

UM11861

NXP 802.15.4 Demo Applications for RW612

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User manual
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Document information

Information	Content
Keywords	Wireless MCU RW612, RW612 EVK board, MCUXpresso SDK, RTOS image
Abstract	Provides step-by-step guidance to configure, compile, debug, flash and run the 802.15.4 sample applications available in the MCUXpresso SDK. Also covers IDE configurations and tool set-ups.



1 Revision history

Revision history

Rev	Date	Description
v.1	7 December 2022	Initial version
v.2	17 July 2023	Modifications <ul style="list-style-type: none">• Section 3.4 "J-Link tool": updated the link to J-Link patch for RW61x• Section 4.1.1 "Build a demo application": updated• Section 4.1.2 "Flash 802.15.4 firmware": updated• Section 4.1.3 "Flash the application image": updated the command to flash the application image• Section 4 "Sample applications": updated the introduction• Section 4.1 "Ot-cli sample application": updated• Section 4.1.5 "NXP vendor commands": added the section• Section 5 "Acronyms and abbreviations": added ED and OTP• Section 7 "Note about the source code in the document": added

2 About this document

2.1 Purpose and scope

This document provides the steps to configure, compile, flash and run the 802.15.4 sample applications available in the MCUXpresso SDK. It also covers IDE configurations and the setup for the required tools on Windows operating system.

2.2 Considerations

RW612 is based on FreeRTOS, and integrates Wi-Fi 6, Bluetooth Low Energy, and 802.15.4 radios. This user manual does not include information about RW612 device, hardware interconnection, board settings, bring-up, IDE setup, or SDK download. Refer to the user manual reference UM11798 for these items (see [Section 2.3](#) below).

Users must install RW612 platform related IDE and tools before using the demo applications.

2.3 References

Table 1. Reference documents

Reference type	Description
User manual	MCUXSDKGSUG - Getting Started with MCUXpresso SDK (link)
User manual	UM11798 - Getting Started with Wireless on RW61x Evaluation board Running RTOS SDK <i>Documents available at SDK_<version>_RDRW610\docs\wireless</i>

3 Tool setup

3.1 Serial console tool

The serial console tool is used to input commands and read out the demo application logs on the computer connected to RW612 evaluation board.

- Download and install the terminal emulator software such as minicom (Linux / Mac OS) or Tera Term (Windows)
- Use the following settings for serial console access

```
Serial Port settings:  
- Determine COM port number  
- 115200 baud rate - 8 data bits - No parity  
- One stop bit  
- No flow control
```

3.2 GNU Arm embedded toolchain

- Download and run the installer from [GNU Arm Embedded Toolchain](#).
The toolchain includes the compiler, linker, and other tools.
- Check the version of GNU Arm Embedded toolchain. It should correspond to the version mentioned in MCUXpresso SDK Release Notes.

Note: GNU Arm Embedded Toolchain version 10-2021.10 is used as an example in this document.

- Update the Windows operating system path environment variable with the path to GNU Arm embedded toolchain
 - Go to *Control Panel->System and Security->System->Advanced System Settings*
 - Look for *Environment variables*
 - Add the path `<GNU_Arm_Embedded_Toolchain_install_dir>\bin`

Figure 1 shows an example where the default installation path is `C:\Program Files (x86)\GNU Arm Embedded Toolchain\10 2021.10`.

Note: The toolchain will not work if the path is not set correctly.

