Getting started with i.MX RT Industrial Drive Development Platform

Rev. 1.2 — 8 April 2024

Application note

Document information

Information	Content		
Keywords	i.MX, RT1170, multi-motor control, TSN		
Abstract	This document explains how to get started with the NXP i.MX RT Industrial Drive Development Platform. It provides detailed instructions to assemble the hardware and program and run the NXP i.MX RT Industrial Drive Development Platform demo application. This allows users to control and monitor up to 4 PMSM motors using either FreeMASTER or a TSN master device.		



1 Abbreviations

Table 1 summarizes the abbreviations used in this document.

Table 1. Abbreviations			
Acronym	Description		
ACIM	AC Induction Motor		
BLDC	Brushless DC		
EVK	Evaluation Kit		
GUI	Graphic User Interface		
IDE	Integrated Development Environment		
PMSM	Permanent Magnet Synchronous Motor		
PSB	Power Stage Board		
RTC	Real Time Clock		
SDK	Software Development Kit		
SNVS	Secure Non-Volatile Storage		
SWD	Serial Wire Debug		
TSN	Time Sensitive Networking		
TTL	Transistor-Transistor-Logic		
UART	Universal Asynchronous Receiver/Transmitter		

2 Introducing the i.MX RT Industrial Drive Development Platform

The **i.MX RT Industrial Drive Development Platform** is a flexible modular-board kit that speeds up the development, evaluation, and validation of complex multi-motor control applications for industrial robots, mobile robotics, multi-axis machinery, digital manufacturing, and many other industrial use cases.

The i.MX RT Industrial Drive Development Platform demonstrates how an **NXP i.MX RT1170 crossover MCU** can be applied to simultaneously control up to four Permanent Magnet Synchronous Motors (PMSMs) while handling advanced functionalities such as data logging, fault detection, deterministic connectivity (Ethernet TSN) and complex user interfaces. By leveraging an NXP EdgeLock SE05x secure element for the secure storage of keys and credentials, the i.MX RT1170 MCU also supports strong cybersecurity based on the latest, most secure cryptographic algorithms and protocols, therefore opening the path to achieving some of the highest security levels of the *ISA/IEC 62443-4-2* industrial standard.

The i.MX RT Industrial Drive Development Platform comes with a fully-featured hardware and software package that allows users to start developing multi-motor control and other industrial applications quickly:

- The i.MX RT Industrial Drive Development Platform **hardware package** consists of a daughter card integrating the i.MX RT1170 crossover MCU, a digital board to expand the interfaces available to the daughter card and up to four power stage boards to transform control commands into power signals for driving up to four servo motors. All the boards can be configured and adapted to meet the specific requirements of the application that is being developed. More information on the hardware package can be found in *i.MX RT Industrial Drive Development Platform hardware overview* (document AN13642).
- The **i.MX RT Industrial Drive Development Platform software package** consists of a reference demo application and API that demonstrate how to take advantage of the i.MX RT Industrial Drive Development Platform hardware's capabilities to develop a secure, robust, and reliable multi-motor control system that meets the requirements, standards, and best practices required by industrial products. This significantly

reduces the effort required to develop multi-motor control applications, in turn reducing the time-to-market of the product. More information on the software package can be found in *i.MX RT Industrial Drive Development Platform software overview* (document <u>AN13643</u>).

2.1 How to use this document

This document provides step-by-step instructions to assemble the i.MX RT Industrial Drive Development Platform hardware and run the demo application. At the end of this document, you should be able to control and monitor four motors simultaneously using NXP's run-time debugging tool (FreeMASTER) and also be able to receive motor control commands from a TSN master device. The document is structured as follows:

- <u>Section 3</u> lists the hardware and software material required to run the i.MX RT Industrial Drive Development Platform demo;
- <u>Section 4</u> describes how to assemble the different hardware components of the i.MX RT Industrial Drive Development Platform;
- <u>Section 5</u> describes how to install in the PC the tools required to compile and debug the i.MX RT Industrial Drive Development Platform demo;
- <u>Section 6</u> describes how to import, compile, flash, and execute the i.MX RT Industrial Drive Development Platform demo application;
- <u>Section 7</u> describes how to control the motors connected to the i.MX RT Industrial Drive Development Platform using the FreeMASTER tool;
- <u>Section 8</u> describes how to control the motors connected to the i.MX RT Industrial Drive Development Platform using a TSN master device.

3 Hardware and software required

This section lists the hardware and software material needed for executing the i.MX RT Industrial Drive Development Platform demo application. The required hardware components are listed in <u>Table 2</u>. The required software tools are listed in <u>Table 3</u>.

Note: Additional hardware components are required to control motors using a TSN master device. See <u>Section 8</u> for more information.

Component name	Description	Picture
Daughter card (ISI-QMC-DGC02)	The daughter card provides an i.MX RT1176 dual- core crossover MCU featuring a 1 GHz (800 MHz in industrial qualified version) Arm Cortex-M7 core and a 400 MHz Arm Cortex-M4 core.	

Table 2. Hardware material

Table 2.	Hardware	materialcontinued
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Component name	Description	Picture
Digital board (ISI-QMC-DB02)	The digital board works as an external platform to prototype multi-motor control applications. It includes widely used industrial communication and peripheral interfaces.	
Power stage board (ISI-QMC-PSB02 or ISI- QMC-PSB02B)	The power stage board includes a 3-phase inverter with the gate driver for the control and connection of the motors. Up to 4 power stage boards can be connected to the digital board to control up to 4 motors through the i.MX RT1170 crossover processor. The power stage board must be supplied through an external power source using connectors. The maximum voltage allowed is 55 V, and the Over Current (OC) peak level is 14.9 A. This board houses the 3-phase MOSFET-based inverter with Gate driver NXP GD3000 gate driver IC connections port for	
	incremental encoder, and Analog Front End IC 13388 for temperature monitoring.	
3-phase PM Synchronous Motors (PMSM	i.MX RT Industrial Drive Development Platform is able to control up to 4 PMSM 3-phase motors. In this document <i>Teknic Industrial-Grade NEMA 23</i> <i>motors</i> (<u>M-2310P-LN-04K</u>) are used. Other motors can be used as well; however, it is recommended to use motors with similar characteristics (maximum voltage 30 V, maximum power 200 W, incremental TTL encoder). Note: It is not included in the i.MX RT Industrial Drive Development Platform hardware package.	
MCU-Link Pro debug probe (or Segger J-Link debug probe)	The MCU-Link Pro is a fully featured debug probe that can be used with the MCUXpresso IDE. Alternatively, it is also possible to use Segger J-Link debug probes. Note: It is not included in the i.MX RT Industrial Drive Development Platform hardware package.	

Table 2. Hardware material...continued

Component name	Description	Picture
Power supply	A power supply that can provide enough voltage and current to power the motors connected to the power stage boards. It is recommended not to go beyond a maximum voltage of 30 V to power the motors. In this document we apply a voltage of 24 V and limit the current to 3 A. Note: It is not included in the i.MX RT Industrial Drive Development Platform hardware package.	
CR2032 coin cell battery (<i>Optional</i>)	A CR2032 coin cell battery is used for powering the SNVS_LP (low power) of the i.MX RT1176 MCU in the daughter card for RTC backup. Note: It is not included in the i.MX RT Industrial Drive Development Platform hardware package.	
Cables and wires	 Cable and wires to connect different hardware components of the i.MX RT Industrial Drive Development Platform: 30-pin flat cables and 10-pin flat cables to connect the power stage boards to the digital board. These cables are included in the power stage board package; A micro-USB cable to connect the digital board to the PC; An SWD cable to connect the debug probe to the daughter card. This cable is typically included in the debug probe package; Wires to connect motors to power stage boards. These cables are not included in the i.MX RT Industrial Drive Development Platform; Wires to connect the power supply to power stage boards. These cables are not included in the i.MX RT Industrial Drive Development Platform; 	
LCD	The digital board supports the connection of an MIPI DSI LCD that can be used as a user interface to display data and, if touch functionality is supported, as an input interface as well. Two MIPI DSI connectors (J132 and J44, respectively) are provided to connect the 5.5" LCD panel (NXP Semiconductors module or a Raspberry Pi compatible LCD). The J53 jumper is used to connect the Raspberry Pi compatible LCD to the 5-V external power supply.	

Table 3. Software tools

Name	Description	
MCUXpresso IDE	ed on Arm Cortex-M cores, MCUs. The MCUXpresso es. The minimum supported	
FreeMASTER	FreeMASTER is a user-friendly real-time debug monitor and of enables runtime configuration and tuning of embedded softward is used to control and monitor the motors connected to the i.M Development Platform. The minimum supported version of	data visualization tool that are applications. This tool IX RT Industrial Drive FreeMASTER is 3.2.
AN13644	. All information provided in this document is subject to legal disclaimers.	© 2024 NXP B.V. All rights reserved

Note: A Windows PC has been used to run the software tools listed in <u>Table 3</u>. Other operating systems might be supported as well.

4 Hardware preparation

This section describes how to connect different hardware components of the i.MX RT Industrial Drive Development Platform. After completing this section you should be able to power up the system which consists of a daughter card, a digital board and up to four power stage boards, each one controlling a PMSM motor.

- Prepare the daughter card and connect it to the digital board
- <u>Connect the power stage board to the digital board</u>
- <u>Connect the motors and power up the system</u>
- Connect LCD with digital board

4.1 Prepare the daughter card and connect it to the digital board

The daughter card is the core of the i.MX RT Industrial Drive Development Platform as it provides the i.MX RT1176 crossover MCU that controls the whole system. The daughter card can control up to four motors simultaneously. To do this, the daughter card first must be connected to the digital board that contains provision for peripheral connections. Up to four power-stage boards can then be connected to the digital board, each controlling one motor.

