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ROHM Co., Ltd. April 1, 2024



FEXK715x1_AN_Sniffer-02

Bluetooth[®] low energy Module (MK71511/MK71521) Application Note How to use Sniffer for MK71521

Issue: Nov. 19, 2020



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Introduction

This application note describes the method of using "nRF Sniffer for Bluetooth LE" of the development tool offered by Nordic on the evaluation-kit implemented with LAPIS's **Bluetooth**[®] low energy modules: MK71521 that support Bluetooth 5.

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

- MK71511 Data Sheet
- MK715x1EK1 Hardware Manual
- MK715x1EK1A/MK715x1EK1AP Hardware Manual
- MK715x1 Software Development Start-up Guide

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	0x <i>nn</i> 0b <i>nnn</i>	Represents a hexadecimal number. Represents a binary number.
• Address	0xnnnn_nnnn	Represents a hexadecimal number. (indicates 0xnnnnnnn)
• Unit	Word, WORD Byte, BYTE Mega, M Kilo, K Kilo, k Milli, m Micro,µ Nano, n Second, s (lowercase)	1 word = 32 bits 1 byte = 8 bits 10^{6} $2^{10} = 1024$ $10^{3} = 1000$ 10^{-3} 10^{-6} 10^{-9} Second
• Term	"H" level "L" level	Indicates high voltage signal levels V_{IH} and V_{OH} as specified by the electrical characteristics. 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

nRF Sniffer for Bluetooth LE can display the wireless protocol packet for Bluetooth low energy in real time and check the wireless communication state.

The below describes Operation Environment, Setup and Operation for "nRF Sniffer for Bluetooth" using the evaluation kit implemented with MK71521.

Because the firmware corresponding to "nRF Sniffer for Bluetooth LE" is not prepared, MK71511 cannot be used.

1.1. System Requirements

The operation environment using "nRF Sniffer for Bluetooth LE" is shown as follows.

"nRF Sniffer for Bluetooth LE" captures the wireless communication packets between two Bluetooth low energy devices, and displays captured data to Wireshark of the network protocol analyzer on PC.

Refer to "MK715x1EK1 Hardware Manual" or "MK715x1EK1A/MK715x1EK1AP Hardware Manual" for details of the evaluation kit implemented of MK71521.



Figure 1-1 nRF Sniffer for Bluetooth LE Operation Environment

This document is described for Windows 10. Moreover, the operation of other software is described in the following table.

Table 1-1 Sof	tware Version
Software	Version
nRF Sniffer (Nordic)	Version 3.0.0
Wireshark	Version 3.2.1
Python	Version 3.8.1

Refer to the following support site for details of these software.

nRF Sniffer (Nordic) : <u>https://infocenter.nordicsemi.com/index.jsp?topic=%2Fug_sniffer_ble%2FUG%2Fsniffer_ble%2Fintro.html</u>

- Wireshark Python
- : <u>https://www.wireshark.org/</u> : https://www.python.org/

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2. Setup

The setup procedure of the software relates to "nRF Sniffer for Bluetooth LE" is described. PC needs to connect to internet for the following setup procedure.

2.1. Installing USB-Serial Driver

When PC and the evaluation kit implemented of MK71521 are connected, the FT232RQ driver is needed. The FT232RQ driver corresponding to PC is installed from the following site if necessary.

URL: http://www.ftdichip.com/Drivers/D2XX.htm

2.2. Writing Sniffer Firmware for MK71521

The ZIP file of "nRF Sniffer for Bluetooth LE" is downloaded from the following site, and unzip it to one folder of PC.

URL: <u>https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Sniffer-for-Bluetooth-LE/Download#infotabs</u> ZIP file: nrf_sniffer_for_bluetooth_le_3.0.0_129d2b3.zip *Version 3.0.0

Next, the Hex file of the following folder is written in Flash ROM with built-in MK71521. Refer to "2.6. Installing nRF Connect for Desktop" of "MK715x1 Software Development Start-up Guide" and "3.4. Writing Built Program" for method of writing the firmware. The writing procedure only of the application program is done without doing the writing procedure of SoftDevice.

Folder : ".\<nRF Sniffer Folder Name>\hex\" Hex File : "sniffer_pca10040_129d2b3.hex"

The other files in ZIP file is used at Wireshark installing.

2.3. Installing Wireshark

The installation file of Wireshark is downloaded and executed from the following site. Complete the installation according to the procedure of the executed installer.

URL: https://www.wireshark.org/

2.4. Python Setup

The following procedure is executed, and Python is set up.

(1) Python Downloading & Installing

The installation file of Python is downloaded and executed from the following site. Complete the installation according to the procedure of the executed installer.

