How to Enable Boot from Octal SPI Flash and SD Card

1. Introduction

The i.MX RT Series is industry’s first crossover processor provided by NXP. This document describes how to program a bootable image into the external storage device.

The i.MX RT1050 Flashloader is an application that you load into the internal RAM of a i.MX RT1050 device. The Flashloader is designed to work as a second stage of Bootloader for i.MX RT1050 device, it detects communication traffic on one of the supported peripherals (USB-HID and UART), download a user application, and write the application to external Serial NOR or Serial NAND Flash device. The Flashloader is loaded by MfgTool at first stage and work with MfgTool to do Flash programming at second stage.

The release includes the PC-hosted MfgTool application, this application is used for downloading application to Flash device in both development phase and production phase. This release also includes elftosb command-line application, it is used to generate bootable image for i.MX RT1050 ROM and generate programable image supported by Flashloader1.1.

For this Application Note the software used for example in this document is based on the i.MXRT1050 SDK 2.4.0. The development environment is IAR Embedded Workbench 8.22.2 The hardware development environment is IMXRT1050-EVKB.

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This document describes three typical boot use cases:

- **SD Card**
  - Code in ITCM
  - Data in DTCM
- **Hyper Flash**
  - Code XIP in Hyper Flash
  - Data in DTCM
- **Hyper Flash with SDRAM enabled (with DCD)**
  - Code XIP in Hyper Flash
  - Data in SDRAM

## 2. i.MXRT1050 boot overview

### 2.1. Boot feature

The boot process begins at the Power-On Reset (POR) where the hardware reset logic forces the ARM core to begin the execution starting from the on-chip boot ROM. The boot ROM uses the state of the **BOOT_MODE register** and eFUSEs to determine the boot device. For development purposes, the eFUSEs used to determine the boot device may be overridden using the GPIO pin inputs. The boot ROM code also allows to download the programs to be run on the device. The example is a provisioning program that can make further use of the serial connection to provide a boot device with a new image.

#### 2.1.1. Device Configuration Data (DCD)

DCD feature allows the boot ROM code to obtain the SOC configuration data from an external program image residing on the boot device. As an example, the DCD can be used to program the SDRAM controller (SEMC) for optimal settings, improving the boot performance. The DCD is restricted to the memory areas and peripheral addresses that are considered essential for the boot purposes.

#### 2.1.2. Secure boot (High-Assurance Boot)

Before the HAB allows the user image to execute, the image must be signed. The signing process is done during the image build process by the private key holder and the signatures are then included as a part of the final program image. If configured to do so, the ROM verifies the signatures using the public keys included in the program image. In addition to supporting the digital signature verification to authenticate the program images, the encrypted boot is also supported. The encrypted boot can be used to prevent the cloning of the program image directly off the boot device. A secure boot with HAB can be performed on all boot devices supported on the chip in addition to the serial downloader. The HAB
library in the boot ROM also provides the API functions, allowing the additional boot chain components (bootloaders) to extend the secure boot chain.

### 2.2. Boot ROM overview

The mainly features of the Boot Rom include:

- Support for booting from various boot devices
- Serial downloader support (USB OTG and UART)
- Device Configuration Data (DCD) and plugin
- Digital signature and encryption based High-Assurance Boot (HAB)
- Wake-up from the low-power modes
- Encrypted eXecute In Place (XIP) on Serial NOR via FlexSPI interface powered by Bus Encryption Engine (BEE)
- Encrypted boot on devices except the Serial NOR by Data Co-Processor (DCP) controller

The Boot Rom supports these boot devices:

- Serial NOR Flash via FlexSPI
- Serial NAND Flash via FlexSPI
- Parallel NOR Flash via Smart External Memory Controller (SEMC)
- RAWNAND Flash via SEMC
- SD/MMC
- SPI NOR/EEPROM

