FreeRTOS BSP for i.MX 7Dual Demo User's Guide

Freescale Semiconductor, Inc.

Document Number: FRTOS7D101DAUG
Rev. 0
Mar 2016

Contents

Chapter 1
Introduction

FreeRTOS^{TM} BSP 1.0.1 i.MX 7Dual includes applications, which provide examples that show how to use this BSP for i.MX 7Dual Processor. This document describes applications and provides instructions to configure each application (if available). The document also describes the required board setup and steps to run the applications.

This document does not cover the details about compiling and running using the Linux® OS. To run the examples with Linux OS, note the following:

- By default, Linux BSP does not come with ARM® Cortex® -M4 enabled. The device tree needs to be changed in U-Boot with the command "setenv fdt_file zImage-imx7d-sdb-m4.dtb" for SABRE--SD board or "setenv fdt_file zImage-imx7d-12x12-lpddr3-arm2-m4.dtb" for validation board.
- Add "uart_from_osc" to the U-Boot "bootargs" variable to make sure that the Linux UART driver uses OSC as the clock source to comply with the FreeRTOS application. Otherwise, it gets messy output messages.
- To run RPMsg demos, configure and build the corresponding RPMsg kernel modules in Linux OS.

Chapter 2
LED Blinking Demo

2.1 Overview

This demo use GPIO and GPT driver as well as RDC SEMAPHORE driver to demonstrates how to toggle a blinking LED or printing "+" and "-" on the Terminal with different frequencies. In this demo, a safe shared peripheral access way is introduced with RDC SEMAPHORE.

NOTE: Sharing of GPIO need deep customization in Linux OS kernel, so it is not recommended to run this demo with the default Linux OS kernel together.

2.2 Supported platforms

2.2.1 i.MX 7Dual SABRE board

2.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal Computer with USB port

2.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench®
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

2.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/blinking_imx_-demo/<toolchain>.

2.2.1.4 Getting started

2.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

2.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information.

```
================= Blinking Demo ==================

====== Blinking interval 100ms ======

Press the (FUNC1) key to switch the blinking frequency:
- + - + - + - + - + - + - + - + - + -
```

After the user presses the "FUNC1" button, something new appears on the terminal, and the blinking runs much slower:

```
====== Blinking interval 200ms ======

Press the (FUNC1) key to switch the blinking frequency:
```

When this operation can be repeated, the UART print slower and slower until the print interval increases to 1000 ms. The user can press the button again to recover the print interval to 100 ms.

2.2.2 i.MX 7Dual Validation board

2.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

2.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

2.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/blinking_imx_-demo/<toolchain>.

2.2.2.4 Getting started

2.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

2.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information.

```
================= Blinking Demo ==================

====== Blinking interval 100ms ======

Press the (VOLUME UP) key to switch the blinking frequency:
```

After the user presses the "VOLUME UP" button, something new appears on the terminal, and the blinking runs much slower:

```
====== Blinking interval 200ms ======

Press the (VOLUME UP) key to switch the blinking frequency:
```

The Debug LED blinks become slower every 5 seconds. And it will recover the blinking interval to 100 ms until the blinking interval increases to 1000 ms.

Chapter 3
eCSPI Flash Demo

3.1 Overview

This demo application demonstrates the eCSPI driver working with FreeRTOS OS and how to use the eCSPI driver to access SPI flash memory. The demo provides following SPI flash features:

- Read memory status
- Set memory writing protection
- Erase memory
- Read data from memory
- Write data to memory

NOTE: The eCSPI1 instance on i.MX 7Dual Validation board is assigned to the ARM Cortex-M4 core when this example starts. Do not use this demo when Linux OS is running at the ARM Cortex-A7 core, because eCSPI1 is occupied by ARM Cortex-A7 when Linux OS kernel boots.

3.2 Supported platforms

3.2.1 i.MX 7Dual Validation board

3.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

3.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

3.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/ecspi_flash_-demo/<toolchain>.

3.2.1.4 Getting started

Hardware settings

To run this demo, enable the eCSPI flash on this board. The following rework steps is required: Route ECSPI1 signals to "ECSPI1_CLOCK", "ECSPI1_MOSI", "ECSPI1_MISO", and "ECSPI1_CS0_B".

Populate R601, R565, R566, and R591 to position B.

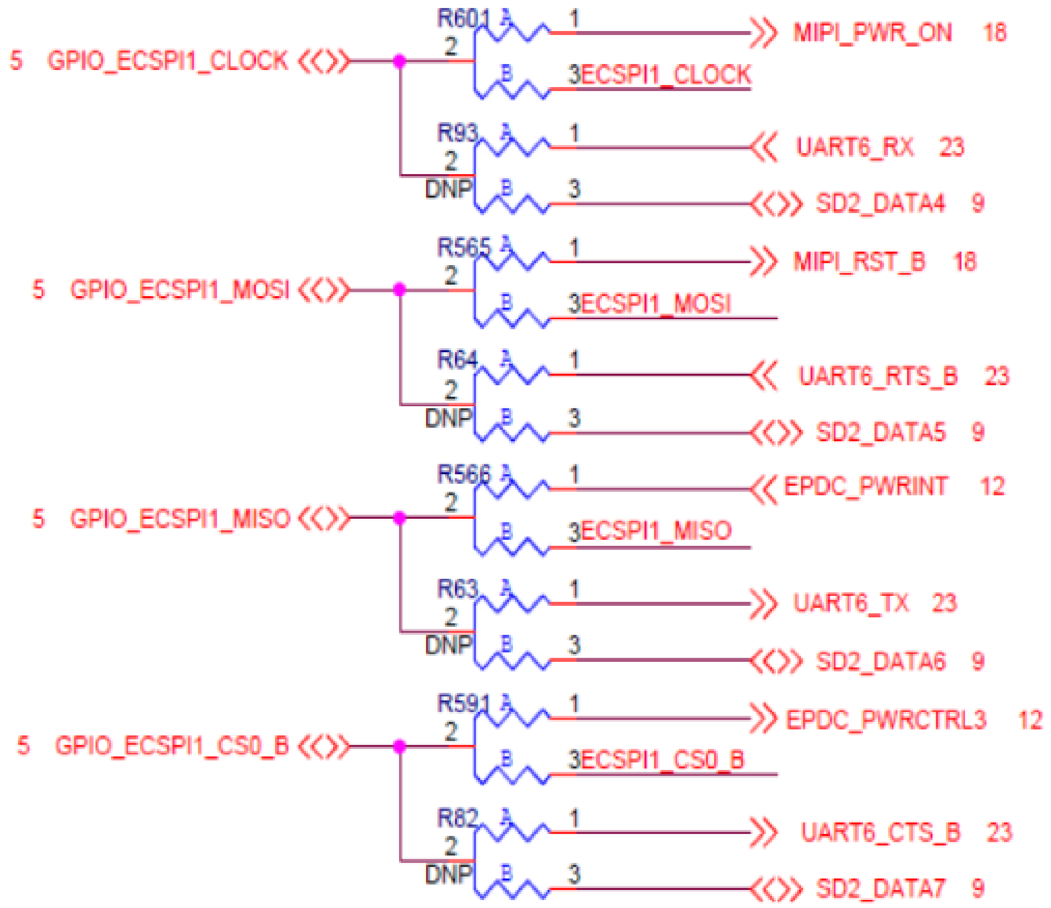


Figure 3.2.1: eCSPI rework guidance schematic diagram for i.MX 7Dual Validation board

3.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

3.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
--------------------------- eCSPI Flash Demo ----------------------------

This demo application demonstrates usage of eCSPI driver based on FreeRTOS.
It transfers data to/from external memory over SPI bus.

