Integrating NFC Reader Library in a KW4x Bluetooth Low Energy ApplicationRev. 1 — 30 May 2023Application note

Document information

Information	Content
Keywords	AN13953, Bluetooth LE, KW45/KW47, NFC, Reader library, PN5180, CLRC663, NCF3320
Abstract	This document gives instructions on how to create a Bluetooth Low Energy project for the EVK-KW45 development board and MCUXpresso IDE, and how to integrate NFC Reader Library.



1 Introduction

This document gives instructions on how to create a Bluetooth Low Energy (Bluetooth LE) project for the EVK-KW45 development board and MCUXpresso IDE, and how to integrate NFC Reader Library.

This document guides software developers who want to use, adapt, and integrate the NFC Reader Library to an SDK wireless connectivity example.

1.1 NFC reader library overview

The NXP NFC Reader Library is a modular software library written in C language, which provides an API that enables customers to create their own software stack and applications for the NXP contactless reader ICs:

- PN512
- CLRC633 family
- PN7462 family
- PN5180

This API facilitates the most common operations required in NFC applications such as:

- reading or writing data into contactless cards or tags;
- exchanging data with other NFC-enabled devices;
- allowing NFC reader ICs to emulate cards.

The NFC Reader Library is designed in a way to be easily portable to many different microcontrollers with a multi-layered architecture:

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Figure 1. NFC reader library

As main blocks, we have:

- Application Layer (AL) implements the command sets to interact with MIFARE cards and NFC tags;
- NFC activity implements a configurable Discovery loop for the detection of contactless cards, NFC tags, or other NFC devices;
- HCE and P2P components, for the emulation of Type 4 tags and P2P data exchange respectively;
- Protocol abstraction layer (PAL) contains the RF protocol implementation of the ISO14443, FeliCa, vicinity and NFC standards;

- Hardware abstraction layer (HAL) implements the drivers for controlling the NFC front ends RF interface and capabilities;
- Driver Abstraction Layer (DAL) implements the GPIO pinning, the timer configuration, and the physical interface (BAL) between the host MCU and the reader IC;
- OSAL module, in charge of abstracting the OS or RTOS specifics (tasks events, semaphores, and threads).

1.2 KW45 wireless microcontroller overview

The KW45 product family is a low-power, highly secure, and single-chip wireless MCU that integrates a high performance Bluetooth Low Energy version 5.3 radio and CAN FD for Automotive and Industrial applications.

The KW45 microcontroller is a low-power, highly secure, Arm Cortex-M33-based wireless device targeting these applications with up to 1 MB program Flash, 128 kB SRAM, and a 2.4 GHz upgradable radio supporting up to 24 simultaneous hardware connections in any central/peripheral combination.

For more details, see <u>Bluetooth® Smart/Bluetooth Low Energy</u>.

1.3 NFC reader library – integration with KW45B41Z-EVK overview

The current NFC Reader Library v5.22.01 does not support Kinetis KW4x MCU. For reference, see the <u>K82</u> <u>NFC Reader Library package</u>.

To integrate the library, perform the following steps:

- Hardware preparation (the connection between KW45B41Z-EVK board and NFC reader board);
- Setting up the development environment (SDK download, workspace);
- Preparing adaptation files for KW45 board;
- Integrating NFC application to wireless uart Bluetooth LE example;
- Running the demo.

2 Hardware setup

2.1 Hardware required

To perform the NFC integration to a wireless uart Bluetooth LE example, the platforms below are needed:

- NCF3320 Antenna v1.0 board as an NFC transceiver;
- KW45B41Z-EVK board as host MCU, used to load and run the Bluetooth Low Energy Stack and NFC application logic.



2.2 Pin configuration

The communication between the boards is via the SPI communication using the following pin configuration:

Table 1. Pin configuration

Master board (KW45B41Z-EVK)	Connects to	Slave board (NCF3320 Antenna v 1.0)
PTC0 (J2-pin10)	_	IRQ
PTC1 (J2-pin9)	_	Reset
PTA18 (J2-pin2)	—	MOSI
PTA17 (J1-pin2)	—	MISO
PTA19 (J1-pin5)	-	SCK
PTA16 (J1-pin1)	—	CS
GND (J3-pin7)	_	GND

2.3 Power configuration

The KW45 must be put in Bypass mode by placing the jumper JP5 in position 3-4 (its default position is 1-2, DCDC mode).