To prepare the daughter card and connect it to the digital board, follow these steps :

 (Optional) Place a CR2032 coin cell battery in the coin cell holder of the daughter card as shown in Figure 1. The coin cell battery is required to power the SNVS_LP (Low Power) of the i.MX RT1176 MCU for RTC backup.

Note: This step is optional. The daughter card can operate without a coin cell battery.



Figure 1. Insert a CR2032 coin cell battery in the coin cell holder of the daughter card

 Check that the DIP switch configuration of the daughter card is the one shown in <u>Figure 2</u> (SW4.1: ON; SW4.2: OFF; SW4.3: OFF; SW4.4: OFF – Serial Downloader Mode (SDP)):



Figure 2. Daughter card DIP switch configurations

3. To check that the daughter card is properly working, connect it to a 5V power supply (for example, a laptop) using its micro-USB connector (*J3*) as shown in Figure 3. Status LEDs *D6*, *D7*, *D8*, *D9*, and *D11* should turn green if the board is correctly supplied.

Note: The daughter card integrates a superCAP that can power the daughter card for a few seconds when power is cut off (for example, to save important data before shutting down the system). It takes approximately 10 seconds for the superCAP to charge completely. Discharge of the superCAP takes approximately 30 seconds (all LEDs will turn off).

Note: The micro-USB connector must be used to power the board ONLY when the daughter card is used as a standalone device.



Figure 3. Daughter card supplied using the micro-USB connector (standalone operation)

4. Remove the USB cable from the daughter card, then connect it to the bottom side of the digital board using the *SODIMM-200* connector as shown in Figure 4:



Figure 4. Connect the daughter card to the digital board

5. Check that the daughter card is properly connected to the digital board as shown in <u>Figure 5</u>:
(1) Connect the digital board to a 5V power supply (for example, a laptop) through a micro USB cable (*J48* connector);

(2) Turn the switch SW1 into the ON position;

(3) If the digital board is correctly supplied, the D94 LED turns on;

(4) If the daughter card is correctly connected and supplied, the status LEDs *D6*, *D7*, *D8*, *D9*, and *D11* in the daughter card turn on as well.

Note: The micro-USB connector must be used to supply the digital board only when no power stage board is connected. If at least a power stage board is connected to the digital board, then the power supply will come from the individual stages connected to the digital board.

Note: The J48 micro-USB connector will also be used for FreeMASTER communication.

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Figure 5. Digital board supplied using the micro-USB connector (standalone operation)

4.2 Connect the power stage board to the digital board

Up to 4 power stage boards can be connected to the digital board, each one supporting the connection and control of a 3-phase motor. Follow these instructions to connect one or more power stage boards to the digital board:

- The digital board provides four pairs of 30-pin and 10-pin connectors. The 30-pin connectors (*J1*, *J153*, *J159*, *J161*) are used for signal interconnection between the digital board and the power stage boards. The 10-pin connectors (*J5*, *J154*, *J160*, *J162*) are used to supply the digital board and the daughter card with power provided by the power stage boards. Connectors are shown in Figure 6:
 - (1) Connectors for the power stage board controlling motor 1 (*J153, J154*);
 - (2) Connectors for the power stage board controlling motor 2 (*J161, J162*);
 - (3) Connectors for the power stage board controlling motor 3 (J1, J5);
 - (4) Connectors for the power stage board controlling motor 4 (J159, J160).

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Figure 6. Power stage board connectors in the digital board

2. Connect the power stage boards to the digital board using the connectors described in the previous step.
 Figure 7 shows as an example the connection of the power stage board controlling *motor 1*:

 (1) Use a 10-pin flat cable to connect the *J154* connector in the digital board to the *J5* connector in the power stage board;

(2) Use a 30-pin flat cable to connect the *J153* connector in the digital board to the *J1* connector in the power stage board.

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Figure 7. Connect a power stage board to the digital board

3. Repeat the above step for all the power stage boards that you want to connect to your system. You can stack two power stage boards on top of one another using the standoffs and screws included in the i.MX RT Industrial Drive Development Platform hardware package. If you connect all power stage boards, the result must be similar to Figure 8:

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4.3 Connect the motors and power up the system

To connect the PMSM motors to the power stage boards and supply and power up the system, follow these steps:

 Identify in the motor connector the *incremental encoder signals* (5V, GND, ENC_A, ENC_B, ENC_I) and the *motor phase signals* (R, S, T or A, B, C). These signals must be routed to the power stage board using the proper wires based on the motor manufacturer recommendation for wire gauges. The *Teknic Industrial-Grade NEMA 23 motor* (<u>M-2310P-LN-04K</u>) used as reference in this document has the pinout shown in Figure 9:



Figure 9. Teknic Industrial-Grade NEMA 23 motor - Connector pinout

2. Connect the motors to the power stage boards as shown in <u>Figure 10</u>:
(1) Encoder signals of the motor must be routed to the 5-pin *J14* connector of the power stage board as described in <u>Table 4</u>:

Table 4. Mapping of J14 pins to incremental encoder signals

J14 pin	Signal
1	5VDC_IN
2	GND
3	ENC_A
4	ENC_B
5	ENC_I

(2) The three phases of the motor must be routed to the *J13* connector of the power stage board as described in <u>Table 5</u>:

Note: Loosen the screws of the connector before inserting the wires, then tighten them again.

Table 5.	Mapping	of J13	pins to	phase signals
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J13 pin	Signal
1	PHASE R (A)
2	PHASE S (B)
3	PHASE T (C)

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Figure 10. Connect a motor to the power stage board (incremental encoder and phase signals)

3. Connect the power supply to the power stage boards as shown in Figure 11:

(1) Connect the positive wire of the power supply to any of the two pins of the *J*7 connector of all connected power stage boards. See Figure 11;

(2) Connect the ground wire of the power supply to any of the two pins of the *J*6 connector of all connected power stage boards. See <u>Figure 11</u>;

(3) Set the maximum output voltage of the power supply unit to 24 V and the maximum current output to 0.5 A, then turn on the power supply unit;

(4) If power stage boards are correctly supplied, the status LEDs of the power stage boards should turn green and fans should start spinning. The digital board and the daughter card should turn on as well if the power stage boards are correctly connected to the digital board;

Note: Make sure that the ON/OFF switch (SW1) of the digital board is in the ON position; otherwise power will not be supplied to the digital board.

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Figure 11. Connect the power supply to a power stage board

4. If the power stage boards are correctly supplied and no fault has occurred, increase the maximum output current of the power supply unit to *3 A*. At the end, the whole system must look as shown in Figure 12.



4.4 Connect LCD with digital board

The digital board supports the connection of a MIPI DSI LCD that can be used as a user interface to display data and, if touch functionality is supported, as an input interface as well. Two MIPI DSI connectors (J132 and J44, respectively) are provided to connect the <u>RK055HDMIPI4MA0 NXP LCD module</u> or a Raspberry Pi

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compatible LCD. The J53 jumper is used to connect the Raspberry Pi compatible LCD to the 5-V external power supply.

To enable the J132 connector, the J122 jumper must be in the open position. This enables the usage of the <u>RK055HDMIPI4MA0 NXP LCD module</u>.

Note: There is a known issue with the display output. Due to the framebuffers being stored in the Octal RAM and the logs in the Octal FLASH, writes and reads to both share the same Octal bus. Race conditions can lead to display flickering and "rolling" effects. This is purely cosmetic and once the display content stabilizes, the application continues running without any issues.



Figure 13. Connect the LCD

5 Software environment preparation

This section describes how to install in the PC the tools required to compile and debug the i.MX RT Industrial Drive Development Platform demo:

- Install the MCUXpresso IDE as described in <u>Section 5.1;</u>
- Install the *FreeMASTER* tool as described in <u>Section 5.2</u>;
- Configure the MCU-Link Pro debug probe as described in Section 5.3;
- Install the USB to UART drivers as described in <u>Section 5.4</u>.

5.1 Install the MCUXpresso IDE

MCUXpresso is an Eclipse-based development environment for NXP MCUs based on Arm Cortex-M cores offering advanced editing, compiling, and debugging features. In this document, MCUXpresso is used to build and run the i.MX RT Industrial Drive Development Platform software project. To install MCUXpresso, follow the steps below:

1. Go to the <u>MCUXpresso</u> webpage and click the *downloads* button as shown in <u>Figure 14</u>: **Note:** To download MCUXpresso, you need an NXP account.

Oterview Software Details Design Resources ① Training Support	MCUXpresso Integrated Development Environment (IDE) MCUXpresso-IDE Receive alerts ()			
The MCUXpresso IDE brings developers an easy-to-use E development environment for NXP® MCUs based on Armelincluding its general purpose crossover and wireless - ena MCUXpresso IDE offers advanced editing, compiling, and with the addition of MCU-specific debugging views, code to multicore debugging, and integrated configuration tools. The debug connections support Freedom, Tower® system, RT-based EVKs, and your custom development boards wits ource and commercial debug probes from NXP, P&E Mice	DOWNLOAD S	rare Details Design Resources ① Training Support		
	clipse-based Cortex®-M cores, bled MCUs. The debugging features race and profiling, he MCUXpresso LPCXpresso, i.MX th optimized open- ro®, and SEGGER®.	The MCUXpresso IDE brings developers an easy-to-use Eclips development environment for NXP® MCUs based on Arm® Cor including its general purpose crossover and wireless - enabled MCUXpresso IDE offers advanced editing, compiling, and debu with the addition of MCU-specific debugging views, code trace multicore debugging, and integrated configuration tools. The MIDE debug connections support Freedom, Tower® system, LPC RT-based EVKs, and your custom development boards with op source and commercial debug probes from NXP. P&E Micro®, and commerc		

Figure 14. Download MCUXpresso IDE - homepage

2. Download the latest available version of MCUXpresso (under the *current* tab) as shown in Figure 15: **Note:** The minimum recommended version of MCUXpresso is 11.7.1. It is recommended to always use the latest available version.

