AN13687

K32W148 Connectivity Test for 802.15.4 Application

Rev. 0 — 12 August 2022   **Application note**

Document information

Information	Content
Keywords	K32W148, 802.15.4, RF performance, FCC/CE Certification
Abstract	This Application note describe RF performance test with connectivity test tool using the K32W148 EVK board.

1   Introduction

The application note describes how to use the connectivity test tool to perform the K32W148 802.15.4 RF performance.

2   Test setup

2.1   Hardware

- K32W148 EVK of NXP
- A Mini USB cable
- A personal computer with a serial port terminal application installed

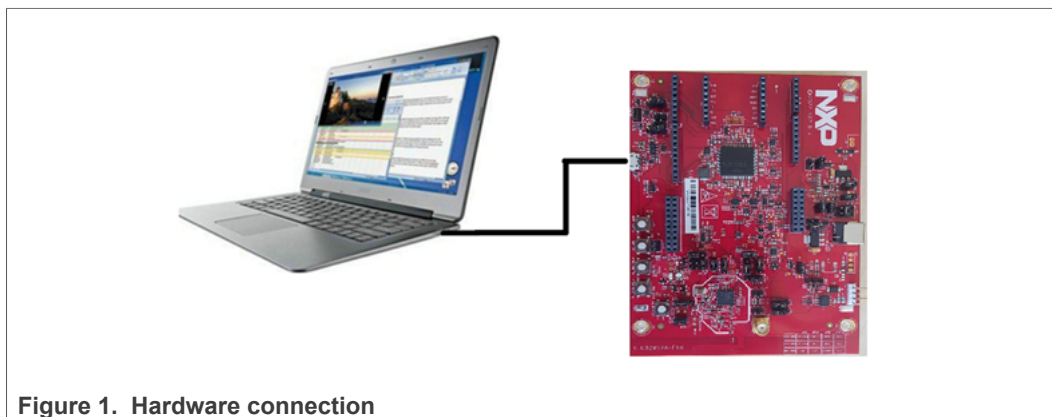As shown in Figure 1, connect the USB port of K32W148 EVK to PC USB port by the USB cable.

Figure 1.   Hardware connection

2.2   Software

- Firmware: Connectivity test, is located in K32W148 SDK
- Test tools: PuTTy or other terminal tools

2.3   Test preparation

1. Download the firmware into target board.
2. Set COM port terminal.
    a. Open the COM port terminal on your computer.
    b. Select the correct setting for COM port with 115200 baud rate.
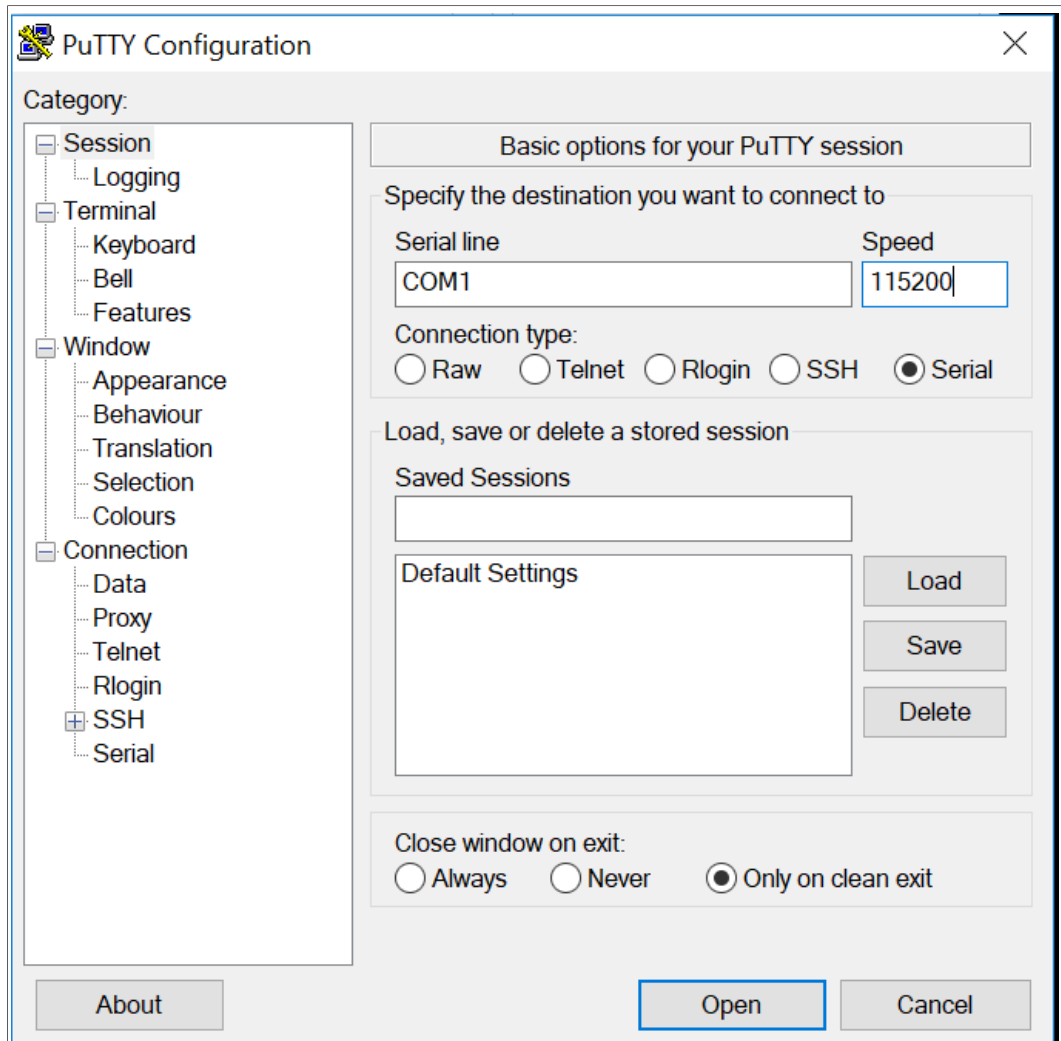   c. Taking Putty as an example, COM port setting is as shown in Figure 2.

