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ROHM Co., Ltd.
April 1, 2024

Bluetooth® low energy Module (MK71511/MK71521)

Application Note

MK71511 Connection distance measurement

Issue Date: Oct. 16, 2020

NOTES

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Preface

This application note describes Connection distance measurement using the MK71511 Evaluation Kit Mini (MK71511EK1) equipped with Bluetooth® 5 compatible Bluetooth low energy module MK71511 made by Lapis Technology. The following related documents are available, so please refer to them if necessary.

< Documents related to MK71511 >

- MK71511 Data Sheet
- MK715x1 Evaluation Kit Mini (MK715x1EK1) Hardware Manual

Note: In this document, MK715x1 refers to both MK71511 and MK71521.

Communication distance measurement uses modified sample software provided by LAPIS Technology. Please refer to the related documents as necessary.

< Documents related to sample software >

- MK715x1 Software Development Getting Started Guide
- MK715x1 AT Command Application User's Manual

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Notation

Category	Notation	Description
● Value	0xnn	Represents a hexadecimal number.
	0bnnnn	Represents a binary number.
● Address	0xnnnn_nnnn	Represents a hexadecimal number. (indicates 0xnnnnnnnn)
● Unit	Word, WORD	1 word = 32 bits
	Byte, BYTE	1 byte = 8 bits
	Mega, M	10^6
	Kilo, K	$2^{10} = 1024$
	Kilo, k	$10^3 = 1000$
	Milli, m	10^{-3}
	Micro, μ	10^{-6}
	Nano, n	10^{-9}
● Term	"H" level	Indicates high voltage signal levels V_{IH} and V_{OH} as specified by the electrical characteristics.
	"L" level	Indicates low voltage signal levels V_{IL} and V_{OL} as specified by the electrical characteristics.
● Register Description		
Read/write attribute: R indicates read-enabled; W indicates write-enabled.		
MSB: Most significant bit in an 8-bit register (memory)		
LSB: Least significant bit in an 8-bit register (memory)		

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1. Measurement environment

This chapter describes the environment and preparation for connection distance measurement.

1.1. Overview

The communication distance measurement configuration and environment using MK71511EK1 is shown below.