	DUCTS APPLICATIONS	DESIGN CENTER	SUPPORT	COMPANY	
NXP > Design > Product Info	rmation : MCUXpresso IDE				
Software & Support Product List	Product Infor	mation			
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License Lists	11. 7. 1 MCUXpresso IDE			Mar 30	0, 2023 Download Log
Figure 15. Down	ioad wicuxpresso II	JE - Select Vers	ion		

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 Run the downloaded installer file and follow the setup wizard until the MCUXpresso installation is completed. Make sure you allow the installation of the additional drivers required by MCUXpresso during the installation as shown in <u>Figure 16</u>. Detailed information on how to use the MCUXpresso IDE can be found in the MCUXpresso IDE User Guide (document <u>MCUXPRESSO-UG</u>).



5.2 Install FreeMASTER

FreeMASTER is a user-friendly, real-time debug monitor, and data visualization tool that enables runtime configuration and tuning of embedded software applications. This tool is used to control and monitor the motors connected to the i.MX RT Industrial Drive Development Platform. To install FreeMASTER in your PC, follow the steps below:

1. Go to the FreeMASTER webpage and click the DOWNLOADS button, as shown in Figure 17:

Overview	Software Details Design Resources ① Training	Support	DOWNLOADS
		53	FreeMASTER is a user-friendly real-time debug monitor and data visualization to that enables runtime configuration and tuning of embedded software applications. Both global automotive OEMs and appliance manufacturers widely adopted FreeMASTER as it is suitable for use in a broad range of automotive and industrial applications. TreeMASTER supports non-intrusive monitoring of variables on a running standard widgets (gauges, silders and more) or as data in text form, offering simple-to-use data recorders.
-*			USER GUIDE

 Click the DOWNLOAD button next to the FreeMASTER version for your operating system as shown in Figure 18. The FreeMASTER Windows version is used in this document. Once you have downloaded the installer, double-click the executable file to start the installation wizard. Note: Accept the license agreement before you can download the installer. Also, log in with your NXP account.

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FreeMASTER Run-Time Debugging Tool		Q Search nxp.c
Overview Software Details Do	ocumentation Design Resources () Training Support	DOWNLOADS
NXP (10)	√ Filter by keyword	
FILTER BY Embedded Software BSPs and Device Drivers Examples and Quick Start Software	10 downloads UI DEVELOPER Host IO Driver for FreeMaster GUI ZIP Rev 1 Oct 27, 2023 6.6 MB HOST_IO Sign in required	Sort by Newest/Date ~
Software Development Tools Debugging and Visualization Tools Development IDEs and Build Tools	DEBUGGING AND VISUALIZATION TOOLS FreeMASTER tool 3.2 (includes Lite 1.2) – Windows installer EXE Rev 3.2.2.2 Aug 31, 2023 326603 KB FMASTERSW32 Sign in required	DOWNLOAD
UI Developer	DEVELOPMENT IDES AND BUILD TOOLS FreeMASTER Lite 1.2 – Windows 64bit Installer EXE Rev 1.2 Aug 14, 2023 154391 KB FMASTERL12 Sign in required	DOWNLOAD
Figure 18. Download FreeMAST	ER - select the operating system	

3. During installation, an activation code is requested to activate FreeMASTER Lite. Retrieve the activation code as shown in Figure 19:

(1) Click the yes button when you are prompted to visit the NXP licensing portal to retrieve the code;

(2) The activation key is in the *license keys* tab of the website. Insert the activation key when prompted, then continue with the installation.

Note: The software licensing webpage can also be accessed from <u>this link</u>.

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FreeMASTER Lite Activation	×		
FreeMASTER Lite requires an act Do you want to visit the licensing portal complimentary code ?	ivation code. at nxp.com to retrieve your		
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5.3 Configure MCU-Link Pro for J-Link debugging

The MCU-Link Pro is a fully featured debug probe that can be used with MCUXpresso IDE or other IDEs supporting CMSIS-DAP and/or J-Link protocols. Flashing the i.MX RT Industrial Drive Development Platform demo software in the daughter card requires the user to configure the MCU-Link Pro for J-Link debugging.

Follow these instructions to configure the MCU-Link Pro for J-Link debugging:

1. First, you must flash the J-Link firmware in the MCU-Link Pro. To do this, go to the MCU-Link Pro website and download the MCU-Link installer software for your operating system as shown in Figure 20. Note: The Windows installer is used in this document.

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FIDUUCI Details D	esign Resources () Support	BUY OPTIONS	GET STARTER
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NXP (5)	5 software files	Sort b	y Relevance
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	MCU-Link installer for MacOS FEATURED	DC	WNLOAD

Figure 20. Flash J-Link firmware in MCU-Link Pro - Download MCU-Link installer

2. Run the *MCU-Link installer* executable and follow the installation wizard. By default, the installer creates an *MCU-LINK_installer* folder in *C:\nxp* as shown in Figure 21.

Note: The name of the folder might change depending on the version of the installer downloaded.

Name	Date modified	Туре	Size
FreeMASTER 3.1	6/2/2022 4:01 PM	File folder	
MCU-LINK_installer_2.250	6/1/2022 3:10 PM	File folder	
MCUXpressoIDE_11.5.0_7232	2/24/2022 5:45 PM	File folder	and the second of the second second
MCUXpressoIDE_11.5.1_7266	6/20/2022 11:04 AM	File folder	
NxpNfcCockpit_v6.5.0.0	3/21/2022 2:45 PM	File folder	

3. Follow the next steps to configure the jumpers of the MCU-Link Pro debug probe for flashing the J-Link firmware. See Figure 22:

- (1) Close the $J\overline{4}$ jumper of the MCU-Link Pro;
- (2) Connect the MCU-Link Pro to the PC using the micro-USB connector (J1).

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4. Flash the J-Link firmware in the MCU-Link Pro debug probe. Open a command prompt in the folder where the MCU-Link installer has been already installed (by default C:\nxp\MCU-LINK_installer_2.250), then send the command below to program the J-Link firmware:

.\scripts\program_JLINK

If the flashing is successful, you should see the message shown in <u>Figure 23</u>. Then, the MCU-Link PRO is ready to be used for J-Link debugging and flashing.



Note: Once the script has been flashed, the J4 jumper must be removed from the MCU-Link Pro debug probe.

5.4 Install USB to UART drivers

USB to UART drivers are required to detect the COM ports when the digital board is connected to the PC. Follow these instructions to download and install the USB to UART drivers in your PC:

1. Go to the following <u>website</u> and download the *CP210x Windows Drivers* software package as shown in <u>Figure 24</u>:

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/ Developers // USB to UART	Bridge VCP Drivers			¥80.
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Download and Downloads for Windows *Note: The Linux 3.x.x a	Install VCP Drivers , Macintosh, Linux and Android below. and 4 x x version of the driver is maintained in the current Linux 3	x.x and 4.x.x tree at	Legacy OS Software Versions	
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2. Run the executable and follow the steps of the installation wizard to install the drivers. Click the *finish* button to complete the installation as shown in Figure 25:

Getting started with i.MX RT Industrial Drive Development Platform

	Completing the In CP210x USB to UA	stallation of the RT Bridge Driver
	The drivers were successfully in	stalled on this computer.
Section 200	You can now connect your dev	ice to this computer. If your device
1		
	Driver Name	Status
	Driver Name ✓ Silicon Laboratories Inc	Status Ready to use

Figure 25. Complete installation of USB to UART Bridge Driver

 Connect the digital board to the PC using the *J1* micro-USB connector, then use the Windows device manager to check that the two COM ports of the digital board are correctly detected as shown in Figure 26. The *Enhanced COM port* is used for FreeMASTER communication, while the *Standard COM port* is used for printing debug messages.

Getting started with i.MX RT Industrial Drive Development Platform



6 Software preparation

The i.MX RT Industrial Drive Development Platform software package includes a demo application that demonstrates how to monitor and control up to four PMSM motors connected to the system. Follow the instructions in this section to provision the secure element through the provisioning tool, import, and configure the i.MX RT Industrial Drive Development Platform demo application in MCUXpresso, compile it, flash it in the daughter card, and execute it. The following subsections provide details on software preparation:

- Provision the secure element
- Import the i.MX RT Industrial Drive Development Platform demo application
- <u>Configure the i.MX RT Industrial Drive Development Platform demo application</u>
- Compile the i.MX RT Industrial Drive Development Platform demo application
- Install the J-Link software and configure the flash loader .
- Flash the i.MX RT Industrial Drive Development Platform demo application and execute it
- <u>Control the platform though a web interface</u>

6.1 Provision the secure element

To provision the onboard Secure Element, use the NFC reader included in the digital board package. Provisioning takes several steps, as described below. To use the full security features provided with the application, obtain an ACS ACR1252 1S CL Reader PICC 0, open */tools/Release/Qmc2gProvisioningTool.*

ini, comment out the default CARD READER, uncomment the ACS ACR1252, and skip steps 10 to 14 of this subchapter. There is an alternative path described at the end of the subchapter.



