Using Direct Test Mode

BL652 Series

Application Note *v2.0*

1 Introduction

The BL652 firmware natively supports Direct Test Mode (DTM) commands as specified in the Bluetooth SIG's Bluetooth Core Specifications v 4.1 vol. 6 part F - Direct Test Mode, found at www.bluetooth.com/specifications/bluetooth-core-specification.

The purpose of DTM is to test the operation of radio at the physical level, such as Transmit power and Receiver Sensitivity. This is useful for regulatory EMC testing or for co-located radio testing with another radio system.

This radio test can be carried out by dedicated test equipment (such as Anritsu MT8852 or similar) with the BL652 in DTM mode as the device under test. Alternatively, one can send DTM commands from PC using a terminal program like UwTerminalX. In both cases, the DTM commands are the same.

This document describes BL652 radio testing using the in-built Direct Test Mode (DTM) firmware and Nordic's nRFgo Studio.

- Entering DTM mode for the BL652
- Using Nordic nRFgoStudio DTM panel to BLE radio test BL652 in either Transmit or Receive mode.
- Exiting DTM mode for the BL652

2 Requirements

You will require the following:

- DVK-BL652-1.0 development board
- Windows PC
- UwTerminalX by Ezurio (available at https://github.com/LairdCP/UwTerminalX/releases
- Nordic nRFgoStudio application software (the complete install found on the Downloads panel at the following link: http://www.nordicsemi.com/eng/Products/Bluetooth-low-energy/nRF52832

Note: Please install the correct version (32- or 64-bit) for your operating system.

Code	Name	Version
nRFgo Studio-Win32	Software tool for nRFgo Starter Kit and Development Kits for 32-bit (x86) Windows XP, Windows Vista, Windows 7, and Windows 8	1.21.2
nRFgo Studio-Win64	Software tool for nRFgo Starter Kit and Development Kits for 64-bit (x64) Windows Vista, Windows 7, and Windows 8	1.21.2

3 Setup

We assume the DVK-BL652-1.0 development has its default out-of-the-box settings as described in the BL652 Quick Start Guide at http://www.ezurio.com/bl652-quick-start. In this mode, it is running a sample *smart*BASIC application on power up. This means it is in nAutoRUN mode by default.

To bring the BL652 module back into AT or "interactive" mode, move the J12 nAutoRUN jumper from its default position (over pins 2-3) to the interactive mode position (over pins 1-2) as shown below. Then uncheck DTR from UwTerminalX, and press the reset button, also shown below in Figure 1.

Note: You may also tick and then untick the BREAK checkbox in UwTerminalX to reset the board.

