

**Bluetooth[®] low energy Module
(MK71511/MK71521)
Application Notes**

Radio authentication and testing

Issue Date: October 1, 2020

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Preface

This application note describes the antenna radiation characteristics of MK715x1 evaluation boards equipped with Bluetooth® 5 compatible Bluetooth low energy modules (MK71511 and MK71521) made by Lapis Technology .

The following related documents are available, so please refer to them if necessary.

MK71511 Datasheet

MK71521 Datasheet

【Note】

MK715x1 is intended for both MK71511 and MK71521 in this document.

- Bluetooth® is a registered trademark of Bluetooth SIG, Inc.
- All other company and product names are the trademarks or registered trademarks of the respective companies

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1. Status and Notes of Acquisition of Radio Certification in Each Country and notes

1.1. FCC (USA)

MK715x1 has been module approved for the FCC Part15 Subpart C.

Name	Authorization number
MK71511/MK71511A	FCC ID:2ACIJ71511
MK71521/MK71521A	FCC ID:2ACIJ71521

Therefore, the final device is optional for conformity testing and approval application as a wireless device. However, the final equipment may require the support of Subpart B (unintentional radiator).

In addition, please contact the certification agencies because it is necessary to display the following items in the label with FCC ID on the final equipment, and in an easy-to-read place of the product, and other displays may be required depending on the specifications of the final device.

This device complies with Part 15 of the FCC Rules.
 Operation is subject to the following two conditions:
 (1)this device may not cause harmful interference, and (2)this device must accept any interference received, including interference that may cause undesired operation.

【Reference】 What is FCC?

It stands for Federal Communications Communication and is an organization that regulates and supervises the broadcasting and telecommunications business in the United States. It is involved in the licensing of wireless communication devices in the United States, and Bluetooth products are also eligible.

This device complies with Part 15 of the FCC Rules.
 Operation is subject to the following two conditions:
 (1)this device may not cause harmful interference, and (2)this device must accept any interference received, including interference that may cause undesired operation.

The regulatory label on the final system must include the statement: "Contains FCC ID: 2ACIJ715x1" or using electronic labeling method as documented in KDB 784748.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
 The antenna used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter within a host device, except in accordance with FCC multi-transmitter product procedures.

The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.

OEM Responsibilities to comply with FCC Regulations

This module has been certified for integration into products only by OEM integrators under the following condition:

- The transmitter module must not be collocated or operating in conjunction with any other antenna or transmitter.

As long as the conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE:

In the event that any of these conditions can not be met (for example the reference trace specified in this manual, or use of a different antenna), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.2. ISED(Canada)

MK715x1 is module certified based on radio testing based on RSS-247.

Name	Authorization number
MK71511/MK71511A	IC:20971-71511
MK71521/MK71521A	IC:20971-71521

Therefore, the final device is optional for conformity testing and approval application as a wireless device. However, the necessity of the response of ICES-003 in the final equipment is required to be confirmed as the final device by the customer, so please contact the certification agencies for details.

In addition, please note that the following display is required for the final equipment.

“Contains IC: 20971-71511” or “Contains IC: 20971-71521”

【Reference】 What is ISED?

It stands for Innovation, Science and Economic Development Canada and has become a federal agency that manages communications, telegraph and radio waves, and regulates products that intentionally emit radio waves.

This device complies with ISED(Innovation, Science and Economic Development Canada)’s licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d’ ISED(Innovation, Science and Economic Development Canada) applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes :

- (1) l’appareil ne doit pas produire de brouillage;
- (2) l’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

The regulatory label on the final system must include the statement: “Contains IC: 20971-715x1”.

1.3. MIC (Japan Ministry of Internal Affairs and Communications)

MK715x1 has acquired as a certification of construction type for Second-Generation Low-Power Data Communication System/Wireless LAN System ARIB standard Version 2.1 (ARIB STD-T66)".

When the final product equipped with this module is used in Japan, it can be used as a wireless equipment without applying for a radio station license.

Name	Authorization number
MK71511	006-000797
MK71511A	006-000799
MK71521	006-000798
MK71521A	006-000800

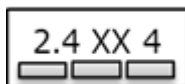
◆FAQ◆

Q1) Is there a duty to display the skill mark on products equipped with lapis Technology modules?

A1) Displaying to the final product is not required, so you don't have to display it. In the past, it was not possible to display the skill mark on the final product, but it has changed that the same thing displayed in the module can be displayed on the final product due to the revision of the Radio Law in 2014.

