

# ARM® Versatile™ Express Cortex®-M Prototyping System (V2M-MPS2)

## Technical Reference Manual



**ARM® Versatile™ Express Cortex®-M Prototyping System (V2M-MPS2)****Technical Reference Manual**

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### Conformance Notices

#### Federal Communications Commission Notice

This device is test equipment and consequently is exempt from part 15 of the FCC Rules under section 15.103 (c).

#### CE Declaration of Conformity



The system should be powered down when not in use.

It is recommended that ESD precautions be taken when handling Versatile™ Express boards.

The motherboard generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

- Ensure attached cables do not lie across the target board
- Reorient the receiving antenna
- Increase the distance between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

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#### Note

It is recommended that wherever possible shielded interface cables be used.

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# Preface

This preface introduces the *ARM® Versatile™ Express Cortex®-M Prototyping System (V2M-MPS2) Technical Reference Manual*.

It contains the following:

- [About this book on page 7.](#)
- [Feedback on page 10.](#)

## About this book

This book describes the ARM Versatile Express Cortex-M Prototyping System, that is, the V2M-MPS2 motherboard. Previous issues of this book had document number DDI0525.

### Product revision status

The *rm**pn* identifier indicates the revision status of the product described in this book, for example, r1p2, where:

*rm* Identifies the major revision of the product, for example, r1.

*pn* Identifies the minor revision or modification status of the product, for example, p2.

### Intended audience

This book is written for experienced hardware and software engineers who are doing ARM M-Class processor evaluation and development using the Versatile™ Express Cortex®-M Prototyping System, the V2M-MPS2 motherboard.

### Using this book

This book is organized into the following chapters:

#### Chapter 1 Introduction

This chapter provides an introduction to the Versatile Express Cortex-M Prototyping System, the V2M-MPS2 motherboard.

#### Chapter 2 Hardware Description

This chapter describes the Versatile Express V2M-MPS2 motherboard hardware.

#### Chapter 3 Configuration

This chapter describes the powerup and configuration process of the Versatile Express V2M-MPS2 motherboard.

#### Chapter 4 Programmers Model

This chapter describes the programmers model of the Versatile Express V2M-MPS2 motherboard.

#### Chapter 5 Signal Descriptions

This chapter describes the signals present at the interface connectors of the Versatile Express V2M-MPS2 motherboard

#### Appendix A.1 Specifications

This chapter contains the electrical specification of the Versatile Express V2M-MPS2 motherboard and FPGA.

#### Appendix B.2 Revisions

This chapter describes the technical changes between released issues of this book.

### Glossary

The ARM Glossary is a list of terms used in ARM documentation, together with definitions for those terms. The ARM Glossary does not contain terms that are industry standard unless the ARM meaning differs from the generally accepted meaning.

See the [ARM Glossary](#) for more information.

### Typographic conventions

*italic*

Introduces special terminology, denotes cross-references, and citations.

**bold**

Highlights interface elements, such as menu names. Denotes signal names. Also used for terms in descriptive lists, where appropriate.

#### **monospace**

Denotes text that you can enter at the keyboard, such as commands, file and program names, and source code.

#### **monospace**

Denotes a permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.

#### ***monospace italic***

Denotes arguments to monospace text where the argument is to be replaced by a specific value.

#### **monospace bold**

Denotes language keywords when used outside example code.

#### **<and>**

Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example:

```
MRC p15, 0 <Rd>, <CRn>, <CRm>, <Opcode_2>
```

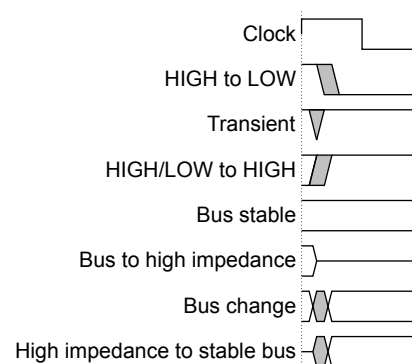
#### **SMALL CAPITALS**

Used in body text for a few terms that have specific technical meanings, that are defined in the *ARM glossary*. For example, IMPLEMENTATION DEFINED, IMPLEMENTATION SPECIFIC, UNKNOWN, and UNPREDICTABLE.

## **Timing diagrams**

The following figure explains the components used in timing diagrams. Variations, when they occur, have clear labels. You must not assume any timing information that is not explicit in the diagrams.

Shaded bus and signal areas are undefined, so the bus or signal can assume any value within the shaded area at that time. The actual level is unimportant and does not affect normal operation.



**Figure 1 Key to timing diagram conventions**

## **Signals**

The signal conventions are:

### **Signal level**

The level of an asserted signal depends on whether the signal is active-HIGH or active-LOW. Asserted means:

- HIGH for active-HIGH signals.
- LOW for active-LOW signals.

### **Lower-case n**

At the start or end of a signal name denotes an active-LOW signal.

## **Additional reading**

This book contains information that is specific to this product. See the following documents for other relevant information.

## ARM publications

- *Cortex<sup>®</sup>-M0+ Technical Reference Manual* (ARM DDI 0484)
- *Cortex<sup>®</sup>-M0 Technical Reference Manual* (ARM DDI 0432)
- *Cortex<sup>®</sup>-M1 FPGA Development Kit Cortex-M1 User Guide: Altera Edition v1.1* (ARM DUI 0395)
- *Cortex<sup>®</sup>-M1 FPGA Development Kit v1.1: Installation Guide* (ARM DSI 0048)
- *Cortex<sup>®</sup>-M1 Technical Reference Manual* (ARM DDI 0413)
- *Cortex<sup>®</sup>-M3 Technical Reference Manual* (ARM DDI 0337)
- *Cortex<sup>®</sup>-M3 Devices Generic User Guide* (ARM DUI 0552)
- *Cortex<sup>®</sup>-M4 Technical Reference Manual* (ARM DDI 0439)
- *Cortex<sup>®</sup>-M4 Devices Generic User Guide* (ARM DUI 0553)
- *Cortex<sup>®</sup>-M System Design Kit Technical Reference Manual* (ARM DDI 0479)
- *Application Note AN382 ARM<sup>®</sup> Cortex<sup>®</sup>-M0 SMM on V2M-MPS2* (ARM DAI 0382)
- *Application Note AN383 ARM<sup>®</sup> Cortex<sup>®</sup>-M0+ SMM on V2M-MPS2* (ARM DAI 0383)
- *Application Note AN384 ARM<sup>®</sup> Cortex<sup>®</sup>-M1 SMM on V2M-MPS2* (ARM DAI 0384)
- *Application Note AN385 ARM<sup>®</sup> Cortex<sup>®</sup>-M3 SMM on V2M-MPS2* (ARM DAI 0385)
- *Application Note AN386 ARM<sup>®</sup> Cortex<sup>®</sup>-M4 SMM on V2M-MPS2* (ARM DAI 0386)
- *Application Note AN387 ARM<sup>®</sup> Cortex<sup>®</sup>-M0 Design Start SMM on V2M-MPS2* (ARM DAI 0387)
- *Application Note AN399 ARM<sup>®</sup> Cortex<sup>®</sup>-M7 SMM on V2M-MPS2* (ARM DAI 0399)
- *Application Note AN400 ARM<sup>®</sup> Cortex<sup>®</sup>-M7CS SMM on V2M-MPS2* (ARM DAI 0400)
- *Cortex<sup>®</sup>-M1 FPGA Development Kit Example System Tutorial: Altera Cyclone III Edition* (ARM DUI 0430)
- *ARM DSTREAM System and Interface Design Reference* (ARM DUI 0499)
- *ARM DSTREAM Setting up the Hardware* (ARM DUI 0481)
- *ARM DSTREAM and RVT Using the Debug Hardware Configuration Utilities* (ARM DUI 0498)
- *ARM CoreSight<sup>™</sup> Components Technical Reference Manual* (ARM DDI 0314)

## Other publications

- See the Altera website <http://altera.com> for information on the Altera Cyclone 5CEA7 FPGA.

## Feedback

### Feedback on this product

If you have any comments or suggestions about this product, contact your supplier and give:

- The product name.
- The product revision or version.
- An explanation with as much information as you can provide. Include symptoms and diagnostic procedures if appropriate.

### Feedback on content

If you have comments on content then send an e-mail to [errata@arm.com](mailto:errata@arm.com). Give:

- The title.
- The number ARM 100112\_0100\_03\_en.
- The page number(s) to which your comments refer.
- A concise explanation of your comments.

ARM also welcomes general suggestions for additions and improvements.

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# Chapter 1

## Introduction

This chapter provides an introduction to the Versatile Express Cortex-M Prototyping System, the V2M-MPS2 motherboard.

It contains the following sections:

- [1.1 Precautions](#) on page 1-12.
- [1.2 About the Versatile™ Express V2M-MPS2 motherboard](#) on page 1-13.
- [1.3 Location of components on the V2M-MPS2 motherboard](#) on page 1-14.

## 1.1 Precautions

This section contains advice about how to prevent damage to your V2M-MPS2 motherboard.

This section contains the following subsections:

- [1.1.1 Ensuring safety on page 1-12.](#)
- [1.1.2 Preventing damage on page 1-12.](#)

### 1.1.1 Ensuring safety

An on-board connector supplies 12V DC to the Cortex-M Prototyping System.

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#### Warning

Do not use the Cortex-M Prototyping System near equipment that is sensitive to electromagnetic emissions, for example, medical equipment.

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### 1.1.2 Preventing damage

The Cortex Prototyping System is intended for use within a laboratory or engineering development environment. The board is sensitive to electrostatic discharges and permits electromagnetic emissions.

---

#### Caution

To avoid damage to the Cortex Prototyping System, observe the following precautions:

- You must connect the external power supply to the board before powerup to prevent damage.
  - Never subject the board to high electrostatic potentials. Observe Electrostatic Discharge (ESD) precautions when handling any board.
  - Always wear a grounding strap when handling the board.
  - Only hold the board by the edges.
  - Avoid touching the component pins or any other metallic element except the metal shielding for the connectors.
  - Avoid contact with components on the board which may be hot or sharp.
  - Ensure that the voltage on the pins of the FPGA and interface circuitry on the board is at the correct level.
  - You must not configure as outputs any FPGA pins that connect directly to other outputs or an external signal source.
  - Do not use the board near a transmitter of electromagnetic emissions.
-

## 1.2 About the Versatile™ Express V2M-MPS2 motherboard

The V2M-MPS2 motherboard is a development platform for ARM Cortex-M evaluation and development.

The V2M-MPS2 motherboard provides the following:

### **Altera Cyclone 5CEA7 FPGA and board powerup and configuration**

The V2M-MPS2 motherboard provides an Altera Cyclone 5CEA7 FPGA, speed grade C8, that supports ARM Cortex-M software evaluation and development. A *Motherboard Configuration Controller* (MCC) supports board powerup and configuration. An on-board EEPROM stores board and file identification information and a microSD card stores FPGA and software images and configuration files. You can access the microSD card to perform configuration file editing and to update FPGA and software images.

### **External user memory**

On-board external SSRAM and PSRAM connect to memory interfaces in the FPGA.

### **Access ports**

The V2M-MPS2 motherboard provides access through Ethernet, general-purpose UART and SPI ports. A general-purpose user expansion port supports user expansion to extra signal or bus IO.

### **Video and audio output**

The V2M-MPS2 motherboard provides video output through VGA and CLCD ports. The CLCD port drives an LCD module configured for SPI graphics and I<sup>2</sup>C touch screen. Input and output audio ports connect to a stereo audio codec which connects to an I<sup>2</sup>S digital audio interface on the FPGA.

### **User LEDs and user switches**

The V2M-MPS2 motherboard provides user LEDs, an 8-way dip switch and push buttons that connect to the FPGA and to the MCC. The meaning of these LEDs and push buttons depend upon the image that you implement in the FPGA.

### **System LEDs**

The V2M-MPS2 motherboard provides LEDs which denote *Configuration Complete*, *MCC Powered*, *Ethernet Duplex Link Established*, *Ethernet Link Operating at 100Mbps*, *Ethernet Link Established* and *microSD Card Read or Write Access*.

### **Debug**

The V2M-MPS2 motherboard supports P-JTAG Processor debug, F-JTAG *Integrated Logic Analyzer* (ILA) FPGA debug, 4-bit trace and 16-bit trace debug, and CMSIS-DAP FPGA debug.

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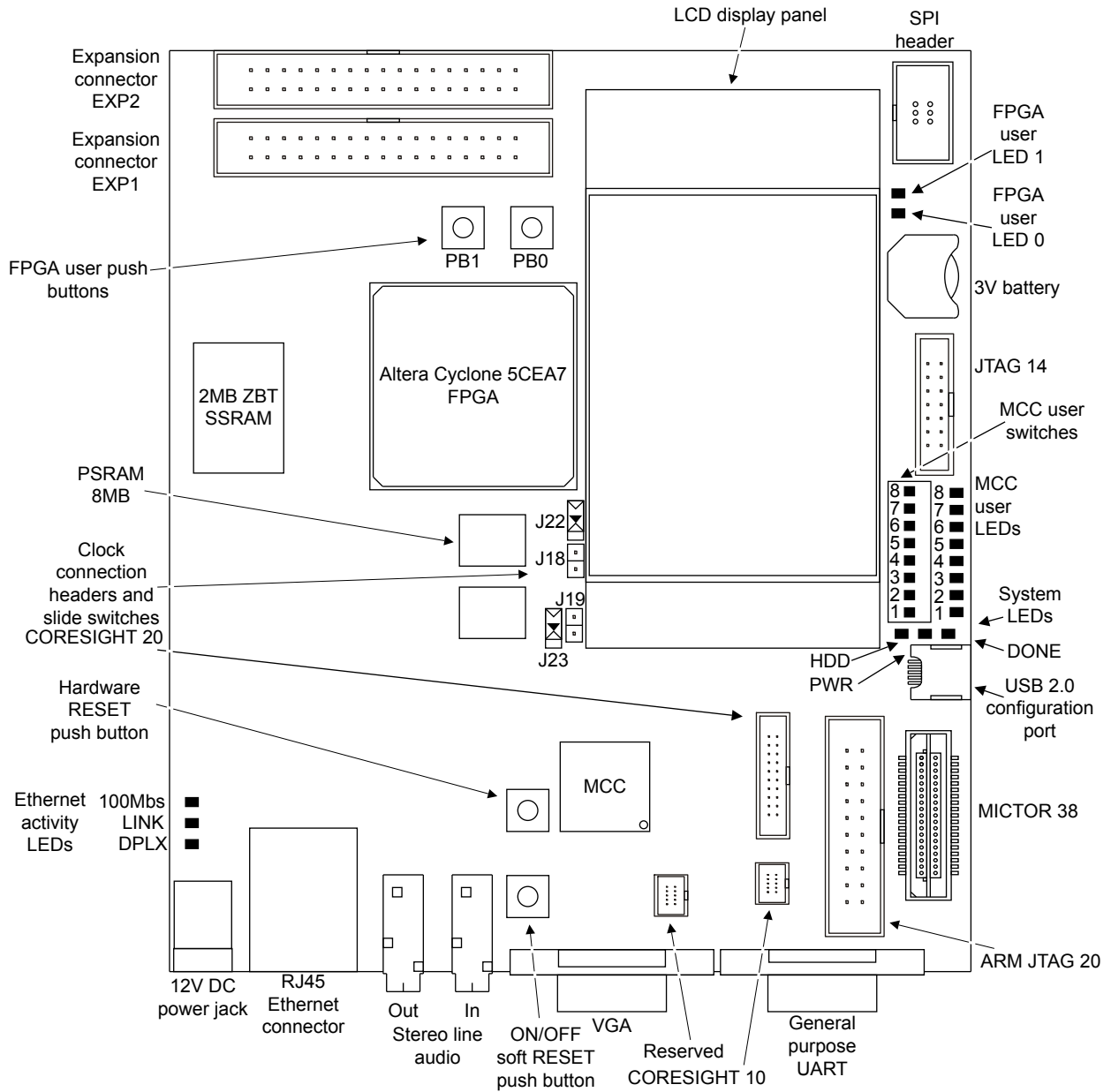
#### **Note**

The V2M-MPS2 motherboard requires motherboard configuration controller firmware version 2.0.1 or later to support CMSIS-DAP FPGA debug.

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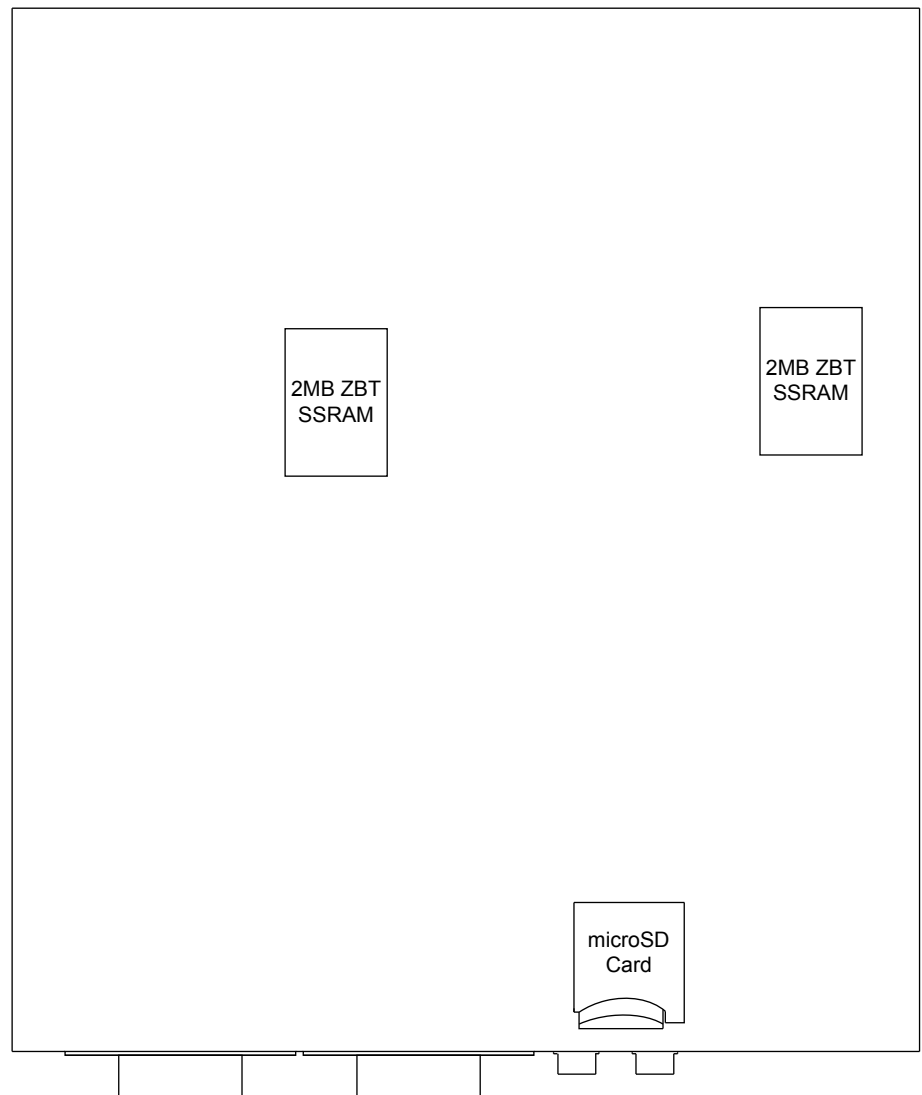
## 1.3 Location of components on the V2M-MPS2 motherboard

The following figure shows the upper face of the V2M-MPS2 motherboard.