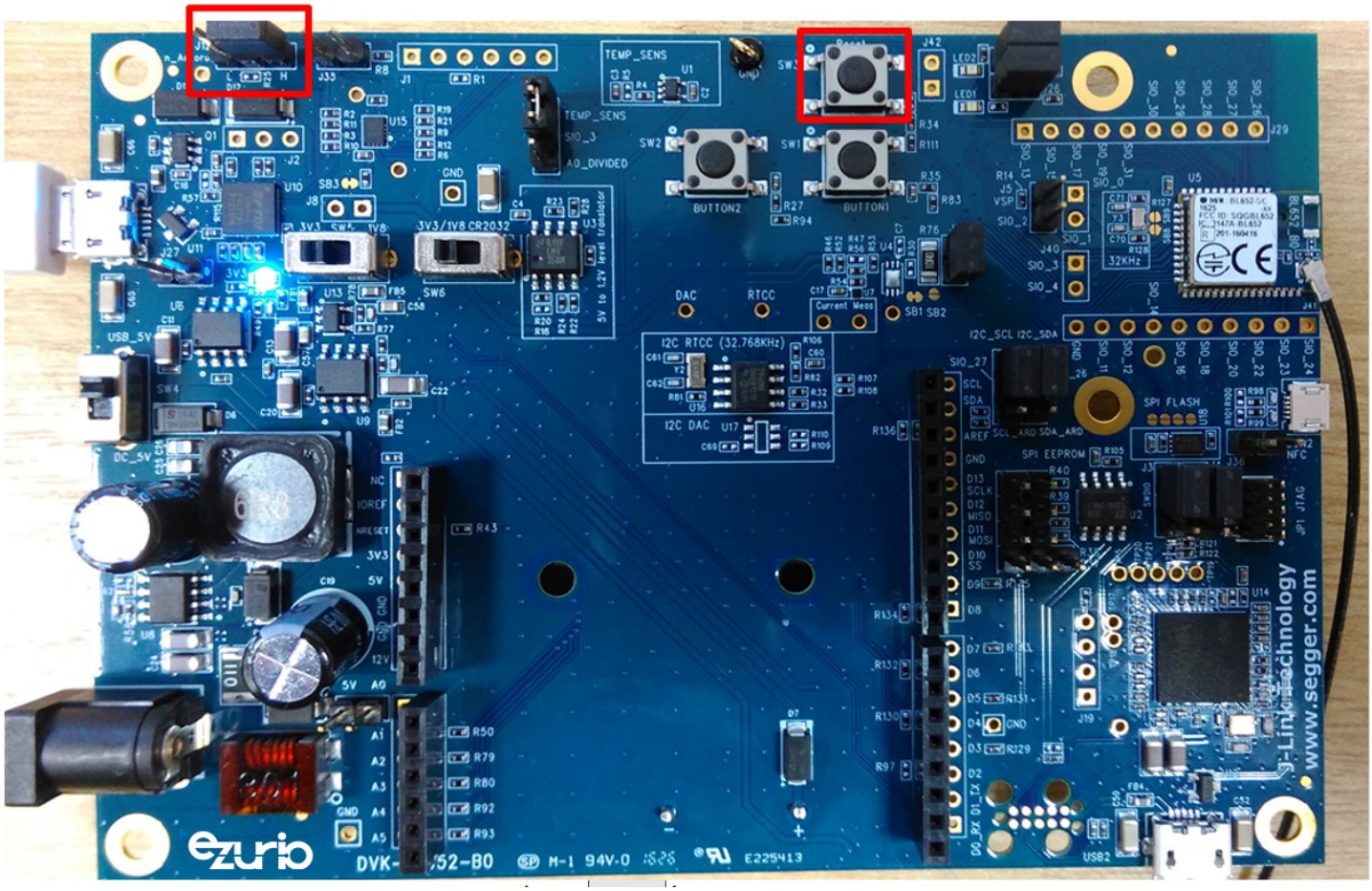

Figure 1: J12 fitted over pins 1 and 2, and SW3 (reset button)

4 Entering Direct Test Mode

Module needs to be in AT mode. Open UwTerminalX. Ensure you're using the latest version of UwTerminalX by clicking on the *Update* tab, and then in the UwTerminalX panel, click **Check For Updates**.

When you're running the newest version of UwTerminalX, open the *Config* tab. In the device drop down, select *BL652* to populate the default communications settings, and then select the correct COM port.

If you cannot select *BL652,* manually select the following UART settings (shown in Figure 2):

- **COM Port**: [Port corresponding to your Development Kit]
- **Baudrate:** 115200
- **Parity:** None
- **Stop Bits**: 1
- **Data Bits**: 8
- **Handshaking**: CTS/RTS