Figure 2. COM port settings

3   Test items and options

The project uses COM port terminal as commands console to control the operations of K32W148 EVK. After the setup completes successfully, open Putty with the correct settings and then press the Reset button (SW1). The output is as shown in Figure 3.
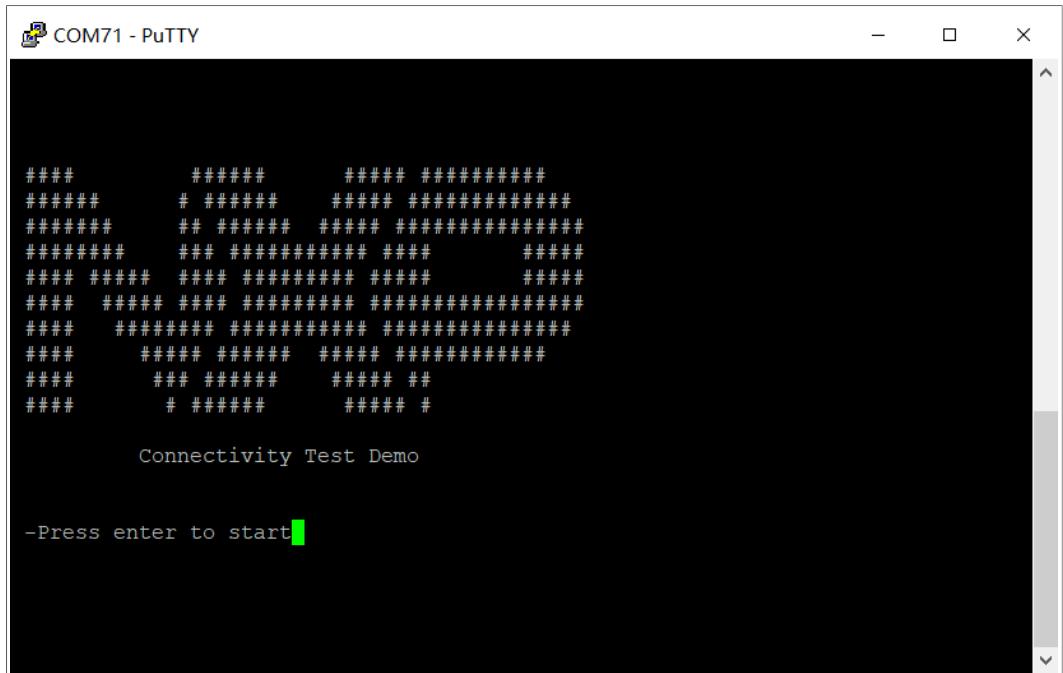
Figure 3. Initialization output

