

# TMS320DM335

## Digital Media System-on-Chip (DMSoC)

Check for Samples: [TMS320DM335](#)

## 1 Digital Media System-on-Chip (DMSoC)

### 1.1 TMS320DM335 Features

- **Highlights**
  - High-Performance Digital Media System-On-Chip (DMSoC)
  - Up to 216-MHz ARM926EJ-S™ Clock Rate
  - Digital HDTV (720p/1080i) output for connection to external encoder
  - Video Processing Subsystem
    - Hardware IPIPE for Real-Time Image Processing
    - Up to 14-bit CCD/CMOS Digital Interface
    - Histogram Module
    - Resize Image 1/16x to 8x
    - Hardware On-Screen Display
    - Up to 75-MHz Pixel Clock
    - Composite NTSC/PAL video encoder output
  - Peripherals include DDR and mDDR SDRAM, 2 MMC/SD/SDIO and SmartMedia Flash Card Interfaces, USB 2.0, 3 UARTs and 3 SPIs
  - Enhanced Direct-Memory-Access (EDMA)
  - Configurable Power-Saving Modes
  - On-Chip ARM ROM Bootloader (RBL) to Boot From NAND Flash, MMC/SD, or UART
  - 3.3-V and 1.8-V I/O, 1.3-V Core
  - Debug Interface Support
  - Up to 104 General-Purpose I/O (GPIO) Pins
  - 337-Pin Ball Grid Array at 65 nm Process Technology
- High-Performance Digital Media System-on-Chip (DMSoC)
  - 135-, 216-MHz ARM926EJ-S™ Clock Rate
  - Fully Software-Compatible With ARM™
  - Extended Temperature 135- and 216-MHz Devices are Available
- ARM926EJ-S Core
  - Support for 32-Bit and 16-Bit (Thumb Mode) Instruction Sets
  - DSP Instruction Extensions and Single Cycle MAC
  - ARM® Jazelle® Technology
- EmbeddedICE-RT™ Logic for Real-Time Debug
- ARM9 Memory Architecture
  - 16K-Byte Instruction Cache
  - 8K-Byte Data Cache
  - 32K-Byte RAM
  - 8K-Byte ROM
  - Little Endian
- Video Processing Subsystem
  - Front End Provides:
    - Hardware IPIPE for Real-Time Image Processing
    - Up to 14-bit CCD/CMOS Digital Interface
    - 16-/8-bit Generic YcBcR-4:2 Interface (BT.601)
    - 10-/8-bit CCIR6565/BT655 Interface
    - Up to 75-MHz Pixel Clock
    - Histogram Module
    - Resize Engine
      - Resize Images From 1/16x to 8x
      - Separate Horizontal/Vertical Control
      - Two Simultaneous Output Paths
  - Back End Provides:
    - Hardware On-Screen Display (OSD)
    - Composite NTSC/PAL video encoder output
    - 8-/16-bit YCC and Up to 18-Bit RGB666 Digital Output
    - BT.601/BT.656 Digital YCbCr 4:2:2 (8-/16-Bit) Interface
    - Digital HDTV (720p/1080i) output for connection to external encoder
- External Memory Interfaces (EMIFs)
  - DDR2 and mDDR SDRAM 16-bit wide EMIF With 256 MByte Address Space (1.8-V I/O)
  - Asynchronous 16-/8-bit Wide EMIF (AEMIF)
    - Flash Memory Interfaces
      - NAND (8-/16-bit Wide Data)
      - OneNAND (16-bit Wide Data)
- Flash Card Interfaces



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- Two Multimedia Card (MMC) / Secure Digital (SD/SDIO)
- SmartMedia
- Enhanced Direct-Memory-Access (EDMA) Controller (64 Independent Channels)
- USB Port with Integrated 2.0 High-Speed PHY that Supports
  - USB 2.0 Full and High-Speed Device
  - USB 2.0 Low, Full, and High-Speed Host
- Three 64-Bit General-Purpose Timers (each configurable as two 32-bit timers)
- One 64-Bit Watch Dog Timer
- Three UARTs (One fast UART with RTS and CTS Flow Control)
- Three Serial Port Interfaces (SPI) each with two Chip-Selects
- One Master/Slave Inter-Integrated Circuit (I<sup>2</sup>C) Bus®
- Two Audio Serial Port (ASP)
  - I2S and TDM I2S
  - AC97 Audio Codec Interface
  - S/PDIF via Software
  - Standard Voice Codec Interface (AIC12)
  - SPI Protocol (Master Mode Only)
- Four Pulse Width Modulator (PWM) Outputs
- Four RTO (Real Time Out) Outputs
- Up to 104 General-Purpose I/O (GPIO) Pins (Multiplexed with Other Device Functions)
- On-Chip ARM ROM Bootloader (RBL) to Boot from NAND Flash (with SPI EEPROM Boot option), MMC/SD, or UART
- Configurable Power-Saving Modes
- Crystal or External Clock Input (typically 24 MHz or 36 MHz)
- Flexible PLL Clock Generators
- Debug Interface Support
  - IEEE-1149.1 (JTAG) Boundary-Scan-Compatible
  - ETB™ (Embedded Trace Buffer™) with 4K-Bytes Trace Buffer memory
  - Device Revision ID Readable by ARM
- 337-Pin Ball Grid Array (BGA) Package (ZCE Suffix), 0.65-mm Ball Pitch
- 90nm Process Technology
- 3.3-V and 1.8-V I/O, 1.3-V Internal
- Community Resources
  - [TI E2E Community](#)
  - [TI Embedded Processors Wiki](#)

## 1.2 Description

The DM335 processor is a low-cost, low-power processor providing advanced graphical user interface for display applications that do not require video compression and decompression. Coupled with a video processing subsystem (VPSS) that provides 720p display, the DM335 processor is powered by a 135/216-MHz ARM926EJ-S core so developers can create feature-rich graphical user interfaces allowing customers to interact with their portable, electronic devices such as video-enabled universal remote controls, Internet radio, e-books, video doorbells, and digital telescopes. The new DM335 is packed with the same peripherals as its predecessor, the TMS320DM355 device, including high-speed USB 2.0 on-the-go, external memory interface (EMIF), mobile DDR/DDR2, two SDIO ports, three UART Ports, two Audio Serial Ports, three SPI Ports, and SLC/MCL NAND Flash memory support. These peripherals help customers create DM335 processor-based designs that add video and audio excitement to a wide range of today's static user-interface applications while keeping silicon costs and power consumption low. The new digital media processor is completely scalable with the DM355 processor and Digital Video Evaluation Board (DVEVM), allowing customers to utilize their same code for their new DM335 processor focused designs.

The new DM335 device delivers a sophisticated suite of capabilities allowing for flexible image capture and display. Through its user interface technology, such as a four-level on-screen display, developers are able to create picture-within-picture and video-within-video as well as innovative graphic user interfaces. This is especially important for portable products that require the use of button or touch screen, such as portable karaoke, video surveillance and electronic gaming applications. Additional advanced capture and imaging technologies include support for CCD/CMOS image sensors, resize capability and video stabilization. The 1280-by-960-pixel digital LCD connection runs on a 75-MHz pixel clock and supports TV composite output for increased expandability. This highly integrated device is packaged in a 13 x 13 mm, 337 pin , 0.65 mm pitch BGA package.

The DM335 processor core is an ARM926EJ-S RISC processor. The ARM926EJ-S is a 32-bit processor core that performs 32-bit and 16-bit instructions and processes 32-bit, 16-bit, and 8-bit data. The core uses pipelining so that all parts of the processor and memory system can operate continuously. The ARM core incorporates:

- A coprocessor 15 (CP15) and protection module
- Data and program Memory Management Units (MMUs) with table look-aside buffers.
- Separate 16K-byte instruction and 8K-byte data caches. Both are four-way associative with virtual index virtual tag (VIVT).

The DM335 device has a Video Processing Subsystem (VPSS) with two configurable video/imaging peripherals:

- A Video Processing Front-End (VPFE)
- A Video Processing Back-End (VPBE)

The VPFE port provides an interface for CCD/CMOS imager modules and video decoders. The VPBE provides hardware On Screen Display (OSD) support and composite NTSC/PAL and digital LCD output.

The DM335 peripheral set includes:

- An inter-integrated circuit (I2C) Bus interface
- Two audio serial ports (ASP)
- Three 64-bit general-purpose timers each configurable as two independent 32-bit timers
- A 64-bit watchdog timer
- Up to 104-pins of general-purpose input/output (GPIO) with programmable interrupt/event generation modes, multiplexed with other peripherals
- Three UARTs with hardware handshaking support on one UART
- Three serial port Interfaces (SPI)
- Four pulse width modulator (PWM) peripherals
- Four real time out (RTO) outputs

- Two Multi-Media Card / Secure Digital (MMC/SD/SDIO) interfaces
- Wireless interfaces (Bluetooth, WLAN, WUSB) through SDIO
- A USB 2.0 full and high-speed device and host interface
- Two external memory interfaces:
  - An asynchronous external memory interface (AEMIF) for slower memories/peripherals such as NAND and OneNAND,
  - A high speed synchronous memory interface for DDR2/mDDR.

For software development support the DM335 has a complete set of ARM development tools which include: C compilers, assembly optimizers to simplify programming and scheduling, and a Windows™ debugger interface for visibility into source code execution.

### 1.3 Functional Block Diagram

The below figure shows the functional block diagram of the DM335 device.

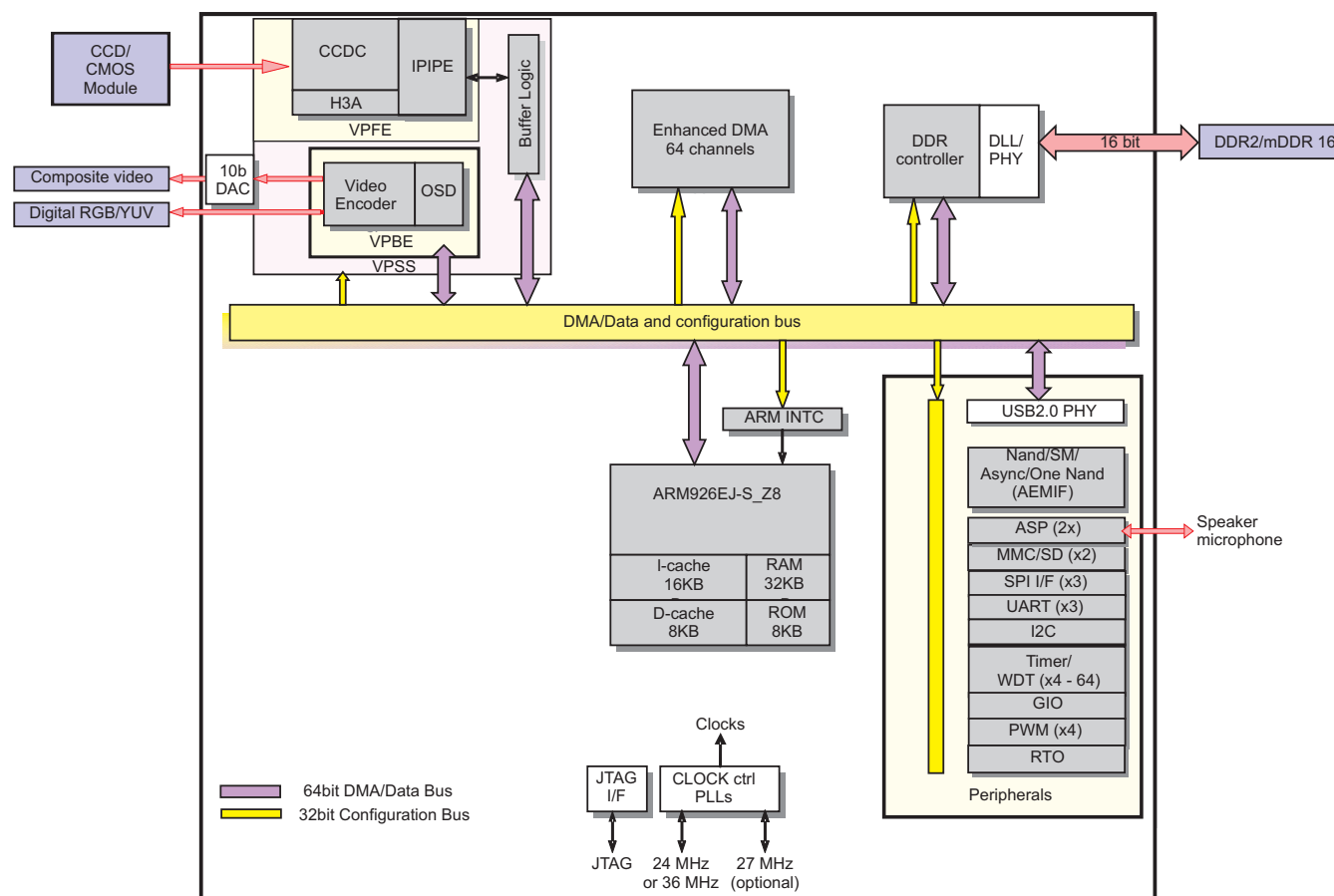


Figure 1-1. Functional Block Diagram

|                         |                                                      |           |          |                                                                                                                              |            |
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## Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

This data sheet revision history highlights the technical changes made to the SPRS528B device-specific data sheet to make it an SPRS528C revision.

**Scope:** Applicable updates to the DM335 device family, specifically relating to the DM335 device, have been incorporated. The A135 and A216 DM335 devices both support extended temperature.

## Revision C Updates

| ADDS/CHANGES/DELETES            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Global                          | Added SPI EEPROM Boot option to NAND.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <a href="#">Section 1.1</a>     | Changed Feature bullet from NAND Flash to NAND Flash (with SPI EEPROM Boot option).                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <a href="#">Section 2.4</a>     | <p><a href="#">Table 2-9</a> and <a href="#">Table 2-11</a>:</p> <ul style="list-style-type: none"> <li>Added "Used to drive boot status LED signal (active low) in ROM boot modes." to pin number P16.</li> <li>Deleted "Used to drive boot status LED signal (active low) in ROM boot modes." from pin number V19.</li> </ul>                                                                                                                                                                                                          |
| <a href="#">Section 2.20</a>    | Updated <a href="#">Table 2-23</a> , changed Reset State values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <a href="#">Section 2.21.2</a>  | Updated <a href="#">Figure 2-5</a> Device Nomenclature.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <a href="#">Section 3.2.4</a>   | Changed NAND to NAND (with SPI EEPROM Boot option).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <a href="#">Section 3.5</a>     | <p><a href="#">Table 3-4</a>:</p> <ul style="list-style-type: none"> <li>Updated/Changed "(/2 or /1 programmable)" to "POSTDIV" and added "(/2 or /1 programmable)" to 2nd row.</li> </ul>                                                                                                                                                                                                                                                                                                                                               |
| <a href="#">Table 3-15</a>      | Updated BTSEL Function and NAND configuration in table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <a href="#">Table 3-16</a>      | <p>Updated table:</p> <ul style="list-style-type: none"> <li>Changed BTSEL[1:0] = 00 – Enable (NAND) to BTSEL[1:0] = 00 – Enable (NAND, SPI)</li> </ul> <p>Changed SPI0 Module State from SyncRst to:</p> <ul style="list-style-type: none"> <li>BTSEL[1:0] = 00 – Enable (NAND, SPI)</li> <li>BTSEL[1:0] = 01 – SyncRst (OneNAND)</li> <li>BTSEL[1:0] = 10 – Enable (MMC/SD)</li> <li>BTSEL[1:0] = 11 – Enable (UART)</li> </ul>                                                                                                        |
| <a href="#">Section 3.12</a>    | Added <a href="#">Section 3.12.2</a> , "RBL NAND Boot Process" and associated Standard and Compatibility mode references throughout the document.                                                                                                                                                                                                                                                                                                                                                                                        |
| <a href="#">Section 3.12.1</a>  | Added ARM ROM Boot - SPI boot in NAND Mode bullet and sub-bullets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <a href="#">Figure 3-6</a>      | Added SPI Flash to Diagram.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <a href="#">Section 4.2</a>     | Added last row to table including table note.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <a href="#">Section 4.3</a>     | <p>Updated/Changed the following values in <a href="#">Section 4.3</a>:</p> <ul style="list-style-type: none"> <li>I<sub>OH</sub> MAX value from "-100 <math>\mu</math>A" to "-4000 <math>\mu</math>A"</li> <li>I<sub>OZ</sub> TYP (IPU disabled) value from "<math>\pm</math>10 <math>\mu</math>A" to "<math>\pm</math>20 <math>\mu</math>A"</li> <li>I<sub>OZ</sub> TYP (IPU enabled) added value of <math>\pm</math>100 <math>\mu</math>A"</li> </ul> <p>Added "Test Conditions" for I<sub>OH</sub> and I<sub>OL</sub> parameters</p> |
| <a href="#">Table 5-5</a>       | Changed parameter 4 on table and added table note.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <a href="#">Table 5-6</a>       | Changed parameter 4 on table and added table note.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <a href="#">Table 5-45</a>      | Changed parameter 4 on table and added table note.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <a href="#">Section 5.7.1.3</a> | Added note to <a href="#">Table 5-14</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## 2 Device Overview

### 2.1 Device Characteristics

**Table 2-1** provides an overview of the DMSoC. The table shows significant features of the device, including the peripherals, capacity of on-chip RAM, ARM operating frequency, the package type with pin count, etc.

**Table 2-1. Characteristics of the Processor**

| HARDWARE FEATURES                                                                                                                   |                                                                               | DM335                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Peripherals<br><br>Not all peripherals pins are available at the same time (For more detail, see the Device Configuration section). | DDR2 / mDDR Memory Controller                                                 | DDR2 / mDDR (16-bit bus width)                                                                         |
|                                                                                                                                     | Asynchronous EMIF (AEMIF)                                                     | Asynchronous (8/16-bit bus width) RAM, Flash (NAND, OneNAND)                                           |
|                                                                                                                                     | Flash Card Interfaces                                                         | Two MMC/SD<br>One SmartMedia/xD                                                                        |
|                                                                                                                                     | EDMA                                                                          | 64 independent DMA channels<br>Eight EDMA channels                                                     |
|                                                                                                                                     | Timers                                                                        | Three 64-Bit General Purpose (each configurable as two separate 32-bit timers)<br>One 64-Bit Watch Dog |
|                                                                                                                                     | UART                                                                          | Three (one with RTS and CTS flow control)                                                              |
|                                                                                                                                     | SPI                                                                           | Three (each supports two slave devices)                                                                |
|                                                                                                                                     | I <sup>2</sup> C                                                              | One (Master/Slave)                                                                                     |
|                                                                                                                                     | Audio Serial Port [ASP]                                                       | Two ASP                                                                                                |
|                                                                                                                                     | General-Purpose Input/Output Port                                             | Up to 104                                                                                              |
|                                                                                                                                     | Pulse width modulator (PWM)                                                   | Four outputs                                                                                           |
|                                                                                                                                     | Configurable Video Ports                                                      | One Input (VPFE)<br>One Output (VPBE)                                                                  |
|                                                                                                                                     | USB 2.0                                                                       | High, Full Speed Device<br>High, Full, Low Speed Host                                                  |
| On-Chip CPU Memory                                                                                                                  | Organization                                                                  | ARM<br>16-KB I-cache, 8-KB D-cache,<br>32-KB RAM, 8-KB ROM                                             |
| JTAG BSDL_ID                                                                                                                        | JTAGID register (address location: 0x01C4 0028)                               | 0x0B73B01F                                                                                             |
| CPU Frequency (Maximum)                                                                                                             | MHz                                                                           | ARM 135, 216 MHz                                                                                       |
| Voltage                                                                                                                             | Core (V)                                                                      | 1.3 V                                                                                                  |
|                                                                                                                                     | I/O (V)                                                                       | 3.3 V, 1.8 V                                                                                           |
| PLL Options                                                                                                                         | Reference frequency options<br>Configurable PLL controller                    | 24 MHz (typical), 36 MHz<br>PLL bypass, programmable PLL                                               |
| BGA Package                                                                                                                         | 13 x 13 mm                                                                    | 337-Pin BGA (ZCE)                                                                                      |
| Process Technology                                                                                                                  |                                                                               | 90 nm                                                                                                  |
| Product Status <sup>(1)</sup>                                                                                                       | Product Preview (PP),<br>Advance Information (AI),<br>or Production Data (PD) | PD                                                                                                     |

(1) PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

## 2.2 Memory Map Summary

Table 2-3 shows the memory map address ranges of the device. Table 2-3 depicts the expanded map of the Configuration Space (0x01C0 0000 through 0x01FF FFFF). The device has multiple on-chip memories associated with its processor and various subsystems. To help simplify software development a unified memory map is used where possible to maintain a consistent view of device resources across all bus masters. The bus masters are the ARM, EDMA, USB, and VPSS.