Q2) How should the display of the actual product by ARIB STD-T66 be expressed?


A2) The following is an example of how to use Bluetooth low energy.



2.4: Represents radio equipment using the 2.4 GHz band.

XX: Modulation system(other System)

4: Indication of Interference-causing Radius(e.g. Estimated interference-causing radius 40m /1mW)

 :The graph indicates that the equipment can use the entire band and is capable of avoiding the band used by RFID systems

[Note] Unlike the Radio Law, the display of the present product of ARIB is not legally binding on the description, so please judge the display contents and the display necessity by the customer.

Q3) What should I do if I want to add an antenna and register?

A3) Please consult with Lapis Technology.

Japan can respond to applications for additional antennas, but overseas needs to be re-certified. There is an expense in both cases.

1.4. CE(Radio Equipment Directive 2014/53/EU[RED])

MK715x1 module complies with radio-related tests (test standard: EN300 328 V2.2.2) under the RE Directive. The final product requires the following tests, but depending on the specifications of the final equipment, the required test contents may vary, so please contact the certification body for more information.

- (1) Radio test*1
- (2) EMC test
- (3) Safety test

*1: For the Connected radio test, you can quote the test results of the MK715x1 module.

◆FAQ◆

Q1) What is the procedure for obtaining CE certification for products?

A1) Lapis provides a test report for CE certification.

The module conducts radio tests (Radiated/Contracted) in accordance with EN 300 328 ver2.2.2 with respect to the European RE Directive, but you must conduct radio tests (the Delivered test can cite the module's test report), Safety, and EMC tests on your final product, and you must declare your conformity to the RE Directive.

2. Radio test method at the radio wave authentication

This chapter describes the operation required for the test device (DUT: Device Under Test) in radio testing during radio wave authentication and how to prepare and implement the radio test. The contents of this chapter are for reference. For details of the implementation method, please be sure to check with the laboratory requested by the test because it may vary depending on the specifications of DUT, the test conditions, the laboratory, and the radio law in each country.

2.1. Radio testing and DUT required behavior

The main behavior required for DUT in radio testing depends on the test item:

DUT behavior	Test item
Continuous transmit state (unmodulated)	Frequency tolerance
Continuous transmit state (modulated)	Occupied bandwidth Spurious emission intensity Tolerance for antenna power
Continuous receive state	Limit on secondary radiated emissions
Packet receive state	Blocking performance Spurious emission intensity
Communication (Scan, Advertise)	Interference prevention function

2.2. Radio Test Overview (Hardware)

There are a Conducted test that connects DUT and measuring instruments directly, and a Radiated test via an antenna.

The Conducted test uses RF connectors (such as SMA connectors) to connect to the certification agency's measuring instruments. Therefore, you must measure the path loss (Path Loss) to the RF connector as needed.

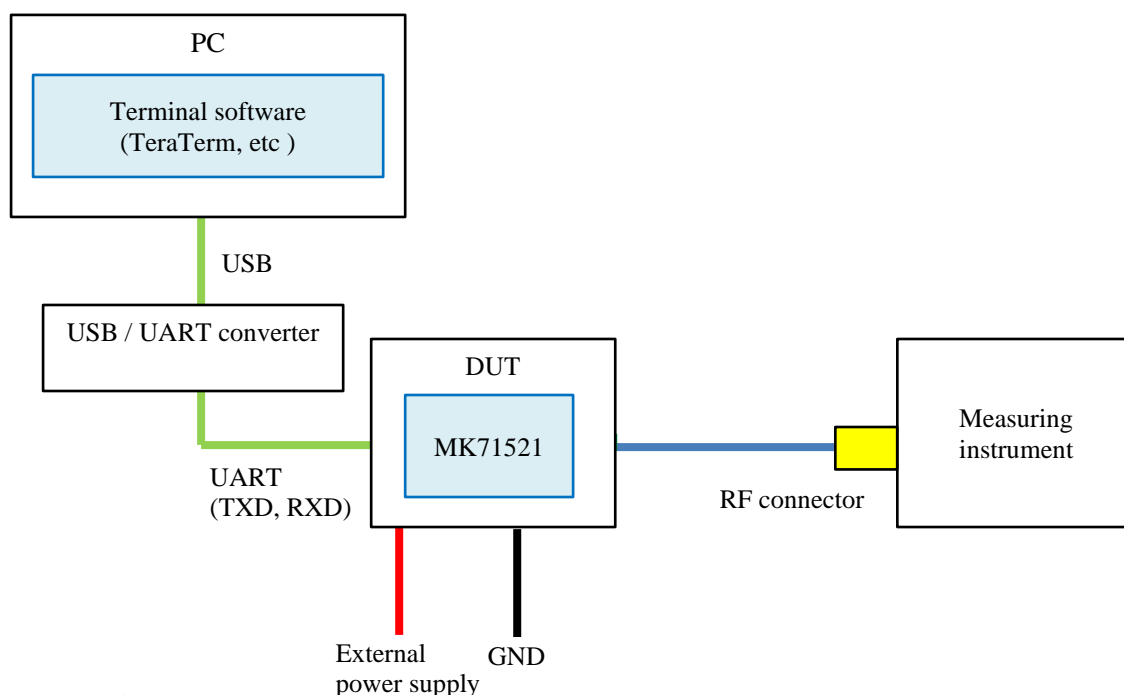
Bluetooth devices often require a Path Loss at 2440 MHz, but some certification authorities may also require Path Loss an out-of-band Path Loss.