### 2.3. Boot related address

<table>
<thead>
<tr>
<th>Start Address</th>
<th>End Address</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x80000000</td>
<td>0xFFFFFFFF</td>
<td>1.5GB</td>
<td>SEMC external memories (SDRAM, NOR, PSRAM, NAND and 8080) shared memory space</td>
</tr>
<tr>
<td>0x60000000</td>
<td>0xF7FFFFFF</td>
<td>504MB</td>
<td>FlexSPI/FlexSPI cipherer text</td>
</tr>
<tr>
<td>0x20200000</td>
<td>0x2027FFFF</td>
<td>512KB</td>
<td>OCRAM</td>
</tr>
<tr>
<td>0x20000000</td>
<td>0x2007FFFF</td>
<td>512KB</td>
<td>DTCM</td>
</tr>
<tr>
<td>0x00000000</td>
<td>0x0007FFFF</td>
<td>512KB</td>
<td>ITCM</td>
</tr>
</tbody>
</table>

### 2.4. Boot settings

The BOOT_MODE is initialized by sampling the BOOT_MODE0 and BOOT_MODE1 inputs on the rising edge of the POR_B and stored in the internal BOOT_MODE register (can be read from SRC_SBMR2[BMOD[1:0]]).
Table 2.  Boot MODE pin settings

<table>
<thead>
<tr>
<th>BOOT_MODE[1:0]</th>
<th>Boot Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Boot From Fuses</td>
</tr>
<tr>
<td>01</td>
<td>Serial Downloader (From USB or UART)</td>
</tr>
<tr>
<td>10</td>
<td>Internal Boot (Continues to execute the boot code from the internal boot ROM)</td>
</tr>
<tr>
<td>11</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

NOTE

Boot From Fuses is like the Internal Boot mode with one difference:

In this mode, the GPIO boot override pins are ignored. The boot ROM code uses the boot eFUSE settings only.

For these four boot modes (one is reserved for NXP use). The boot mode is selected based on the binary value stored in the internal BOOT_MODE register. Switch (SW7-3 & SW7-4) is used to select the boot mode on the MIMXRT1050 EVK Board.

Table 3.  Boot MODE pin settings based on MIMXRT1050-EVK

<table>
<thead>
<tr>
<th>BOOT_MODE[1:0] (SW7-3 SW7-4)</th>
<th>BOOT Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Boot From Fuses</td>
</tr>
<tr>
<td>01</td>
<td>Serial Downloader</td>
</tr>
<tr>
<td>10</td>
<td>Internal Boot</td>
</tr>
<tr>
<td>11</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Typically, the internal boot is selected for normal boot, which is configured by external BOOT_CFG GPIOs. The Table 4 shows the typical Boot Mode and Boot Device settings.

Table 4.  Typical Boot Mode and Boot Device settings

<table>
<thead>
<tr>
<th>SW7-1</th>
<th>SW7-2</th>
<th>SW7-3</th>
<th>SW7-4</th>
<th>Boot Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>Hyper Flash</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>QSPI Flash</td>
</tr>
<tr>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>SD Card</td>
</tr>
</tbody>
</table>
NOTE

For more information about boot mode configuration, see the System Boot chapter of the IMXRT 1050 Reference Manual.

For more information about MIMXRT1050 EVK boot device selection and configuration, see the main board schematic.

2.5. Boot Image

There are two types of i.MX MCU bootable image:

- Normal boot image: This type of image can boot directly by boot ROM.
- Plugin boot image: This type of image can be used to load a boot image from devices that are not natively supported by boot ROM.

Both types of image can be unsigned, signed, and encrypted for different production phases and different security level requirements:

- Unsigned Image: The image does not contain authentication-related data and is used during development phase.
- Signed Image: The image contains authentication-related data (CSF section) and is used during production phase.
- Encrypted Image: The image contains encrypted application data and authentication-related data and is used during the production phase with higher security requirement.

The Boot Image consists of:

- Image Vector Table (IVT): A list of pointers located at a fixed address that the ROM examines to determine where the other components of the program image are located.
- Boot Data: A table that indicates the program image location, program image size in bytes, and the plugin flag.
- Device Configuration Data (DCD): IC configuration data (ex: SDRAM register config).
- User code and data.
- CSF (optional): signature block for Secure Boot, generated by CST.
- KeyBlob (optional) – a data structure consists of wrapped DEK for encrypt boot.