Start Flash Memory Operating!
Read memory status ... 0x00
Enable write latch in memory ...OK
Read memory status ... 0x02
Write unprotect memory ... OK
Read memory status ... 0x00
Enable write latch in memory ...OK
Page write 32 bytes to location 0x00000120 in memory:
Read memory status ... 0x00
0x00    0x01    0x02    0x03    0x04    0x05    0x06    0x07    0x08    0x09   0x0a     0x0b    0x0c
      0x0d    0x0e    0x0f
0x0f    0x0e    0x0d    0x0c   0x0b     0x0a    0x09    0x08    0x07    0x06    0x05    0x04    0x03
      0x02   0x01     0x00
Reading 32 bytes from location 0x00000120 in memory:
0x00    0x01    0x02    0x03    0x04    0x05    0x06    0x07    0x08    0x09   0x0a     0x0b    0x0c
      0x0d    0x0e    0x0f
0x0f    0x0e    0x0d    0x0c   0x0b     0x0a    0x09    0x08    0x07    0x06    0x05    0x04    0x03
      0x02   0x01     0x00
Finish Flash Memory Operating!
```

Chapter 4
Hello World DDR Demo

4.1 Overview

The Hello World DDR project is same as Hello World project, except they use different code regions. The project mainly shows that it can use external memory, such as DDR, to run the program.

In addition to that, RDC memory protection is introduced in hardware_init.c. The FreeRTOS code space read/write operation is only allowed by the ARM Cortex-M4 core.

NOTE: The DDR memory is system resource and make sure there is no conflict in memory allocation between the ARM Cortex-A7 core and ARM Cortex-M4 core. The code space of FreeRTOS demo is defined in platform/devices/MCIMX7D/linker/<toolchain>/MCIMX7D_M4_ddr.<ext> and the base address and length of the code region can be changed per requirement.

4.2 Supported platforms

4.2.1 i.MX 7Dual SABRE board

4.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

4.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

4.2.1.3 Software requirements

- The Hello World DDR project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/hello_world_ddr/<toolchain>.

4.2.1.4 Getting started

4.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the DDR using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

4.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

4.2.2 i.MX 7Dual Validation board

4.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

4.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench

- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

4.2.2.3 Software requirements

- The Hello World DDR project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_-apps/hello_world_ddr/<toolchain>.

4.2.2.4 Getting started

4.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port(J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the DDR using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

4.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

Chapter 5
Hello World Demo

5.1 Overview

The Hello World project is a simple demonstration program that uses the BSP software. It prints the "Hello World" message to the ARM Cortex-M4 terminal using the BSP UART drivers. The purpose of this demo is to show how to use the UART and to provide a simple project for debugging and further development.

5.2 Supported platforms

5.2.1 i.MX 7Dual SABRE board

5.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

5.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

5.2.1.3 Software requirements

- The hello world project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/hello_-world/<toolchain>.

5.2.1.4 Getting started

5.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the PC host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

5.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

5.2.2 i.MX 7Dual Validation board

5.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

5.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench

- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

5.2.2.3 Software requirements

- The hello world project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/hello_-world/<toolchain>.

5.2.2.4 Getting started

5.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

5.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

Chapter 6
Hello World OCRAM Demo

6.1 Overview

The Hello World OCRAM project is same as Hello World project, except they use different code regions. The project mainly shows that it can use internal memory, such as OCRAM, to run the program.

In addition to that, RDC memory protection is introduced in hardware_init.c. The FreeRTOS code space read/write operation is allowed by both Cortex-A7 and Cortex-M4 core.

NOTE: The OCRAM memory is a system resource and make sure there is no conflict in memory allocation between the ARM Cortex-A7 core and ARM Cortex-M4 core. The code space of FreeRTOS demo is defined in platform/devices/MCIMX7D/linker/<toolchain>/MCIMX7D_M4_ocram.<ext> and the base address and length of the code region can be changed per requirement.

6.2 Supported platforms

6.2.1 i.MX 7Dual SABRE board

6.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

6.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

6.2.1.3 Software requirements

- The hello world ocram project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_-apps/hello_world_ocram/<toolchain>.

6.2.1.4 Getting started

6.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the OCRAM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

6.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

6.2.2 i.MX 7Dual Validation board

6.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

6.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench

- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

6.2.2.3 Software requirements

- The hello world ocram project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/hello_world_ocram/<toolchain>.

6.2.2.4 Getting started

6.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the OCRAM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FRTOS7DGSUG).

6.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

Chapter 7
Hello World QSPI Demo

7.1 Overview

The Hello World QSPI project is same as Hello World project, except they use different code regions. The project mainly shows that it can use external flash, such as QSPI, to run the program.

In addition to that, RDC memory protection is introduced in hardware_init.c. The FreeRTOS code space read/write operation is only allowed by the ARM Cortex-M4 core.

NOTE:

1. Do not use this demo and Linux on the ARM Cortex-A7 core at the same time, because the IO Pins for QSPI Flash on i.MX 7Dual Validation board are occupied by Linux OS for EPDC display.
2. To start this demo, the QSPI Flash in U-Boot should be enabled.

7.2 Supported platforms

7.2.1 i.MX 7Dual SABRE board

7.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

7.2.1.2 Toolchain requirements

One of the following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

7.2.1.3 Software requirements

- The Hello World QSPI project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_-apps/hello_world_qspi/<toolchain>.

- To start the Hello World QSPI demo, U-Boot must be configured with QSPI flash enabled.

7.2.1.4 Getting started

7.2.1.4.1 Hardware settings

To enable FreeRTOS application running on the QSPI flash, perform the following board rework:

1. Remove R388, R389, R390, R391, R397, and R399.
2. Populate R392, R393, R394, R395, R299, and R300.

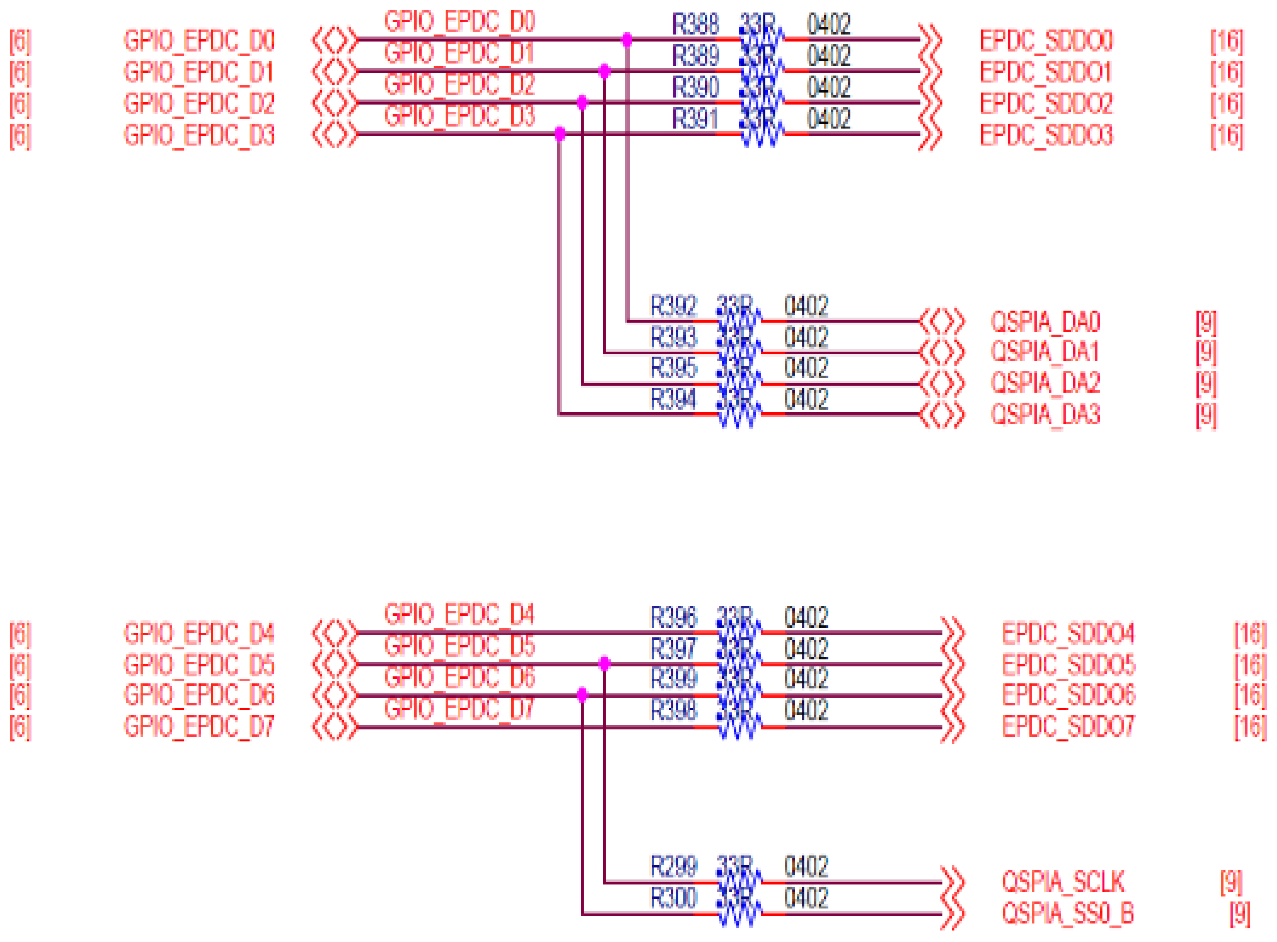


Figure 7.2.1: QSPI rework guidance schematic diagram for i.MX 7Dual SDB board

7.2.1.4.2 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:

   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to DDR using U-Boot. Write the image from DDR to QSPI flash.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

7.2.1.4.3 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

7.2.2 i.MX 7Dual Validation board

7.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

7.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

7.2.2.3 Software requirements

- The Hello World QSPI project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_-apps/hello_world_qspi/<toolchain>.
- To start the Hello World QSPI demo, U-Boot must be configured with QSPI flash enabled.

7.2.2.4 Getting started

7.2.2.4.1 Hardware settings

To enable FreeRTOS application running on the QSPI flash, perform the following board rework: -1. Populate R781, R182, R783, R184, R774, R183, R778, and R777 to position B. -2. Populate R185, R186, R188, R775, R776, R187, R772, and R189 to position B.

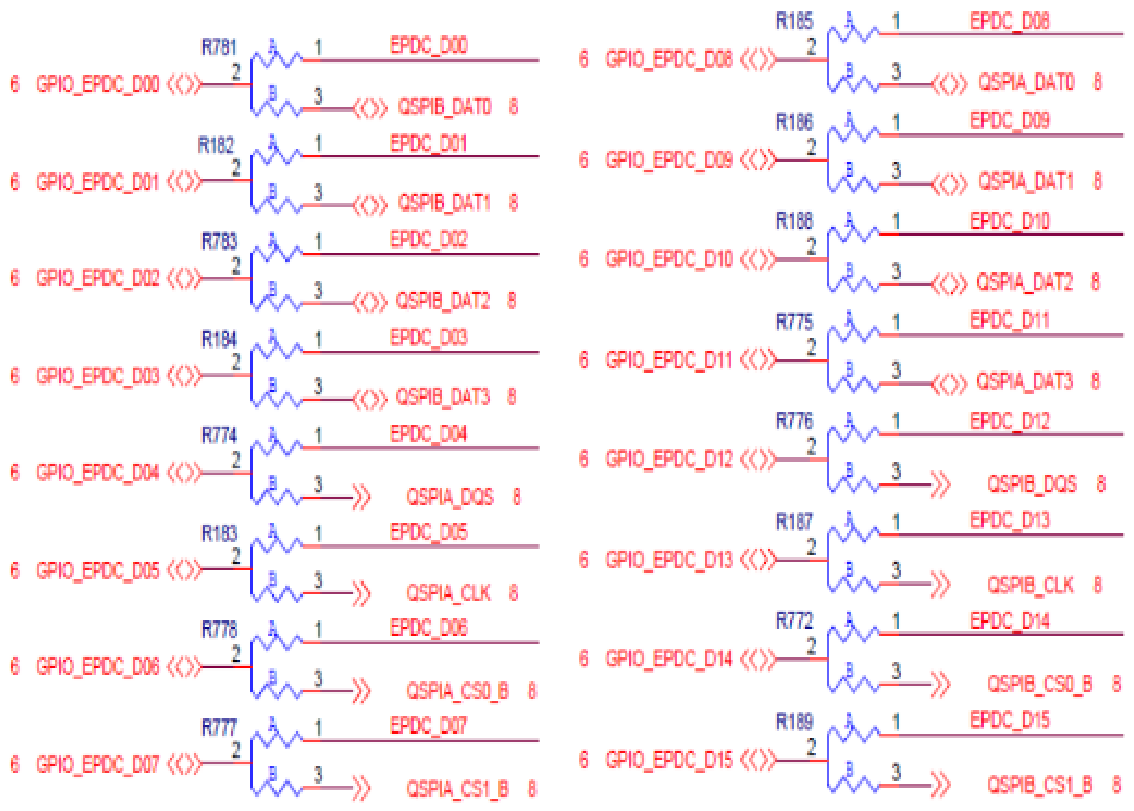


Figure 7.2.2: QSPI rework guidance schematic diagram for i.MX 7Dual Validation board

7.2.2.4.2 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.

2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to DDR using U-Boot. Write the image from DDR to QSPI flash.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

7.2.2.4.3 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Hello World!
```

You can puts some inputs like this :

```
Hello World!
test
```

Chapter 8
Low Power Random WFI Demo

This demo application exhibits the low-power feature of i.MX 7Dual SoC.

8.1 Overview

This demo exhibits dual-core low-power management. i.MX 7Dual is a dual-core chip, including an ARM Cortex-A7 core and an ARM Cortex-M4 core. Both the ARM Cortex-A7 core and the ARM Cortex-M4 core have different power modes - RUN, WAIT, and STOP. During WAIT and STOP, the core clock is gated off. The core stops running and enters low-power mode. Peripheral interrupt can be registered and wake up the core from low-power mode. Other than that, ARM Cortex-A7 core can do more power saving by shutting down the PLL, making DDR in self-refresh, etc. ARM Cortex-M4 core and its peripherals may need these resources, so the application on ARM Cortex-M4 should supervise the state of all its peripherals. When all of them do not need the high-power resources, ARM Cortex-M4 can inform ARM Cortex-A7 about it. ARM Cortex-A7 can then actually shut down these resources based on the system-level situation (including ARM Cortex-M4 and other peripherals directly managed by ARM Cortex-A7).

This demo is based on the GPT timer on the ARM Cortex-M4 side. With the timer, the ARM Cortex-M4 can switches between RUN, WAIT, and STOP modes continuously. ARM Cortex-M4 core also switches its clock source from PLL2 to OSC. When ARM Cortex-M4 and all its peripheral relinquish the high-power resources, ARM Cortex-M4 runs a part of code in TCM and lets ARM Cortex-A7 shut down these resources safely. When both ARM Cortex-M4 and ARM Cortex-A7 come into the STOP mode. The whole system enters a deep sleep mode (DSM). In DSM mode, ARM Cortex-M4 platform including the TCM are totally powered off. After exiting from DSM, ARM Cortex-A7 cold boots ARM Cortex-M4 again.

8.2 Supported platforms

8.2.1 i.MX 7Dual SABRE board

8.2.1.1 Hardware requirements

- SD Card with Linux image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD boards
- Personal computer with USB port

8.2.1.2 Toolchain requirements

One of the following toolchains is required:

- IAR Embedded Workbench®
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

8.2.1.3 Software requirements

- The random WFI project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_-apps/lowpower_imx7d/rand_wfi/<toolchain>.
- The default linker script is for TCM.

8.2.1.4 Getting started

8.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the target board using U-Boot.
4. Boot ARM Cortex-M4 core and ARM Cortex-A7 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FRTOS7DGSUG).

8.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
Low Power Demo

Please wait :
    1) A7 peer is ready
Then press "S" to start the demo


Press "S" to start the demo :
```

After ARM Cortex A7 core boots up, press ’s’ in the terminal. ARM Cortex-M4 core begins to switch between RUN/WAIT/STOP with a random time interval between 5 seconds to 10 seconds. The random time interval can be adjusted by changing the 2 macro "PERIOD_MIN" and "PERIOD_MAX" defined in

<BSP_Install>/examples/src/demo_apps/lowpower_imx7d/rand_wfi/main.c. The CPU clock switches to OSC when in WAIT / STOP mode and switches to PLL2 when in RUN mode. The terminal displays the following information.

```
GPT will triggle interrupt in 6s
go to mode WAIT
GPT Event! Total time 6s
GPT will triggle interrupt in 6s
go to mode STOP
GPT Event! Total time 12s
GPT will triggle interrupt in 8s
go to mode RUN
GPT Event! Total time 20s
GPT will triggle interrupt in 8s

...
```

If the LPM_MCORE_PRINT_DEBUG_INFO macro in lpm_mcore.h is enabled, the terminal will also display the debug information of the low-power demo.

After ARM Cortex-M4 switch to OSC and get into WAIT/STOP mode, ARM Cortex-A7 side can shut down high-bus resources. Running bus freq switch test script in ARM Cortex-A7, related information can be seen.

After ARM Cortex-M4 enters STOP mode, if ARM Cortex-A7 also enters STOP mode, then the whole system enters DSM. After exiting from DSM, ARM Cortex-M4 core is cold booted. Running MEM suspend script on the ARM Cortex-A7 core, related information can be seen.