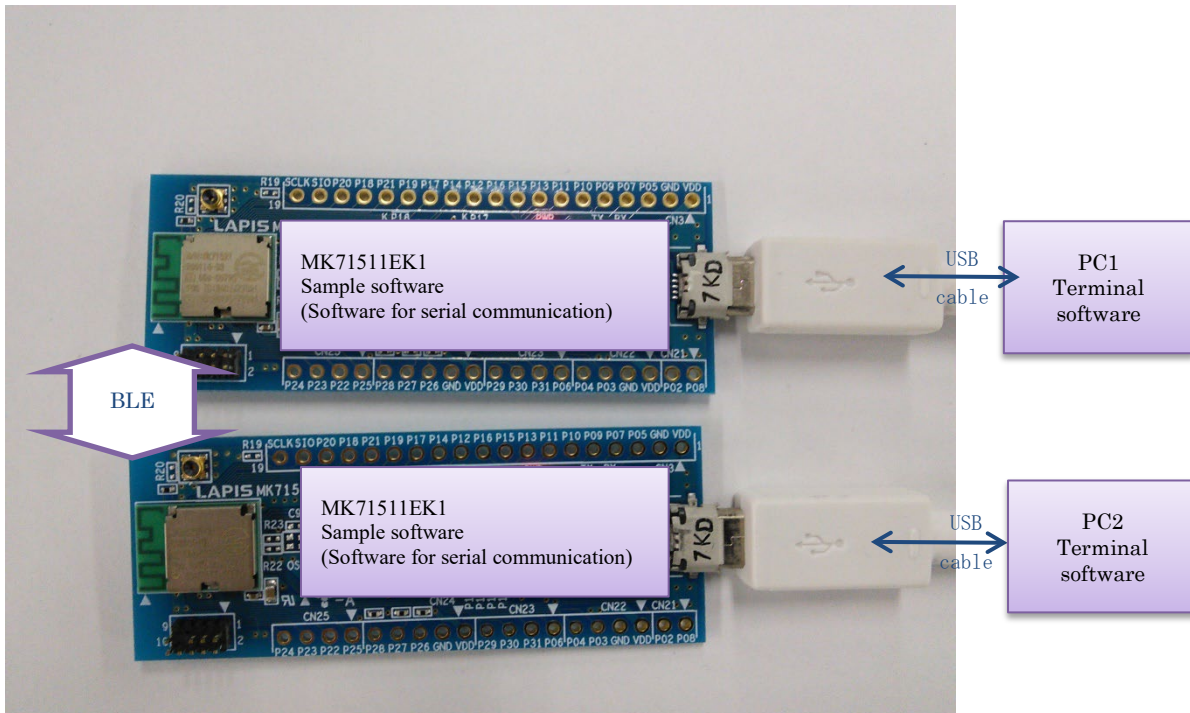


Fig. 1-1 Communication distance measurement board



Fig. 1-2 Communication distance measurement environment

1.2. Preparation (PC)

FT232RQ driver is required to connect the PC and MK71511EK1 USB connector with a USB cable.

If necessary, please install the driver corresponding to your PC from the following site.

<http://www.ftdichip.com/Drivers/D2XX.htm>

In order to write the built-in firmware from the dedicated tool, download and install the following two.

*If the download and installation procedures differ depending on the tool version, refer to the latest information for each tool.

(1) nRF5 SDK (Nordic)

Download site : <https://www.nordicsemi.com/Software-and-tools/Software/nRF5-SDK>

Download file : nRF5_SDK_16.0.0_98a08e2.zip (nRF5 Version 16.0.0)

How to install : Unzip the downloaded ZIP file to any folder.

Note : Please do not use deep-paths and double-byte characters in the extracted folder.

(2) Segger Embedded Studio for ARM & J-Link Device Driver (Segger)

Download site : <https://www.segger.com/downloads/embedded-studio/>

How to install : Run the download file to install Segger Embedded Studio and J-Link Device Driver.

The first time you run it, follow the steps to activate.

1.3. Preparation (MK71511EK1)

Communication distance measurement uses modified sample software provided by LAPIS Technology.

Refer to the MK715x1 Software Development Getting Started Guide and the MK715x1 AT Command Application User's Manual for how to apply the changes.

The changes are shown below.

Change system parameters

Parameter (definition name)	Default value	Change value
LS_PHY_UPDATE	0x00	0x01 : PHY=1M 0x02 : PHY=2M 0x04 : PHY=coded(125kbit/s) *Set according to the expected PHY
LS_NORMAL_CI	40	8 *The setting for this measurement.
LS_NORMAL_SVTO	256	3200 *The setting for this measurement.
LC_RF_TX_POWER_CONN	0	0 or +4 *Set according to the expected transmission power
LS_CONN_INACT_TIMER	3000	0

Program changed

By default in the sample software, the value of LS_NORMAL_CI +20 is the connection interval.

At the time of our measurement, the following changes have been made to set the connection interval to the value of LS_NORMAL_CI.

Line 781 of ble_handler.c

Change before

```
gap_conn_params.max_conn_interval = (LS_NORMAL_CI + MSEC_TO_UNITS(20, UNIT_1_25_MS));
```

After change

```
gap_conn_params.min_conn_interval = LS_NORMAL_CI;
```

2. Measuring method

The communication distance measurement procedure in this application note is shown below.

- (1) Connect MK71511EK1 to PC with USB cable.
Please change the PHY settings to be measured in advance and write the generated application code.
- (2) Start the terminal software such as TeraTerm and set the serial port.
Port: Your COM port number
Baud rate: 57,600 bps
Data: 8bit
Parity: None
Stop: 1 bit
Flow control: hardware
- (3) Push the Reset SW (central/peripheral)
Enter the AT command "at<CR>" for command acceptance confirmation from the terminal, and if the result code "OK" is displayed, the UART communication between the PC and MK71511EK1 is normal.
The "at" command input is not output because the echo back from the MK71511EK1 is invalid.
- (4) Start sending advertisement by inputting "atd<CR>" from the peripheral terminal.
The "atd" input is not output because the echo back from the MK71511EK1 is invalid.
When the connection is completed, the result code "CONNECT" will be displayed. (Fig. 2-1)

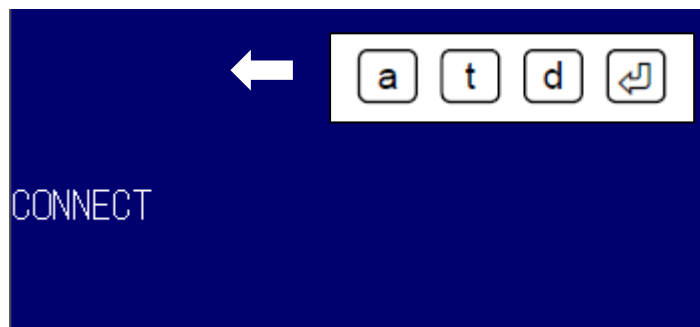


Fig.2-1 Peripheral terminal software

- (5) Scan operation is started by inputting "ata<CR>" from the terminal on the central , and a connection is requested to the detected connection target device.
The "ata" input is not output because the echo back from the MK71511EK1 is invalid.
When the connection is completed, the result code "CONNECT" will be displayed. (Fig. 2-2)
For details on how to use the sample software, refer to the MK715x1 AT command application user's manual.