The methods described in this chapter control MK71521 with UART.

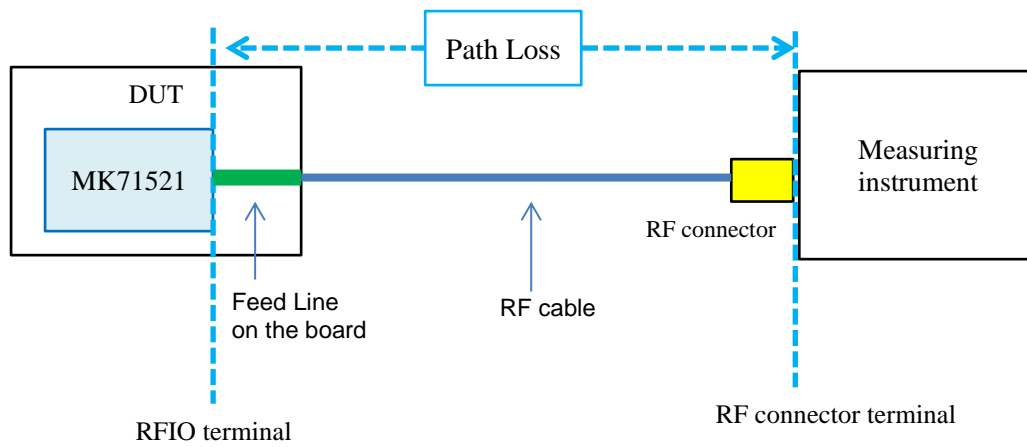
In particular, for test items that measure packet error rates, such as blocking performance and spurious responses, Bluetooth certification testers may be used as test equipment, so the MK71521 mounted in the DUT must be able to be controlled by UART from the outside.

In addition, depending on the test conditions, the test may be required to be able to connect the power supply to an external power source because the test is carried out by changing the supply voltage.