**Figure 1-1 Upper face of the V2M-MPS2 motherboard.**

The following figure shows the lower face of the V2M-MPS2 motherboard.



**Figure 1-2 Lower face of the V2M-MPS2 motherboard.**

# Chapter 2

## Hardware Description

This chapter describes the Versatile Express V2M-MPS2 motherboard hardware.

It contains the following sections:

- [2.1 Overview of the V2M-MPS2 motherboard hardware on page 2-18.](#)
- [2.2 Clocks on page 2-21.](#)
- [2.3 Powerup, powerdown and resets on page 2-23.](#)
- [2.4 User expansion port on page 2-24.](#)
- [2.5 USB 2.0 Full Speed interface on page 2-25.](#)
- [2.6 SPI interface on page 2-26.](#)
- [2.7 UART interface on page 2-27.](#)
- [2.8 VGA and CLCD interfaces on page 2-28.](#)
- [2.9 Audio interface on page 2-29.](#)
- [2.10 Ethernet interface on page 2-30.](#)
- [2.11 User switches and user LEDs on page 2-31.](#)
- [2.12 External user memory on page 2-32.](#)
- [2.13 MCC FPGA serial interface on page 2-35.](#)
- [2.14 Power on page 2-38.](#)
- [2.15 Debug and trace on page 2-39.](#)
- [2.16 Minimum design settings for motherboard operation on page 2-43.](#)

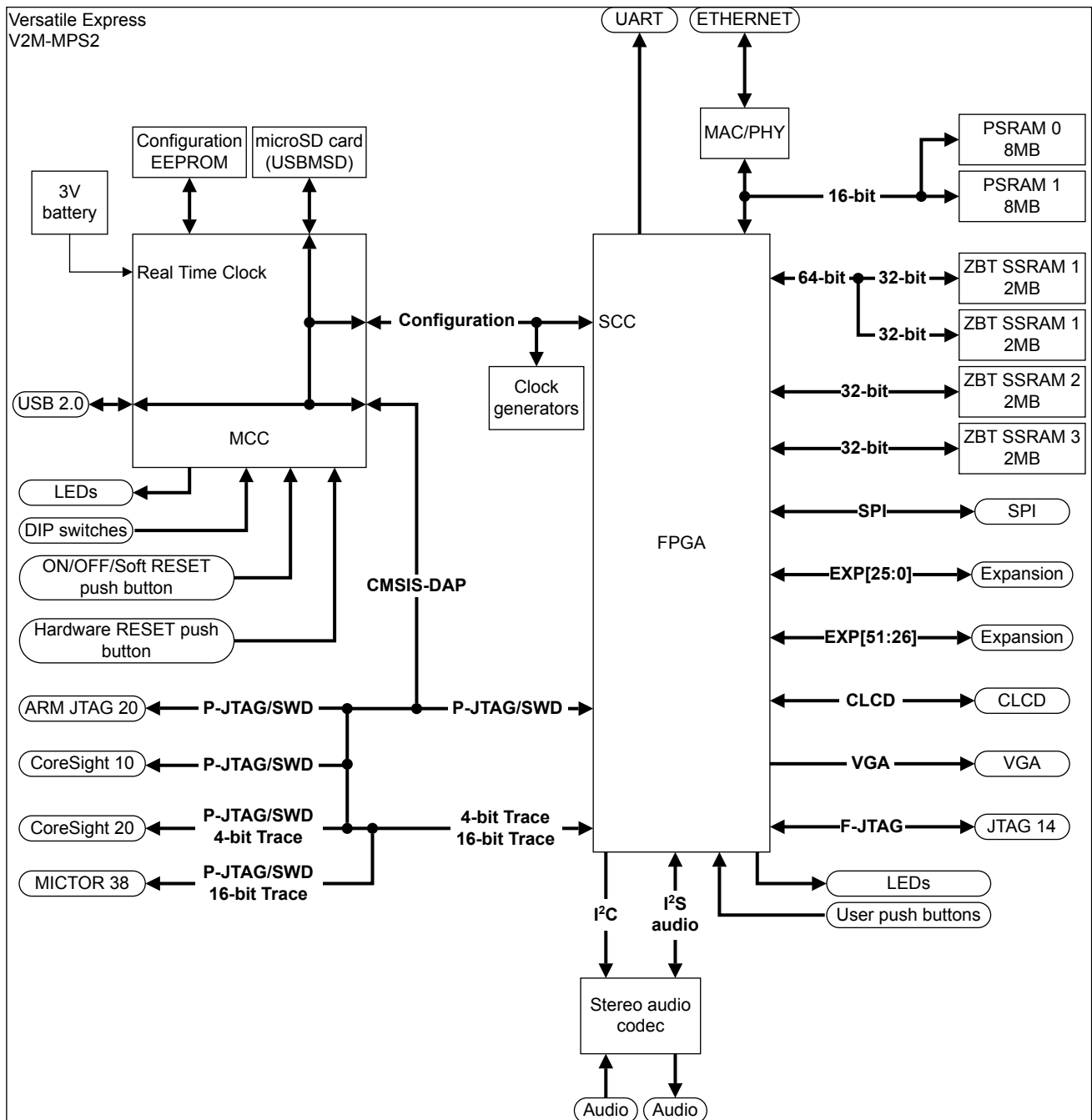
## 2.1 Overview of the V2M-MPS2 motherboard hardware

The hardware infrastructure supports ARM M-class processor evaluation and development, system expansion and a number of debug interfaces.

The following figure shows the high-level hardware infrastructure.

**- Note**

The image that the configuration systems loads into the FPGA at powerup defines the functionality of the V2M-MPS2 motherboard.



**Figure 2-1 V2M-MPS2 motherboard hardware infrastructure**

The V2M-MPS2 motherboard contains the following components and interfaces:

- One Altera Cyclone 5CEA7 FPGA:
  - speed grade C8.
- External user system memory for Cortex-M processors:
  - Two 32-bit 2MB ZBT SSRAM with independent 32-bit memory interfaces.
  - One 64-bit 4MB ZBT SSRAM:
    - Two 32-bit 2MB ZBT SSRAM connected as one 4MB 64-bit memory.
  - Two 16-bit 8MB PSRAM to supplement ZBT SSRAM.
- One MCC that supports board configuration at powerup or reset:
  - FPGA configuration.
  - Clock generator configuration.
  - Board configuration.
  - Pre-loading of SRAM images.
  - Loading of *Real Time Clock* (RTCC) registers.
  - CMSIS-DAP FPGA debug through the USB 2.0 port.
- One microSD card that stores the following:
  - FPGA images.
  - Software images.
  - Board configuration files.
- On-board clock generators:
  - One fixed 25MHz clock for Ethernet MAC/PHY.
  - Three programmable system clocks.
  - Two crystals for MCC.
- *Real Time Clock* (RTC) in MCC:
  - Powered by 3V lithium coin cell battery.
- I<sup>2</sup>S digital audio output:
- IDC expansion ports:
- Ethernet port.
- UART.
- SPI interface.
- Video output:
  - VGA output.
  - CLCD output with SPI interface.
- USB 2.0 Full Speed port that supports:
  - USB memory access to the microSD card for *Drag-and-Drop* configuration file editing.
- User switches and user LEDs:
  - Two green LEDs and two push buttons that connect to the FPGA.
  - Eight green LEDs and one 8-way dip switch that connect to the MCC.
- System LEDs:
  - *DONE* green LED that denotes board powerup and configuration complete.
  - *PWR* green LED that denotes MCC powered up and active.
  - *HDD* green LED that flashes during access to microSD card.
  - *LINK* green LED that denotes Ethernet activity.
  - *DPLX* green LED that denotes Ethernet connection operating in duplex mode.
  - *100Mbps* green LED that denotes Ethernet connection operating at 10Mbps or 100Mbps.
- Debug and trace interfaces:
  - *ARM JTAG 20* connector that supports P-JTAG Processor debug and SWD.
  - *CoreSight™ 10* connector that supports P-JTAG Processor debug and SWD.
  - *CoreSight™ 20* connector that supports P-JTAG Processor debug, SWD and 4-bit trace.
  - *MICTOR 38* connector that supports P-JTAG Processor debug, SWD and 16-bit trace.
  - *JTAG 14* connector that supports F-JTAG FPGA debug.
  - USB 2.0 Full Speed port that supports CMSIS-DAP FPGA debug.

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**Note**

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- The availability of P-JTAG, SWD, 4-bit trace or 16-bit trace, F-JTAG FPGA debug or CMSIS-DAP FPGA debug depends upon the design which you implement in the FPGA.
  - CMSIS-DAP debug accesses the FPGA on the same bus as P-JTAG/SWD.
  - The V2M-MPS2 motherboard requires motherboard configuration controller firmware version 2.0.1 or later to support CMSIS-DAP.
-

## 2.2 Clocks

The V2M-MPS2 motherboard provides three programmable on-board clock generators.

### Overview of clocks

The three clock generators on the V2M-MPS2 motherboard and other clock generators inside the FPGA generate the clocks that the board uses. The MCC configures the programmable clock generators during powerup sequencing using values that the configuration files define.

You configure the frequencies of the on-board clock generators by editing the *OSCLKS* section of the application note .txt file in the microSD card.

You can bypass the on-board clock generators and import external clocks to the MCC board using the connection headers that the V2M-MPS2 motherboard provides.

The following figure shows the clocks on the V2M-MPS2 motherboard. The figure shows two of the clock generators connected to PLLs inside the FPGA with external loopback to logic inside the FPGA. The third clock generator connects directly to logic inside the FPGA.

#### Note

- The slide switches and connection headers are for general-purpose use. You can use them for any purpose whatsoever according to the needs of the design which you implement in the FPGA.
- The availability of clock generators and logic in the FPGA depend upon the design which you implement in the FPGA.

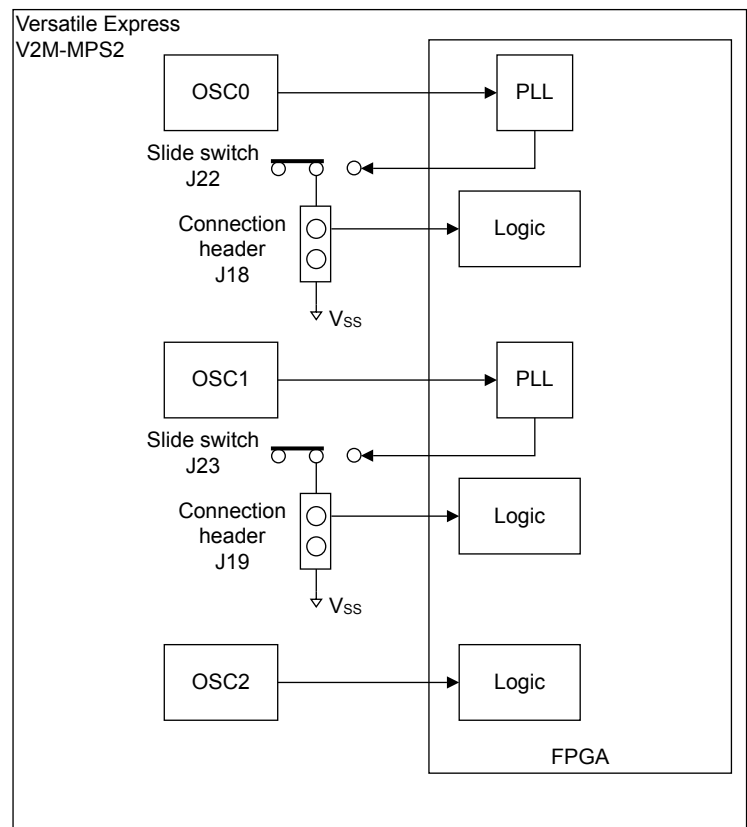


Figure 2-2 V2M-MPS2 motherboard clocks

### Related concepts

[3.5.2 config.txt generic motherboard configuration file on page 3-52.](#)

## Related references

*1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.*

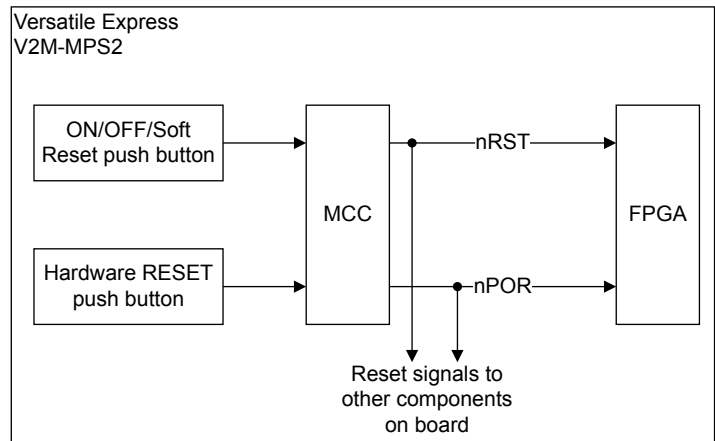
## 2.3 Powerup, powerdown and resets

The two reset push buttons generate the reset request signals on the V2M-MPS2 motherboard.

When you press one of the reset push buttons, *Hardware RESET* button or *ON/OFF/Soft Reset* button the MCC generates appropriate signals to the FPGA and other systems to reset the system.

The MCC asserts **nRST** after a reset request from the ON/OFF/Soft RESET button. Optionally, when you set *ASSERTNPOR* to TRUE in the *config.txt* file, the MCC also asserts **nPOR**.

The following figure shows the powerup *ON/OFF/Soft RESET* and *Hardware RESET* push-button signals in the system.



**Figure 2-3 V2M-MPS2 motherboard push-button resets**

### Note

- The board labels the *ON/OFF/Soft RESET* push button as *nPBON*.
- The board labels the *Hardware RESET* push button as *nCFGRST*.

The V2M-MPS2 motherboard performs a full system configuration at powerup.

### Related concepts

[3.3 Powerup and configuration process on page 3-48.](#)

[3.5.2 config.txt generic motherboard configuration file on page 3-52.](#)

### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 2.4 User expansion port

The V2M-MPS2 motherboard supports expansion to add user functionality.

### Overview of the user expansion port

Two IDC headers support general-purpose user expansion.

The general purpose headers provide:

- Six 3V volt power pins:
  - The 3V supply can supply up to 300mA total through the six power pins.
- 52 general purpose IO signals.

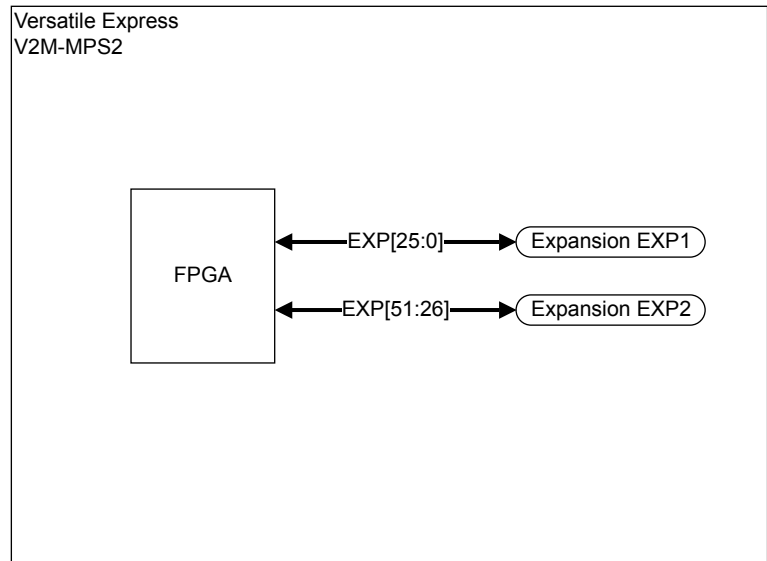


Figure 2-4 V2M-MPS2 motherboard user expansion port

### Related references

[5.2 Expansion connectors on page 5-75.](#)

## 2.5 USB 2.0 Full Speed interface

The V2M-MPS2 motherboard provides one USB 2.0 Full Speed interface that connects to the MCC.

In the standby state or during run time the USB 2.0 Full Speed interface supports memory access to the microSD card for *Drag-and-Drop* configuration file editing. The V2M-MPS2 motherboard then uses the updated files during the configuration process.

During run time, the USB 2.0 Full Speed interface supports:

- Virtual UART access to the FPGA through a connection between the MCC and the FPGA.
- CMSIS-DAP FPGA debug through a connection between the MCC and the FPGA.

The following figure shows the USB 2.0 Full Speed interface.