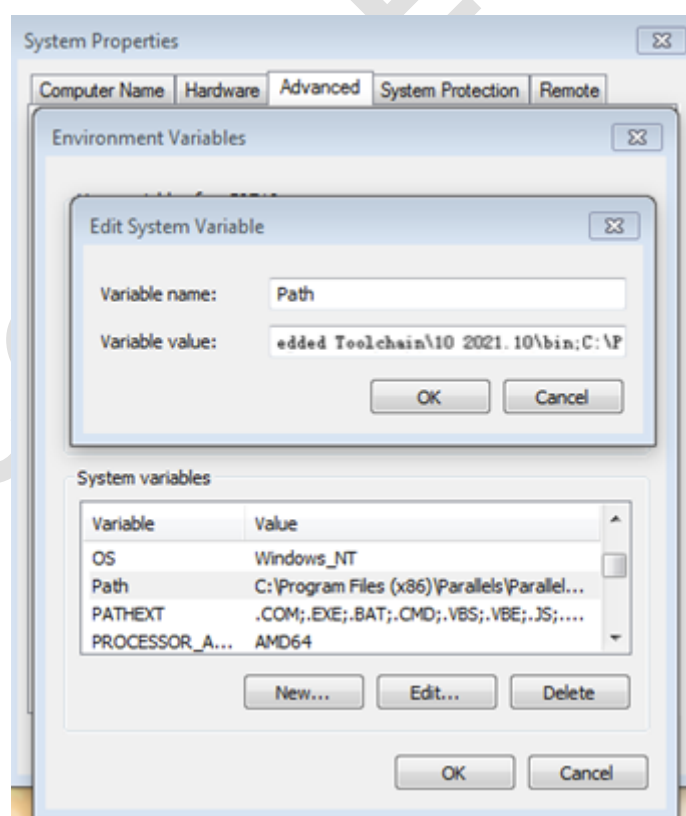


Figure 1. Adding GNU Arm embedded toolchain path to the system environment

3.3 CMake tool

- Download CMake 3.x from [CMake](#)
- Install CMake
 - Select the option *Add CMake to system PATH*
 - Choose the option to add CMake to system PATH for all users or just the current user

[Figure 2](#) shows the example of CMake installation with the option to add CMake to the system PATH for all users.

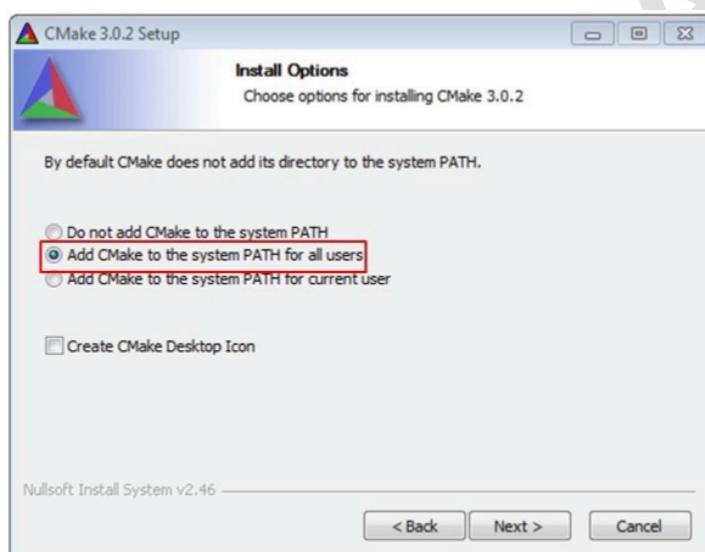


Figure 2. CMake installation options

- Follow the remaining instructions of the installer to complete the installation
- Reboot your system for the PATH changes to take effect

3.4 J-Link tool

- Download SEGGER J-Link for Windows OS from [J-Link](#)
- Run the installer and follow the instructions to complete the installation
- Download J-Link patch for RW61x from NXP ([link](#))
- Unzip *iar_segger_support_patch_rw610_flash.zip*
- Copy *Devices* directory and *JLinkDeivces.xml* files to *J-Link install* directory at the location: *C:\Program Files\SEGGER\JLink*, as shown in [Figure 3](#)

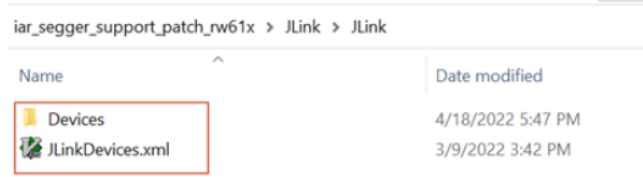


Figure 3. J-Link install directory

3.5 Python3

- Download Python 3.x from [Python3](#)
- Run the installer and follow the instructions to complete the installation.
 - Select the option *Add Python to PATH* as shown in [Figure 4](#)



Figure 4. Python installation

- Type `python` in Windows command line to get the python version
- Make sure the version is above 3 (3.x)

```
>python
Python 3.8.9
```