Figure 27. Default GMMC Pocket NFC CCID 0 reader included in the HW package

- 1. Power off the HW to enable provisioning via NFC.
- 2. Insert the NFC reader into your PC and let the installation happen. After successful installation, the LED blinks red/blue/white color.
- 3. Go into the *tools* folder at the *root* directory and unzip the *ProvisioningTool.zip* archive into the *tools* folder. The zip password is "123".
- 4. Run *ProvisioningTool.exe*. All files are placed in and taken from the working folder. Change the working folder according to your preference (copy *image_enc.exe* into your customized working folder).
- 5. Go to the *Create Identities* tab and click *Quick Create and Issue All Identities*. All generated content is placed into your working folder.

🖳 i.MX RT Industrial Drive Provisioning Tool	—	×
Options Select Working Folder Update Working Folder	Help	
YOUR_PATH\qmc2g-industrial\tools\Release	Output Die Format	
Card Reader Name: GMMC Pocket NFC CCID 0	DER O PEM	
Provisioning Create Identities Create Certificate Create Firmware Update Ho	st Crypto SE05x Crypto	
Quick Create/Issue Identities		
OEM CA Identity issues FW Update Creator Identity		
Custome CA Harita		
Customer CA identity issues FVV Update issuer identity		
issues Log Reader Identity		
issues AWDT Signer Identity		
issues AWDT Server Identity a	awdt.server WDT Server DNS Name	
Azure Root CA		
AWS Root CA		
Quick Create and Issue All Identities		
Figure 28. Create identities in the Provisioning Tool		

6. Go to the SE05x_Crypto tab.

7. Take the unpowered Digital board and place the board by the NFC antenna below the NFC reader. The LED color changes to white once a connection is established. To ensure a strong and uninterrupted connection, make sure that the NFC reader is positioned properly on top of the digital board's NFC antenna.



Figure 29. Place the NFC reader on the Digital Board NFC antenna

8. In the provisioning tool, click the *Factory reset* button while having the NFC reader connected to the Secure Element on the Digital Board.

🔜 i.MX RT Industrial Drive Provisioning Tool	– 🗆 X
Options Select Working Folder Update Working Folder	Help
YOUR_PATH\qmc2g-industrial\tools\Release Card Reader Name: GMMC Pocket NFC CCID 0	●utput File Format ● DER ○ PEM
Provisioning Create Identities Create Certificate Create Firmware Update Host C Working Key ID 00000001 Firmware Min Revisic V Get Key Info	Crypto SE05x Crypto
Delete All Key	rs Factory Reset
- Write /Dead Dieser Data	
Figure 30. Perform a Factory Reset of the Secure Element	

- 9. To provision the Secure Element with security assets, go to the *Provisioning* tab. The provisioning steps must be done as described below as policies for secure objects have not been fully defined yet.
- 10. Apply Policies by clicking the Yes radio button and select *Auth Objects*. Click the *Provision Selected* button while holding the NFC Reader connected to the Secure Element on the Digital Board.

AN13644

Getting started with i.MX RT Industrial Drive Development Platform

Options	
Select Working Folder Update Working Folder Help	
YOUR_PATH\qmc2g-industrial\tools\Release	
Card Reader Name: GMMC Pocket NFC CCID 0 O DER O PE	EM
Provisioning Create Identities Create Certificate Create Firmware Update Host Crypto SE05x Crypt	to
Prerequisites	
OEM CA Certificate oem.crt	
Customer CA Certificate customer.crt Customer CA Key Pair customer priv.key	
Log Reader Certificate	- 1
	-
Avvol i Certificate. Server avvol_server_io.crt Signer avvol_signer_io.crt	
Firmware Update Creator Certificate [w_update_creator_id.crt	_
Minimum Revision: Firmware 0 0 0 Manifest 0 0	
Server Root Certificate: Azure BaltimoreCyberTrustRoot.crt AWS AmazonRootCA1.crt	
Default User Maintenance V admin Password1	
Auth Objects OEM CA Identity	1
Device ID Customer CA Identity	
Web Server ID Log Reader Identity Provision All	
Azure Cloud Service Firmware Update Issuer Identity	1
Avvis Cloud Service Avvis I Identifies Apply Policies	
Himware Min. Rev. Himware Update Creator Identity Imware Min. Rev. Default Llear	

- 11. Deselect Auth Objects and set Apply Policies to NO.
- 12. Select all remaining checkboxes.
- 13. Click the *Provision Selected* button again, while still holding the NFC reader connected to the Secure Element on the Digital Board. It takes a few seconds to complete the operation.



Figure 32. Provision the Secure Element with the rest of the options and Apply Policies disabled

14. The Secure Element on the Digital board is provisioned and you are ready to program your board and try out the application.

Note: Optional steps for the ACS ACR1252 1S CL Reader PICC 0:

10. Apply Policies by clicking the Yes radio button and click the Provision All button while holding the NFC Reader connected to the Secure Element on the Digital Board.

11. The Secure Element on the Digital board is provisioned and you are ready to program your board and try out the application.

6.2 Import the i.MX RT Industrial Drive Development Platform demo application

 Launch the MCUXpresso IDE. When you are prompted to select the workspace, do as shown in <u>Figure 33</u>: (1) Choose an existing workspace where you will import the project or create a new workspace. *Note:* The name of your folder may be different from the one shown in <u>Figure 33</u>. (2) Click the Launch button to open the selected workspace.

MCUXpresso IDE Launcher ×
Select a directory as workspace
MCUXpresso IDE uses the workspace directory to store its preferences and development artifacts.
Workspace: C:\AppCodeHub\AP-QMC2G-Industrial
Use this as the default and do not ask again
<u>R</u> ecent Workspaces
2 Launch Cancel
Select the project workspace

2. There are two ways of downloading and installing the i.MX RT Industrial Drive Development Platform software package. You can use the command line and the West utility or let MCUXpresso download and install the package directly. The package is distributed as an application software pack. West and Git must be installed and configured into your PATH variable for the next steps.

6.2.1 Option 1: Get the App Software Pack with MCUXpresso IDE

- 1. Open the MCUXpresso IDE and select a workspace location in an empty directory.
- 2. Right-click the blank area of the *Installed SDKs* panel at the bottom and select *Import remote SDK Git repository....*

 Import remote SDK Git repository Copy SDK Paste SDK Open Default Location Open Location Unzip archive Uninstall SDK
 Open Location Unzip archive Uninstall SDK

Figure 34. Import remote SDK Git repository

- 3. In the dialog box that comes up:
 - a. In the Location field, click the Browse button and create an empty directory named "ap-qmc2g-industrial" for the application software pack to be downloaded to. Make note of this location as it will be used throughout this lab.
 - b. In the Repository field, write "https://github.com/nxp-appcodehub/ap-qmc2gindustrial".
 - c. In the *Revision* field, write "main". Then click *OK* to download the application software pack.

	Import Remote SDK Git X	
	Import remote SDK Git repository	
	Location	
	Local folder where the files will be saved. Folder should be empty.	
	C:\Users\\Documents\ap-qmc2g-industrial	
	Git	
	Remote Git information	
	Repository https://github.com/nxp-appcodehub/ap-qmc2g-industrial ~	
	Revision main 🗸	
	Clone all examples (this will take a while)	
	OK Cancel	
		1
Figure 35. Import Remote SDK Git	t	
4 Once imported the Installed S	DKs tab looks as shown in Figure 36:	
\pm . Once imported, the <i>motalicu</i> of		

✓ ☑ ⊕ ap-qmc2g-industrial (Git) ☑ ⊕ SDK_2x_ISI-QMC-DGC-02
2.11.2
3.9.0
Decuments\ap-qmc2g-industrial \components\sp-qmc2g-industrial \components\sp-qmc2g-industrial

6.2.2 Option 2: Use the command line

1. Open the Windows Command Prompt and execute the following:

```
west init -m https://github.com/nxp-appcodehub/ap-qmc2g-industrial --mr main
    ap-qmc2gindustrial
    cd ap-qmc2g-industrial
    west update
```

2. Open the MCUXpresso IDE and select a workspace location in an empty directory.

Getting started with i.MX RT Industrial Drive Development Platform

3. Drag and drop the "ap-qmc2g-industrial directory" that was created in the previous step into the *Installed SDKs* window located in a tab at the bottom of the screen named *Installed SDKs*. Click *OK* for pop-ups shown in Figure 37 and Figure 38:

	🔀 Import SDK Git 🛛 🕹
	Import SDK Git
	Location
	Select location of the repository and the folder where the manifests are located
	Repository location: C:\Users\\Documents\ap-qmc2g-industrial Browse
	Manifest(s) folder: C:\Users\ Documents\ap-qmc2g-industrial\manifests Browse
	OK Cancel
Figure 37 Import	t SDK Cit via command line
i igure or. import	
	MCUXpresso IDE SDK import
	Are you sure you want to import the following SDK in the common 'mcuxpresso'
	folder?
	C:\Users\\Documents\ap-qmc2g-industrial
	Do not ask for confirmation on SDK Drag and Drop install
	OK Cancel
Figure 38. Import	t SDK to MCUXpresso IDE
4. Once importe	d, the <i>Installed SDKs</i> panel looks as shown in <u>Figure 39</u>
	✓ ✓ ⊕ ap-qmc2g-industrial (Git) 2.11.2 (1d721a3b77e) 39.0 @ Ct/Users Documents/ap-qmc2g-industrial Crime SNK 2x (SLOMC DCC D2 2.11.2
	אסירעער איז
Figure 39. Install	ed SDKs tab
5. Select the i.M	X RT Industrial Drive Development Platform demo projects to import, as show
(1) Select the (2) Choose th	inipon Surveyaniples option from the Quickstant Panel.
(3) Click the <i>n</i>	<i>iext</i> button.