**Table 2-2. DM335 Memory Map**

| Start Address | End Address | Size (Bytes) | ARM Mem Map                             | EDMA Mem Map          | USB Mem Map | VPSS Mem Map |
|---------------|-------------|--------------|-----------------------------------------|-----------------------|-------------|--------------|
| 0x0000 0000   | 0x0000 3FFF | 16K          | ARM RAM0 (Instruction)                  | Reserved              | Reserved    |              |
| 0x0000 4000   | 0x0000 7FFF | 16K          | ARM RAM1 (Instruction)                  |                       |             |              |
| 0x0000 8000   | 0x0000 FFFF | 32K          | ARM ROM (Instruction)<br>- only 8K used |                       |             |              |
| 0x0001 0000   | 0x0001 3FFF | 16K          | ARM RAM0 (Data)                         | ARM RAM0              | ARM RAM0    | Reserved     |
| 0x0001 4000   | 0x0001 7FFF | 16K          | ARM RAM1 (Data)                         | ARM RAM1              | ARM RAM1    |              |
| 0x0001 8000   | 0x0001 FFFF | 32K          | ARM ROM (Data)<br>- only 8K used        | ARM ROM               | ARM ROM     |              |
| 0x0002 0000   | 0x000F FFFF | 896K         | Reserved                                | Reserved              | Reserved    |              |
| 0x0010 0000   | 0x01BB FFFF | 26M          |                                         |                       |             |              |
| 0x01BC 0000   | 0x01BC 0FFF | 4K           | ARM ETB Mem                             |                       |             |              |
| 0x01BC 1000   | 0x01BC 17FF | 2K           | ARM ETB Reg                             |                       |             |              |
| 0x01BC 1800   | 0x01BC 18FF | 256          | ARM IceCrusher                          |                       |             |              |
| 0x01BC 1900   | 0x01BC FFFF | 59136        | Reserved                                |                       |             |              |
| 0x01BD 0000   | 0x01BF FFFF | 192K         |                                         |                       |             |              |
| 0x01C0 0000   | 0x01FF FFFF | 4M           | CFG Bus Peripherals                     | CFG Bus Peripherals   |             |              |
| 0x0200 0000   | 0x09FF FFFF | 128M         | ASYNC EMIF (Data)                       | ASYNC EMIF (Data)     |             |              |
| 0x0A00 0000   | 0x11EF FFFF | 127M - 16K   | Reserved                                | Reserved              |             |              |
| 0x11F0 0000   | 0x11F1 FFFF | 128K         |                                         |                       |             |              |
| 0x11F2 0000   | 0x1FFF FFFF | 141M-64K     |                                         |                       |             |              |
| 0x2000 0000   | 0x2000 7FFF | 32K          | DDR EMIF Control Regs                   | DDR EMIF Control Regs |             |              |
| 0x2000 8000   | 0x41FF FFFF | 544M-32K     | Reserved                                | Reserved              |             |              |
| 0x4200 0000   | 0x49FF FFFF | 128M         |                                         | Reserved              |             |              |
| 0x4A00 0000   | 0x7FFF FFFF | 864M         |                                         | Reserved              |             |              |
| 0x8000 0000   | 0x8FFF FFFF | 256M         | DDR EMIF                                | DDR EMIF              | DDR EMIF    | DDR EMIF     |
| 0x9000 0000   | 0xFFFF FFFF | 1792M        | Reserved                                | Reserved              | Reserved    | Reserved     |

**Table 2-3. DM335 ARM Configuration Bus Access to Peripherals**

| Region   | Address     |             |      | Accessibility |      |
|----------|-------------|-------------|------|---------------|------|
|          | Start       | End         | Size | ARM           | EDMA |
| EDMA CC  | 0x01C0 0000 | 0x01C0 FFFF | 64K  | √             | √    |
| EDMA TC0 | 0x01C1 0000 | 0x01C1 03FF | 1K   | √             | √    |
| EDMA TC1 | 0x01C1 0400 | 0x01C1 07FF | 1K   | √             | √    |
| Reserved | 0x01C1 0800 | 0x01C1 9FFF | 38K  | √             | √    |
| Reserved | 0x01C1 A000 | 0x01C1 FFFF | 24K  | √             | √    |
| UART0    | 0x01C2 0000 | 0x01C2 03FF | 1K   | √             | √    |

**Table 2-3. DM335 ARM Configuration Bus Access to Peripherals (continued)**

|                              | Address     |             |       | Accessibility |   |
|------------------------------|-------------|-------------|-------|---------------|---|
| UART1                        | 0x01C2 0400 | 0x01C2 07FF | 1K    | √             | √ |
| Timer4/5                     | 0x01C2 0800 | 0x01C2 0BFF | 1K    | √             | √ |
| Real-time out                | 0x01C2 0C00 | 0x01C2 0FFF | 1K    | √             | √ |
| I2C                          | 0x01C2 1000 | 0x01C2 13FF | 1K    | √             | √ |
| Timer0/1                     | 0x01C2 1400 | 0x01C2 17FF | 1K    | √             | √ |
| Timer2/3                     | 0x01C2 1800 | 0x01C2 1BFF | 1K    | √             | √ |
| WatchDog Timer               | 0x01C2 1C00 | 0x01C2 1FFF | 1K    | √             | √ |
| PWM0                         | 0x01C2 2000 | 0x01C2 23FF | 1K    | √             | √ |
| PWM1                         | 0x01C2 2400 | 0x01C2 27FF | 1K    | √             | √ |
| PWM2                         | 0x01C2 2800 | 0x01C2 2BFF | 1K    | √             | √ |
| PWM3                         | 0x01C2 2C00 | 0x01C2 2FFF | 1K    | √             | √ |
| System Module                | 0x01C4 0000 | 0x01C4 07FF | 2K    | √             | √ |
| PLL Controller 0             | 0x01C4 0800 | 0x01C4 0BFF | 1K    | √             | √ |
| PLL Controller 1             | 0x01C4 0C00 | 0x01C4 0FFF | 1K    | √             | √ |
| Power/Sleep Controller       | 0x01C4 1000 | 0x01C4 1FFF | 4K    | √             | √ |
| Reserved                     | 0x01C4 2000 | 0x01C4 7FFF | 24K   | √             | √ |
| ARM Interrupt Controller     | 0x01C4 8000 | 0x01C4 83FF | 1K    | √             | √ |
| Reserved                     | 0x01C4 8400 | 0x01C6 3FFF | 111K  | √             | √ |
| USB OTG 2.0 Regs / RAM       | 0x01C6 4000 | 0x01C6 5FFF | 8K    | √             | √ |
| SPI0                         | 0x01C6 6000 | 0x01C6 67FF | 2K    | √             | √ |
| SPI1                         | 0x01C6 6800 | 0x01C6 6FFF | 2K    | √             | √ |
| GPIO                         | 0x01C6 7000 | 0x01C6 77FF | 2K    | √             | √ |
| SPI2                         | 0x01C6 7800 | 0x01C6 FFFF | 2K    | √             | √ |
| <b>VPSS Subsystem</b>        | 0x01C7 0000 | 0x01C7 FFFF | 64K   | √             | √ |
| VPSS Clock Control           | 0x01C7 0000 | 0x01C7 007F | 128   | √             | √ |
| Hardware 3A                  | 0x01C7 0080 | 0x01C7 00FF | 128   | √             | √ |
| Image Pipe (IPIPE) Interface | 0x01C7 0100 | 0x01C7 01FF | 256   | √             | √ |
| On Screen Display            | 0x01C7 0200 | 0x01C7 02FF | 256   | √             | √ |
| Reserved                     | 0x01C7 0300 | 0x01C7 03FF | 256   | √             | √ |
| Video Encoder                | 0x01C7 0400 | 0x01C7 05FF | 512   | √             | √ |
| CCD Controller               | 0x01C7 0600 | 0x01C7 07FF | 256   | √             | √ |
| VPSS Buffer Logic            | 0x01C7 0800 | 0x01C7 08FF | 256   | √             | √ |
| Reserved                     | 0x01C7 0900 | 0x01C7 09FF | 256   | √             | √ |
| Image Pipe (IPIPE)           | 0x01C7 1000 | 0x01C7 3FFF | 12K   | √             | √ |
| Reserved                     | 0x01C7 4000 | 0x01CD FFFF | 432K  | √             | √ |
| Multimedia / SD 1            | 0x01E0 0000 | 0x01E0 1FFF | 8K    | √             | √ |
| ASP0                         | 0x01E0 2000 | 0x01E0 3FFF | 8K    | √             | √ |
| ASP1                         | 0x01E0 4000 | 0x01E0 5FFF | 8K    | √             | √ |
| UART2                        | 0x01E0 6000 | 0x01E0 63FF | 1K    | √             | √ |
| Reserved                     | 0x01E0 6400 | 0x01E0 FFFF | 39K   | √             | √ |
| ASYNCEMIF Control            | 0x01E1 0000 | 0x01E1 0FFF | 4K    | √             | √ |
| Multimedia / SD 0            | 0x01E1 1000 | 0x01E1 FFFF | 60K   | √             | √ |
| Reserved                     | 0x01E2 0000 | 0x01FF FFFF | 1792K | √             | √ |
| ASYNCEMIF Data (CE0)         | 0x0200 0000 | 0x03FF FFFF | 32M   | √             | √ |
| ASYNCEMIF Data (CE1)         | 0x0400 0000 | 0x05FF FFFF | 32M   | √             | √ |
| Reserved                     | 0x0600 0000 | 0x09FF FFFF | 64M   | √             | √ |
| Reserved                     | 0x0A00 0000 | 0x0BFF FFFF | 32M   | √             | √ |

**Table 2-3. DM335 ARM Configuration Bus Access to Peripherals (continued)**

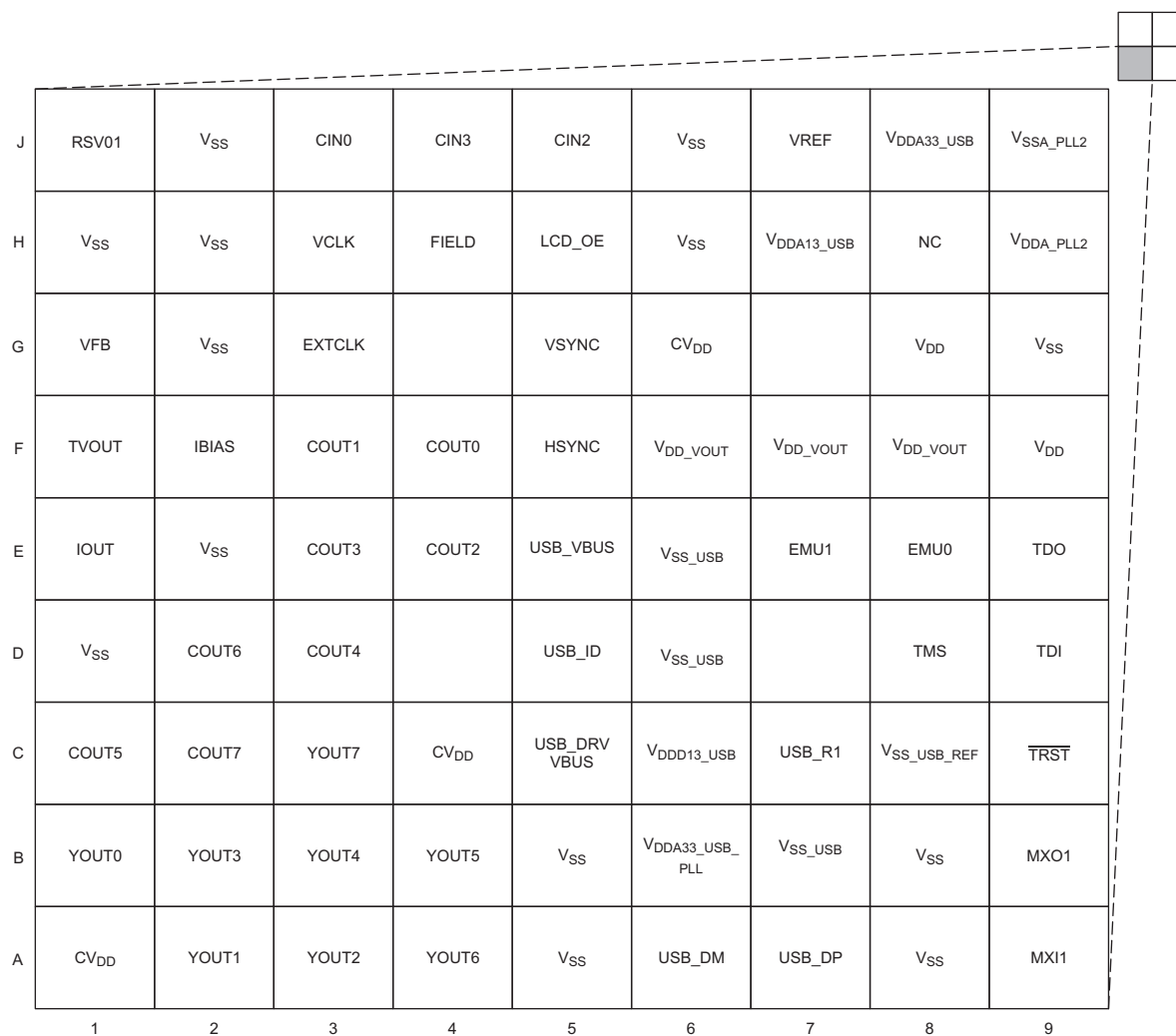
| Reserved | Address     |             |     | Accessibility |   |
|----------|-------------|-------------|-----|---------------|---|
|          | 0x0C00 0000 | 0x0FFF FFFF | 64M | √             | √ |

## 2.3 Pin Assignments

Extensive use of pin multiplexing is used to accommodate the largest number of peripheral functions in the smallest possible package. Pin multiplexing is controlled using a combination of hardware configuration at device reset and software programmable register settings.

### 2.3.1 Pin Map (Bottom View)

Figure 2-1 through Figure 2-4 show the pin assignments in four quadrants (A, B, C, and D). Note that micro-vias are not required. Contact your TI representative for routing recommendations.

**Figure 2-1. Pin Map [Quadrant A]**

|   | 1                   | 2               | 3               | 4               | 5               | 6                            | 7                       | 8                            | 9                            |
|---|---------------------|-----------------|-----------------|-----------------|-----------------|------------------------------|-------------------------|------------------------------|------------------------------|
| W | V <sub>SS</sub>     | DDR_A02         | DDR_A03         | DDR_A05         | DDR_A08         | DDR_A09                      | DDR_A11                 | $\overline{\text{DDR\_CLK}}$ | DDR_CLK                      |
| V | V <sub>SS</sub>     | DDR_A00         | DDR_A01         | DDR_A04         | DDR_A07         | DDR_A10                      | DDR_A12                 | DDR_BA[2]                    | $\overline{\text{DDR\_CAS}}$ |
| U | V <sub>SS</sub>     | V <sub>SS</sub> | V <sub>SS</sub> | V <sub>SS</sub> | DDR_A06         | DDR_A13                      | DDR_BA[1]               | DDR_BA[0]                    | V <sub>SS</sub>              |
| T | MX02                | V <sub>SS</sub> | PCLK            |                 | V <sub>SS</sub> | $\overline{\text{DDR\_RAS}}$ |                         | $\overline{\text{DDR\_CS}}$  | DDR_ZN                       |
| R | MXI2                | V <sub>SS</sub> | YIN3            | CAM_VD          | CAM_WEN_FIELD   | V <sub>SS</sub>              | CV <sub>DD</sub>        | CV <sub>DD</sub>             | V <sub>DD_DDR</sub>          |
| P | V <sub>SS_MX2</sub> | YIN1            | YIN4            | YIN2            | YIN0            | V <sub>DD_VIN</sub>          | V <sub>DD_VIN</sub>     | V <sub>DD_VIN</sub>          | V <sub>DD_DDR</sub>          |
| N | V <sub>SS</sub>     | RSV05           | CIN7            |                 | CAM_HD          | CV <sub>DD</sub>             |                         | V <sub>SS</sub>              | V <sub>SS</sub>              |
| M | RSV04               | RSV06           | CIN5            | YIN6            | YIN5            | V <sub>SS</sub>              | V <sub>SS</sub>         | V <sub>SS</sub>              | V <sub>DD_DDR</sub>          |
| L | RSV03               | V <sub>SS</sub> | CIN1            | CIN4            | YIN7            | V <sub>DD</sub>              | V <sub>DDA18V_DAC</sub> | V <sub>SS_DAC</sub>          | V <sub>SS</sub>              |
| K | RSV02               | RSV07           | V <sub>SS</sub> |                 | CIN6            | CV <sub>DD</sub>             |                         | V <sub>DD</sub>              | V <sub>SS</sub>              |

**Figure 2-2. Pin Map [Quadrant B]**

|               | 10       | 11       | 12         | 13       | 14        | 15         | 16        | 17          | 18          | 19     |   |
|---------------|----------|----------|------------|----------|-----------|------------|-----------|-------------|-------------|--------|---|
|               | DDR_WE   | DDR_DQ01 | DDR_DQ05   | DDR_DQ07 | DDR_DQ10  | DDR_DQ11   | DDR_DQ13  | DDR_DQ15    | DDR_DQGATE0 | CVDD   | W |
|               | DDR_CKE  | DDR_DQ00 | DDR_DQS[0] | DDR_DQ06 | DDR_DQ09  | DDR_DQS[1] | DDR_DQ14  | DDR_DQGATE1 | VSS         | EM_A13 | V |
|               | DDR_VREF | DDR_DQ02 | DDR_DQ04   | DDR_DQ08 | VSS       | DDR_DQM[1] | DDR_DQ12  | VSS         | UART0_RXD   | EM_A12 | U |
|               |          | DDR_DQ03 | DDR_DQM[0] |          | VDD_DDR   | VSS        |           | CVDD        | UART0_TXD   | EM_A08 | T |
| VDDA33_DDRDLL | VSSA_DLL | VDD_DDR  | I2C_SDA    | I2C_SCL  | UART1_RXD | EM_A11     | UART1_TXD | EM_A10      | EM_A05      |        | R |
| VDD_DDR       | VDD_DDR  | VDD_DDR  | VDD_DDR    | VDD_DDR  | EM_A04    | EM_A07     | EM_A09    | EM_A06      | EM_BA1      |        | P |
|               | VDD      | VDD      |            | VSS      | EM_A02    |            | EM_A01    | EM_A03      | EM_BA0      |        | N |
| VDD           | VDD      | VDD      | VDD        | VSS      | EM_D13    | EM_A00     | VSS       | EM_D15      | EM_D14      |        | M |
| VSS           | CVDD     | CVDD     | VDD        | VSS      | EM_D04    | EM_D08     | EM_D11    | EM_D12      | EM_D10      |        | L |
| VSS           | CVDD     | CVDD     |            | VSS      | VDD       |            | EM_D06    | EM_D09      | EM_D07      |        | K |

Figure 2-3. Pin Map [Quadrant C]



|                     |                  |                       |                  |                 |                 |              |                  |              |                  |   |
|---------------------|------------------|-----------------------|------------------|-----------------|-----------------|--------------|------------------|--------------|------------------|---|
| V <sub>SS</sub>     | CV <sub>DD</sub> | CV <sub>DD</sub>      | CV <sub>DD</sub> | V <sub>SS</sub> | EM_WE           | EM_CE0       | EM_D01           | EM_D03       | EM_D05           | J |
| CV <sub>DD</sub>    | V <sub>SS</sub>  | V <sub>SSA_PLL1</sub> | CV <sub>DD</sub> | V <sub>SS</sub> | ASP0_DX         | EM_ADV       | CV <sub>DD</sub> | EM_D00       | EM_D02           | H |
|                     | CV <sub>DD</sub> | V <sub>DDA_PLL1</sub> |                  | V <sub>DD</sub> | GIO003          |              | ASP0_FSX         | EM_WAIT      | EM_CE1           | G |
| V <sub>DD</sub>     | V <sub>DD</sub>  | V <sub>DD</sub>       | V <sub>DD</sub>  | V <sub>DD</sub> | GIO002          | ASP0_FSR     | ASP0_CLKR        | ASP0_CLKX    | EM_OE            | F |
| TCK                 | RTCK             | SPI0_SDO              | SPI1_SDENA[0]    | GIO001          | V <sub>SS</sub> | ASP1_FSX     | ASP1_FSR         | ASP0_DR      | EM_CLK           | E |
|                     | <u>RESET</u>     | CLKOUT1               |                  | MMCS00_DATA1    | GIO005          |              | ASP1_CLKS        | ASP1_CLKR    | ASP1_CLKX        | D |
| V <sub>SS_MX1</sub> | CLKOUT3          | SPI0_SCLK             | SPI1_SCLK        | MMCS00_CMD      | MMCS01_CLK      | GIO000       | GIO007           | ASP1_DX      | ASP1_DR          | C |
| V <sub>SS</sub>     | SPI0_SDO         | SPI0_SDENA[0]         | MMCS00_DATA2     | MMCS00_DATA0    | MMCS01_DATA1    | MMCS01_DATA3 | GIO004           | GIO006       | CV <sub>DD</sub> | B |
| CV <sub>DD</sub>    | CLKOUT2          | SPI0_SDI              | SPI1_SDI         | MMCS00_DATA3    | MMCS00_CLK      | MMCS01_DATA2 | MMCS01_CMD       | MMCS01_DATA0 | V <sub>SS</sub>  | A |
| 10                  | 11               | 12                    | 13               | 14              | 15              | 16           | 17               | 18           | 19               |   |

**Figure 2-4. Pin Map [Quadrant D]**

## 2.4 Pin Functions

The pin functions tables (Table 2-4 through Table 2-22) identify the external signal names, the associated pin (ball) numbers along with the mechanical package designator, the pin type, whether the pin has any internal pullup or pulldown resistors, and a functional pin description. For more detailed information on device configuration, peripheral selection, multiplexed/shared pins, and debugging considerations, see Section 3. For the list of all pin in chronological order see Section 2.20

### 2.4.1 Image Data Input - Video Processing Front End

The CCD Controller module in the Video Processing Front End has an external signal interface for image data input. It supports YUV (YC) inputs as well as Bayer RGB and complementary input signals (i.e., image data input).

