# AN14647

## KW47-LOC In-System Programming Utility

Rev. 1.1 — 10 December 2025 Application note

**Document information**

| Information | Content |
|---|---|
| Keywords | AN14647, ISP, UART, I2C, SPI, CAN, ROM Bootloader |
| Abstract | The document provides steps to boot the KW47 MCU in ISP mode and establish various serial connections to communicate with the MCU. |

# 1 Introduction

The KW47 MicroController Unit (MCU) contains a Read-Only Memory (ROM) bootloader, which is a boot code resident in the ROM. The ROM bootloader begins its execution when the Arm Cortex-M33 core is released from reset. The bootloader can follow different paths. One of them is the In-System Programming (ISP) path. To make the bootloader follow the ISP path, a utility, called ISP utility, is used. The ISP utility operates over a serial connection on the MCU. To upload/download the application code using the bootloader, you can use host-side tools.

The document provides steps to boot the KW47 MCU in ISP mode and establish various serial connections to communicate with the MCU. For demonstrating the ISP functionality, the KW47-LOC board is used as the KW47 MCU platform. For simplicity, the KW47 MCU is referred to as the target MCU at some places in the document.

# 2 Entering ISP mode

The KW47 device has two different ways of entering ISP mode.

- Use the designated button in the KW47-LOC board, which asserts the appropriate signal for the ROM bootloader to boot in ISP mode while powering the board.
- Follow the ISP path using the software method, which can be used at any time while the MCU is running.

## 2.1 ISP entry via hardware

To make the bootloader follow the ISP path (to boot the KW47 MCU in the ISP mode), the `BOOT_CFG` (PTA4) pin of the MCU must be active. To activate this pin and boot the target MCU in the ISP mode, follow these steps:

1. Disconnect the KW47-LOC board from all power sources.
2. Keep the **SW4** (`BOOT_CONFIG`) button pressed, while connecting the board to the host computer USB port, using the J3 USB type-C connector.
3. Release the **SW4** (`BOOT_CONFIG`) button. The KW47 boots in the ISP mode.
4. Connect any external power supply, if needed.

## 2.2 ISP entry via software

To enter the ISP mode using the software, assert the `FORCECFG` bit from the `CMC[FM]` register, followed by a software reset. Once the device resets, it enters the ISP mode.

# 3 Software and tools

For the current document:

- The `blhost` utility of the Security Part SDK (SPSDK) software is used, when $I^2C$ or SPI protocols are selected as the communication interface.
- The standalone `blhost` application is used, when the Controller Area Network (CAN) interface is selected as the communication interface, since the current version of SPSDK does not yet support CAN.

Table 1 shows the versions of the tools used for the current document.

**Table 1. Tool versions**

| Tool | Version |
|---|---|
| SPSDK | 2.6.0 |

Table 1. Tool versions...*continued*

| Tool | Version |
|---|---|
| Blhost | 2.6.7 |

### 3.1 Buspal

`Buspal` is an embedded software tool available as a companion to the `blhost` application. It acts as a bus translator between `blhost` and the target device. It connects to the `blhost` application over a Universal Asynchronous Receiver Transmitter (UART) connection, and connects to the target device over an $I^2C$, an SPI, or a CAN connection. It assists the `blhost` application in performing commands and responses from the target device.

The source code for `Buspal` is provided with the Kinetis bootloader release. The source code is only available for selected platforms, but it can be customized to run on other platforms.

For more details on the `Buspal` software tool and the MCU bootloader for NXP MCUs, see the MCU Bootloader for NXP Microcontrollers.

## 4 Establishing communication

This section describes how to establish communication between the host computer and the target MCU using the UART, $I^2C$, SPI, or CAN interface. A host-side command-line tool (for example, `blhost`) can be used to communicate with the target MCU directly over a UART connection. However, to enable $I^2C$, SPI, or CAN communication between the host computer and the target MCU, you must create a bridge (for example, Buspal) using an external device, along with a host-side command-line tool (for example, `blhost`).

You can use one of the following NXP MCUs to create a Buspal bridge:

- MKL25Z
- MKV46
- MK65F
- MCX W71
- MCX A156

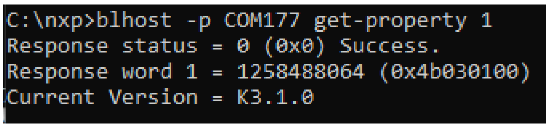
To learn more about Buspal devices and how to program the Buspal firmware, see the BusPal Application for FRDM MCX Families.