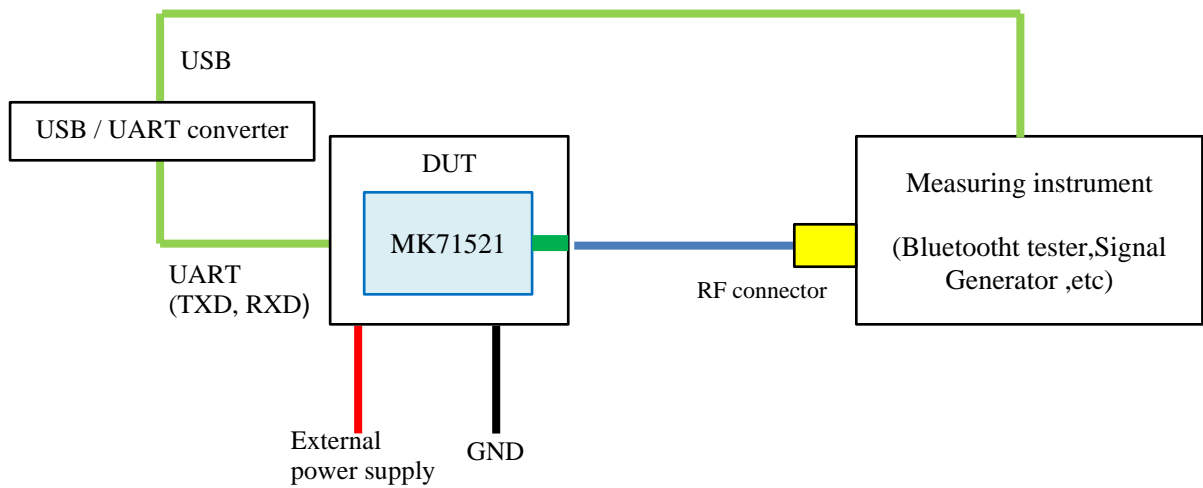
■ Example of a Conducted test



■ Path Loss example



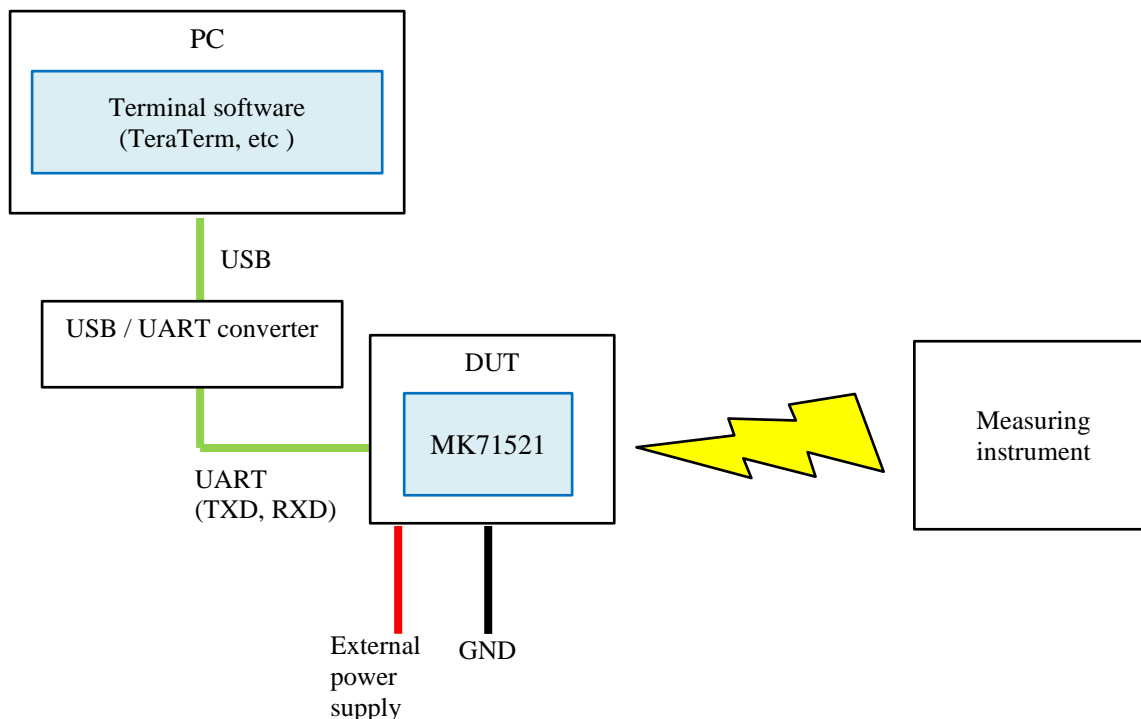
■ Example of blocking and spurious response tests



The Radiused test involves testing through an antenna. Therefore, you must have prepared the characteristic information of the antenna used. For information about the pattern antennas included in the MK71521, see the MK71511/MK71521 Application Notes (Antenna Radiation Characteristics: FEXK715x1_AN_Antenna_radiation_characteristics).