3.6 Ninja build tool

- Download Ninja from [Ninja](#)
- Create a dedicated directory to install Ninja. For example *C:\Program Files\ninja-win*
- Copy the *ninja.exe* executable file to the new Ninja directory
- Add the path of the *ninja.exe* file to the Windows environment variables
- Type `ninja --version` in Windows command line to get Ninja version
- Check the version is above 1 (1.x)

```
>ninja --version  
1.11.0
```

3.7 Git

- Download Git for Windows Standalone Installer from [Git](#)
- Run the installer and follow the instructions to complete the installation
- Open Windows Explorer
- Right click any directory and look for *Git Bash Here* in the menu ([Figure 5](#))

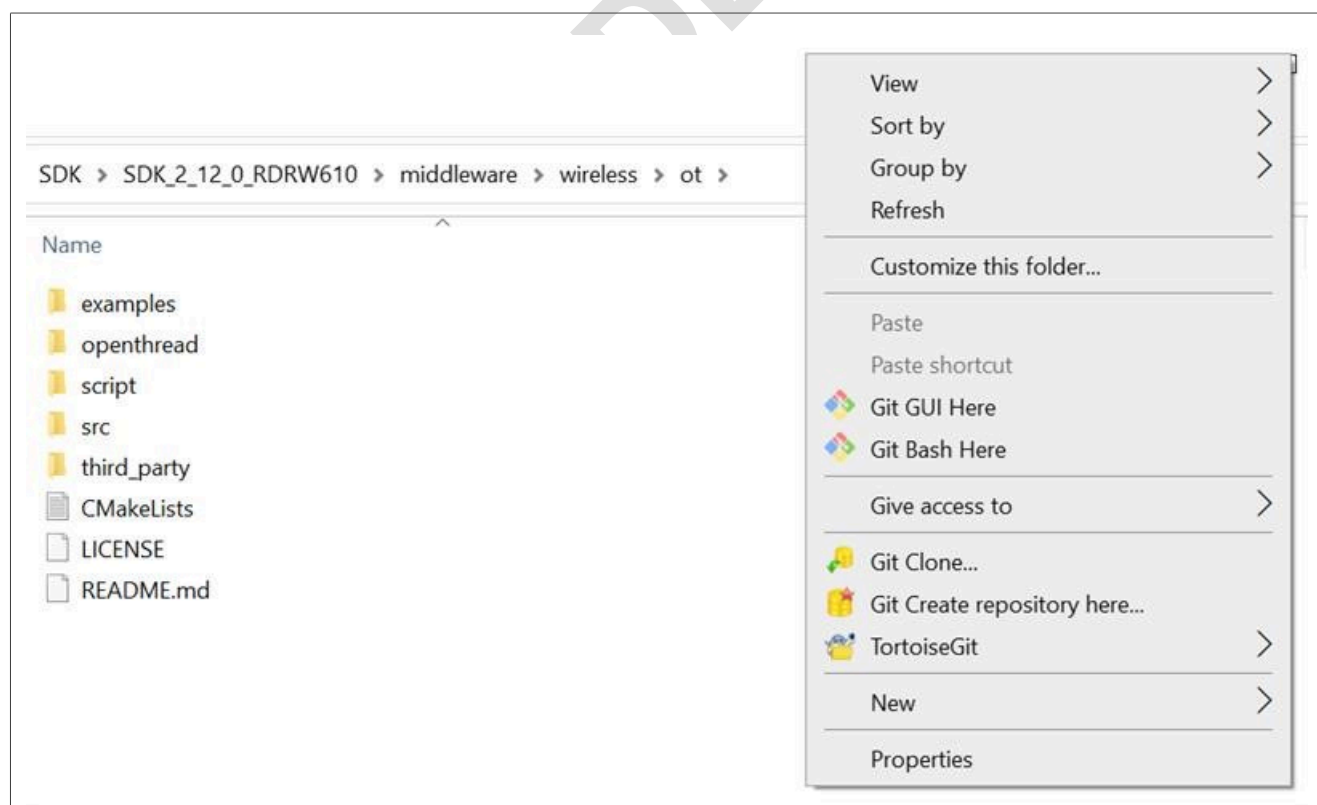


Figure 5. *Git Bash Here* in right-click menu of Windows Explorer

4 Sample applications

The sample applications for 802.15.4 are available in the SDK. This section covers the steps to configure, compile, debug, flash, and execute these examples.