(4) Select all three given projects under Industrial Application:

- Industrial_app_master_cm7
- Industrial_app_slave_cm4
- Industrial_bootloader
- 6. Click the *Finish* button to import the projects to MCUXpresso. **Note:** "Industrial" is the internal identifier of the i.MX RT Industrial Drive Development Platform.

		New States	P PRIMA PROVIDE A DECEMBER OF	en source ou your	i projecu				
		Please click above or visit	Supported boards for	device: MIMXRT1	11760000				
	Ouickstart Panel ×	additional SDKs.	Date and the						
	MCIIX presso IDE - Quickstart Pane	NOP MINORT1175xxxxx			2.				
	No project selected	MIMXRT1170		1					
	- Contra or investo a scalart	MINOURT1176xxxxxx	554 BS						
	Crette or import a project		275.024.333						
	Create a new C/C++ project		ini ana dan	(SDK)					
	M Import SDK example(s)		is (due) ade						
	 Import project(s) from file system 								
	- Build your project								
	👧 🂊 Build								
	Clean								
	+ Debug your project								
	😥 🌞 Debug 😻 Terminate, Build and Debug								
	- Miscellaneous								
	Edit project settings	Selected Device: MIMXRT117	61012010		Please select a board				
	MCLXpresso Config Tools>>	Target Core: multicore dev	ice with cores: cortex-m4	cortex-m7	Name	SDK Versi., Manif	iest Location		
	Quick Settings>> Support project(s) to archive (zip)	Description: MIMXRT1176: Microcontrol	: LNO(# MINORT1176 1GH; ers (MCUs) based on ARM	z, ZNB RAM I® Cortex®-N4 G	BDK_2x_ISI-QMC-E	DG-2112 39.0	😕 <appswpad< th=""><th>s_qmc2g_indu</th><th></th></appswpad<>	s_qmc2g_indu	
	P Export project(s) and references to archive (zip)	ARM® Cortex	@-M7 Core						
	iii Build all projects								
							3.		
		0			1.854	Marka	Fields	Created	
		w lateral states and s			< Dark	195971 >	ninsri	Cancel	
Figure 40. Import SD	K example board s	election							
	Import projects								
	Project name prelix: isi_qmc_dgc		× Pro	oject name su	uffix:				
	Use default location								
	Location: C:\Users\NXF89098\Documents	MCUXpressolDE_11.7.0	9198\release1.1_cod	de_testing\isi	gmc_dgc			Browse	
	Basiast Trees			Design to On					
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	○ C Project ○ C++ Project ○ C Static	Library O C++ Static Lit	brary	Copy so	ources other files	UARI @ Exam	ipie derault		
	Examples			and the post of			🔤 🗹 🎉		
	type to filter								
	Name		Description				Version		
	✓ ✓								
	✓ ≡ industrial_app_master_cm7		QMC2G App	plication CM7	7_MASTER				
	F industrial_app_slave_cm4		QMC2G App	plication CM4	4_SLAVE				
	✓ ≡ industrial_bootloader		QMC2G App	plication BOC	DTLOADER				
	®			< B	lack Next >	Finish	Can	cel	

Figure 41. Import SDK Git via command line

6.3 Configure the application

The application can be configured through the *source/qmc_features_config.h* files in the CM4 and CM7 projects. Keep the configurations that share the name in sync between the projects. The most important things to configure before the first run are in the CM7 project on lines 38 and 75-78: Depending on how many Power Stage Boards are connected, the same or lower number must be configured in *MC_MAX_MOTORS*. There are four connectors on the Digital Board: Motor 1 (J153), Motor 2 (J161), Motor 3 (J1), and Motor 4 (J159). The application assumes that if only one Power Stage Board is connected, it is connected to the Motor 1 (J153)

connector on the Digital Board. Likewise, if two are connected, it is assumed that they are connected to Motor 1 (J153) and Motor 2 (J161), and so on.

#define MC MAX MOTORS (4) /* Number of supported motors */

Depending on the type of Power Stage Board, it either does or does not have the NAFE chip soldered on it. These four macros must be configured accordingly. Otherwise, the application does not run correctly. If fewer than 4 power stage boards are used, set the unused ones to 0 as well.

```
#define MC_HAS_AFE_MOTOR1 (1) /* Defines if PSB1 has the AFE soldered on. 1
means the AFE is soldered, 0 means the AFE is missing. */
#define MC_HAS_AFE_MOTOR2 (1) /* Defines if PSB2 has the AFE soldered on. 1
means the AFE is soldered, 0 means the AFE is missing. */
#define MC_HAS_AFE_MOTOR3 (1) /* Defines if PSB3 has the AFE soldered on. 1
means the AFE is soldered, 0 means the AFE is missing. */
#define MC_HAS_AFE_MOTOR4 (1) /* Defines if PSB4 has the AFE soldered on. 1
means the AFE is soldered, 0 means the AFE is missing. */
```

The other configurations can control TSN and Secure Element debug information, whether the FreeMASTER connection should be supported by the application, various thresholds, delays, sizes and other configuration values, the GUI color scheme, pin usage, and more.

6.4 Compile the i.MX RT Industrial Drive Development Platform demo application

There are several build targets for all three of the projects. The CM7 and CM4 projects have the Debug, Release, Debug_SBL, and Release_SBL targets.

The Debug and Release targets require a debug probe to be connected to the board. When the application is built this way, it must be initialized by the debug probe and started manually through the IDE. However, it does not need the Bootloader project to be compiled and is simpler to get started with for testing and debugging purposes.

Note: The Release target has some debug symbols disabled and the debugging experience will be affected.

The Debug_SBL and Release_SBL targets require the Bootloader project to be compiled as well. To run the application when it is built with one of these targets, refer to the Provisioning and Secure Bootloader User Guide document in the *tools/ folder*. It is more complicated to set up but the application is able to boot on its own.

The Bootloader project has the Debug_Non_Secure, Debug, and Release targets. The Debug_Non_Secure is the simplest version, which does not enable any of the security features and must only be used for testing and debugging purposes. The Debug target enables most of the security features but not FW encryption and does not need all security-related fuses burned. The Release target is the production target that requires some critical security fuses to be burned. It is irrevocable and can negatively influence debugging and testing of the application.

- 1. Build the *isi_qmc_dgc_industrial_app_slave_cm4* project, as shown in Figure 42:
 - (1) Select the *isi_qmc_dgc_industrial_app_slave_cm* project from the left pane.

(2) Click the arrow next to the hammer icon in the top bar. Select the *Debug (Debug build)* option. Wait a few seconds to finish the compilation.



2. Build the *isi_qmc_dgc_industrial_app_master_cm7* project, as shown in <u>Figure 43</u>:

(1) Select the *isi_qmc_dgc_industrial_app_master_cm7* project from the left pane.

(2) Click the arrow next to the hammer icon in the top bar. Select the *Debug (Debug build)* option. Wait a few seconds for the project to compile.

Note: it is important to compile the isi_qmc_dgc_industrial_app_slave_cm4 project before compiling the isi_qmc_dgc_industrial_app_master_cm7 project.



6.5 Install the J-Link software and configure the flashloader

Before you can flash the i.MX RT Industrial Drive Development Platform demo application, install the J-Link software and configure the J-Link flashloader. To do it, follow these steps:

Note: Before following the instructions in this section, make sure you have installed MCUXpresso on your PC. Installing MCUXpresso after completing the instructions in this section might override some of the configurations applied.

1. Go to the <u>SEGGER J-Link website</u> and download the J-Link installer for your operating system as shown in <u>Figure 44</u>. Run the executable and follow the installation wizard until the installation is completed

successfully. Use the following link for J-Link installations: <u>https://wiki.segger.com/UM08001_J-Link_/_J-Trace_User_Guide</u>

// www.seyger.co m/wownioaos/jiiiiK/			
	@ Conta	t Us 🗣 Forum 🛛 Wiki 🏲 Web Shop 🕻	Newsletter
Products + Downloads + Purchase + Support + About Us	5 •	🔍 🚔 Jobs 📽 Videos 👗 Blo	g 💋 Sustai
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J-Link Software and Documentation Pack			
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J-Link Software and Documentation pack	V7.66g 🗸	Windows	
 All-in-one debugging solution Can be downloaded and used free of charge by any owner of a SEGGER <u>J-Link</u>, <u>J-Trace</u> or <u>Flasher</u> 	[2022-07-07]	▲ <u>64-bit Installer</u> ▲ <u>32-bit</u>	Installer
model. Not all features of it may be available on all J-Link / J-Trace / Flasher models. Updated frequently		Windows ARM	
Release Notes More information		Linux	
		▲ <u>64-bit DEB Installer</u> ▲ <u>32-bit</u> ▲ <u>32-bit</u>	DEB Installer RPM Installer
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		Linux ARM	
			DEB Installer
		[±] 64-bit DEB Installer [±] 32-bit	TGZ Archive
		[±] 64-bit DEB Installer [±] 32-bit	TGZ Archive

Figure 44. Download J-Link installer

 During the installation process, a J-Link configurations folder is created in "%APPDATA%/SEGGER/". Copy the JLinkDevices folder from the "tools" folder of the application software pack into the "%APPDATA%/ SEGGER/" folder, as shown in <u>Figure 45</u>.



Figure 45. Update the SEGGER flashloader configuration

Note: For a different OS, the J-Link device file must be updated in different locations. Use the following locations:

Table 6. Device file locations

OS	Location
Windows	C:\Users\ <user>\AppData\Roaming\SEGGER\JLink Devices</user>
Linux	\$HOME/.config/SEGGER/JLinkDevices
macOS	\$HOME/Library/Application Support/SEGGER/JLinkDevices

6.6 Flash the i.MX RT Industrial Drive Development Platform demo application and execute it

Follow the instructions provided below to flash the i.MX RT Industrial Drive Development Platform demo application in the daughter card and execute it:

Note: In this section, the MCU-Link Pro debug probe is used to flash the software. However, Segger J-Link debug probes can also be used in a similar way to flash the demo application in the daughter card.

