

MK715x1

AT Command Application

Quick Reference Guide

Issue: Nov. 20, 2020

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Introduction

This document is the quick reference guide of the AT command application designed for LAPIS **Bluetooth®** low energy modules: MK71511 and MK71521 that support Bluetooth 5.

As well as this document, read the following provided documents as needed.

- MK71511 Data Sheet
- MK71521 Data Sheet
- MK715x1EK1 Hardware Manual
- MK715x1EK1A/MK715x1EK1AP Hardware Manual
- MK715x1 Software Development Startup Guide
- MK715x1 AT Command Application User's Manual
- BLE Tool User's Manual

Note: In this document, MK715x1 is used to indicate both MK71511 and MK71521.

- Bluetooth® is a registered trademark of Bluetooth SIG, Inc.
- Other names are generally trademarks or registered trademarks of their respective development companies.

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}
• Term	Nano, n	10^{-9}
	Second, s (lowercase)	Second
• Register Description	"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. Overview

The AT command application can realize Bluetooth low energy communication easily using the simple command interface called AT command via UART. After a Bluetooth low energy connection is established, the data transmitted to UART can be received by a counter device. Therefore, the communication path can be made wireless easily with Bluetooth low energy.

This document describes simply how to use the MK715x1 AT command application using the MK715x1 evaluation kit.

For details about the MK715x1 evaluation kit, refer to "MK715x1EK1 Hardware Manual" or

"MK715x1EK1A/MK715x1EK1AP Hardware Manual". And, refer to "MK715x1 AT Command Application User's Manual" for detailed specification about MK715x1 AT Command Application.

1.1. System Configuration

The following shows the configuration diagram of the AT command application. The AT command application is an application that operates on MK715x1 and is controlled from the host system using AT commands. The host system can control MK715x1 using AT commands and result codes via the UART interface.

The following figure shows the configuration that MK715x1 is connected to a central device such as smartphone as a peripheral device.

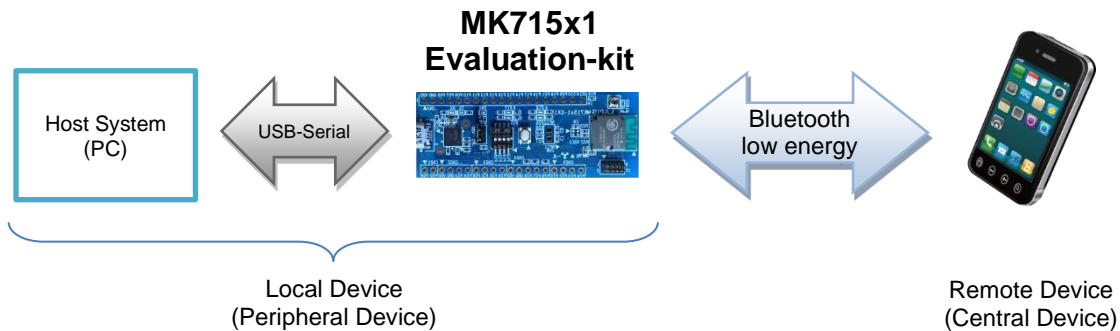


Figure 1-1 System Configuration (Connecting to Smartphone, etc.)

Since MK715x1 is equipped with the central function, data communication between MK715x1 modules is possible as shown in the following figure.

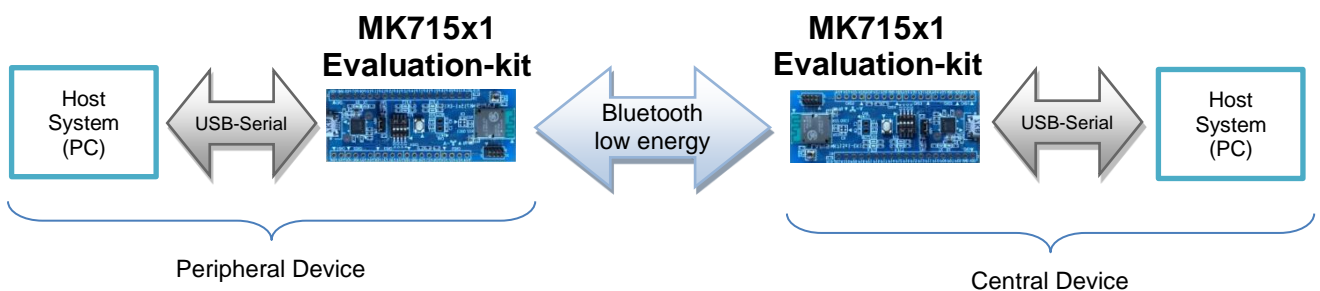


Figure 1-2 System Configuration (Connecting between MK715x1 Modules)

1.2. Function Overview

The AT command application provides the following functions.