Each bootable image starts with appropriate IVT. In general, for the external memory devices that support XIP feature, the IVT offset is 0x1000 else it is 0x400. For example, for FlexSPI NOR on RT1052, the IVT must start at address 0x60001000 (start address is 0x6000_0000, IVT offset is 0x1000).
2.5.1. IVT data structure

Table 5. IVT data structure

<table>
<thead>
<tr>
<th>Offset</th>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00 - 0x03</td>
<td>header</td>
<td>Byte tag, fixed to 0xD1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Byte 1,2 length, bit endian format containing the overall length of the IVT in bytes, fixed to 0x00, 0x20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Byte 3: version, valid values: 0x40, 0x41, 0x42, 0x43</td>
</tr>
<tr>
<td>0x04 - 0x07</td>
<td>entry</td>
<td>Absolute address of the first instruction to execute from the image, or the vector address of the image</td>
</tr>
<tr>
<td>0x08 - 0x0b</td>
<td>reserved1</td>
<td>Reserved for future use, set to 0</td>
</tr>
<tr>
<td>0x0c - 0x0f</td>
<td>dcd</td>
<td>Absolute address of the image DCD. It is optional, so this field can be set to NULL if no DCD is required</td>
</tr>
<tr>
<td>0x10 - 0x13</td>
<td>boot_data</td>
<td>Absolute address of the boot data</td>
</tr>
<tr>
<td>0x14 - 0x17</td>
<td>self</td>
<td>Absolute address of the IVT</td>
</tr>
<tr>
<td>0x18 - 0x1b</td>
<td>csf</td>
<td>Absolute address of the Command Sequence File (CSF) used by the HAB library</td>
</tr>
<tr>
<td>0x1c - 0x1f</td>
<td>reserved2</td>
<td>Reserved, set to 0</td>
</tr>
</tbody>
</table>
2.5.2. Boot data structure

<table>
<thead>
<tr>
<th>Offset</th>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00-0x03</td>
<td>start</td>
<td>Absolute address of the bootable image</td>
</tr>
<tr>
<td>0x04-0x07</td>
<td>length</td>
<td>Size of the bootable image</td>
</tr>
<tr>
<td>0x08-0x0b</td>
<td>plugin</td>
<td>Plugin flag, set to 0 if it is a normal boot image</td>
</tr>
</tbody>
</table>

2.6. Image generation tool

The Elftosb utility is a command-line host program used to generate the i.MX bootable image for the i.MX MCU boot ROM. Elftosb tool supports SREC input program image.

It also can generate wrapped binary file with command sequences and bootable image together called SB file, using corresponding options and proper command file called BD file. (MFGTool using this .sb file)

More details about BD file, you can take *i.MX MCU Manufacturing User’s Guide (Chapter 4.1)* for reference. How to generate a bootable image for a unsigned normal / signed normal / encrypted normal / plugin bootable image you can take you can take *i.MX MCU Manufacturing User’s Guide (Chapter 4.2)* for reference.

3. Program tools

3.1. DAP-Link (OpenSDA MSD drag/drop)

- Hyper Flash/QSPI Flash on EVK only
- Binary file support only

**NOTE**

The default firmware of DAP-Link on EVK supports Hyper Flash only. The firmware of DAP-Link should be replaced if the QSPI flash drag/drop is used.

3.2. MFG tool

The MfgTool supports LMXRT BootROM and KBOOT based Flashloader, it can be used in factory production environment. The Mfgtool can detect the presence of BootROM devices connected to PC and invokes “blhost” to program the image on target memory devices connected to LMX MCU device.

The blhost is a command-line host program used to interface with devices running KBOOT based Bootloader, part of MfgTool release. sb file support only.