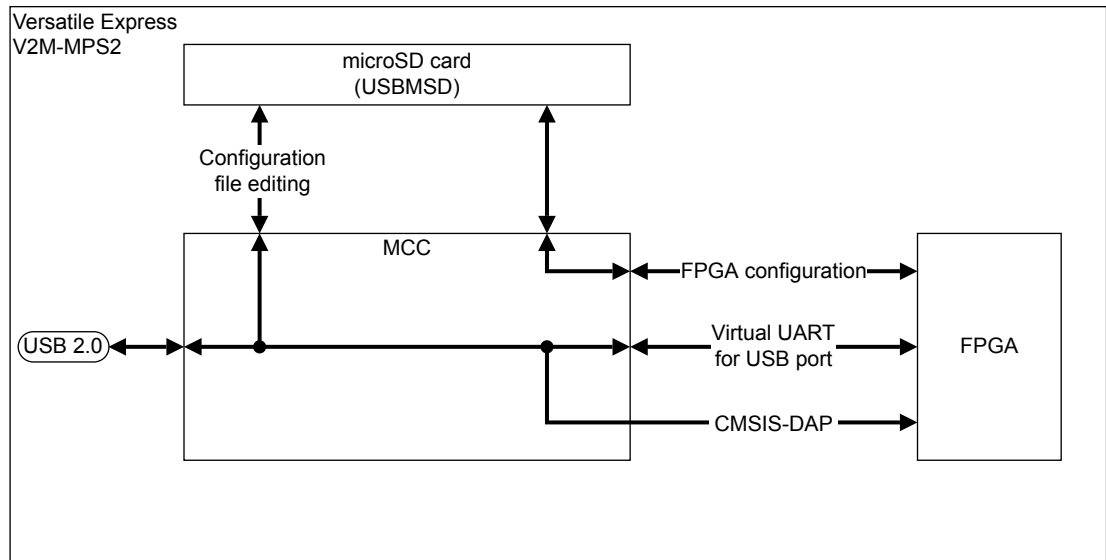


Figure 2-5 V2M-MPS2 motherboard USB 2.0 Full Speed interface

### Note

The designs supplied by ARM do not implement virtual UART access to the FPGA. If you implement the virtual UART, you must make the following pin assignments in the FPGA to enable the virtual UART to operate.

```
assign CLCD_PDH[10] = uart_txd;
assign uart_rxd_mcu_i = CLCD_PDH[11];
```

### Note

After configuration, the board uses the FPGA configuration interface as the SCC and SPI interface.

### Related concepts

- [3.1 Overview of the V2M-MPS2 motherboard configuration process on page 3-45.](#)
- [3.2 Configuration system on page 3-47.](#)
- [3.5.1 Overview of configuration files and microSD card directory structure on page 3-51.](#)
- [2.15.7 CMSIS-DAP FPGA debug on page 2-41.](#)

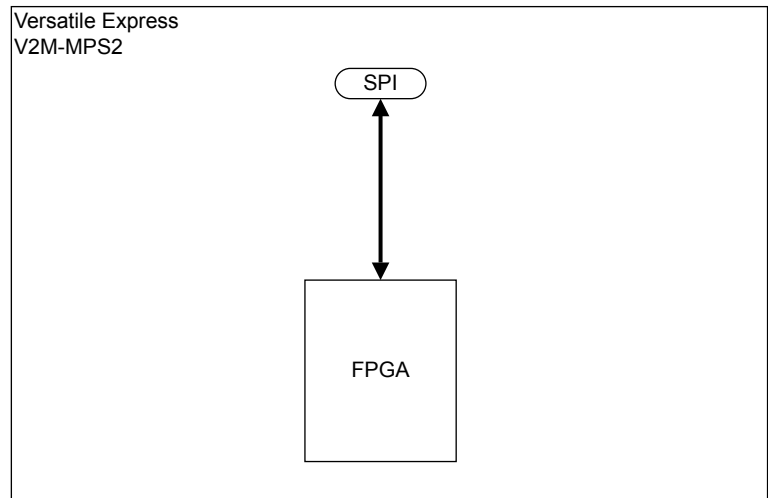
### Related references

- [5.4 USB 2.0 connector on page 5-78.](#)

## 2.6 SPI interface

The V2M-MPS2 motherboard provides access to a general-purpose SPI interface from the FPGA.

The following figure shows the general purpose SPI interface.



**Figure 2-6 V2M-MPS2 motherboard general purpose SPI interface**

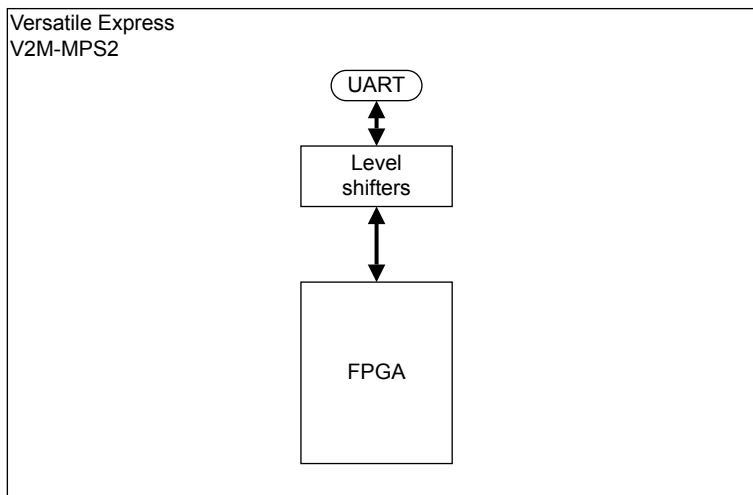
### Related references

[5.6 SPI connector on page 5-80.](#)

## 2.7 UART interface

The V2M-MPS2 motherboard provides access to a general-purpose UART interface from the FPGA in Data Communications Equipment (DCE) configuration.

The following figure shows the general purpose UART interface.



**Figure 2-7 V2M-MPS2 motherboard general purpose UART interface**

### Related references

[5.5 UART connector on page 5-79.](#)

## 2.8 VGA and CLCD interfaces

The V2M-MPS2 motherboard supports VGA and CLCD video output.

### Overview of the VGA interface

The VGA interface consists of a VGA controller in the FPGA, a passive resistor network and an output VGA port. The VGA output has 4 bits per channel color depth.

### Overview of the CLCD interface

The CLCD interface consists of an SPI bus connected between the FPGA and a CLCD connector and an LCD touch screen.

The LCD *Thin Film Technology* (TFT) display panel is fitted to the CLCD connector and has 320x240 pixel resolution. The panel includes a 4-wire resistive touch screen and an STEMPE811 touch screen controller connected to the FPGA over an I<sup>2</sup>C bus.

The following figure shows the V2M-MPS2 motherboard VGA and CLCD interfaces.

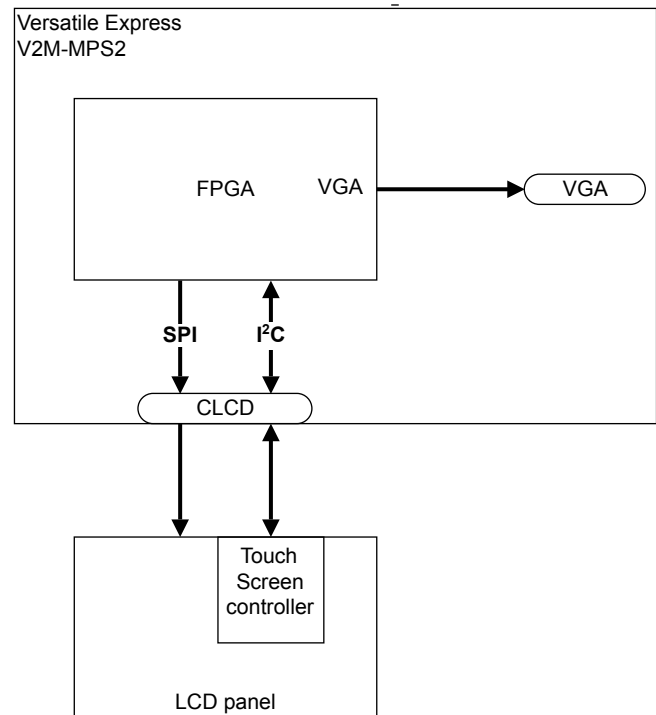


Figure 2-8 V2M-MPS2 motherboard VGA and CLCD interfaces.

### LCD panel

The LCD panel is configured for SPI graphics and I<sup>2</sup>C touch-screen.

### Related references

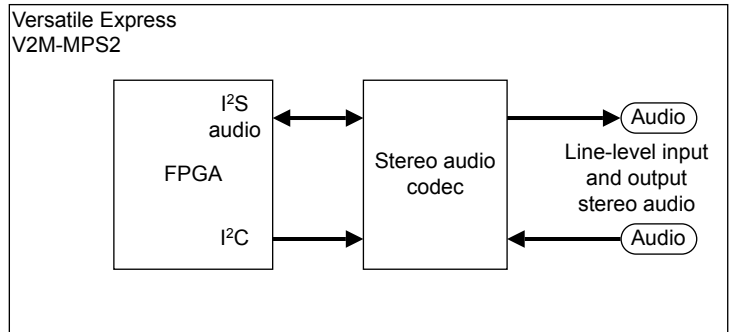
- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.3 CLCD connector on page 5-77.](#)
- [5.7 VGA connector on page 5-81.](#)

## 2.9 Audio interface

The V2M-MPS2 motherboard provides a stereo line-level input and a stereo line-level output.

The audio interface consists of an audio controller in the FPGA, a low-power audio codec and input and output stereo audio ports. The audio controller configures the codec over an I<sup>2</sup>C bus. The FPGA and codec send audio data to each other over an I<sup>2</sup>S bus.

The following diagram shows the audio interface.



**Figure 2-9 V2M-MPS2 motherboard audio interface**

### Related references

[5.8 Audio connectors on page 5-82.](#)

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 2.10 Ethernet interface

The V2M-MPS2 motherboard provides an Ethernet MAC interface.

### Overview of the Ethernet interface.

The Ethernet interface consists of a 16-bit interface on the FPGA, a combined Ethernet MAC and PHY on the board and Ethernet connector for external connection.

#### Note

The MAC/PHY connects to the same 16-bit interface as the 16MB PSRAM external memory.

The V2M-MPS2 motherboard contains three LEDs that denote Ethernet activity:

- *LINK LED*:
  - On denotes Ethernet connection established.
  - Off denotes Ethernet connection not established.
- *DPLX LED*:
  - On denotes connection operating in duplex mode.
  - Off denotes Ethernet connection operating in simplex mode
- *100Mbs LED*:
  - On denotes Ethernet connection operating at 100Mbs.
  - Off denotes Ethernet connection operating at 10Mbs.

The following diagram shows the V2M-MPS2 motherboard Ethernet interface.

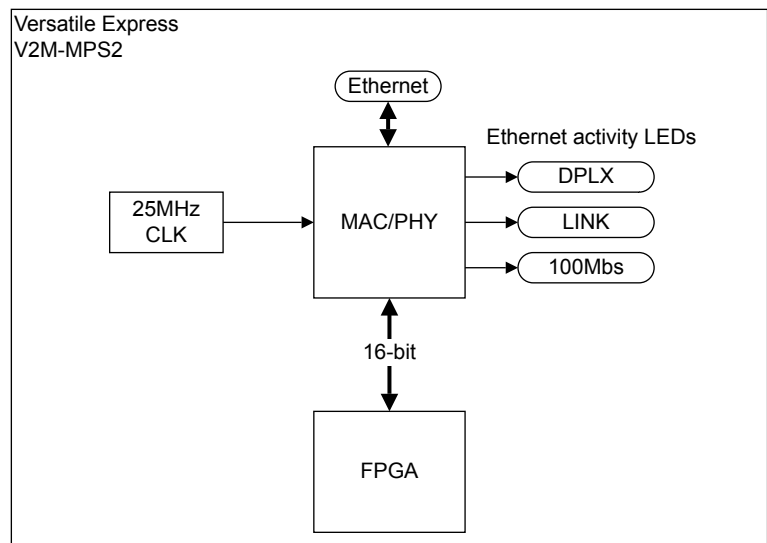


Figure 2-10 V2M-MPS2 motherboard Ethernet interface

### Related concepts

[2.12 External user memory on page 2-32.](#)

### Related references

[5.9 Ethernet connector on page 5-83.](#)

## 2.11 User switches and user LEDs

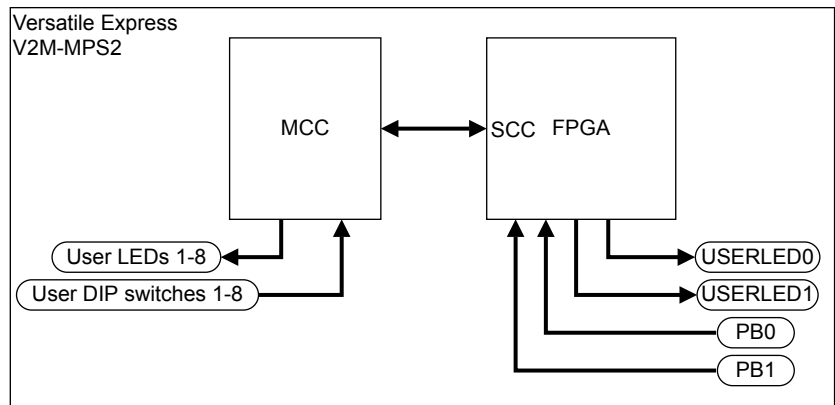
The V2M-MPS2 motherboard provides a user interface that consists of user LEDs and user switches that connect to the FPGA and MCC. The FPGA image and application software define their meaning.

The board provides the following LEDs and switches:

- Two LEDs and two push buttons that connect directly to the FPGA:
  - The board labels the LEDs as *USERLED0* and *USERLED1*.
  - The board labels the push buttons as *PB0* and *PB1*.
- Eight LEDs and an 8-way DIP switch that connect to the MCC.

You can write the values from these LEDs and switches to system registers inside the FPGA using a serial SCC interface.

The following diagram shows the user switches and LEDs that form the FPGA and MCC user interface.



**Figure 2-11 V2M-MPS2 motherboard FPGA and MCC user interface**

### Related concepts

[2.13 MCC FPGA serial interface on page 2-35.](#)

### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

[4.4.3 SCC\\_CFG1 Register on page 4-59.](#)

[4.4.4 SCC\\_CFG3 Register on page 4-59.](#)

## 2.12 External user memory

The V2M-MPS2 motherboard provides external user ZBT SSRAM and PSRAM memory.

The external user memory connects to the FPGA and consists of the following:

- Two 2MB 32-bit fast single-cycle ZBT SSRAM memory:
  - These connect to two independent 32-bit memory interfaces on the FPGA.
- One 4MB 32-bit fast single-cycle ZBT SSRAM memory:
  - This consists of two 2MB 32-bit memories which the board configures as one 64-bit memory. They connect to one 64-bit memory interface on the FPGA.
- Two 16-bit 8MB PSRAM memory:
  - These supplements the ZBT SSRAM.

---

### Note

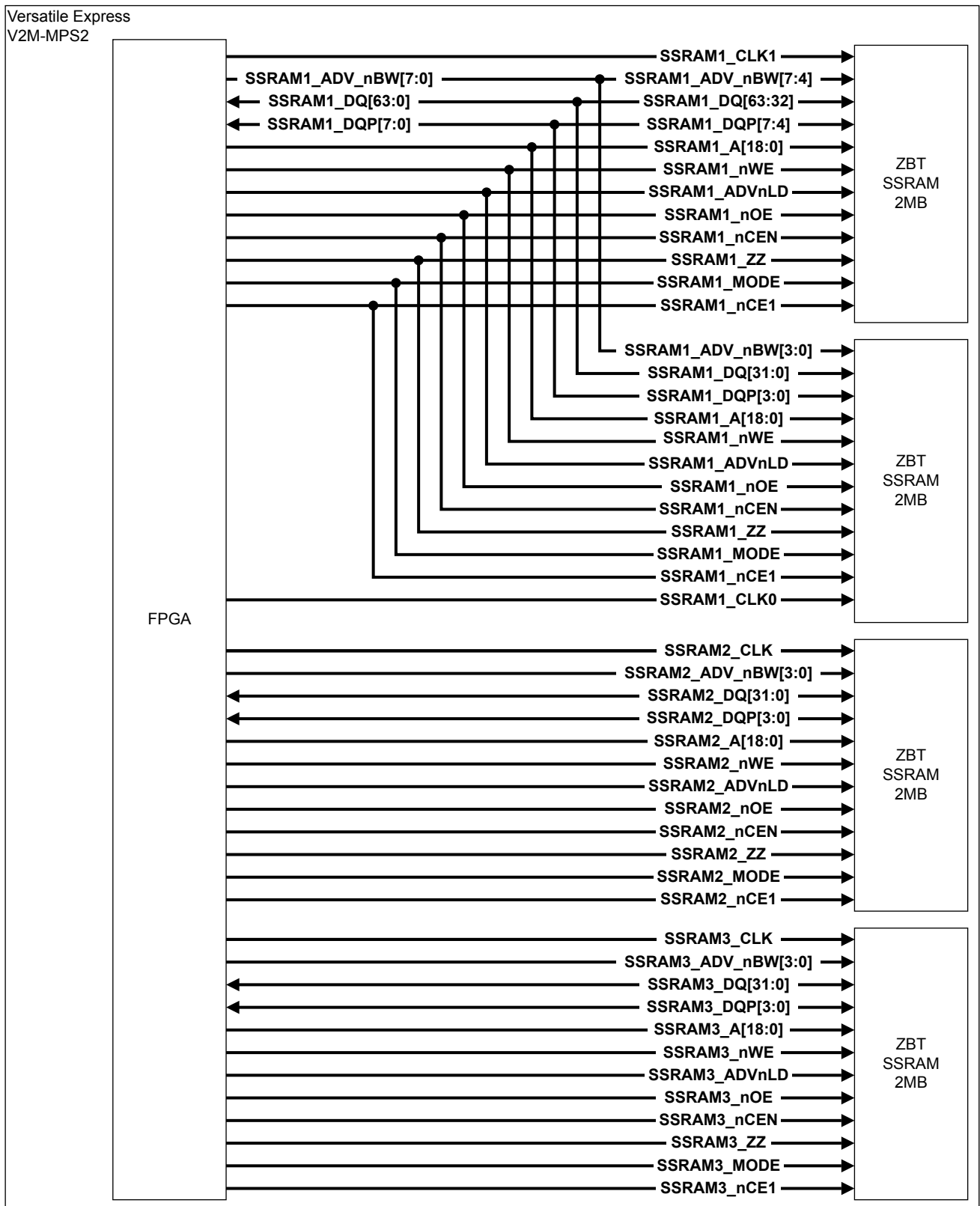
---

The 16MB PSRAM connects to the same 16-bit interface on the FPGA as the Ethernet MAC/PHY.

---

The MCC can pre-load the external user memory using the `images.txt` file before releasing reset. This enables the V2M-MPS2 motherboard to use the external memory as boot RAM.

The following diagram shows the external ZBT SSRAM user memory interface.



