UG10114

eCAT File Access over EtherCAT Example

Rev. 1.0 — 7 March 2024

User guide

COMPANY PUBLIC

1 Introduction

The File Access over EtherCAT (FoE) example uses TwinCAT software as EtherCAT Master, i.MXRT1180 as EtherCAT Slave to upgrade firmware.

The EtherCAT Slave Controller (ESC) integrated on i.MXRT1180 takes care of the EtherCAT communication as an interface between the EtherCAT fieldbus and the slave application.

The EtherCAT Slave Stack Code(SSC) from Beckhoff Automation is a tool to generate the EtherCAT slave stack code in ANSI C. The code serves as a development base for the implementation of EtherCAT in devices with its own processor. The Object Dictionary Tool (OD-Tool) has been integrated into the SSC OD configuration tools, supporting a consistent definition of the offline and online object dictionary.

FoE example features:

- Upgrade firmware
- Download upgraded firmware

2 Hardware setup

- Hardware requirements
  - MIMXRT1180-EVK RevC
  - RJ45 Network cable
  - Mini/micro USB cable
  - Personal Computer with TwinCat3
- Board settings
  - No special settings are required.
- Connection

1. Connect EtherCAT Port 0(J28 RJ45 Interface) on the MIMXRT1180-EVK board with TwinCAT3 via the Ethernet cable.
2. Connect a USB cable between the host PC and the OpenSDA USB port on the MIMXRT1180-EVK board.
3. Open a serial terminal with the following settings
   - 115,200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control

3 MCUXpresso SDK download

To configure and download the MCUXpresso SDK for the FoE example building:

1. Click the link https://mcuxpresso.nxp.com/en/welcome to launch the MCUXpresso main page.

2. Click the **Select Development Board** button.

Figure 1. Select the development board

3. Type **1180** in the **Search for Hardware** field.
4. Select **MIMXRT1180-EVK** from the drop-down list.

Figure 2. Select a board

5. Select the SDK version from which the SDK will be generated.
6. Click the **build MCUXpresso SDK** button.

Figure 3. Select the SDK version and build the SDK

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7. To select the components, click '**SELECT ALL**'.
8. To download the SDK, click the **Download SDK** button.

Figure 4. Select host operating system and toolchains

9. Click the **Download SDK** button.

Figure 5. Download the SDK

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10. Click the **Download SDK archive including documentation** link.

Figure 6. Download the SDK archive including documentation

4 Generate SSC for FoE

Due to the license issue, the MCUXpresso SDK does not include the EtherCAT Slave Stack Code (SSC). The SSC tool must generate the slave stack code first. This section lists the steps to download the SSC tool and generate the slave stack code for the FoE example via the SSC tool.

Note: You must have a Backoff account to download the EtherCAT SSC tool.

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1. Download and install the SSC tool.
   a. Click the link https://www.ethercat.org/en/downloads.html.
   b. Type `SSC` in the **Text Filter** field.
   c. Select the **EtherCAT Slave Stack Code (SSC)** link under the **Description** column.
   Note: *To proceed with the download, you must provide your account credentials, if you are not already logged in.*

Figure 7. Search and select EtherCAT SSC

2. Install the downloaded SSC tool.
   a. Launch the SSC tool.
   b. Import the configuration file for the FoE example.
   c. Select **Tool > Options**.

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Figure 8. Select tool options

The **Slave Stack Code Tool | Options** window appears.

d. Click the **Configurations** tab.

e. To open the **Import Configuration file(s)** dialog box, click the + icon.

f. Navigate to the `\boards\evkmimxrt1180\ecat_examples\foe\<core>\SSC` folder.

g. Select the **foe.xml** file.

h. Click the **Open** button.

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Figure 9. Select the foe.xml file

The configuration is imported.

3. Create a new project with the imported configuration.
   a. Select **File** > **New**.

Figure 10. Select the custom project

The **New Project** dialog box appears.

   b. Select the **Custom** option.

4. Select **NXP ECAT FOE modular <NXP>** from the drop-down list.

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Figure 11. Select the custom project

5. Save this new project as **ECAT-FOE.esp** to any folder.
   a. Select **File** > **Save**.

Figure 12. Select File > Save

   b. Save the file with an appropriate name. For example, **ECAT-FOE.esp**.