3 Setting up the development environment

Follow the next steps to create an EVK-KW45 Bluetooth Low Energy project for MCUXpresso IDE (in which the NFC library is integrated) and to get the latest NFC Reader Library release. For this example, the version of SDK used is **SDK_2_12_KW45B41Z-EVK** and the **NFC Reader Library** version is **v5.22.01**.

- 1. Download and Install MCUXpresso IDE (for this example, we are using **MCUXpresso IDE v11.7.0 [Build 9198**]).
 - Go to the MCUXpresso-IDE webpage and download the latest version of IDE.



Install the IDE.

- 2. Get the latest NFC Reader Library release (for this example, we are using v5.22.01)
 - Go to the <u>NXP NFC Reader Library</u> webpage.
 - Go to the **Downloads** tab.

Integrating NFC Reader Library in a KW4x Bluetooth Low Energy Application

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	September 2015 and 100 and	upt-based event handling, Free RTO' ompliancy, are provided along with th s software is designed in a way to be different microcontrollers.	0	Documentation	Note: For better experience, software downloads are recomment on desitop.

Figure 5. Downloads tab

• Download the NFC Reader Library for Kinetis K82F package.

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Select a ver	sion. To access older versions, click on the " Previous " tab							
Current	Previous							
Version	Description	Date Available						
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	NFC Reader Library for Linux	Way 4, 2023	Download Log					
v07.08.00	NFC Reader Library for Linux NFC Reader Library for PN5180	May 4, 2023	Download Log					
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Figure 6. Download NFC reader library

3. Generate a downloadable SDK package for KW45B41Z-EVK board (SDK_2_12_2_KW45B41Z-EVK).

- Navigate to Select Development Board webpage and search for KW45B41Z-EVK board.
- Select Build MCUXpresso SDK.

NXP Semiconductors

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Figure 8. Start downloading

- 4. Create the MCUXpresso workspace.
 - Open MCUXpresso IDE and create a workspace.
 - Drag and drop SDK_2_12_2_KW45B41Z-EVK into the installed SDKs tab of the MCUXpresso IDE.

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Figure 9. Dragging and dropping SDK_2_12_2_KW45B41Z-EVK

- Click Import SDK example(s) from the Quickstart panel.
- Search and select kw45b41zevk in the board and/or device selection page. Then, click next.

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Figure 10. Select kw45b41zevk

• Select wireless_uart_freertos Bluetooth LE project.

Integrating NFC Reader Library in a KW4x Bluetooth Low Energy Application

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tame i component_examples i dorp_apps i dorp_amples i dorp_amples <td>Description Version</td> <td></td>	Description Version	
✓ ■ interios ✓ ■ wireless uart freertos	The BLE wireless uart application is a simple demonstration program based on the MCUXpresso SDK. The application implements a custom GATT based Wire	
>	— словая на прилована и и интрискатаната раздити нации на постратива и или предокта или продоктала Парателия и халон со от 2000 ТИКа.	
2	< Back Next >	inish Cancel

Figure 11. Selecting wireless_uart_freertos

4 Preparing adaptation files for KW45B41Z-EVK board

After unzipping the NFC Reader Library, create an equivalent file for KW45B41Z-EVK (*Board_FRDM_KW45FRc663.h*) by setting the right configuration for GPIOs and handlers.

The following files below must also be adapted:

- DAL\cfg\BoardSelection.h: include the new header file created.
- DAL\src\KinetisSDK\phbalReg_KinetisSpi: configure low-power SPI, include the LPIT driver, and add the SPI initialization afferent to K45 as follows:

```
lpspi master config t g masterConfig;
   if ( (pDataParams == NULL) || (sizeof(phbalReg Type t) !=
wSizeOfDataParams))
   {
        return (PH DRIVER ERROR | PH COMP DRIVER);
   ((phbalReg Type t *)pDataParams)->wId
                                                   = PH COMP DRIVER |
PHBAL REG KINETIS SPI ID;
   ((phbalReg Type t *)pDataParams)->bBalType = PHBAL REG TYPE SPI;
   memset(&g_masterConfig, 0, sizeof(lpspi_master_config_t));
g_masterConfig.baudRate = PHDRIVER_KSDK_SPI_DATA_RATE;
   g_masterConfig.bitsPerFrame = 8U;
g_masterConfig.cpol = kLPSPI_ClockPolarityActiveHigh;
   g_masterConfig.cpha = kLPSPI_ClockPhaseFirstEdge;
   g masterConfig.direction = kLPSPI MsbFirst;
   g_masterConfig.pcsToSckDelayInNanoSec = 10000000000 /
PHDRIVER KSDK SPI DATA RATE;
   g masterConfig.lastSckToPcsDelayInNanoSec = 1000000000 /
PHDRIVER KSDK SPI DATA RATE;
   g masterConfig.betweenTransferDelayInNanoSec = 1000000000 /
PHDRIVER KSDK SPI DATA RATE;
   g masterConfig.whichPcs = kLPSPI_Pcs0;
```

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```
g_masterConfig.pcsActiveHighOrLow = kLPSPI_PcsActiveLow;
/*Set clock source for LPSPI and get master clock source*/
CLOCK_SetIpSrc(kCLOCK_Lpspi0, kCLOCK_IpSrcFro192M);
CLOCK_SetIpSrcDiv(kCLOCK_Lpspi0, kSCG_SysClkDivBy16);
phbalReg_SpiInit();
/* Initialize the DSPI peripheral */
LPSPI_MasterInit(PHDRIVER_KSDK_SPI_MASTER, &g_masterConfig,
CLOCK_GetIpFreq(PHDRIVER_KSDK_SPI_CLK_SRC));
```

• DAL\src\KinetisSDK\phDriver_KinetisSDK.c: include the lpit driver, update interrupt types, and initialize the lpit timer as follows:

```
lpit chnl params t lpitChannelConfig;
   lpitChannelConfig.chainChannel
                                           = false;
   lpitChannelConfig.enableReloadOnTrigger = false;
   lpitChannelConfig.enableStartOnTrigger = false;
  lpitChannelConfig.enableStopOnTimeout = false;
   lpitChannelConfig.timerMode
                                          = kLPIT PeriodicCounter;
   /* Set default values for the trigger source */
   lpitChannelConfig.triggerSelect = kLPIT_Trigger_TimerChn0;
   lpitChannelConfig.triggerSource = kLPIT TriggerSource External;
   LPIT SetupChannel (PH DRIVER KSDK PIT TIMER,
PH DRIVER KSDK TIMER CHANNEL, & [pitChannelConfig);
   LPIT StopTimer(PH DRIVER KSDK PIT TIMER, PH DRIVER_KSDK_TIMER_CHANNEL);
   LPIT ClearStatusFlags (PH DRIVER KSDK PIT TIMER, kLPIT ChannelOTimerFlag);
   LPIT EnableInterrupts (PH DRIVER KSDK PIT TIMER,
kLPIT ChannelOTimerInterruptEnable);
```

```
/* Configure timer period */
LPIT_SetTimerPeriod(PH_DRIVER_KSDK_PIT_TIMER, PH_DRIVER_KSDK_TIMER_CHANNEL,
(uint32_t)qwTimerCnt);
```

Also in this source an equivalent function for PIT IRQ Handler is needed:

```
void PIT_DriverIRQHandler(void)
{
    /* Clear interrupt flag.*/
    LPIT_ClearStatusFlags(PH_DRIVER_KSDK_PIT_TIMER, kLPIT_Channel0TimerFlag);
    /* Single shot timer. Stop it. */
    LPIT_StopTimer(PH_DRIVER_KSDK_PIT_TIMER, PH_DRIVER_KSDK_TIMER_CHANNEL);
    LPIT_DisableInterrupts(PH_DRIVER_KSDK_PIT_TIMER,
    kLPIT_Channel0TimerInterruptEnable);
    pPitTimerCallBack();
}
```

• In *NxpNfcRdLib\types\ph_NxpBuild_Platform.h*, add a definition for KW45 board.

For additional changes that are not outlined in this chapter, see the source code.

5 Integrating NFC application to Wireless_UART Bluetooth LE example

This chapter introduces how to integrate the <code>BasicDiscoveryLoop</code> NFC example to <code>Wireless_UART</code> Bluetooth LE application.

For the integration, perform the following steps:

Integrating NFC Reader Library in a KW4x Bluetooth Low Energy Application

• Add pit drivers in the project.

• On the wireless uart project location, create an nfc folder.

Name	Date modified	Туре	Size
.settings	3/16/2023 3:22 PM	File folder	
bluetooth	3/16/2023 1:42 PM	File folder	
📕 board	3/16/2023 1:42 PM	File folder	
CMSIS	3/16/2023 1:42 PM	File folder	
📜 component	3/16/2023 1:42 PM	File folder	
📜 Debug	3/16/2023 5:36 PM	File folder	
📕 device	3/16/2023 1:42 PM	File folder	
📜 doc	3/16/2023 1:42 PM	File folder	
drivers	3/16/2023 2:35 PM	File folder	
Framework	3/16/2023 1:42 PM	File folder	
Freertos	3/16/2023 1:41 PM	File folder	
📜 libs	3/16/2023 1:41 PM	File folder	
📜 linkscripts	3/16/2023 1:42 PM	File folder	
📜 mcmgr	3/16/2023 1:42 PM	File folder	
📕 nfc	3/16/2023 3:08 PM	File folder	
📜 rpmsg_lite	3/16/2023 1:41 PM	File folder	
📜 secure-subsystem	3/16/2023 1:42 PM	File folder	
📜 source	3/16/2023 1:50 PM	File folder	
📜 startup	3/16/2023 1:41 PM	File folder	
📜 utilities	3/16/2023 1:41 PM	File folder	
.cproject	3/20/2023 5:59 PM	CPROJECT File	135 KB
.project	3/16/2023 4:21 PM	PROJECT File	1 KB
kw45b41zevk w uart ncf3320 basic discovery JLink Debug, Jaunch	3/16/2023 5:09 PM	LAUNCH File	8 KB

Figure 12. Creating an *nfc* folder





Figure 13. Copy folders

• On the wireless_uart project location, the *source* folder, create an *nfc* subfolder to integrate the BasicDiscovery loop files from *NfcrdlibEx1_BasicDiscoveryLoop* folder.

> OSDisk (C:) > nxp > KW45_nfc > kw45b41zevk_w_uart_ncf3320_basic_discovery > source > nfc

Name	Date modified	Туре	Size	
A NfcrdlibEx1_BasicDiscoveryLoop.c	3/20/2023 2:37 PM	C File	18 KB	
A NfcrdlibEx1_BasicDiscoveryLoop.h	3/16/2023 1:50 PM	H File	2 KB	
a) ph_NxpBuild_App.h	3/16/2023 1:50 PM	H File	14 KB	
a) phApp_Init.c	3/20/2023 3:04 PM	C File	36 KB	
a) phApp_Init.h	3/16/2023 1:50 PM	H File	6 KB	

Figure 14. Source folder

These files require the changes below:

- In *NfcrdlibEx1_BasicDiscoveryLoop.c* file, rename main function to NFC_BasicDiscoveryLoop_Start and remove OS initialization.
- In *NfcrdlibEx1_BasicDiscoveryLoop.h*, declare NFC_BasicDiscoveryLoop_Start function.
- In ph_NxpBuild_App.h, add the definition for KW45,

- In *phApp_Init.h*, add the definition for ph driver.
- In phApp_Init.c, include the needed headers add the CPU initialization for KW45 in phApp_CPU_Init function and add the IRQ handler as follows:

```
IRQ_HANDLE_ARRAY_DEFINE(g_IrqHandle, 1);
#define gBoardIrqHandle ((irq_handle_t)g_IrqHandle[0])
void CLIF_HalIRQHandler(void *param)
{
    CLIF_IRQHandler();
}
```

Configure the GPIO pins in the phApp Configure IRQ function:

```
#if !gAppButtonCnt c
    NVIC SetPriority (EINT IRQn, EINT PRIORITY);
    NVIC ClearPendingIRQ(EINT IRQn);
    EnableIRQ(EINT IRQn);
#else
#include "fsl adapter gpio.h"
    static const hal_gpio_pin_config_t g_IrqConfig = {
    kHAL GpioDirectionIn,
    PHDRIVER_IRQ_GPIO_PIN_DEFAULT_STATE,
PHDRIVER_IRQ_GPIO_PORT_INSTANCE,
    PHDRIVER IRQ GPIO PIN
    };
        if (kStatus HAL GpioSuccess !
=HAL GpioInit((hal gpio handle t)gBoardIrqHandle,
 (hal gpio pin config t *) &g IrqConfig))
    {
        return PH ERR ABORTED;
    (void) HAL GpioInstallCallback(gBoardIrqHandle,CLIF HallRQHandler, NULL);
```

Also, call BleApp SendNfcCardInfo in phApp PrintTagInfo function.

- In *wireless_uart.h*, define the nfcCardInfo_tag structure, declare BleApp_SendNfcCardInfo function, and define a HexToAscii function:

```
typedef struct nfcCardInfo_tag
{
    uint8_t technology;
    uint8_t uid[8];
    }nfcCardInfo_t;
extern nfcCardInfo_t gNfcCardInfo;
void BleApp_SendNfcCardInfo(void);
#define HexToAscii(hex) (uint8_t)( ((hex) & 0x0F) + ((((hex) & 0x0F) <= 9) ?
    '0' : ('A'-10)) )</pre>
```

- In *wireless_uart.c*, call the initializations for pit module and the nfc basic discovery start and add definitions for BleApp_SendNfcCardInfoHandler and BleApp_SendNfcCardInfo functions.

```
static void BleApp_SendNfcCardInfoHandler(void *pParam)
{
  static uint8_t dataToSend = 1;
  uint8_t *pString;
  uint8_t stringSize;
  uint8_t index = 0;
```

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```
uint8_t hexString1[13] = {"Card Detected"};
uint8_t hexString2[12] = {"Technology=A"};
uint8_t hexString3[20] = {"UID=000000000000000"};
 if(dataToSend == 1)
 {
 pString = hexString1;
 stringSize = 13;
 dataToSend = 2;
 }
 else if (dataToSend == 2)
 {
 hexString2[11] = gNfcCardInfo.technology;
 pString = hexString2;
 stringSize = 12;
          dataToSend = 3;
 }
 else
 {
  index = 4;
  for(uint8 t i = 0; i < 8; i++)</pre>
   hexString3[index++] = HexToAscii( (gNfcCardInfo.uid[i])>>4 );
  hexString3[index++] = HexToAscii( gNfcCardInfo.uid[i] );
  }
  pString = hexString3;
  stringSize = 20;
 dataToSend = 1;
 }
BleApp SendUartStream(pString, stringSize);
 if(dataToSend!=1)
 {
 (void) App PostCallbackMessage((appCallbackHandler t) BleApp SendNfcCardInfo,
NULL);
 }
}
void BleApp SendNfcCardInfo(void)
{
     (void)App PostCallbackMessage(BleApp SendNfcCardInfoHandler, NULL);
}
```

- In main.c, include board.

- In board.c, include fsl_lpit.h and initialize pit module.

- In **board.h**, declare pit initialization.

 Update the linker information (Project Properties -> C/C++ Build -> Settings) and preprocessor defines (Project Properties -> C/C++ Build -> Preprocessor).



6 Running the demo

To run the demo, perform the following steps:

- Create hardware connection based on Section 2.
- Open a serial terminal on the corresponding COM port for KW45 board. The baud rate used is 115200.
- Start advertising.
- Open Mobile APP IoT toolbox Wireless UART. The KW45 board is listed as NXP_WU.

Integrating NFC Reader Library in a KW4x Bluetooth Low Energy Application



Figure 18. Serial log

- To initiate discovery demo, use NFC cards close to NCF3320 Antenna v1.0 board.
- Once the card is detected, an event is sent to the mobile application including technology and UUID of the card.



7 Reference

- <u>NFC Reader Library</u>
- <u>NCF3320</u>
- <u>CLRC663 plus</u>
- FRDM- KW41Z board
- KW45B41Z-EVK SDK
- MCUXpresso IDE

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9 Revision history

Table 2 summarizes the revisions to this document.

Document ID	Release date	Description
AN13953 v.1	30 May 2024	Initial public release

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