```
Change M4 clock freq to 24M
Verify M4 Speed : 10 of 10 ... Done.
GPT will triggle interrupt in 6s
go to mode WAIT
GPT Event! Total time 6s
Verify M4 Speed : 10 of 10 ... Done.
GPT will triggle interrupt in 6s
go to mode STOP
GPT Event! Total time 12s
Change M4 clock freq to SysPLL Div2 (240M)
Verify M4 Speed : 10 of 10 ... Done.
GPT will triggle interrupt in 8s
go to mode RUN
GPT Event! Total time 20s
Change M4 clock freq to 24M
Verify M4 Speed : 10 of 10 ... Done.
GPT will triggle interrupt in 8s

...
```

Chapter 9
RPMsg Ping-Pong Bare Metal Demo

9.1 Overview

This demo application demonstrates the RPMsg remote peer stack working on bare metal with OpenAMP RPMsg API. It works with Linux RPMsg master peer to transfer integer values back and forth. The name service handshake is performed first to create the communication channels. Next, Linux OS transfers the first integer to ARM Cortex-M4 bare metal application. The receiving peer adds 1 to the integer and transfers it back. The loop continues infinitely.

9.2 Supported platforms

9.2.1 i.MX 7Dual SABRE board

9.2.1.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

9.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

9.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/rpmsg/pingpong_-bm/<toolchain>.
- Linux RPMsg master side ping-pong module

9.2.1.4 Getting started

9.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open two serial terminals on computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, and install the pingpong master side module.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

9.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG PingPong Bare Metal Demo...
RPMSG Init as Remote
```

After the Linux ping-pong master side module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
Get Data From Master Side : 0
Get Data From Master Side : 2
Get Data From Master Side : 4
Get Data From Master Side : 6
Get Data From Master Side : 8
......
```

As is shown on the log, the RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 Bare Metal Application) perform a name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core begins to send the first data to ARM Cortex-M4 core. After receiving the data, ARM Cortex-M4 core adds 1 to it and sends it back to ARM Cortex-A7 core. ARM Cortex-A7 core responds with the same behaviour.

9.2.2 i.MX 7Dual Validation board

9.2.2.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

9.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

9.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/rpmsg/pingpong_bm/<toolchain>.
- Linux RPMsg master side ping-pong module

9.2.2.4 Getting started

9.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open two serial terminals on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, and install the ping-pong master side module.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FRTOS7DGSUG).

9.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG PingPong Bare Metal Demo...
RPMSG Init as Remote
```

After the Linux ping-pong master side module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
Get Data From Master Side : 0
Get Data From Master Side : 2
Get Data From Master Side : 4
Get Data From Master Side : 6
Get Data From Master Side : 8
......
```

As is shown on the log, the RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 Bare Metal Application) perform a name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core begins to send the first data to ARM Cortex-M4 core. After receiving the data, ARM Cortex-M4 core adds 1 to it and sends it back to ARM Cortex-A7 core. ARM Cortex-A7 core responds with the same behaviour.

Chapter 10
RPMsg Ping-Pong FreeRTOS Demo with RTOS API

10.1 Overview

This demo application demonstrates the RPMsg remote peer stack working on FreeRTOS OS with RPMsg RTOS API extension. It works with Linux RPMsg master peer to transfer integer values back and forth. The name service handshake is performed first to create the communication channels. Next, Linux OS transfers the first integer to FreeRTOS OS. The receiving peer adds 1 to the integer and transfers it back. The loop continues infinitely.

The RPMsg RTOS API extension is a set of easy to use APIs that support multitask receive/send messages.

If the raw RPMsg API is preferred, it is easy to integrate with FreeRTOS OS by referring to the RPMsg Ping-Pong Bare Metal Demo.

10.2 Supported platforms

10.2.1 i.MX 7Dual SABRE board

10.2.1.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

10.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

10.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/rpmsg/pingpong_-freertos/<toolchain>.

- Linux RPMsg master side ping-pong module

10.2.1.4 Getting started

10.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open two serial terminals on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, and install the ping-pong master side module.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

10.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG PingPong FreeRTOS RTOS API Demo...
RPMSG Init as Remote
```

After the Linux ping-pong master side module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
Get Data From Master Side : 0
Get Data From Master Side : 2
Get Data From Master Side : 4
Get Data From Master Side : 6
Get Data From Master Side : 8
......
```

As is shown on the log, the RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 FreeRTOS O-S) perform a name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core begins to send the first data to ARM Cortex-M4 core. After receiving the data, ARM Cortex-M4 core adds 1 to it and sends it back to ARM Cortex-A7 core. ARM Cortex-A7 core responds with the same behaviour.

10.2.2 i.MX 7Dual Validation board

10.2.2.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

10.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

10.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/rpmsg/pingpong_-freertos/<toolchain>.
- Linux RPMsg master side ping-pong module

10.2.2.4 Getting started

10.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open two serial terminals on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, and install the ping-pong master side module.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

10.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG PingPong FreeRTOS RTOS API Demo...
RPMSG Init as Remote
```

After the Linux ping-pong master side module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
Get Data From Master Side : 0
Get Data From Master Side : 2
Get Data From Master Side : 4
Get Data From Master Side : 6
Get Data From Master Side : 8
......
```

As is shown on the log, the RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 FreeRTOS O-S) perform a name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core begins to send the first data to ARM Cortex-M4 core. After receiving the data, ARM Cortex-M4 core adds 1 to it and sends it back to ARM Cortex-A7 core. ARM Cortex-A7 core responds with the same behaviour.

Chapter 11
RPMsg String Echo Bare Metal Demo

11.1 Overview

This demo application demonstrates the RPMsg extension API working on Bare Metal application. It works with Linux RPMsg master peer to transfer string content back and forth. The name service handshake is performed first to create the communication channels. Next, Linux OS waits for user input to the RPMsg virtual tty. Anything received is sent to ARM Cortex-M4 core. ARM Cortex-M4 core displays what is received, and echoes back the same message as an acknowledgement. The tty reader on ARM Cortex-A7 core can get the message, and start another transaction. The demo demonstrates RPMsg's ability to send arbitrary content back and forth.

The RPMsg extension API is introduced in rpmsg_ext.h to achieve zero-copy receive/send operation which can improve performance significantly in busy transaction.

Note: The maximum message length supported by RPMsg is now 496 bytes. String longer than 496 is divided by virtual tty into several messages.

11.2 Supported platforms

11.2.1 i.MX 7Dual SABRE board

11.2.1.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

11.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

11.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/rpmsg/str_echo_-bm/<toolchain>.
- Linux RPMsg master side RPMsg tty module and application

11.2.1.4 Getting started

11.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open TWO serial terminals on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, install the RPMsg tty module.
6. Run RPMsg tty receive program "/unit_tests/mxc_mcc_tty_test.out /dev/ttyRPMSG 115200 R 100 1000 &"

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

11.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG String Echo Bare Metal Demo...
RPMSG Init as Remote
```

After the Linux RPMsg tty module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
```

The user can then input an arbitrary string to the virtual RPMsg tty using the following echo command on Cortex-A7 terminal:

```
echo test > /dev/ttyRPMSG
echo deadbeaf > /dev/ttyRPMSG

...
```

On the ARM Cortex-M4 terminal, the received string content and its length is output, as shown in the log.

```
Get Message From Master Side : "test
                                   " [len : 5] From Slot 0
Get Message From Master Side : "deadbeaf
                                       " [len : 9] From Slot 1
...
```

The RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 Bare Metal Application) perform name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core then waits for user input to RPMsg virtual tty and sends the content to ARM Cortex-M4 core. On receiving the data, ARM Cortex--M4 core outputs the content and its length on the terminal and echoes back the same message to ARM Cortex-A7 core. If some application is reading from /dev/ttyRPMSG on ARM Cortex-A7 core, it could get the echo message. The loop continues to demonstrate RPMsg's ability to send arbitrary content.

As seen in the log, there are 3 slots that are used in the remote side. The Master side may send a bundle of messages faster than the remote can consume them. To resolve this problem, synchronization is used to prevent Master from sending too many messages. Even when this is used, there is still a possibility Master can send up to 3 messages before Remote consumes them. Therefore, the remote application layer adds a size 3 buffer to hold these messages. Each entry of the buffer is called a slot. See the code for the detailed explanation.

11.2.2 i.MX 7Dual Validation board

11.2.2.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation main board
- Personal computer with USB port

11.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench

Supported platforms

- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

11.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/rpmsg/str_echo_-bm/<toolchain>.
- Linux RPMsg master side RPMsg tty module and application

11.2.2.4 Getting started

11.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open TWO serial terminals on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, and install the RPMsg tty module.
6. Run rpmsg tty receive program "/unit_tests/mxc_mcc_tty_test.out /dev/ttyRPMSG 115200 R 100 1000 &"

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

11.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG String Echo Bare Metal Demo...
RPMSG Init as Remote
```

After the Linux RPMsg tty module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
```

The user can then input an arbitrary string to the virtual RPMsg tty using the following echo command on Cortex-A7 terminal:

```
echo test > /dev/ttyRPMSG

echo deadbeaf > /dev/ttyRPMSG

...
```

On the ARM Cortex-M4 terminal, the received string content and its length is output, as shown in the log.

```
Get Message From Master Side : "test
                                    " [len : 5] From Slot 0
Get Message From Master Side : "deadbeaf
                                        " [len : 9] From Slot 1
...
```

The RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 Bare Metal Application) perform name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core then waits for user input to RPMsg virtual tty and sends the content to ARM Cortex-M4 core. On receiving the data, ARM Cortex--M4 core outputs the content and its length on the terminal and echoes back the same message to ARM Cortex-A7 core. If some application is reading from /dev/ttyRPMSG on ARM Cortex-A7 core, it could get the echo message. The loop continues to demonstrate RPMsg's ability to send arbitrary content.

As seen in the log, there are 3 slots that are used in the remote side. The Master side may send a bundle of messages faster than the remote can consume them. To resolve this problem, synchronization is used to prevent Master from sending too many messages. Even when this is used, there is still a possibility Master can send up to 3 messages before Remote consumes them. Therefore, the remote application layer adds a size 3 buffer to hold these messages. Each entry of the buffer is called a slot. See the code for the detailed explanation.

Chapter 12
RPMsg String Echo FreeRTOS Demo with RTOS API

12.1 Overview

This demo application demonstrates the RPMsg remote peer stack working on FreeRTOS OS with R-PMsg RTOS API extension. It works with Linux RPMsg master peer to transfer string content back and forth. The name service handshake is performed first to create the communication channels. Next, Linux OS waits for user input to the RPMsg virtual tty. Anything which is received is sent to ARM Cortex-M4 core. ARM Cortex-M4 core displays what is received, and echoes back the same message as an acknowledgement. The tty reader on ARM Cortex-A7 core can get the message, and start another transaction. The demo demonstrates RPMsg's ability to send arbitrary content back and forth.

The RPMsg RTOS API extension is a set of easy to use APIs that support multitask receive/send messages. In this demo, zero-copy operation in RTOS API is leveraged to improve transaction performance.

If the raw RPMsg API is preferred, it is easy to integrate with FreeRTOS OS by referring to the RPMsg String Echo Bare Metal Demo.

Note: The maximum message length supported by RPMsg is now 496 bytes. String longer than 496 is divided by the virtual tty into several messages.

12.2 Supported platforms

12.2.1 i.MX 7Dual SABRE board

12.2.1.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal Computer with USB port

12.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain versions, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

12.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/rpmsg/str_echo_-freertos/<toolchain>.
- Linux RPMsg master side RPMsg tty module and application

12.2.1.4 Getting started

12.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open TWO serial terminals on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, install the RPMsg tty module.
6. Run RPMsg tty receive program "/unit_tests/mxc_mcc_tty_test.out /dev/ttyRPMSG 115200 R 100 1000 &"

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

12.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG String Echo FreeRTOS RTOS API Demo...
RPMSG Init as Remote
```

After the Linux RPMsg tty module was installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
```

The user can then input an arbitrary string to the virtual RPMsg tty using the following echo command on Cortex-A7 terminal:

```
echo test > /dev/ttyRPMSG
echo deadbeaf > /dev/ttyRPMSG

...
```

On the ARM Cortex-M4 terminal, the received string content and its length is output, as shown in the log.

```
Get Message From Master Side : "test
                                    " [len : 5]
Get Message From Master Side : "deadbeaf
                                        " [len : 9]
...
```

The RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 FreeRTOS OS) perform name service handshake to create the communication channel. The ARM Cortex-M4 channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core then waits for user input to RPMsg virtual tty and sends the content to ARM Cortex-M4 core. On receiving the data, ARM Cortex-M4 core outputs the content and its length on the terminal and echoes back the same message to ARM Cortex-A7 core. If some application is reading from /dev/ttyRPMSG on ARM Cortex-A7 core, it could get the echo message. The loop continues to demonstrate RPMsg's ability to send arbitrary content.

The RTOS API implementation leverages queue to store received messages so that all the messages from ARM Cortex-A7 core could be well buffered for future receiving.

12.2.2 i.MX 7Dual Validation board

12.2.2.1 Hardware requirements

- SD Card with Linux OS image for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

12.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

12.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/rpmsg/str_echo_-freertos/<toolchain>.
- Linux RPMsg master side RPMsg tty module and application

12.2.2.4 Getting started

12.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open TWO serial terminals on computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.
5. Boot the Linux OS kernel, install the RPMsg tty module.
6. Run RPMsg tty receive program "/unit_tests/mxc_mcc_tty_test.out /dev/ttyRPMSG 115200 R 100 1000 &"

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

12.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
RPMSG String Echo FreeRTOS RTOS API Demo...
RPMSG Init as Remote
```

After the Linux RPMsg tty module is installed, the ARM Cortex-M4 terminal displays the following information:

```
Name service handshake is done, M4 has setup a rpmsg channel [1 ---> 1024]
```

The user can then input an arbitrary string to the virtual RPMsg tty using the following echo command on ARM Cortex-A7 terminal:

```
echo test > /dev/ttyRPMSG
echo deadbeaf > /dev/ttyRPMSG

...
```

On the ARM Cortex-M4 terminal, the received string content and its length is output, as shown in the log.

```
Get Message From Master Side : "test
                                    " [len : 5]
Get Message From Master Side : "deadbeaf
                                        " [len : 9]
...
```

The RPMsg Master (Cortex-A7 Linux OS) and Remote (Cortex-M4 FreeRTOS OS) perform name service handshake to create the communication channel. The ARM Cortex-M4 core channel address is 1, and the ARM Cortex-A7 channel address is 1024. ARM Cortex-A7 core then waits for user input to RPMsg virtual tty and sends the content to ARM Cortex-M4 core. On receiving the data, ARM Cortex-M4 core outputs the content and its length on the terminal and echoes back the same message to ARM Cortex-A7 core. If some application is reading from /dev/ttyRPMSG on ARM Cortex-A7 core, it could get the echo message. The loop continues to demonstrate RPMsg's ability to send arbitrary content.

