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## Enabling the Bluetooth low energy direct test mode (DTM) with BlueNRG-MS

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Main components	
BlueNRG-MS	Upgradable Bluetooth® Low Energy network processor
SPBTLE-RF	Very low power module for Bluetooth® Smart v4.1
SPBTLE-RF0	Very low power module for Bluetooth® Smart v4.1

### Purpose and benefits

The BlueNRG-MS is a very low power Bluetooth® low energy (BLE) single-mode network processor, compliant with Bluetooth core specification v4.1. The entire BLE stack runs on the embedded Cortex M0 core. The device interfaces with an external host microcontroller using the SPI transport layer and a set of APIs composed of standard Host Controller Interface (HCI) commands and vendor-specific Application Command Interface (ACI) commands.

Among the set of HCI commands is a subset of commands used in order to enable Direct Test Mode (DTM) as described in the Low Energy Controller Volume in the Bluetooth core specification v4.1.

DTM is used to control the “Device Under Test” (DUT) and provides a report back to the Tester. According to the specification, DTM shall be set up using one of two alternate methods:

1. over HCI
2. through a 2-wire UART interface

BlueNRG-MS implements the first method, “over HCI”.

The purpose of this document is to detail how to setup DTM working with the BlueNRG-MS device.

Note that the content of this document applies to the SPBTLE-RF and SPBTLE-RF0 modules.

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## Description

BlueNRG-MS supports the DTM as per Bluetooth core specification v4.1 [Vol. 6, Part F].

The HCI test commands, which are fully compliant with the specifications, are the following:

HCI\_LE\_Transmitter\_Test

HCI\_LE\_Receiver\_Test

HCI\_LE\_Test\_End

For reference, the function prototypes are listed below:

```
int hci_le_receiver_test(uint8_t frequency);
```

```
int hci_le_transmitter_test(uint8_t frequency, uint8_t length, uint8_t payload);
```

```
int hci_le_test_end(uint16_t *num_pkts);
```

These commands can be found within the HCI interface driver files `hci_le.c` and `hci_le.h` in the device Development Kit (DK) available online at [www.st.com](http://www.st.com).

The number of the received test packets is a return value of the function `HCI_LE_Test_End`.

Additionally, the following functions are available in the files `bluenrg_hal_aci.c` and `bluenrg_hal_aci.h`:

- `tBleStatus aci_hal_le_tx_test_packet_number(uint32_t *number_of_packets);`
  - This command provides the number of the transmitted test packets during a DTM test.
- `tBleStatus aci_hal_set_tx_power_level(uint8_t en_high_power, uint8_t pa_level);`
  - This command is used to set the TX output power. The ACI command set Reference Manual (UM1865) contains a complete description on the TX power levels values.
- `tBleStatus aci_hal_tone_start(uint8_t rf_channel);`
  - This command is used to generate a Continuous Waveform (CW) from the BlueNRG-MS radio.
- `tBleStatus aci_hal_tone_stop(void);`
  - This command is used to terminate the CW emission.

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The command sequence below is a typical flow for enabling CW transmission from the BlueNRG-MS radio:

- hci\_reset
- aci\_hal\_set\_tx\_power\_level
- aci\_hal\_tone\_start
- aci\_hal\_tone\_stop

### Using the BlueNRG evaluation kits for DTM tests

For the BlueNRG-MS device, the evaluation kits are named STEVAL-IDB005V1, STEVAL-IDB006V1 and STEVAL-IDB006V1M. While using these kits, the following procedure can be followed to enable DTM test mode:

- Download from [www.st.com](http://www.st.com) the BlueNRG GUI software and open it on the PC.
- The Device Firmware Update (DFU) application is preloaded in the STM32L1 Flash with a sample application.
- The DFU application must be started to load the VCOM firmware to run the DTM tests. Using the GUI, load the VCOM firmware onto the evaluation board's STM32L1, overwriting the sample application. To do this:
  - If working with STEVAL-IDB006V1 or STEVAL-IDB006V1M, then press and hold the SW1 button and plug the USB Dongle on a PC USB port, then release the button. The board now is in DFU mode. Wait for the success message indicating the DFU driver is installed properly.
  - If working with STEVAL-IDB005V1, connect the board to the PC USB port. Then press and hold at the same time both the Reset and Push Button on the board. Then keeping the Push button pressed, release the Reset button after at least 2 seconds. The DL2 amber LED will start blinking. The board now is in DFU mode. Wait for the success message indicating the DFU driver is installed properly.
- In the BlueNRG GUI, go to "Tools -> Flash Motherboard FW..." then click OK in the pop-up window and select from the file explorer the file "BlueNRG\_VCOM\_1\_8.hex". This file is located in the folder "\Firmware\STM32L1\_prebuilt\_images" of the BlueNRG GUI installation path.
- After the VCOM firmware has been programmed on the board, the board will be assigned to a COM port in the PC. In the GUI, in the drop-down menu next to the "Port" label, a COM port labelled "(ST DK)" will be visible. Select this COM port and then click on the "Open" button. At this point, the GUI is capable of sending commands to and receiving response and events from the BlueNRG-MS device.
- Select the "RF Test" tab in the GUI (see Figure 1). Set the RF parameters as desired. In the "TRANSMITTER" section, the "Start Transmitter" button will start the

DTM transmitter test while the “Start Tone” button will start the CW test. In the “RECEIVER” section, the “Start Receiver” button will start the DTM receiver test. Note that only one DTM transmitter test, DTM receiver test, or CW test can be performed on the board at a time.