- Connection control on the peripheral side (advertisement/pairing/connection/disconnection)
- Connection control on the central side (scanning/pairing/connection/disconnection)
- Pairing (Just Works/Passkey Entry) supported: Pairing with up to five terminals is possible.
- Terminal unique information setting (BD address, etc.)
- Parameter setting related to Bluetooth low energy communication
- Operation with low current consumption by dynamic change of connection parameter
- Mounted profile/service:
 - LAPIS original VSSPP (Vendor Specific Serial Port Profile)
 - Bluetooth SIG standard BAS (Battery Service)
 - Bluetooth SIG standard DIS (Device Information Service)

[Note]

The central side of the AT command application provides the functions to perform data communication between MK715x1 modules mainly.

2. Let's Start Using

This chapter explains how to use the MK715x1 AT command application simply. Prepare the MK715x1 evaluation kit and the smartphone application "BLE Tool" at hand. BLE Tool can be downloaded for free from Google Play or App Store.

Google Play https://play.google.com/store/apps/details?id=com.lapis_semi.bleapp
App Store [https://itunes.apple.com/jp/app/BLE Tool/id915714158?mt=8&ign-mpt=uo%3D4](https://itunes.apple.com/jp/app/BLE-Tool/id915714158?mt=8&ign-mpt=uo%3D4)

2.1. Preparation on MK715x1 Side

2.1.1. Installing Driver for USB Serial Conversion IC

To start the MK715x1 side, connect the MK715x1 evaluation kit to the USB port of a PC. When connecting for the first time, the driver for USB serial conversion IC needs to be installed. Download the latest version of the USB serial conversion IC driver from the following site as needed.

<https://www.ftdichip.com/Drivers/VCP.htm>

2.1.2. Updating MK715x1 Software

The software of the AT command application is written in the MK715x1 evaluation kit at the factory default. Update the MK715x1 software according to the following procedure if the other software was updated.

2.1.2.1. Installing PC Tool

For the PC tool installation procedure, refer to "2.6. Installing nRF Connect for Desktop" in "MK715x1 Software Development Startup Guide".

2.1.2.2. Downloading Application Program

Download the "MK715x1 Software Development Kit" file (ZIP file) from the Bluetooth low energy related section in the following LAPIS support site and unzip the file to obtain the following Hex file (*.hex) of the AT command application program.

LAPIS support site: <https://www.lapis-semi.com/cgi-bin/MyLAPIS/regi/login.cgi> (English)
 https://www.lapis-semi.com/cgi-bin/MyLAPIS/regi/login_J.cgi (Japanese)

ZIP file of MK715x1 software development kit: mk715x1_sdk_verXXX.zip * XXX indicates a version number.

Hex file storage folder: .\mk715x1_sdk_verXXX\software\examples\lapis\mk715x1_at_cmd\hex

AT command application code: mk71511ek1_at_cmd_rXXX.hex (MK71511EK1)
 mk71511ek1a_at_cmd_rXXX.hex (MK71511EK1A/MK71511EK1AP)
 mk71521ek1_at_cmd_rXXX.hex (MK71521EK1)
 mk71521ek1a_at_cmd_rXXX.hex (MK71521EK1A/MK71521EK1AP)
 * XXX indicates a revision number of the code.

2.1.2.3. Writing Application Program

For how to write an application program, refer to " 3.4. Writing Built Program " in "MK715x1 Software Development Startup Guide"

2.1.3. Executing Application

Connect the MK715x1 evaluation kit to the USB (power feed included) of a PC. For the MK715x1-EKA evaluation kit, turn the power switch (POWER_SW) ON. Then, set all the DIP SW on the MK715x1 evaluation kit to OFF and press the button to execute the AT command application.