**Figure 2-12 V2M-MPS2 motherboard ZBT SSRAM external user memory interface**

The following diagram shows the external PSRAM user memory interface.

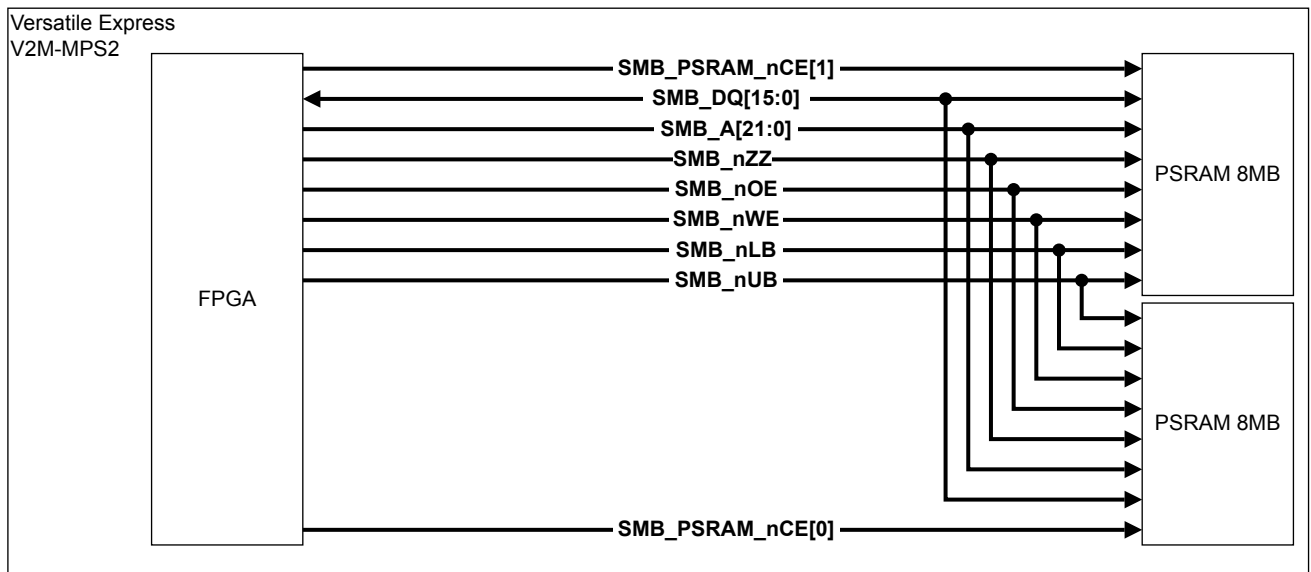


Figure 2-13 V2M-MPS2 motherboard PSRAM external user memory interface

#### Related concepts

[2.10 Ethernet interface](#) on page 2-30.

## 2.13 MCC FPGA serial interface

This section describes the Serial Configuration Controller (SCC) between the MCC and the FPGA.

This section contains the following subsections:

- [2.13.1 Serial Configuration Controller \(SCC\) on page 2-35.](#)
- [2.13.2 SCC READ and WRITE operations on page 2-36.](#)
- [2.13.3 SCC READ and WRITE timings on page 2-36.](#)

### 2.13.1 Serial Configuration Controller (SCC)

The MCC uses a serial communication channel to receive from and transmit information to the FPGA on the board. You must implement a Serial Configuration Controller (SCC) in the FPGA.

#### Overview of MCC-SCC interface

The SCC interface operates at 0.5MHz. The serial interface is similar to a memory-mapped peripheral because it has an address and data phase.

The **nCFGRST** output from the MCC loads the default configuration settings into the FPGA. **CFGLOAD** determines when WRITE DATA is complete, or when the system expects READ DATA to be ready. The MCC provides the SCC clock. **CFGWnR** changes depending upon the access type. The SCC operates a 12-bit address and 32-bit data phase.

The following figure shows the MCC-SCC interface.

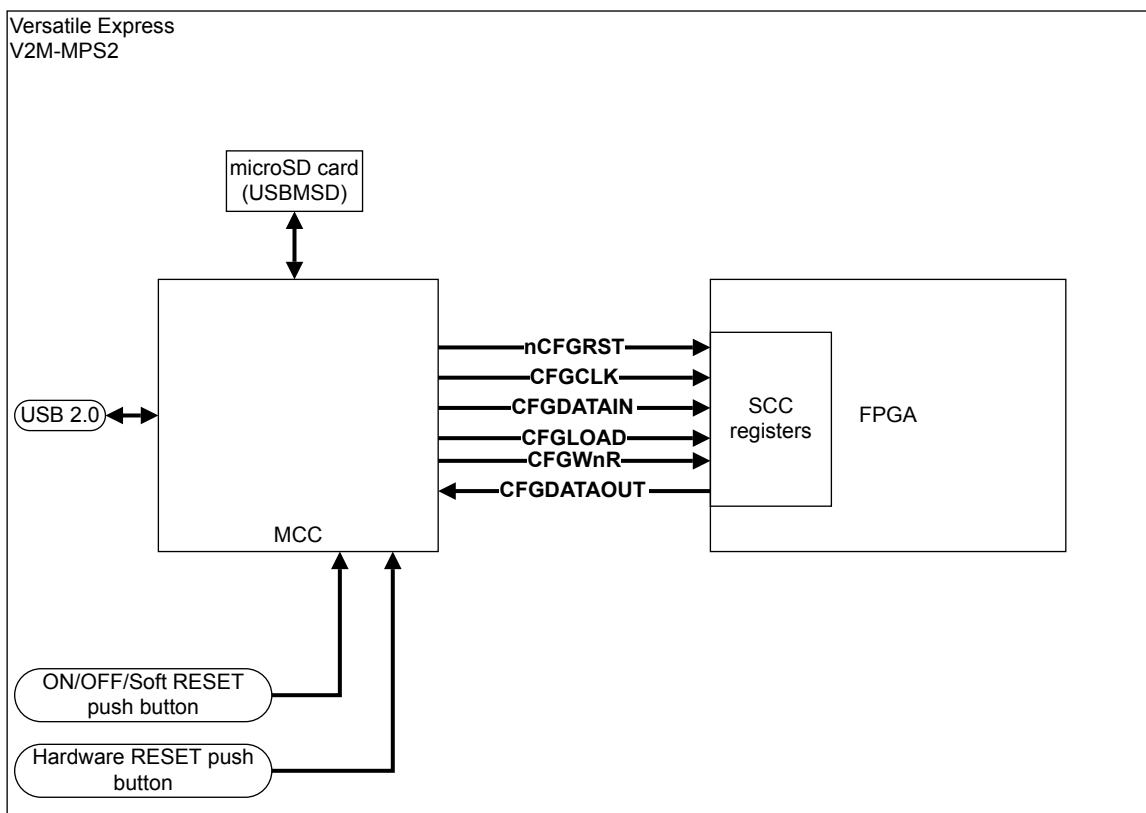


Figure 2-14 MCC-FPGA serial interface

#### FPGA pin assignments to implement an MCC-SCC interface

If you implement an SCC interface, you must make the following pin assignments in the FPGA:

```
assign CFGCLK      = CLCD_PDH[13];
assign nCFGRST     = CLCD_PDH[14];
```

```
assign CFGLOAD      = CLCD_PDH[15];
assign CFGWnR       = CLCD_PDH[16];
assign CFGDATAIN    = CLCD_PDH[17];
assign CLCD_PDH[12] = CFGDATAOUT;
```

#### Note

See *Application Note AN387 ARM® Cortex®-M0 Design Start SMM on V2M-MPS2* for an example `scc.v` file that implements these registers.

#### Note

If the FPGA does not implement an SCC interface, ARM recommends that you tie off the **CFGDATAOUT** and **nRSTREQ** signals as follows:

- Tie the **CFGDATAOUT** signal from the FPGA LOW.
- Tie the **nRSTREQ** signal from the FPGA HIGH.

### Related concepts

[2.16 Minimum design settings for motherboard operation on page 2-43.](#)

## 2.13.2 SCC READ and WRITE operations

During WRITE operations, after clocking in the address and data, **CFGLOAD** loads the address and data into the SCC. The MCC clocks the WRITE DATA *Most Significant Bit* (MSB) first.

During READ operations, after clocking in the address, **CFGLOAD** loads the read address into the SCC. The SCC clocks the READ DATA *Least Significant Bit* (LSB) first.

## 2.13.3 SCC READ and WRITE timings

The following figure shows the timings for the WRITE operation.

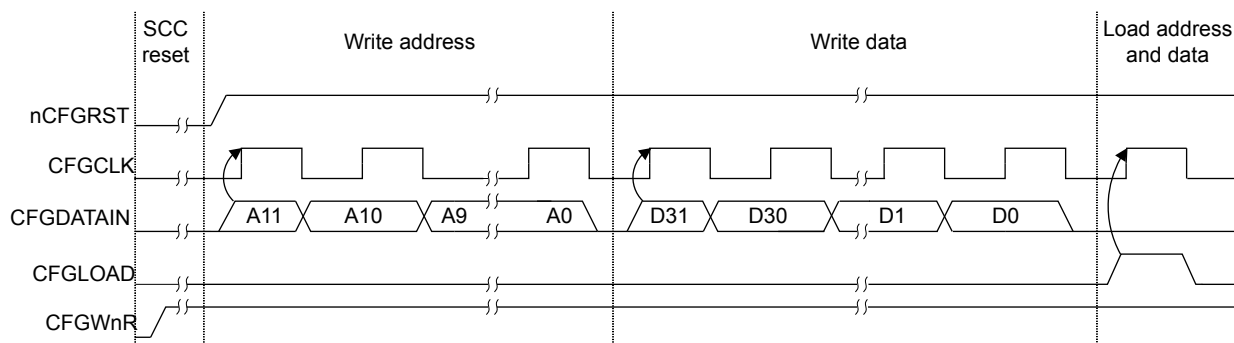


Figure 2-15 MCC write to SCC

The following figure shows the timings for the READ operation.

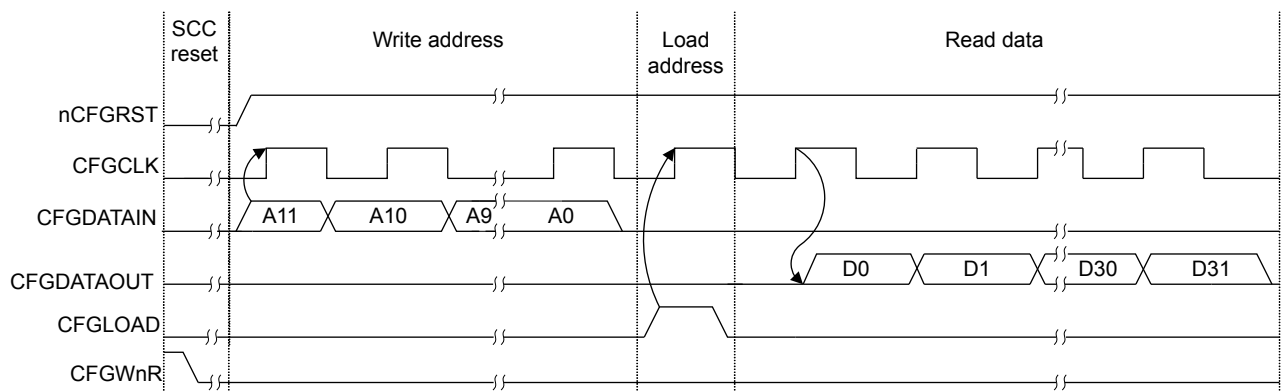


Figure 2-16 MCC read from SCC

The following table shows the MCC AC timing requirements.

Table 2-1 MCC AC timing requirements for SCC interface

Variable	Time
MCC Clock to output valid time: $T_{ov}$	-500ns
MCC Clock to output invalid time: $T_{oh}$	500ns
MCC input setup time: $T_{is}$	500ns
MCC input hold time: $T_{ih}$	-500ns

Related concepts

- 2.11 User switches and user LEDs on page 2-31.
- 4.3 Register summary on page 4-57.
- 4.4 SCC register descriptions on page 4-58.

## 2.14 Power

You supply power to the V2M-MPS2 motherboard from the mains supply using the on-board connector and the connector cable that ARM supplies with the board.

ARM supplies an external power supply unit which converts mains power to 12V DC which connects to the 12V connector on the board. The unit accepts mains power in the range 110V AC to 240V AC.

Alternatively, you can connect an external 12V DC supply, +/- 10%, directly to the 12V connector.

On-board regulators supply power to the V2M-MPS2 motherboard power domains and to the FPGA power domains.

---

### Note

---

The *PWR* LED illuminates when the MCC is powered up and active.

---

### Related references

[5.10 12V power connector on page 5-84.](#)

## 2.15 Debug and trace

This section describes the debug and trace systems on the V2M-MPS2 motherboard.

This section contains the following subsections:

- [2.15.1 Overview of FPGA debug and trace systems on page 2-39.](#)
- [2.15.2 F-JTAG on page 2-40.](#)
- [2.15.3 P-JTAG on page 2-40.](#)
- [2.15.4 4-bit Trace on page 2-41.](#)
- [2.15.5 16-bit Trace on page 2-41.](#)
- [2.15.6 Serial Wire Debug on page 2-41.](#)
- [2.15.7 CMSIS-DAP FPGA debug on page 2-41.](#)

### 2.15.1 Overview of FPGA debug and trace systems

The V2M-MPS2 motherboard provides several debug and trace interfaces:

- P\_JTAG processor debug.
- F-JTAG FPGA debug.
- 16-bit parallel Trace.
- 4-bit parallel Trace.
- *Serial Wire Debug* (SWD).
- CMSIS-DAP FPGA debug.

---

#### Note

- The availability of system debug depends upon the design that you implement in the FPGA.
- The V2M-MPS2 motherboard requires motherboard configuration controller firmware version 2.0.1 or later to support CMSIS-DAP.

---

The following diagram shows a simplified view of the F-JTAG, P-JTAG, Trace, SWD, and CMSIS-DAP connections.

---

#### Caution

The total current limit for the four P-JTAG connectors, *ARM JTAG 20*, *MICTOR 38*, *CoreSight™ 20*, and *CoreSight™ 10* is 50mA.

---

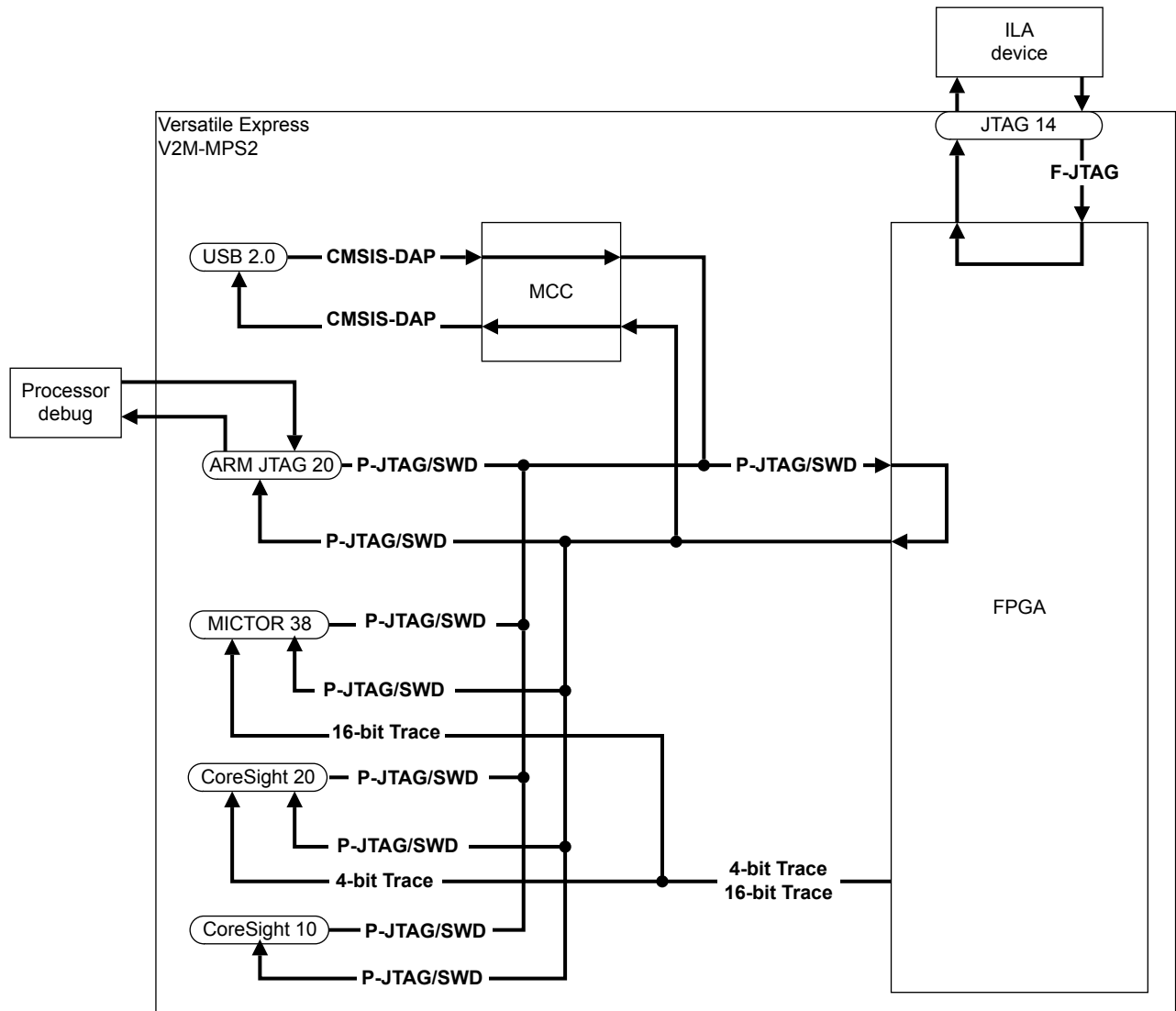


Figure 2-17 Overview of V2M-MPS2 motherboard debug and trace

**Note**

- The ILA device can be any compatible device, for example, *SignalTap II*.
- The processor debug device can be any compatible debugger, for example *SignalTap II*.

## 2.15.2 F-JTAG

The JTAG 14 connector supports F-JTAG, FPGA debug.

The F-JTAG chain connects to the hard TAP controllers in the FPGA. The availability of F-JTAG depends upon the design which you implement in the FPGA.