3.1 Test items

After pressing the Reset button (SW1) and the Enter key, the main menu with all the options and test items is as shown in Figure 4.
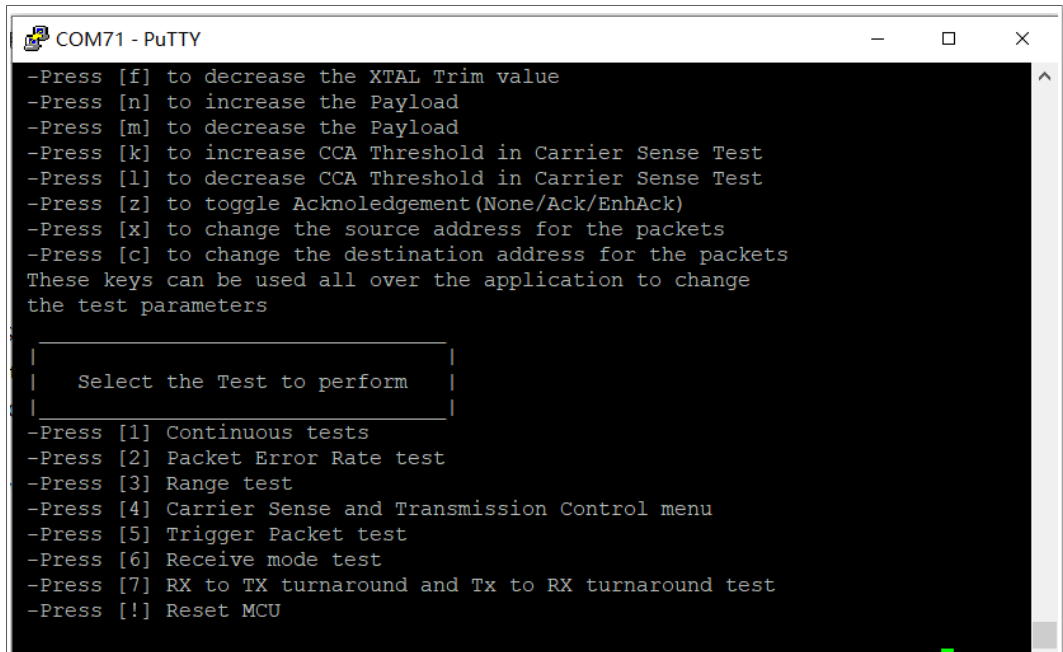

Figure 4. Main menu
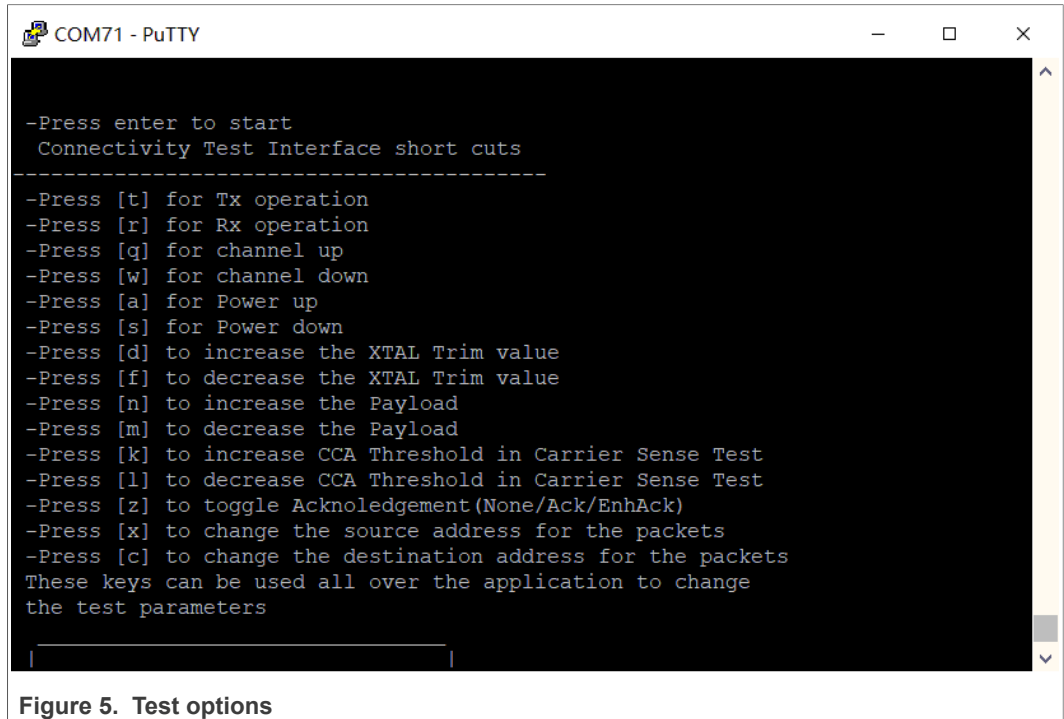
3.2 Test options

Figure 5. Test options

- Tx/Rx mode:
  - Press [t] for Tx operation.
  - Press [r] for Rx operation.
- Channel change:
  - Press [q] for channel up.
  - Press [w] for channel down.

  The K32W148 can be configured to use any channel frequency between ch11 and ch26 with each channel frequency interval 5 MHz. This parameter is used to select the channel number from ch11 to 26. The default channel is Channel 11.

Table 1. Channel

Channel	Frequency (MHz)
Ch11	2405
Ch12	2410
Ch13	2415
. .	. .
Ch18	2440
. .	. .
Ch26	2480

- Tx power:
  - Press [a] for power-up.
  - Press [s] for power-down.

Tx power is maximum 10 dBm when Power code is 32.
- Set the 32 MHz xtal trim value:
  - To increase the xtal trim value, press [d].
  - To decrease the xtal trim value, press [f].