For MFG:

- cfg.ini

Configure for which device, board and program list (in the ucl2.xml) to use

*How to Enable Boot from Octal SPI Flash and SD Card, Application Note, Rev. 5, 07/2019*
3.2.1. Macros for the boot header

The Table 7 shows three macros that are added in flexspi_nor targets to support XIP:

<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XIP_EXTERNAL_FLASH</td>
<td>1: Exclude the code which will change the clock of flexspi. 0: make no changes.</td>
</tr>
<tr>
<td>XIP_BOOT_HEADER_ENABLE</td>
<td>1: Add flexspi configuration block, image vector table, boot data and device configuration data(optional) to the image by default. 0: Add nothing to the image by default.</td>
</tr>
</tbody>
</table>
XIP_BOOT_HEADER_DCD_ENABLE

1: Add device configuration data to the image.
0: Do NOT add device configuration data to the image.

The Table 8 shows the different effect on the built image with different combination of these macros:

<table>
<thead>
<tr>
<th>XIP_EXTERNAL_FLASH</th>
<th>XIP_BOOT_HEADER_DCD_ENA BLE=1</th>
<th>XIP_BOOT_HEADER_DCD_ENA BLE=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>XIP_BOOT_HEADER_ENABLE=1</td>
<td>Can be programmed to Hyper Flash by IDE and can run after POR reset if Hyper Flash is the boot source. SDRAM will be initialized.</td>
<td>Can be programmed to Hyper Flash by IDE and can run after POR reset if Hyper Flash is the boot source. SDRAM will NOT be initialized.</td>
</tr>
<tr>
<td>XIP_BOOT_HEADER_ENABLE=0</td>
<td>Can NOT run after POR reset if it is programmed by IDE even if Hyper Flash is the boot source.</td>
<td></td>
</tr>
<tr>
<td>XIP_EXTERNAL_FLASH =0</td>
<td>This image can NOT do XIP because when this macro is set to 1, it will exclude the code which will change the clock of FlexSPI.</td>
<td></td>
</tr>
</tbody>
</table>

3.3. OpenSDA Drag/Drop and boot from Hyper Flash

This chapter will show a detail steps that program an image to Hyper Flash by using OpenSDA Drag/Drop. The steps are as following:

Step 1:
Open the Hello world demo in the SDK and select the project configuration as flexspi_nor_debug.
Step 2:

Build the project and generate an image. You can find the hello_world.bin as in Figure 4:

Figure 3. Select the project configuration as flexspi_nor_debug
Step 3:

Configure the board to serial downloader mode and make sure the power supply is from the Debug USB. To achieve these, SW7-4 should pull-up others pull-down Figure 5 and the J1-5, J1-6 should be connected Figure 6.

Figure 5. SW7-4 pull-up and others pull-down
Step 4:
Now we can power up the board by connecting USB Debug Cable to J28 and open windows explorer and confirm that a U-Disk appears as a drive like Figure 7.

Figure 6. Power supply switch

Figure 7. RT1050-EVK appeared
NOTE
The first time you connect the MBED USB to Host Computer Windows will ask to install the MBED serial driver.

Step 5:
Drag/drop the hello_world.bin to RT1050-EVK. Then the RT1050-EVK disappears and appears again after few seconds.

Step 6:
Disconnect the USB Debug Cable and configure the board to Hyper Flash Boot Mode which means SW7-2 and SW7-3 pull-up others pull-down Figure 8.

Figure 8. Hyper Flash Boot Mode Configuration

Connect the USB Debug Cable again and configure the Terminal Window:

- Baud rate: 115200
- Data bits: 8
- Stop bit: 1
- Parity: None
- Flow control: None

Press SW3 to reset the EVK Board and “hello world” will be printed to the terminal as in Figure 9
Figure 9. Hello world output
3.4. MFG boot from Hyper Flash

This chapter shows the steps that using MFG Tool how to program an image to Hyper Flash and Boot from the Hyper Flash.

Step 1:

Open the Hello world demo in the SDK and select the project configuration as flexspi_nor_debug Figure 10 and make sure the settings likes Figure 11.