Start the terminal software such as TeraTerm and set the serial port as follows:

Port:	COM port number used
Baud rate:	57600 bps
Data:	8 bit
Parity:	None
Stop:	1 bit
Flow control:	Hardware

Input "at<CR>", which is the AT command for command reception confirmation, from the terminal. When the result code string is output as shown below, it indicates that UART communication is performed normally between the PC and MK715x1 evaluation kit. The input of the "at" command is not output because echoing back from MK715x1 is disabled



Figure 2-1 Screen Outputting Result Code String for Command Reception Confirmation

After that, input "atd <CR>" to start the peripheral operation. The MK715x1 evaluation kit will start transmission of advertisement. To start the central operation, input "ata <CR>". The MK715x1 evaluation kit will start scanning to search for peripheral devices. The preparation on the MK715x1 side is now completed. For the overview of AT commands, refer to "3. AT Command Operation"

2.2. Preparation on Central Side (Smartphone)

2.2.1. Starting Application

Tap the following "BLE Tool" icon on the smartphone to start the application.
The left figure shows the icon for Android terminals, and the right figure shows the icon for iOS terminals.



Figure 2-2 BLE Tool Icons (Left: Android, Right: iOS)

2.2.2. Data Communication

Bluetooth low energy communication can be performed according to the following steps. For details about the usage of BLE Tool, refer to the related document "BLE Tool User's Manual".

- A) When BLE Tool is started, the following screen (A) is displayed. This screen displays Bluetooth low energy devices from the advertisement packet detected through scanning by the central side. The MK715x1 AT command application is displayed as the device name "LapisDev" by default. Tap this device.
- B) The Bluetooth low energy connection procedure is executed, and the following service search screen (B) is displayed. Also, at this time, "CONNECT" is output to the terminal screen on the peripheral side. The following screen (B) displays the services detected with a service search by the central side. For the MK715x1 AT command application, the two services: "Device Information" and "LAPIS Serial Port Profile" are displayed. The latter is the service used by the AT command application for data communication. Tap the [VSSPP] icon.
- C) The VSSPP service becomes enabled, and the following screen (C) is displayed. Data transmission/reception is performed on this screen. Tapping the text box at the bottom of the screen displays a software keyboard. When a character string is input using the software keyboard and the [Send] button is tapped, the input character string will be transmitted to the peripheral side. Likewise, characters input from the terminal screen on the peripheral side are transmitted to the central side.

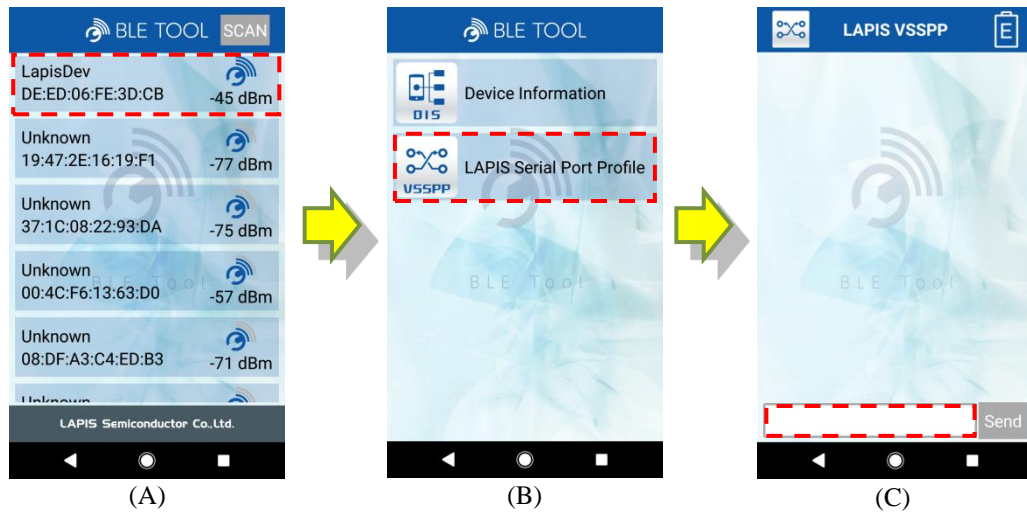


Figure 2-3 Examples of BLE Tool Operation Screen

The following figure shows an example of data communication performed according to the above steps. The character string input from BLE Tool is output in black as shown by (a) in the following figure, and the same character string is output to the terminal screen on the peripheral side ((b) in the following figure). The character string input from the terminal on the peripheral side ((c) in the following figure) is output to the BLE Tool screen in red ((d) in the following figure).



Figure 2-4 Examples of Data Communication Screen

2.2.3. Reading Device Information

The MK715x1 AT command application also provides the Bluetooth SIG standard DIS (Device Information Service). As shown in the following figure, the device information held by the peripheral can be read by tapping the [DIS] icon on the service search screen. The following figure shows the default settings of the MK715x1 AT command application. The device information needs to be changed according to the system settings. For correction of the device information, refer to "MK715x1 AT Command Application User's Manual".