  This value can be set from 0 to 127. To calibrate the 32 M clock accuracy, adjust the suitable value.
- Set the Payload length:
  - To increase the payload, press [n].
  - To decrease the payload, press [m].

  This parameter specifies the payload length when K32W148 needs to send a packet of data. The default payload length is 20. This parameter will be insignificance when Rx operation.
- CCA threshold:
  - To increase CCA threshold in carrier sense test, press [k].
  - To decrease CCA Threshold in carrier sense test, press [l].

  This parameter specifies the CCA threshold. It can be configured from 0 dBm to -110 dBm. Th default value is -80 dBm.
- Toggle acknowledgement (None/Ack/EnhAck):
  - Press [z].
- Change the source short address for packets:
  - Press [x].

  This parameter specifies the device short address. It can be configured from `0x0000` to `0xffff`.
- Change the destination short address for packets:
  - Press [c].

  This parameter specifies the device short address. It can be configured from `0x0000` to `0xffff`.

3.3 Test cases

3.3.1 Continuous tests

The test case puts the device into a transmission with continuous mode or a reception with continuous mode, as show in Figure 6.
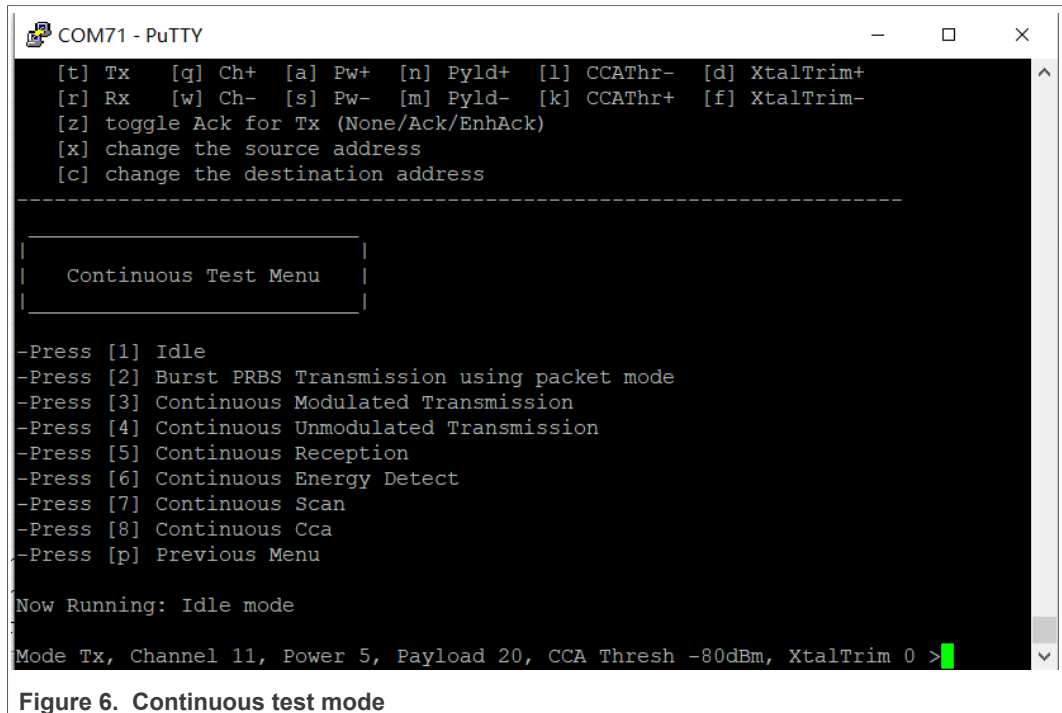
Figure 6. Continuous test mode

- To choose the Tx mode with burst PRBS transmission, press [2].
- To choose the Tx mode with Continuous modulated transmission, press [3].
  This mode can be used for Tx cases testing, such as, EVM and Tx output power and some test cases which related to FCC and CE and MIIT certification.
- To choose the Tx mode with Continuous unmodulated transmission, press [4].
  This mode is enabled for Tx output signal tone.
- To choose the Rx mode with Continuous Reception, press [5].
- To choose the Rx mode with Energy Detect, press [6].
  To exit this mode, press the Reset button (SW1).
- To choose the Rx mode with Signal Scan, press [7].
  To exit this mode, press the Reset button (SW1).
- To choose the Rx mode with channel CCA, press [8].
  To exit this mode, press the Reset button (SW1).

