factory defaults, enter the command `at&f*` in the Terminal tab as shown ([Figure 3](#)).

**Note:** If you are using a new development board with the sample application, you may need to press the reset button (SW3) to exit out of the sample application, and then issue the `at&f*` command to erase the file system and all non-volatile data.

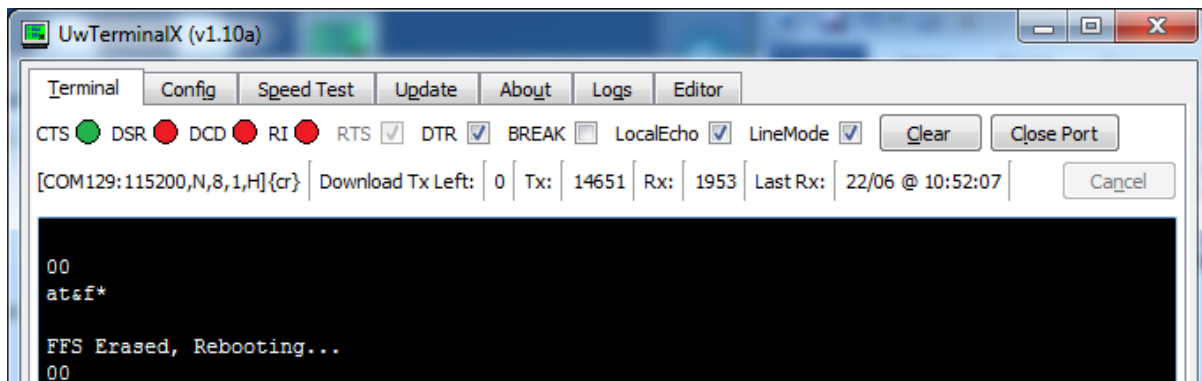


Figure 3: Return BL654 to factory default settings

## 4 RUNNING LOW POWER APPLICATION

The low power modes application can be downloaded and extracted from the Zip file from GitHub, or saved from the GitHub raw file page:

<https://github.com/LairdCP/BL654-Applications/blob/master/Applications/lp.low.power.deep.sleep.sb>

**Note:** This application note assumes that you are familiar with loading smartBASIC applications onto the BL654 module using UwTerminalX. If not, see the application note “Loading smartBASIC Applications - BL654,” available in the Documentation tab of the [BL654 product page at lairdtech.com](http://lairdtech.com).

### 4.1 Deep Sleep Mode

To measure the deep sleep current, complete the following steps:

1. Since the application is placed into deep sleep mode through `SystemStateSet(0)` smartBASIC function, ensure that the function is not commented out in the file ([Figure 4](#)).

```
56 //*****
57 // Equivalent to main() in C
58 //*****
59
60 PRINT "To get the expected low power consumption please remove jumpers J3 and J4 on your DVK-BL652 board."
61
62 rc=gpiofunc(17,2,0) //Sets LED 0 to digital out low
63 rc=gpiofunc(19,2,0) //Sets LED 1 to digital out low
64 rc=gpiofunc(3,2,0) //Disables the temperature sensor
65 while (uartinfo(5) > 0)
66     //Wait for the UART transmit buffer to empty
67 endwhile
68 uartclose() //Closes the UART
69 rc=gpiofunc(6,2,0) //TX - set high on default
70 rc=gpiofunc(5,2,0) //RTS
71
72 //Put module into deep sleep
73 rc = SystemStateSet(0)
74
```

**Figure 4: Placing module into deep sleep mode**

2. Load the Low Power application – use the right-click menu on UwTerminalX window and select XCompile + Load and browse to the `lp.low.power.deep.sleep.sb` location on your computer.
3. You can ensure that the application is loaded by issuing `at+dir` as shown in [Figure 5](#).

```
00
at+dir
06 lp
00
```

**Figure 5: Checking file system**

4. Run the low power application by typing `at+run lp`.
5. Through the current measuring DMM, current should fall to about 0.5 uA ([Figure 6](#)).