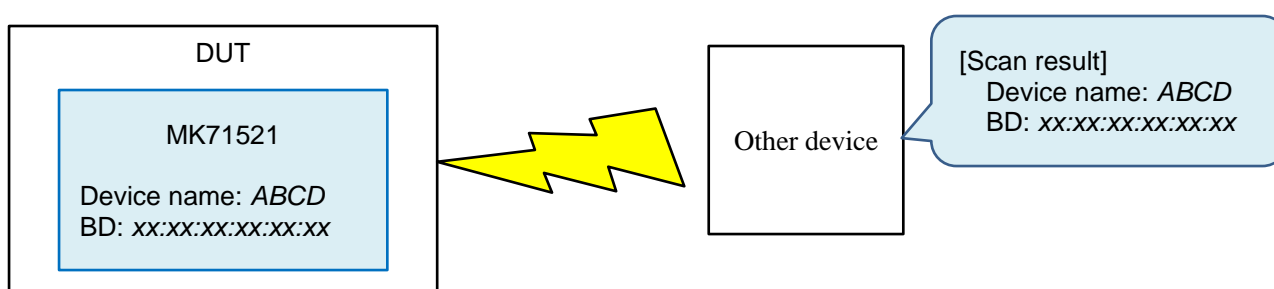
In addition, the Radiused test may require that the power supply and GND be able to connect to an external power source because the test is carried out by changing the supply voltage depending on the test conditions.

■ Example of a radiated test



In the test to operate the DUT in a communication state, the anti-interference function is confirmed using the oncoming device. As a way to check the anti-interference function, DUT and oncoming devices check each other's device addresses (BD) and DUT must be able to perform Scan and Advertise operations.

■ Communication



2.3. Radio Test Overview (Software)

You can use the applications included in the nRF5 SDK provided by Nordic to perform the actions required by radio testing. The following is an application that performs DUT behavior:

DUT behavior	Nordic nRF5 SDK Application name and Folder	Application file name	Remarks
Continuous transmit state (unmodulate,modulate)	Name: radio_test Folder: .\<nRF5 SDK> \examples \peripheral \radio_test \hex	For MK71511: Nordic nRF5 SDK does not include For MK71521: Radio_test_pca10040.hex	(*1)
Continuous receive state			
Packet receive state	Name: dtm Folder: .\<nRF5 SDK> \examples \dtm \hex	For MK71511: direct_test_mode_pca10056e.hex For MK71521: direct_test_mode_pca10040.hex	
Communication	Name: ble_app_interactive Folder: .\<nRF5 SDK> \examples\ble_central_and_peripheral \experimental\ble_app_interactive	MK71511: Nordic nRF5 SDK does not include MK71521: ble_app_interactive_s132_pca10040	(*1) (*2) (*3)

However, if you want to keep the applications included in then RF5 SDK, UART is assigned as follows: Therefore, if you are using the GPIO assignment of MK71521 with a different configuration, you should change the GPIO assignment for the application or pull GPIO (P0.06, P0.08) directly from DUT: For information about how to write and build applications included in the nRF5 SDK, see Software Development Flow for MK715x1.”

GPIO (MK71521)	UART
P0.06	TXD
P0.08	RXD

(*1) If you run a radio test application on MK71511, you will need to create and build the application.

For more information, please refer to the following:

https://infocenter.nordicsemi.com/topic/sdk_nrf5_v16.0.0/nrf52811_user_guide.html?cp=7_1_5_1

(*2) If the application can verify the device address, there is no problem in any application.

(*3) Nordic nRF5 SDK does not contain hex files.

For information on how to build the application, see SoftwareDevelopment Flow for MK715x1.

2.4. How to operate DUT

Demonstrates how to directly control the MK71521 using the applications included in the nRF5 SDK provided by Nordic Semiconductor.

2.4.1. Continuous transmission / Continuous receiving

The operation method varies depending on the operation of the DUT, so refer to the legend below.

【Common】: Operations common

【CW】: Operations required only for continuous transmission (unmodulated)

【MOD】: Operations required only for continuous transmission (modulation)

【RX】: Operations required only for continuous receiving

Setting 1. **【Common】** Write radio test application to MK71521 radio test.

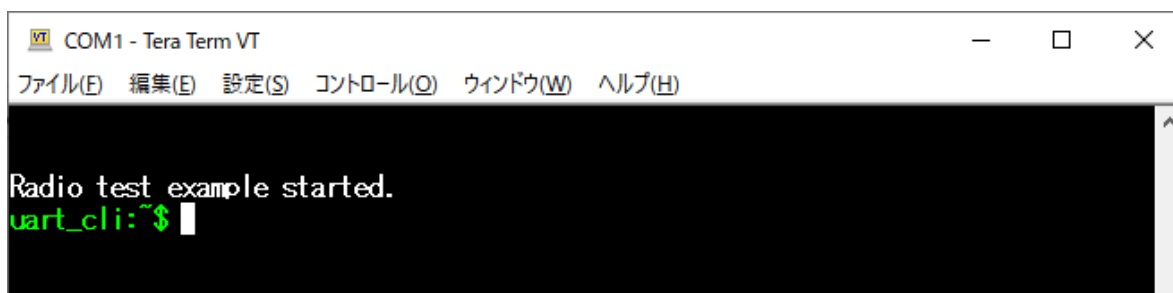
For information on how to write and build applications, see "Software Development Flow for MK715x1."