3.3.2 Packet Error Rate test

The test case allows the measurement of packet error rate using two boards running this mode. One device must be configured as a slave, and the other as a master that controls the test and displays the results, as show in Figure 7.
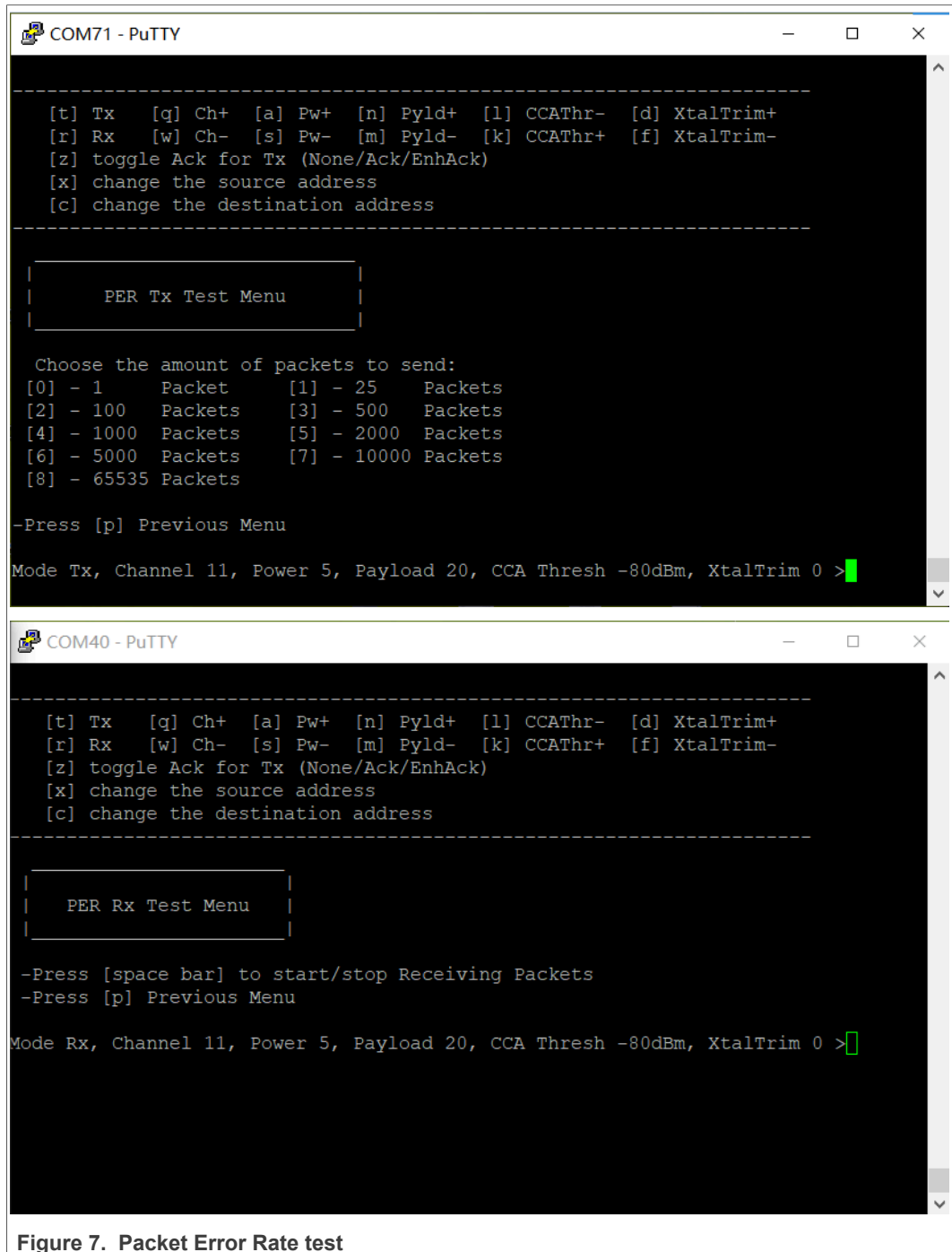
Figure 7. Packet Error Rate test

- To choose Packet Error Rate test and enable PER Test menu, press [2].
  Select Tx or Rx by option [t] and [r]. The default is Rx mode.
  – Tx mode for Master
    Choose the amount of packets to send and type the Tx interval. To enable packets send, press [enter].
  – Rx mode for Slave
    To start/stop receiving packets, press [Space bar].