### Related references

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.1.1 JTAG 14 connector on page 5-70.](#)

## 2.15.3 P-JTAG

The V2M-MPS2 motherboard provides several connectors that support P-JTAG, processor debug.

- ARM JTAG 20 connector.
- CoreSight 10 connector.
- CoreSight 20 connector.
- MICTOR 38 connector.

The availability of P-JTAG depends upon the design which you implement in the FPGA.

#### **Related references**

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.1.2 ARM JTAG 20 connector on page 5-71.](#)
- [5.1.3 CoreSight™ 10 connector on page 5-72.](#)
- [5.1.4 CoreSight™ 20 connector on page 5-72.](#)
- [5.1.5 MICTOR 38 connector on page 5-73.](#)

### **2.15.4 4-bit Trace**

The CoreSight 20 connector supports 4-bit Trace on the V2M-MPS2 motherboard.

The availability of 4-bit Trace depends upon the design which you implement in the FPGA.

#### **Related references**

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.1.4 CoreSight™ 20 connector on page 5-72.](#)

### **2.15.5 16-bit Trace**

The MICTOR 38 connector supports 16-bit Trace on the V2M-MPS2 motherboard.

The availability of 16-bit Trace depends upon the design which you implement in the FPGA.

#### **Related references**

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.1.5 MICTOR 38 connector on page 5-73.](#)

### **2.15.6 Serial Wire Debug**

The V2M-MPS2 motherboard provides several connectors that support Serial Wire Debug (SWD).

- ARM JTAG 20 connector.
- CoreSight 10 connector.
- CoreSight 20 connector.
- MICTOR 38 connector.

The availability of SWD depends upon the design which you implement in the FPGA.

#### **Related references**

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)
- [5.1.2 ARM JTAG 20 connector on page 5-71.](#)
- [5.1.3 CoreSight™ 10 connector on page 5-72.](#)
- [5.1.4 CoreSight™ 20 connector on page 5-72.](#)
- [5.1.5 MICTOR 38 connector on page 5-73.](#)

### **2.15.7 CMSIS-DAP FPGA debug**

The USB 2.0 Full Speed port on the V2M-MPS2 motherboard supports CMSIS-DAP debug.

A workstation running a debugger connects to the CMSIS-DAP port which connects to the MCC. The MCC implements CMSIS-DAP which runs over JTAG connection to the debug access port in the FPGA.

The availability of CMSIS-DAP depends on the design that you implement in the FPGA. The V2M-MPS2 motherboard requires motherboard configuration software version 2.0.1 or later to support CMSIS-DAP.

**Related concepts**

[2.5 USB 2.0 Full Speed interface on page 2-25.](#)

## 2.16 Minimum design settings for motherboard operation

You must implement a minimum amount of RTL in the FPGA for the V2M-MPS2 motherboard to operate correctly.

You must tie off the following FPGA signals to generate the minimum RTL in the FPGA for correct motherboard operation:

1. Set the following signals to the inactive HIGH state:
  - **SMB\_PSRAM\_nce[1:0]**.
  - **SMB\_ETH\_nCS**.
  - **SSRAM1\_nCE1**.
  - **SSRAM2\_nCE1**.
  - **SSRAM3\_nCE1**.
2. Set the SMB chip select to the inactive HIGH state by tying the chip selects **SMB\_nCS** to **0b11111111**.
3. Set the **CFGDATAOUT** signal to the inactive LOW state by tying **NAND\_D[5]** to **0b0**.

————— **Note** —————

This informs the MCC that the V2M-MPS2 motherboard does not implement any of its features.

4. Set the **nRSTREQ** to the inactive HIGH state by tying **NAND\_D[7]** to **0b1**.

————— **Note** —————

This prevents **nRSTREQ** from generating a reset. **nRSTREQ** is usually a system-wide master soft reset signal that is both generated and observed by the JTAG debug box.

————— **Note** —————

ARM recommends that you tie all unused pins to their inactive states.

### Related concepts

[2.13.1 Serial Configuration Controller \(SCC\) on page 2-35.](#)

# Chapter 3

## Configuration

This chapter describes the powerup and configuration process of the Versatile Express V2M-MPS2 motherboard.

It contains the following sections:

- [3.1 Overview of the V2M-MPS2 motherboard configuration process](#) on page 3-45.
- [3.2 Configuration system](#) on page 3-47.
- [3.3 Powerup and configuration process](#) on page 3-48.
- [3.4 Reset push buttons](#) on page 3-50.
- [3.5 Configuration files](#) on page 3-51.

## 3.1 Overview of the V2M-MPS2 motherboard configuration process

The MCC, in association with the microSD card, configures the V2M-MPS2 motherboard during powerup or reset. Once the configuration process starts after application of power or a press of one of the RESET buttons, the configuration process completes without further intervention from the user.

The microSD card stores the board configuration files, including the `board.txt` and `config.txt` files. You can access the microSD card as a *Universal Serial Bus Mass Storage Device* (USBMSD)

The MCC:

- Reads the FPGA image from the microSD card and loads it into the FPGA.
- Sets the board oscillator frequencies using values from the `board.txt` file.
- Configures the FPGA SCC registers using values from the `board.txt` file
- Pre-loads the SRAM with the boot image that the `images.txt` file defines.

---

### Note

You must make the following pin assignments in the FPGA to enable the MCC to pre-load the boot image into the SRAM.

```
assign config_spiclk = CLCD_PDL[6];
assign config_spidi = CLCD_PDL[8];
assign CLCD_PDL[7] = config_spido;
```

---

At the start of the configuration process, the MCC reads the contents of the configuration EEPROM. The EEPROM contains the following information:

- Board HBI number.
- Board revision.
- Board variant.
- Number of FPGAs.
- The names of the current images in 8.3 format and the file creation dates.

---

### Note

The HBI number is a unique code that identifies the board. The root directories of the EEPROM and the microSD card contain sub-directories in the form *HBIBoardNumberBoardrevision*, for example HBI0263B.

---

There are two stages in programming and configuring the images into the FPGA:

1. The MCC compares the file names and dates in the EEPROM to the information in the configuration files in the microSD card. The microSD card contains the FPGA images and information about their creation dates.  
If the microSD card contains an updated image, the MCC validates it and updates the information in the EEPROM.

---

### Note

- The USB 2.0 Full Speed connection to the MCC supports MSD class enabling *Drag-and-Drop* for transferring new images to the microSD card. The microSD card appears in the file system as a device with removable storage.
  - The *HDD* LED illuminates during read or write accesses to the microSD card.
- 
2. The MCC loads the FPGA image into the FPGA.
  3. The MCC illuminates the *DONE* LED to indicate that configuration is complete.

## Related concepts

[2.5 USB 2.0 Full Speed interface on page 2-25.](#)

## 3.2 Configuration system

The V2M-MPS2 motherboard provides hardware infrastructure to enable board configuration during powerup or reset.

The following diagram shows the V2M-MPS2 motherboard configuration system.

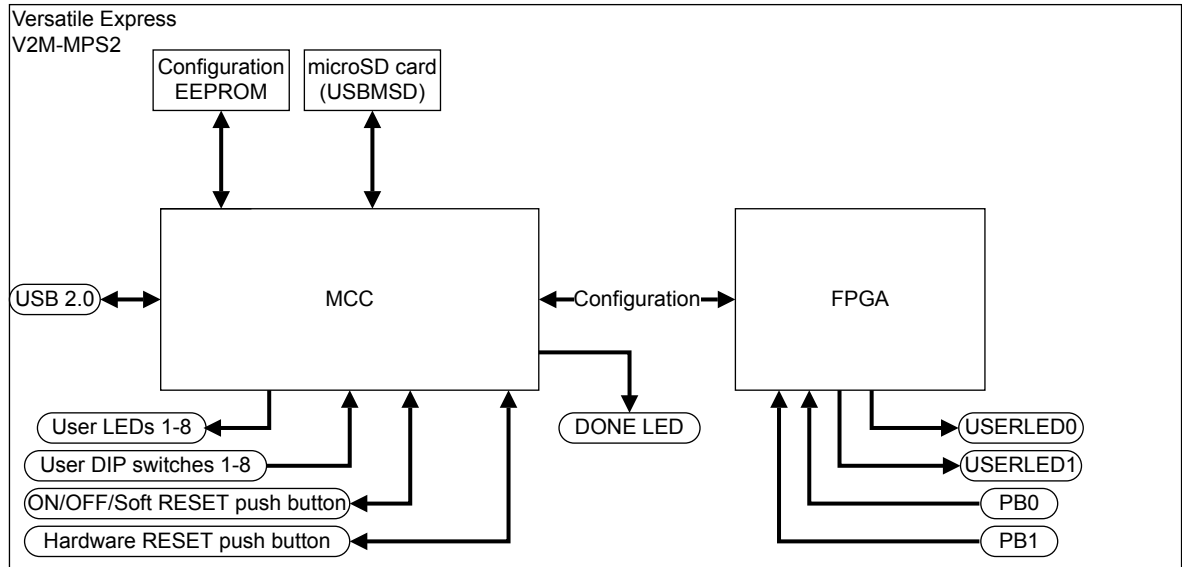


Figure 3-1 V2M-MPS2 motherboard configuration system

### Configuration port connected to an external workstation

If you connect an external workstation to the MCC USB 2.0 Full Speed port, you can access the configuration memory in the microSD card. You can then edit and copy configuration files and software images to the SD card.

### Related concepts

- [2.5 USB 2.0 Full Speed interface on page 2-25.](#)
- [3.5.2 config.txt generic motherboard configuration file on page 3-52.](#)
- [3.5.3 Contents of the V2M-MPS2 motherboard MB directory on page 3-52.](#)
- [3.5.4 Contents of the SOFTWARE directory on page 3-53.](#)
- [3.5.1 Overview of configuration files and microSD card directory structure on page 3-51.](#)

### 3.3 Powerup and configuration process

The power push buttons and configuration files control the sequence of events of the V2M-MPS2 motherboard powerup and configuration process.

The following figure shows the powerup and configuration process.

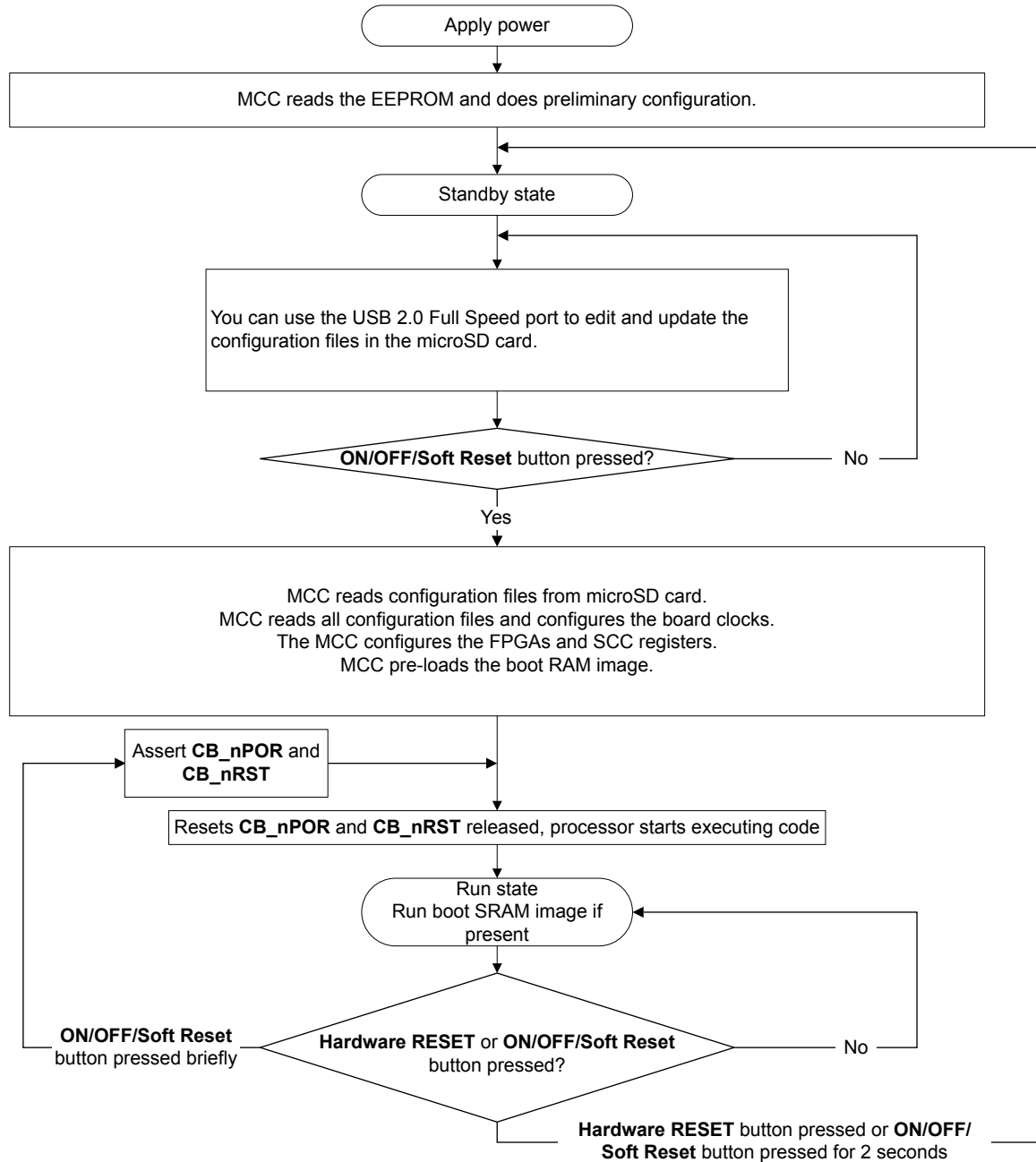


Figure 3-2 Powerup and configuration sequence

The V2M-MPS2 motherboard powerup and configuration sequence is:

1. The board applies power to the system.
2. The MCC powers the EEPROM and reads it to determine the HBI identification code for the board.
3. The system enters standby mode.
4. The system enables the microSD memory card and you can connect a workstation to the MCC USB 2.0 Full Speed port to edit existing configuration files or *Drag-and-Drop* new configuration files.
5. The system stays in standby state until you press the *ON/OFF/Soft RESET* push button.

6. The system loads the board configuration file:
  - The MCC reads the generic `config.txt` file.
  - The MCC searches the microSD card MB directory for the HBI0263x subdirectory that matches the board HBI code from the board EEPROM.
7. The next steps depend on the configuration files:
  - If the MCC finds configuration subdirectories that match the HBI code of the V2M-MPS2 motherboard, configuration continues and the MCC reads the `board.txt` file.
  - If the MCC does not find the correct configuration files, it records the failure to a log file on the microSD card. Configuration stops and the system re-enters standby state.
8. The MCC measures the board power supplies.
9. The MCC configures the board clocks and FPGA SCC registers.
10. If the MCC finds new software images, it loads them into the SRAM through the FPGA.
11. The MCC releases the system resets nPOR and nRST, the system enters RUN state.
12. Normal operation continues until a new event occurs:

#### **Related concepts**

- [3.5.2 `config.txt` generic motherboard configuration file on page 3-52.](#)
- [3.5.3 Contents of the V2M-MPS2 motherboard MB directory on page 3-52.](#)
- [3.5.4 Contents of the SOFTWARE directory on page 3-53.](#)
- [3.5.1 Overview of configuration files and microSD card directory structure on page 3-51.](#)

## 3.4 Reset push buttons

The V2M-MPS2 motherboard provides two push buttons which initiate reset and configuration. The two reset push buttons are the ON/OFF/Soft RESET and the Hardware RESET buttons. This section describes the use and functions of these push buttons.

This section contains the following subsections:

- [3.4.1 ON/OFF Soft RESET button on page 3-50.](#)
- [3.4.2 Hardware RESET button on page 3-50.](#)

### 3.4.1 ON/OFF Soft RESET button

The V2M-MPS2 motherboard provides an ON/OFF/Soft RESET push button that enables you to perform a software reset of the system.

You initiate a software reset of the system by briefly pressing the *ON/OFF Soft RESET* button during run time. The MCC performs a software reset of the FPGA and resets the devices on the board. It does not perform a full reconfiguration of the FPGA.

The software reset sequence is as follows:

1. You briefly press the ON/OFF/Soft RESET button.

————— **Caution** —————

If you press and hold the *ON/OFF Soft RESET* button for more than two seconds, the system enters the Standby State in the same way as pressing the *Hardware RESET* button.

2. The MCC asserts the **nRST** reset signal. It might also assert **nPOR** but this depends on the setting of the variable *ASSERTNPOR* in the configuration file *config.txt*.
3. The MCC releases **nPOR** if it is active depending on the setting of the variable *ASSERTNPOR* in the configuration file *config.txt*.
4. The MCC releases **nRST**.
5. The V2M-MPS2 motherboard enters the run state.

————— **Note** —————

The MCC does not read the configuration files or perform a board reconfiguration as a result of a software reset.

#### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

### 3.4.2 Hardware RESET button

The V2M-MPS2 motherboard provides a Hardware RESET push button that enables you to perform a hardware reset of the system.

You can change the operation of the board from ON to Standby by briefly pressing this button. This switches off the power to the board and resets the system to the default values.

If you then press the ON/OFF/Soft RESET push button, the system performs a full configuration and enters the run state.

#### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 3.5 Configuration files

This section describes the V2M-MPS2 motherboard configuration files in the microSD card which control the board powerup and configuration process.

This section contains the following subsections:

- [3.5.1 Overview of configuration files and microSD card directory structure on page 3-51.](#)
- [3.5.2 config.txt generic motherboard configuration file on page 3-52.](#)
- [3.5.3 Contents of the V2M-MPS2 motherboard MB directory on page 3-52.](#)
- [3.5.4 Contents of the SOFTWARE directory on page 3-53.](#)

### 3.5.1 Overview of configuration files and microSD card directory structure

Because the V2M-MPS2 motherboard microSD card is non-volatile memory, it is only necessary to load new configuration files if you change the system configuration. The V2M-MPS2 motherboard contains default configuration files.

If you connect a workstation to the MCC USB 2.0 Full Speed port, the configuration memory device, the SD card, appears as a *USB Mass Storage Device* (USBMSD) and you can add, edit or delete files.

You can use a standard text editor that produces DOS line endings to read and edit the board configuration files.

The following figure shows a typical example of the directory structure in the microSD card memory.