***Note:*** *The current document only includes examples with MKL25Z, MCX W71, and MCX A156 MCUs used as Buspal bridge devices.*

### 4.1 Using UART interface

To communicate with the target MCU using a UART interface, no external hardware or modifications are needed. To establish a UART connection between the host computer and the KW47 MCU (KW47-LOC board), boot the MCU in ISP mode, as explained in Section 2. The target MCU starts receiving ISP commands using the host-side tool.

Figure 1 shows the response from the target MCU after running the ISP command using the UART interface.



```
C:\nxp>blhost -p COM177 get-property 1
Response status = 0 (0x0) Success.
Response word 1 = 1258488064 (0x4b030100)
Current Version = K3.1.0
```

Figure 1. Running ISP command using UART interface

## 4.2 Using I$^2$C interface

To communicate with the target MCU using the Inter-Integrated Circuit (I$^2$C) interface, you must create a Buspal bridge (using an external device) between the host computer and the target MCU. Devices, such as an NXP MCU MCXW71 or MCXA156, can be used as a Buspal bridge device for I$^2$C communication.

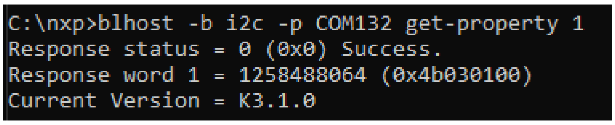
To establish an I$^2$C connection between the host computer and the target MCU while using an MKL25Z MCU (FRDM-KL25Z board), MCX W71 (FRDM-MCXW71 board), or an MCX A156 MCU (FRDM-MCXA156 board) as a bridge device, follow these steps:

1. Boot the target MCU in the ISP, as explained in Section 2.
2. Set up an I$^2$C connection between the KW47-LOC board and the FRDM-KL25Z/FRDM-MCXW71/FRDM-MCXA156 board, as described in Table 2.
3. Place JP24 in the 2-3 position.

**Table 2. I$^2$C connection setup**

| Signal | Target MCU | | MKL25Z Buspal | MCX W71 Buspal | MCX A156 Buspal |
|---|---|---|---|---|---|
| | MCU pin | KW47-LOC connector | FRDM-KL25Z connector | FRDM-MCXW71 connector | FRDM-MCXA156 connector |
| LPI2C_SCL | PTB5 | J2, pin 5 | J1, pin 14 | J2, pin 1 | J5, pin 5 |
| LPI2C_SDA | PTB4 | J2, pin 6 | J1, pin 16 | J2, pin 2 | J5, pin 6 |

After following the above steps, the target MCU starts receiving ISP commands using the host-side tool. Figure 2 shows the response from the target MCU after running the ISP command using the I$^2$C interface.



```
C:\nxp>blhost -b i2c -p COM132 get-property 1
Response status = 0 (0x0) Success.
Response word 1 = 1258488064 (0x4b030100)
Current Version = K3.1.0
```

**Figure 2. Running ISP command using I$^2$C interface**

## 4.3 Using SPI interface

To communicate with the target MCU using the Serial Peripheral Interface (SPI), you must create a Buspal bridge (using an external device) between the host computer and the target MCU. Devices, such as an NXP MCU MCX W71 or MCX A156, can be used as a Buspal bridge device for SPI communication.

To establish an SPI connection between the host computer and the target MCU while using an MKL25Z MCU (FRDM-KL25Z board), MCX W71 (FRDM-MCXW71 board), or an MCX A156 MCU (FRDM-MCXA156 board) as a bridge device, follow these steps:

1. Boot the target MCU in the ISP, as explained in Section 2.
2. Set up an SPI connection between the KW47-LOC board and the FRDM-KL25Z/FRDM-MCXW71/FRDM-MCXA156 board, as described in Table 3.