3.3.3 Range test

The test case allows the measurement of range using two boards running this mode. One device must be configured as a slave, and the other device as a master that controls the test and displays the results, as show in Figure 8.
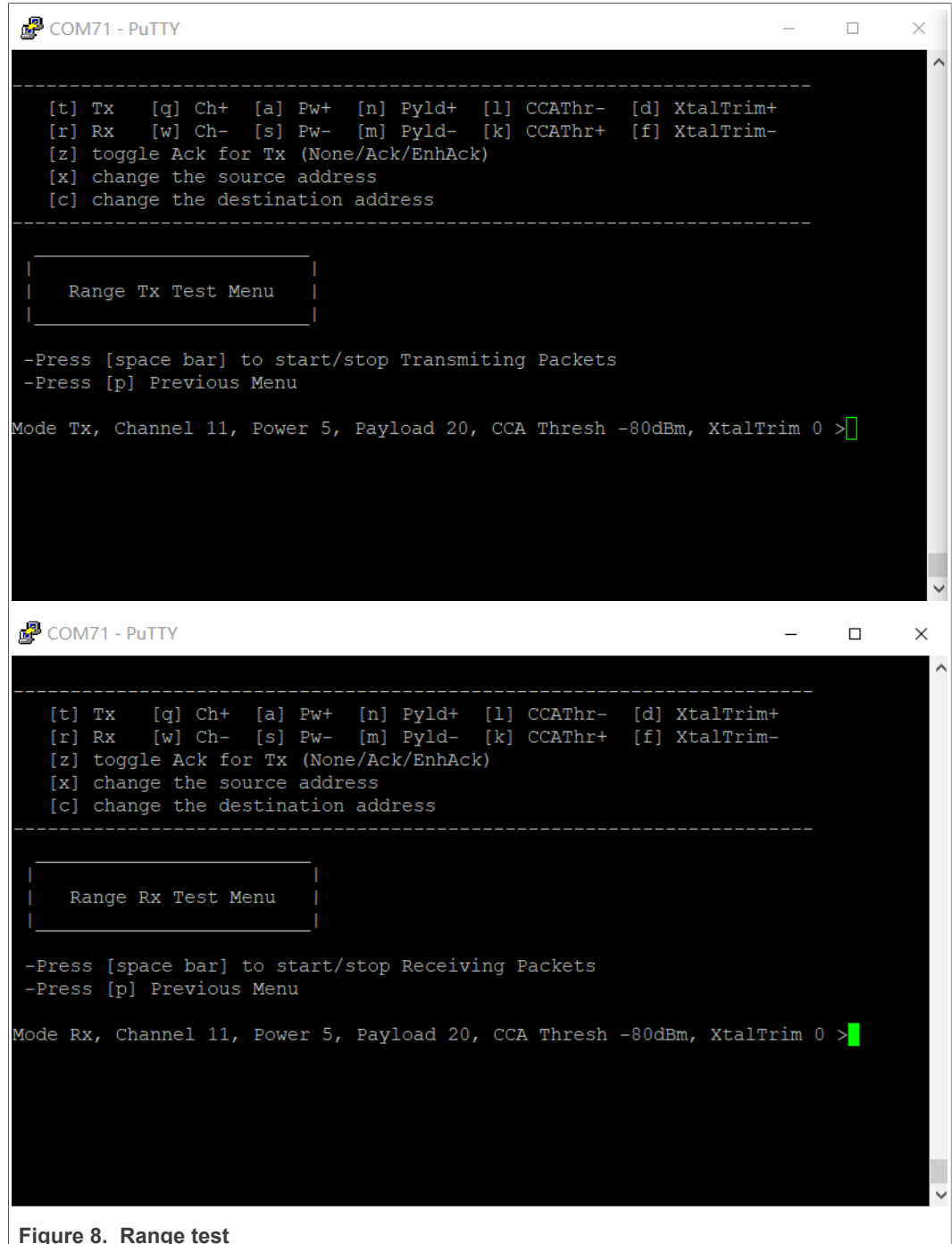

Figure 8. Range test

• To choose Range test and enable Range test menu, press [3].

Select Tx or Rx by option [t] and [r]. The default is Rx mode.
  – Tx mode for Master
    – To start/stop transmitting packets, press [space bar].
  – Rx mode for Slave
    – To start/stop receiving packets, press [Space bar].

3.3.4 Carrier sense and transmission control

To do some experiments if needed, adjust the carrier sense of the CCA threshold value.

- To choose carrier sense and transmission control test and enable the Test menu, press [4].
  – To choose the carrier sense test with un-modulation input signal, press [1].
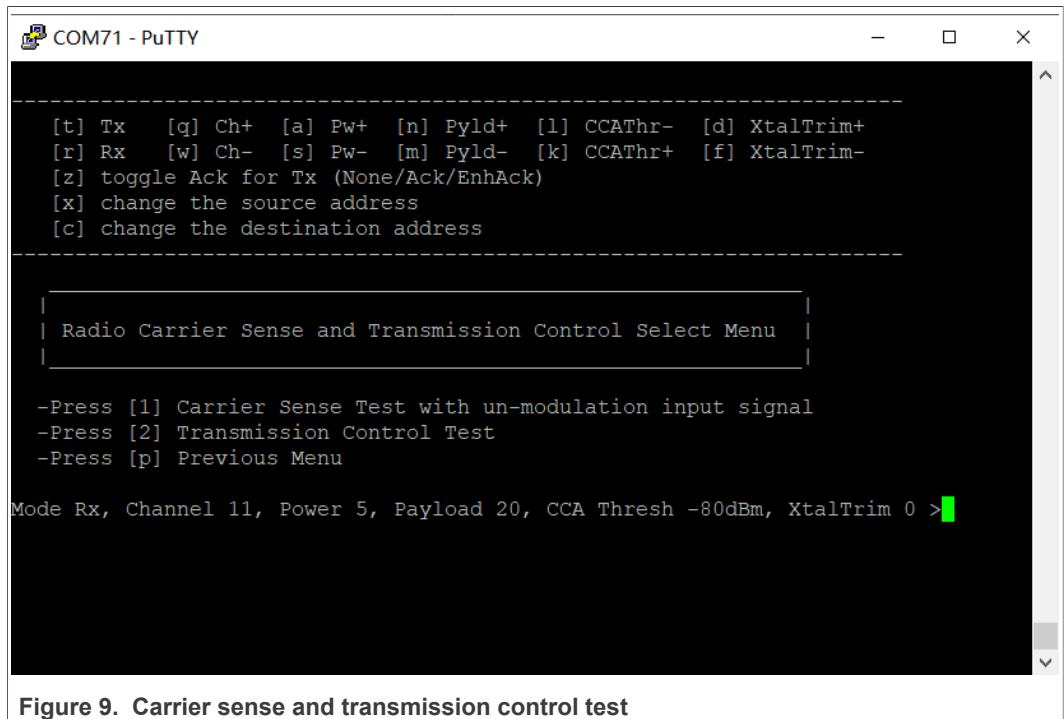 – To choose the transmission control test, press [2].