The definition of the CCD controller data input signals depend on the input mode selected.

- In 16-bit YCbCr mode, the Cb and Cr signals are multiplexed on the CI signals and the order is configurable (i.e., Cb first or Cr first).
- In 8-bit YCbCr mode, the Y, Cb, and Cr signals are multiplexed and not only is the order selectable, but also the half of the bus used.

**Table 2-4. CCD Controller Signals for Each Input Mode**

| PIN NAME | CCD   | 16-BIT YCbCr | 8-BIT YCbCr |
|----------|-------|--------------|-------------|
| CI7      |       | Cb7,Cr7      | Y7,Cb7,Cr7  |
| CI6      |       | Cb6,Cr6      | Y6,Cb6,Cr6  |
| CI5      | CCD13 | Cb5,Cr5      | Y5,Cb5,Cr5  |
| CI4      | CCD12 | Cb4,Cr4      | Y4,Cb4,Cr4  |
| CI3      | CCD11 | Cb3,Cr3      | Y3,Cb3,Cr3  |
| CI2      | CCD10 | Cb2,Cr2      | Y2,Cb2,Cr2  |
| CI1      | CCD9  | Cb1,Cr1      | Y1,Cb1,Cr1  |
| CI0      | CCD8  | Cb0,Cr0      | Y0,Cb0,Cr0  |
| YI7      | CCD7  | Y7           | Y7,Cb7,Cr7  |
| YI6      | CCD6  | Y6           | Y6,Cb6,Cr6  |
| YI5      | CCD5  | Y5           | Y5,Cb5,Cr5  |
| YI4      | CCD4  | Y4           | Y4,Cb4,Cr4  |
| YI3      | CCD3  | Y3           | Y3,Cb3,Cr3  |
| YI2      | CCD2  | Y2           | Y2,Cb2,Cr2  |
| YI1      | CCD1  | Y1           | Y1,Cb1,Cr1  |
| YI0      | CCD0  | Y0           | Y0,Cb0,Cr0  |

**Table 2-5. CCD Controller/Video Input Terminal Functions**

| TERMINAL                              |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------|-----|---------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                  | NO. |                     |                          |                                                                                                                                                                                                                                                                                                                                             |
| CIN7/<br>GIO101/<br>SPI2_SCLK         | N3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: NOT USED<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[07]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07]</li> </ul> SPI: SPI2 Clock<br>GIO: GIO[101]      |
| CIN6/<br>GIO100/<br>SPI2_SDO          | K5  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: NOT USED<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[06]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[06]</li> </ul> SPI: SPI2 Data Out<br>GIO: GIO[100]   |
| CIN5/<br>GIO099/<br>SPI2_SDEN<br>A[0] | M3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[13]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[05]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[05]</li> </ul> SPI: SPI2 Chip Select<br>GIO: GIO[099] |
| CIN4/<br>GIO098/<br>SPI2_SDEN<br>A[1] | L4  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[12]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[04]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[04]</li> </ul> SPI: SPI2 Data In<br>GIO: GIO[098]     |
| CIN3/<br>GIO097/                      | J4  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input(AFE): Raw[11]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[03]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[03]</li> </ul> GIO: GIO[097]                     |
| CIN2/<br>GIO096/                      | J5  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[10]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[02]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[02]</li> </ul> GIO: GIO[097]                          |
| CIN1/<br>GIO095/                      | L3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[09]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[01]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[01]</li> </ul> GIO: GIO[095]                          |
| CIN0/<br>GIO094/                      | J3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[08]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: CB/SR[00]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[00]</li> </ul> GIO: GIO[094]                          |
| YIN7/<br>GIO093                       | L5  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[07]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[07]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07]</li> </ul> GIO: GIO[093]                              |
| YIN6/<br>GIO092                       | M4  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: Raw[06]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[06]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[06]</li> </ul> GIO: GIO[092]                              |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) PD = internal pull-down, PU = internal pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

(3) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

**Table 2-5. CCD Controller/Video Input Terminal Functions (continued)**

| TERMINAL                     |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup>  | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|-----|---------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                         | NO. |                     |                           |                                                                                                                                                                                                                                                                                                                                                                  |
| YIN5/<br>GIO091              | M5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[05]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[05]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[05]</li> </ul> GIO: GIO[091]                                                   |
| YIN4/<br>GIO090              | P3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[04]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[04]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[04]</li> </ul> GIO: GIO[090]                                                   |
| YIN3/<br>GIO089              | R3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[03]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[03]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[03]</li> </ul> GIO: GIO[089]                                                   |
| YIN2/<br>GIO088              | P4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[02]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[02]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[02]</li> </ul> GIO: GIO[088]                                                   |
| YIN1/<br>GIO087              | P2  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[01]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[01]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[01]</li> </ul> GIO: GIO[087]                                                   |
| YIN0/<br>GIO086              | P5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: Raw[00]<br><ul style="list-style-type: none"> <li>YCC 16-bit: Time multiplexed between chroma: Y[00]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[00]</li> </ul> GIO: GIO[086]                                                   |
| CAM_HD/<br>GIO085            | N5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Horizontal synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new line starts.<br>GIO: GIO[085]                                                                                                                                                                                                   |
| CAM_VD<br>GIO084             | R4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Vertical synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new frame starts.<br>GIO: GIO[084]                                                                                                                                                                                                    |
| CAM_WEN<br>_FIELD\<br>GIO083 | R5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Write enable input signal is used by external device (AFE/TG) to gate the DDR output of the CCDC module. Alternately, the field identification input signal is used by external device (AFE/TG) to indicate which of two frames is input to the CCDC module for sensors with interlaced output. CCDC handles 1- or 2-field sensors in hardware.<br>GIO: GIO[083] |
| PCLK/<br>GIO082              | T3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Pixel clock input (strobe for lines C17 through Y10)<br>GIO: GIO[082]                                                                                                                                                                                                                                                                                            |

## 2.5 Image Data Output - Video Processing Back End (VPBE)

The Video Encoder/Digital LCD interface module in the video processing back end has an external signal interface for digital image data output as described in [Table 2-7](#) and [Table 2-8](#).

The digital image data output signals support multiple functions / interfaces, depending on the display mode selected. The following table describes these modes. Parallel RGB mode with more than RGB565 signals requires enabling pin multiplexing to support (i.e., for RGB666 mode).

**Table 2-6. Signals for VPBE Display Modes**

| PIN NAME                         | YCC16     | YCC8/<br>REC656 | PRGB      | SRGB      |
|----------------------------------|-----------|-----------------|-----------|-----------|
| HSYNC<br>GIO073                  | HSYNC     | HSYNC           | HSYNC     | HSYNC     |
| VSYNC<br>GIO072                  | VSYNC     | VSYNC           | VSYNC     | VSYNC     |
| LCD_OE<br>GIO071                 | As needed | As needed       | As needed | As needed |
| FIELD<br>GIO070<br>R2<br>PWM3C   | As needed | As needed       | As needed | As needed |
| EXTCLK<br>GIO069<br>B2<br>PWM3D  | As needed | As needed       | As needed | As needed |
| VCLK<br>GIO068                   | VCLK      | VCLK            | VCLK      | VCLK      |
| YOUT7                            | Y7        | Y7,Cb7,Cr7      | R7        | Data7     |
| YOUT6                            | Y6        | Y6,Cb6,Cr6      | R6        | Data6     |
| YOUT5                            | Y5        | Y5,Cb5,Cr5      | R5        | Data5     |
| YOUT4                            | Y4        | Y4,Cb4,Cr4      | R4        | Data4     |
| YOUT3                            | Y3        | Y3,Cb3,Cr3      | R3        | Data3     |
| YOUT2                            | Y2        | Y2,Cb2,Cr2      | G7        | Data2     |
| YOUT1                            | Y1        | Y1,Cb1,Cr1      | G6        | Data1     |
| YOUT0                            | Y0        | Y0,Cb0,Cr0      | G5        | Data0     |
| COUT7<br>GIO081<br>PWM0          | C7        | LCD_AC          | G4        | LCD_AC    |
| COUT6<br>GIO080<br>PWM1          | C6        | LCD_OE          | G3        | LCD_OE    |
| COUT5<br>GIO079<br>PWM2A<br>RTO0 | C5        | BRIGHT          | G2        | BRIGHT    |
| COUT4<br>GIO078<br>PWM2B<br>RTO1 | C4        | PWM             | B7        | PWM       |
| COUT3<br>GIO077<br>PWM2C<br>RTO2 | C3        | CSYNC           | B6        | CSYNC     |
| COUT2<br>GIO076<br>PWM2D<br>RTO3 | C2        | -               | B5        | -         |
| COUT1<br>GIO075<br>PWM3A         | C1        | -               | B4        | -         |
| COUT0<br>GIO074<br>PWM3B         | C0        | -               | B3        | -         |

**Table 2-7. Digital Video Terminal Functions**

| TERMINAL                         |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup>   | DESCRIPTION <sup>(4)</sup>                                                                                                                                              |
|----------------------------------|-----|---------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                             | NO. |                     |                            |                                                                                                                                                                         |
| YOUT7-R7                         | C3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT6-R6                         | A4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT5-R5                         | B4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT4-R4                         | B3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT3-R3                         | B2  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT2-G7                         | A3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT1-G6                         | A2  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| YOUT0-G5                         | B1  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function                                                                                                                     |
| COUT7-G4/GIO081 /PWM0            | C2  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[081] PWM0                                                                                                  |
| COUT6-G3 /GIO080 /PWM1           | D2  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[080] PWM1                                                                                                  |
| COUT5-G2 / GIO079 / PWM2A / RTO0 | C1  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[079] PWM2A RTO0                                                                                            |
| COUT4-B7 / GIO078 / PWM2B / RTO1 | D3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[078] PWM2B RTO1                                                                                            |
| COUT3-B6 / GIO077 / PWM2C / RTO2 | E3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[077] PWM2C RTO2                                                                                            |
| COUT2-B5 / GIO076 / PWM2D / RTO3 | E4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[076] PWM2D RTO3                                                                                            |
| COUT1-B4 / GIO075 / PWM3A        | F3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[075] PWM3A                                                                                                 |
| COUT0-B3 / GIO074 / PWM3B        | F4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[074] PWM3B                                                                                                 |
| HSYNC / GIO073                   | F5  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: Horizontal Sync<br>GIO: GIO[073]                                                                                                                         |
| VSYSN / GIO072                   | G5  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: Vertical Sync<br>GIO: GIO[072]                                                                                                                           |
| FIELD / GIO070 / R2 / PWM3C      | H4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Video Encoder: Field identifier for interlaced display formats<br>GIO: GIO[070]<br>Digital Video Out: R2<br>PWM3C                                                       |
| EXTCLK / GIO069 / B2 / PWM3D     | G3  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: External clock input, used if clock rates > 27 MHz are needed, e.g. 74.25 MHz for HDTV digital output<br>GIO: GIO[069]<br>Digital Video Out: B2<br>PWM3D |
| VCLK / GIO068                    | H3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Video Encoder: Video Output Clock<br>GIO: GIO[068]                                                                                                                      |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 k $\Omega$  resistor should be used.)

(4) To reduce EMI and reflections, depending on the trace length, approximately 22  $\Omega$  to 50  $\Omega$  damping resistors are recommend on the following outputs placed near the DM335: YOUT(0-7),COUT(0-7), HSYNC,VSYSN,LCD\_OE,FIELD,EXTCLK,VCLK. The trace lengths should be minimized.

**Table 2-8. Analog Video Terminal Functions**

| TERMINAL               |     | TYPE <sup>(1)</sup> | OTHER <sup>(2)</sup> | DESCRIPTION                                                                                                                                                                                                                                       |
|------------------------|-----|---------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                   | NO. |                     |                      |                                                                                                                                                                                                                                                   |
| VREF                   | J7  | A I/O/Z             |                      | Video DAC: Reference voltage output (0.45V, 0.1uF to GND). When the DAC is not used, the VREF signal should be connected to V <sub>SS</sub> .                                                                                                     |
| IOUT                   | E1  | A I/O/Z             |                      | Video DAC: Pre video buffer DAC output (1000 ohm to VFB). When the DAC is not used, the IOUT signal should be connected to V <sub>SS</sub> .                                                                                                      |
| IBIAS                  | F2  | A I/O/Z             |                      | Video DAC: External resistor (2550 Ohms to GND) connection for current bias configuration. When the DAC is not used, the IBIAS signal should be connected to V <sub>SS</sub> .                                                                    |
| VFB                    | G1  | A I/O/Z             |                      | Video DAC: Pre video buffer DAC output (1000 Ohms to IOUT, 1070 Ohms to TVOUT). When the DAC is not used, the VFB signal should be connected to V <sub>SS</sub> .                                                                                 |
| TVOUT                  | F1  | A I/O/Z             | V                    | Video DAC: Analog Composite NTSC/PAL output (See <a href="#">Figure 5-31</a> and <a href="#">Figure 5-32</a> for circuit connection). When the DAC is not used, the TVOUT signal should be left as a No Connect or connected to V <sub>SS</sub> . |
| V <sub>DDA18_DAC</sub> | L7  | PWR                 |                      | Video DAC: Analog 1.8V power. When the DAC is not used, the V <sub>DDA18_DAC</sub> signal should be connected to V <sub>SS</sub> .                                                                                                                |
| V <sub>SSA_DAC</sub>   | L8  | GND                 |                      | Video DAC: Analog 1.8V ground. When the DAC is not used, the V <sub>SSA_DAC</sub> signal should be connected to V <sub>SS</sub> .                                                                                                                 |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal. Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(2) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

## 2.6 Asynchronous External Memory Interface (AEMIF)

The Asynchronous External Memory Interface (AEMIF) signals support AEMIF, NAND, and OneNAND.

**Table 2-9. Asynchronous EMIF/NAND/OneNAND Terminal Functions**

| TERMINAL                       |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                  |
|--------------------------------|-----|---------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                           | NO. |                     |                          |                                                                                                                                                                                                                                                              |
| EM_A13/<br>GIO067/<br>BTSEL[1] | V19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[13]<br>GIO: GIO[67]<br>System: BTSEL[1:0] sampled at power-on-reset to determine boot method.                                                                                                                                    |
| EM_A12/<br>GIO066/<br>BTSEL[0] | U19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[12]<br>GIO: GIO[66]<br>System: BTSEL[1:0] sampled at power-on-reset to determine boot method.                                                                                                                                    |
| EM_A11/<br>GIO065/<br>AECFG[3] | R16 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[11]<br>GIO: GIO[65]<br>AECFG[3:0] sampled at power-on-reset to AECFG configuration. AECFG[3] sets default for PinMux2_EM_D15_8: AEMIF default bus width (16 or 8 bits)                                                           |
| EM_A10/<br>GIO064/<br>AECFG[2] | R18 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[10]<br>GIO: GIO[64]<br>AECFG[3:0] sampled at power-on-reset to AECFG configuration. AECFG[2:1] sets default for PinMux2_EM_BA0: AEMIF EM_BA0 definition (EM_BA0, EM_A14, GIO[054], rsvd)                                         |
| EM_A09/<br>GIO063/<br>AECFG[1] | P17 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[09]<br>GIO: GIO[63]<br>AECFG[3:0] sampled at power-on-reset to AECFG configuration. AECFG[2:1] sets default for PinMux2_EM_BA0: AEMIF EM_BA0 definition (EM_BA0, EM_A14, GIO[054], rsvd)                                         |
| EM_A08/<br>GIO062/<br>AECFG[0] | T19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit[08]<br>GIO: GIO[62]<br>AECFG[0] sets default for:<br><ul style="list-style-type: none"> <li>PinMux2_EM_A0_BA1: AEMIF address width (OneNAND or NAND)</li> <li>PinMux2_EM_A13_3: AEMIF address width (OneNAND or NAND)</li> </ul> |
| EM_A07/<br>GIO061              | P16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[07]<br>GIO: GIO[61]<br>Used to drive boot status LED signal (active low) in ROM boot modes.                                                                                                                                      |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-9. Asynchronous EMIF/NAND/OneNAND Terminal Functions (continued)**

| TERMINAL                    |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                          |
|-----------------------------|-----|---------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                        | NO. |                     |                          |                                                                                                                                                                                                                                      |
| EM_A06/<br>GIO060           | P18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[06]<br>GIO: GIO[60]                                                                                                                                                                                      |
| EM_A05/<br>GIO059           | R19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[05]<br>GIO: GIO[59]                                                                                                                                                                                      |
| EM_A04/<br>GIO058           | P15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[04]<br>GIO: GIO[58]                                                                                                                                                                                      |
| EM_A03/<br>GIO057           | N18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[03]<br>GIO: GIO[57]                                                                                                                                                                                      |
| EM_A02/                     | N15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[02]<br>NAND/SM/xD: CLE - Command latch enable output                                                                                                                                                     |
| EM_A01/                     | N17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[01]<br>NAND/SM/xD: ALE - Address latch enable output                                                                                                                                                     |
| EM_A00/<br>GIO056           | M16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address bus bit[00]<br>GIO: GIO[56]                                                                                                                                                                                      |
| EM_BA1/<br>GIO055           | P19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Bank address 1 signal - 16-bit address:<br><ul style="list-style-type: none"> <li>In 16-bit mode, lowest address bit.</li> <li>In 8-bit mode, second lowest address bit.</li> </ul> GIO: GIO[055]                        |
| EM_BA0/<br>GIO054<br>EM_A14 | N19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Bank address 0 signal - 8-bit address:<br><ul style="list-style-type: none"> <li>In 8-bit mode, lowest address bit. or can be used as an extra address line (bit14) when using 16-bit memories.</li> </ul> GIO: GIO[054] |
| EM_D15/<br>GIO053           | M18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 15<br>GIO: GIO[053]                                                                                                                                                                                         |
| EM_D14/<br>GIO052           | M19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 14<br>GIO: GIO[052]                                                                                                                                                                                         |
| EM_D13/<br>GIO051           | M15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 13<br>GIO: GIO[051]                                                                                                                                                                                         |
| EM_D12/<br>GIO050           | L18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 12<br>GIO: GIO[050]                                                                                                                                                                                         |
| EM_D11/<br>GIO049           | L17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 11<br>GIO: GIO[049]                                                                                                                                                                                         |
| EM_D10/<br>GIO048           | L19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 10<br>GIO: GIO[048]                                                                                                                                                                                         |
| EM_D09/<br>GIO047           | K18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 09<br>GIO: GIO[047]                                                                                                                                                                                         |
| EM_D08/<br>GIO046           | L16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 08<br>GIO: GIO[046]                                                                                                                                                                                         |
| EM_D07/<br>GIO045           | K19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 07<br>GIO: GIO[045]                                                                                                                                                                                         |
| EM_D06/<br>GIO044           | K17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 06<br>GIO: GIO[044]                                                                                                                                                                                         |
| EM_D05/<br>GIO043           | J19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 05<br>GIO: GIO[043]                                                                                                                                                                                         |
| EM_D04/<br>GIO042           | L15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 04<br>GIO: GIO[042]                                                                                                                                                                                         |
| EM_D03/<br>GIO041           | J18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 03<br>GIO: GIO[041]                                                                                                                                                                                         |
| EM_D02/<br>GIO040           | H19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 02<br>GIO: GIO[040]                                                                                                                                                                                         |
| EM_D01/<br>GIO039           | J17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 01<br>GIO: GIO[039]                                                                                                                                                                                         |
| EM_D00/<br>GIO038           | H18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data bus bit 00<br>GIO: GIO[038]                                                                                                                                                                                         |

**Table 2-9. Asynchronous EMIF/NAND/OneNAND Terminal Functions (continued)**

| TERMINAL           |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                        |
|--------------------|-----|---------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME               | NO. |                     |                          |                                                                                                                                                                                                                    |
| EM_CE0/<br>GIO037  | J16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Lowest numbered chip select. Can be programmed to be used for standard asynchronous memories (example: flash), OneNAND, or NAND memory. Used for the default boot and ROM boot modes.<br>GIO: GIO[037] |
| EM_CE1/<br>GIO036  | G19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Second chip select. Can be programmed to be used for standard asynchronous memories(example: flash), OneNAND, or NAND memory.<br>GIO: GIO[036]                                                         |
| EM_WE/<br>GIO035   | J15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Write Enable<br>NAND/SM/xD: WE (Write Enable) output<br>GIO: GIO[035]                                                                                                                                  |
| EM_OE/<br>GIO034   | F19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Output Enable<br>NAND/SM/xD: RE (Read Enable) output<br>GIO: GIO[034]                                                                                                                                  |
| EM_WAIT/<br>GIO033 | G18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Async WAIT<br>NAND/SM/xD: RDY/ BSY input<br>GIO: GIO[033]                                                                                                                                              |
| EM_ADV/<br>GIO032  | H16 | I/O/Z               | V <sub>DD</sub>          | OneNAND: Address valid detect for OneNAND interface<br>GIO: GIO[032]                                                                                                                                               |
| EM_CLK/<br>GIO031  | E19 | I/O/Z               | V <sub>DD</sub>          | OneNAND: Clock for OneNAND flash interface<br>GIO: GIO[031]                                                                                                                                                        |

## 2.7 DDR Memory Interface

The DDR EMIF supports DDR2 and mobile DDR.