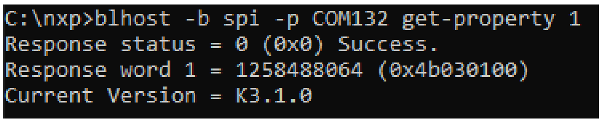
**Table 3. SPI connection setup**

| Signal | Target MCU | | MKL25Z Buspal | MCX W71 Buspal | MCX A156 Buspal |
|---|---|---|---|---|---|
| | MCU pin | KW47-LOC connector | FRDM-KL25Z connector | FRDM-MCXW71 connector | FRDM-MCXA156 connector |
| LPSPI_PCS0 | PTB0 | J1, pin 3 | J2, pin 6 | J2, pin 8 | J6, pin 3 |
| LPSPI_SIN | PTB1 | J1, pin 5 | J2, pin 8 | J2, pin 7 | J6, pin 6 |

Table 3. SPI connection setup*...continued*

| Signal | Target MCU | | MKL25Z Buspal | MCX W71 Buspal | MCX A156 Buspal |
|---|---|---|---|---|---|
| | MCU pin | KW47-LOC connector | FRDM-KL25Z connector | FRDM-MCXW71 connector | FRDM-MCXA156 connector |
| LPSPI_SCK | PTB2 | J1, pin 4 | J2, pin 12 | J2, pin 5 | J6, pin 4 |
| LPSPI_SOUT | PTB3 | J1, pin 6 | J2, pin 10 | J2, pin 6 | J6, pin 5 |

After following the above steps, the target MCU starts receiving ISP commands using the host-side tool. Figure 3 shows the response from the target MCU after running the ISP command using the SPI interface.



```
C:\nxp>blhost -b spi -p COM132 get-property 1
Response status = 0 (0x0) Success.
Response word 1 = 1258488064 (0x4b030100)
Current Version = K3.1.0
```

Figure 3. Running ISP command using SPI interface

## 4.4 Using CAN interface

To communicate with the target MCU using the Controller Area Network (CAN), you must create a Buspal bridge (using an external device) between the host computer and the target MCU. For CAN communication, only MCX W71 and MCX A156 MCUs can be used as a Buspal bridge device.

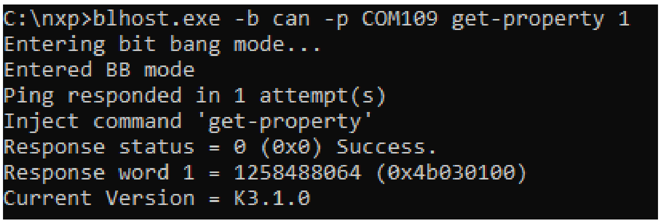
To establish a CAN connection between the host computer and the target MCU while using an MCX W71 (FRDM-MCXW71 board), or an MCX A156 MCU (FRDM-MCX A156 board) as a bridge device, follow these steps:

1. Boot the target MCU in the ISP, as explained in Section 2. To power on the CAN transceiver in the KW47-LOC board, an external 12 V power supply must be provided at the J9 connector.
2. Set up a CAN connection between the KW47-LOC board and the FRDM-MCXW71/FRDM-MCXA156 board, as described in Table 4.

Table 4. CAN connection setup

| Signal | Target MCU | | MCX W71 Buspal | MCX A156 Buspal |
|---|---|---|---|---|
| | MCU pin | KW47-LOC connector | FRDM-MCXW71 connector | FRDM-MCXA156 connector |
| CAN0_TX | PTC4 | J10, pin 1 | J21, pin 1 | J22, pin 2 |
| CAN0_RX | PTC5 | J10, pin 2 | J21, pin 2 | J22, pin 4 |

After following the above steps, the target MCU starts receiving ISP commands using the host-side tool. Figure 4 shows the response from the target MCU after running the ISP command using the CAN interface.



```
C:\nxp>blhost.exe -b can -p COM109 get-property 1
Entering bit bang mode...
Entered BB mode
Ping responded in 1 attempt(s)
Inject command 'get-property'
Response status = 0 (0x0) Success.
Response word 1 = 1258488064 (0x4b030100)
Current Version = K3.1.0
```

Figure 4. Running ISP command using CAN interface

## 5 Note about the source code in the document

The example code shown in this document has the following copyright and BSD-3-Clause license:

## 6 Revision history

Table 5 summarizes the revisions to this document.

**Table 5. Revision history**

| Document ID | Release date | Description |
|---|---|---|
| AN14647 v.1.1 | 10 December 2025 | Initial public release |
| AN14647 v.1.0 | 14 April 2025 | Initial NDA release |

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