1. Connect the MCU-Link Pro debug probe to the system as shown in Figure 46:

(1) First, connect the MCU-Link Pro to the PC using a micro-USB cable. Make sure that the *J4* jumper (firmware update jumper) of the MCU-Link Pro is not placed;

(2) Use a 10-pin to 10-pin Cortex SWD cable to connect the MCU-Link Pro SWD connector (J7) to the daughter card SWD connector (J1). Make sure that the SWD cable is inserted in the daughter card SWD connector with the same orientation shown in the picture.

Note: The red cable of the SWD cable must be connected to pin number 2 of the SWD connector in the daughter card.

(3) Make sure that the daughter card is correctly supplied, so that the status LEDs are turned on. If not, make sure that the system is correctly supplied and that the *SW1* switch of the digital board is in the ON position.



Figure 46. Connect the MCU-Link Pro to the daughter card

2. If you have not done it already, connect the digital board to the PC using the *J48* connector as shown in <u>Figure 47</u>. If you open the Windows device manager, you should see two *Silicon Labs Dual CP2105 USB*

to UART bridge ports: the enhanced COM port will be used for the FreeMASTER communication, while the standard COM port will be used to print debug logs in the terminal. Take note of the two COM port numbers. **Note:** If you cannot see the two UART ports, make sure you correctly installed the USB to UART drivers as described in <u>Section 5.4</u>.



Figure 47. Connect the digital board to the PC

3. In MCUXpresso, open a serial terminal window as shown in <u>Figure 48</u>. The serial terminal window will be used to see debug logs when the software is running.

- (1) Click the terminal tab on the bottom pane of MCUXpresso IDE;
- (2) Click the open a new terminal icon;
- (3) Select serial terminal;

(4) Select the serial communication port number from the dropdown menu. This corresponds to the *standard COM port* retrieved in the previous step;

(5) Set the baud rate to 115200;

(6) Leave the default value for the other settings (*data size: 8, parity: none, stop bits: 1, encoding: default*);
 (7) To open the serial terminal window, click the OK button.

Note: Alternatively, use your preferred terminal application to print debug logs. Make sure to use the same settings as in <u>Figure 48</u>.

Getting started with i.MX RT Industrial Drive Development Platform

File Edit Navigate Search Pro	ject ConfigTools Run RTOS Analysis Window Help	
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Pr ☆ Fa ☆ Fa 异	🔀 Launch Terminal 📃 🗆] × ^{te} ☆ ^{(x)=} Glo!
> 😂 isi_qmc_dgc_industrial_app_s	Choose terminal	✓ o active editor
y 🖉 loi_qino_dgo_inddodidi_dpp_ii	Settings	
	Serial port: COM31 4	~
	Baud rate: 115200 5	~
	Data size: 8	~
	Parity: None	~
	Stop bits: 1	~
	Franking D-6-14 (ICO 1050 1)	
(1) Ouick S? (x)= Varia On B	Encoding: Default (ISU-8659-1)	
	2	
		ancel
No project selected		
✓ Create or import a project	🎁 Installe 🔲 Properti 🖹 Prot 🚺 🍠 Terminal 🛛 🔜 Image I 🙀 Deb	ougg 🚼 Offline P 👘
New project		14 4 6 6 6 1 6 1
import SDK example(s)		-
Import project(s) from f	ile system	
Figure 48. Open a serial	terminal window in MCUXpresso	

- 4. Start debugging the *isi_qmc_dgc_industrial_app_master_cm7* project as shown in Figure 49: (1) Select the *isi_qmc_dgc_industrial_app_master_cm7* project;
 - (2) Click the arrow next to the green *debug* icon;
 - (3) Select debug configurations.

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Project Explorer 🛛 🗰 Registers 🎋 Faults 🛣 Peripherals+	(no launch history)
E 🕄 7 # � 📓 ▼ 1	Debug As >
isi_qmc_dgc_industrial_app_slave_cm4 <slave></slave>	Debug Configurations
isi_duic_ddc_industrial_app_master_cm/ <masterx <="" debudy<="" td=""><td>Organize Favorites</td></masterx>	Organize Favorites

Figure 49. Select debug configuration for isi_qmc_dgc_industrial_app_master_cm7 project

5. Follow the steps shown in Figure 50 to start the debugging process:

(1) Select the *isi_qmc_dgc_industrial_app_master_cm7* Debug configuration under *GDB* SEGGER Interface debugging;

(2) Open the *J-Link debugger* tab;

(3) Check that the *J-Link interface settings* are set as in <u>Figure 50</u>. In particular, the *device* field should have the value *MIMXRT1170_FLEXSPI2_UFL*;

(4) Make sure to uncheck the *Reset before running* option.

Note: If the device field is not set correctly, check that you correctly applied the Segger flashloader configuration as described in <u>Section 6.5</u>.

(5) Click the *debug* button to start debugging the software. Wait a few seconds for MCUXpresso to load the software image in the daughter card.

Getting started with i.MX RT Industrial Drive Development Platform

reate, manage, and run configurations	
B 🖗 🗈 🖹 🗶 🖻 🍸 🕶 Name: [isi_qmc_dgc_industrial_a	app_master_cm7 JLink Detter
type filter text	🖇 JLink Debugger 🐹 🙎 ol 🚸 Other Symbols 🕨 Startup 🤤 Source 🔲 Common
> LS C/C++ (NXP Semiconductors) MCU Application JLink Interface	● USB 51007-90 ○ IP
C /C++ Application Nickname	
© C/C++ Postmortem Debugger Device	
C/C++ Remote Application	SWD
GDB PEMicro Interface Debugging	Ordenting Quete Official
GDB SEGGER Interface Debugging	
isi_qmc_dgc_industrial_app_master_cm7 JLink Debug	
isi_qmc_dgc_industrial_app_slave_cm4 JLink Debug Server startup and port selection	ction 💿 auto 🔿 manual
Server execution	Start local server Connect to remote server
GDB Server Port	2331
SWO Port	2332
Teinet Port	2333
Endianess	little 🗸
Disconnect behaviour	Run ~
🗌 Power Target 🗹 Enable	Semihosting
GDB Client Settings	
Halt target on startup	Initialize CPU registers
GDB Client Port	2331
Additional Options	
Silent Verify Sing	gle run Attach to a running target
Reset before running	4
Script	Browse
Select RTOS plugin	GDBServer/RTOSPlugin_FreeRTOS
Settings file	\${ProjDirPath}/\${ConfigName}/\${LaunchConfigName} SettingsFile.jlink Browse
Other server options	· · · · · · · · · · · · · · · · · · ·
ilter matched 14 of 14 items	Re <u>v</u> ert Apply
	Debug

Figure 50. Debug configurations for isi_qmc_dgc_industrial_app_master_cm7

6. The software starts running on the daughter card and will stop at a preconfigured breakpoint. Set a second breakpoint as shown in Figure 51:

(1) Double-click on the *main()* function running in *thread* #1;

(2) Set a breakpoint in line 184 (*CLOCK_GetFreqFromObs(CCM_OBS_ADC1_CLK_ROOT*);), just after the *BOARD_InitBootPeripheral()* function. To do this, double-click the blue line next to the line number where you want to set the breakpoint. A small blue dot must appear indicating that the breakpoint has been correctly set;

(3) Click the resume button to run the software until it reaches the breakpoint in line 184.

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Figure 51. Execute Software: set breakpoint in main() ofisi_qmc_dgc_industrial_app_master_cm7

 Start a debugging session for isi_qmc_dgc_industrial_app_slave_cm4 following the same steps described for isi_qmc_dgc_industrial_app_master_cm7 (Step 4). Select the appropriate debugging configuration as shown in Figure 52:

(1) Select the *isi_qmc_dgc_industrial_app_slave_cm4 J-Link Debug* configuration under *GDB SEGGER Interface debugging*;

(2) Open the *J-Link debugger* tab;

(3) Check that the *J-Link interface settings* are set as in <u>Figure 52</u>. In particular, the *device* field should have the value *MIMXRT1176xxxA_M4*; Uncheck the "Attach to a Running Target" option.

(4) Click the *Debug* button to start debugging the software. Wait a few seconds for MCUXpresso to load the software image in the daughter card.

Getting started with i.MX RT Industrial Drive Development Platform

0 🕡 🖷 🖊 🖃 🔟 👗	Name: qmc2g_industrial_M4SLAVE JLir	nk Release	
filter text	📄 Main 🕸 GDB Debugger 🕸 JLink	c Debugger 🔁 er Symbols 🌘 GUI Flash Tool 🔈 Startup 🤤 Source 🔲 Common	
C/C++ (NXP Semiconductors) MCU Application	Debugger settings		
C/C++ Attach to Application C/C++ Postmortem Debugger	JLink Interface Settings		
/C++ Remote Application	ll ink Interface		
DB PEMicro Interface Debugging	No. 1		
DB SEGGER Interface Debugging	Nickname		
amc2g industrial M4SLAVE JLink Debug		MIMXR111/bxxxA_M4	
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aunen Group	GDB Server Settings		
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	GDB Server Port	2339	
	SWO Port	2337	
	Telnet Port	2338	
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matched 13 of 13 items			мерен

8. Once the software is loaded (1), double-click the *main()* function of the *isi_qmc_dgc_industrial_app_slave_cm4*, (2) then click the *resume* button as shown in Figure 53:



Figure 53. Resume debugging session in isi_qmc_dgc_industrial_app_slave_cm4

9. Go back to the main() function of isi_qmc_dgc_industrial_app_master _cm7 and click the resume button to resume the execution of the software after the breakpoint. If the software is running correctly on the daughter card, you should see the message shown in Figure 54 in the terminal window that was opened in Step 3. You can now control the motors using either FreeMASTER or a TSN master device. Note: Other logs might be shown right after the QMC2G code started message.