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Figure 13. Save the file with the name ECAT-FOE.esp

6. Create the FoE example application by importing the **foe.xlsx** file.
   a. Select **Tool** > **Application** > **Import**.

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Figure 14. Import file

The **File selection** dialog box appears.

b. Navigate to the '\boards\evkmimxrt1180\ecat_examples\foe\<core>\SSC' folder.

c. Select the **foe.xlsx** file.

d. Click the **Open** button.

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Figure 15. Select the foe.xlsx file

The filename appears in the **Application name** field.

e. Rename the application to **ECAT-FOE** and click **OK**.

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Figure 16. Confirm the import

7. Create the slave stack code for the FoE example.
   a. Click **Project** > **Create new Slave Files**.

Figure 17. Create new files

   b. To create the code, select **Start**. By default, the code is located in the Src subfolder under the folder where the project is saved.

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Figure 18. Start to create the code

8. Copy the **Src** subfolder to `boards\evkmimxrt1180\ecat_examples\foe\<core>\SSC\Src` under the SDK source code.
9. Delete the **foe.c** file under the **Src** folder because this file is provided by MCUXpresso SDK.

5 Compile and download the image to RT1180

The GCC Arm Embedded 12.3.1 toolchain is supported.

1. Download the `mcuboot_opensource` program to the target board.
   a. Change **EVK SW5[1..4]** to **0000** and press the reset **SW3** key.
   b. Enter `boards\evkmimxrt1180\ota_examples\mcuboot_opensource\cm33\armgcc`.
   c. Compile and use the SPSDK tool to download the image to the board.
   Note: *For details on the image download and program, see section from 4 to 7 of the Getting Started with MCUXpresso SDK for MIMXRT1180-EVK document in the SDK package.*
   Note: *For more information on mcuboot, refer to the* ***mcuboot_opensource*** *example.*
2. Download the **signed FoE image** to the target board.
   a. Enter `boards\evkmimxrt1180\ecat_examples\foe\cm33\armgcc` and compile the FoE image.
   b. Open **cmd.exe** and type `pip install imgtool` to install the imgtool using the Python package manager.

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```
C:\Users\nxf86974\Desktop>pip install imgtool
Requirement already satisfied: imgtool in c:\users\nxf86974\app\python3.8.2\lib\site-packages (2.0.0)
Requirement already satisfied: click in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from imgtool) (8.1.3)
Requirement already satisfied: cbor2 in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from imgtool) (5.5.1)
Requirement already satisfied: cryptography>=2.4.2 in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from imgtool)
 (37.0.2)
Requirement already satisfied: intelhex>=2.2.1 in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from imgtool) (2.
3.0)
Requirement already satisfied: cffi>=1.12 in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from cryptography>=2.4
.2->imgtool) (1.15.0)
Requirement already satisfied: colorama in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from click->imgtool) (0.
4.6)
Requirement already satisfied: pycparser in c:\users\nxf86974\app\python3.8.2\lib\site-packages (from cffi>=1.12->crypto
graphy>=2.4.2->imgtool) (2.21)
WARNING: There was an error checking the latest version of pip.

C:\Users\nxf86974\Desktop>
C:\Users\nxf86974\Desktop>imgtool version
2.0.0
```

Figure 19. Install the imgtool

c. Type `imgtool sign --key sign-rsa2048-priv.pem --align 4 --header-size 0x400 --pad-header --slot-size 0x200000 --pad --confirm --max-sectors 800 --version "2.3.0" ecat_examples_foe_cm33.bin ecat_foe_2-3-0_SIGNED.bin` to generate the FoE example signed image.

```
C:\Users\nxf86974\Desktop\1180_2.14.2_FRP\boards\evkmimxrt1180\ota_examples\mcuboot_opensource\cm33\keys>imgtool sign --
key sign-rsa2048-priv.pem --align 4 --header-size 0x400 --pad-header --slot-size 0x200000 --pad --confirm --max-sectors
800 --version "2.3.0" ecat_examples_foe_cm33.bin ecat_foe_2-3-0_SIGNED.bin
image.py: sign the payload
```

Figure 20. Generate the FoE example signed image

d. Open the **Jlink** command Line and download the image to the target board.