![Figure 10. Select the project configuration as flexspi_nor_debug](image)
Step 2:
Change the default entry to Reset_Handler likes following Figure.
Step 3:
Build the project and generate an image with .srec format. You can find the hello_world.srec as in Figure 13:
Step 4:
Copy hello_world.srec to the elftosb folder:
Step 5:
Open the `imx-flexspinor-normal-unsigned.bd` under path
`Flashloader_i.MXRT1050_GA\Tools\bd_file\imx10xx`. Open it and set the `entryPointAddress` to
0x60002000 likes following Figure.

```c
options {
    flags = 0x00;
    startAddress = 0x60000000;
    ivtOffset = 0x1000;
    initialLoadSize = 0x2000;
    # Note: This is required if the default entrypoint is not the
    # Please set the entryPointAddress to Reset_Handler address
    entryPointAddress = 0x60002000;
}
```

**Figure 15.** Set the entryPointAddress to 0x60002000

**NOTE**

Step 2 can be skipped if this step is set.

**Step 6:**

Now we can use command to generate the i.MX Bootable image using elftosb file. Open cmd.exe and type following command:

```
elftosb.exe -f imx -V -c ..../bd_file/imx10xx/imx-flexspinor-normal-unsigned.bd -o
ivt_flexspi_nor_hello_world.bin hello_world.srec
```
Figure 16. Generate i.MX Bootable image

After above command, two bootable images are generated:

- ivt_flexspi_nor_hello_world.bin
- ivt_flexspi_nor_hello_world_nopadding.bin

ivt_flexspi_nor_hello_world.bin:
The memory regions from 0 to ivt_offset are filled with padding bytes (all 0x00s).

ivt_flexspi_nor_hello_world_nopadding.bin:
Starts from ivtdata directly without any padding before ivt.
The later one will be used to generate SB file for Hyper FLASH programming in subsequent section.

Step 7:
This step we will create a SB file for Hyper Flash programming. A boot_image.sb file will be generated that is for MfgTool use later. Open cmd.exe and type following command:

```
elftosb.exe -f kinetis -V -c ..../bd_file/imx10xx/program_flexspinor_image_HyperFlash.bd -o boot_image.sb ivt_flexspi_nor_hello_world_nopadding.bin
```
Create a SB file for Hyper Flash programming

After performing above command, the `boot_image.sb` is generated under elftosb folder.
Step 8:
Copy the `boot_image.sb` file to OS Firmware folder:
Copy the `boot_image.sb` to OS Firmware folder.

Now,

Make sure the “name” under “[List]” to “MXRT105x-DevBoot” in `cfg.ini` file under `<mfgtool_root_dir>` folder.
Make sure the name is "MXRT105X-DevBoot".

Switch the EVK-Board to Serial Downloader mode by setting SW7 to “1-OFF, 2-OFF, 3-OFF, 4-ON”. Connect a UAB Cable to J9 and power on the EVK Board by inserting USB Cable to J28.

Open MfgTool, it will show the detected device like Figure 21:

![MfgTool GUI with device connected](image)

Click **Start**. The Mfgtool process initiates. Once completed, MfgTool shows the success status as shown in Figure 22. Click **Stop** and **Close** the Mfgtool.
Step 9:
Switch the RT1050-EVK board to Internal boot mode and select Hyper FLASH as boot device by setting SW7 to “1-OFF, 2-ON, 3-ON, 4-OFF”. Connect the USB Cable to J28 and open a terminal, then reset the Board. “hello world” will be printed on the terminal.

3.5. MFG boot from SD Card

This chapter will show the steps that using MFG tool to program an image to SD Card and Boot from the SD Card.

Step 1:
Open the Hello world demo in the SDK and select the project configuration as Debug

![Debug Configuration](image)

**Figure 24.** Select the project configuration as Debug

**Step 2:**
Change the default entry to Reset_Handler like following Figure.
Program tools

Figure 25. Change the default entry to Reset_Handler

NOTE

Step 6 can be skipped if this step is set.