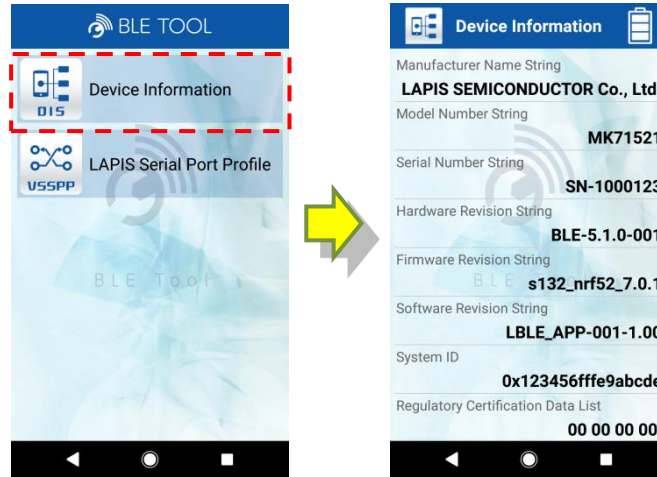


Figure 2-5 Examples of Device Information Screen

This is the end of the explanation about the usage of the MK715x1 AT command application. Refer to "3. AT Command Operation" for operation of the other AT command.

3. AT Command Operation

This chapter describes the operation as the following for the MK715x1 AT command application.

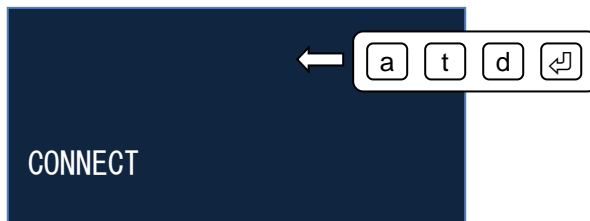
- Connection in Peripheral Operation
- Connection in Central Operation
- Data Transmission / Reception
- Disconnection
- Continuous scanning

3.1. Connection in Peripheral Operation

The following describes the AT command operation related to the connection in peripheral operation.

(1) Peripheral connection

For the peripheral connection, when "atd<CR>" is input, the advertising is transmitted. And, the connection procedure is started by the connection operation from the central device. When the connection is established, the CONNECT result code is displayed. The input data can be transmitted and the the received data can be outputted.



•"atd" has not output because the echo-back function is disabled on MK715x1.

Figure 3-1 Peripheral Connection

(2) Peripheral Connection Canceling

When "<CR>" is input during the time from the input of "ATD<CR>" to the display of CONNECT result code, the AT command application cancels the connection operation. The NO CARRIER result code is returned when the connection is canceled. And, the AT command can be input.



•"atd" has not output because the echo-back function is disabled on MK715x1.

Figure 3-2 Peripheral Connection Canceling

3.2. Connection in Central Operation

The following describes the AT command operation related to the connection in central operation.

(1) Central connection

For the central connection, when "ata<CR>" is input, the scanning is started. And, the advertisings are received. Next, the connection device is selected by device name in received advertising and the connection request is transmitted. When the connection succeeds, the CONNECT result code is displayed. It able to transmit the input data and output the reception data.

The connection device is decided by the device name in the advertising. The device name can be modified by "Advertising Device Name (LS_ADV_DEVIC_NAME)" of the system parameters. Refer to "AT Command Application User's Manual" for method of the system parameters setting.



•"ata" has not output because the echo-back function is disabled on MK715x1.

Figure 3-3 Central Connection

(2) Central Connection Canceling

When "<CR>" is input during the time from the input of "ata<CR>" to the display of CONNECT result code, the AT command application cancels the connection operation. The NO CARRIER result code is returned when the connection is canceled. And, the AT command can be input.



•"ata" has not output because the echo-back function is disabled on MK715x1.

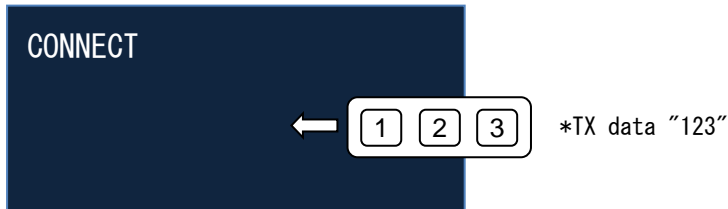
Figure 3-4 Central Connection Canceling

3.3. Data Transmission / Reception

The data transmission and data reception are described as the following.