**Table 2-10. DDR Terminal Functions**

| TERMINAL                     |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                |
|------------------------------|-----|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                         | NO. |                     |                          |                                                                                                                                                            |
| DDR_CLK                      | W9  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Clock                                                                                                                                             |
| $\overline{\text{DDR\_CLK}}$ | W8  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Complementary Data Clock                                                                                                                               |
| DDR_RAS                      | T6  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Row Address Strobe                                                                                                                                     |
| $\overline{\text{DDR\_CAS}}$ | V9  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Column Address Strobe                                                                                                                                  |
| $\overline{\text{DDR\_WE}}$  | W10 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Write Enable                                                                                                                                           |
| $\overline{\text{DDR\_CS}}$  | T8  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Chip Select                                                                                                                                            |
| DDR_CKE                      | V10 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Clock Enable                                                                                                                                           |
| DDR_DQM[1]                   | U15 | I/O/Z               | V <sub>DD_DDR</sub>      | Data mask outputs:                                                                                                                                         |
| DDR_DQM[0]                   | T12 | I/O/Z               | V <sub>DD_DDR</sub>      | <ul style="list-style-type: none"> <li>DDR_DQM[1] - For DDR_DQ[15:8]</li> <li>DDR_DQM[0] - For DDR_DQ[7:0]</li> </ul>                                      |
| DDR_DQS[1]                   | V15 | I/O/Z               | V <sub>DD_DDR</sub>      | Data strobe input/outputs for each byte of the 16-bit data bus used to synchronize the data transfers. Output to DDR when writing and inputs when reading. |
| DDR_DQS[0]                   | V12 | I/O/Z               | V <sub>DD_DDR</sub>      | <ul style="list-style-type: none"> <li>DDR_DQS[1] - For DDR_DQ[15:8]</li> <li>DDR_DQS[0] - For DDR_DQ[7:0]</li> </ul>                                      |
| DDR_BA[2]                    | V8  | I/O/Z               | V <sub>DD_DDR</sub>      | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                               |
| DDR_BA[1]                    | U7  | I/O/Z               | V <sub>DD_DDR</sub>      | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                               |
| DDR_BA[0]                    | U8  | I/O/Z               | V <sub>DD_DDR</sub>      | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                               |
| DDR_A13                      | U6  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 13                                                                                                                                     |
| DDR_A12                      | V7  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 12                                                                                                                                     |
| DDR_A11                      | W7  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 11                                                                                                                                     |
| DDR_A10                      | V6  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 10                                                                                                                                     |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-10. DDR Terminal Functions (continued)**

| TERMINAL                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                    |
|---------------------------|-----|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                      | NO. |                     |                          |                                                                                                                                                |
| DDR_A09                   | W6  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 09                                                                                                                         |
| DDR_A08                   | W5  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 08                                                                                                                         |
| DDR_A07                   | V5  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 07                                                                                                                         |
| DDR_A06                   | U5  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 06                                                                                                                         |
| DDR_A05                   | W4  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 05                                                                                                                         |
| DDR_A04                   | V4  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 04                                                                                                                         |
| DDR_A03                   | W3  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 03                                                                                                                         |
| DDR_A02                   | W2  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 02                                                                                                                         |
| DDR_A01                   | V3  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 01                                                                                                                         |
| DDR_A00                   | V2  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Address Bus bit 00                                                                                                                         |
| DDR_DQ15                  | W17 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 15                                                                                                                            |
| DDR_DQ14                  | V16 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 14                                                                                                                            |
| DDR_DQ13                  | W16 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 13                                                                                                                            |
| DDR_DQ12                  | U16 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 12                                                                                                                            |
| DDR_DQ11                  | W15 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 11                                                                                                                            |
| DDR_DQ10                  | W14 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 10                                                                                                                            |
| DDR_DQ09                  | V14 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 09                                                                                                                            |
| DDR_DQ08                  | U13 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 08                                                                                                                            |
| DDR_DQ07                  | W13 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 07                                                                                                                            |
| DDR_DQ06                  | V13 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 06                                                                                                                            |
| DDR_DQ05                  | W12 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 05                                                                                                                            |
| DDR_DQ04                  | U12 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 04                                                                                                                            |
| DDR_DQ03                  | T11 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 03                                                                                                                            |
| DDR_DQ02                  | U11 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 02                                                                                                                            |
| DDR_DQ01                  | W11 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 01                                                                                                                            |
| DDR_DQ00                  | V11 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR Data Bus bit 00                                                                                                                            |
| DDR_DQGATE0               | W18 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Loopback signal for external DQS gating. Route to DDR and back to DDR_DQGATE1 with same constraints as used for DDR clock and data.       |
| DDR_DQGATE1               | V17 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Loopback signal for external DQS gating. Route to DDR and back to DDR_DQGATE0 with same constraints as used for DDR clock and data.       |
| DDR_VREF                  | U10 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Voltage input for the SSTL_18 I/O buffers. Note even in the case of mDDR an external resistor divider connected to this pin is necessary. |
| V <sub>SSA_DLL</sub>      | R11 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Ground for the DDR DLL                                                                                                                    |
| V <sub>DDA33_DDRDLL</sub> | R10 | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Power (3.3 V) for the DDR DLL                                                                                                             |
| DDR_ZN                    | T9  | I/O/Z               | V <sub>DD_DDR</sub>      | DDR: Reference output for drive strength calibration of N and P channel outputs. Tie to ground via 50 ohm resistor @ 0.5% tolerance.           |

## 2.8 GPIO

The General Purpose I/O signals provide generic I/O to external devices. Most of the GPIO signals are multiplexed with other functions.

**Table 2-11. GPIO Terminal Functions**

| TERMINAL                                       |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------|-----|---------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                           | NO. |                     |                          |                                                                                                                                                                                                                                                                                                                                            |
| GIO000                                         | C16 | I/O/Z               | V <sub>DD</sub>          | GIO:GIO[000] is sampled at reset and stored in the GIO0_RESET bit of the BOOTCFG register.<br>Active low during MMC/SD boot (can be used as MMC/SD power control).<br>Can be used as external clock input for Timer 3.<br><b>Note:</b> The GIO000 pin <b>must</b> be held high during NAND boot for the boot process to function properly. |
| GIO001                                         | E14 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[001] Can be used as external clock input for Timer 3.                                                                                                                                                                                                                                                                             |
| GIO002                                         | F15 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[002] Can be used as external clock input for Timer 3.                                                                                                                                                                                                                                                                             |
| GIO003                                         | G15 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[003] Can be used as external clock input for Timer 3.                                                                                                                                                                                                                                                                             |
| GIO004                                         | B17 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[004]                                                                                                                                                                                                                                                                                                                              |
| GIO005                                         | D15 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[005]                                                                                                                                                                                                                                                                                                                              |
| GIO006                                         | B18 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[006]                                                                                                                                                                                                                                                                                                                              |
| GIO007 /<br>SPI0_SDE<br>NA[1]                  | C17 | I/O/Z               | V <sub>DD</sub>          | GIO: GIO[007]<br>SPI0: Chip Select 1                                                                                                                                                                                                                                                                                                       |
| SPI1_SD<br>O /<br>GIO008                       | E12 | I/O/Z               | V <sub>DD</sub>          | SPI1: Data Out<br>GIO: GIO[008]                                                                                                                                                                                                                                                                                                            |
| SPI1_SDI<br>/ GIO009 /<br>SPI1_SDE<br>NA[1]    | A13 | I/O/Z               | V <sub>DD</sub>          | SPI1: Data In -OR- SPI1: Chip Select 1 GIO: GIO[009]                                                                                                                                                                                                                                                                                       |
| SPI1_SCL<br>K /<br>GIO010                      | C13 | I/O/Z               | V <sub>DD</sub>          | SPI1: Clock GIO:<br>GIO[010]                                                                                                                                                                                                                                                                                                               |
| SPI1_SDE<br>NA[0] /<br>GIO011                  | E13 | I/O/Z               | V <sub>DD</sub>          | SPI1: Chip Select 0<br>GIO: GIO[011]                                                                                                                                                                                                                                                                                                       |
| UART1_T<br>XD /<br>GIO012                      | R17 | I/O/Z               | V <sub>DD</sub>          | UART1: Transmit Data<br>GIO: GIO[012]                                                                                                                                                                                                                                                                                                      |
| UART1_R<br>XD /<br>GIO013                      | R15 | I/O/Z               | V <sub>DD</sub>          | UART1: Receive Data<br>GIO: GIO[013]                                                                                                                                                                                                                                                                                                       |
| I2C_SCL /<br>GIO014                            | R14 | I/O/Z               | V <sub>DD</sub>          | I2C: Serial Clock GIO:<br>GIO[014]                                                                                                                                                                                                                                                                                                         |
| I2C_SDA /<br>GIO015                            | R13 | I/O/Z               | V <sub>DD</sub>          | I2C: Serial Data<br>GIO: GIO[015]                                                                                                                                                                                                                                                                                                          |
| CLKOUT3<br>/ GIO016                            | C11 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 3<br>GIO: GIO[016]                                                                                                                                                                                                                                                                                                    |
| CLKOUT2<br>/ GIO017                            | A11 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 2<br>GIO: GIO[017]                                                                                                                                                                                                                                                                                                    |
| CLKOUT1<br>/ GIO018                            | D12 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 1<br>GIO: GIO[018]                                                                                                                                                                                                                                                                                                    |
| MMCS1<br>_DATA0 /<br>GIO019 /<br>UART2_T<br>XD | A18 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA0<br>GIO: GIO[019]<br>UART2: Transmit Data                                                                                                                                                                                                                                                                                      |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-11. GPIO Terminal Functions (continued)**

| TERMINAL                                         |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                       |
|--------------------------------------------------|-----|---------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                             | NO. |                     |                          |                                                                                                                                                                                                                   |
| MMCSDB1<br>_DATA1 /<br>GIO020 /<br>UART2_R<br>XD | B15 | I/O/Z               | V <sub>DD</sub>          | MMCSDB1: DATA1<br>GIO: GIO[020]<br>UART2: Receive Data                                                                                                                                                            |
| MMCSDB1<br>_DATA2 /<br>GIO021 /<br>UART2_C<br>TS | A16 | I/O/Z               | V <sub>DD</sub>          | MMCSDB1: DATA2<br>GIO: GIO[021]<br>UART2: CTS                                                                                                                                                                     |
| MMCSDB1<br>_DATA3 /<br>GIO022 /<br>UART2_R<br>TS | B16 | I/O/Z               | V <sub>DD</sub>          | MMCSDB1: DATA3<br>GIO: GIO[022]<br>UART2: RTS                                                                                                                                                                     |
| MMCSDB1<br>_CMD /<br>GIO023                      | A17 | I/O/Z               | V <sub>DD</sub>          | MMCSDB1: Command<br>GIO: GIO[023]                                                                                                                                                                                 |
| MMCSDB1<br>_CLK /<br>GIO024                      | C15 | I/O/Z               | V <sub>DD</sub>          | MMCSDB1: Clock<br>GIO: GIO[024]                                                                                                                                                                                   |
| ASP0_FS<br>R /<br>GIO025                         | F16 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive Frame Synch<br>GIO: GIO[025]                                                                                                                                                                        |
| ASP0_CL<br>KR /<br>GIO026                        | F17 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive Clock<br>GIO: GIO[026]                                                                                                                                                                              |
| ASP0_DR<br>/ GIO027                              | E18 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive Data<br>GIO: GIO[027]                                                                                                                                                                               |
| ASP0_FS<br>X /<br>GIO028                         | G17 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Frame Synch<br>GIO: GIO[028]                                                                                                                                                                       |
| ASP0_CL<br>KX /<br>GIO029                        | F18 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Clock<br>GIO: GIO[029]                                                                                                                                                                             |
| ASP0_DX<br>/ GIO030                              | H15 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Data<br>GIO: GIO[030]                                                                                                                                                                              |
| EM_CLK /<br>GIO031                               | E19 | I/O/Z               | V <sub>DD</sub>          | OneNAND: Clock signal for OneNAND flash interface GIO: GIO[031]                                                                                                                                                   |
| EM_ADV /<br>GIO032                               | H16 | I/O/Z               | PD<br>V <sub>DD</sub>    | OneNAND: Address Valid Detect for OneNAND interface<br>GIO: GIO[032]                                                                                                                                              |
| EM_WAIT<br>/ GIO033                              | G18 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Async WAIT NAND/SM/xD: RDY/_BSY input<br>GIO: GIO[033]                                                                                                                                                |
| EM_OE /<br>GIO034                                | F19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Output Enable<br>NAND/SM/xD: RE (Read Enable) output<br>GIO: GIO[034]                                                                                                                                 |
| EM_WE /<br>GIO035                                | J15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Write Enable<br>NAND/SM/xD: WE (Write Enable) output<br>GIO: GIO[035]                                                                                                                                 |
| EM_CE1 /<br>GIO036                               | G19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Second Chip Select., Can be programmed to be used for standard asynchronous memories (example: flash), OneNand or NAND memory.<br>GIO: GIO[036]                                                       |
| EM_CE0 /<br>GIO037                               | J16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Lowest numbered Chip Select. Can be programmed to be used for standard asynchronous memories (example: flash), OneNand or NAND memory. Used for the default boot and ROM boot modes.<br>GIO: GIO[037] |
| EM_D00 /<br>GIO038                               | H18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[00]<br>GIO: GIO[038]                                                                                                                                                                     |

**Table 2-11. GPIO Terminal Functions (continued)**

| TERMINAL                         |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                     |
|----------------------------------|-----|---------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                             | NO. |                     |                          |                                                                                                                                                                                                 |
| EM_D01 /<br>GIO039               | J17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[01]<br>GIO: GIO[039]                                                                                                                                                   |
| EM_D02 /<br>GIO040               | H19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[02]<br>GIO: GIO[040]                                                                                                                                                   |
| EM_D03 /<br>GIO041               | J18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[03]<br>GIO: GIO[041]                                                                                                                                                   |
| EM_D04 /<br>GIO042               | L15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[04]<br>GIO: GIO[042]                                                                                                                                                   |
| EM_D05 /<br>GIO043               | J19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[05]<br>GIO: GIO[043]                                                                                                                                                   |
| EM_D06 /<br>GIO044               | K17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[06]<br>GIO: GIO[044]                                                                                                                                                   |
| EM_D07 /<br>GIO045               | K19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[07]<br>GIO: GIO[045]                                                                                                                                                   |
| EM_D08 /<br>GIO046               | L16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[08]<br>GIO: GIO[046]                                                                                                                                                   |
| EM_D09 /<br>GIO047               | K18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[09]<br>GIO: GIO[047]                                                                                                                                                   |
| EM_D10 /<br>GIO048               | L19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[10]<br>GIO: GIO[048]                                                                                                                                                   |
| EM_D11 /<br>GIO049               | L17 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[11]<br>GIO: GIO[049]                                                                                                                                                   |
| EM_D12 /<br>GIO050               | L18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[12]<br>GIO: GIO[050]                                                                                                                                                   |
| EM_D13 /<br>GIO051               | M15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[13]<br>GIO: GIO[051]                                                                                                                                                   |
| EM_D14 /<br>GIO052               | M19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[14]<br>GIO: GIO[052]                                                                                                                                                   |
| EM_D15 /<br>GIO053               | M18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Data Bus bit[15]<br>GIO: GIO[053]                                                                                                                                                   |
| EM_BA0 /<br>GIO054 /<br>EM_A14   | N19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Bank Address 0 signal = 8-bit address. In 8-bit mode, lowest address bit. Or, can be used as an extra Address line (bit[14] when using 16-bit memories.<br>GIO: GIO[054]            |
| EM_BA1 /<br>GIO055               | P19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Bank Address 1 signal = 16-bit address. In 16-bit mode, lowest address bit. In 8-bit mode, second lowest address bit<br>GIO: GIO[055]                                               |
| EM_A00 /<br>GIO056               | M16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[00] Note that the EM_A0 is always a 32-bit address<br>GIO: GIO[056]                                                                                                 |
| EM_A03 /<br>GIO057               | N18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[03]<br>GIO: GIO[057]                                                                                                                                                |
| EM_A04 /<br>GIO058               | P15 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[04]<br>GIO: GIO[058]                                                                                                                                                |
| EM_A05 /<br>GIO059               | R19 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[05]<br>GIO: GIO[059]                                                                                                                                                |
| EM_A06 /<br>GIO060               | P18 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[06]<br>GIO: GIO[060]                                                                                                                                                |
| EM_A07 /<br>GIO061               | P16 | I/O/Z               | V <sub>DD</sub>          | Async EMIF: Address Bus bit[07]<br>GIO: GIO[061] - Used to drive Boot Status LED signal (active low) in ROM boot modes                                                                          |
| EM_A08 /<br>GIO062 /<br>AECFG[0] | T19 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Address Bus bit[08]<br>GIO: GIO[062] AECFG[0] sets default for - PinMux2.EM_A0_BA1: AEMIF Address Width (OneNAND or NAND) - PinMux2.EM_A13_3: AEMIF Address Width (OneNAND or NAND) |

**Table 2-11. GPIO Terminal Functions (continued)**

| TERMINAL                                      |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup>   | DESCRIPTION                                                                                                                                                                                                                   |
|-----------------------------------------------|-----|---------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                          | NO. |                     |                            |                                                                                                                                                                                                                               |
| EM_A09 /<br>GIO063 /<br>AECFG[1]              | P17 | I/O/Z               | PD<br>V <sub>DD</sub>      | Async EMIF: Address Bus bit[09]<br>GIO: GIO[063] System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration AECFG[2:1] sets default for PinMux2.EM_BA0: AEMIF EM_BA0 Definition (EM_BA0, EM_A14, GIO[054], rsvd) |
| EM_A10 /<br>GIO064 /<br>AECFG[2]              | R18 | I/O/Z               | PU<br>V <sub>DD</sub>      | Async EMIF: Address Bus bit[10]<br>GIO: GIO[064] System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration AECFG[2:1] sets default for PinMux2.EM_BA0: AEMIF EM_BA0 Definition (EM_BA0, EM_A14, GIO[054], rsvd) |
| EM_A11 /<br>GIO065 /<br>AECFG[3]              | R16 | I/O/Z               | PU<br>V <sub>DD</sub>      | Async EMIF: Address Bus bit[11]<br>GIO: GIO[065] System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration AECFG[3] sets default for PinMux2.EM_D15_8: AEMIF Default Bus Width (16 or 8 bits)                   |
| EM_A12 /<br>GIO066 /<br>BTSEL[0]              | U19 | I/O/Z               | PD<br>V <sub>DD</sub>      | Async EMIF: Address Bus bit[12]<br>GIO: GIO[066] System: BTSEL[1:0] sampled at Power-on-Reset to determine Boot method                                                                                                        |
| EM_A13 /<br>GIO067 /<br>BTSEL[1]              | V19 | I/O/Z               | PD<br>V <sub>DD</sub>      | Async EMIF: Address Bus bit[13]<br>GIO: GIO[067] System: BTSEL[1:0] sampled at Power-on-Reset to determine Boot method.                                                                                                       |
| VCLK /<br>GIO068                              | H3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Video Encoder: Video Output Clock<br>GIO: GIO[068]                                                                                                                                                                            |
| EXTCLK /<br>GIO069 /<br>B2 /<br>PWM3D         | G3  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: External clock input, used if clock rates > 27 MHz are needed, e.g. 74.25 MHz for HDTV digital output<br>GIO: GIO[069] Digital Video Out: B2 PWM3D                                                             |
| FIELD /<br>GIO070 /<br>R2 /<br>PWM3C          | H4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Video Encoder: Field identifier for interlaced display formats<br>GIO: GIO[070] Digital Video Out: R2 PWM3C                                                                                                                   |
| VSYN /<br>GIO072                              | G5  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: Vertical Sync<br>GIO: GIO[072]                                                                                                                                                                                 |
| HSYN /<br>GIO073                              | F5  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: Horizontal Sync<br>GIO: GIO[073]                                                                                                                                                                               |
| COUT0-<br>B3 /<br>GIO074 /<br>PWM3B           | F4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[074] PWM3B                                                                                                                                                       |
| COUT1-<br>B4 /<br>GIO075 /<br>PWM3A           | F3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[075] PWM3A                                                                                                                                                       |
| COUT2-<br>B5 /<br>GIO076 /<br>PWM2D /<br>RTO3 | E4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[076] PWM2D RTO3                                                                                                                                                  |
| COUT3-<br>B6 /<br>GIO077 /<br>PWM2C /<br>RTO2 | E3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[077] PWM2C RTO2                                                                                                                                                  |
| COUT4-<br>B7 /<br>GIO078 /<br>PWM2B /<br>RTO1 | D3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[078] PWM2B RTO1                                                                                                                                                  |
| COUT5-<br>G2 /<br>GIO079 /<br>PWM2A /<br>RTO0 | C1  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[079] PWM2A RTO0                                                                                                                                                  |