Figure 9. Carrier sense and transmission control test

3.3.5 Trigger packet test

The test case allows the measurement of Rx sensitivity, as shown in Figure 10.
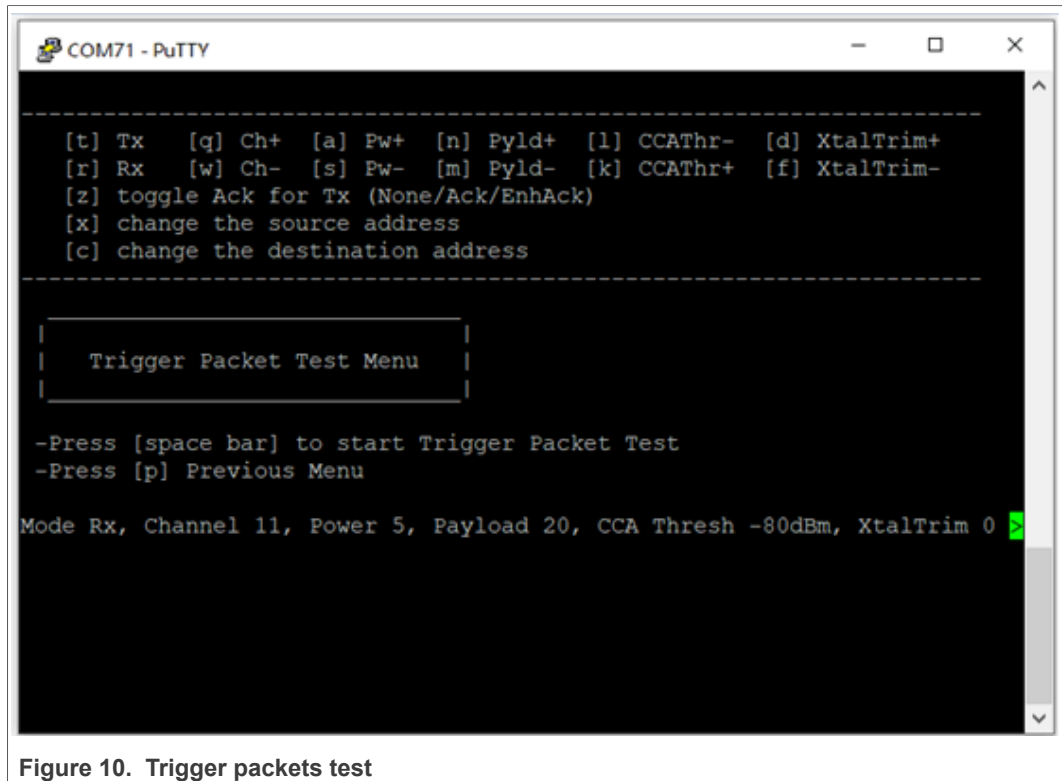
Figure 10. Trigger packets test

Connect the RFIO port of device to a RF signal generator and a GPIO of device to external trigger input of the RF generator. The RF generator must be supported for arbitrary waveform configuration and to generate an ideal packet each time when it is triggered. The default number of 1000 trigger pulses generated by the device GPIO. The trigger number can be configured by `#define trigger_cont` in *connectivity_test.h*.

The external trigger input of generator must be set in rising edge mode with an external delay equal to about 2 ms.

The device counts the number of packets received, It also displays the number of packets expected and number of packets actually received.

The GPIO pin that carries the trigger signal can be configured by configuring the **BOARD_TRIGGER_GPIO_PIN** in *connectivity_test.c*. The default value is PTA18 pin for this purpose.

- To choose trigger packets test and enable the Test Menu, press [5].
- To start the trigger packet test, press [space bar]. Wait for about 4 ms and it shows received packets.
- To go back to the test menu, press [enter].