#### Caution

Files names and directory names are in 8.3 format:

- File names that you generate must be in lower case.
- Directory names must be in upper case.
- All configuration files must end in DOS line endings (0x0D/0x0A).

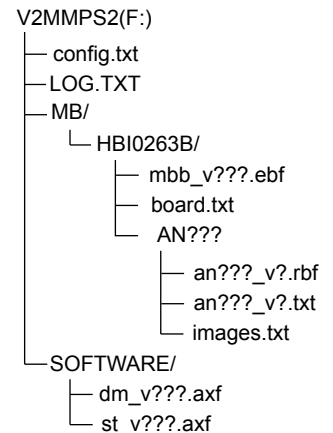


Figure 3-3 Example USBMSD directory structure

The directory structure and file name format ensure that each image is matched to the correct target device defined in the board configuration EEPROM.

- `config.txt` is the generic configuration file for all motherboards. This file applies to all Versatile Express motherboards including the V2M-MPS2 motherboard.
- The MB directory contains subdirectories for any motherboard variants that might be present in the system. The subdirectory names match the HBI codes for the specific motherboard variants. The files in this directory contain clock, register and other settings for the motherboard.
- The SOFTWARE directory contains application files that the MCC can load into the ZBT SSRAM or PSRAM on the board. The `images.txt` file defines the file that the MCC loads.

### Related concepts

[2.5 USB 2.0 Full Speed interface on page 2-25.](#)

#### 3.5.2 `config.txt` generic motherboard configuration file

You can use the V2M-MPS2 motherboard USB 2.0 Full Speed port to update the generic Versatile Express configuration file `config.txt` from your workstation to the root directory of the microSD card.

The following example shows a configuration file that you can load into the configuration flash memory.

##### Note

- Colons (:) indicate the end of commands and must be separated by a space character (0x20) from the value fields.
- Semicolons (;) indicate comments.

```
TITLE: Versatile Express V2M-MPS2 configuration file

[CONFIGURATION]
AUTORUN: FALSE           ;Auto Run from power on
AUTORUNDELAY: 3          ;Delay in seconds to wait for key press to stop bootup
RTC: FALSE               ;TRUE = Enable RTC, FALSE = Disable RTC

ASSERTNPOR: TRUE         ;External resets assert nPOR
WDRESET: NONE            ;Watchdog reset options NONE/RESETMB/RESETDB

USB_REMOTE: TRUE         ;Selects remote command via USB

MACADDRESS: 0xFFFFFFFF   ;MAC Address
```

#### 3.5.3 Contents of the V2M-MPS2 motherboard MB directory

The V2M-MPS2 motherboard MB directory contains a configuration HBI subdirectory that matches the HBI code of the board.

The HBI subdirectory contains:

- A file of the form `mbb_vxxx.ebf`. This is an MCC BIOS image.
- A `board.txt` file that defines the MCC bios image.
- An application-specific subdirectory that contains the following board configuration files:
  - Image files for the FPGA and MCC on the board. These have `.rbf` extensions.
  - An `images.txt` file that defines the `.axf` files that the MCC loads into external memory during configuration.
  - An application note `.txt` file that defines the number of FPGAs on the board, the number of oscillators and their frequencies, FPGA and MCC image files and details of the SCC registers.

The following example shows a typical V2M-MPS2 motherboard configuration `board.txt` file.

```
BOARD: HBI0263
TITLE: Motherboard configuration file

[MCCS]
MBBIOS mbb_v201.ebf      ;MB BIOS IMAGE

[APPLICATION NOTE]
;APPFILE: AN382\an382_v2.txt ; - Cortex-M0
```

```
;APPFILE: AN383\an383_v2.txt      ; - Cortex-M0+
;APPFILE: AN384\an384_v2.txt      ; - Cortex-M1
APPFILE: AN385\an385_v2.txt      ; - Cortex-M3
;APPFILE: AN386\an386_v2.txt      ; - Cortex-M4
;APPFILE: AN387\an387_v2.txt      ; - Cortex-M0 Design Start
;APPFILE: AN399\an399_v2.txt      ; - Cortex-M7
;APPFILE: AN400\an400_v2.txt      ; - Cortex-M7 with CoreSight
```

The following example shows a typical V2M-MPS2 motherboard application note *.txt* file.

```
BOARD: HBI0263
TITLE: Application Note File

[FPGAS]
TOTALFPGAS: 1                      ;Total Number of FPGAS (Max : 1)
F0FILE: an385_v2.rbf               ;FPGA0 Filename
F0MODE: FPGA                       ;FPGA0 Programming Mode

[OSCCCLKS]
TOTALOSCCCLKS: 3
OSC0: 50.0                         ;OSC0 System clock in MHz
OSC1: 24.576                       ;OSC1 AACI clock in MHz
OSC2: 25.0                         ;OSC2 MISC clock in MHz

[SCC REGISTERS]
TOTALSYSCONS: 1                   ;Total Number of SYSCON registers defined
SYSCON: 0x000 0x00000001          ;SCC enable ZBT remap
```

The following example shows a typical V2M-MPS2 motherboard *images.txt* file.

```
TITLE: Versatile Express V2M-MPS2 software image configuration file

[IMAGES]
TOTALIMAGES: 1                    ;Number of Images (Max : 32)

IMAGE0ADDRESS:0x00000000           ;Please select the required executable program
IMAGE0FILE: \SOFTWARE\dm_v111.axf  ; - demo
;IMAGE0FILE: \SOFTWARE\st_v111.axf ; - selftest
```

### 3.5.4 Contents of the SOFTWARE directory

The SOFTWARE directory contains applications that you can load into the ZBT SSRAM or PSRAM memory.

You can create new applications and load them into the RAM on the V2M-MPS2 motherboard. Application images are typically boot images or demo programs and have a *.axf* extension.

Typical applications in this directory are:

- *dm\_v102.axf* board demonstration software.
- *st\_v103.axf* board test software.
- *user.axf* user test software.

# Chapter 4

## Programmers Model

This chapter describes the programmers model of the Versatile Express V2M-MPS2 motherboard.

It contains the following sections:

- [4.1 About this programmers model on page 4-55.](#)
- [4.2 Memory map on page 4-56.](#)
- [4.3 Register summary on page 4-57.](#)
- [4.4 SCC register descriptions on page 4-58.](#)
- [4.5 System configuration registers on page 4-65.](#)

## 4.1 About this programmers model

The following information applies to the SCC registers and to the system configuration registers or SYS\_CFG registers:

- The base address is not fixed, and can be different for any particular system implementation. The offset of each register from the base address is fixed.
- Do not attempt to access reserved or unused address locations. Attempting to access these locations can result in UNPREDICTABLE behavior.
- Unless otherwise stated in the accompanying text:
  - Do not modify undefined register bits.
  - Ignore undefined register bits on reads.
  - All register bits are reset to a logic 0 by a system or powerup reset.
  - [Table 4-1 V2M-MPS2 motherboard SCC register summary on page 4-57](#) describes register access type as follows:

RW Read and write.

RO Read only.

WO Write only.

## 4.2 Memory map

The image that you load into the FPGA on the V2M-MPS2 motherboard determines the board memory map. See the relevant SMM Application Note for an example memory map for the V2M-MPS2 motherboard.

## 4.3 Register summary

This section summarizes the V2M-MPS2 motherboard SCC registers and system configuration registers characteristics.

The following table shows the registers in offset order from the base memory address.

**Table 4-1 V2M-MPS2 motherboard SCC register summary**

Offset	Name	Type	Reset	Width	Comment
0x000	SCC_CFG0	RW	0x00000000	32	Remaps block RAM to ZBT.
0x004	SCC_CFG1	RW	0x00000000	32	Controls the MCC user LEDs.
0x008	-	-	-	-	Reserved. Do not write to or read from this register.
0x00C	SCC_CFG3	RO	0x00000000	32	Denotes the state of the MCC user switches.
0x010	SCC_CFG4	RO	0x00000000	32	Denotes the board revision.
0x014 - 0x09C	-	-	-	-	Reserved. Do not write to or read from these registers
0x0A0	SYS_CFGDATA_RTN	RO	0x00000000	32	This is one oUser data return register for reads from board peripherals.
0x0A4	SYS_CFGDATA_OUT	RW	0x00000000	32	User data output register for writes to board peripherals.
0x0A8	SYS_CTRL	RW	0x00100000	32	Control register. Controls read and write operations.
0x0AC	SYS_CFGSTAT	RO	0x00000000	32	Status register. Shows status of read and write operations.
0x0AD - 0x0FC	-	-	-	-	Reserved. Do not write to or read from these registers.
0x100	SCC_DLL	RO	0xFFFC0000	32	DLL Lock Register
0x104 - 0xFF7	-	-	-	-	Reserved. Do not write to or read from these registers
0xFF8	SCC_AID	RO	0x03100708	32	Contains the FPGA build number, the target board of the FPGA build, and information about the SCC register implementation.
0xFFC	SCC_ID	RO	0x4104XXX1	32	Contains information about the FPGA image.

### Related concepts

[2.13 MCC FPGA serial interface on page 2-35.](#)

### Related references

- [4.4.2 SCC\\_CFG0 Register on page 4-58.](#)
- [4.4.3 SCC\\_CFG1 Register on page 4-59.](#)
- [4.4.4 SCC\\_CFG3 Register on page 4-59.](#)
- [4.4.5 SCC\\_CFG4 Register on page 4-60.](#)
- [4.5.2 SYS\\_CFGDATA\\_RTN Register on page 4-66.](#)
- [4.5.3 SYS\\_CFGDATA\\_OUT Register on page 4-66.](#)
- [4.5.4 SYS\\_CFGCTRL Register on page 4-67.](#)
- [4.5.5 SYS\\_CFGSTAT Register on page 4-68.](#)
- [4.4.6 SCC\\_DLL Register on page 4-61.](#)
- [4.4.7 SCC\\_AID Register on page 4-62.](#)
- [4.4.8 SCC\\_ID Register on page 4-63.](#)

## 4.4 SCC register descriptions

This section describes the SCC registers on the V2M-MPS2 motherboard FPGA.

This section contains the following subsections:

- [4.4.1 Overview of SCC registers on page 4-58.](#)
- [4.4.2 SCC\\_CFG0 Register on page 4-58.](#)
- [4.4.3 SCC\\_CFG1 Register on page 4-59.](#)
- [4.4.4 SCC\\_CFG3 Register on page 4-59.](#)
- [4.4.5 SCC\\_CFG4 Register on page 4-60.](#)
- [4.4.6 SCC\\_DLL Register on page 4-61.](#)
- [4.4.7 SCC\\_AID Register on page 4-62.](#)
- [4.4.8 SCC\\_ID Register on page 4-63.](#)

#### 4.4.1 Overview of SCC registers

The MCC on the V2M-MPS2 motherboard writes to the SCC registers in the FPGA at powerup with the values that the configuration board file defines.

During run-time, the MCC polls the LED and switch values to ensure that they match the SCC\_CFG1 and SCC\_CFG2 register values. The MCC updates the LEDs to match the SCC\_CFG1 register values and updates the SCC\_CFG2 register to match the user switches.

The SCC\_CFG3 register contains board revision information.

The MCC reads the SYS\_DLL, SCC\_AID and SCC\_ID registers to determine whether the PLLs in the FPGA are locked and to determine the loaded FPGA image.

#### 4.4.2 SCC\_CFG0 Register

The SCC\_CFG0 Register characteristics are:

## Purpose

Remaps block RAM to ZBT.

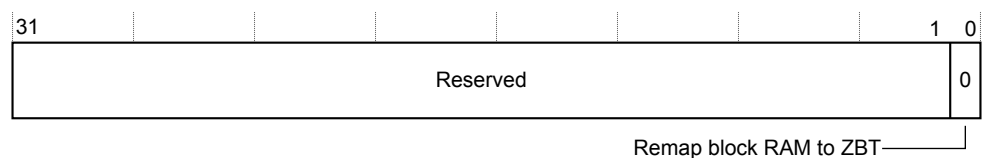
## Usage constraints

There are no usage constraints.

## Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



### Figure 4-1 SCC\_CFG0 Register bit assignments

The following table shows the bit assignments.

**Table 4-2 SCC\_CFG0 Register bit assignments**

Bits	Name	Function
[31:1]	-	Reserved. Do not write to these bits.
[0]	REMAP_BLOCK_RAM_TO_ZBT	This bit remaps block RAM to ZBT: <ul style="list-style-type: none"> <li>• 0b0 Does not remap block RAM to ZBT.</li> <li>• 0b1 Remaps block RAM to ZBT.</li> </ul>

#### Related concepts

[4.3 Register summary on page 4-57.](#)

#### 4.4.3 SCC\_CFG1 Register

The SCC\_CFG1 Register characteristics are:

##### Purpose

Controls the USER LEDS on the V2M-MPS2 motherboard. The MCC polls this SCC register in the FPGA and updates the appropriate LEDs.

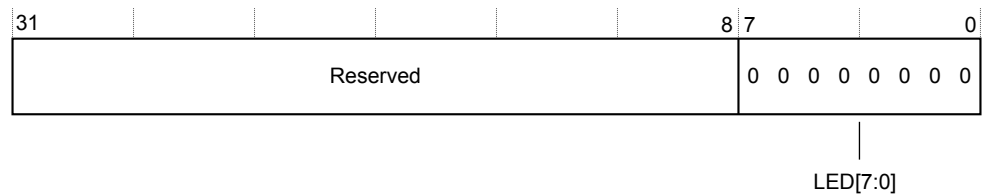
##### Usage constraints

There are no usage constraints.

##### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-2 SCC\_CFG1 Register bit assignments**

The following table shows the bit assignments.

**Table 4-3 SCC\_CFG1 Register bit assignments**

Bits	Name	Function
[31:8]	-	Reserved. Do not write to these bits.
[7:0]	LED[7:0]	These bits control the individual USER LEDS: <ul style="list-style-type: none"> <li>• 0b0 Off</li> <li>• 0b1 On</li> </ul>

#### Related concepts

[2.11 User switches and user LEDs on page 2-31.](#)

[4.3 Register summary on page 4-57.](#)

#### 4.4.4 SCC\_CFG3 Register

The SCC\_CFG3 Register characteristics are:

## Purpose

Determines the state of the eight user switches on the V2M-MPS2 motherboard. The MCC polls the switches and updates this SCC register in the FPGA.

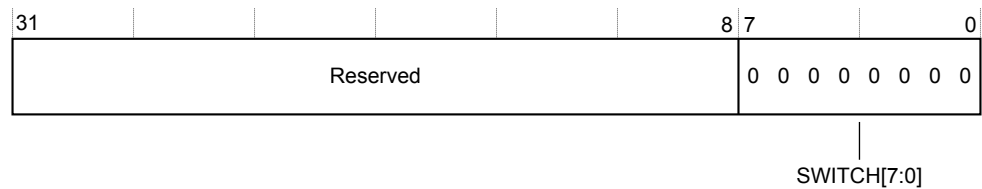
## Usage constraints

The SCC\_CFG3 Register is read-only.

## Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-3 SCC\_CFG3 Register bit assignments**

The following table shows the bit assignments.

#### Table 4-4 SCC\_CFG3 Register bit assignments

Bits	Name	Function
[31:8]	-	Reserved. Do not write to these bits.
[7:0]	SW[7:0]	These bits indicate the state of the user switches: <ul style="list-style-type: none"> <li>• 0b0 Off</li> <li>• 0b1 On</li> </ul>

## Related concepts

*2.11 User switches and user LEDs on page 2-31.*

4.3 Register summary on page 4-57.

#### 4.4.5 SCC\_CFG4 Register

The SCC\_CFG4 Register characteristics are:

## Purpose

Contains V2M-MPS2 motherboard revision information.

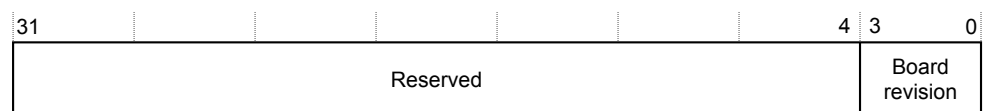
## Usage constraints

The SCC\_CFG4 Register is read-only.

## Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-4 SCC\_CFG4 Register bit assignments**

The following table shows the bit assignments.

**Table 4-5 SCC\_CFG4 Register bit assignments**

Bits	Name	Function
[31:4]	-	Reserved. Do not write to these bits.
[3:0]	Board revision	<ul style="list-style-type: none"> <li>• 0000 = A</li> <li>• 0001 = B</li> <li>• 0010 = C</li> </ul>

#### Related concepts

[4.3 Register summary on page 4-57.](#)

#### 4.4.6 SCC\_DLL Register

The SCC\_DLL Register characteristics are:

##### Purpose

Digital Locked Loop (DLL) lock status bits from the FPGA. You read from it to determine the lock status of the DLLs. You can ignore the lock status of some of the DLLs by writing to the DLL\_LOCK\_MASK bits. The DLLs you ignore depends upon the values of these bits.

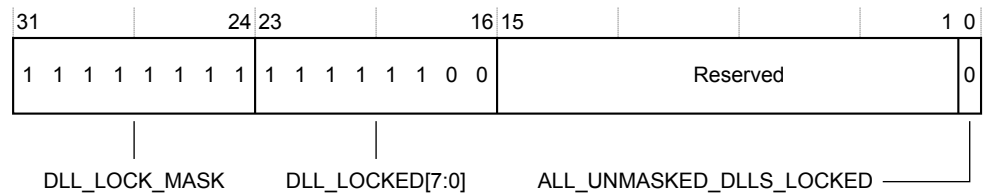
##### Usage constraints

The SCC\_DLL Register is read-only.

##### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-5 SCC\_DLL Register bit assignments**

The following table shows the bit assignments.