**Table 2-11. GPIO Terminal Functions (continued)**

| TERMINAL                           |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup>  | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------|-----|---------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                               | NO. |                     |                           |                                                                                                                                                                                                                                                                                                                                                                   |
| COUT6-<br>G3 /<br>GIO080 /<br>PWM1 | D2  | I/O/Z               | V <sub>DD_VOUT</sub>      | Digital Video Out: VENC settings determine function GIO: GIO[080]<br>PWM1                                                                                                                                                                                                                                                                                         |
| COUT7-<br>G4 /<br>GIO081 /<br>PWM0 | C2  | I/O/Z               | V <sub>DD_VOUT</sub>      | Digital Video Out: VENC settings determine function GIO: GIO[081]<br>PWM0                                                                                                                                                                                                                                                                                         |
| PCLK /<br>GIO082                   | T3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Pixel clock input (strobe for lines CI7 through YI0) GIO: GIO[082]                                                                                                                                                                                                                                                                                                |
| CAM_WE<br>N_FIELD /<br>GIO083      | R5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Write enable input signal is used by external device (AFE/TG) to gate the DDR output of the CCDC module. Alternately, the field identification input signal is used by external device (AFE/TG) to indicate the which of two frames is input to the CCDC module for sensors with interlaced output. CCDC handles 1- or 2-field sensors in hardware. GIO: GIO[083] |
| CAM_VD /<br>GIO084                 | R4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Vertical synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new frame starts. GIO: GIO[084]                                                                                                                                                                                                        |
| CAM_HD /<br>GIO085                 | N5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Horizontal synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new line starts. GIO: GIO[085]                                                                                                                                                                                                       |
| YIN0 /<br>GIO086                   | P5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[00] YCC 16-bit: time multiplexed between luma: Y[00] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[00] GIO: GIO[086]                                                                                                                      |
| YIN1 /<br>GIO087                   | P2  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[01] YCC 16-bit: time multiplexed between luma: Y[01] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[01] GIO: GIO[087]                                                                                                                      |
| YIN2 /<br>GIO088                   | P4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[02] YCC 16-bit: time multiplexed between luma: Y[02] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[02] GIO: GIO[088]                                                                                                                      |
| YIN3 /<br>GIO089                   | R3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[03] YCC 16-bit: time multiplexed between luma: Y[03] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[03] GIO: GIO[089]                                                                                                                      |
| YIN4 /<br>GIO090                   | P3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[04] YCC 16-bit: time multiplexed between luma: Y[04] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[04] GIO: GIO[090]                                                                                                                      |
| YIN5 /<br>GIO091                   | M5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[05] YCC 16-bit: time multiplexed between luma: Y[05] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[05] GIO: GIO[091]                                                                                                                      |
| YIN6 /<br>GIO092                   | M4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[06] YCC 16-bit: time multiplexed between luma: Y[06] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[06] GIO: GIO[092]                                                                                                                      |
| YIN7 /<br>GIO093                   | L5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[07] YCC 16-bit: time multiplexed between luma: Y[07] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[07] GIO: GIO[093]                                                                                                                      |
| CIN0 /<br>GIO094                   | J3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub> | Standard CCD/CMOS input: raw[08] YCC 16-bit: time multiplexed between chroma: CB/CR[00] YCC 8-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[00] GIO: GIO[094]                                                                                                                |

**Table 2-11. GPIO Terminal Functions (continued)**

| TERMINAL                                                 |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------|-----|---------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                                     | NO. |                     |                          |                                                                                                                                                                                                                                                                                                   |
| CIN1 /<br>GIO095                                         | L3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: raw[09] YCC 16-bit: time multiplexed between chroma: CB/CR[01] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[01]<br>GIO: GIO[095]                                            |
| CIN2 /<br>GIO096                                         | J5  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: raw[10] YCC 16-bit: time multiplexed between chroma: CB/CR[02] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[02]<br>GIO: GIO[096]                                            |
| CIN3 /<br>GIO097                                         | J4  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: raw[11] YCC 16-bit: time multiplexed between chroma: CB/CR[03] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[03]<br>GIO: GIO[097]                                            |
| CIN4 /<br>GIO098 /<br>SPI2_SDI<br>/<br>SPI2_SDE<br>NA[1] | L4  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: raw[12] YCC 16-bit: time multiplexed between chroma: CB/CR[04] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[04] SPI: SPI2 Data In -OR- SPI2 Chip select 1.<br>GIO: GIO[098] |
| CIN5 /<br>GIO099 /<br>SPI2_SDE<br>NA[0]                  | M3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: raw[13] YCC 16-bit: time multiplexed between chroma: CB/CR[05] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[05] SPI: SPI2 Chip Select 0.<br>GIO: GIO[099]                   |
| CIN6 /<br>GIO100 /<br>SPI2_SD<br>O                       | K5  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: NOT USED YCC 16-bit: time multiplexed between chroma: CB/CR[06] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[06] SPI: SPI2 Data Out<br>GIO: GIO[100]                        |
| CIN7 /<br>GIO101 /<br>SPI2_SCL<br>K                      | N3  | I/O/Z               | PD<br>$V_{DD\_VIN}$      | Standard CCD/CMOS input: NOT USED YCC 16-bit: time multiplexed between chroma: CB/CR[07] YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07] SPI: SPI2 Clock<br>GIO: GIO[101]                           |
| SPI0_SDI<br>/ GIO102                                     | A12 | I/O/Z               | $V_{DD}$                 | SPI0: Data In<br>GIO: GIO[102]                                                                                                                                                                                                                                                                    |
| SPI0_SDE<br>NA[0] /<br>GIO103                            | B12 | I/O/Z               | $V_{DD}$                 | SPI0: Chip Select 0<br>GIO: GIO[103]                                                                                                                                                                                                                                                              |

## 2.9 Multi-Media Card/Secure Digital (MMC/SD) Interfaces

The DM335 includes two Multi-Media Card/Secure Digital card interfaces that are compatible with the MMC/SD and SDIO protocol.

**Table 2-12. MMC/SD Terminal Functions**

| TERMINAL    |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION    |
|-------------|-----|---------------------|--------------------------|----------------|
| NAME        | NO. |                     |                          |                |
| MMCS0_CLK   | A15 | I/O/Z               | $V_{DD}$                 | MMCS0: Clock   |
| MMCS0_CMD   | C14 | I/O/Z               | $V_{DD}$                 | MMCS0: Command |
| MMCS0_DATA0 | B14 | I/O/Z               | $V_{DD}$                 | MMCS0: DATA0   |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 k $\Omega$  resistor should be used.)

**Table 2-12. MMC/SD Terminal Functions (continued)**

| TERMINAL                                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                           |
|-------------------------------------------|-----|---------------------|--------------------------|-------------------------------------------------------|
| NAME                                      | NO. |                     |                          |                                                       |
| MMCS0_ DATA1                              | D14 | I/O/Z               | V <sub>DD</sub>          | MMCS0: DATA1                                          |
| MMCS0_ DATA2                              | B13 | I/O/Z               | V <sub>DD</sub>          | MMCS0: DATA2                                          |
| MMCS0_ DATA3                              | A14 | I/O/Z               | V <sub>DD</sub>          | MMCS0: DATA3                                          |
| MMCS1_ CLK/<br>GIO024                     | C15 | I/O/Z               | V <sub>DD</sub>          | MMCS1: Clock<br>GIO: GIO[024]                         |
| MMCS1_ CMD/<br>GIO023                     | A17 | I/O/Z               | V <sub>DD</sub>          | MMCS1: Command<br>GIO: GIO[023]                       |
| MMCS1_ DATA0/<br>GIO019/<br>UART2_T<br>XD | A18 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA0<br>GIO: GIO[019]<br>UART2: Transmit data |
| MMCS1_ DATA1/<br>GIO020/<br>UART2_R<br>XD | B15 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA1<br>GIO: GIO[020]<br>UART2: Receive data  |
| MMCS1_ DATA2/<br>GIO021/<br>UART2_C<br>TS | A16 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA2<br>GIO: GIO[021]<br>UART2: CTS           |
| MMCS1_ DATA3/<br>GIO022/<br>UART2_R<br>TS | B16 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA3<br>GIO: GIO[022]<br>UART2: RTS           |

## 2.10 Universal Serial Bus (USB) Interface

The Universal Serial Bus (USB) interface supports the USB2.0 High-Speed protocol and includes dual-role Host/Slave support. However, no charge pump is included.

**Table 2-13. USB Terminal Functions**

| TERMINAL |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                               |
|----------|-----|---------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME     | NO. |                     |                          |                                                                                                                                                                                                                           |
| USB_DP   | A7  | A I/O/Z             | V <sub>DDA33_USB</sub>   | USB D+ (differential signal pair).<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                      |
| USB_DM   | A6  | A I/O/Z             | V <sub>DDA33_USB</sub>   | USB D- (differential signal pair).<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                      |
| USB_R1   | C7  | A I/O/Z             |                          | USB reference current output<br>Connect to V <sub>SS_USB_REF</sub> via 10K ohm , 1% resistor placed as close to the device as possible.<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> . |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#) , *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-13. USB Terminal Functions (continued)**

| TERMINAL                   |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------|-----|---------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                       | NO. |                     |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| USB_ID                     | D5  | A I/O/Z             | V <sub>DDA33_USB</sub>   | USB operating mode identification pin<br>For Device mode operation only, pull up this pin to V <sub>DD</sub> with a 1.5K ohm resistor.<br>For Host mode operation only, pull down this pin to ground (V <sub>SS</sub> ) with a 1.5K ohm resistor.<br>If using an OTG or mini-USB connector, this pin will be set properly via the cable/connector configuration.<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> . |
| USB_VBUS                   | E5  | A I/O/Z             | V <sub>DD</sub>          | For host or device mode operation, tie the VBUS/USB power signal to the USB connector.<br>When used in OTG mode operation, tie VBUS to the external charge pump and to the VBUS signal on the USB connector.<br>When the USB is not used, tie VBUS to V <sub>SS_USB</sub> .                                                                                                                                                                        |
| USB_DRVVBUS                | C5  | O/Z                 | V <sub>DD</sub>          | Digital output to control external 5 V supply<br>When USB is not used, this signal should be left as a No Connect.                                                                                                                                                                                                                                                                                                                                 |
| V <sub>SS_USB_REF</sub>    | C8  | GND                 | V <sub>DD</sub>          | USB Ground Reference<br>Connect directly to ground and to USB_R1 via 10K ohm, 1% resistor placed as close to the device as possible.                                                                                                                                                                                                                                                                                                               |
| V <sub>DDA33_USB</sub>     | J8  | PWR                 | V <sub>DD</sub>          | Analog 3.3 V power USBPHY<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                                                                                                                                                                                                                                                        |
| V <sub>DDA33_USB_PLL</sub> | B6  | PWR                 | V <sub>DD</sub>          | Common mode 3.3 V power for USB PHY (PLL)<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                                                                                                                                                                                                                                        |
| V <sub>DDA13_USB</sub>     | H7  | PWR                 | V <sub>DD</sub>          | Analog 1.3 V power for USB PHY<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                                                                                                                                                                                                                                                   |
| V <sub>DDD13_USB</sub>     | C6  | PWR                 | V <sub>DD</sub>          | Digital 1.3 V power for USB PHY<br>When USB is not used, this signal should be connected to V <sub>SS_USB</sub> .                                                                                                                                                                                                                                                                                                                                  |

## 2.11 Audio Interfaces

The DM335 includes two Audio Serial Ports (ASP ports), which are backward compatible with other TI ASP serial ports and provide I2S audio interface. One interface is multiplexed with GIO signals.

**Table 2-14. ASP Terminal Functions**

| TERMINAL                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                 |
|---------------------------|-----|---------------------|--------------------------|---------------------------------------------|
| NAME                      | NO. |                     |                          |                                             |
| ASP0_CL<br>KR/<br>GIO026  | F17 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive Clock<br>GIO: GIO[026]        |
| ASP0_CL<br>KX /<br>GIO029 | F18 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Clock<br>GIO: GIO[029]       |
| ASP0_DR<br>/<br>GIO027    | E18 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive DataF<br>GIO: GIO[027]        |
| ASP0_DX<br>/<br>GIO030    | H15 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Data<br>GIO: GIO[030]        |
| ASP0_FS<br>R /<br>GIO025  | F16 | I/O/Z               | V <sub>DD</sub>          | ASP0: Receive Frame Synch<br>GIO: GIO[025]  |
| ASP0_FS<br>X /<br>GIO028  | G17 | I/O/Z               | V <sub>DD</sub>          | ASP0: Transmit Frame Synch<br>GIO: GIO[028] |
| ASP1_CL<br>KR             | D18 | I/O/Z               | V <sub>DD</sub>          | ASP1: Receive Clock                         |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-14. ASP Terminal Functions (continued)**

| TERMINAL      |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION               |
|---------------|-----|---------------------|--------------------------|---------------------------|
| NAME          | NO. |                     |                          |                           |
| ASP1_CL<br>KS | D17 | I/Z                 | V <sub>DD</sub>          | ASP1: Master Clock        |
| ASP1_CL<br>KX | D19 | I/O/Z               | V <sub>DD</sub>          | ASP1: Transmit Clock      |
| ASP1_DR       | C19 | I/O/Z               | V <sub>DD</sub>          | ASP1: Receive Data        |
| ASP1_DX       | C18 | I/O/Z               | V <sub>DD</sub>          | ASP1: Transmit Data       |
| ASP1_FS<br>R  | E17 | I/O/Z               | V <sub>DD</sub>          | ASP1: Receive Frame Synch |
| ASP1_FS<br>X  | E16 | I/O/Z               | V <sub>DD</sub>          | ASP1: Transmit Frame Sync |

## 2.12 UART Interface

TheDM335 includes three UART ports. These ports are multiplexed with GIO and other signals.

**Table 2-15. UART Terminal Functions**

| TERMINAL                                 |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                   |
|------------------------------------------|-----|---------------------|--------------------------|-----------------------------------------------|
| NAME                                     | NO. |                     |                          |                                               |
| UART0_RXD                                | U18 | I                   | V <sub>DD</sub>          | UART0: Receive data. Used for UART boot mode  |
| UART0_TXD                                | T18 | O                   | V <sub>DD</sub>          | UART0: Transmit data. Used for UART boot mode |
| UART1_RXD/<br>GIO013                     | R15 | I/O/Z               | V <sub>DD</sub>          | UART1: Receive data.<br>GIO: GIO013           |
| UART1_TXD/<br>GIO012                     | R17 | I/O/Z               | V <sub>DD</sub>          | UART1: Transmit data.<br>GIO: GIO012          |
| MMCS1_DA<br>TA2/<br>GIO021/<br>UART2_CTS | A16 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA2<br>GIO: GIO021<br>UART2: CTS     |
| MMCS1_DA<br>TA3/<br>GIO022/<br>UART2_RTS | B16 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA3<br>GIO: GIO022<br>UART2: RTS     |
| MMCS1_DA<br>TA1/<br>GIO020/<br>UART2_RXD | B15 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA1<br>GIO: GIO020<br>UART2: RXD     |
| MMCS1_DA<br>TA0/<br>GIO019/<br>UART2_TXD | A18 | I/O/Z               | V <sub>DD</sub>          | MMCS1: DATA0<br>GIO: GIO019<br>UART2: TXD     |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

## 2.13 I<sup>2</sup>C Interface

The DM335 includes an I<sup>2</sup>C two-wire serial interface for control of external peripherals. This interface is multiplexed with GIO signals.

**Table 2-16. I<sup>2</sup>C Terminal Functions**

| TERMINAL           |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                      |
|--------------------|-----|---------------------|--------------------------|----------------------------------|
| NAME               | NO. |                     |                          |                                  |
| I2C_SDA/<br>GIO015 | R13 | I/O/Z               | V <sub>DD</sub>          | I2C: Serial data<br>GIO: GIO015  |
| I2C_SCL/<br>GIO014 | R14 | I/O/Z               | V <sub>DD</sub>          | I2C: Serial clock<br>GIO: GIO014 |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

## 2.14 Serial Interface

The DM335 includes three independent serial ports. These interfaces are multiplexed with GIO and other signals.

**Table 2-17. SPI Terminal Functions**

| TERMINAL                              |     | TYPE <sup>(1)</sup> | OTHER <sup>(2)</sup><br>(3) | DESCRIPTION                                                                                                                                                                                                                                                                                  |
|---------------------------------------|-----|---------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                  | NO. |                     |                             |                                                                                                                                                                                                                                                                                              |
| SPI0_SCLK                             | C12 | I/O/Z               | V <sub>DD</sub>             | SPI0: Clock                                                                                                                                                                                                                                                                                  |
| SPI0_SDENA[0]/<br>GIO103              | B12 | I/O/Z               | V <sub>DD</sub>             | SPI0: Chip select 0<br>GIO: GIO[103]                                                                                                                                                                                                                                                         |
| GIO007<br>SPI0_SDENA[1]               | C17 | I/O/Z               | V <sub>DD</sub>             | GIO: GIO[007]<br>SPI0: Chip select 1                                                                                                                                                                                                                                                         |
| SPI0_SDI/<br>GIO102                   | A12 | I/O/Z               | V <sub>DD</sub>             | SPI0: Data in<br>GIO: GIO[102]                                                                                                                                                                                                                                                               |
| SPI0_SDO                              | B11 | I/O/Z               | V <sub>DD</sub>             | SPI0: Data out                                                                                                                                                                                                                                                                               |
| SPI1_SCLK/<br>GIO010                  | C13 | I/O/Z               | V <sub>DD</sub>             | SPI1: Clock<br>GIO: GIO[010]                                                                                                                                                                                                                                                                 |
| SPI1_SDENA[0]/<br>GIO011              | E13 | I/O/Z               | V <sub>DD</sub>             | SPI1: Chip select 0<br>GIO: GIO[011] - Active low during MMC/SD boot (can be used as MMC/SD power control)                                                                                                                                                                                   |
| SPI1_SDI/<br>GIO009/<br>SPI1_SDENA[1] | A13 | I/O/Z               | V <sub>DD</sub>             | SPI1: Data in or<br>SPI1: Chip select 1<br>GIO: GIO[09]                                                                                                                                                                                                                                      |
| SPI1_SDO/<br>GIO008                   | E12 | I/O/Z               | V <sub>DD</sub>             | SPI1: Data out<br>GIO: GIO[008]                                                                                                                                                                                                                                                              |
| CIN7/<br>GIO101/<br>SPI2_SCLK         | N3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub>   | Standard CCD/CMOS input: Not used<br>• YCC 16-bit: time multiplexed between chroma. CB/CR[07]<br>• YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07]<br>SPI: SPI2 clock<br>GIO: GIO[101]        |
| CIN5/<br>GIO099/<br>SPI2_SDENA[0]     | M3  | I/O/Z               | PD<br>V <sub>DD_VIN</sub>   | Standard CCD/CMOS input: Raw[13]<br>• YCC 16-bit: time multiplexed between chroma. CB/CR[05]<br>• YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07]<br>SPI: SPI2 chip select 0<br>GIO: GIO[099] |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-17. SPI Terminal Functions (continued)**

| TERMINAL                                       |     | TYPE <sup>(1)</sup> | OTHER <sup>(2)</sup><br>(3) | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------|-----|---------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                           | NO. |                     |                             |                                                                                                                                                                                                                                                                                                                                                                  |
| CIN4/<br>GIO098/<br>SPI2_SDI/<br>SPI2_SDENA[1] | L4  | I/O/Z               | PD<br>V <sub>DD_VIN</sub>   | Standard CCD/CMOS input: Raw[12]<br><ul style="list-style-type: none"> <li>YCC 16-bit: time multiplexed between chroma. CB/CR[04]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[04]</li> </ul> SPI: SPI2 Data in -OR- SPI2 Chip select 1<br>GIO: GIO[0998] |
| CIN6/<br>GIO100/<br>SPI2_SDO/                  | K5  | I/O/Z               | PD<br>V <sub>DD_VIN</sub>   | Standard CCD/CMOS input: Not used<br><ul style="list-style-type: none"> <li>YCC 16-bit: time multiplexed between chroma. CB/CR[06]</li> <li>YCC 8-bit (which allows for two simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[06]</li> </ul> SPI: SPI2 Data out<br>GIO: GIO[100]                        |

## 2.15 Clock Interface

The DM335 provides interface with the system clocks.