(1) Data Transmission

After output of the CONNECT result code, the input data is transmitted to the remote device.



•Input data has not output because the echo-back function is disabled on MK715x1.

Figure 3-5 Data Transmission

(2) Data Reception

After the output of the CONNECT result code, the received data from the remote device is output.

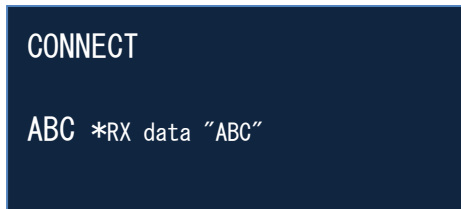


Figure 3-6 Data Reception

3.4. Disconnection

The following describes the disconnection operation of the local device and the remote device. The peripheral device and the central device are same for disconnection operation.

(1) Disconnection from Local Device

When the local device is disconnected, the escape code "+++AT<CR>" is input at the first. And, the input of AT command is changed to enabled state. Next, the disconnection is executed by "ath<CR>". The NO CARRIER result code is returned when the disconnection is completed.

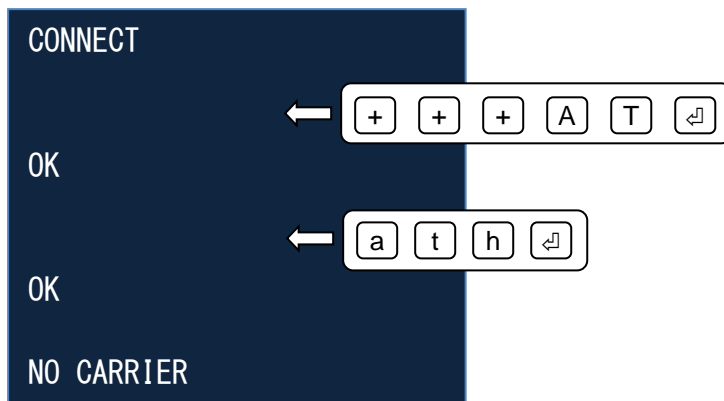


Figure 3-7 Disconnection from Local Device

(2) Disconnection from Remote Device

When the disconnection from the remote device, the NO CARRIER result code is output according to the disconnection request from the remote device. And, the AT command can be input.

Besides the disconnection from the remote device, the NO CARRIER result code is also output according to wireless communication state.

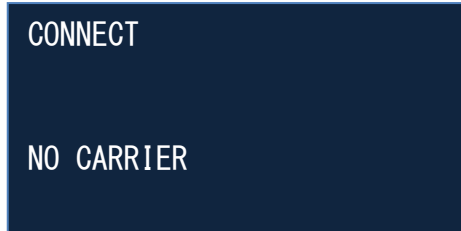


Figure 3-8 Disconnection from Remote Device

3.5. Continuous scanning

The following describes the AT command operation related to continuous scanning.

(1) Start Continuous Scanning

The continuous scanning is started to receive the advertising from the peripheral devices when "AT&A<CR>" is input. The received advertising is output as the following figure.

and it outputs an advertising report of detected peripheral devices.



Figure 3-9 Start Continuous Scanning (Character Output Format)

(2) Stop Continuous Scanning

The continuous scanning is stopped when "<CR>" is input. The NO CARRIER result code is returned. And, the AT command can be input.

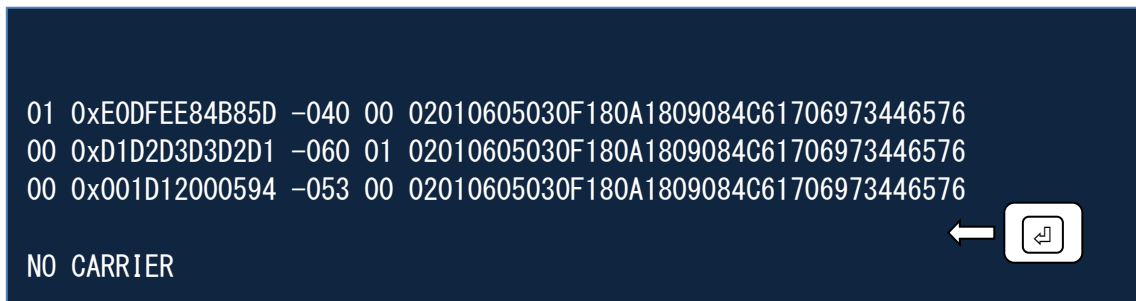


Figure 3-10 Stop Continuous Scanning