```
JLink.exe -device MIMXRT1189xxx8_M33 -if SWD -speed 15000
r
h
loadbin ecat_foe_2-3-0_SIGNED.bin 0x28040000
qc
```

```
J-Link>loadbin C:\Users\nxf86974\Desktop\1180_2.14.2_FRP\boards\evkmimxrt1180\ota_examples\mcuboot_opensource\cm33\keys\
ecat_foe_2-3-0_SIGNED.bin 0x28040000
Downloading file [C:\Users\nxf86974\Desktop\1180_2.14.2_FRP\boards\evkmimxrt1180\ota_examples\mcuboot_opensource\cm33\ke
ys\ecat_foe_2-3-0_SIGNED.bin]...
J-Link: Flash download: Bank 0 @ 0x28000000: 2 ranges affected (98304 bytes)
J-Link: Flash download: Total: 22.719s (Prepare: 0.047s, Compare: 19.387s, Erase: 1.062s, Program: 1.748s, Verify: 0.450
s, Restore: 0.023s)
J-Link: Flash download: Program speed: 55 KB/s
O.K.
J-Link>qc
```

Figure 21. Download the image to the target board

3. Run the FoE example.
   a. Change **EVK SW5[1..4]** to **0100** and press the reset **SW3** key.
   b. The serial terminal displays the following output.

```
hello sbl.
Bootloader Version 1.9.0
Primary image: magic=good, swap_type=0x1, copy_done=0x3, image_ok=0x1
Secondary image: magic=unset, swap_type=0x1, copy_done=0x3, image_ok=0x3
Boot source: primary slot
Swap type: none
Bootloader chainload address offset: 0x40000
Reset_Handler address offset: 0x40400
Jumping to the image

Start the SSC FoE example...
```


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```
Image version: 2.3.0
```

4. Generate a new version of the FoE example signed image.
   a. Type `imgtool sign --key sign-rsa2048-priv.pem --align 4 --header-size 0x400 --pad-header --slot-size 0x200000 --max-sectors 800 --version "2.4.0" ecat_examples_foe_cm33.bin ecat_foe_2-4-0_SIGNED.bin` to generate the new version image.

```
C:\Users\nxf86974\Desktop\1180_2.14.2_FRP\boards\evkmimxrt1180\ota_examples\mcuboot_opensource\cm33\keys>imgtool sign --
key sign-rsa2048-priv.pem --align 4 --header-size 0x400 --pad-header --slot-size 0x200000  --max-sectors 800 --version "
2.4.0" ecat_examples_foe_cm33.bin ecat_foe_2-4-0_SIGNED.bin
image.py: sign the payload
```

Figure 22. Generate a new version of the FoE example signed image

Note: *For subsequent upgrades, the new version number must be greater than the old version number. To generate the new version signed image, perform the step above.*

6 TwinCAT project setup

1. Import the EtherCAT Slave Information (ESI) file of the FoE example.
2. Copy the ESI filename `ECAT-FOE.xml`, generated by the SSC tool, from the SSC project folder to the `<TwinCAT_installation_folder>/<Version>/Config/io/EtherCAT/` folder.
3. Create a new project.
   a. Select **File > New > Project**.

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Figure 23. Create new project

The **New Project** dialog box appears.

b. Select **TwinCAT Projects**.

c. Click **OK**.

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Figure 24. Select TwinCAT projects

4. Scan for the slave devices.
   a. In the **Solution Explorer** view, expand **I/O**.
   b. Right-click on **Device** and select **Scan**.

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Figure 25. Scan for the devices

The scanned devices appear in the **I/O devices found** dialog box.

c. Select the network interface connected with the MIMXRT1180-EVK board.

d. Click **OK**.

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Figure 26. Devices scanned

5. Update the ESI file to E2PROM.

   Note: *The E2PROM must be updated if the FoE example is set up first time on the MIMXRT1180- EVK.*

   a. Under **Device**, double-click **Box1**. The TwinCAT Project dialog box appears.
   b. Click the **EtherCAT** tab.
   c. Click the **Advanced Settings** button.