4.1 Ot-cli sample application

The *ot-cli* sample application demonstrates OpenThread features such as how to create a personal area network (PAN), auto negotiation between nodes, and data transmission. The application is based on the open source OpenThread CLI application and uses additional vendor-specific commands.

The test setup uses two RW612 evaluation boards running the same *ot-cli* sample application where:

- One evaluation board acts as leader node
- The second evaluation board acts as child node
- The two devices have the same network configuration
- The role negotiation between the two nodes happens autonomously

4.1.1 Build a demo application

This section describes the steps to build the demo applications using the ARM GCC toolchain on Windows operating system. Refer to [Section 3.2](#) for ARMGCC toolchain installation details. The *ot-cli* application is used as an example.

- Apply a right mouse click on the directory where you want to save OpenThread and select “Git Bash Here” in the menu
- Get OpenThread from NXP GitHub directory

```
$ git clone https://github.com/NXP/ot-nxp.git -b 'branch-name'
$ cd ot-nxp
$ git submodule update --init --recursive
```

Note: The 'branch-name' depends on the SDK version. Contact the support team to get the compatible branch.

- Configure the environment variables. Change SDK and ARMGCC paths

```
$ export NXP_RW612_SDK_ROOT='/c/NXP/<SDK-top-dir>'
$ export ARMGCC_DIR='/c/Program Files (x86)/GNU Arm Embedded Toolchain/10 2021.10'
```

- Build OpenThread application image

```
$ ./script/build_rw612
```

- Look for the output application image binary at:

ot-nxp\build_rw612\bin\ot-cli-rw612.bin

4.1.2 Flash 802.15.4 firmware

RW612 OpenThread application image and 802.15.4 firmware binary are stored in different partitions of FlexSPI NOR flash. The flash layout for 802.15.4 is shown in [Figure 6](#). RW612 OpenThread application loads 802.15.4 firmware into the CPU used for Bluetooth LE/802.15.4.

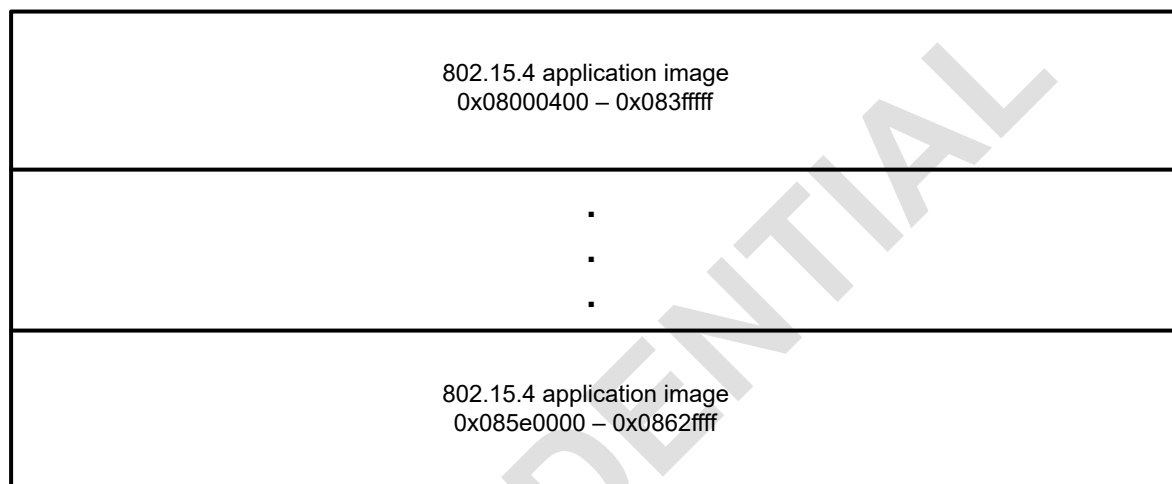


Figure 6. Partitions of FlexSPI NOR flash

This section describes the steps to flash 802.15.4 firmware with SEGGER J-Link tool.