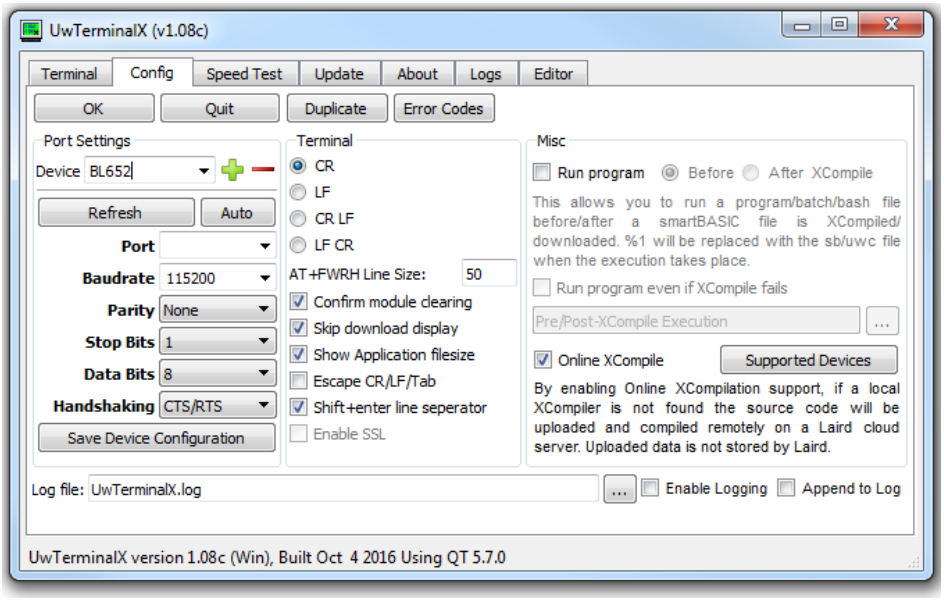

Figure 2: UwTerminalX Settings

Click **OK** to connect.

Then, to set up the module into Direct Test Mode, you will need to retrieve two sets of four characters each which function as a unique passcode to enter direct test mode. To retrieve the characters, issue the following command:

```
AT I 14
```

You should receive a response such as:

```
10      14      01 123456789ABC
```

Note the characters in the highlighted positions above. In our example in Figure 3, they are DB08 and 6494.

Figure 3: Return from at i 14

Finally, to enter Direct Test Mode, using the characters you found in the previous steps, issue the AT+DTM command as follows:

```
AT+DTM 0xDB086494
```

The module has entered Direct Test mode. Click **Close Port** to disconnect the development board from UwTerminalX.

5 Using Direct Test Mode

Now that the module is in Direct Test Mode, it will now accept DTM commands as specified in the BT SIG Bluetooth Core Specifications. See Bluetooth Core Specifications v 4.1 vol. 6 part F - Direct Test Mode, at https://www.bluetooth.com/specifications/bluetooth-core-specification.

To use Direct Test Mode, you'll need Nordic's nRFgo Studio, found at: http://www.nordicsemi.com/eng/Products/Bluetooth-low-energy/nRF52832

Once BL652 is in DTM mode, one can communicate with BL652 over the UART with UwTerminal using the following communications settings:

- **COM Port**: [Same as before]
- **Baud Rate**: 19200
- **Parity**: None
- **Stop Bits**: 1
- **Data Bits**: 8
- **Handshaking**: CTS/RTS

5.1 Optional: Configuration of Module Settings

Before entering DTM Mode, you may configure Tx Power, Baud Rate, and DCDC. It is not required to change these values. However, if you choose, you may set these values as follows:

5.1.1 Tx Power

Command:	AT+DTMCFG 1 *n*
Values for n:	4, 0, -4, -8, -12, -16, -20, -40
Default	4

5.1.2 Baud Rate

Command:	AT+DTMCFG 2 *n*
Values for n:	9600, 14400, 19200, 38400, 57600, 115200
Default	19200

5.1.3 DCDC

Command:	AT+DTMCFG 3 *n*
Values for n:	0 (Disabled), 1 (enabled)
Default	1

5.2 Start Direct Test Mode with nRFgo Studio

To begin using Direct Test Mode, open Nordic nRFgo Studio. In nRFgo Studio click **Direct Test Mode** in the features panel to open the Direct Test Mode panel as shown in Figure 4.

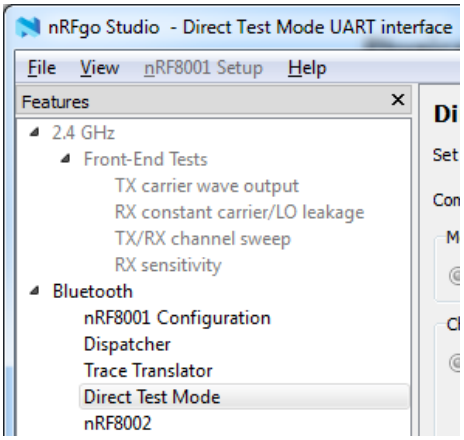

Figure 4: Opening the Direct Test Mode panel

From there, you can place the module in constant Tx or Rx mode. Consult the nRFgo Studio built in help for more information.