Step 3:
Find the linkfile MIMXRT1052xxxxx_ram.icf and change the start vector table from 0x0000A000.

```c
#define symbol m_interrupts_start       = 0x0000A000;
#define symbol m_interrupts_end         = 0x0000A3FF;

#define symbol m_text_start            = 0x0000A400;
#define symbol m_text_end               = 0x0001FFFF;

#define symbol m_data_start             = 0x20000000;
#define symbol m_data_end                = 0x2001FFFF;

#define symbol m_data2_start            = 0x20200000;
#define symbol m_data2_end               = 0x2023FFFF;
```

Figure 26. Change the start vector table from 0x0000A000

Step 4:
Build the project and generate the image. You can find the `hello_world.srec` at following location:

```
build the project and generate the image.
```

You can find the `hello_world.srec` at following location:

![hello_world.srec location](image)

**Figure 27.** hello_world.srec location

**Step 5:**

Copy the `hello_world.srec` to the elftosb folder:

```
Copy hello_world.srec
```

![Copy hello_world.srec](image)

**Figure 28.** Copy hello_world.srec

**Step 6:**

Open the `imx-itcm-unsigned.bd` under path `Flashloader_i_MXRT1050_GA\Tools\bd_file\imx10xx`. Open it and set the entryPointAddress to `0x0000A000` likes following figure.

```
Open the imx-itcm-unsigned.bd under path Flashloader_i_MXRT1050_GA\Tools\bd_file\imx10xx. Open it and set the entryPointAddress to 0x0000A000 likes following figure.
```

![Open the imx-itcm-unsigned.bd](image)
Set the entryPointAddress to 0x0000A000

NOTE

Step 2 can be skipped if this step is set.

Step 7:
Now we can use command to generate the i.MX Bootable image using elftosb file. Open cmd.exe and type following command:

```
elftosb.exe -f imx -V -c ../../../bd_file/imx10xx/imx-itcm-unsigned.bd -o ivt_itcm_hello_world.bin
hello_world.srec
```
After above command, two bootable images are generated:

- ivt_itcm_hello_world.bin
- ivt_itcm_hello_world_nopadding.bin

ivt_flexspi_nor_hello_world.bin:
The memory regions from 0 to ivt_offset are filled with padding bytes (all 0x00s).

ivt_flexspi_nor_hello_world_nopadding.bin:
Starts from ivtdata directly without any padding before ivt.
The later one will be used to generate SB file for SD Card programming in subsequent section.

**Step 8:**
This step we will create a SB file for SD Card programming. A *boot_image.sb* file will be generated that is for MfgTool use later. Open cmd.exe and type following command:

```
elftosb.exe -f kinetis -V -c ./bd_file/imx10xx/program_sdcard_image.bd -o boot_image.sb ivt_itcm_hello_world_nopadding.bin
```
Creat a SB file for SD Card programming

After performing above command, the boot_image.sb is generated under elftosb folder.

Figure 31. Create a SB file for SD Card programming

Step 9:
Copy the boot_image.sb file to OS Firmware folder:

Figure 32. The boot_image.sb is generated
Copy the boot_image.sb to OS Firmware folder

Now, make sure the “name” under “[List]” to “MXRT105x-DevBoot” in cfg.ini file under <mfgtool_root_dir> folder.
Insert a SD Card to J20 slot and switch the EVK-Board to Serial Downloader mode by setting SW7 to “1-OFF, 2-OFF, 3-OFF, 4-ON”. Connect a UAB Cable to J9 and power on the EVK Board by inserting USB Cable to J28.

Open MfgTool, it will show the detected device like Figure 35:

![MfgTool GUI with device connected](image)

**Figure 35. MfgTool GUI with device connected**

Click Start. The Mfgtool process initiates. Once completed, MfgTool shows the success status as shown in Figure 36. Click Stop and Close the Mfgtool.

![MfgTool Succes Status](image)

**Figure 36. MfgTool Succes Status**

**Step 10:**
Switch the RT1050-EVK board to Internal boot mode and select SD Card as boot device by setting SW7 to “1-ON, 2-OFF, 3-ON, 4-OFF”. Connect the USB Cable to J28 and open a terminal, then reset the Board. “hello world” will be printed to the terminal.
3.6. MFG boot from Hyper Flash with DCD for SDRAM

This chapter will show the steps that using MFG tool to program an image to Hyper Flash and Boot from the Hyper Flash.