The RTOS API implementation leverages a queue to store received messages so that all the messages from ARM Cortex-A7 core could be well buffered for future receiving.

Chapter 13
SEMA4 Mutex Demo

13.1 Overview

This demo use SEMA4 driver to implement a multicore mutex without spinning with CPU. The mutex is event driven, and one core can get an "unlocked" event from another core. The user can trigger a mutex lock and unlock by clicking 'm' on the terminal, or let the lock and unlock occur every 5 seconds by clicking 'a'. To verify the multicore functionality, other U-Boot commands are also needed.

In this demo, SEMA4 gate 3 is used.

13.2 Supported platforms

13.2.1 i.MX 7Dual SABRE board

13.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

13.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

13.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/sema4_demo/<toolchain>.

13.2.1.4 Getting started

13.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the PC host and the Debug UART port(J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

13.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
================== SEMA4 demo ==================
Enter command:
----- ’m’ to manually trigger a SEMA4 lock
----- ’a’ to automatically trigger SEMA4 lock every 5 seconds
```

If ’m’ is pressed in terminal, the following information appears:

```
m
...SEMA4 mutex lock successfully!
Enter command:
----- ’m’ to manually trigger a SEMA4 lock
----- ’a’ to automatically trigger SEMA4 lock every 5 seconds
```

This shows the program succeeded in locking and freeing the SEMA4 gate. This operation can be repeated. Try locking the same SEMA4 gate on U-Boot. For example, on U-Boot terminal of i.MX 7Dual:

```
=> mw.b 0x30ac0003 1
```

Then click ’m’ on SEMA4 demo Terminal to see what happens:

```
m
...Lock pending, waiting for the other core unlock the gate
```

Now unlock the SEMA4 gate on U-Boot. For example on U-Boot terminal of i.MX 7Dual:

```
=> mw.b 0x30ac0003 0
```

You can immediately see on SEMA4 demo Terminal:

```
...SEMA4 mutex lock successfully!
Enter command:
----- 'm' to manually trigger a SEMA4 lock
----- 'a' to automatically trigger SEMA4 lock every 5 seconds
```

13.2.2 i.MX 7Dual Validation board

13.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

13.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

13.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/demo_apps/sema4_demo/<toolchain>.

13.2.2.4 Getting started

13.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the PC host and the Debug UART port(J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

13.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
================= SEMA4 demo =================
Enter command:
----- ’m’ to manually trigger a SEMA4 lock
----- ’a’ to automatically trigger SEMA4 lock every 5 seconds
```

If ’m’ is pressed in terminal, the following information appears:

```
m
...SEMA4 mutex lock successfully!
Enter command:
----- ’m’ to manually trigger a SEMA4 lock
----- ’a’ to automatically trigger SEMA4 lock every 5 seconds
```

This shows the program succeeded in locking and freeing the SEMA4 gate. This operation can be repeated. Try locking the same SEMA4 gate on U-Boot. For example, on U-Boot terminal of i.MX 7Dual:

```
=> mw.b 0x30ac0003 1
```

Then click ’m’ on SEMA4 demo Terminal to see what happens:

```
m
...Lock pending, waiting for the other core unlock the gate
```

Now unlock the SEMA4 gate on U-Boot. For example on U-Boot terminal of i.MX 7Dual:

```
=> mw.b 0x30ac0003 0
```

You can immediately see on SEMA4 demo Terminal:

```
...SEMA4 mutex lock successfully!
Enter command:
----- ’m’ to manually trigger a SEMA4 lock
----- ’a’ to automatically trigger SEMA4 lock every 5 seconds
```

Chapter 14
Sensor Demo

14.1 Overview

The Sensor Demo i.MX 7Dual is a simple demonstration program that uses the FreeRTOS OS and a set of drivers provided by Freescale. It can get the current gravitational acceleration, temperature, altitude and magnetic field strength of the board. The purpose of this demo is to show how to use the I2C driver as a Master to communication with other I2C Slaves.

NOTE: The I2C2 instance on i.MX 7Dual SDB board is assigned to ARM Cortex-M4 core when this demo starts. Do not use this I2C instance at ARM Cortex-A7 core side when this demo is running.

14.2 Supported platforms

14.2.1 i.MX 7Dual SABRE board

14.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

14.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

14.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/demo_apps/sensor_demo/<toolchain>.

14.2.1.4 Getting started

14.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port(J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

14.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
-------------- iMX7D SDB on board sensor example --------------

Please select the sensor demo you want to run:
```

The user is prompted to enter which sensor they want to communicate with:

```
[1].FXAS21002 3-axes Gyro sensor Polling Demo
[2].FXAS21002 3-axes Gyro sensor Interrupt Demo
[3].FXOS8700 6-axes Acc+Mag sensor Polling Demo
[4].FXOS8700 6-axes Acc+Mag sensor Interrupt Demo
[5].MPL3115 Pressure sensor Polling Demo
[6].MPL3115 Pressure sensor Interrupt Demo
```

After entering a valid input, the selected sensor data is sampled and displays the result in the terminal:

The FXAS21002 Gyro sensor continuously monitors current angular velocity in 3 axes, and prints to the terminal if the velocity on any axis exceeds 5.0 degrees per second, like this:

```
[FXAS21002] Rotate detected: X:  2.1dps, Y: -1.0dps, Z:  5.3dps
```

The FXOS8700 6-axes Acc+Mag sensor reads the current Acc and Mag of the board in 3 axes every 500 ms, and prints the current value to the terminal, like this:

```
[FXOS8700]Current Acc:X=    -.0g Y=     .0g Z=    1.0g
[FXOS8700]Current Mag:X=  26.3uT Y=  29.7uT Z=   3.7uT
```

The MPL3115 Pressure sensor reads the current altitude and temperature of the board in 3 axes every 500 ms, and prints the current value to the terminal if the altitude delta exceed 0.5 m, or the temperature exceeds 0.3 centigrade:

```
[MPL3115]Current Height =   86.5Meter, Current Temp =  31.4Celsius
```

Chapter 15
ADC Example

15.1 Overview

This ADC example is a demonstration program that uses the BSP software. The microcontroller is set to generate an interrupt about every second to wakes up the ADC module. Then ADC module converts the analog input to digital output displayed in Terminal.

15.2 Supported platforms

15.2.1 i.MX 7Dual SABRE board

15.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

15.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

15.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/adc_-imx7d/<toolchain>.

15.2.1.4 Getting started

15.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the PC host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Connect ADC1_IN3 (J22-PIN8) with external input through dupont line with cable.
3. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
4. Load the demo binary to the TCM using U-Boot.
5. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

15.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
-------------- ADC imx7d driver example --------------

This example demonstrates usage of ADC driver on i.MX processor.
It Continuous convert Analog Input, and print the result to terminal
Current analog value: 1.06v
Current analog value: 1.04v
```

15.2.2 i.MX 7Dual Validation board

15.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation main board
- Personal computer with USB port

15.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC

- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

15.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/adc_-imx7d/<toolchain>.

15.2.2.4 Getting started

15.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Connect ADC1_IN3(JP8-PIN5) with external input through dupont line with cable.
3. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
4. Load the demo binary to the TCM using U-Boot.
5. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

15.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
-------------- ADC imx7d driver example --------------