**Table 4-6 SCC\_DLL Register bit assignments**

Bits	Name	Function
[31:24]	DLL_LOCK_MASK[7:0]	<p>These bits mask bits[23:16], that is, you ignore the corresponding DLL_LOCKED bits.</p> <ul style="list-style-type: none"> <li>• <b>0b0:</b> <ul style="list-style-type: none"> <li>— Mask DLL lock status. Corresponding DLL_LOCKED bit, that is the lock status of the corresponding DLL, does not contribute to the value of bit[0].</li> </ul> </li> <li>• <b>0b1:</b> <ul style="list-style-type: none"> <li>— Do not mask DLL lock status. Corresponding DLL_LOCKED bit, that is the lock status of the corresponding DLL, contributes to the value of bit[0].</li> </ul> </li> </ul>
BIT[23:16]	DLL_LOCKED[7:0]	<p>These bits indicate the lock statuses of the individual DLLs:</p> <ul style="list-style-type: none"> <li>• <b>0b0</b> DLL unlocked.</li> <li>• <b>0b1</b> DLL locked.</li> </ul>

**Table 4-6 SCC\_DLL Register bit assignments (continued)**

Bits	Name	Function
[15:1]	-	Reserved. Do not write to these bits.
[0]	ALL_UNMASKED_DLLS_LOCKED	This bit indicates whether or not all unmasked DLLs are locked: <ul style="list-style-type: none"> <li>• 0b0 One or more unmasked DLLs are not locked.</li> <li>• 0b1 All unmasked DLLs are locked.</li> </ul>

#### Related concepts

[4.3 Register summary on page 4-57.](#)

### 4.4.7 SCC\_AID Register

The SCC\_AID Register characteristics are:

#### Purpose

The SCC\_AID Register contains the FPGA build number, the target board of the FPGA build, and information about the SCC register implementation.

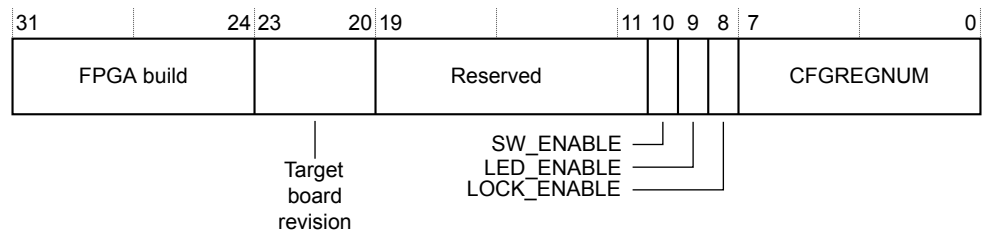
#### Usage constraints

The SCC\_AID Register is read-only.

#### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-6 SCC\_AID Register bit assignments**

The following table shows the bit assignments.

**Table 4-7 SCC\_AID Register bit assignments**

Bits	Name	Function
[31:24]	Build	FPGA build number.
[23:20]	Target board revision.	These bits indicate the target board revision of the FPGA build. <ul style="list-style-type: none"> <li>• 0000 = A</li> <li>• 0001 = B</li> <li>• 0010 = C</li> </ul>
[19:11]	-	Reserved. Do not write to these bits.
[10]	SW_ENABLE	This bit indicates whether the system supports the SCC_SW_READ command.
[9]	LED_ENABLE	This bit indicates whether the system supports the SCC_LED_READ command.
[8]	LOCK_ENABLE	This bit indicates whether the system supports the SCC_LOCK_READ command.
[7:0]	CFGREGNUM	These bits indicate the number of user registers you can define. The maximum number is eight.

## Related concepts

[4.3 Register summary on page 4-57.](#)

### 4.4.8 SCC\_ID Register

The SCC\_ID Register characteristics are:

#### Purpose

The MCC reads this register and uses the information to determine information about the design in the FPGA that you can read through the V2M-MPS2 motherboard SYS\_CFG interface.

#### Usage constraints

The SCC\_ID Register is Read-only.

#### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.

31	24	23	20	19	16	15				0
Implementer				Variant		Architecture		AN		Revision

**Figure 4-7 SCC\_ID Register bit assignments**

The following table shows the bit assignments.

**Table 4-8 SCC\_ID Register bit assignments**

Bits	Name	Function
[31:24]	Implementer	Implementer ID. 0x41 = ARM.
[23:20]	Variant	Product variant or major revision number: <div style="text-align: center;"> <b>Note</b> </div> This refers to the core or cluster image in the FPGA and is the x in <i>rxpy</i>
[19:16]	IP Architecture	Architecture. 0x04 = AHB
[15:4]	AN	Application Note number. <ul style="list-style-type: none"> <li>382 AN382: V2M-M0 Application Note</li> <li>383 AN383: V2M-M0+ Application Note</li> <li>384 AN384: V2M-M1 Application Note</li> <li>385 AN385: V2M-M3 Application Note</li> <li>386 AN386: V2M-M4 Application Note</li> <li>387 AN387: V2M-M0 Design Start Application Note</li> <li>399 AN399: V2M-M7 Application Note</li> <li>400 AN400: V2M-M7 Application Note with CoreSight</li> </ul>
[3:0]	Revision	Product revision or minor revision number. <div style="text-align: center;"> <b>Note</b> </div> This refers to the core or cluster image in the FPGA and is the y in <i>rxpy</i>

## Related concepts

[4.3 Register summary on page 4-57.](#)

## Related concepts

[2.13 MCC FPGA serial interface](#) on page 2-35.

## 4.5 System configuration registers

This section describes system configuration registers, that is the SYS\_CFG registers.

This section contains the following subsections:

- [4.5.1 Overview of system configuration registers on page 4-65.](#)
- [4.5.2 SYS\\_CFGDATA\\_RTN Register on page 4-66.](#)
- [4.5.3 SYS\\_CFGDATA\\_OUT Register on page 4-66.](#)
- [4.5.4 SYS\\_CFGCTRL Register on page 4-67.](#)
- [4.5.5 SYS\\_CFGSTAT Register on page 4-68.](#)

### 4.5.1 Overview of system configuration registers

The system configuration registers enable communication between the MCC and the FPGA.

The configuration, or SYS\_CFG, registers are: SYS\_CFGDATA\_RTN, SYS\_CFGDATA\_OUT, SYS\_CFGCTRL and SYS\_CFGSTAT. These registers implement and control write and read operations when the application software inside the FPGA writes and reads configuration information to and from peripherals on the V2M-MPS2 motherboard.

The following block of example pseudo code shows a write operation to write 24MHz to clock generator 1.

```
//Write frequency value to the user data out register.
1: Set SYS_CFGDATAT_OUT = 24000000

//Write to control register. Initiate write process and select clock generator 1 and
oscillator function.
//This clears Configuration error bit and Configuration complete bit of SYS_CFGSTAT
Register.
2: Set SYS_CFGCTRL    Start = 1; nREAD_Write_access = 1; Function = 1; Device = 1;

//Read status register to determine status of of write operation.
3: Read    SYS_CFGSTAT[Configuration error bit, Configuration complete bit]

    If ( Configuration error bit = 1 )
        return TRANSACTION FAIL;

    If ( Configuration error bit = 0 AND Configuration complete bit = 1)
        return TRANSACTION OK;

    If ( Configuration error bit = 0 AND Configuration complete bit = 0)
        GOTO 1;
```

The following block of example pseudo code show a read operation to read the frequency of clock generator 2.

```
//Write to control register. Initiate read process and select clock generator 2 and
oscillator function.
//This clears Configuration error bit and Configuration complete bit of SYS_CFGSTAT
Register.
1: Set SYS_CFGCTRL    Start = 1; nREAD_Write_access = 0; Function = 1; Device = 2;

//Read status register to determine status of of read operation.
2: Read    SYS_CFGSTAT[Configuration error bit, Configuration complete bit]

    If ( Configuration error bit = 1 )
        return TRANSACTION FAIL;

    If ( Configuration error bit = 0 AND Configuration complete bit = 1)
        return TRANSACTION OK;

    If ( Configuration error bit = 0 AND Configuration complete bit = 0)
        GOTO 1;
```

## 4.5.2 SYS\_CFGDATA\_RTN Register

The SYS\_CFGDATA\_RTN Register characteristics are:

### Purpose

The MCC writes data to the SYS\_CFGDATA\_RTN Register during a read operation. This data represents the value that the addressed V2M-MPS2 motherboard component returns as a result of the read operation, for example a clock generator frequency.

### Usage constraints

The SYS\_CFGDATA\_RTN register is read-only to the application software in the FPGA.

### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.

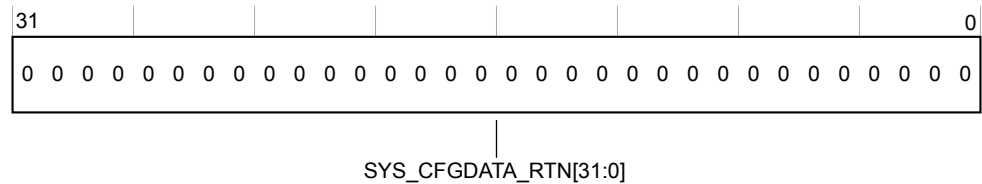


Figure 4-8 SYS\_CFGDATA\_RTN Register bit assignments

The following table shows the bit assignments.

Table 4-9 SYS\_CFGDATA\_RTN Register bit assignments

Bits	Name	Function
[31:0]	SYS_CFGDATA_RTN	User data register return bits.

### Related concepts

[4.3 Register summary on page 4-57.](#)

## 4.5.3 SYS\_CFGDATA\_OUT Register

The SYS\_CFGDATA\_OUT Register characteristics are:

### Purpose

The application software in the FPGA writes data to the SYS\_CFGDATA\_OUT Register during a write operation. This data represents a value or function that the write operation sends to the addressed V2M-MPS2 motherboard component, for example a frequency value to a clock generator.

### Usage constraints

There are no usage constraints.

### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.

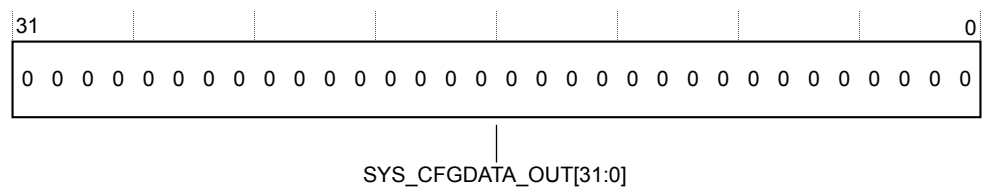


Figure 4-9 SYS\_CFGDATA\_OUT Register bit assignments

The following table shows the bit assignments.

**Table 4-10 SYS\_CFGDATA\_OUT Register bit assignments**

Bits	Name	Function
[31:0]	SYS_CFGDATA_OUT	User data register output bits.

#### Related concepts

[4.3 Register summary on page 4-57.](#)

#### 4.5.4 SYS\_CFGCTRL Register

The SYS\_CFGCTRL Register characteristics are:

##### Purpose

The SYS\_CFGCTRL Register controls write and read data transfer between the MCC and the SCC interface in the FPGA.

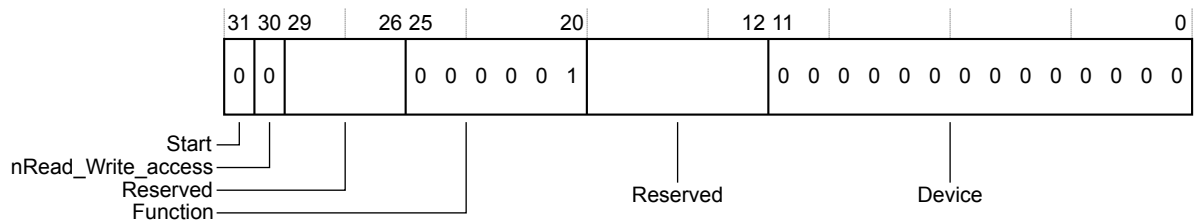
##### Usage constraints

There are no usage constraints.

##### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-10 SYS\_CFGCTRL Register bit assignments**

The following table shows the bit assignments.

**Table 4-11 SYSCFG\_CTRL Register bit assignments**

Bits	Name	Function
[31]	Start	Writing to this bit generates an interrupt.
[30]	nRead_Write_access	<ul style="list-style-type: none"> <li>0b0 Read access</li> <li>0b1 Write access</li> </ul>
[29:26]	-	Reserved. Do not write to these bits.
[25:20]	Function	These bits support the following function: <ul style="list-style-type: none"> <li>0b000001 Clock generator</li> </ul>
[19:12]	-	Reserved. Do not write to these bits.
[11:0]	Device	Selects device to write to or read from: <ul style="list-style-type: none"> <li>0x000 Clock generator 0</li> <li>0x001 Clock generator 1</li> <li>0x002 Clock generator 2</li> </ul>

#### Related concepts

[4.3 Register summary on page 4-57.](#)

## 4.5.5 SYS\_CFGSTAT Register

The SYS\_CFGSTAT Register characteristics are:

### Purpose

The SYS\_CFGSTAT Register contains system configuration status information about read and write operations between the application software in the FPGA and the V2M-MPS2 motherboard peripherals.

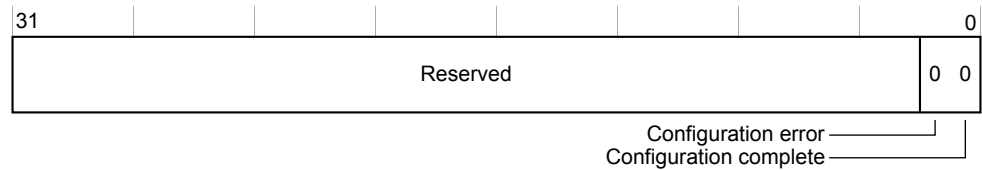
### Usage constraints

The SYS\_CFGSTAT Register is read-only.

### Configurations

Available in all V2M-MPS2 motherboard configurations.

The following figure shows the bit assignments.



**Figure 4-11 SYS\_CFGSTAT Register bit assignments**

The following table shows the bit assignments.

**Table 4-12 SYS\_CFGSTAT Register bit assignments**

Bits	Name	Function
[31:2]	-	Reserved. Do not write to these bits.
[1]	Configuration error	A write to SYS_CFGCTRL clears this bit. <ul style="list-style-type: none"> <li>• 0b0 Configuration successful</li> <li>• 0b1 Configuration failed</li> </ul>
[0]	Configuration complete	A write to SYS_CFGCTRL clears this bit. <ul style="list-style-type: none"> <li>• 0b0 Configuration not complete</li> <li>• 0b1 Configuration complete</li> </ul>

### Related concepts

[4.3 Register summary on page 4-57.](#)

# Chapter 5

## Signal Descriptions

This chapter describes the signals present at the interface connectors of the Versatile Express V2M-MPS2 motherboard

It contains the following sections:

- [5.1 Debug connectors](#) on page 5-70.
- [5.2 Expansion connectors](#) on page 5-75.
- [5.3 CLCD connector](#) on page 5-77.
- [5.4 USB 2.0 connector](#) on page 5-78.
- [5.5 UART connector](#) on page 5-79.
- [5.6 SPI connector](#) on page 5-80.
- [5.7 VGA connector](#) on page 5-81.
- [5.8 Audio connectors](#) on page 5-82.
- [5.9 Ethernet connector](#) on page 5-83.
- [5.10 12V power connector](#) on page 5-84.

## 5.1 Debug connectors

This section describes the V2M-MPS2 motherboard connectors that support P-JTAG processor debug, F-JTAG FPGA debug, 16-bit Trace, 4-bit Trace and SWD. This section describes the connectors and lists their signals.

This section contains the following subsections:

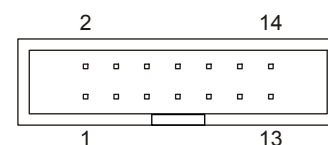
- [5.1.1 JTAG 14 connector on page 5-70.](#)
- [5.1.2 ARM JTAG 20 connector on page 5-71.](#)
- [5.1.3 CoreSight™ 10 connector on page 5-72.](#)
- [5.1.4 CoreSight™ 20 connector on page 5-72.](#)
- [5.1.5 MICTOR 38 connector on page 5-73.](#)

### 5.1.1 JTAG 14 connector

The V2M-MPS2 motherboard provides one F-JTAG, ILA, connector that supports FPGA debug. It enables you to connect an ILA device, such as SignalTap II, to a hard FPGA JTAG chain in the FPGA and debug your design.

The JTAG 14 connector connects to general purpose pins on the FPGA. The availability of F-JTAG depends upon the design which you implement in the FPGA. The V2M-MPS2 motherboard labels this connector as *FJTAG*.

The following figure shows the JTAG 14 connector.



**Figure 5-1 JTAG 14 connector**

The following table shows the F-JTAG connector pin mapping for each ILA signal on the JTAG 14 connector J24.

**Table 5-1 JTAG 14 connector, J24, signal list**

Pin	Signal	Pin	Signal
1	GND	2	+3V_EXT
3	GND	4	FPGA_TMS
5	GND	6	FPGA_TCK
7	GND	8	FPGA_TDO
9	GND	10	FPGA_TDI

#### Note

- Pins 4, 8 and 10 have pullup resistors to **3V**.
- Pin 6 has a pulldown resistor to **GND**.

#### Related concepts

[2.15.2 F-JTAG on page 2-40.](#)

#### Related references

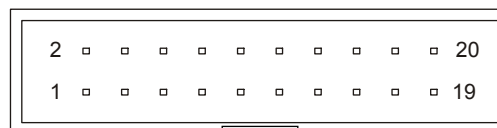
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

### 5.1.2 ARM JTAG 20 connector

The V2M-MPS2 motherboard provides one 3V 20-pin IDC connector that supports P-JTAG processor debug to enable connection of DSTREAM or a compatible third-party debugger. The connector also supports SWD.

The ARM JTAG 20 connector connects to general purpose pins on the FPGA. The availability of P-JTAG or SWD depends upon the design which you implement in the FPGA. The V2M-MPS2 motherboard labels this connector as *PJTAG*.

The following figure shows the ARM JTAG 20 connector.



**Figure 5-2 ARM JTAG 20 connector**

The following table shows the pin mapping for each SWD and P-JTAG signal on the ARM JTAG 20 connector J4.

**Table 5-2 ARM JTAG 20 connector, J4, signal list**

Pin	Signal	Pin	Signal
1	3V0_OUT	2	3V0_OUT -optional
3	nTRST	4	GND
5	TDI	6	GND
7	SWDIO/TMS	8	GND
9	SWDCLK/TCK	10	GND
11	GND/RTCK	12	GND
13	SWO/TDO	14	GND
15	nSRST	16	GND
17	NC/DBGRQ	18	GNDDETECT
19	NC/DBACK	20	GND

#### Note

- The V2M-MPS2 motherboard does not support adaptive clocking. The board ties the **RTCK** signal low.
- Pins 3, 5, 7, 13, 15 and 18 have pullup resistors to 3V.
- Pin 9 has a pulldown resistor to **GND**.