5.3 Transmit Test

To conduct a transmit test, configure the options in the Direct Test Mode panel as follows:

- **COM Port**: [Same as previous]
- **Mode:** Transmit
- **Channel**: 19 (2440 MHz)
- **Payload model**: Either-
    - **PRBS9** (if BLE-modulated Tx signal is required)
    - **Constant Carrier** (if continuous [CW] Tx signal is required
- **Payload Length**: 37 bytes

Once configured, click **Start Test**. If successful, no errors should show, as illustrated in Figure 5:

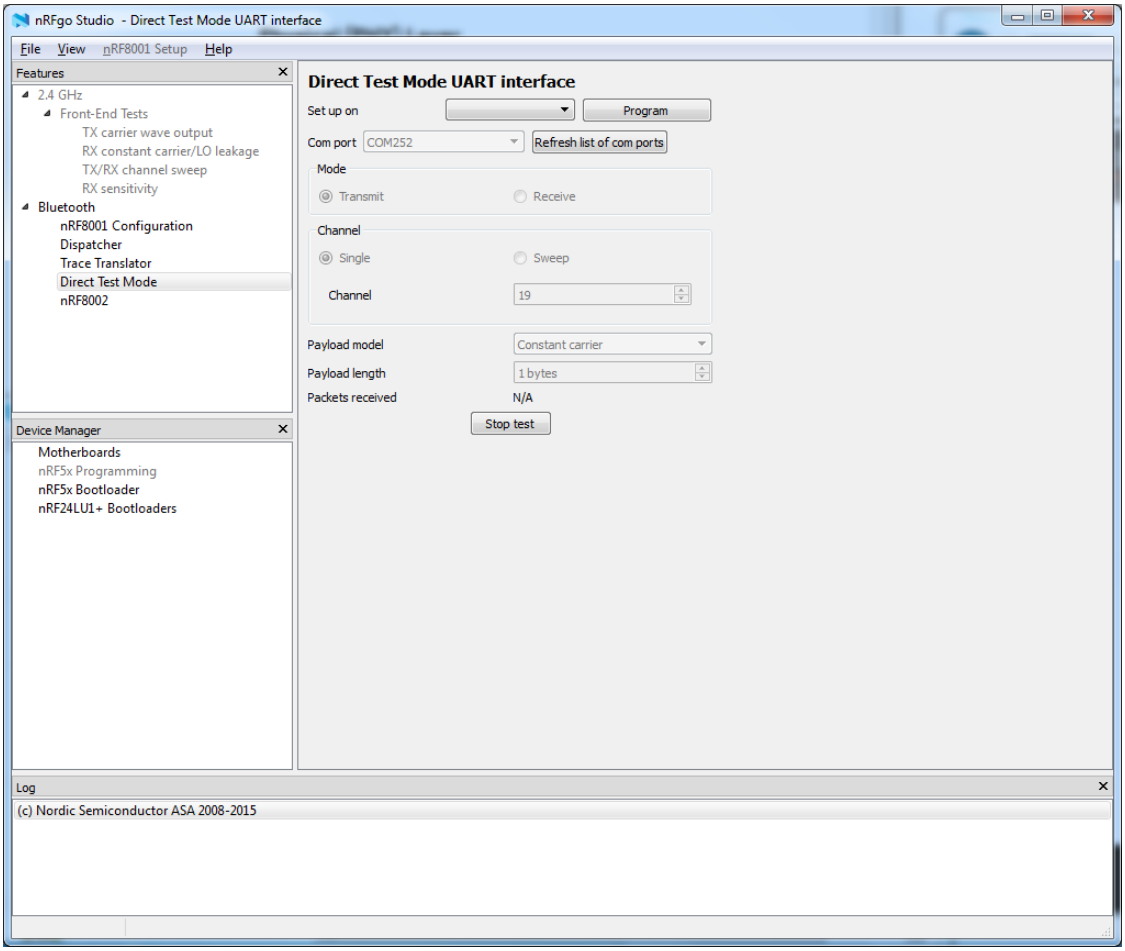

Figure 5:Successful initiation of Tx Test

With the module is in a Transmit test, you may measure the signal on a spectrum analyzer.