- Open J-Link commander on Windows command line and connect RW612 device

```
J-Link>con  
Device>RW612  
TIF>S  
Speed><Enter>
```

- Flash 802.15.4 firmware. The path to 802.15.4 firmware binary is:

`${SDK-top-dir}\components\conn_fwloader\fw_bin\rw610_sb_ble_15d4_combo.bin`

```
> loadbin  
${SDK-top-dir}/components/conn_fwloader/fw_bin/rw610_sb_ble_15d4_combo.bin,0x085e0000
```

- Repeat the above operations for another RW612 evaluation board if using another RW612 evaluation board as end device

Note: 802.15.4 firmware is not erased when the application firmware is flashed into the device, and will only need to be reprogrammed into the device if the Flash is fully erased.

4.1.3 Flash the application image

This section provides the steps to flash the application image on RW612 evaluation board.

- Connect the board to the Windows host system. Open J-Link commander and connect to RW612

```
J-Link>con
Device>RW612
TIF>S
Speed><Enter>
```

- Flash the application image (*ot-cli-rw612.bin*) to RW612 EVK FlexSPI NOR flash

```
J-Link>loadbin ${sdk}/middleware/wireless/ot/build_rw612/bin/ot-cli-rw612.bin,0x08000400
```

- Reset RW612 evaluation board power
- Refer to [Section 3.1](#) to access the serial console log.
- Type `help` to get the list of available commands. Refer to [ot-cli](#), for more information about ot-cli application commands.

```
> help
bbr
br
bufferinfo
ccathreshold
ccm
channel
child
childip
childmax
...
```

- Repeat the above operations for another RW612 evaluation board if using another RW612 evaluation board as end device

4.1.4 Ot-cli application execution

4.1.4.1 Create a Thread network

- Connect RW612 evaluation board to the host computer using the USB Micro connector of the evaluation kit
- Open a terminal emulator program, refer to [section 3.1](#) for serial console access settings
- On one RW612 evaluation board, stop any existing Thread network and do a factory reset for 802.15.4

```
> thread stop
Done
> ifconfig down
Done
> factoryreset
```

- Set the channel of operation

```
> channel 18
Done
```

- Set the PAN ID and the extended PAN ID for the network

```
> panid 0x1234
Done
> extpanid dead00beef00cafe
Done
```

- Set the network key for the network

```
> networkkey 00112233445566778899aabbccddeeff
Done
```

- Set the name for the network

```
> networkname ThreadTest
Done
```

- Start the Thread network and ensure the state of the device is leader

```
> ifconfig up
Done
> thread start
Done
> state
Leader
Done
```

4.1.4.2 Join a Thread network from the end device

Follow the steps below for the end device — the second RW612 evaluation board or a Thread end device. The end device will join the Thread network created in [Section 4.1.4.1](#).

- From the other RW612 evaluation board or a Thread End device, stop any existing Thread network and do a factory reset for 802.15.4

```
> thread stop
Done
> ifconfig down
Done
> factoryreset
```

- Set the channel of operation, as done previously for the leader network

```
> channel 18
Done
```

- Set the extended address for the current node. This is only required when using another RW612 evaluation board as child node. Make sure the extended address is not the same as the leader node extended address

```
> extaddr 8877665544332211
Done
```

- Set the Mesh-local address for the current node. This is only required when using another RW612 evaluation board as child node. Make sure the Mesh-local address is not the same as the leader node address

```
> mliid aabbccddeeff9900
Done
```

- Set the PAN ID and the extended PAN ID for the network, as done previously for the leader network

```
> panid 0x1234
Done
> extpanid dead00beef00cafe
Done
```

- Set the network key for the network, as done previously for the leader network

```
> networkkey 00112233445566778899aabbccddeeff
Done
```

- Set the name for the network, as done previously for the leader network

```
> networkname ThreadTest
Done
```

- Start the Thread network. The initial state is `leader`

```
> ifconfig up
Done
> thread start
Done
> state
Leader
Done
```

- Wait for the state to change to `child` when the leader device has accepted the child

```
> state
Child
Done
> ipaddr
fdde:ad00:beef:0:0:ff:fe00:c800      # Routing Locator (RLOC)
fdde:ad00:beef:0:aabb:ccdd:eeff:9900 # Mesh-Local EID (ML-EID)
fe80:0:0:0:8a77:6655:4433:2211      # Link-Local Address (LLA)
Done
```

Note: If the ML-EID and LLA are exactly the same for the child and leader nodes, the nodes cannot communicate with each other correctly.