**Table 2-18. Clocks Terminal Functions**

| TERMINAL            |     | TYPE <sup>(1)</sup> | OTHER <sup>(2)</sup> (3) | DESCRIPTION                                                                                                                                                                                                                                         |
|---------------------|-----|---------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                | NO. |                     |                          |                                                                                                                                                                                                                                                     |
| CLKOUT1<br>/ GIO018 | D12 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 1<br>GIO: GIO[018]                                                                                                                                                                                                             |
| CLKOUT2<br>/ GIO017 | A11 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 2<br>GIO: GIO[017]                                                                                                                                                                                                             |
| CLKOUT3<br>/ GIO016 | C11 | I/O/Z               | V <sub>DD</sub>          | CLKOUT: Output Clock 3<br>GIO: GIO[016]                                                                                                                                                                                                             |
| MXI1                | A9  | I                   | V <sub>DD</sub>          | Crystal input for system oscillator (24 MHz or 36 MHz)                                                                                                                                                                                              |
| MXO1                | B9  | O                   | V <sub>DD</sub>          | Output for system oscillator (24 MHz or 36 MHz). When the MXO2 is not used, the MXO2 signal can be left open.                                                                                                                                       |
| MXI2                | R1  | I                   | V <sub>DD</sub>          | Crystal input for video oscillator (27 MHz) Optional, use only if 27MHz derived from MXI1 and PLL does not provide sufficient performance for Video DAC. When the MXI2 is not used and powered down, the MXI2 signal should be left as a No Connect |
| MXO2                | T1  | O                   | V <sub>DD</sub>          | Output for video oscillator (27 MHz) Optional, use only if 27MHz derived from MXI1 and PLL does not provide sufficient performance for Video DAC When the MXO2 is not used and powered down, the MXO2 signal should be left as a No Connect.        |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

## 2.16 Real Time Output (RTO) Interface

The DM335 provides Real Time Output (RTO) interface.

**Table 2-19. RTO Terminal Functions**

| TERMINAL                                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                        |
|-------------------------------------------|-----|---------------------|--------------------------|------------------------------------------------------------------------------------|
| NAME                                      | NO. |                     |                          |                                                                                    |
| COUT5-G2 /<br>GIO079 /<br>PWM2A /<br>RTO0 | C1  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[079]<br>PWM2A<br>RTO0 |
| COUT4-B7 /<br>GIO078 /<br>PWM2B /<br>RTO1 | D3  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[078]<br>PWM2B<br>RTO1 |
| COUT3-B6 /<br>GIO077 /<br>PWM2C /<br>RTO2 | E3  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[077]<br>PWM2C<br>RTO2 |
| COUT2-B5 /<br>GIO076 /<br>PWM2D /<br>RTO3 | E4  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[076]<br>PWM2D<br>RTO3 |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

## 2.17 Pulse Width Modulator (PWM) Interface

The DM335 provides Pulse Width Modulator (PWM) interface.

**Table 2-20. PWM Terminal Functions**

| TERMINAL                                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                        |
|-------------------------------------------|-----|---------------------|--------------------------|------------------------------------------------------------------------------------|
| NAME                                      | NO. |                     |                          |                                                                                    |
| COUT7-G4 /<br>GIO081 /<br>PWM0            | C2  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[081]<br>PWM0          |
| COUT6-G3 /<br>GIO080 /<br>PWM1            | D2  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[080]<br>PWM1          |
| COUT5-G2 /<br>GIO079 /<br>PWM2A /<br>RTO0 | C1  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[079]<br>PWM2A<br>RTO0 |
| COUT4-B7 /<br>GIO078 /<br>PWM2B /<br>RTO1 | D3  | I/O/Z               | V <sub>DD_VOUT</sub>     | Digital Video Out: VENC settings determine function GIO: GIO[078]<br>PWM2B<br>RTO1 |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-20. PWM Terminal Functions (continued)**

| TERMINAL                                  |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup>   | DESCRIPTION                                                                                                                                                       |
|-------------------------------------------|-----|---------------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                      | NO. |                     |                            |                                                                                                                                                                   |
| COUT3-B6 /<br>GIO077 /<br>PWM2C /<br>RTO2 | E3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[077]<br>PWM2C<br>RTO2                                                                                |
| COUT2-B5 /<br>GIO076 /<br>PWM2D /<br>RTO3 | E4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[076]<br>PWM2D<br>RTO3                                                                                |
| COUT1-B4 /<br>GIO075 /<br>PWM3A           | F3  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[075]<br>PWM3A                                                                                        |
| COUT0-B3 /<br>GIO074 /<br>PWM3B           | F4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Digital Video Out: VENC settings determine function GIO: GIO[074]<br>PWM3B                                                                                        |
| FIELD /<br>GIO070 /<br>R2 /<br>PWM3C      | H4  | I/O/Z               | V <sub>DD_VOUT</sub>       | Video Encoder: Field identifier for interlaced display formats GIO: GIO[070]<br>Digital Video Out: R2<br>PWM3C                                                    |
| EXTCLK /<br>GIO069 /<br>B2 /<br>PWM3D     | G3  | I/O/Z               | PD<br>V <sub>DD_VOUT</sub> | Video Encoder: External clock input, used if clock rates > 27 MHz are needed, e.g. 74.25 MHz for HDTV digital output GIO: GIO[069] Digital Video Out: B2<br>PWM3D |

## 2.18 System Configuration Interface

The DM335 provides interfaces for system configuration and boot load.

**Table 2-21. System/Boot Terminal Functions**

| TERMINAL                       |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                        |
|--------------------------------|-----|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                           | NO. |                     |                          |                                                                                                                                                                                                                                    |
| EM_A13/<br>GIO067/<br>BTSEL[1] | V19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 13<br>GIO: GIO[067]<br>System: BTSEL[1:0] sampled at power-on-reset to determine boot method.                                                                                                          |
| EM_A12/<br>GIO066/<br>BTSEL[0] | U19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 12<br>GIO: GIO[066]<br>System: BTSEL[1:0] sampled at power-on-reset to determine boot method.                                                                                                          |
| EM_A11/<br>GIO065/<br>AECFG[3] | R16 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 11<br>GIO: GIO[065]<br>System: AECFG[3:0] sampled a power-on-reset to set AEMIF configuration.<br>AECFG[3] sets default fo PinMux2.EM_D15_8. AEMIF default bus width (16 or 8 bits).                   |
| EM_A10/<br>GIO064/<br>AECFG[2] | R18 | I/O/Z               | PU<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 10<br>GIO: GIO[064]<br>System: AECFG[3:0] sampled a power-on-reset to set AEMIF configuration.<br>AECFG[2:1] sets default fo PinMux2.EM_BA0. AEMIF EM_BA0 definition: (EM_BA0, EM_A14, GIO[054], rsvd) |
| EM_A09/<br>GIO063/<br>AECFG[1] | P17 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 09<br>GIO: GIO[063]<br>System: AECFG[3:0] sampled a power-on-reset to set AEMIF configuration.<br>AECFG[2:1] sets default fo PinMux2.EM_BA0. AEMIF EM_BA0 definition: (EM_BA0, EM_A14, GIO[054], rsvd) |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

**Table 2-21. System/Boot Terminal Functions (continued)**

| TERMINAL                       |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                                                                                                                                           |
|--------------------------------|-----|---------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                           | NO. |                     |                          |                                                                                                                                                                                                                                                                       |
| EM_A08/<br>GIO062/<br>AECFG[0] | T19 | I/O/Z               | PD<br>V <sub>DD</sub>    | Async EMIF: Address bus bit 08<br>GIO: GIO[062]<br>System: AECFG[0] sets default for: <ul style="list-style-type: none"> <li>PinMux2.EM_A0_BA1 - AEMIF address width (OneNAND, or NAND)</li> <li>PinMux2.EM_A13_3 - AEMIF address width (OneNAND, or NAND)</li> </ul> |

## 2.19 Emulation

The emulation interface allow software and hardware debugging.

**Table 2-22. Emulation Terminal Functions**

| TERMINAL                 |     | TYPE <sup>(1)</sup> | OTHER <sup>(2) (3)</sup> | DESCRIPTION                                                                                                                                         |
|--------------------------|-----|---------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                     | NO. |                     |                          |                                                                                                                                                     |
| TCK                      | E10 | I                   | V <sub>DD</sub>          | JTAG test clock input                                                                                                                               |
| TDI                      | D9  | I                   | PU<br>V <sub>DD</sub>    | JTAG test data input                                                                                                                                |
| TDO                      | E9  | O                   | V <sub>DD</sub>          | JTAG test data output                                                                                                                               |
| TMS                      | D8  | I                   | PU<br>V <sub>DD</sub>    | JTAG test mode select                                                                                                                               |
| $\overline{\text{TRST}}$ | C9  | I                   | PD<br>V <sub>DD</sub>    | JTAG test logic reset (active low)                                                                                                                  |
| RTCK                     | E11 | O                   | V <sub>DD</sub>          | JTAG test clock output                                                                                                                              |
| EMU0                     | E8  | I/O/Z               | PU<br>V <sub>DD</sub>    | JTAG emulation 0 I/O<br>EMU[1:0] = 00 - Force Debug Scan chain (ARM and ARM ETB TAPs connected)<br>EMU[1:0] = 11 - Normal Scan chain (ICEpick only) |
| EMU1                     | E7  | I/O/Z               | PU<br>V <sub>DD</sub>    | JTAG emulation 1 I/O<br>EMU[1:0] = 00 - Force Debug Scan chain (ARM and ARM ETB TAPs connected)<br>EMU[1:0] = 11 - Normal Scan chain (ICEpick only) |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 k $\Omega$  resistor should be used.)

## 2.20 Pin List

Table 2-23 provides a complete pin description list in pin number order.

**Table 2-23. DM335 Pin Descriptions**

| Name                                     | BGA ID | Type <sup>(1)</sup> | Group                    | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                                                                    | Mux Control        |
|------------------------------------------|--------|---------------------|--------------------------|-----------------------------|----------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| CIN7 / GIO101 / SPI2_SCLK                | N3     | I/O                 | CCDC / GIO / SPI2        | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: NOT USED<br>YCC 16-bit: time multiplexed between chroma: CB/CR[07]<br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[07]<br>SPI: SPI2 Clock<br>GIO: GIO[101]                              | PINMUX0[1:0].CIN_7 |
| CIN6 / GIO100 / SPI2_SDO                 | K5     | I/O                 | CCDC / GIO / SPI2        | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: NOT USED<br>YCC 16-bit: time multiplexed between chroma: CB/CR[06]<br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[06]<br>SPI: SPI2 Data Out<br>GIO: GIO[100]                           | PINMUX0[3:2].CIN_6 |
| CIN5 / GIO099 / SPI2_SDENA[0]            | M3     | I/O                 | CCDC / GIO / SPI2        | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[13]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[05]<br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[05]<br>SPI: SPI2 Chip Select 0<br>GIO: GIO[99]                    | PINMUX0[5:4].CIN_5 |
| CIN4 / GIO098 / SPI2_SDI / SPI2_SDENA[1] | L4     | I/O                 | CCDC / GIO / SPI2 / SPI2 | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[12]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[04]<br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[04]<br>SPI: SPI2 Data In -OR- SPI2 Chip select 1<br>GIO: GIO[098] | PINMUX0[7:6].CIN_4 |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal.

(2) Specifies the operating I/O supply voltage for each signal. See [Section 5.3](#), *Power Supplies* for more detail.

(3) PD = pull-down, PU = pull-up. (To pull up a signal to the opposite supply rail, a 1 kΩ resistor should be used.)

(4) To reduce EMI and reflections, depending on the trace length, approximately 22 Ω to 50 Ω damping resistors are recommend on the following outputs placed near the DM335: YOUT(0-7),COUT(0-7), HSYNC,VSYNC,LCD\_OE,FIELD,EXTCLK,VCLK. The trace lengths should be minimized.

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name          | BGA ID | Type <sup>(1)</sup> | Group      | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                               | Mux Control        |
|---------------|--------|---------------------|------------|-----------------------------|----------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| CIN3 / GIO097 | J4     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[11]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[03]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[03]<br><br>GIO: GIO[097] | PINMUX0[8].CIN_32  |
| CIN2 / GIO096 | J5     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[10]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[02]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[02]<br><br>GIO: GIO[096] | PINMUX0[8].CIN_32  |
| CIN1 / GIO095 | L3     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[09]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[01]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[01]<br><br>GIO: GIO[095] | PINMUX0[9].CIN_10  |
| CIN0 / GIO094 | J3     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[08]<br><br>YCC 16-bit: time multiplexed between chroma: CB/CR[00]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the upper channel. Y/CB/CR[00]<br><br>GIO: GIO[094] | PINMUX0[9].CIN_10  |
| YIN7 / GIO093 | L5     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[07]<br><br>YCC 16-bit: time multiplexed between luma: Y[07]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[07]<br><br>GIO: GIO[093]       | PINMUX0[10].YIN_70 |
| YIN6 / GIO092 | M4     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[06]<br><br>YCC 16-bit: time multiplexed between luma: Y[06]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[06]<br><br>GIO: GIO[092]       | PINMUX0[10].YIN_70 |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name          | BGA ID | Type <sup>(1)</sup> | Group      | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                         | Mux Control            |
|---------------|--------|---------------------|------------|-----------------------------|----------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| YIN5 / GIO091 | M5     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[05]<br><br>YCC 16-bit: time multiplexed between luma: Y[05]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[05]<br><br>GIO: GIO[091] | PINMUX0[10].YIN_7<br>0 |
| YIN4 / GIO090 | P3     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[04]<br><br>YCC 16-bit: time multiplexed between luma: Y[04]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[04]<br><br>GIO: GIO[090] | PINMUX0[10].YIN_7<br>0 |
| YIN3 / GIO089 | R3     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[03]<br><br>YCC 16-bit: time multiplexed between luma: Y[03]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[03]<br><br>GIO: GIO[089] | PINMUX0[10].YIN_7<br>0 |
| YIN2 / GIO088 | P4     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[02]<br><br>YCC 16-bit: time multiplexed between luma: Y[02]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[02]<br><br>GIO: GIO[088] | PINMUX0[10].YIN_7<br>0 |
| YIN1 / GIO087 | P2     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[01]<br><br>YCC 16-bit: time multiplexed between luma: Y[01]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[01]<br><br>GIO: GIO[087] | PINMUX0[10].YIN_7<br>0 |
| YIN0 / GIO086 | P5     | I/O                 | CCDC / GIO | V <sub>DD_VIN</sub>         | PD                   | in          | Standard CCD/CMOS input: raw[00]<br><br>YCC 16-bit: time multiplexed between luma: Y[00]<br><br>YCC 08-bit (which allows for 2 simultaneous decoder inputs), it is time multiplexed between luma and chroma of the lower channel. Y/CB/CR[00]<br><br>GIO: GIO[086] | PINMUX0[10].YIN_7<br>0 |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                    | BGA ID | Type <sup>(1)</sup> | Group             | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                                                                                                                                  | Mux Control                                                                      |
|-------------------------|--------|---------------------|-------------------|-----------------------------|----------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| CAM_HD / GIO085         | N5     | I/O                 | CCDC / GIO        | V <sub>DD_VIN</sub>         | PD                   | in          | Horizontal synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new line starts.<br>GIO: GIO[085]                                                                                                                                                                                                              | PINMUX0[11].CAM_HD                                                               |
| CAM_VD / GIO084         | R4     | I/O                 | CCDC / GIO        | V <sub>DD_VIN</sub>         | PD                   | in          | Vertical synchronization signal that can be either an input (slave mode) or an output (master mode). Tells the CCDC when a new frame starts.<br>GIO: GIO[084]                                                                                                                                                                                                               | PINMUX0[12].CAM_VD                                                               |
| CAM_WEN_FIE LD / GIO083 | R5     | I/O                 | CCDC / GIO        | V <sub>DD_VIN</sub>         | PD                   | in          | Write enable input signal is used by external device (AFE/TG) to gate the DDR output of the CCDC module.<br><br>Alternately, the field identification input signal is used by external device (AFE/TG) to indicate the which of two frames is input to the CCDC module for sensors with interlaced output. CCDC handles 1- or 2-field sensors in hardware.<br>GIO: GIO[083] | PINMUX0[13].CAM_WEN<br><br>plus<br><br>CCDC.MODE[7].CCDMD &<br>CCDC.MODE[5].SWEN |
| PCLK / GIO082           | T3     | I/O                 | CCDC / GIO        | V <sub>DD_VIN</sub>         | PD                   | in          | Pixel clock input (strobe for lines C17 through Y10)<br>GIO: GIO[082]                                                                                                                                                                                                                                                                                                       | PINMUX0[14].PCLK                                                                 |
| YOUT7-R7                | C3     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT6-R6                | A4     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT5-R5                | B4     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT4-R4                | B3     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT3-R3                | B2     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT2-G7                | A3     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT1-G6                | A2     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| YOUT0-G5                | B1     | I/O                 | VENC              | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function <sup>(5)</sup>                                                                                                                                                                                                                                                                                                          |                                                                                  |
| COU7-G4 / GIO081 / PWM0 | C2     | I/O                 | VENC / GIO / PWM0 | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[081]<br>PWM0                                                                                                                                                                                                                                                                                            | PINMUX1[1:0].COUT_7                                                              |
| COU6-G3 / GIO080 / PWM1 | D2     | I/O                 | VENC / GIO / PWM1 | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[080]<br>PWM1 <sup>(5)</sup>                                                                                                                                                                                                                                                                             | PINMUX1[3:2].COUT_6                                                              |

(5) To reduce EMI and reflections, depending on the trace length, approximately 22 Ω to 50 Ω damping resistors are recommended on the following outputs placed near the DM335: YOUT(0-7), COUT(0-7), HSYNC, VSYNC, LCD\_OE, FIELD, EXTCLK, VCLK. The trace lengths should be minimized.

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                                  | BGA ID | Type <sup>(1)</sup> | Group                            | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                               | Mux Control               |
|---------------------------------------|--------|---------------------|----------------------------------|-----------------------------|----------------------|-------------|----------------------------------------------------------------------------------------------------------|---------------------------|
| COU5-G2 /<br>GIO079 /<br>PWM2A / RTO0 | C1     | I/O                 | VENC<br>/ GIO /<br>PWM2<br>/ RTO | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[079]<br>PWM2A<br>RTO0 <sup>(5)</sup> | PINMUX1[5:4].COU<br>T_5   |
| COU4-B7 /<br>GIO078 /<br>PWM2B / RTO1 | D3     | I/O                 | VENC<br>/ GIO /<br>PWM2<br>/ RTO | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[078]<br>PWM2B<br>RTO1 <sup>(5)</sup> | PINMUX1[7:6].COU<br>T_4   |
| COU3-B6 /<br>GIO077 /<br>PWM2C / RTO2 | E3     | I/O                 | VENC<br>/ GIO /<br>PWM2<br>/ RTO | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[077]<br>PWM2C<br>RTO2 <sup>(5)</sup> | PINMUX1[9:8].COU<br>T_3   |
| COU2-B5 /<br>GIO076 /<br>PWM2D / RTO3 | E4     | I/O                 | VENC<br>/ GIO /<br>PWM2<br>/ RTO | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[076]<br>PWM2D<br>RTO3 <sup>(6)</sup> | PINMUX1[11:10].CO<br>UT_2 |
| COU1-B4 /<br>GIO075 /<br>PWM3A        | F3     | I/O                 | VENC<br>/ GIO /<br>PWM3          | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[075]<br>PWM3A <sup>(6)</sup>         | PINMUX1[13:12].CO<br>UT_1 |
| COU0-B3 /<br>GIO074 /<br>PWM3B        | F4     | I/O                 | VENC<br>/ GIO /<br>PWM3          | V <sub>DD_VOUT</sub>        |                      | in          | Digital Video Out: VENC settings determine function<br><br>GIO: GIO[074]<br>PWM3B <sup>(6)</sup>         | PINMUX1[15:14].CO<br>UT_0 |
| HSYNC /<br>GIO073                     | F5     | I/O                 | VENC<br>/ GIO                    | V <sub>DD_VOUT</sub>        | PD                   | in          | Video Encoder: Horizontal Sync<br><br>GIO: GIO[073] <sup>(6)</sup>                                       | PINMUX1[16].HVS<br>Y NC   |
| VSYSN /<br>GIO072                     | G5     | I/O                 | VENC<br>/ GIO                    | V <sub>DD_VOUT</sub>        | PD                   | in          | Video Encoder: Vertical Sync<br><br>GIO: GIO[072] <sup>(6)</sup>                                         | PINMUX1[16].HVS<br>Y NC   |
| LCD_OE /<br>GIO071                    | H5     | I/O                 | VENC<br>/ GIO                    | V <sub>DD_VOUT</sub>        |                      | out         | Video Encoder: LCD Output Enable or<br>BRIGHT signal<br>GIO: GIO[071] <sup>(6)</sup>                     | PINMUX1[17].DLCD          |

(6) To reduce EMI and reflections, depending on the trace length, approximately 22  $\Omega$  to 50  $\Omega$  damping resistors are recommend on the following outputs placed near the DM335: YOUT(0-7), COU(0-7), HSYNC, VSYSN, LCD\_OE, FIELD, EXTCLK, VCLK. The trace lengths should be minimized.