**Step 1:**
Open the Hello world demo in the SDK and select the project configuration as flexspi_nor_debug (Figuire 38) and make sure the settings likes Figure 39.
Select the project configuration as flexspi_nor_debug
Step 2:
Change the default entry to Reset_Handler likes following Figure.

![Options for node “hello_world”](image)

Figure 40. Change the default entry to Reset_Handler

**NOTE**

Step 7 can be skipped if this step is set.

Step 3:
Find the linkfile `MIMXRT1052xxxxx_flexspi_nor.icf` and change data region from TCM to SDRAM.

```c
#define symbol m_interrupts_start = 0x60002000;
#define symbol m_interrupts_end   = 0x600023FF;
#define symbol m_text_start       = 0x60002400;
#define symbol m_text_end         = 0x63FPPPFFFF;
#define symbol m_data_start       = 0x80000000;
#define symbol m_data_end         = 0x8001FFFF;
#define symbol m_data2_start      = 0x80200000;
#define symbol m_data2_end        = 0x8023FFFF;
```
Figure 41. Change data region from TCM to SDRAM

Step 4:

Build the project and generate the image. You can find the `hello_world.srec` at following location:

![Image of file structure]

Figure 42. `hello_world.srec` location
Step 5:
Copy `hello_world.srec` to the elftosb folder:

![Image](image1)

Figure 43. Copy `hello_world.srec`

Step 6:
Copy `imx-flexspinor-normal-unsigned.bd` and rename it to `imx-flexspinor-normal-unsigned-dcd.bd`.

![Image](image2)

Figure 44. Find the file copy and rename it
Open `imx-flexspinor-normal-unsigned-dcd.bd` and add a DCD path.

```c
options {
  flags = 0x00;
  startAddress = 0x60000000;
  ivtOffset = 0x1000;
  initialLoadSize = 0x2000;
  DCDFilePath = "dcd.bin";
  # Note: This is required if the default entrypoint is not the Reset_Handler
  # Please set the entryPointAddress to Reset_Handler address
  // entryPointAddress = 0x60002411;
}
```

Figure 45. Add DCD path

**Step 7:**
Open the `imx-flexspinor-normal-unsigned-dcd.bd` under path `Flashloader_i.MXRT1050_GATools\bd_file\imx10xx`. Open it and set the `entryPointAddress` to `0x60002000` likes following figure.

```c
options {
  flags = 0x00;
  startAddress = 0x60000000;
  ivtOffset = 0x1000;
  initialLoadSize = 0x2000;
  DCDFilePath = "dcd.bin";
  # Note: This is required if the default entrypoint is not the Reset_Handler
  # Please set the entryPointAddress to Reset_Handler address
  entryPointAddress = 0x60002000;
}
```

Figure 46. Set the `entryPointAddress` to `0x60002000`

**NOTE**

Step 2 can be skipped if this step is set.

**Step 8:**
Copy `dcd.bin` to the following path:
Copy dcd.bin to the following path

**Step 9:**

Now we can use command to generate the i.MX Bootable image using elftosb file. Open cmd.exe and type following command:

```
elftosb.exe -f imx -V -c ../../bd_file/imx10xx/imx-flexspinor-normal-unsigned-dcd.bd -o ivt_flexspi_nor_hello_world.bin hello_world.srec
```
After above command, two bootable images are generated:

- `ivt_flexspi_nor_hello_world.bin`
- `ivt_flexspi_nor_hello_world_nopadding.bin`

`ivt_flexspi_nor_hello_world.bin`:
The memory regions from 0 to `ivt_offset` are filled with padding bytes (all 0x00s).

`ivt_flexspi_nor_hello_world_nopadding.bin`:
Starts from `ivtdata` directly without any padding before `ivt`.

The later one will be used to generate SB file for HyperFLASH programming in subsequent section.