3.3.6 Receive mode test

The test case allows the measurement of Rx receiver, as shown in Figure 11. In this mode, it enables Rx receiving continuously.
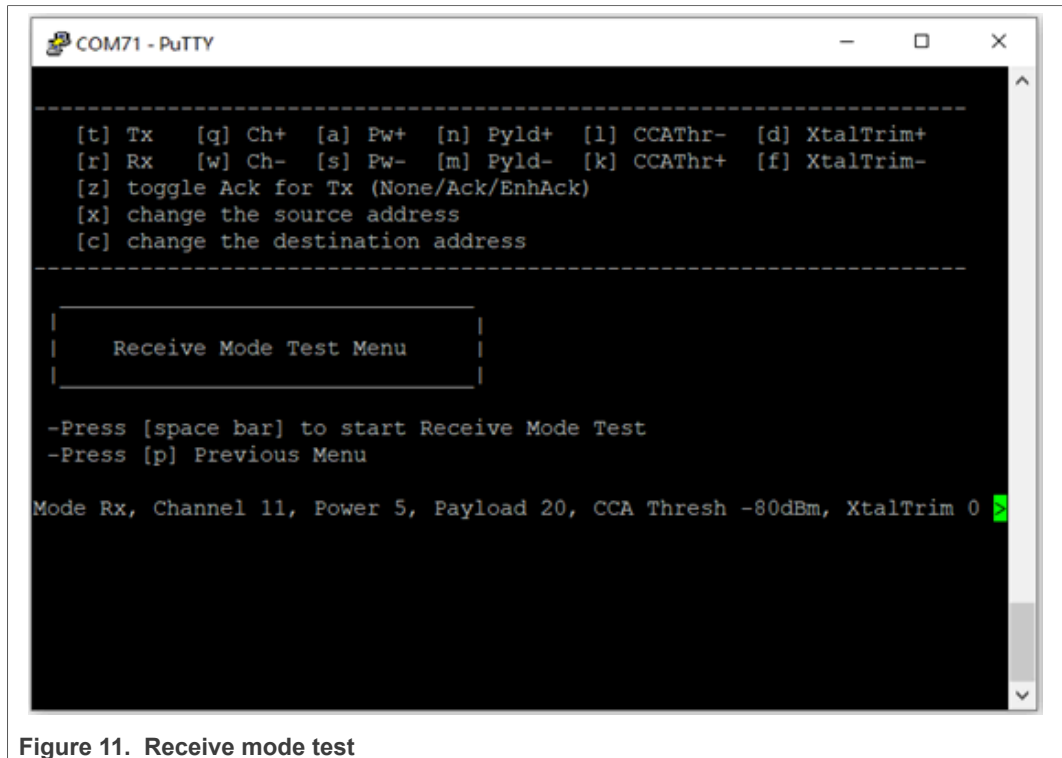
Figure 11. Receive mode test

To choose receive mode test and enable the Test menu, press [6].

- To start receiving packets and enable receiving mode, press [space bar].
- To stop the receiving packets mode and show number of received packets, press again [space bar].
- To go back to the receive test menu, press [enter].

3.3.7 Tx/Rx turnaround test

The Rx to Tx and Tx to Rx turnaround tests are part of the 802.15.4 PHY requirements.

- Rx to Tx:
  Connect the RFIO port of device to a RF signal generator. RF signal generator shall be configured to transmit a standard conforming signal and packet with an arbitrary payload and correct CRC to device.
  To choose the Rx to Tx turnaround and Tx to Rx turnaround test and enable the test menu, press [7].
  – To enable the Rx/Tx turnaround test, select the **Rx** mode by option [r].
  – To start receiving packets, press [space bar].
  The device is in receive mode and waiting for packets. Each time a packet has been received the device sends an acknowledge, the RF signals can be monitored with a spectrum analyzer and the delay between the end of the received packet and the start of the sent ACK can be measured,
- Tx to Rx:
  Connected the RFIO port of device to a RF signal generator and a GPIO of device (the default is PTD1) to external trigger input of the RF generator. The RF generator shall be configured to transmit an Acknowledge when requested by an external trigger signal.

To choose the Rx to Tx turnaround and Tx to Rx turnaround test and enable the test menu, press [7].

– To enable the Tx/Rx turnaround test, select the **Tx** mode by option [r].

– To start receiving packets, press [space bar].

The device sends a packet and generates a negative trigger on PTD1 at the end of the packet. At the reception of trigger signal, the generator sends an ACK. The delay between the start of the trigger and the actual beginning of the ACK sent by the device is the Tx-to-Rx turnaround time that can be measured. An acknowledge message is displayed in the windows and the device stops transmitting.

4   Revision history

Rev.	Date	Description
0	12 August 2022	Initial release

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Application note

Rev. 0 — 12 August 2022

14 / 15

Contents