Table 2-23. DM335 Pin Descriptions (continued)

| Name                         | BGA ID | Type <sup>(1)</sup> | Group                    | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                   | Mux Control            |
|------------------------------|--------|---------------------|--------------------------|-----------------------------|----------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| FIELD / GIO070 / R2 / PWM3C  | H4     | I/O                 | VENC / GIO / VENC / PWM3 | V <sub>DD_VOUT</sub>        |                      | in          | Video Encoder: Field identifier for interlaced display formats<br><br>GIO: GIO[070]<br>Digital Video Out: R2<br>PWM3C <sup>(6)</sup>                                                         | PINMUX1[19:18].FI ELD  |
| EXTCLK / GIO069 / B2 / PWM3D | G3     | I/O                 | VENC / GIO / VENC / PWM3 | V <sub>DD_VOUT</sub>        | PD                   | in          | Video Encoder: External clock input, used if clock rates > 27 MHz are needed, e.g. 74.25 MHz for HDTV digital output<br><br>GIO: GIO[069]<br>Digital Video Out: B2<br>PWM3D <sup>(6)</sup>   | PINMUX1[21:20].EX TCLK |
| VCLK / GIO068                | H3     | I/O                 | VENC / GIO               | V <sub>DD_VOUT</sub>        |                      | in          | Video Encoder: Video Output Clock<br><br>GIO: GIO[068] <sup>(6)</sup>                                                                                                                        | PINMUX1[22].VCLK       |
| VREF                         | J7     | A I/O               | Video DAC                |                             |                      |             | Video DAC: Reference voltage output (0.45V, 0.1uF to GND)                                                                                                                                    |                        |
| IOUT                         | E1     | A I/O               | Video DAC                |                             |                      |             | Video DAC: Pre video buffer DAC output (1000 ohm to VFB)                                                                                                                                     |                        |
| IBIAS                        | F2     | A I/O               | Video DAC                |                             |                      |             | Video DAC: External resistor (2550 Ohms to GND) connection for current bias configuration                                                                                                    |                        |
| VFB                          | G1     | A I/O               | Video DAC                |                             |                      |             | Video DAC: Pre video buffer DAC output (1000 ohm to IOUT, 1070 ohm to TVOUT)                                                                                                                 |                        |
| TVOUT                        | F1     | A I/O               | Video DAC                | V <sub>DDA18_DAC</sub>      |                      |             | Video DAC: Analog Composite NTSC/PAL output (See <a href="#">Figure 5-31</a> and <a href="#">Figure 5-32</a> for circuit connection)                                                         |                        |
| V <sub>DDA18V_DAC</sub>      | L7     | PWR                 | Video DAC                |                             |                      |             | Video DAC: Analog 1.8V power                                                                                                                                                                 |                        |
| V <sub>SSA_DAC</sub>         | L8     | GND                 | Video DAC                |                             |                      |             | Video DAC: Analog 1.8V ground                                                                                                                                                                |                        |
| DDR_CLK                      | W9     | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out L       | DDR Data Clock                                                                                                                                                                               |                        |
| $\overline{\text{DDR\_CLK}}$ | W8     | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out H       | DDR Complementary Data Clock                                                                                                                                                                 |                        |
| $\overline{\text{DDR\_RAS}}$ | T6     | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out H       | DDR Row Address Strobe                                                                                                                                                                       |                        |
| $\overline{\text{DDR\_CAS}}$ | V9     | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out H       | DDR Column Address Strobe                                                                                                                                                                    |                        |
| $\overline{\text{DDR\_WE}}$  | W10    | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out H       | DDR Write Enable (active low)                                                                                                                                                                |                        |
| $\overline{\text{DDR\_CS}}$  | T8     | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out H       | DDR Chip Select (active low)                                                                                                                                                                 |                        |
| DDR_CKE                      | V10    | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | out L       | DDR Clock Enable                                                                                                                                                                             |                        |
| DDR_DQM[1]                   | U15    | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | in          | Data mask outputs: DDR_DQM1: For DDR_DQ[15:8]                                                                                                                                                |                        |
| DDR_DQM[0]                   | T12    | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | in          | Data mask outputs: DDR_DQM0: For DDR_DQ[7:0]                                                                                                                                                 |                        |
| DDR_DQS[1]                   | V15    | I/O                 | DDR                      | V <sub>DD_DDR</sub>         |                      | in          | Data strobe input/outputs for each byte of the 16 bit data bus used to synchronize the data transfers. Output to DDR when writing and inputs when reading.<br><br>DDR_DQS1: For DDR_DQ[15:8] |                        |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name        | BGA ID | Type <sup>(1)</sup> | Group | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                              | Mux Control |
|-------------|--------|---------------------|-------|-----------------------------|----------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| DDR_DQS[0]  | V12    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | Data strobe input/outputs for each byte of the 16 bit data bus used to synchronize the data transfers. Output to DDR when writing and inputs when reading.<br>DDR_DQS0: For DDR_DQ[7:0] |             |
| DDR_BA[2]   | V8     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                                                            |             |
| DDR_BA[1]   | U7     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                                                            |             |
| DDR_BA[0]   | U8     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | Bank select outputs. Two are required for 1Gb DDR2 memories.                                                                                                                            |             |
| DDR_A13     | U6     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 13                                                                                                                                                                  |             |
| DDR_A12     | V7     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 12                                                                                                                                                                  |             |
| DDR_A11     | W7     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 11                                                                                                                                                                  |             |
| DDR_A10     | V6     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 10                                                                                                                                                                  |             |
| DDR_A09     | W6     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 09                                                                                                                                                                  |             |
| DDR_A08     | W5     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 08                                                                                                                                                                  |             |
| DDR_A07     | V5     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 07                                                                                                                                                                  |             |
| DDR_A06     | U5     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 06                                                                                                                                                                  |             |
| DDR_A05     | W4     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 05                                                                                                                                                                  |             |
| DDR_A04     | V4     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 04                                                                                                                                                                  |             |
| DDR_A03     | W3     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 03                                                                                                                                                                  |             |
| DDR_A02     | W2     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 02                                                                                                                                                                  |             |
| DDR_A01     | V3     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 01                                                                                                                                                                  |             |
| DDR_A00     | V2     | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out L       | DDR Address Bus bit 00                                                                                                                                                                  |             |
| DDR_DQ15    | W17    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 15                                                                                                                                                                     |             |
| DDR_DQ14    | V16    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 14                                                                                                                                                                     |             |
| DDR_DQ13    | W16    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 13                                                                                                                                                                     |             |
| DDR_DQ12    | U16    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 12                                                                                                                                                                     |             |
| DDR_DQ11    | W15    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 11                                                                                                                                                                     |             |
| DDR_DQ10    | W14    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 10                                                                                                                                                                     |             |
| DDR_DQ09    | V14    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 09                                                                                                                                                                     |             |
| DDR_DQ08    | U13    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 08                                                                                                                                                                     |             |
| DDR_DQ07    | W13    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 07                                                                                                                                                                     |             |
| DDR_DQ06    | V13    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 06                                                                                                                                                                     |             |
| DDR_DQ05    | W12    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 05                                                                                                                                                                     |             |
| DDR_DQ04    | U12    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 04                                                                                                                                                                     |             |
| DDR_DQ03    | T11    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 03                                                                                                                                                                     |             |
| DDR_DQ02    | U11    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 02                                                                                                                                                                     |             |
| DDR_DQ01    | W11    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 01                                                                                                                                                                     |             |
| DDR_DQ00    | V11    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR Data Bus bit 00                                                                                                                                                                     |             |
| DDR_DQGATE0 | W18    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | out         | DDR: Loopback signal for external DQS gating. Route to DDR and back to DDR_DQGATE1 with same constraints as used for DDR clock and data.                                                |             |
| DDR_DQGATE1 | V17    | I/O                 | DDR   | V <sub>DD_DDR</sub>         |                      | in          | DDR: Loopback signal for external DQS gating. Route to DDR and back to DDR_DQGATE0 with same constraints as used for DDR clock and data.                                                |             |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                             | BGA ID | Type <sup>(1)</sup> | Group                      | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                        | Mux Control                                                |
|----------------------------------|--------|---------------------|----------------------------|-----------------------------|----------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| DDR_VREF                         | U10    | PWR                 | DDRIO                      | V <sub>DD_DDR</sub>         |                      |             | DDR: Voltage input for the SSTL_18 IO buffers                                                                                                                                                                                                                     |                                                            |
| V <sub>SSA_DLL</sub>             | R11    | GND                 | DDRDLL                     | V <sub>DD_DDR</sub>         |                      |             | DDR: Ground for the DDR DLL                                                                                                                                                                                                                                       |                                                            |
| V <sub>DDA33_DDRDLL</sub>        | R10    | PWR                 | DDRDLL                     | V <sub>DD_DDR</sub>         |                      |             | DDR: Power (3.3 Volts) for the DDR DLL                                                                                                                                                                                                                            |                                                            |
| DDR_ZN                           | T9     | I/O                 | DDRIO                      | V <sub>DD_DDR</sub>         |                      |             | DDR: Reference output for drive strength calibration of N and P channel outputs. Tie to ground via 50 ohm resistor @ 0.5% tolerance.                                                                                                                              |                                                            |
| EM_A13 /<br>GIO067 /<br>BTSEL[1] | V19    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PD                   | in L        | <p>Async EMIF: Address Bus bit[13]</p> <p>GIO: GIO[067]</p> <p>System: BTSEL[1:0] sampled at Power-on-Reset to determine Boot method (00:NAND, 01:Flash, 10:MMC/SD, 11:UART)</p>                                                                                  | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A12 /<br>GIO066 /<br>BTSEL[0] | U19    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PD                   | in L        | <p>Async EMIF: Address Bus bit[12]</p> <p>GIO: GIO[066]</p> <p>System: BTSEL[1:0] sampled at Power-on-Reset to determine Boot method (00:NAND, 01:Flash, 10:MMC/SD, 11:UART)</p>                                                                                  | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A11 /<br>GIO065 /<br>AECFG[3] | R16    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PU                   | in H        | <p>Async EMIF: Address Bus bit[11]</p> <p>GIO: GIO[065]</p> <p>System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration<br/>AECFG[3] sets default for PinMux2.EM_D15_8: AEMIF Default Bus Width (0:16 or 1:8 bits)</p>                             | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A10 /<br>GIO064 /<br>AECFG[2] | R18    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PU                   | in H        | <p>Async EMIF: Address Bus bit[10]</p> <p>GIO: GIO[064]</p> <p>System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration<br/>AECFG[2:1] sets default for PinMux2.EM_BA0: AEMIF EM_BA0 Definition (00: EM_BA0, 01: EM_A14, 10:GIO[054], 11:rsvd)</p> | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                             | BGA ID | Type <sup>(1)</sup> | Group                      | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                                                                                 | Mux Control                                                |
|----------------------------------|--------|---------------------|----------------------------|-----------------------------|----------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| EM_A09 /<br>GIO063 /<br>AECFG[1] | P17    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PD                   | in L        | <p>Async EMIF: Address Bus bit[09]</p> <p>GIO: GIO[063]</p> <p>System: AECFG[3:0] sampled at Power-on-Reset to set AEMIF Configuration</p> <p>AECFG[2:1] sets default for PinMux2.EM_BA0: AEMIF EM_BA0 Definition (00: EM_BA0, 01: EM_A14, 10: GIO[054], 11: rsvd)</p>                                                     | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A08 /<br>GIO062 /<br>AECFG[0] | T19    | I/O                 | AEMIF /<br>GIO /<br>system | V <sub>DD</sub>             | PU                   | in H        | <p>Async EMIF: Address Bus bit[08]</p> <p>GIO: GIO[062]</p> <p>AECFG[0] sets default for</p> <ul style="list-style-type: none"> <li>- PinMux2.EM_A0_BA1: AEMIF Address Width (OneNAND or NAND)</li> <li>- PinMux2.EM_A13_3: AEMIF Address Width (OneNAND or NAND)</li> </ul> <p>(0: AEMIF address bits, 1: GIO[67:57])</p> | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A07 /<br>GIO061               | P16    | I/O                 | AEMIF /<br>GIO             | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[07]</p> <p>GIO: GIO[061] - Used to drive Boot Status LED signal (active low) in ROM boot modes</p>                                                                                                                                                                                          | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A06 /<br>GIO060               | P18    | I/O                 | AEMIF /<br>GIO             | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[06]</p> <p>GIO: GIO[060]</p>                                                                                                                                                                                                                                                                | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A05 /<br>GIO059               | R19    | I/O                 | AEMIF /<br>GIO             | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[05]</p> <p>GIO: GIO[059]</p>                                                                                                                                                                                                                                                                | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A04 /<br>GIO058               | P15    | I/O                 | AEMIF /<br>GIO             | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[04]</p> <p>GIO: GIO[058]</p>                                                                                                                                                                                                                                                                | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A03 /<br>GIO057               | N18    | I/O                 | AEMIF /<br>GIO             | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[03]</p> <p>GIO: GIO[057]</p>                                                                                                                                                                                                                                                                | <p>PINMUX2[0].EM_A13_3,</p> <p>default set by AECFG[0]</p> |
| EM_A02                           | N15    | I/O                 | AEMIF                      | V <sub>DD</sub>             |                      | out L       | <p>Async EMIF: Address Bus bit[02]</p> <p>NAND/SM/xD: CLE - Command Latch Enable output</p>                                                                                                                                                                                                                                |                                                            |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                     | BGA ID | Type <sup>(1)</sup> | Group                  | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                         | Mux Control                                           |
|--------------------------|--------|---------------------|------------------------|-----------------------------|----------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| EM_A01                   | N17    | I/O                 | AEMIF                  | V <sub>DD</sub>             |                      | out L       | Async EMIF: Address Bus bit[01]<br><br>NAND/SM/xD: ALE - Address Latch Enable output                                                                                                               |                                                       |
| EM_A00 / GIO056          | M16    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | out L       | Async EMIF: Address Bus bit[00] Note that the EM_A0 is always a 32-bit address<br><br>GIO: GIO[056]                                                                                                | PINMUX2[1].EM_A0_BA1,<br><br>default set by AECFG[0]  |
| EM_BA1 / GIO055          | P19    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | out H       | Async EMIF: Bank Address 1 signal = 16-bit address.<br><br>In 16-bit mode, lowest address bit.<br><br>In 8-bit mode, second lowest address bit<br>GIO: GIO[055]                                    | PINMUX2[1].EM_A0_BA1,<br><br>default set by AECFG[0]  |
| EM_BA0 / GIO054 / EM_A14 | N19    | I/O                 | AEMIF / GIO / EMIF2.30 | V <sub>DD</sub>             |                      | out H       | Async EMIF: Bank Address 0 signal = 8-bit address.<br><br>In 8-bit mode, lowest address bit.<br><br>Or, can be used as an extra Address line (bit[14] when using 16-bit memories.<br>GIO: GIO[054] | PINMUX2[3:2].EM_BA0,<br><br>default set by AECFG[2:1] |
| EM_D15 / GIO053          | M18    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[15]<br><br>GIO: GIO[053]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |
| EM_D14 / GIO052          | M19    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[14]<br><br>GIO: GIO[052]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |
| EM_D13 / GIO051          | M15    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[13]<br><br>GIO: GIO[051]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |
| EM_D12 / GIO050          | L18    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[12]<br><br>GIO: GIO[050]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |
| EM_D11 / GIO049          | L17    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[11]<br><br>GIO: GIO[049]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |
| EM_D10 / GIO048          | L19    | I/O                 | AEMIF / GIO            | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[10]<br><br>GIO: GIO[048]                                                                                                                                                  | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3]   |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name            | BGA ID | Type <sup>(1)</sup> | Group        | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                            | Mux Control                                         |
|-----------------|--------|---------------------|--------------|-----------------------------|----------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| EM_D09 / GIO047 | K18    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[09]<br><br>GIO: GIO[047]                                                                                                                                                                     | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3] |
| EM_D08 / GIO046 | L16    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[08]<br><br>GIO: GIO[046]                                                                                                                                                                     | PINMUX2[4].EM_D15_8,<br><br>default set by AECFG[3] |
| EM_D07 / GIO045 | K19    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[07]<br><br>GIO: GIO[045]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D06 / GIO044 | K17    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[06]<br><br>GIO: GIO[044]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D05 / GIO043 | J19    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[05]<br><br>GIO: GIO[043]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D04 / GIO042 | L15    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[04]<br><br>GIO: GIO[042]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D03 / GIO041 | J18    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[03]<br><br>GIO: GIO[041]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D02 / GIO040 | H19    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[02]<br><br>GIO: GIO[040]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D01 / GIO039 | J17    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[01]<br><br>GIO: GIO[039]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_D00 / GIO038 | H18    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | in          | Async EMIF: Data Bus bit[00]<br><br>GIO: GIO[038]                                                                                                                                                                     | PINMUX2[5].EM_D7_0                                  |
| EM_CE0 / GIO037 | J16    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | out H       | Async EMIF: Lowest numbered Chip Select. Can be programmed to be used for standard asynchronous memories (example: flash), OneNand or NAND memory. Used for the default boot and ROM boot modes.<br><br>GIO: GIO[037] | PINMUX2[6].EM_CE 0                                  |
| EM_CE1 / GIO036 | G19    | I/O                 | AEMI F / GIO | V <sub>DD</sub>             |                      | out H       | Async EMIF: Second Chip Select., Can be programmed to be used for standard asynchronous memories (example: flash), OneNand or NAND memory.<br><br>GIO: GIO[036]                                                       | PINMUX2[7].EM_CE 1                                  |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name               | BGA ID | Type <sup>(1)</sup> | Group          | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                            | Mux Control          |
|--------------------|--------|---------------------|----------------|-----------------------------|----------------------|-------------|---------------------------------------------------------------------------------------|----------------------|
| EM_WE / GIO035     | J15    | I/O                 | AEMI F / GIO   | V <sub>DD</sub>             |                      | out H       | Async EMIF: Write Enable<br><br>NAND/SM/xD: WE (Write Enable) output<br>GIO: GIO[035] | PINMUX2[8].EM_W E_OE |
| EM_OE / GIO034     | F19    | I/O                 | AEMI F / GIO   | V <sub>DD</sub>             |                      | out H       | Async EMIF: Output Enable<br><br>NAND/SM/xD: RE (Read Enable) output<br>GIO: GIO[034] | PINMUX2[8].EM_W E_OE |
| EM_WAIT / GIO033   | G18    | I/O                 | AEMI F / GIO   | V <sub>DD</sub>             | PU                   | in H        | Async EMIF: Async WAIT<br><br>NAND/SM/xD: RDY/_BSY input<br>GIO: GIO[033]             | PINMUX2[9].EM_W AIT  |
| EM_ADV / GIO032    | H16    | I/O                 | AEMI F / GIO   | V <sub>DD</sub>             | PD                   | in L        | OneNAND: Address Valid Detect for OneNAND interface<br><br>GIO: GIO[032]              | PINMUX2[10].EM_A DV  |
| EM_CLK / GIO031    | E19    | I/O                 | AEMI F / GIO   | V <sub>DD</sub>             |                      | out L       | OneNAND: Clock signal for OneNAND flash interface<br><br>GIO: GIO[031]                | PINMUX2[11].EM_C LK  |
| ASP0_DX / GIO030   | H15    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Transmit Data<br><br>GIO: GIO[030]                                              | PINMUX3[0].GIO30     |
| ASP0_CLKX / GIO029 | F18    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Transmit Clock<br><br>GIO: GIO[029]                                             | PINMUX3[1].GIO29     |
| ASP0_FSX / GIO028  | G17    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Transmit Frame Synch<br><br>GIO: GIO[028]                                       | PINMUX3[2].GIO28     |
| ASP0_DR / GIO027   | E18    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Receive Data<br><br>GIO: GIO[027]                                               | PINMUX3[3].GIO27     |
| ASP0_CLKR / GIO026 | F17    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Receive Clock<br><br>GIO: GIO[026]                                              | PINMUX3[4].GIO26     |
| ASP0_FSR / GIO025  | F16    | I/O                 | ASP5 120 / GIO | V <sub>DD</sub>             |                      | in          | ASP0: Receive Frame Synch<br><br>GIO: GIO[025]                                        | PINMUX3[5].GIO25     |
| MMCS1_CLK / GIO024 | C15    | I/O                 | MMC SD / GIO   | V <sub>DD</sub>             |                      | in          | MMCS1: Clock<br><br>GIO: GIO[024]                                                     | PINMUX3[6].GIO24     |
| MMCS1_CMD / GIO023 | A17    | I/O                 | MMC SD / GIO   | V <sub>DD</sub>             |                      | in          | MMCS1: Command<br><br>GIO: GIO[023]                                                   | PINMUX3[7].GIO23     |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                              | BGA ID | Type <sup>(1)</sup> | Group                 | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                | Mux Control          |
|-----------------------------------|--------|---------------------|-----------------------|-----------------------------|----------------------|-------------|-----------------------------------------------------------|----------------------|
| MMCS1_DAT A3 / GIO022 / UART2_RTS | B16    | I/O                 | MMC SD / GIO / UART 2 | V <sub>DD</sub>             |                      | in          | MMCS1: DATA3<br><br>GIO: GIO[022]<br>UART2: RTS           | PINMUX3[9:8].GIO2 2  |
| MMCS1_DAT A2 / GIO021 / UART2_CTS | A16    | I/O                 | MMC SD / GIO / UART 2 | V <sub>DD</sub>             |                      | in          | MMCS1: DATA2<br><br>GIO: GIO[021]<br>UART2: CTS           | PINMUX3[11:10].GIO21 |
| MMCS1_DAT A1 / GIO020 / UART2_RXD | B15    | I/O                 | MMC SD / GIO / UART 2 | V <sub>DD</sub>             |                      | in          | MMCS1: DATA1<br><br>GIO: GIO[020]<br>UART2: Receive Data  | PINMUX3[13:12].GIO20 |
| MMCS1_DAT A0 / GIO019 / UART2_TXD | A18    | I/O                 | MMC SD / GIO / UART 2 | V <sub>DD</sub>             |                      | in          | MMCS1: DATA0<br><br>GIO: GIO[019]<br>UART2: Transmit Data | PINMUX3[15:14].GIO19 |
| CLKOUT1 / GIO018                  | D12    | I/O                 | Clocks / GIO          | V <sub>DD</sub>             |                      | in          | CLKOUT: Output Clock 1<br><br>GIO: GIO[018]               | PINMUX3[16].GIO18    |
| CLKOUT2 / GIO017                  | A11    | I/O                 | Clocks / GIO          | V <sub>DD</sub>             |                      | in          | CLKOUT: Output Clock 2<br><br>GIO: GIO[017]               | PINMUX3[17].GIO17    |
| CLKOUT3 / GIO016                  | C11    | I/O                 | Clocks / GIO          | V <sub>DD</sub>             |                      | in          | CLKOUT: Output Clock 3<br><br>GIO: GIO[016]               | PINMUX3[18].GIO16    |
| I2C_SDA / GIO015                  | R13    | I/O                 | I2C / GIO             | V <sub>DD</sub>             |                      | in          | I2C: Serial Data<br><br>GIO: GIO[015]                     | PINMUX3[19].GIO15    |
| I2C_SCL / GIO014                  | R14    | I/O                 | I2C / GIO             | V <sub>DD</sub>             |                      | in          | I2C: Serial Clock<br><br>GIO: GIO[014]                    | PINMUX3[20].GIO14    |
| UART1_RXD / GIO013                | R15    | I/O                 | UART 1 / GIO          | V <sub>DD</sub>             |                      | in          | UART1: Receive Data<br><br>GIO: GIO[013]                  | PINMUX3[21].GIO13    |
| UART1_TXD / GIO012                | R17    | I/O                 | UART 1 / GIO          | V <sub>DD</sub>             |                      | in          | UART1: Transmit Data<br><br>GIO: GIO[012]                 | PINMUX3[22].GIO12    |
| SPI1_SDENA[0] / GIO011            | E13    | I/O                 | SPI1 / GIO            | V <sub>DD</sub>             |                      | in          | SPI1: Chip Select 0<br><br>GIO: GIO[011]                  | PINMUX3[23].GIO11    |