- Use the command `mliid <ML-EID>` to change ML-EID on the child node while setting the network parameters
- Use the command `extaddr <LLA>` to change LLA respectively on the child node while setting the network parameters
- Refer to [ot-cli](#), for more information about ot-cli application commands

4.1.4.3 Connectivity test

- Ping the child node using the mesh-local address from the leader node

```
> ping fdde:ad00:beef:0:aabb:ccdd:eeff:9900
```

The example below indicates a successful connection:

```
> ping fdde:ad00:beef:0:aabb:ccdd:eeff:9900
16 bytes from fdde:ad00:beef:0:aabb:ccdd:eeff:9900: icmp_seq=2 hlim=64 time=9ms
1 packets transmitted, 1 packets received. Packet loss = 0.0%. Round-trip min/avg/max =
9/9.0/9 ms.
Done
```

4.1.5 NXP vendor commands

4.1.5.1 Get/set TX power limit

This section shows how to set/get TX power limit for 802.15.4 radio using NXP vendor specific command.

Syntax: radio_nxp txpwrlimit <parameter>

Where:

Command parameter	Description
parameter	0 = no TX power limit 1 to 30 = 0.5 dBm to 15 dBm. TX power limit with 0.5 dBm step No parameter: get TX power limit setting

Examples

Vendor command to set TX power limit to 10 dBm:

```
> radio_nxp txpwrlimit 20
Done
```

Vendor command to get TX power limit:

```
> radio_nxp txpwrlimit
20
Done
```

Note:

- 1. If no TX power limit is set in the OTP, the default value is 0 which means no power limit is applied.
- 2. The TX power limit command is specified in units of 0.5 dBm. For example, to set the limit to 10 dBm, use a value of 20.

4.1.5.2 RF test mode

This section introduces the usage of RF test mode with the production firmware and ot-cli sample application.

Syntax: `radio_nxp mfgcmd <Command ID> <Parameters...>`

[Table 2](#) describes RF test mode commands.

Table 2. RF Test Mode Commands

Feature	Command ID	Parameters	Description
RF test mode	1 (enable) / 0 (disable)	–	Enable/disable 802.15.4 RF test mode. By default RF test mode is disabled.
Channel	11 (get) / 12 (set)	Channel 11 to 26	RF channel for RF tests
TX power	15 (get) / 16 (set)	-20 to 15 in the unit of 1 dBm	TX power used for RF tests
Continuous TX	17	1 (enable) / 0 (disable)	Start or stop continuous transmission using the channel and TX power defined above
Payload size	20 (get) / 21 (set)	17 to 116 bytes	Size of the payload used for transmission
Start RX test	32	–	Start receiving frames. Count the frames and calculate the average RSSI
Get RX test result	31	–	Get the result from RX test (command 32)
Burst TX	33	mode(0-7) + packet gap	Start to transmit a specific number of packets with a specific packet gap mode: mode options (unit: packet): 0=1, 1=25, 2=100, 3=500, 4=1000, 5=2000, 6=5000, 7=10000 Packet gap: must be > 5ms
Duty cycle TX	35	1 (enable) / 0 (disable)	Start or stop to transmit in duty cycle TX mode
CCA threshold	47 (get) / 48 (set)	0 dBm to -110 dBm	Configure CCA threshold for following test
Continuous CCA test	49	1 (enable) / 0 (disable) + mode	Start CCA tests mode= mode options (1/2/3)
Get CCA status	50	–	Get the result from CCA tests
Continuous ED Test	55	1 (enable) / 0 (disable)	Start/stop energy detection (ED) test
Get ED value	56	–	Get ED test results

RF test mode commands can return the following error codes:

- **INVALID_PARAMETER:** out-of-range parameter or wrong number of parameters
- **NOT_IMPLEMENTED:** unknown command ID
- **FAILED:** no response or response with an error code

Examples

Command to enable the RF test mode functionality:

```
> radio_nxp mfgcmd 1
Done
```

Command to disable the RF test mode functionality:

```
> radio_nxp mfgcmd 0  
Done
```

Command to set RF channel to channel 11:

```
> radio_nxp mfgcmd 12 11  
Done
```