URL: https://www.python.org/downloads/

(2) Environment Variable Addition

A new path is added to the system environment variable according to the following operating procedure.

Operation 1: The control panel is opened by the figure below operation of the Explorer of Windows.

📃 🕑 📑 🗢 This PC			- 🗆 X
File Computer View	N		~
$\leftarrow \rightarrow \checkmark \uparrow \blacksquare $ > This	PC →	V Ö Search T	his PC
> 🖈 Quick access Ste	P.1 Right-click 3D Objects	Desktop	
This PC	Collapse Manage	Downloads	
 Desktop Documents Downloads 	Pin to Start Open in new window Pin to Quick access	Pictures	
 Music Pictures 	TortoiseSVN >		
21 items	Map network drive Disconnect network drive		8== 6
	Add a network location Delete Stop 2 0	liak	
	Rename Step.2 C	IICK	

Figure 2-1 Python Environment Variable Addition (1)

Operation 2: "System Properties" window is opened by the operation in the figure below.

🖳 System	
← → ✓ ↑ 🗹 > Control Pane	I > System and Security > System
Control Panel Home	View basic information about your computer
💡 Device Manager	Windows edition
Remote settings	Windows 10 Pro
System protection	© 2019 Microsoft Corporation. All rights reserved.
Advanced system settings	
	System



Operation 3: "Environment Variables" window is opened by the operation in the figure below.

/stem Propertie				
Computer Name	Hardware	Advanced	System Protection	Remote
You must be lo	gged on as :	an Administra	tor to make most of	these changes
-Performance				
Visual effects	, processor	scheduling, n	nemory usage, and vi	rtual memory
			•	•
				Settings
Desktop setti	ner volatad :	to your sime-	.in	
Desktop setti	iigs related	to your sign		
				Settings
_Startup and R	ecovery —			
System startu	up, system fi	ailure, and de	bugging information	
				Se <u>t</u> tings
		Click -	En viro <u>n</u>	ment Variables.
		01	K 🔤 Cancel	App

Operation 4: "Edit environment variable" window is opened by the operation in the figure below.

Variable	Value	
OneDrive	C:\Users\hiro\OneDrive	
Path	C:\Users\hiro\AppData\Local\Microsoft\WindowsApps;	
TEMP	C:\Users\hiro\AppData\Local\Temp	
TMP	C:\Users\hiro\AppData\Local\Temp	
	<u>N</u> ew <u>E</u> dit <u>D</u> ele	te
variables Variable NUMBER_OF_PROCESSORS	Value 8	
Variable NUMBER_OF_PROCESSORS OS	8 Windows NT	
Variable NUMBER_OF_PROCESSORS	8 <u>Windows NT</u> C:\Program Files (x86)\Common Files\Oracle\Java\javapath;C:\WIN	J
Variable NUMBER_OF_PROCESSORS OS Path	8 Windows NT C:\Program Files (x86)\Common Files\Oracle\Java\javapath;C:\WIN .COM;,EXE;.BA1;.CMD;.VBS;.VBE;JS;JSE;.WSF;.WSF;.MSC	۹
Variable NUMBER_OF_PROCESSORS OS Path PATHEX1	8 Windows NT C:\Program Files (x86)\Common Files\Oracle\Java\javapath;C:\WIN .COM;,EXE;.BA1;.CMD;.VBS;.VBE;JS;JSE;.WSF;.WSF;.MSC	4
Variable NUMBER_OF_PROCESSORS OS Path PATHEXT PROCESSOR_ARCHITECTURE	8 Windows NT C:\Program Files (x86)\Common Files\Oracle\Java\javapath;C:\WIN .COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSF;.MSC AMD64	J

Figure 2-4 Python Environment Variable Addition (4)

Operation 5: A new path is added to system variable by the operation in the figure below. The command prompt needs to restart after adding a new path.

Edit environment variable	×
C:\Program Files (x86)\Common Files\Oracle\Java\javapath C:\WINDOWS\system32 Step.1 Click	<u>N</u> ew
C:\WINDOWS	Edit
C:\WINDOWS\System32\Wbem	Lan
C:\WINDOWS\System32\WindowsPowerShell\v1.0\	Browse
C:\WINDOWS\System32\OpenSSH\	<u>D</u> rowsen
C:\Program Files (x86)\Nordic Semiconductor\nrf5x\bin\	Delete
C:\Python27	—
C:\Python27\Scripts	
C:\Program Files\NVIDIA Corporation\NVIDIA NGX	Move <u>U</u> p
C:\Program Files\NVIDIA Corporation\NVIDIA NvDLISR	
C:\Program Files\TortoiseSVN\bin	Move D <u>o</u> wn
C:\Program Files (x86)\GnuWin32\bin	
C:\Program Files\Git\cmd	
C:\Users\hiro\AppData\Local\Programs\Python\Python38-32\Scripts	Edit <u>t</u> ext
Step.2 Enter new path	
	_
Step.3 Click	Cancel
	.:
図 2.5 Dythen Environment Veriable Addition	