#### Related concepts

[2.15.3 P-JTAG on page 2-40.](#)

[2.15.6 Serial Wire Debug on page 2-41.](#)

#### Related references

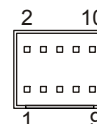
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

### 5.1.3 CoreSight™ 10 connector

The V2M-MPS2 motherboard provides one 3V 10-pin IDC connector. This connector supports P-JTAG processor debug to enable connection of DSTREAM or a compatible third-party debugger. This connector also support SWD.

The CoreSight 10 connector connects to general purpose pins on the FPGA. The availability of P-JTAG or SWD depends upon the design which you implement in the FPGA. The V2M-MPS2 motherboard labels this connector as *PJTAG*

The following figure shows the CoreSight 10 connector.



**Figure 5-3 CoreSight 10 connector**

The following table shows the pin mapping for each SWD and P-JTAG signal on the CoreSight 10 connector J11.

**Table 5-3 CoreSight 10 connector, J11, signal list**

Pin	Signal	Pin	Signal
1	3V0_OUT	2	SWDIO/TMS
3	GND	4	SWDCLK/TCK
5	GND	6	SWO/TDO
7	KEY	8	NC/TDI
9	GNDDETECT	10	nSRST

---

**Note**

- Pins 2, 6, 8 and 10 have pullup resistors to **3V**.
  - Pin 4 on both connectors have pulldown resistors to **GND**.
- 

#### Related concepts

[2.15.3 P-JTAG on page 2-40.](#)

[2.15.6 Serial Wire Debug on page 2-41.](#)

#### Related references

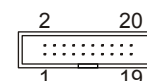
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

### 5.1.4 CoreSight™ 20 connector

The V2M-MPS2 motherboard provides one 3V 20-pin Cortex debug and ETM connector that supports P-JTAG processor debug to enable connection of DSTREAM or a compatible third-party debugger. The connector also supports SWD and 4-bit Trace.

The CoreSight 20 connector connects to general purpose pins on the FPGA. The availability of P-JTAG, SWD or 4-bit Trace depends upon the design which you implement in the FPGA. The V2M-MPS2 motherboard labels this connector as *PJTAG*

The following figure shows the CoreSight 20 connector.



**Figure 5-4 CoreSight 20 connector**

The following table shows the pin mapping for each SWD, P-JTAG and 4-bit Trace signal on the CoreSight 20 connector J1.

**Table 5-4 CoreSight 20 connector, J1, signal list**

Pin	Signal	Pin	Signal
1	3V0_OUT	2	SWDIO/TMS
3	GND	4	SWDCLK/TCK
5	GND	6	SWO/TDO/EXTa
7	Key1	8	NC/TDI/EXTb
9	GNDDETECT	10	nSRST
11	3V0_OUT	12	TRACECLK
13	3V0_OUT	14	TRACEDATA[0]
15	GND	16	TRACEDATA[1]
17	GND	18	TRACEDATA[2]
19	GND	20	TRACEDATA[3]

**Note**

- Pins 2, 6, 8, 9 and 10 have pullup resistors to **3V**.
- Pin 4 has a pulldown resistor to **GND**.

**Related concepts**

- [2.15.3 P-JTAG on page 2-40.](#)
- [2.15.4 4-bit Trace on page 2-41.](#)
- [2.15.6 Serial Wire Debug on page 2-41.](#)

**Related references**

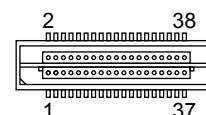
- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

### 5.1.5 MICTOR 38 connector

The V2M-MPS2 motherboard provides one 3V 38-pin MICTOR connector that supports P-JTAG processor debug to enable connection of DSTREAM or a compatible third-party debugger. The connector also supports 16-bit Trace and SWD.

The MICTOR 38 connector connects to general purpose pins on the FPGA. The availability of P-JTAG, SWD and 16-bit Trace depends upon the design which you implement in the FPGA. The V2M-MPS2 motherboard labels this connector as *PJTAG/TRACE*.

The following figure shows the MICTOR 38 connector.



**Figure 5-5 MICTOR 38 connector**

The following table shows the pin mapping for each P-JTAG, SWD and 16-bit Trace signal on the MICTOR 38 connector J6.

**Table 5-5 MICTOR 38 connector, J6, signal list**

Pin	Signal	Pin	Signal
1	NC	2	NC
3	NC	4	NC
5	<b>GND</b>	6	<b>TRACECLK</b>
7	<b>GND</b>	8	<b>GND</b>
9	NC/ <b>nSRST</b>	10	<b>GND</b>
11	<b>TDO/SWO</b>	12	<b>3V</b> reference
13	<b>RTCK</b>	14	<b>3V0_OUT</b>
15	<b>TCK/SWCLK</b>	16	<b>TRACEDATA[7]</b>
17	<b>TMS/SWDIO</b>	18	<b>TRACEDATA[6]</b>
19	<b>TDI</b>	20	<b>TRACEDATA[5]</b>
21	<b>nTRST</b>	22	<b>TRACEDATA[4]</b>
23	<b>TRACEDAT[15]</b>	24	<b>TRACEDATA[3]</b>
25	<b>TRACEDAT[14]</b>	26	<b>TRACEDAT[2]</b>
27	<b>TRACEDATA[13]</b>	28	<b>TRACEDATA[1]</b>
29	<b>TRACEDATA[12]</b>	30	<b>GND</b>
31	<b>TRACEDATA[11]</b>	32	<b>GNDDTECT</b>
33	<b>TRACEDATA[10]</b>	34	<b>3V</b> reference
35	<b>TRACEDATA[9]</b>	36	<b>TRACECTL</b>
37	<b>TRACEDATA[8]</b>	38	<b>TRACEDATA[0]</b>

**Note**

- Pins 9, 11, 17, 19 and 21 have pullup resistors to **3V**.
- Pin 15 has a pulldown resistor to **GND**.

**Related concepts**

- [2.15.3 P-JTAG on page 2-40.](#)
- [2.15.5 16-bit Trace on page 2-41.](#)
- [2.15.6 Serial Wire Debug on page 2-41.](#)

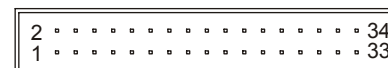
**Related references**

- [1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.2 Expansion connectors

The V2M-MPS2 motherboard provides two IDC header connectors that support user expansion.

The following figure shows the IDC expansion connector.



**Figure 5-6 IDC expansion connector**

The following two tables show the pin mappings for the IDC expansion connectors *EXP1*, component number J7, and *EXP2*, component number J8, which support general purpose IO expansion.

**Table 5-6 Expansion connector EXP1, J7, signal list**

Pin	Signal	Pin	Signal
1	EXP0	2	EXP14
3	EXP1	4	EXP15
5	EXP2	6	EXP16
7	EXP3	8	EXP17
9	EXP4 SI Clock output	10	EXP18
11	GND	12	GND
13	EXP5 SI Clock output	14	EXP19 Clock output
15	EXP6	16	EXP20
17	EXP7	18	EXP21
19	EXP8	20	EXP22
21	EXP9	22	EXP23
23	EXP10	24	GND
25	EXP11 SI Clock output	26	3V
27	3V	28	GND
29	GND	30	3V
31	EXP12	32	EXP24
33	EXP13	34	EXP25

Pins 9, 13, 14, and 25 of connector *EXP1* have source series terminating resistors. These resistors help to maintain the integrity of high slew-rate signals. ARM recommends these pins for use as clock outputs or sensitive data outputs in preference to other pins.

**Table 5-7 Expansion connector EXP2, J8, signal list**

Pin	Signal	Pin	Signal
1	EXP26	2	EXP40
3	EXP27	4	EXP41
5	EXP28	6	EXP42
7	EXP29	8	EXP43

**Table 5-7 Expansion connector EXP2, J8, signal list (continued)**

Pin	Signal	Pin	Signal
9	EXP30 Clock output	10	EXP44 Clock output
11	GND	12	GND
13	EXP31 Clock output	14	EXP45
15	EXP32	16	EXP46
17	EXP33	18	EXP47
19	EXP34	20	EXP48
21	EXP35	22	EXP49 Clock input
23	EXP36	24	GND
25	EXP37	26	3V
27	3V	28	GND
29	GND	30	3V
31	EXP38	32	EXP50 Clock output
33	EXP39	34	EXP51

**Note**

- Pins 9, 10, 13, 22 and 32 of connector *EXP2* have source series termination resistors. These resistors help to maintain the integrity of high-slew rate signals:
  - ARM recommends pins 9, 10, 13 and 32 for use as clock outputs or sensitive data outputs in preference to other pins.
  - ARM recommends pin 22 of connector *EXP2* for use as a clock input in preference to other pins.

**Related concepts**

[2.4 User expansion port on page 2-24.](#)

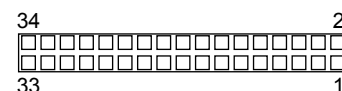
**Related references**

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.3 CLCD connector

The V2M-MPS2 motherboard provides a female IDC connector that supports CLCD.

The following figure shows the CLCD connector.



**Figure 5-7 CLCD connector**

### Note

A mark on the V2M-MPS2 motherboard indicates pin 1.

The following table shows the pin mapping for the CLCD connector J9.

**Table 5-8 CLCD connector, J9, signal list**

Pin	Signal	Pin	Signal
1	CLCD_T_SCL	2	CLCD_T_SDA
3	CLCD_CS	4	CLCD_RS
5	CLCD_WR_SCL	6	CLCD_RD
7	CLCD_RESET	8	CLCD_PD1
9	CLCD_PD2	10	CLCD_PD3
11	CLCD_PD4	12	CLCD_PD5
13	NC	14	NC
15	NC	16	NC
17	NC	18	NC
19	NC	20	NC
21	NC	22	NC
23	NC	24	GND
25	CLCD_BL_CTRL	26	3V
27	3V	28	GND
29	GND	30	3V
31	CLCD_SDO	32	CLCD_SDI
33	CLCD_T_CS	34	CLCD_T_SCK

### Note

Pins 1, 2, 5, 31, and 32 have 10k pullup resistors to 3V.

### Related concepts

[2.8 VGA and CLCD interfaces on page 2-28.](#)

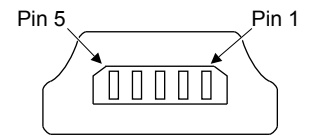
### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.4 USB 2.0 connector

The V2M-MPS2 motherboard provides one USB 2.0 mini-B connector that provides a USB 2.0 Full Speed port. This port supports configuration file editing in the microSD, virtual UART access to the FPGA, and CMSIS-DAP FPGA debug.

The following figure shows the USB 2.0 mini-B connector.



**Figure 5-8 USB 2.0 mini-B connector**

The following table shows the pin mapping for the USB 2.0 mini-B connector J14.

**Table 5-9 USB 2.0 mini-B connector, J14, signal list**

Pin	Signal	Pin	Signal
1	MSD5V	2	MSD_DMRAW
3	MSD_DPRAW	4	MSD_ID
5	GND	6	GND_EARTH

### Note

- The **GND\_EARTH** connection is the casing of the mini-B connector.

### Related concepts

[2.5 USB 2.0 Full Speed interface on page 2-25.](#)

### Related references

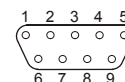
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.5 UART connector

The V2M-MPS2 motherboard provides one general-purpose female UART connector that supports access to the FPGA.

The general-purpose UART connector connects through a level-shifter to the FPGA. The meaning of the UART signals depends upon the design which you implement in the FPGA.

The following figure shows the general-purpose UART connector.



**Figure 5-9 General-purpose female UART connector**

The following table shows the pin mapping for the general-purpose UART connector J20.

**Table 5-10 general-purpose UART connector, J20, signal list**

Pin	Signal
1	NC
2	<b>SER_RX</b>
3	<b>SER_TX</b>
4	NC
5	<b>SER_GND</b>
6	NC
7	<b>SER_RTS</b>
8	<b>SER_CTS</b>
9	NC

**Note**

**SER\_RTS** loops back to connect to **SER\_CTS**.

### Related concepts

[2.7 UART interface on page 2-27.](#)

### Related references

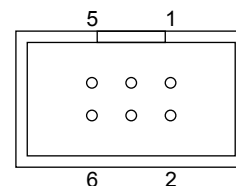
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.6 SPI connector

The V2M-MPS2 motherboard provides one general purpose SPI connector that supports access to the FPGA.

The general purpose SPI connector connects to the FPGA. The meaning of the SPI signals depends upon the design which you implement in the FPGA.

The following figure shows the general purpose SPI connector.



**Figure 5-10** general purpose SPI connector

The following table shows the pin mapping for the general purpose SPI connector J21.

**Table 5-11** General purpose SPI connector, J21, signal list

Pin	Signal
1	GND
2	SPI_SCK
3	SPI_MISO
4	SPI_nSS
5	3V_EXT
6	SPI_MOSI

### Related concepts

[2.6 SPI interface on page 2-26.](#)

### Related references

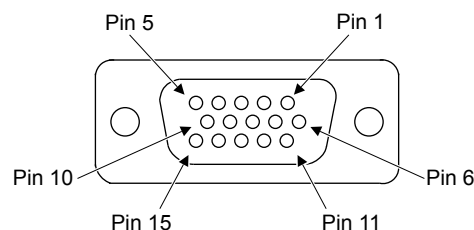
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.7 VGA connector

The V2M-MPS2 motherboard provides one VGA connector that supports VGA and CLCD output.

The VGA connector connects to the VGA controller which connects to general purpose pins on the FPGA. The availability of VGA or CLCD depends upon the design which you implement in the FPGA.

The following figure shows the VGA connector.



**Figure 5-11** VGA connector

The following table shows the pin mapping for the VGA connector J10.

**Table 5-12** VGA connector, J10, signal list

Pin	Signal	Pin	Signal
1	RED	2	GREEN
3	BLUE	4	NC
5	GND	6	GND
7	GND	8	GND
9	NC	10	GND
11	NC	12	NC
13	HSYNC	14	VSYNC
15	NC		

### Related concepts

[2.8 VGA and CLCD interfaces on page 2-28.](#)

### Related references

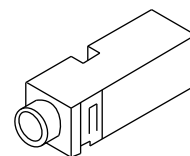
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.8 Audio connectors

The V2M-MPS2 motherboard provides two 3.5mm stereo jack connectors that connect to a low power stereo audio codec. The two connectors provide an independent line-level stereo input and an independent line-level stereo output.

The audio codec connects to general purpose pins on the FPGA. The availability of an audio controller depends upon the design which you implement in the FPGA.

The following figure shows the audio connector. *Audio In* is component number J32 and *Audio Out* is component number J33 on the board.



**Figure 5-12 Audio connector**

### Related concepts

[2.9 Audio interface on page 2-29.](#)

### Related references

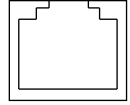
[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

## 5.9 Ethernet connector

The V2M-MPS2 motherboard provides one 100Mb/s Ethernet connector.

The Ethernet connector connects to the MAC/PHY on the V2M-MPS2 motherboard. The MAC/PHY connects to general purpose pins on the FPGA. The availability of the Ethernet function depends upon the design which you implement in the FPGA.

The following figure shows the Ethernet connector J31.



**Figure 5-13 Ethernet connector**

### Related concepts

[2.10 Ethernet interface](#) on page 2-30.

### Related references

[1.3 Location of components on the V2M-MPS2 motherboard](#) on page 1-14.

## 5.10 12V power connector

The V2M-MPS2 motherboard provides a Thru-hole DC power jack for connecting external power to the board.

Connect the external mains power supply unit, which ARM supplies, to the power jack.

Alternatively, you can connect an external 12V, +/- 10%, power supply to the power jack to supply power to the board.

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**Note**

The center pin is the positive side of the power supply.

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### Related concepts

[2.14 Power on page 2-38.](#)

### Related references

[1.3 Location of components on the V2M-MPS2 motherboard on page 1-14.](#)

# Appendix A.1

## Specifications

This chapter contains the electrical specification of the Versatile Express V2M-MPS2 motherboard and FPGA.

It contains the following sections:

- [A.1.1 Electrical specification on page Appx-A-86.](#)

## A.1.1 Electrical specification

This section provides information on the current characteristics of the Versatile Express V2M-MPS2 motherboard. It also supplies information to help you implement your design in the FPGA without exceeding the power and current ratings of the board and the temperature rating of the FPGA.

This section contains the following subsections:

- [FPGA current requirements on page Appx-A-86.](#)

### FPGA current requirements

See <http://altera.com> for software to help you calculate the current requirements for your particular application.

The following table shows the power available for each power domain, or group of power domains, of the FPGA.

**Table A-1 Available FPGA current**

FPGA power domain	Board power supply	Voltage	Maximum available current from board power supply	Comment
VCCO_3V0 VCCPD_3V0 VCCPGM VREF_3V	3V	3V	50mA	-
VBATT	VBAT	3V	-	-
VCC	1V1	1V1	2.5A	-
VCCAUX VCCO_2V5 VCCPD_2V5 VREF_2V5 VCCA_FPLL	2V5	2V5	1.5A	An analog filter on the V2M-MPS2 motherboard smooths the supply to the VCCA_FPLL domain.

#### Caution

- Some FPGA designs might exceed the current and temperature rating of the board. Therefore you must estimate the power requirements of such designs, using tools such as *Quartus II* before implementation.
- The FPGA package has a thermal resistance of 13.7° per Watt. The recommended maximum FPGA junction temperature is 85°C.

## Appendix B.2

# Revisions

This chapter describes the technical changes between released issues of this book.

It contains the following sections:

- [B.2.1 Revisions on page Appx-B-88](#).

## B.2.1 Revisions

This appendix describes the technical changes between released issues of this book.

**Table B-1 Issue A**

Change	Location	Affects
No changes, first release	-	-

**Table B-2 Difference between issue A and issue B**

Change	Location	Affects
Added application notes AN399 and AN400.	<a href="#">Additional reading on page 8</a>	All revisions of board.

**Table B-3 Differences between issue B and issue C**

Change	Location	Affects
Added CMSIS-DAP FPGA debug.	Throughout document	All revisions of board.
Corrected SCC register descriptions.	<a href="#">4.3 Register summary on page 4-57</a> <a href="#">4.4 SCC register descriptions on page 4-58</a>	All revisions of board.
Updated example configuration files.	<a href="#">3.5.3 Contents of the V2M-MPS2 motherboard MB directory on page 3-52</a>	All revisions of board.

**Table B-4 Difference between issue DDI0525C and issue 100112-0100-03**

Change	Location	Affects
Document number changed from ARM DDI0525 to 100112.	Throughout document	All revisions of board.