Command to get RF channel setting:

```
> radio_nxp mfgcmd 11  
11  
Done
```

Command to set TX power to 10 dBm:

```
> radio_nxp mfgcmd 16 10  
Done
```

Command to get TX power setting:

```
> radio_nxp mfgcmd 15  
10  
Done
```

Command to set TX payload size to 30 bytes:

```
> radio_nxp mfgcmd 21 30  
Done
```

Command to get TX payload size setting:

```
> radio_nxp mfgcmd 20  
30  
Done
```

Command to start continuous TX mode:

```
> radio_nxp mfgcmd 17 1  
Done
```

Command to start burst TX mode for 10000 packets with the packet gap of 10 ms:

```
> radio_nxp mfgcmd 33 7 10  
Done
```

Command to start duty cycle TX mode

```
> radio_nxp mfgcmd 35 1  
Done
```

Command to start RX test mode

```
> radio_nxp mfgcmd 32  
Done
```

Command to get the result from RX test:

```
> radio_nxp mfgcmd 31
Status : 0
rx_packet_count : 500
total_packet_count : 500
rssi : -32
Done
```

Command sequence example for 802.15.4 Transmitter/Receiver test:

802.15.4 Transmitter test

```
> radio_nxp mfgcmd 1          # Enable 15.4 RF test mode
Done
> radio_nxp mfgcmd 12 11      # Set channel to 11
Done
> radio_nxp mfgcmd 11         # Get the channel setting
11
Done
> radio_nxp mfgcmd 21 30      # Set TX payload size to 30 bytes
Done
> radio_nxp mfgcmd 20         # Get TX payload size setting
30
Done
> radio_nxp mfgcmd 16 10      # Set TX power to 10 dBm
Done
> radio_nxp mfgcmd 15         # Get TX power setting
10
Done
> radio_nxp mfgcmd 33 7 10    # start Burst TX mode for 10000 Packets with the
                             # Packet gap of 10ms
Done
```

802.15.4 receiver test

```
> radio_nxp mfgcmd 1          # Enable 15.4 RF test mode
Done
> radio_nxp mfgcmd 12 11      # Set channel to 11
Done
> radio_nxp mfgcmd 11         # Get the channel setting
11
Done
> radio_nxp mfgcmd 32         # Start 15.4 RX test
Done
# After 15.4 RX test started, start TX with corresponding settings from another device
> radio_nxp mfgcmd 31         # End RX test and get the result
Status : 0
rx_packet_count : 500
total_packet_count : 500
rssi : -32
Done
```

5 Acronyms and abbreviations

Table 3. Acronyms and abbreviations

Terms	Definition
CLI	Command line interface
ED	Energy detection
EVK	Evaluation kit
FW	Firmware
IDE	Integrated development environment
IP	Internet protocol
OT	OpenThread
OTP	One time programmable
PAN	Personal area network
SDK	Software development kit
SW	Software

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Tables

Tab. 1.	Reference documents	3	Tab. 3.	Acronyms and abbreviations	20
Tab. 2.	RF Test Mode Commands	17			

Figures

Fig. 1.	Adding GNU Arm embedded toolchain path to the system environment	5	Fig. 4.	Python installation	8
Fig. 2.	CMake installation options	6	Fig. 5.	Git Bash Here in right-click menu of Windows Explorer	9
Fig. 3.	J-Link install directory	7	Fig. 6.	Partitions of FlexSPI NOR flash	11

Contents

1	Revision history	2
2	About this document	3
2.1	Purpose and scope	3
2.2	Considerations	3
2.3	References	3
3	Tool setup	4
3.1	Serial console tool	4
3.2	GNU Arm embedded toolchain	5
3.3	CMake tool	6
3.4	J-Link tool	7
3.5	Python3	8
3.6	Ninja build tool	9
3.7	Git	9
4	Sample applications	10
4.1	Ot-cli sample application	10
4.1.1	Build a demo application	10
4.1.2	Flash 802.15.4 firmware	11
4.1.3	Flash the application image	12
4.1.4	Ot-cli application execution	13
4.1.4.1	Create a Thread network	13
4.1.4.2	Join a Thread network from the end device	14
4.1.4.3	Connectivity test	15
4.1.5	NXP vendor commands	16
4.1.5.1	Get/set TX power limit	16
4.1.5.2	RF test mode	17
5	Acronyms and abbreviations	20
6	Contact Us	21
7	Note about the source code in the document	22
8	Legal information	23

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