Setting 2. **【Common】** Make sure your PC and MK71521 are connected via UART.

Setting 3. **【Common】** Start terminal software (TeraTerm, etc.) on your PC and set the port settings as follows.

Port	Your PC COM port number
Baud rate	115,200 bps
Data bit	8 bit
Parity	None
Stop bit	1 bit
Flow Contro	None

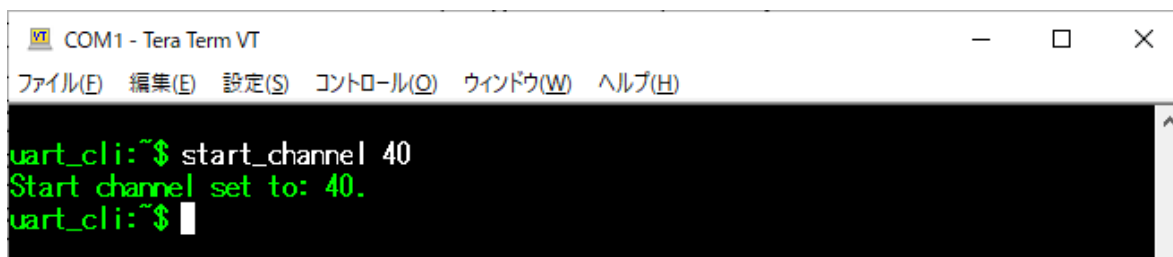
When you perform a hard reset to the MK71521, you will see a display similar to the following on the TeraTerm terminal:



Setting 4. **【Common】** Frequency setting is as follows.

Command	Parameter	Remarks
start_channel	<channel>	<channel>
		0 : 2400MHz
		1 : 2401MHz
		80 : 2480MHz

The following example sets channel to "40".



Setting 5. **[CW, MOD]** Transmission output setting is as follows.

Command	Parameter	Remarks
output_power	<sub_cmd>	<sub_cmd> pos4dBm : +4dBm pos3dBm : +3dBm pos0dBm : 0dBm neg4dBm : -4dBm neg8dBm : -8dBm neg12dBm : -12dBm neg16dBm : -16dBm neg20dBm : -20dBm neg40dBm : -40dBm

The following example sets the output to "+4dBm".

```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(O) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ output_power pos4dBm
TX power: RADIO_TXPOWER_TXPOWER_Pos4dBm
uart_cli:~$
    
```

Settings 6. **[MOD]** Send test pattern setting is done as follows.

Command	Parameter	Remarks
transmit_pattern	<sub_cmd>	<sub_cmd> Pattern_random : Pseudo-random pattern

```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(O) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ transmit_pattern pattern_random
Transmission pattern: TRANSMIT_PATTERN_RANDOM.
uart_cli:~$
    
```

Setting 7. **[MOD, RX]** Data rate setting is done as follows.

Command	Parameter	Remarks
data_rate	<sub_cmd>	<sub_cmd> ble_1Mbit : BLE1Mbps ble_2Mbit : BLE2Mbps

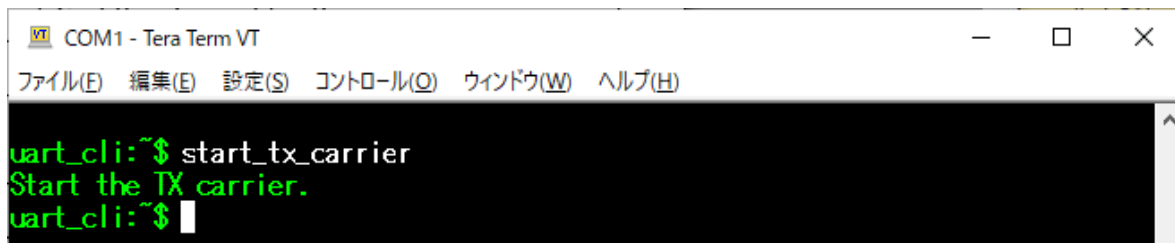
The following example shows how to set the datarate to "1Mbps".

```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(O) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ data_rate ble_1Mbit
Data rate: RADIO_MODE_MODE_Ble_1Mbit
uart_cli:~$
    
```

[CW] Continuous transmission (unmodulation) is performed by the following command after setting 1 to 5.