Figure 27. Configure advance settings

   The **Advanced Settings** dialog box appears.

   d. From the left pane of the Advanced Settings dialog box, select **ESC Access** > **Smart View**.

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e. Click the **Write E2PROM** button.

Figure 28. Advanced settings

f. From the available EEPROM list, select **NXP > ECAT > foe**.

g. Click **OK**.

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Figure 29. Select foe

h. Remove the **device** and **rescan the** device.

6. Configure the slave.
   a. Click the **DC** tab.
   b. From the **Operation Mode** field, select the **SM-Synchron** or **DC-Synchron** option.

Figure 30. Select the operation mode

7. Program the PLC code.
   a. In the Solution Explorer view, right-click on **PLC**.
   b. Select **Add New Item**.

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Figure 31. Create a new PLC code project

The **Add New Item** dialog box appears.

c. From the **Installed list** in the left pane, select **PLC Templates**.

d. Select **Standard PLC Project**.

e. Click **OK**.

Figure 32. Select a template

8. To open the PLC edit page, select MAIN (PRG) under PLC.

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9. Copy the code below and paste it in the MAIN view.

```
PROGRAM MAIN
VAR
Delay : TON;
LedIn AT %I* : BOOL;
LedOut AT %Q* : BOOL;
END_VAR
```

```
Delay(IN := TRUE, PT := T#1S);
IF Delay.Q THEN
LedOut := NOT LedIn;
Delay(IN := FALSE);
END_IF;
```

Figure 33. Copy and paste the code

10. To build the PLC code, right-click on the PLC project and select **Build**.

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Figure 34. Build the PLC code

11. Map the PLC variables to the slave IO channel.
    a. Right-click on **MAIN.LedIn**, select **Change Link**.

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Figure 35. Map the PLC variables

The **Attach Variable MAIN.LedIn (Input)** dialog box appears.

b. Select **LED**.

c. Click **OK**.

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Figure 36. Attach variable MAIN.LedIn (Input)

d. In the **Solution Explorer**, under PlcTask Outputs, right-click on **MAIN.LedOut** and select **Change Link**.

Figure 37. Change link

The **Attach Variable MAIN.LedOut (Output)** dialog box appears.

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e. Select **LED**.
f. Click **OK**.

Figure 38. Attach variable MAIN.LedOut (Output)

12. Activate Configuration
    a. To activate the configuration, select **TwinCAT** > **Restart TwinCAT (Config Mode)**.

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Figure 39. Restart TwinCAT (Config Mode)

13. FoE image upgrade.
    a. Click **Device > Box1 > Online > Bootstrap**.

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Figure 40. FoE image upgrade

b. Click **Download > ecat_foe_2-4-0_SIGNED.bin > Password' > OK** to upgrade the image.

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Figure 41. Upgrade the image

Note: *FoE download Password: '**12369874**'.*

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Figure 42. Edit FoE name

The serial terminal prints the following output.

```
storage addr: 0x28240000
FoE_StoreImage: processed 256 bytes
FoE_StoreImage: processed 512 bytes
...
FoE_StoreImage: upload complete (42028 bytes)
write magic number offset = 0x43ff00
Update image success
```

c. After download, click **'Init'** to restart the board.
The serial terminal prints the following output.

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Figure 43.

```
System reset...
hello sbl.
Bootloader Version 1.9.0
Primary image: magic=good, swap_type=0x1, copy_done=0x3, image_ok=0x1
Secondary image: magic=good, swap_type=0x1, copy_done=0x3, image_ok=0x3
Boot source: none
Swap type: test
Starting swap using move algorithm.
Bootloader chainload address offset: 0x40000
Reset_Handler address offset: 0x40400
Jumping to the image

Start the SSC FoE example...
Image version: 2.4.0
Image state: testing
Set image as confirmed: success
```

14. FoE image download.
    a. Click **Upload** to choose the file to download.

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Figure 44. Choose the file to download

15. To download the upgraded image, click **OK.**

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Figure 45. Download the upgraded image

Note: *The download image name must be the same as the upgraded image name.*

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8 Revision history

Table 1. Revision history

Document ID	Release date	Description
UG10114 v.1.0	07 March 2024	• Initial version

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