6.7 Control the platform through a web interface

The application can be controlled through a web API used to communicate with a web server running on the i.MX RT Industrial Drive Platform. To set this up, a host machine is required with an Ethernet connection to the

platform. The host machine can be either a separate PC running a Linux or Windows OS or it can be the same PC used to program the boards. If you use the same PC, set up a dual network to allow the server connection to work correctly. A simple way is to use a static IP for your PC as described below:

- 1. Make sure that the application is running on the platform.
- 2. Connect an Ethernet cable between the daughter card and your host machine.
- 3. The web server IP is set as 10.42.0.10 by default. Set up the host machine IP within the same subnet IP range. Navigate to the IPV4 Properties and configure them as in the figure below:

Internet Protoc	col Version 4 (TCP/IPv4)	Properties	\times
General			
You can get I this capability for the appro	P settings assigned autom . Otherwise, you need to priate IP settings. IP address automatically	atically if your network supports ask your network administrator y	
Use the IP address	following IP address:	10 42 0 15	
Subnet ma	sk:	255.255.255.0	
Default ga	teway:	10 . 42 . 0 . 1	
Obtain D Otse the Preferred D Alternate D	DNS server address autom following DNS server addr DNS server: DNS server:	atically esses: 8 . 8 . 8 . 8	
Validate	e settings upon exit	Advanced	
		OK Cancel	
E Configure the best mashing	notwork optingo		

Figure 55. Configure the host machine network settings

4. Optional: Test the connection with a ping to confirm it is ok.

5. Open 10.42.0.10 in your web browser. The following webpage should appear:

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C	ଜ		🗴 Not sea	cure 🖡	https://10	0.42.0.1)					
• Moto	or Contro	ol s	Settings	System	n Info	Admin						
									Login			×
									Quad Motor Control 2nd Gen. En Please enter your credentials:	nsure you ha	ave the needed training to operate	the system.
									Email		Password	
									Login			Cancel
Fig	ure 56	. L	oain sc	reen								
6.	The lo a <i>dmin</i>	gin	creder Passwo	ntials v	were	confi	gured	durir	ng the provisioning ste	ps. The	default login for an ad	ministrator is
							L				L	
	Defa	ult I	User	Main	tenar	nce	~	ſ	admin		Password1	

Figure 57. Login credentials in the Provisioning Tool

7. Once logged in, the motor control dashboard must be visible. In this dashboard, configure and send motor commands and control the motors similarly to how it is done in FreeMASTER.

Getting started with i.MX RT Industrial Drive Development Platform

NXP Motor Control Log	s Setting	gs System Info A	dmin			admin [maintenance] Logout
Dashboard						Reset
	Motor 1	1			show history	
		stop noFaultMC	iA 0	іВ 0	iC 0	
			current alpha 0	current beta 0	current DCBus 25.07898331	
			Speed 0	# Turns 0	Rotor position 0	
	mode off on		control method scalar V	gain enter target gain	frequency enter target frequency	
					submit motor command	
	Motor 2	2			show history	
				125	1 4	

Figure 58. Motor Control tab

- 8. The Logs tab shows the latest logs reported by the application.
- 9. The Settings tab can be used to reconfigure various device settings:

NXP Motor Control	Logs Setting	s System Info	Admin
Key	ν	alue	
IP_config		0A2A000A	
IP_mask_config		FFFFF	
IP_gateway		0A2A0001	
IP_DNS		08080808	
MAC_address		02	
TSN_VLAN_ID		02	
TSN_RX_Stream_M	IAC	91E0F000FE70	
TSN_TX_Stream_M	IAC	91E0F000FE71	
MOTD		51756164204D6F	746F722(
AZURE_IOTHUB_H	lubName	516D6332674875	62
reset submit cha	anges		
re 59. Settings tab			

10. The System Info tab is used for the system time and lifecycle state configuration and FW updates:

NXP Motor Control Logs Settings System Info Admin		
DeviceId	FwVersion	Lifecycle
93CFD5670023DA97DC45AD9D5373906C3AAD21BB2812E7F7A3093D911E576562	1.0.0	maintenance
Set System Time		
Thu Feb 08 2024 15:22:08 GMT+0530 (India Standard Time)		
set Time		
Update Firmware		
Choose File No file chosen		
upload		
Lifecycle State		
maintenance		
Figure 60. System Info tab		

11. The Admin tab is for user management. Its features are only available to administrators:

NXP Motor Control	ogs Settings	System Info Admi	in		
User Management					
User Name	Role	Password	new user		
admin	maintenance	****	edit delete		
adminuser	operator	****	edit delete		
finalopuser	operator	***	edit delete		
OperatorUser	operator	***	edit delete		
OperatorUser123	operator	***	edit delete		
igure 61. User Management tab					

7 Spin the motors with FreeMASTER

This section describes how to spin the motors connected to the i.MX RT Industrial Drive Development Platform using the FreeMASTER GUI. If you have not installed FreeMASTER, follow the instructions in <u>Section 5.2</u> to download the tool and install it. Make sure that the hardware has been correctly assembled (see <u>Section 4</u>) and the software is running correctly in the i.MX RT Industrial Drive Development Platform as described in <u>Section 6</u>.

In MCUXpresso, double-click the *pmsm_demo_QUAD_release.pmp* file located in the *freemaster_exe* folder of the *isi_qmc_dgc_industrial_app_master_cm7* project, as shown in <u>Figure 62</u>. FreeMASTER should open and display the interface shown in <u>Figure 63</u>.
 Note: The error message next to each motor will disappear once FreeMASTER connects to the system in the next step.

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• • a x						
FOC A						
MOs	Data hub API test					
FAULTS	Disable status update!					
FAULTS						
FAULTS	Control	Motor	Motor status			
tor M1						
5. Voltage open-l	Motor ID Selection	Motor1:	Motor2:			
6. Current open-I	Motor 1 Motor 2					
2. Current Control	Motor 3	Motor Switch - ERROR: Could not read the variable 'Motor1_app_switch'. Error	Motor Switch - ERROR: Could not read the variable 'Motor2_app_switch'. Error			
Current Conti	O Motor 4	Fault Status - ERROR: Could not read the variable 'Motor1' fault status'. Error	Fault Status - ERROR: Could not read the variable 'Motor' fault status', Error			
Phase current	Control Method Selection	0x8000fffb (Communication port is not open.).	0x8000fffb (Communication port is not open.).			
Positions	Scalar Control	State - ERROR: Could not read the variable 'Motor1_state'. Error 0x8000fffb	State - ERROR: Could not read the variable 'Motor2_state'. Error 0x8000fffb			
😫 Observer	Speed Control(FOC)	DC bus voltage : ERROR: Could not read the variable 'Motor1' Udcb' Error 0x8000fffb	Communication port is not open.).			
😫 Current Conti	O Position Control(FOC)	(Communication port is not open.).Volts	(Communication port is not open.). Volts			
1. Voltage Contrc		Speed : ERROR: Could not read the variable 'Motor1_speed'. Error 0x8000fffb	Speed : ERROR: Could not read the variable 'Motor2_speed'. Error 0x8000fffb			
😸 Voltage/Spee	Speed command: 0 RPM	Position : ERROR: Could not read the variable 'Motor1' position' Error 0x8000fffb	Communication port is not open.).RPM Position : ERROR: Could not read the variable 'Motor2' nosition' Error 0x\$000fffb			
Phase current	Position command: 0 Rounds	(Communication port is not open.) Rounds	(Communication port is not open.) Rounds			
Positions Y	Frequency in VF: 0 Hz	Phase A current : ERROR: Could not read the variable 'Motor1_Ia'. Error 0x8000fffb	Phase A current : ERROR: Could not read the variable 'Motor2_Ia'. Error 0x8000fffb			
Contraction of the local division of the loc	Gain in VF: 0	Phase B current : ERROR: Could not read the variable 'Motor1 Ib'. Error 0x8000fffb	Phase B current : ERROR: Could not read the variable 'Motor2' Ib'. Error 0x8000fffb			
0450201000000000000000000000000000000000	Is position command from a trajectory?	(Communication port is not open.).A	(Communication port is not open.).A			
	• No	Phase C current : ERROR: Could not read the variable 'Motor1_Ic'. Error 0x8000fffb	Phase C current : ERROR: Could not read the variable 'Motor2_Ic'. Error 0x8000fffb			
	C Yes	Phase Alpha voltage : ERROR: Could not read the variable 'Motor1' Ualpha'. Error 0x8000fffb	Phase Alpha voltage : ERROR: Could not read the variable 'Motor2' Ualpha'. Error 0x8000			
	Motor Switch	(Communication port is not open.).Volts	(Communication port is not open.).Volts			
	• Off	Phase Beta voltage : ERROR: Could not read the variable 'Motor2_Ubeta'. Error 0xS000fffb	Phase Beta voltage : ??Volta			
	On	(Communication port is not open.). voits				
	Click to update!	Motor3:	Motor4:			
		Motor Switch - ERROR: Could not read the variable 'Motor3 app switch', Error	Motor Switch - ERROR: Could not read the variable 'Motor4 app switch', Error			
		0x8000fffb (Communication port is not open.).	0x8000fffb (Communication port is not open.).			
		I F A R A FRANCISCO AND A R A R A R A R A R A R A R A R A R A	I TO A COMPANY OF			

Figure 63. Open the $pmsm_demo_QUAD_release$ FreeMASTER project

2. Open the FreeMASTER communication with the daughter card as shown in Figure 64. Before executing this step, make sure that the digital board is connected to the PC using the *J48* micro-USB connector (see Figure 47).