This example demonstrates usage of ADC driver on i.MX 7Dual processor.
It Continuous convert Analog Input, and print the result to terminal
Current analog value: 1.06v
Current analog value: 1.04v
```

Chapter 16
eCSPI Interrupt Example

16.1 Overview

This example application demonstrates how to use the eCSPI driver to transfer data between two boards with interrupt mode.

NOTE: Do not use this example and Linux OS on ARM Cortex-A7 core at the same time, because the IO Pins for eCSPI2 on i.MX 7Dual Validation board will be occupied by Linux OS for EPDC display.

16.2 Supported platforms

16.2.1 i.MX 7Dual Validation board

16.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5 V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port
- 4-pin metal-shielded wire

16.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

16.2.1.3 Software requirements

- The master project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/ecspi/ecspi-_interrupt/master/<toolchain>.
- The slave project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/ecspi/ecspi-_interrupt/slave/<toolchain>.

16.2.1.4 Getting started

16.2.1.4.1 Hardware settings

To run this example, the eCSPI signals need to be routed on the board. The following is the rework steps required for some boards.

To test eCSPI master and slave example, route ECSPI2 signals to "UART7_RX", "UART7_RTS_B", "UART7_TX", and "UART7_CTS_B".

1. Remove R597, R567, R592, R621.
2. Populate R84, R62, R81, R109 to position A.

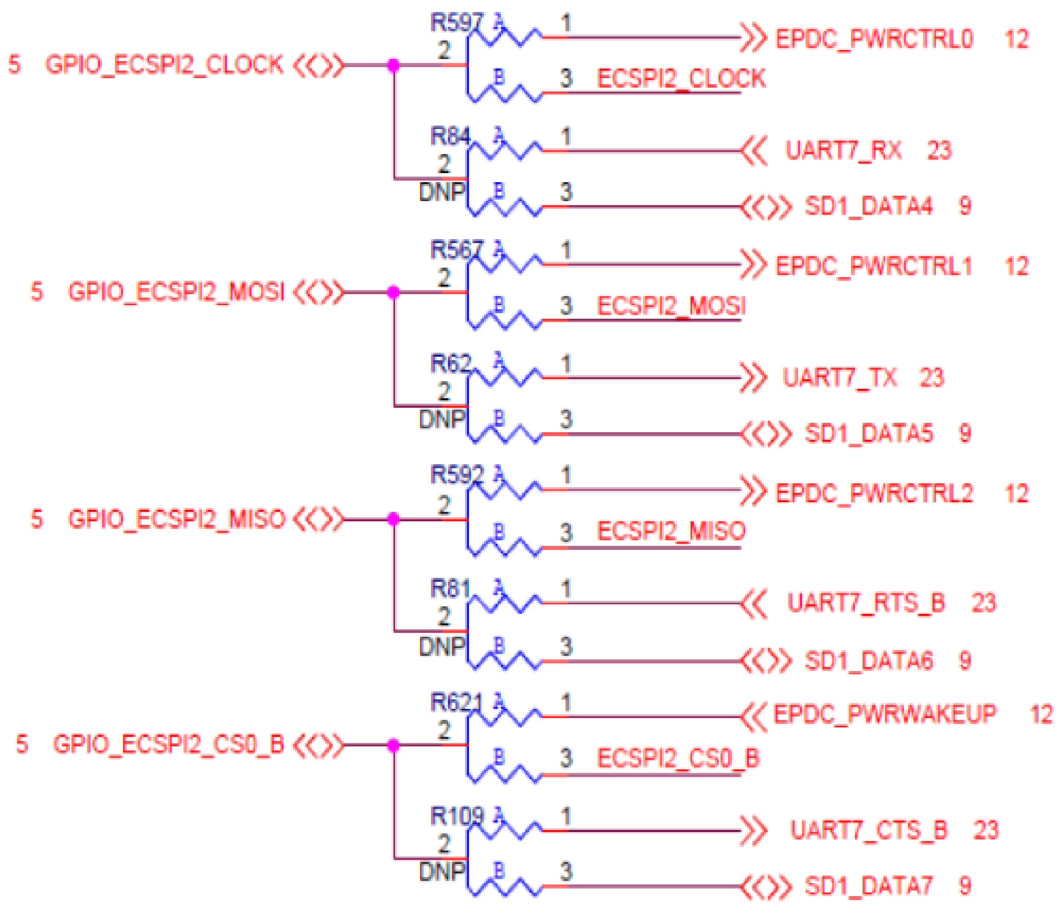


Figure 16.2.1: eCSPI rework guidance schematic diagram for i.MX 7Dual Validation board

This example requires two separate boards. You can connect ECSPI2 signals on jumper "J8".

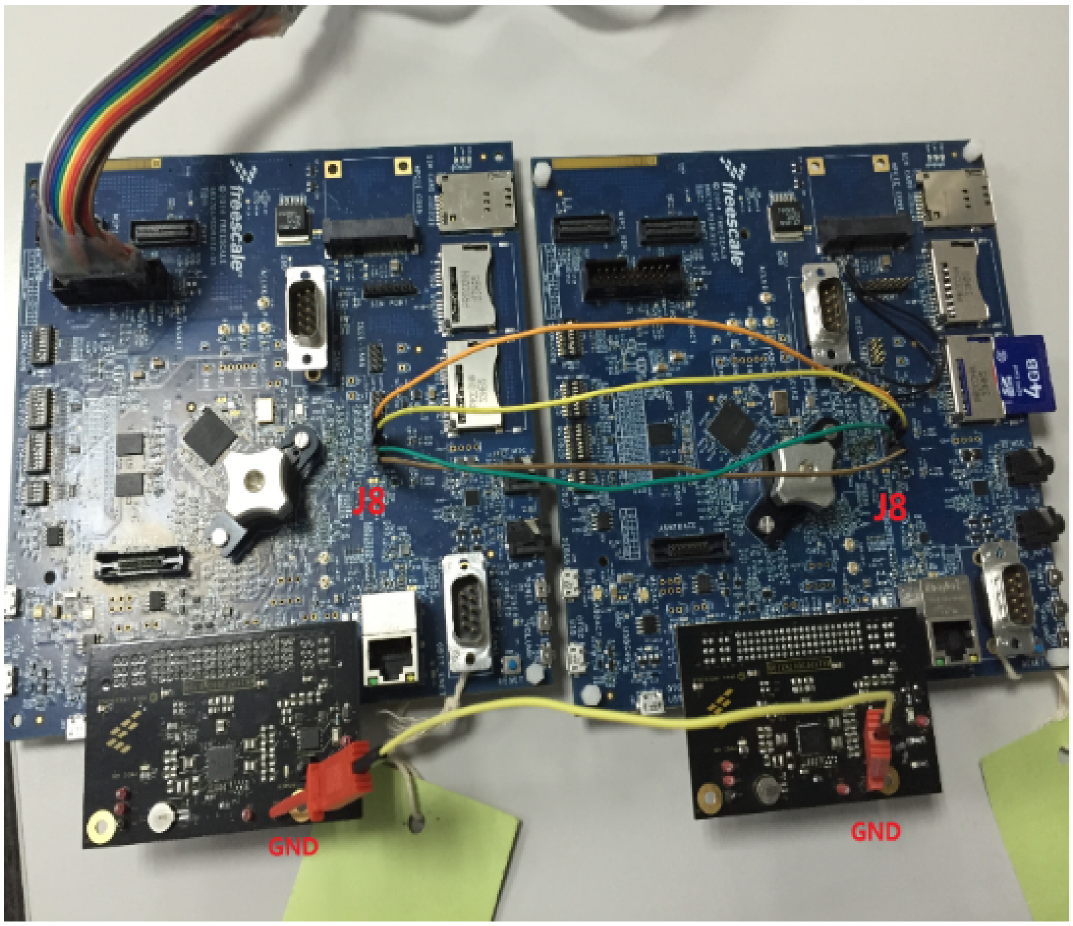
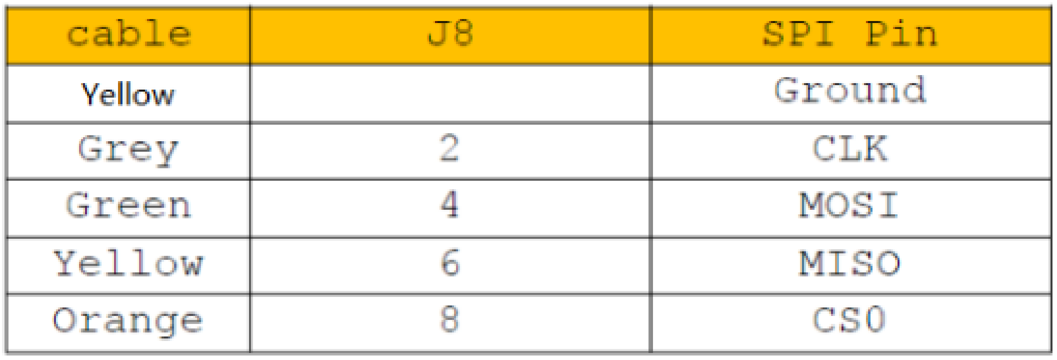


Figure 16.2.2: eCSPI Interrupt example board connection



cable	J8	SPI Pin
Yellow		Ground
Grey	2	CLK
Green	4	MOSI
Yellow	6	MISO
Orange	8	CS0

Figure 16.2.3: eCSPI pin assignment table

J8 in the table specifies the sequential pin position (From 1 to 8) on the board.

16.2.1.4.2 Preparing the demo

1. Connect two micro USB cable for each computer host and Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open two serial terminals on computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Connect these 2 board to ECSPI4.
4. Load the demo binary to the TCM using U-Boot.
5. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

16.2.1.4.3 Running the demo

The master example must be run before slave example, or the initialization of master SPI would cause slave example data loss. The master board prints on ARM Cortex-M4 terminal:

```
-------------- eCSPI master driver example --------------
This example application demonstrates usage of SPI driver in master mode.
It transfers data to/from remote MCU in SPI slave mode.
Press "s" when spi slave is ready.
```

Run the slave example on another board. The slave board prints on ARM Cortex-M4 terminal:

```
-------------- eCSPI slave driver example --------------
This example application demonstrates usage of eCSPI slave driver.
It responding to master via SPI bus.
SLAVE: Initial transmit data: 255
```

After eCSPI slave example is executed, press “s” to start the communication. The master board prints on terminal:

```
MASTER: Transmited data: 1
      : Received data: 255

MASTER: Transmited data: 2
      : Received data: 0

MASTER: Transmited data: 3
      : Received data: 1

...

MASTER: Transmited data: 20
      : Received data: 18
```

The slave board prints on terminal:

```
SLAVE: Next step transmit data: 0
     : Currently received data: 1

SLAVE: Next step transmit data: 1
     : Currently received data: 2

SLAVE: Next step transmit data: 2
     : Currently received data: 3

...

SLAVE: Next step transmit data: 19
     : Currently received data: 20
```

Chapter 17
eCSPI Polling Example

17.1 Overview

This example application demonstrates how to use the eCSPI driver to transfer data between two boards with polling mode.

NOTE: Do not use this example and Linux OS on Cortex-A7 Core at the same time, because the IO Pins for eCSPI2 on i.MX 7Dual Validation board are occupied by Linux OS for EPDC display.

17.2 Supported platforms

17.2.1 i.MX 7Dual Validation board

17.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5 V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port
- 4-pin metal-shielded wire

17.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

17.2.1.3 Software requirements

- The master project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/ecspi/ecspi-_polling/master/<toolchain>.
- The slave project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/ecspi/ecspi-_polling/slave/<toolchain>.

17.2.1.4 Getting started

17.2.1.4.1 Hardware settings

To run this example, the eCSPI signals need to be routed on the board. The following is the rework steps required for some boards.

To test eCSPI master and slave example, route ECSPI2 signals to "UART7_RX", "UART7_RTS_B", "UART7_TX", and "UART7_CTS_B".

1. Remove R597, R567, R592, R621.
2. Populate R84, R62, R81, R109 to position A.

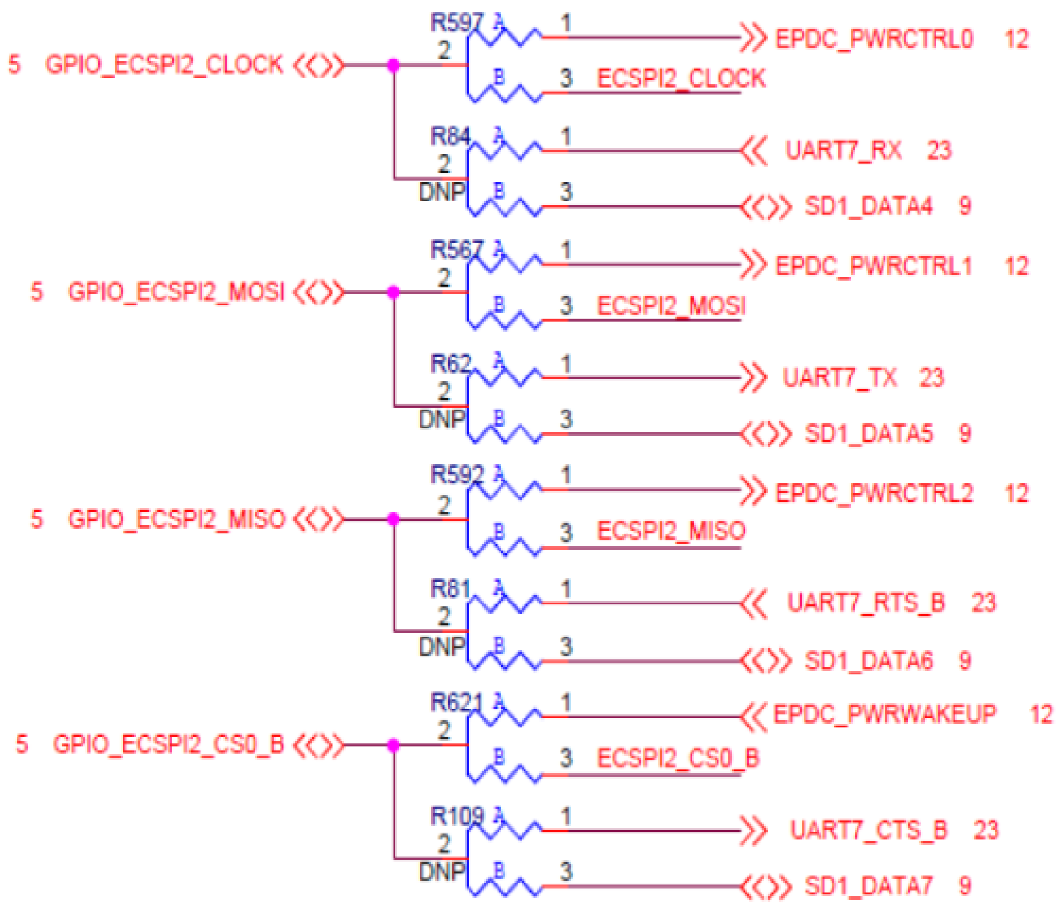


Figure 17.2.1: eCSPI rework guidance schematic diagram for i.MX 7Dual Validation board

This example requires two separate boards. You can connect ECSPI2 signals on jumper "J8".

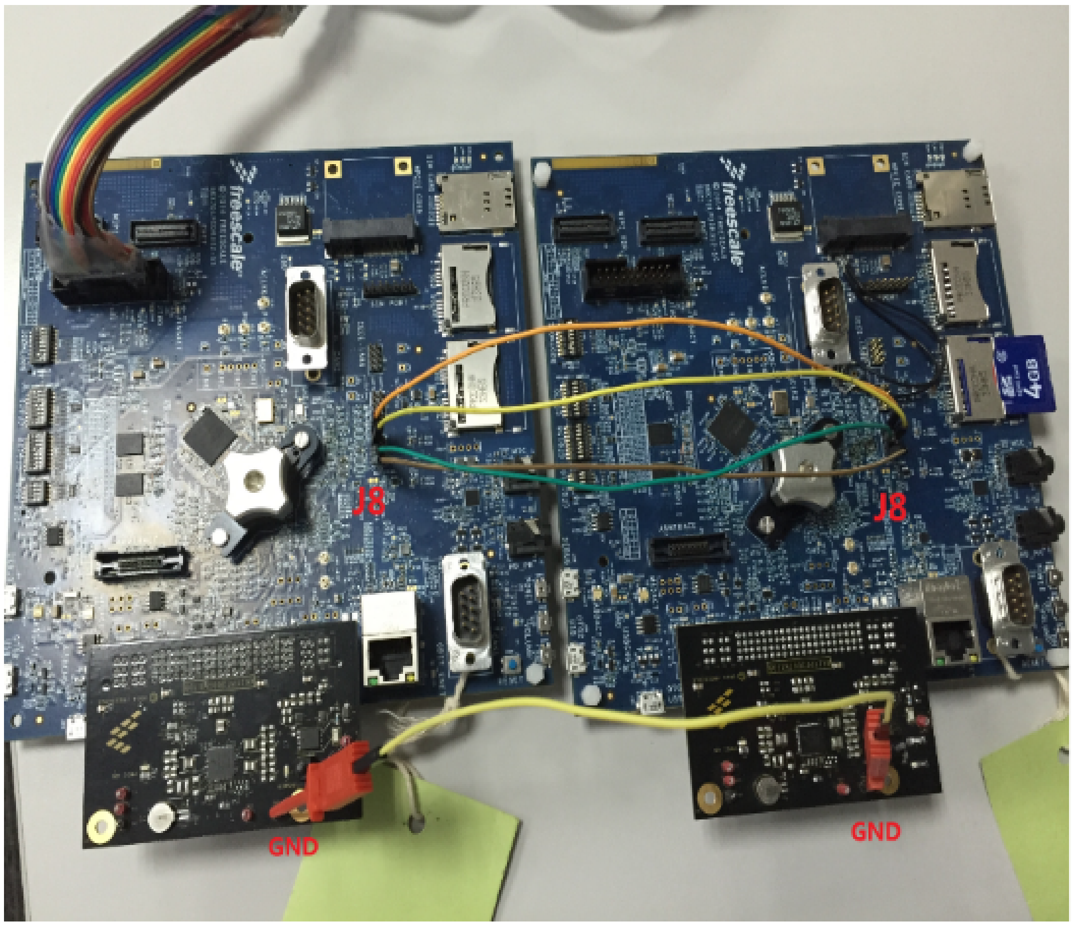
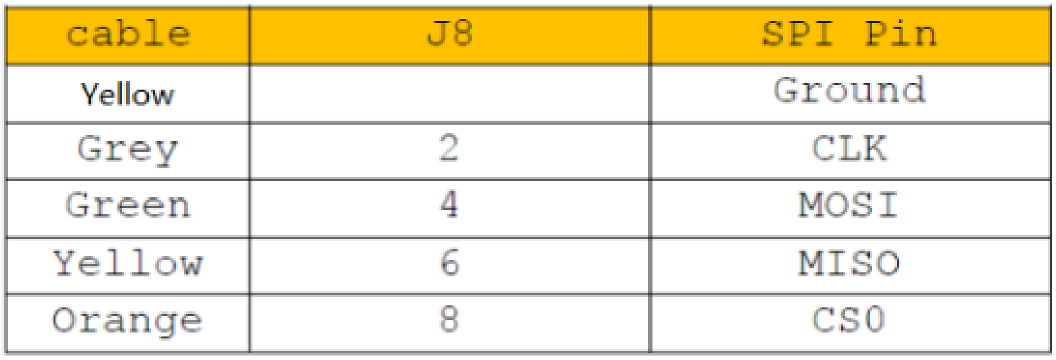


Figure 17.2.2: eCSPI Polling example board connection



cable	J8	SPI Pin
Yellow		Ground
Grey	2	CLK
Green	4	MOSI
Yellow	6	MISO
Orange	8	CS0

Figure 17.2.3: eCSPI pin assignment table

J8 in the table specifies the sequential pin position (From 1 to 8) on the board.

17.2.1.4.2 Preparing the demo

1. Connect two micro USB cable for each computer host and Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open two serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Connect these 2 board to ECSPI4.
4. Load the demo binary to the TCM using U-Boot.
5. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

17.2.1.4.3 Running the demo

The master example must be run before slave example, or the initialization of master SPI would cause slave example data loss. The master board prints on ARM Cortex-M4 terminal:

```
-------------- eCSPI master driver example --------------
This example application demonstrates usage of SPI driver in master mode.
It transfers data to/from remote MCU in SPI slave mode.
Press "s" when spi slave is ready.
```

Run the slave example on another board. The slave board prints on ARM Cortex-M4 terminal:

```
-------------- eCSPI slave driver example --------------
This example application demonstrates usage of eCSPI slave driver.
It responding to master via SPI bus.
SLAVE: Initial transmit data: 255
```

After eCSPI slave example is executed, press “s” to start the communication. The master board prints on terminal:

```
MASTER: Transmited data: 1
      : Received data: 255

MASTER: Transmited data: 2
      : Received data: 0

MASTER: Transmited data: 3
      : Received data: 1

...

MASTER: Transmited data: 20
      : Received data: 18
```

The slave board prints on terminal:

```
SLAVE: Next step transmit data: 0
     : Currently received data: 1

SLAVE: Next step transmit data: 1
     : Currently received data: 2

SLAVE: Next step transmit data: 2
     : Currently received data: 3

...

SLAVE: Next step transmit data: 19
     : Currently received data: 20
```

Chapter 18
FlexCAN Loopback Example

18.1 Overview

This FlexCAN Loopback example demonstrates the FlexCAN module loopback operating mode.

This example use two message buffers: one is for transmitting data, and the other is for receiving data. When the example starts, the example sends data from TX message buffer to its own RX message buffer, and prints the received data to terminal.

18.2 Supported platforms

18.2.1 i.MX 7Dual SABRE board

18.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

18.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

18.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/flexcan/flexcan-_loopback/<toolchain>.

18.2.1.4 Getting started

18.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

18.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
       FLEXCAN LOOPBACK TEST *********
Message format: Standard (11 bit id)
Message buffer 9 used for Rx.
Message buffer 13 used for Tx.
Interrupt Mode: Enabled
Operating Mode: TX and RX --> LoopBack
```

After that the data is sent through transmit MB and received from its own receive MB every 1 second. At the beginning the received data is print to the terminal like this:

```
DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3

DLC=1, mb_idx=0x123
RX MB data: 0x4

DLC=1, mb_idx=0x123
RX MB data: 0x5
```

When the received data is up to 0xff, it will be back to 0x0.

```
DLC=1, mb_idx=0x123
RX MB data: 0xfe

DLC=1, mb_idx=0x123
RX MB data: 0xff

DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3
```

18.2.2 i.MX 7Dual Validation board

18.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 12V DC adapter
- i.MX 7Dual Validation main board
- Personal computer with USB port

18.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

18.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/flexcan/flexcan-_loopback/<toolchain>.

18.2.2.4 Getting started

18.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

18.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
       FLEXCAN LOOPBACK TEST *********
Message format: Standard (11 bit id)
Message buffer 9 used for Rx.
Message buffer 13 used for Tx.
Interrupt Mode: Enabled
Operating Mode: TX and RX --> LoopBack
```

After that the data is sent through transmit MB and received from its own receive MB every 1 second. At the beginning the received data is print to the terminal like this:

```
DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3

DLC=1, mb_idx=0x123
RX MB data: 0x4

DLC=1, mb_idx=0x123
RX MB data: 0x5
```

When the received data is up to 0xff, it is back to 0x0.

```
DLC=1, mb_idx=0x123
RX MB data: 0xfe

DLC=1, mb_idx=0x123
RX MB data: 0xff

DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3
```

Chapter 19
FlexCAN Network Example

19.1 Overview

This FlexCAN Network example demonstrates the FlexCAN module in normal operating mode.

This example uses two boards. Each board transfers data to the other, and receives data at the same time. Two message buffers are used in this example. One is used to transmit data, and the other is used to receive data. When the example starts, the example sends data from TX message buffer to the other board, and receives data from RX message buffer and prints the received data to terminal.

19.2 Supported platforms

19.2.1 i.MX 7Dual SABRE board

19.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

19.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

19.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/flexcan/flexcan-_network/<toolchain>.

19.2.1.4 Getting started

19.2.1.4.1 Hardware settings

To run this example, connect two boards through the CAN interface: The CAN1 DB-9 Connector on the i.MX 7Dual SABRE-SD board is used as the CAN interface, PIN2 connects to CANL and PIN7 connects to CANH:

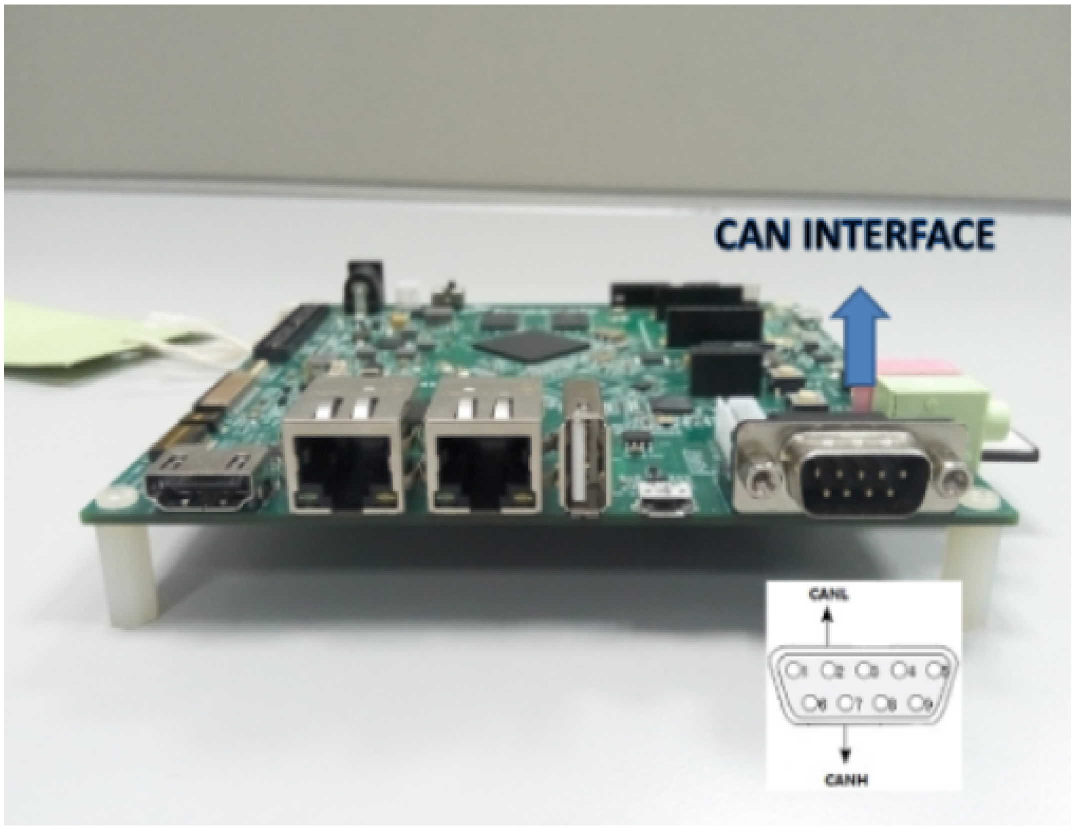


Figure 19.2.1: CAN bus interface DB-9 connector usage for i.MX 7Dual SDB board

Connect two boards to the CAN Bus through the DB-9 Connector like this(CANH <-> CANH, CANL <-> CANL):

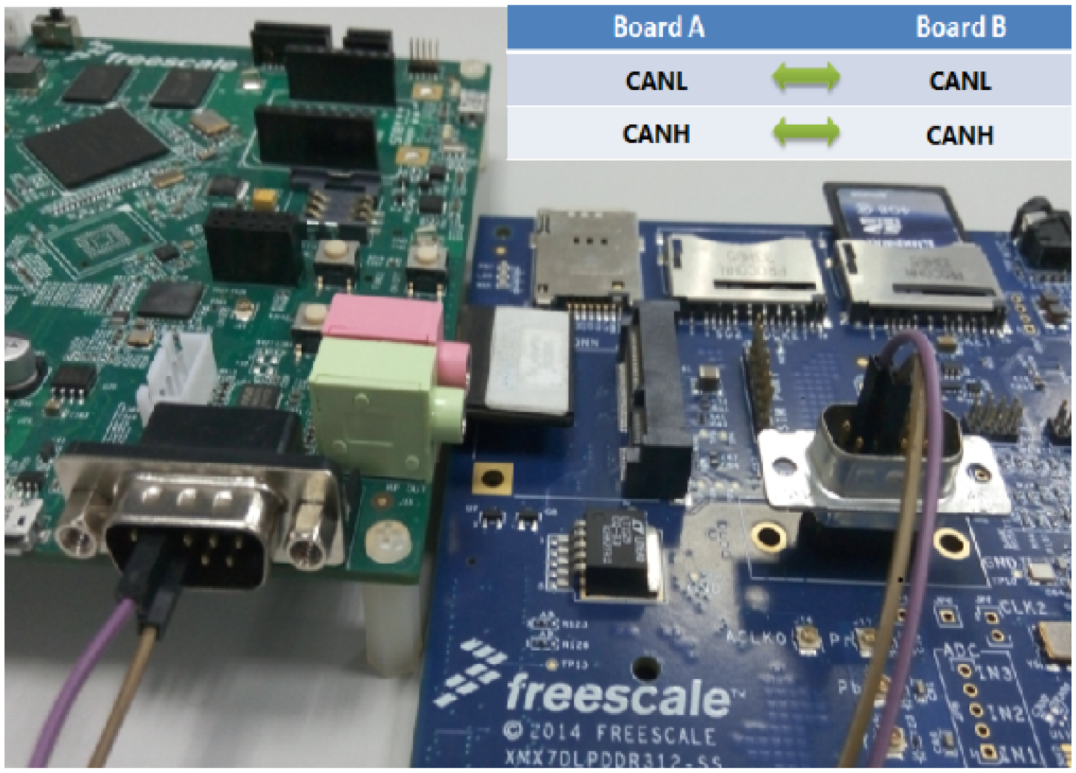


Figure 19.2.2: FlexCAN network example board connection

19.2.1.4.2 Prepare the Demo

1. Set the Note configuration in main.c: one board set to NODE 1 (#define NODE 1) and the other set to NODE 2 (#define NODE 2).
2. Build project with different NODE configurations for these two boards.
3. Connect two micro USB cable for each PC host and Debug UART port(J11) on the i.MX 7Dual SABRE-SD board.
4. Open two serial terminals for these two boards with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
5. Connect these two boards to the CAN Bus.
6. Load the demo binary to the TCM using U-Boot.
7. Boot auxiliary Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

19.2.1.4.3 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information on each board:

```
          FLEXCAN NETWORK TEST *********
   Message format: Standard (11 bit id)
   Message buffer 9 used for Rx.
   Message buffer 8 used for Tx.
   Interrupt Mode: Enabled
   Operating Mode: TX and RX --> Normal



NODE is 2 (the NODE number you set)
```

After both of the boards are ready, the data is sent through transmit MB to the other board and receive data from the other board from its receive MB every 1 second. At the beginning, the received data prints to the terminal like this:

```
DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3

DLC=1, mb_idx=0x123
RX MB data: 0x4

DLC=1, mb_idx=0x123
RX MB data: 0x5
```

When the received data is up to 0xff, it is back to 0x0.