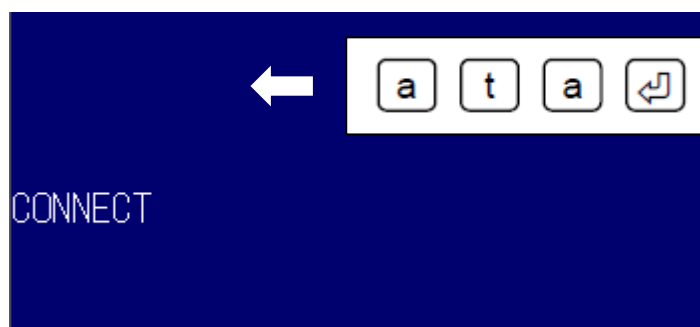


Fig.2-2 Central terminal software

- (6) Move one MK71511EK1 that has established a connection and check the connection is maintained.
(It is judged that the connection is maintained by not receiving the result code "NO CARRIER" for 1 minute.)
- (7) Gradually separate the two MK71511EK1 and measure the distance to disconnect.

3. Measurement data

The connection distance measurement data of MK71511EK1 is shown below.

PHY	TX_ Power=4dBm	TX_ Power=0dBm
LE 2M	140m (Disconnect at 145m)	70m (Disconnect at 75m)
LE 1M	200m (Disconnect at 210m)	100m (Disconnect at 110m)
LE Coded (Data rate 125kB/s)	270m (Disconnect at 280m)	200m (Disconnect at 210m)

*Communication distance varies depending on the measurement environment.
It does not guarantee communication performance.

Communication parameters

C.I: 7.5msec

S.L: 0

T.O: 3200msec

Connection maintenance confirmation time: 1 min

Equipment orientation: Z-Plane-0° facing (Fig. 3-1)

Equipment height: 1.5m (Fig. 3-2)

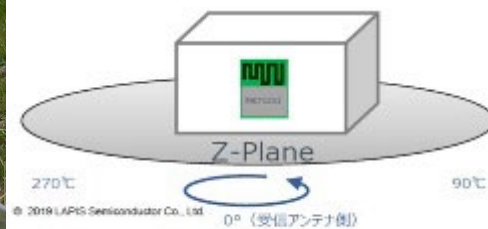
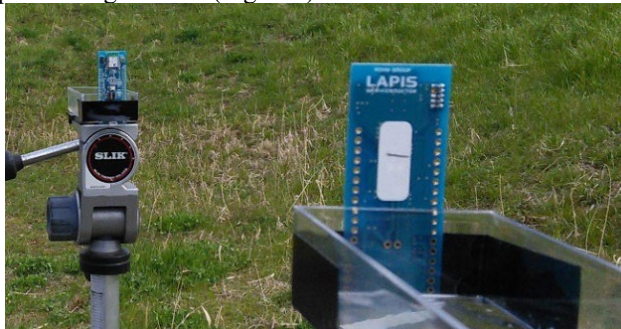


Fig.3-1 Equipment direction during measurement

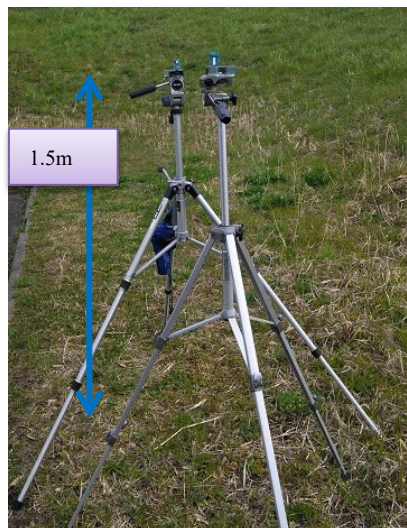


Fig. 3-2 Height of equipment during measurement

Revision history

[illegible]