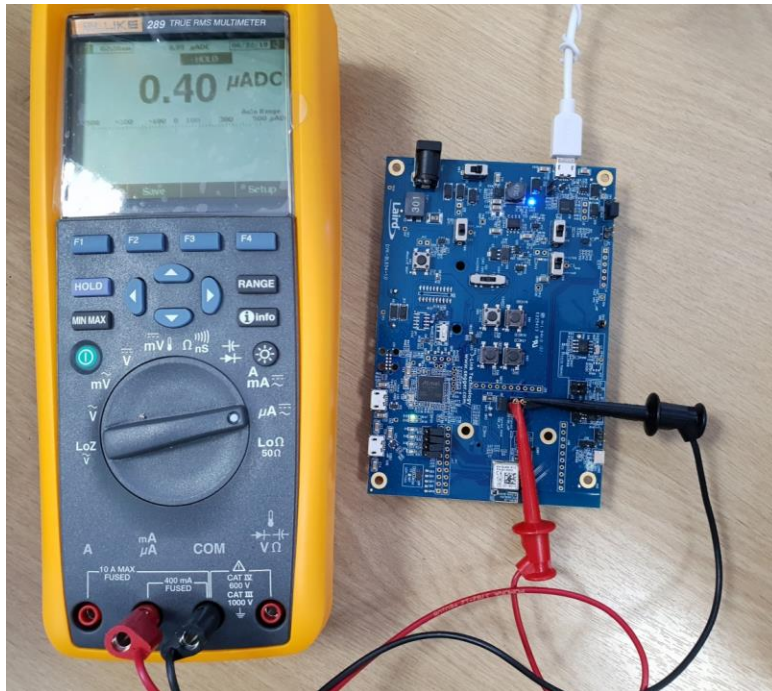


Figure 6: The current falls to about 0.4uA (400nA) when placed in deep sleep mode

**Note:** The only way to exit deep sleep mode is through a hardware reset. This returns the BL654 into interactive mode or runs an \$autorun\$ application if one exists in the file system.

## 4.2 Standby Doze Mode

To measure the standby doze mode current, complete the following steps:

1. The BL654 is placed into standby doze mode when the smartBASIC application reaches WAITEVENT and there are no pending events. To achieve this through the low power mode application, comment out the `SystemStateSet(0)` line in the `lp.low.power.deep.sleep.sb` file as shown in Figure 7.

```
62 rc=gpiofunc(17,2,0) //Sets LED 0 to digital out low
63 rc=gpiofunc(19,2,0) //Sets LED 1 to digital out low
64 rc=gpiofunc(3,2,0) //Disables the temperature sensor
65 while (uartinfo(5) > 0)
66     //Wait for the UART transmit buffer to empty
67 endwhile
68 uartclose() //Closes the UART
69 rc=gpiofunc(6,2,0) //TX - set high on default
70 rc=gpiofunc(5,2,0) //RTS
71
72 //Put module into deep sleep
73 //rc = SystemStateSet(0)
74
75 //-----
76 // Wait for a synchronous event.
77 // An application can have multiple <WaitEvent> statements
78 //-----
79 waitevent //Waits for an event to happen
80
```

Figure 7: Placing module into standby doze mode

2. Reset the BL654 using the reset button (SW3).
3. Erase the flash file system using the interactive command `at&F*`.
4. Load the Low Power application – use the right-click menu on UwTerminalX window and select **XCompile + Load** and browse to the `lp.low.power.deep.sleep.sb` location on your computer.
5. Run the low power application by typing `at+run "lp"`.
6. Through the current measuring DMM, the current should fall to about 3.1 uA to 3.7 uA (Figure 8).

**Note:** Once you're done with the current measurement, place the jumper back on J7 as otherwise the BL654 will not be powered (through the USB port) and will be powered parasitically instead.

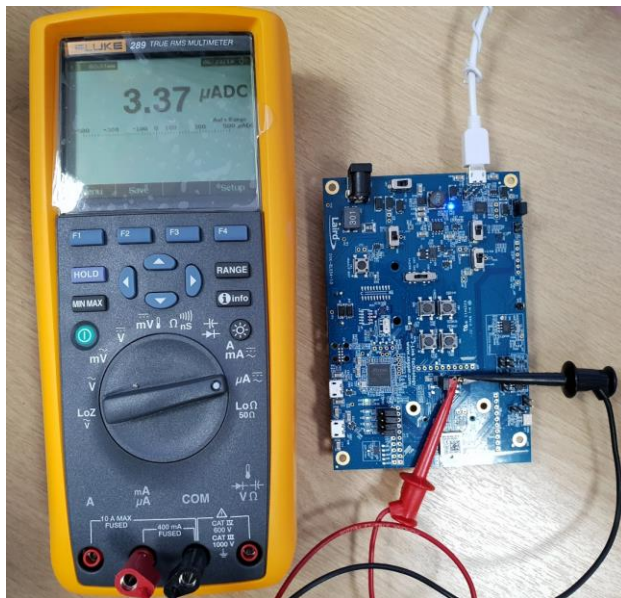


Figure 8: The current falls to about 3.3uA (3.1 uA to 3.7 uA is expected value) when placed in standby doze mode

## 5 FURTHER INFORMATION

Additional documents are also accessible from the Documentation tab in the [BL654 product page](#) of lairdtech.com.

## 6 REVISION HISTORY

Version	Date	Notes	Contributor(s)	Approver
1.0	25 June 2018	Initial Release	Raj Khatri	Jonathan Kaye
1.1	17 July 2018	Made the following changes Through the current measuring DMM, current should fall to about <b>0.4 uA</b> (changed to 0.5 uA) Through the current measuring DMM, the current should fall to about <b>2.1uA</b> (changed to 3.1 uA to 3.7 uA)	Raj Khatri	Jonathan Kaye