2-5 Python Environment Variable Addition (5)

New Path

: "C:\Users\<User Folder Name>\AppData\Local\Programs\Python\Python38-32\Scripts" (Reference) *A new path is different according to the version of Python. Referring to the above new path, the folder path of "Pip3.exe" is confirmed after installing Python.

(3) Serial Library Addition

The serial library is added by the following command entering. It is necessary to connect PC with the Internet when command is executed

C:\>pip install pyserial

Figure 2-6 Python Serial library addition

2.5. Wireshark Setup

Wireshark is set up by the following procedures.

(1) Installing Wireshark Plug-in

The plug-in is installed to Wireshark by the following command entering. It is necessary to connect PC with the Internet when command is executed

C:\>cd <nRF Sniffer Folder Name>\extcap

C:\Work\nRF Sniffer\extcap>pip3 install -r requirements.txt

Figure 2-7 Installing Wireshark Plug-in

(2) Wireshark setting

Wireshark is started and set by the following operating procedure.

Operation 1: Windows Start - "Wireshark"

Operation 2: Wireshark Menu "Help" - "About Wireshark" and the procedure of the following figure is done.

About Wireshark		×
Wireshark Authors	Folders Plugins Keyboard Shortcuts Acknowledge	nents License
Filter by path	Step.1 Click	
Name "File" dialogs Temp Personal configuration Global configuration System Program Personal Plugins Global Plugins Personal Lua Plugins Global Lua Plugins Global Lua Plugins Personal Extcap path Global Extcap path	Location C:¥Users¥a260664¥Documents¥ C:¥Users¥a260664¥AppData¥Local¥Temp C:¥Users¥a260664¥AppData¥Roaming¥Wireshark C:¥Program Files¥Wireshark C:¥Program Files¥Wireshark C:¥Users¥a260664¥AppData¥Roaming¥Wireshark¥plugins¥3.4 C:¥Users¥a260664¥AppData¥Roaming¥Wireshark¥plugins C:¥Users¥a260664¥AppData¥Roaming¥Wireshark¥plugins C:¥Users¥a260664¥AppData¥Roaming¥Wireshark¥plugins C:¥Users¥a260664¥AppData¥Roaming¥Wireshark¥extcap C:¥Program Files¥Wireshark¥extcap	Typical Files capture files untitled capture files dfilters, preferences, ethers, dfilters, preferences, manuf, ethers, ipxnets program files binary plugins binary plugins lua scripts lua scripts Extcap Plugins search path Extcap Plugins search path
MaxMind DB path MaxMind DB path MIB/PIB path	<u>C:¥ProgramData¥GeolP</u> C:¥GeolP Step.2 Double	MaxMind DB database search path MaxMind DB database search path SMI MIB/PIB search path
		Step.3 Click
		ОК
	Figure 2.9 Wireshark Setting (anon	

Figure 2-8 Wireshark Setting (open Extcap folder)

Operation 3: The files in the following folder are copied (overwrite) to the related folder of Operation 2.

Copy source: files in ".\<nRF Sniffer Folder Name>\extcap" Copy destination: Related folder of Operation 2.

Operation 4: Change to related folder of Operation 2, the following command is executed in the command prompt.

C:\>cd < Related folder path of Operation 2>

C:\Program Files\Wireshark\extcap>nrf_sniffer_ble.bat --extcap-interfaces



Operation 5: Wireshark Menu "Help" - "About Wireshark" and the procedure of the following figure is done.



Figure 2-10 Wireshark Setting (Open Configration Folder)

Operation 6: The files in the following folder are copied into the related folder "profiles" of Operation 5.

Copy source: ".\<nRF Sniffer Folder Name>\ Profile_nRF_Sniffer_Bluetooth_LE" Copy destination: Into related folder " profiles" of Operation 5.

Operation 7: Wireshark Menu "Edit" - "Configuration Profiles..." and the procedure of the following figure is done.

earch for profile ····		All profiles
earch for profile ***		All profiles
Profile		Туре
Default		Default
Bluetooth		Personal
Profile_nRF_Sniffer_Blu	ietooth_LE	Personal
Profile_nRF_Sniffer_v2_	001	Personal
Bluetooth	Step.1 Click	Global
Classic	Step.1 Click	Global
No Reassembly		Global
	Step.2 Click	
	· · · · ·	
+ – Pa	C+User +=260664+AppData+Reaming+Wire OK Import • Export	

3. Operation

The operation method to capture the wireless communication packets for "nRF Sniffer for Bluetooth LE" is described as follows.