5.4 Receive Test

To conduct a receive test, configure the options in the Direct Test Mode panel as follows:

- **COM Port**: [Same as previous]
- **Mode:** Receive
- **Channel**: 0 (2402 MHz)

Once configured, click **Start Test**. If successful, no errors should show.

Note: Rx Mode produces an RX LO leakage at frequency that is 2*fRx-1MHz.

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6 Exiting DTM Mode

Open UwTerminalX with the following settings:

- **COM Port**: [Same as previous]
- **Baud Rate**: 19200
- **Parity**: None
- **Stop Bits**: 1
- **Data Bits**: 8
- **Handshaking**: None

Click **OK** to connect.

Right-click the terminal screen and in the context menu, click **Automation.** In the following screen, modify the fields as shown in Figure 6:

1. In the first field, enter \3F\FF.
2. Tick the box for **De-Escape Strings.**

Click **Send.**

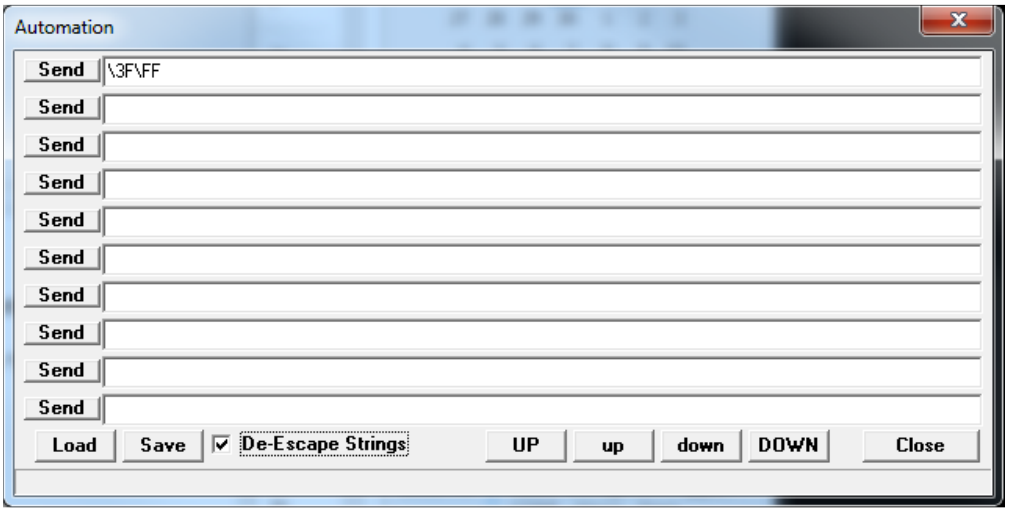

Figure 6: Automation dialogue

After this command is complete, close UwTerminalX. Then re-open it and connect to the BL652 with its default parameters:

- **COM Port**: [Same as previous]
- **Baudrate:** 115200
- **Parity:** None
- **Stop Bits**: 1
- **Data Bits**: 8
- **Handshaking**: CTS/RTS

Click **OK** to connect. Check that you get a response by pressing *Enter* in the terminal window. You should receive back:

```
00
```

Lastly, issue the following command to erase non-volatile data and the module's file system:

```
at&f*
```

The module will erase its file system and reboot, as shown in Figure 7.

Figure 7: at&f to erase and reboot module*

7 Revision History

Version	Date	Notes	Approver
1.0	18 Jan 2017	Initial Release	Jonathan Kaye
1.1	25 Mar 2021	Fixed RX LO leakage at frequency that is **2*fRx-1MHZ**	Raj Khatri
2,0	20 Mar 2025	Ezurio rebranding	Dave Drogowski