Command	Remarks
start_tx_carrier	Continuous transmission (unmodulation) start
cancel	Stop



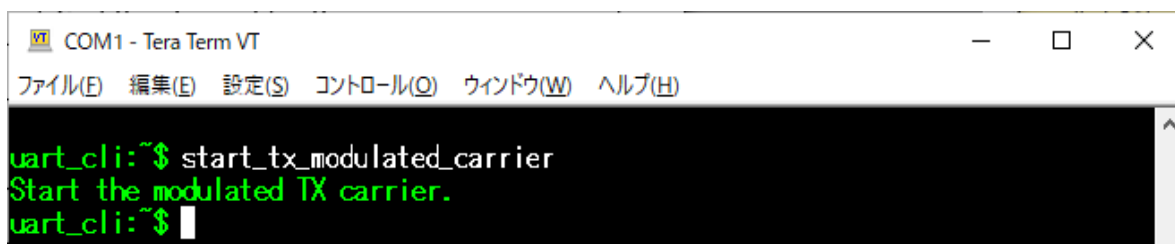
```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(Q) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ start_tx_carrier
Start the TX carrier.
uart_cli:~$
    
```

If you want to change the frequency setting and etc , stop working with the "cancel" command and then do so.

[MOD] Perform continuous transmission (modulation) after setting 1 to 7, and then use the following command.

Command	Remarks
start_tx_modulated_carrier	Continuous transmission (modulation) start
cancel	Stop



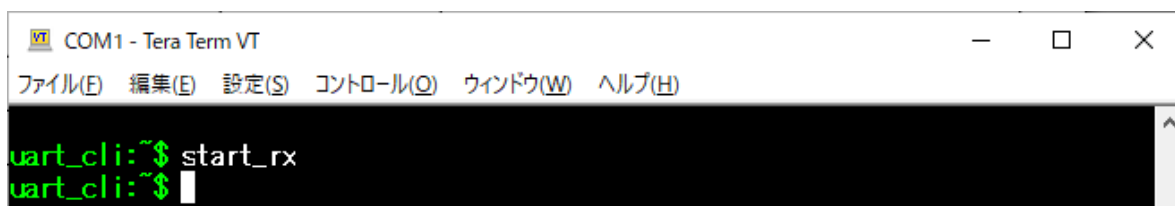
```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(Q) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ start_tx_modulated_carrier
Start the modulated TX carrier.
uart_cli:~$
    
```

If you want to change the frequency setting and etc , stop working with the "cancel" command and then do so.

[RX] Perform a continuous receiving, after setting 1 to 4 and 7, and then use the following command:

Command	Remarks
start_rx	Continuous receiving
cancel	Stop



```

COM1 - Tera Term VT
ファイル(E) 編集(E) 設定(S) コントロール(Q) ウィンドウ(W) ヘルプ(H)
uart_cli:~$ start_rx
uart_cli:~$
    
```

If you want to change the frequency setting and etc , stop working with the "cancel" command and then do so.

2.4.2. Packet-receiving

To perform packet receive operation, perform the following steps:

1. Write the direct test mode application to MK71521.
For information about how to write and build applications, see “Software Development Flow for MK715x1”.
2. Make sure your Bluetooth tester and MK71521 are connected via UART.
3. In the Bluetooth tester, set the control method and port settings as follows:
By receiving a command for Receiver test from the Bluetooth tester, the DUT is in a packet-receiving state.

Control system	2-Wire
Port	Your PC COM port number
Baud rate	19,200 bps
Data	8 bit
Parity	None
Stop	1 bit
Flow Control	None

2.4.3. Communication

In the test to operate the DUT in the communication state, Scan and Advertise must be able to operate. For more information ble_app_interactive how to use the application "ble_app_interactive", refer to the following document or MK71511/MK71521 application note (communication distance measurement: FEXK715x1_AN_Distance).

<nRF5 SDK Related Documentation >

https://infocenter.nordicsemi.com/topic/sdk_nrf5_v16.0.0/ble_sdk_app_interactive.html

Revision history

Document No.	Date	Page		Remarks
		Before	After	
FEXK715x1_AN_RadioTest-01	2020.10.01	—	—	First edition