```
DLC=1, mb_idx=0x123
RX MB data: 0xfe

DLC=1, mb_idx=0x123
RX MB data: 0xff

DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3
```

19.2.2 i.MX 7Dual Validation board

19.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 12V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

19.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

19.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/flexcan/flexcan-_network/<toolchain>.

19.2.2.4 Getting started

19.2.2.4.1 Hardware settings

To run this example, connect two boards through the CAN interface: The CAN1 DB-9 Connector on the i.MX 7Dual Validation board is used as the CAN interface, PIN2 connects to CANL and PIN7 connects to CANH:

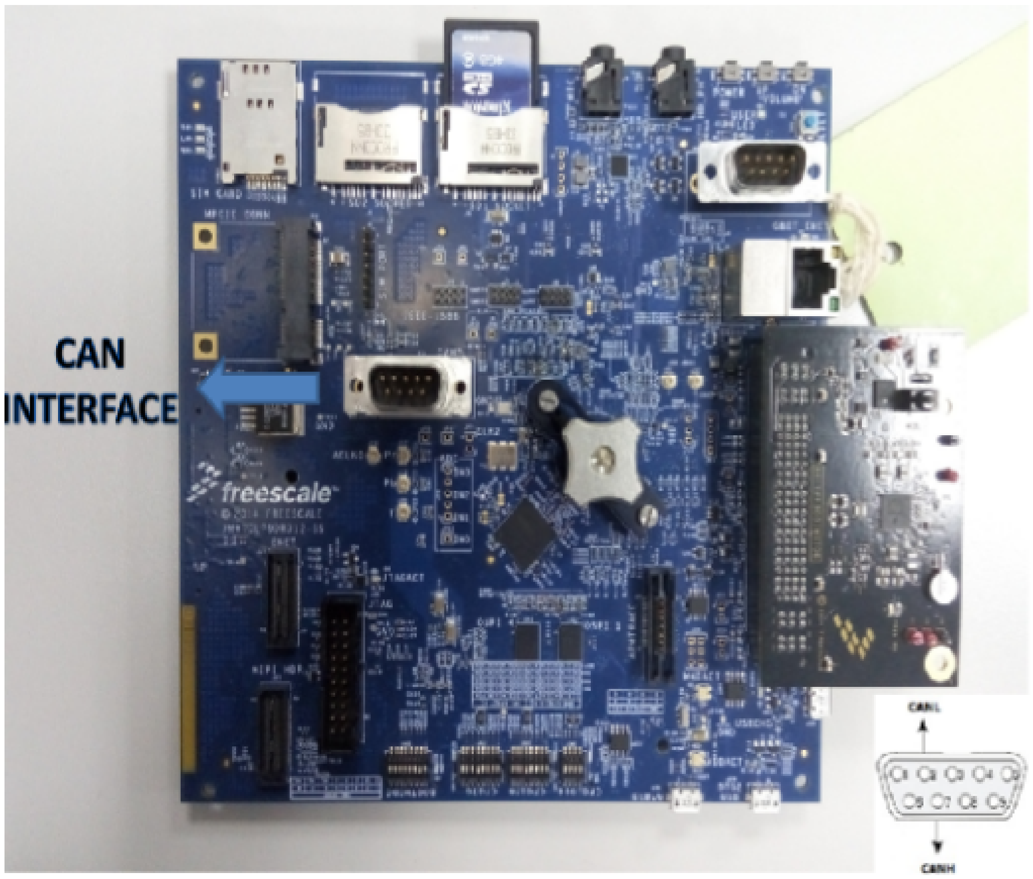


Figure 19.2.3: FlexCAN interface DB-9 connector usage for i.MX 7Dual Validation board

Connect two boards to the CAN Bus through the DB-9 Connector like this(CANH <-> CANH, CANL <-> CANL):

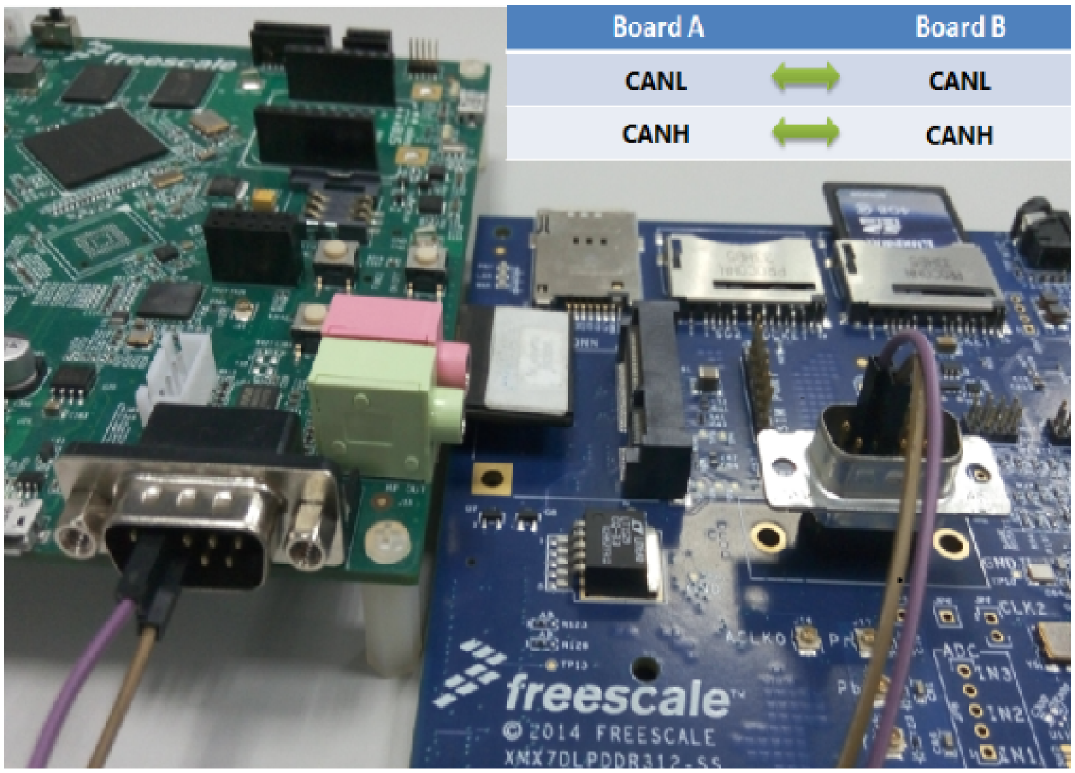


Figure 19.2.4: FlexCAN Network example board connection

19.2.2.4.2 Prepare the Demo

1. Set the Note configuration in main.c: one board set to NODE 1 (#define NODE 1) and the other set to NODE 2 (#define NODE 2).
2. Build project with different NODE configuration for these two board.
3. Connect two micro USB cable for each PC host and Debug UART port (J28) on the i.MX 7Dual Validation board.
4. Open two serial terminal for these two boards with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
5. Connect these two boards to CAN Bus.
6. Load the demo binary to the TCM using U-Boot.
7. Boot auxiliary Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

19.2.2.4.3 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information on each board:

```
          FLEXCAN NETWORK TEST *********
   Message format: Standard (11 bit id)
   Message buffer 9 used for Rx.
   Message buffer 8 used for Tx.
   Interrupt Mode: Enabled
   Operating Mode: TX and RX --> Normal



NODE is 2 (the NODE number you set)
```

After both of the boards are ready, the data is sent through transmit MB to the other board and receive data from the other board from its receive MB every 1 second. At the beginning, the received data prints to the terminal like this:

```
DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3

DLC=1, mb_idx=0x123
RX MB data: 0x4

DLC=1, mb_idx=0x123
RX MB data: 0x5
```

When the received data is up to 0xff, it is back to 0x0.

```
DLC=1, mb_idx=0x123
RX MB data: 0xfe

DLC=1, mb_idx=0x123
RX MB data: 0xff

DLC=1, mb_idx=0x123
RX MB data: 0x0

DLC=1, mb_idx=0x123
RX MB data: 0x1

DLC=1, mb_idx=0x123
RX MB data: 0x2

DLC=1, mb_idx=0x123
RX MB data: 0x3
```

Chapter 20
GPIO Example

20.1 Overview

This example application demonstrates how to use the GPIO driver to access LEDs or Buttons on the board. On the i.MX 7Dual SABRE-SD board, the application support the GPIO key function. And on the i.MX 7Dual Validation board, the application switches the LED on board when user press GPIO key.

NOTE: Sharing of GPIO need deep customization in Linux OS kernel, so it is not recommended to run this example with default Linux OS kernel together.

20.2 Supported platforms

20.2.1 i.MX 7Dual SABRE board

20.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

20.2.1.2 Toolchain requirements

One of the following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

20.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/gpio_-imx/<toolchain>.

20.2.1.4 Getting started

20.2.1.4.1 Preparing the demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

20.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
====================== GPIO Example ========================

=================== GPIO Interrupt =====================
The (FUNC1) button is configured to trigger GPIO interrupt
Press the (FUNC1) button 3 times to continue.
```

Press the specific button 3 times. The board prints on terminal:

```
Button pressed 1 time.
Button pressed 2 time.
Button pressed 3 time.

================= GPIO Functionality==================
The button state is now polled.
Press the button to switch LED on or off
```

Press the specific button on the board. The board prints on terminal:

```
+ - + - + - + - + - + - + - + - + - + - + -
```

20.2.2 i.MX 7Dual Validation board

20.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual

- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

20.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

20.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/gpio_-imx/<toolchain>.

20.2.2.4 Getting started

20.2.2.4.1 Preparing the demo

1. Connect a micro USB cable between the PC host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

20.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
===================== GPIO Example ========================
=================== GPIO Interrupt =====================
The (VOLUME UP) button is configured to trigger GPIO interrupt
Press the (VOLUME UP) button 3 times to continue.
```

Press the specific button 3 times. The board prints following information on terminal:

```
Button pressed 1 time.
Button pressed 2 time.
Button pressed 3 time.

================= GPIO Functionality==================
The button state is now polled.
Press the button to switch LED on or off
```

Input the any data from terminal. The board prints on terminal:

```
Button pressed 1 time.
Button pressed 2 time.
Button pressed 3 time.
Button pressed 4 time.
Button pressed 5 time.
Button pressed 6 time.
```

It switches the LED each time you input any data from terminal.

Chapter 21
GPT Example

21.1 Overview

This GPT example application demonstrates the GPT driver working with interrupt.

This example uses different clock sources for 2 GPT instances and capture the counter of each clock source every 0.5 seconds. If they both work correctly, the captured counter should be close to half of the GPT frequency. The clock source frequency is not 100% accurate, and the divider could also affect the clock error so that the captured number would be different from the expected value.

21.2 Supported platforms

21.2.1 i.MX 7Dual SABRE board

21.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

21.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

21.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/gpt/<toolchain>.

21.2.1.4 Getting started

21.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

21.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information. The frequency and counter value might change on different hardware, but the ratio should be close to 0.0 or 1.0:

```
GPT timer will now start
counter/freq ratio should be close to 0.0 or 1.0 ...
        GPT A freq 6000000, counter 7.
        GPT B freq 49090907, counter 15.
        GPT A freq 6000000, counter 7.
        GPT B freq 49090907, counter 25.
        GPT A freq 6000000, counter 2.
        GPT B freq 49090907, counter 59.
        GPT A freq 6000000, counter 1.
        GPT B freq 49090907, counter 60.
        GPT A freq 6000000, counter 0.
        GPT B freq 49090907, counter 60.
GPT example finished...
```

21.2.2 i.MX 7Dual Validation board

21.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation main board
- Personal Computer with USB port

21.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

21.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/gpt/<toolchain>.

21.2.3.1 Getting started

21.2.3.1.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

21.2.3.1.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information. The frequency and counter value might change on different hardware, but the ratio should be close to 0.0 or 1.0:

```
GPT timer will now start
counter/freq ratio should be close to 0.0 or 1.0 ...
        GPT A freq 6000000, counter 7.
        GPT B freq 49090907, counter 15.
        GPT A freq 6000000, counter 7.
        GPT B freq 49090907, counter 25.
        GPT A freq 6000000, counter 2.
        GPT B freq 49090907, counter 59.
        GPT A freq 6000000, counter 1.
        GPT B freq 49090907, counter 60.
        GPT A freq 6000000, counter 0.
        GPT B freq 49090907, counter 60.
GPT example finished...
```

Chapter 22
I2C Interrupt EEPROM Example

22.1 Overview

This I2C example application demonstrates the I2C driver working with interrupt.

Programming on board EEPROM through I2C bus and read back to compare if the data wrote to EEPROM are correct.

NOTE: The I2C1 instance on i.MX 7Dual Validation board is assigned to ARM Cortex-M4 core when this example start. Do not use this I2C instance at ARM Cortex-A7 core side when this demo is running.

22.2 Supported platforms

22.2.1 i.MX 7Dual Validation board

22.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

22.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

22.2.2.1 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/i2c_imx/i2c_-interrupt_eeprom/<toolchain>.

22.2.2.2 Getting started

22.2.2.2.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on PC for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

22.2.2.2.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
++++++++++++++++ I2C Send/Receive Interrupt Driven Example +++++++++++++++++
This example writes data to the board EEPROM through I2C Bus,
and reads them back to see if the EEPROM is programmed successfully.
```

After printing the information mentioned above, the example writes a piece of data to EEPROM and reads it back to verify if the data is wrote successfully:

```
[1].Initialize the I2C module with initialize structure.
[2].Launch a I2C write action to 0x0000 address.
[3].Prepare Data for Sending.
[4].Write data to EEPROM.
[5].Wait until transmission is finished.
[6].Launch a I2C read action from 0x0000 address.
[7].Read data from EEPROM.
[8].Wait until transmission is finished.
[9].Compare data between txBuf and rxBuf:
    txBuf and rxBuf are same, example passed!!!
```

Chapter 23
I2C Interrupt Sensor Example

23.1 Overview

This I2C example application demonstrates the I2C driver working with interrupt.