(1) Click the start communication button in the top bar;

(2) If the communication is successfully established, the state of the motors changes from *Error 0x8000fffb* (*Communication port is not open*) to *kMC_NoFaultMC* (fault status), *kMC_App_Off* (motor switch) and *kMC_Stop* (state). If fewer than four motors are connected, faults still appear for the missing motors but it does not prevent the connected motors to run.



Figure 64. Start FreeMASTER communication

3. You can now control the motors using the FreeMASTER GUI as shown in Figure 65:

(1) Select the motor to which you want to send a command;

(2) Select the control method. If you select *speed control*, the motor will be controlled by speed commands (in RPM). If you select *position control*, the motor will be controlled by position commands (in rounds). If you select *scalar control*, the motor will be controlled by *frequency in VF* (Hz) and *gain in VF*;

(3) Set the speed command value (if you set *speed control*), the position command value (if you set *position control*) or the *frequency in VF* (Hz) and *gain in VF* (if you set *scalar control*);

(4) If position control has been selected, indicate if the position command is from a trajectory or not;

(5) Indicate if you want to turn the selected motor on or off;

(6) Click *click to update* button to send the motor control command to the system;

(7) The selected motor should start spinning and the motor control data shall be displayed in real-time in FreeMASTER.

Note: Make sure to set only motor control values that do not exceed the limits of the motors you are controlling. Check the motor data sheet or contact the motor manufacturer for more information. **Note:** In the currently released version the buttons are disabled. The system assumes that they are under a locked cover and direct access without opening the cover would result in a tampering event. To enable the buttons and test this behavior, the FEATURE_HANDLE_BUTTON_PRESS_EVENTS macro in qmc_features_config.h must be set to 1.

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		7	
Control		Motor status	
Motor ID Selection		Motor1:	Motor2:
• Motor 2 • Motor 3 • Motor 4		Motor Switch - kMC_App_On Fault Status - kMC_NoFaultMC	Motor Switch - kMC_App_On Fault Status - kMC_NoFaultMo
Control Method Selection • Scalar Control • Speed Control(FOC) • Position Control(FOC)		DC bus voltage : 28.62Volts Speed : -64.865RPM Position : -40.266Rounds Phase A current : 0.155A Phase B current : 0.180A	DC bus voltage : 28.72Volts Speed : -198.761RPM Position : -112.288Rounds Phase A current : -0.226A Phase B current : -0.025A
Speed command: -125 Position command: 0	RPM Rounds	Phase C current : 0.397A Phase Alpha voltage : -0.32Volts Phase Beta voltage : -0.75Volts	Phase C current : 0.251A Phase Alpha voltage : -0.85Volts Phase Beta voltage : -0.87Volts
Gain in VF: 0 Gain 200	HZ	Motor3:	Motor4:
Is position command from a trajectory? • No • Yes		Motor Switch - kMC_App_On Fault Status - kMC_NoFaultMC State - kMC Run	Motor Switch - kMC_App_On Fault Status - kMC_NoFaultMC State - kMC_Run
• Off • On		DC bus voltage : 28.96Volts Speed : 75.775RPM Position : 30.819Rounds Phase 4 surrent : 0.2684	DC bus voltage : 28.70Volts Speed : -127.548RPM Position : -28.701Rounds
Click to update! Motor4/ Speed control Speed: -125RPM		Phase B current : -0.099A Phase C current : -0.194A Phase Alpha voltage : -0.73Volts	Phase B current : -0.135A Phase C current : -0.018A Phase Alpha voltage : 0.92Volts
		Phase Beta voltage : -0.17Volts	Phase Beta voltage : -0.15Volts

Figure 65. Send motor control commands to i.MX RT Industrial Drive Development Platform

8 Spin the motors with a TSN master device

This section describes how to control the motors connected to the i.MX RT Industrial Drive Development Platform using a TSN master device. The TSN master device is simulated using the i.MX RT1170 EVK board. The example application sends a predefined sequence of motor control commands using the Ethernet connection. This section consists of the following subsections:

- Additional Hardware required
- <u>Setting up the TSN master device with i.MX RT1170 EVK</u>
- Flash the TSN master device and spin the motors

8.1 Additional hardware required

This section lists additional hardware material required to set up the TSN master device and run the example application. The required hardware components are listed in <u>Table 7</u>:

 Table 7. Hardware required (TSN master demo)

Component Name	Description	Picture
i.MX RT1170 EVK	The i.MX RT1170 EVK integrates the i.MX RT1170 crossover MCU and provides a high- performance solution in a highly integrated board. The i.MX RT1170 EVK acts as a TSN master device.	
RJ45 Ethernet cable	An RJ45 Ethernet cable is required for connecting the i.MX RT1170 EVK (TSN master device) to the i.MX RT Industrial Drive Development Platform.	

8.2 Setting up the TSN master device with i.MX RT1170 EVK

This section explains how to prepare the i.MX RT1170 EVK board and connect it to the i.MX RT Industrial Drive Development Platform using the Ethernet cable:

- 1. Power up the using the 5V DC input as shown in Figure 66:
 - (1) Set the power selection jumper (J38) in the 1-2 position;
 - (2) Set the DIP switch (SW1) to internal boot mode: SW1.1: OFF; SW1.2: OFF; SW1.3: ON; SW1.4: OFF;
 - (3) Connect the board to the power supply using the 5V DC IN connector (J45);

(4) Use the SW5 ON-OFF switch to turn on the board. The D16 LED right next to the switch should turn on indicating that the board is correctly supplied.



Figure 66. Power up the i.MX RT1170 EVK board

2. Connect the i.MX RT1170 EVK to the i.MX RT Industrial Drive Development Platform using an RJ-45 Ethernet cable as shown in Figure 67:

(1) Connect one end of the RJ-45 Ethernet cable to the Gigabit Ethernet connector of the i.MX RT1170 EVK board (*J3*);

(2) Connect the other end of the RJ-45 Ethernet cable to the TSN Ethernet connector of the daughter card (J4).



8.3 Flash the TSN master device and spin the motors

Follow the steps outlined in this section to flash the demo application in the i.MX RT1170 EVK. After flashing the board, the software starts running and sends a pre-defined sequence of motor control commands to the i.MX RT Industrial Drive Development Platform. When motor control commands are received by the daughter card, the motors connected to the system start spinning.

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Application	note

Note: Make sure that the i.MX RT Industrial Drive Development Platform demo application is running as described in <u>Section 6</u> before executing the steps described in this section.

- Connect the i.MX RT1170 EVK board to the PC using a micro-USB cable as shown in Figure 68:
 (1) Connect the micro-USB cable to the *J11* connector of the i.MX RT1170 EVK board;
 - (2) If you open the Windows device manager, you should see a new USB Serial Device.



Figure 68. Connect the i.MX RT1170 EVK board to the PC

 Flash the *imxrt1170evk_industrial_app_tsn_motion_controller.bin* file containing the demo application in the i.MX RT1170 EVK board using the DAP-Link interface of the board as shown in <u>Figure 69</u>. The binary file for i.MX RT1170 EVK is delivered with the <u>i.MX RT Industrial Drive Development Platform software package</u>. It can be found in the *tools/ folder*.

(1) Open the RT1170-EVK drive from the Windows file explorer;

(2) Drag and drop the *imxrt1170evk_industrial_app_tsn_motion_controller.bin* binary file in the drive. The window will close for a moment and reopen again after the software has been successfully flashed.

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Figure 69. Flash the imxrt1170evk_industrial_app_tsn_motion_controller.bin binary in the i.MX RT1170 EVK board

- 3. Power cycle the i.MX RT1170 EVK board using the ON-OFF switch (*SW5*). The TSN master demo application will start running and will send motor control commands to the i.MX RT Industrial Drive Development Platform. If the demo is working correctly, you should see the motors spinning following a predefined sequence.
- 4. You can see the logs of the i.MX RT1170 EVK demo application by opening a serial connection to the board using any terminal application (in this document the <u>Tera Term</u> application has been used):

(1) Select from the dropdown menu the serial port number obtained in Step 1;

(2) Set the baud rate to *115200*;

(3) You can leave the default value for the other settings (*data: 8 bit, parity: none, stop bits: 1 bit, flow control: none*);

(4) Then, click the *New open* button. You should see logs as in Figure 71.

Tera Term: Serial port s	setup and connection	×
Port:	L COM45 ∨	New open
Speed:	2 115200 ~	
Data:	8 bit 🗸	Cancel
Parity:	none ~	
Stop bits:	1 bit 🗸 🗸	Help
Flow control:	none ~	
Tran	smit delay	
0	msec/char 0	msec/line
Device Friendly Device Instance Device Manufa Provider Name Driver Date: 6-2 Driver Version:	y Name: USB Serial Dev e ID: USB\VID_0D28&PI cturer: Microsoft : Microsoft 21-2006 10.0.19041.1202	rice (COM45) D_0204&MI_01\6&5E88
		×
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9 Note about the source code in the document

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AN13644 Application note

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10 Revision history

Table 8. Revision history

Table 6. Revision history				
Document ID	Release date	Description		
AN13644_Rev.1.2	08 April 2024	Updated with changes belonging to application software pack release v1.2		
AN13644_Rev.1.1	1 November 2023	Updated with changes belonging to application software pack release v1.1		
AN13644_Rev.1.0	8 September 2023	Initial version		

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