Note: the VCOM firmware is provided in the BlueNRG SDK both in binary form precompiled for the STM32L microcontroller and in source form. The source code is available in the BlueNRG DK (downloadable at [www.st.com](http://www.st.com)) in a reference project for IAR Embedded Workbench Integrated Development Environment (IDE). The project name is “VirtualCOMPort.eww” and it is located in the folder “\Projects\Projects\_STD\_Library\Virtual\_COM\_Port\EWARM”. Refer to the IAR workspace named “USB”.

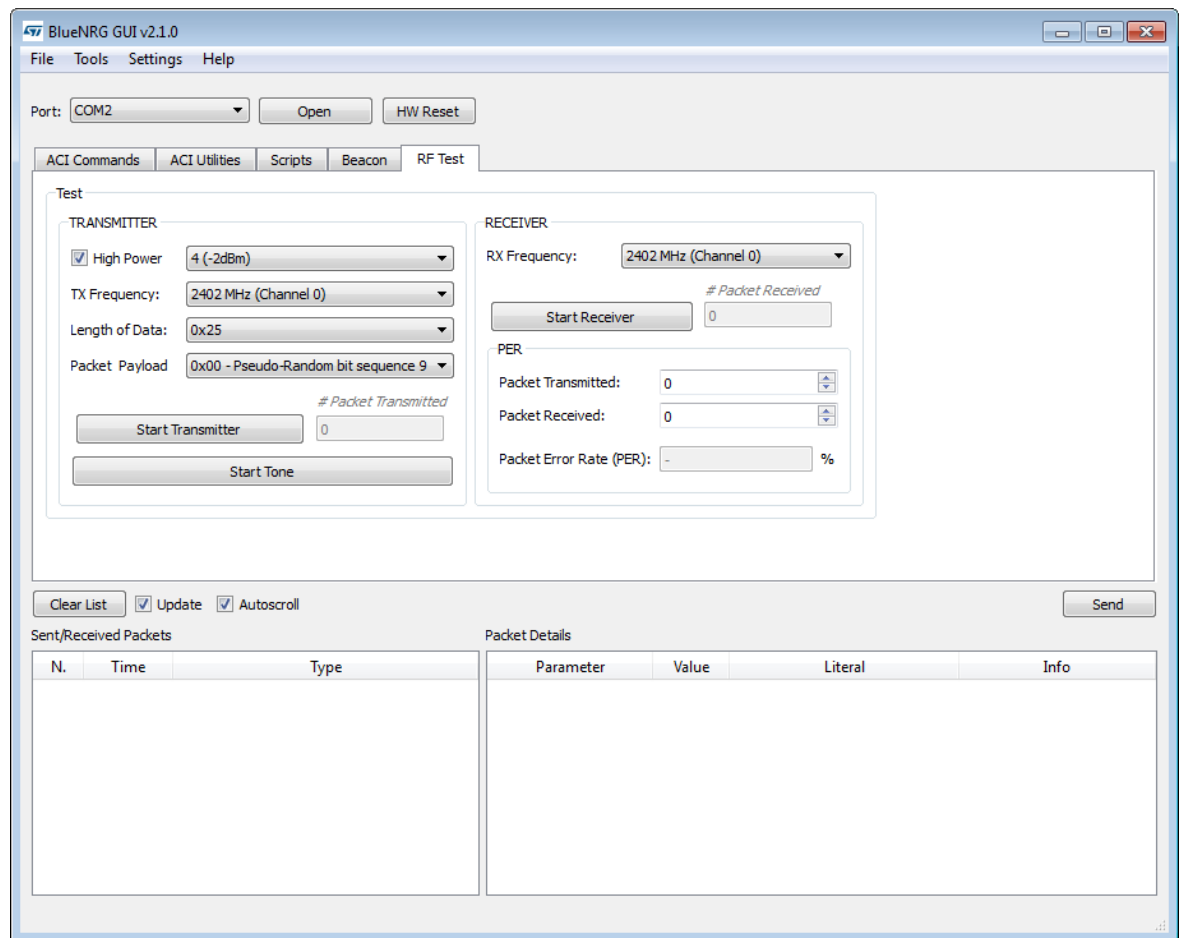


Figure 1: BlueNRG GUI v2.1.0 - RF Test Tab

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## Support material

Related design support material
STEVAL-IDB005V1 – Bluetooth® low energy board based on the BlueNRG-MS network processor
STEVAL-IDB006V1 - BlueNRG-MS based Bluetooth® Smart USB
STEVAL-IDB006V1M - Bluetooth® low energy USB dongle based on the SPBTLE-RF module
Documentation
DS10691: Upgradable Bluetooth® low energy network processor
DS11045: SPBTLE-RF Very low power module for Bluetooth® Smart v4.1
UM1870: BlueNRG-MS development kits
UM1865: BlueNRG-MS Bluetooth® LE stack application command interface (ACI)
PM0237: BlueNRG, BlueNRG-MS stacks programming guidelines

## Revision history

Date	Version	Changes
26-Jun-2016	1	Initial release
19-Dec-2018	2	Updated to comply with new API functions. Added reference to the SPBTLE-RF0 module

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