Programming on FXOS8700 acceleration sensor through I2C bus and read the 3-Axis acceleration of gravity.

23.2 Supported platforms

23.2.1 i.MX 7Dual SABRE board

23.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal Computer with USB port

23.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

23.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/i2c_imx/i2c_-interrupt_sensor_imx7d/<toolchain>.

23.2.1.4 Getting started

23.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

23.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
++++++++++++++++ I2C Send/Receive interrupt Example ++++++++++++++++
This example will configure on board accelerometer through I2C Bus
and read 10 samples back to see if the accelerometer is configured successfully.
```

After printing the information mentioned above, the example reads acceleration sensor's data and print it to terminal like this:

```
[1].Initialize the I2C module with initialize structure.
[2].Set on-board Acc sensor range to 2G
[3].Set on-board Acc sensor working at fast read and active mode
[4].Acc sensor WHO_AM_I check... OK
[5].Acquire 10 samples from Acc sensor
2G MODE: X= 0.058g Y= 0.039g Z= 0.977g
2G MODE: X= 0.058g Y= 0.023g Z= 1.004g
2G MODE: X= 0.056g Y= 0.031g Z= 0.995g
2G MODE: X= 0.063g Y= 0.027g Z= 0.980g
2G MODE: X= 0.057g Y= 0.036g Z= 0.979g
2G MODE: X= 0.054g Y= 0.032g Z= 0.981g
2G MODE: X= 0.058g Y= 0.035g Z= 0.985g
2G MODE: X= 0.055g Y= 0.034g Z= 0.978g
2G MODE: X= 0.057g Y= 0.028g Z= 0.999g
2G MODE: X= 0.059g Y= 0.038g Z= 0.972g

Example finished!!!
```

Chapter 24
I2C Polling EEPROM Example

24.1 Overview

This I2C example application demonstrates the I2C driver working with polling.

Programming on board EEPROM through I2C bus and read back to compare if the data wrote to EEPROM are correct.

NOTE: The I2C1 instance on i.MX 7Dual Validation board is assigned to M4 Core when this example start. Do not use this I2C instance at A7 side when this demo is running.

24.2 Supported platforms

24.2.1 i.MX 7Dual Validation board

24.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

24.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

24.2.2.1 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/i2c_imx/i2c_-polling_eeprom/<toolchain>.

24.2.2.2 Getting started

24.2.2.2.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

24.2.2.2.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
++++++++++++++++ I2C Send/Receive polling Driven Example +++++++++++++++++
This example writes data to the board EEPROM through I2C Bus,
and reads them back to see if the EEPROM is programmed successfully.
```

After printing the information mentioned above, the example writes a piece of data to EEPROM and reads it back to verify if the data is wrote successfully:

```
[1].Initialize the I2C module with initialize structure.
[2].Launch a I2C write action to 0x0000 address.
[3].Prepare Data for Sending.
[4].Write data to EEPROM.
[5].Wait until transmission is finished.
[6].Launch a I2C read action from 0x0000 address.
[7].Read data from EEPROM.
[8].Wait until transmission is finished.
[9].Compare data between txBuf and rxBuf:
    txBuf and rxBuf are same, example passed!!!
```

Chapter 25
I2C Polling Sensor Example

25.1 Overview

This I2C example application demonstrates the I2C driver working with polling.

Programming on FXOS8700 acceleration sensor through I2C bus and read the 3-Axis acceleration of gravity.

25.2 Supported platforms

25.2.1 i.MX 7Dual SABRE board

25.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

25.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

25.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/i2c_imx/i2c_-polling_sensor_imx7d/<toolchain>.

25.2.1.4 Getting started

25.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

25.2.1.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
++++++++++++++++ I2C Send/Receive polling Example ++++++++++++++++
This example will configure on board accelerometer through I2C Bus
and read 10 samples back to see if the accelerometer is configured successfully.
```

After printing the information mentioned above, the example reads acceleration sensor's data and print it to terminal like this:

```
[1].Initialize the I2C module with initialize structure.
[2].Set on-board Acc sensor range to 2G
[3].Set on-board Acc sensor working at active mode
[4].Acc sensor WHO_AM_I check... OK
[5].Acquire 10 samples from Acc sensor
2G MODE: X= 0.060g Y= 0.022g Z= 1.010g
2G MODE: X= 0.058g Y= 0.036g Z= 0.977g
2G MODE: X= 0.062g Y= 0.024g Z= 0.998g
2G MODE: X= 0.058g Y= 0.038g Z= 0.970g
2G MODE: X= 0.059g Y= 0.024g Z= 1.018g
2G MODE: X= 0.058g Y= 0.036g Z= 0.987g
2G MODE: X= 0.056g Y= 0.024g Z= 1.002g
2G MODE: X= 0.057g Y= 0.031g Z= 0.987g
2G MODE: X= 0.060g Y= 0.022g Z= 1.002g
2G MODE: X= 0.061g Y= 0.034g Z= 0.990g

Example finished!!!
```

Chapter 26
UART Interrupt Example

26.1 Overview

This UART example demonstrates the UART driver working with interrupt.

Transfer data between the board and computer. The board transfers and receives characters with the PC through UART interface. Type characters from keyboard, and the board receives and then echoes them to terminal screen. Look for instructions output to the terminal.

26.2 Supported platforms

26.2.1 i.MX 7Dual SABRE board

26.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

26.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

26.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/uart_imx/uart-_interrupt/<toolchain>.

26.2.1.4 Getting started

26.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

26.2.1.4.2 Running the demo

After the boot process succeeds, the Cortex-M4 terminal displays the following information:

```
++++++++++++++++ UART Send/Receive Interrupt Driven Example +++++++++++++++++

Type characters from keyboard, the board will receive and then echo them to terminal screen
```

The user needs to type characters from the keyboard and the board receives and then echoes them to terminal screen.

26.2.2 i.MX 7Dual Validation board

26.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

26.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC

- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

26.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/uart_imx/uart_interrupt/<toolchain>.

26.2.2.4 Getting started

26.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FRTOS7DGSUG).

26.2.2.4.2 Running the demo

After the boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
++++++++++++++++ UART Send/Receive Interrupt Driven Example +++++++++++++++++

Type characters from keyboard, the board will receive and then echo them to terminal screen
```

The user needs to type characters from the keyboard and the board receives and then echoes them to terminal screen.

Chapter 27
UART Polling Example

27.1 Overview

This UART example demonstrates the UART driver working with polling.

Transfer data between the board and computer. The board transfers and receives characters with the computer through UART interface. Type characters from keyboard, and the board receives and then echoes them to terminal screen. Look for instructions output to the terminal.

27.2 Supported platforms

27.2.1 i.MX 7Dual SABRE board

27.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

27.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

27.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/uart_imx/uart-_polling/<toolchain>.

27.2.1.4 Getting started

27.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

27.2.1.4.2 Running the demo

After the boot process succeeds, the Cortex-M4 terminal displays the following information:

```
++++++++++++++++ UART Send/Receive Polling Driven Example +++++++++++++++++

Type characters from keyboard, the board will receive and then echo them to terminal screen
```

The user needs to type characters from the keyboard and the board receives and then echoes them to terminal screen.

27.2.2 i.MX 7Dual Validation board

27.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal Computer with USB port

27.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC

- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRTOS1017DRN).

27.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/uart_imx/uart_polling/<toolchain>.

27.2.2.4 Getting started

27.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the PC host and the Debug UART port(J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on PC for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM using U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FRTOS7DGSUG).

27.2.2.4.2 Running the demo

After the boot process succeeds, the Cortex-M4 terminal displays the following information:

```
++++++++++++++++ UART Send/Receive Polling Driven Example +++++++++++++++++

Type characters from keyboard, the board will receive and then echo them to terminal screen
```

The user needs to type characters from the keyboard and the board receives and then echoes them to terminal screen.

Chapter 28
WDOG Example

28.1 Overview

This WDOG example application demonstrates the WDOG driver working on i.MX device.

This example enables WDOG with timeout 1.5 seconds, and at the same time, an interrupt is enabled to trigger interrupt service route (ISR) 0.5 seconds before watchdog expires. In the ISR, the WDOG timer is refreshed fours times, so the WDOG does not timeout until 4 + 1.5 = 5.5 seconds.

28.2 Supported platforms

28.2.1 i.MX 7Dual SABRE board

28.2.1.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual SABRE-SD board
- Personal computer with USB port

28.2.1.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

28.2.1.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_sdb_m4/driver_examples/wdog_-imx/<toolchain>.

28.2.1.4 Getting started

28.2.1.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J11) on the i.MX 7Dual SABRE-SD board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
    - 115200 baud rate
    - 8 data bits
    - No parity
    - One stop bit
    - No flow control
3. Load the demo binary to the TCM by U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

28.2.1.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
WDOG with timeout 1.5 seconds will now start
WDOG was refreshed 4
WDOG was refreshed 3
WDOG was refreshed 2
WDOG was refreshed 1
WDOG was refreshed 0
Counter down to 0, WDOG is starved now...
```

A CPU reset occurs, as this is not a full system reset and many register fields of WDOG peripheral can write once only, so the second run will keep the WDOG setting unchanged. The WDOG counter will keep running and work just like the first time. The loop coninues for ever.

28.2.2 i.MX 7Dual Validation board

28.2.2.1 Hardware requirements

- SD Card with U-Boot for i.MX 7Dual
- Micro USB cable
- 5V DC adapter
- i.MX 7Dual Validation board
- Personal computer with USB port

28.2.2.2 Toolchain requirements

One of following toolchains is required:

- IAR Embedded Workbench
- ARM GCC
- ARM DS-5

For the toolchain version, see the *FreeRTOS BSP v.1.0.1 for i.MX 7Dual Release Notes* (document FRT-OS1017DRN).

28.2.2.3 Software requirements

- The project files are in: <BSP_Install>/examples/imx7d_val_m4/driver_examples/wdog_-imx/<toolchain>.

28.2.2.4 Getting started

28.2.2.4.1 Prepare the Demo

1. Connect a micro USB cable between the computer host and the Debug UART port (J28) on the i.MX 7Dual Validation board.
2. Open a serial terminal on the computer for Debug UART port with these settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Load the demo binary to the TCM by U-Boot.
4. Boot auxiliary ARM Cortex-M4 Core to begin running the demo.

For the detailed instructions, see the *Getting Started with FreeRTOS BSP for i.MX 7Dual* (document FR-TOS7DGSUG).

28.2.2.4.2 Running the demo

After boot process succeeds, the ARM Cortex-M4 terminal displays the following information:

```
WDOG with timeout 1.5 seconds will now start
WDOG was refreshed 4
WDOG was refreshed 3
WDOG was refreshed 2
WDOG was refreshed 1
WDOG was refreshed 0
Counter down to 0, WDOG is starved now...
```

A CPU reset occurs, as this is not a full system reset and many register fields of WDOG peripheral can write once only, so the second run keeps the WDOG setting unchanged. The WDOG counter keeps running and works just like the first time. The loop continues for ever.

Chapter 29 Revision History

This table summarizes the revisions made to this document.

Table 1 Revision history

Revision number	Date	Substantive changes
0	03/2016	Initial release.

How to Reach Us:

Home Page:
www.nxp.com

Web Support:
www.nxp.com/support

Document Number: FRTOS7D101DAUG
Rev. 0
03/2016