(1) Connect MK71251 Evaluation-kit to PC

Prepared MK71521 evaluation kit for "nRF Sniffer for Bluetooth LE" is connected to PC.

(2) Wireshark Start-up

Wireshark is started by the following operation.

Operation: Windows Menu - "Wireshark"

(3) Selecting the Network Device

After Wireshark is started, the network device is selected by operation of the figure below (red). "COM" port number is different by PC used.

The packet list screen is displayed after the network device is selected, and the output of the capture data is started..



(4) Selecting the Bluetooth low energy Device for Capturing

The Bluetooth low energy device is selected to display captured data at connecting by operating the figure below (red). When Bluetooth low energy device (device name or device address) is not displayed in the pull-down list, the advertising packet of the Bluetooth low energy device is captured at first.

*nRF Sniffer for Blueto	both LE COM15
File Edit View Go	Capture Analyze Statistics Telephony Wireless Tools Help
🥖 🔳 🔬 💿 📘 📑) 🔀 🖻 🤇 🗢 🕾 🐨 🐌 🚍 📃 🤤 🤤 🤤 🗮
Apply a display filter •	••• <0tr H/>
Interface COM15 🗸 I	Device All advertising devices Passkey / OOB key
No. Time	All advertising devices Source "" -33 dBm 1a:37:cf:4e:08:2a random length Delta time (μs end to start) SN NES
631 3.057	Hon He *** -56 dBm 25:d5:ad:86:51:85 random -83 dBm 30:f7:72:4c:1c:6c public Click (Select device for capturing)
632 3.062	HonHa" -93 dBm 76:5b:a4:92:3d:30 random
633 3.066	30: 6 172: 44 17 17 18 dBm e7:52:4bb4:c2:0e random 36 4031µs
Fig	gure 3-2 Selecting the Bluetooth low energy Device for Capturing

(5) Starting the Capturing

Capture is started by operating in the following figure (red).

File	Edit View Go	Capture Analyze Statist	ics Telephony	Wireless	Tools Hel	p		
		ै 🔀 🖾 । ९ 🗢 🕾	T 🕹 📃	• •	Q. 🏨 🗌	•		
	pply a display filter	···· <otri=></otri=>						
Inter	face COM15 🗸	Device All advertising devices	3		\sim	Passkey / OOB key		Ad 🗠
		Device All advertising device: Source	s PHY	Protocol	∼ Length	Passkey / OOB key Delta time (μs end to start)	SN	
	Click			Protocol	Length		SN	NESI
No.	Click 7	Source	PHY		Length	Delta time (µs end to start)	SN	
No.	Click 7 13405 219.823	Source 0d:5c:0d:14:d4:28	PHY LE 1M	LE LL	Length	Delta time (µs end to start) 37 66021µs	SN	

Figure 3-3 Starting the Capturing

(6) Stop the Capturing

Capture is stopped by operating in the following figure (red).

<u>F</u> ile	Edit View Go	<u>Capture Analyze Statis</u>	tics Telephor	n <u>y W</u> ireless	<u>T</u> ools <u>H</u> elp						
◢▰◢ :::::::::::::::::::::::::::::::::::											
App <mark>y</mark> a display filter ···· <otrl-></otrl->											
Interface COM15 🗸 Device All advertising devices			∼ Passk	ey / OOB key		Adv	Hop 3				
No.	Click	Source	PHY	Protocol	Length	Delta time (µs end to start)	SN	NE			
CIICK		0d:5c:0d:14:d4:28	LE 1M	LE LL	37	163µs					
3881 54.091		71:85:9d:7a:93:af	LE 1M	LE LL	23	3083µs					
3882 54.091		71:85:9d:7a:93:af	LE 1M	LE LL	23	368µs					
	2002 54 406	71:85:9d:7a:93:af	LE 1M	LE LL	23	368µs					

(7) Saving the Captured Data

The following operation saves the captured data when the capturing is the stopped condition

Operation: Wireshark Menu "File" - "Save"

Revision History

	Issue date	Page		
Document No.		Before revision	After revision	Remarks
FEXK715x1_AN_Sniffer- 01	Apr. 4, 2020	-	-	Final edition 1 st
FEXK715x1_AN_Sniffer- 02	Nov. 19, 2020	2 6	2 6	Add Installing Wireshark Correct Installing Plug-in Wireshark
1				