**Step 10:**

This step we will create a SB file for Hyper Flash programming. A `boot_image.sb` file will be generated that is for MfgTool use later. Open cmd.exe and type following command:

```
elftosb.exe -f kinetis -V -c ../../bd_file/imx10xx/program_flexspinor_image_HyperFlash.bd -o boot_image.sb ivt_flexspi_nor_hello_world_nopadding.bin
```
Create a SB file for Hyper Flash programming

After performing above command, the *boot_image.sb* is generated under elftosb folder.

**Figure 49.** Create a SB file for Hyper Flash programming

**Figure 50.** *boot_image.sb* is generated
Step 11:
Copy the boot_image.sb file to OS Firmware folder:

![Image showing the boot_image.sb file in OS Firmware folder](image)

Figure 51. Copy the boot_image.sb to OS Firmware folder

Now,
Make sure the “name” under “[List]” to “MXRT105x-DevBoot” in cfg.ini file under `<mfgtool_root_dir>` folder.

![Image showing the “name” in cfg.ini file](image)

Figure 52. Make sure the name to “MXRT105x-DevBoot”
Switch the EVK-Board to Serial Downloader mode by setting SW7 to “1-OFF, 2-OFF, 3-OFF, 4-ON”. Connect a UAB Cable to J9 and power on the EVK Board by inserting USB Cable to J28.

Open MfgTool, it will show the detected device like Figure 53:

![MfgTool MultiPanel (Library: 2.7.0)](image)

**Figure 53. MfgTool GUI with device connected**

Click **Start**, Mfgtool. The Mfgtool process initiates. Once completed, MfgTool shows the success status as shown in Figure 54. Click **Stop** and **Close** the Mfgtool.

![MfgTool MultiPanel (Library: 2.7.0)](image)

**Figure 54. MfgTool Success Status**

**Step 12:**

Switch the RT1050-EVK board to Internal boot mode and select Hyper FLASH as boot device by setting SW7 to “1-OFF, 2-ON, 3-ON, 4-OFF”. Connect the USB Cable to J28 and open a terminal, then reset the Board. “hello world” will be printed to the terminal.
4. Octal SPI Flash support list

Besides the EVK onboard Hyper Flash, the following Flashes are also support:

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISSI (Hyper Flash)</td>
<td>IS26KS256</td>
</tr>
<tr>
<td>SPANSION (Hyper Flash)</td>
<td>KS512SBPHI02</td>
</tr>
<tr>
<td>Macronix</td>
<td>MX25UM513</td>
</tr>
<tr>
<td>Micron</td>
<td>MT35X</td>
</tr>
<tr>
<td>Adesto</td>
<td>ATXP032/ ATXP128</td>
</tr>
<tr>
<td>GigaDevice</td>
<td>GD25LX256E</td>
</tr>
</tbody>
</table>

5. Conclusion

This application note mainly describes how to use Flashloader step by step. For more information, you can take i.MX MCU Manufacturing User’s Guide for reference.
## 6. Revision history

<table>
<thead>
<tr>
<th>Revision number</th>
<th>Date</th>
<th>Substantive changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12/2017</td>
<td>Initial release</td>
</tr>
<tr>
<td>1</td>
<td>06/2018</td>
<td>The name of the application note changed to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How to Enable Boot from Octal SPI Flash and SD Card</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Document updated to adapt SDK version 2.3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Document updated to adapt Flashloader version 1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Caption of Table 9. Hyper Flash supports list changed to Table 9. Octal SPI flash supports list</td>
</tr>
<tr>
<td>2</td>
<td>07/2018</td>
<td>• Added steps to change the entry address.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Used .srec file instead of .out file as the source file.</td>
</tr>
<tr>
<td>3</td>
<td>09/2018</td>
<td>Updated Table 9. Octal SPI Flash supports list</td>
</tr>
<tr>
<td>4</td>
<td>09/2018</td>
<td>Updated Adesto detail in Table 9. Octal SPI Flash supports list.</td>
</tr>
<tr>
<td>5</td>
<td>07/2019</td>
<td>Updated Table 9. Octal SPI Flash supports list.</td>
</tr>
</tbody>
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