Table 2-23. DM335 Pin Descriptions (continued)

| Name                              | BGA ID | Type <sup>(1)</sup> | Group               | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                                                                                                                                   | Mux Control         |
|-----------------------------------|--------|---------------------|---------------------|-----------------------------|----------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| SPI1_SCLK / GIO010                | C13    | I/O                 | SPI1 / GIO          | V <sub>DD</sub>             |                      | in          | SPI1: Clock<br><br>GIO: GIO[010]                                                                                                                                                                                                                                                                                                                                             | PINMUX3[24].GIO10   |
| SPI1_SDI / GIO009 / SPI1_SDENA[1] | A13    | I/O                 | SPI1 / GIO / SPI1   | V <sub>DD</sub>             |                      | in          | SPI1: Data In -OR- SPI1: Chip Select 1<br><br>GIO: GIO[009]                                                                                                                                                                                                                                                                                                                  | PINMUX3[26:25].GIO9 |
| SPI1_SDO / GIO008                 | E12    | I/O                 | SPI1 / GIO          | V <sub>DD</sub>             |                      | in          | SPI1: Data Out<br><br>GIO: GIO[008]                                                                                                                                                                                                                                                                                                                                          | PINMUX3[27].GIO8    |
| GIO007 / SPI0_SDENA[1]            | C17    | I/O                 | GIO debounce / SPI0 | V <sub>DD</sub>             |                      | in          | GIO: GIO[007]<br><br>SPI0: Chip Select 1                                                                                                                                                                                                                                                                                                                                     | PINMUX3[28].GIO7    |
| GIO006                            | B18    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[006]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO005                            | D15    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[005]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO004                            | B17    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[004]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO003                            | G15    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[003]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO002                            | F15    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[002]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO001                            | E14    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[001]                                                                                                                                                                                                                                                                                                                                                                |                     |
| GIO000                            | C16    | I/O                 | GIO debounce        | V <sub>DD</sub>             |                      | in          | GIO: GIO[000]<br><b>Note:</b> The GIO000 pin <i>must</i> be held high during NAND boot for the boot process to function properly.                                                                                                                                                                                                                                            |                     |
| USB_DP                            | A7     | A I/O               | USBPHY              | V <sub>DDA33_USB</sub>      |                      |             | USB D+ (differential signal pair)                                                                                                                                                                                                                                                                                                                                            |                     |
| USB_DM                            | A6     | A I/O               | USBPHY              | V <sub>DDA33_USB</sub>      |                      |             | USB D- (differential signal pair)                                                                                                                                                                                                                                                                                                                                            |                     |
| USB_R1                            | C7     | A I/O               | USBPHY              |                             |                      |             | USB Reference current output<br><br>Connect to V <sub>SS_USB_REF</sub> via 10K $\Omega$ $\pm$ 1% resistor placed as close to the device as possible.                                                                                                                                                                                                                         |                     |
| USB_ID                            | D5     | A I/O               | USBPHY              | V <sub>DDA33_USB</sub>      |                      |             | USB operating mode identification pin<br><br>For Device mode operation only, pull up this pin to V <sub>DD</sub> with a 1.5K ohm resistor.<br><br>For Host mode operation only, pull down this pin to ground (V <sub>SS</sub> ) with a 1.5K ohm resistor.<br><br>If using an OTG or mini-USB connector, this pin will be set properly via the cable/connector configuration. |                     |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                       | BGA ID | Type <sup>(1)</sup> | Group      | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                                                                                                                                                          | Mux Control            |
|----------------------------|--------|---------------------|------------|-----------------------------|----------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| USB_VBUS                   | E5     | A I/O               | USBP HY    |                             |                      |             | For host or device mode operation, tie the VBUS/USB power signal to the USB connector.<br><br>When used in OTG mode operation, tie VBUS to the external charge pump and to the VBUS signal on the USB connector.<br><br>When the USB is not used, tie VBUS to V <sub>SS_USB</sub> . |                        |
| USB_DRVVBUS                | C5     | O                   | USBP HY    | V <sub>DD</sub>             |                      |             | Digital output to control external 5 V supply                                                                                                                                                                                                                                       |                        |
| V <sub>SS_USB_REF</sub>    | C8     | GND                 | USBP HY    | V <sub>DD</sub>             |                      |             | USB Ground Reference<br><br>Connect directly to ground and to USB_R1 via 10K $\Omega$ $\pm$ 1% resistor placed as close to the device as possible.                                                                                                                                  |                        |
| V <sub>DDA33_USB</sub>     | J8     | PWR                 | USBP HY    | V <sub>DD</sub>             |                      |             | Analog 3.3 V power USB PHY (Transceiver)                                                                                                                                                                                                                                            |                        |
| V <sub>SS_USB</sub>        | B7     | GND                 | USBP HY    | V <sub>DD</sub>             |                      |             | Analog 3.3 V ground for USB PHY (Transceiver)                                                                                                                                                                                                                                       |                        |
| V <sub>DDA33_USB_PLL</sub> | B6     | PWR                 | USBP HY    | V <sub>DD</sub>             |                      |             | Common mode 3.3 V power for USB PHY (PLL)                                                                                                                                                                                                                                           |                        |
| V <sub>SS_USB</sub>        | D6     | GND                 | USBP HY    | V <sub>DD</sub>             |                      |             | Common mode 3.3 V ground for USB PHY (PLL)                                                                                                                                                                                                                                          |                        |
| V <sub>DDA13_USB</sub>     | H7     | PWR                 | USBP HY    | V <sub>DD</sub>             |                      |             | Analog 1.3 V power for USB PHY                                                                                                                                                                                                                                                      |                        |
| V <sub>SS_USB</sub>        | E6     | GND                 | USBP HY    | V <sub>DD</sub>             |                      |             | Analog 1.3 V ground for USB PHY                                                                                                                                                                                                                                                     |                        |
| V <sub>DD13_USB</sub>      | C6     | PWR                 | USBP HY    | V <sub>DD</sub>             |                      |             | Digital 1.3 V power for USB PHY                                                                                                                                                                                                                                                     |                        |
| MMCSD0_CLK                 | A15    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | out L       | MMCSD0: Clock                                                                                                                                                                                                                                                                       | PINMUX4[2].MMCS D0_MS  |
| MMCSD0_CMD                 | C14    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | in          | MMCSD0: Command                                                                                                                                                                                                                                                                     | PINMUX4[2].MMCS D0_MS  |
| MMCSD0_DAT A3              | A14    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | in          | MMCSD0: DATA3                                                                                                                                                                                                                                                                       | PINMUX4[2].MMCS D0_MS  |
| MMCSD0_DAT A2              | B13    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | in          | MMCSD0: DATA2                                                                                                                                                                                                                                                                       | PINMUX4[2].MMCS D0_MS  |
| MMCSD0_DAT A1              | D14    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | in          | MMCSD0: DATA1                                                                                                                                                                                                                                                                       | PINMUX4[2].MMCS D0_MS  |
| MMCSD0_DAT A0              | B14    | I/O                 | MMC SD0    | V <sub>DD</sub>             |                      | in          | MMCSD0: DATA0                                                                                                                                                                                                                                                                       | PINMUX4[2].MMCS D0_MS  |
| UART0_RXD                  | U18    | I                   | UART 0     | V <sub>DD</sub>             |                      | in          | UART0: Receive Data<br><br>Used for UART boot mode                                                                                                                                                                                                                                  |                        |
| UART0_TXD                  | T18    | O                   | UART 0     | V <sub>DD</sub>             |                      | out H       | UART0: Transmit Data<br><br>Used for UART boot mode                                                                                                                                                                                                                                 |                        |
| SPI0_SDENA[0] / GIO103     | B12    | I/O                 | SPI0 / GIO | V <sub>DD</sub>             |                      | in          | SPI0: Enable / Chip Select 0<br><br>GIO: GIO[103]                                                                                                                                                                                                                                   | PINMUX4[0].SPI0_S DENA |
| SPI0_SCLK                  | C12    | I/O                 | SPI0       | V <sub>DD</sub>             |                      | in          | SPI0: Clock                                                                                                                                                                                                                                                                         |                        |
| SPI0_SDI / GIO102          | A12    | I/O                 | SPI0 / GIO | V <sub>DD</sub>             |                      | in          | SPI0: Data In<br><br>GIO: GIO[102]                                                                                                                                                                                                                                                  | PINMUX4[1].SPI0_S DI   |
| SPI0_SDO                   | B11    | I/O                 | SPI0       | V <sub>DD</sub>             |                      | in          | SPI0: Data Out                                                                                                                                                                                                                                                                      |                        |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                      | BGA ID | Type <sup>(1)</sup> | Group       | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                                                                                          | Mux Control |
|---------------------------|--------|---------------------|-------------|-----------------------------|----------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| ASP1_DX                   | C18    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Transmit Data                                                                                                                                 |             |
| ASP1_CLKX                 | D19    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Transmit Clock                                                                                                                                |             |
| ASP1_FSX                  | E16    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Transmit Frame Sync                                                                                                                           |             |
| ASP1_DR                   | C19    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Receive Data                                                                                                                                  |             |
| ASP1_CLKR                 | D18    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Receive Clock                                                                                                                                 |             |
| ASP1_FSR                  | E17    | I/O                 | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Receive Frame Synch                                                                                                                           |             |
| ASP1_CLKS                 | D17    | I                   | ASP5 121    | V <sub>DD</sub>             |                      | in          | ASP1: Master Clock                                                                                                                                  |             |
| $\overline{\text{RESET}}$ | D11    | I                   |             | V <sub>DD</sub>             | PU                   | in          | Global Chip Reset (active low)                                                                                                                      |             |
| MXI1                      | A9     | I                   | Clocks      | V <sub>DD</sub>             |                      | in          | Crystal input for system oscillator (24 MHz)                                                                                                        |             |
| MXO1                      | B9     | O                   | Clocks      | V <sub>DD</sub>             |                      | out         | Output for system oscillator (24 MHz)                                                                                                               |             |
| MXI2                      | R1     | I                   | Clocks      | V <sub>DD</sub>             |                      | in          | Crystal input for video oscillator (27 MHz). This crystal is not required<br>V <sub>DD</sub>                                                        |             |
| MXO2                      | T1     | O                   | Clocks      | V <sub>DD</sub>             |                      | out         | Output for video oscillator (27 MHz). This crystal is not required.<br>V <sub>DD</sub>                                                              |             |
| TCK                       | E10    | I                   | EMUL ATIO N | V <sub>DD</sub>             | PU                   | in          | JTAG test clock input                                                                                                                               |             |
| TDI                       | D9     | I                   | EMUL ATIO N | V <sub>DD</sub>             | PU                   | in          | JTAG test data input                                                                                                                                |             |
| TDO                       | E9     | O                   | EMUL ATIO N | V <sub>DD</sub>             |                      | out L       | JTAG test data output                                                                                                                               |             |
| TMS                       | D8     | I                   | EMUL ATIO N | V <sub>DD</sub>             | PU                   | in          | JTAG test mode select                                                                                                                               |             |
| $\overline{\text{TRST}}$  | C9     | I                   | EMUL ATIO N | V <sub>DD</sub>             | PD                   | in          | JTAG test logic reset (active low)                                                                                                                  |             |
| RTCK                      | E11    | O                   | EMUL ATIO N | V <sub>DD</sub>             |                      | out L       | JTAG test clock output                                                                                                                              |             |
| EMU0                      | E8     | I/O                 | EMUL ATIO N | V <sub>DD</sub>             | PU                   | in          | JTAG emulation 0 I/O<br>V <sub>DD</sub><br>V <sub>DD</sub>                                                                                          |             |
| EMU1                      | E7     | I/O                 | EMUL ATIO N | V <sub>DD</sub>             | PU                   | in          | JTAG emulation 1 I/O<br>EMU[1:0] = 00 - Force Debug Scan chain (ARM and ARM ETB TAPs connected)<br>EMU[1:0] = 11 - Normal Scan chain (ICEpick only) |             |
| RSV01                     | J1     | A I/O/Z             |             |                             |                      |             | Reserved. This signal should be left as a No Connect or connected to V <sub>SS</sub> .                                                              |             |
| RSV02                     | K1     | A I/O/Z             |             |                             |                      |             | Reserved. This signal should be left as a No Connect or connected to V <sub>SS</sub> .                                                              |             |
| RSV03                     | L1     | A I/O/Z             |             |                             |                      |             | Reserved. This signal should be left as a No Connect or connected to V <sub>SS</sub> .                                                              |             |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name                  | BGA ID | Type <sup>(1)</sup> | Group | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>                                                             | Mux Control |
|-----------------------|--------|---------------------|-------|-----------------------------|----------------------|-------------|----------------------------------------------------------------------------------------|-------------|
| RSV04                 | M1     | A I/O/Z             |       |                             |                      |             | Reserved. This signal should be left as a No Connect or connected to V <sub>SS</sub> . |             |
| RSV05                 | N2     | A I/O/Z             |       |                             |                      |             | Reserved. This signal should be connected to V <sub>SS</sub> .                         |             |
| RSV06                 | M2     | PWR                 |       |                             |                      |             | Reserved. This signal should be connected to V <sub>SS</sub> .                         |             |
| RSV07                 | K2     | GND                 |       |                             |                      |             | Reserved. This signal should be connected to V <sub>SS</sub> .                         |             |
| NC                    | H8     |                     |       |                             |                      |             | No connect                                                                             |             |
| V <sub>DD_VIN</sub>   | P6     | PWR                 |       |                             |                      |             | Power for Digital Video Input IO (3.3 V)                                               |             |
| V <sub>DD_VIN</sub>   | P7     | PWR                 |       |                             |                      |             | Power for Digital Video Input IO (3.3 V)                                               |             |
| V <sub>DD_VIN</sub>   | P8     | PWR                 |       |                             |                      |             | Power for Digital Video Input IO (3.3 V)                                               |             |
| V <sub>DD_VOUT</sub>  | F6     | PWR                 |       |                             |                      |             | Power for Digital Video Output IO (3.3 V)                                              |             |
| V <sub>DD_VOUT</sub>  | F7     | PWR                 |       |                             |                      |             | Power for Digital Video Output IO (3.3 V)                                              |             |
| V <sub>DD_VOUT</sub>  | F8     | PWR                 |       |                             |                      |             | Power for Digital Video Output IO (3.3 V)                                              |             |
| V <sub>DD_DDR</sub>   | M9     | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P9     | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P10    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P11    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P12    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P13    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | P14    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | R9     | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | R12    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DD_DDR</sub>   | T14    | PWR                 |       |                             |                      |             | Power for DDR I/O (1.8 V)                                                              |             |
| V <sub>DDA_PLL1</sub> | G12    | PWR                 |       |                             |                      |             | Analog Power for PLL1 (1.3 V)                                                          |             |
| V <sub>DDA_PLL2</sub> | H9     | PWR                 |       |                             |                      |             | Analog Power for PLL2 (1.3 V)                                                          |             |
| CV <sub>DD</sub>      | A1     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | A10    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | B19    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | C4     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | G6     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | G11    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | H10    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | H13    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | H17    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | J11    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | J12    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | J13    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | K6     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | K11    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | K12    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | L11    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | L12    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | N6     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | R7     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | R8     | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |
| CV <sub>DD</sub>      | T17    | PWR                 |       |                             |                      |             | Core power (1.3 V)                                                                     |             |

Table 2-23. DM335 Pin Descriptions (continued)

| Name                  | BGA ID | Type <sup>(1)</sup> | Group | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup>          | Mux Control |
|-----------------------|--------|---------------------|-------|-----------------------------|----------------------|-------------|-------------------------------------|-------------|
| CV <sub>DD</sub>      | W19    | PWR                 |       |                             |                      |             | Core power (1.3 V)                  |             |
| V <sub>DD</sub>       | F9     | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | F10    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | F11    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | F12    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | F13    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | F14    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | G8     | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | G14    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | K8     | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | K15    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | L6     | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | L13    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | M10    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | M11    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | M12    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | M13    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | N11    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>DD</sub>       | N12    | PWR                 |       |                             |                      |             | Power for Digital IO (3.3 V)        |             |
| V <sub>SS_MX1</sub>   | C10    | GND                 |       |                             |                      |             | System oscillator (24 MHz) - ground |             |
| V <sub>SS_MX2</sub>   | P1     | GND                 |       |                             |                      |             | Video oscillator (27 MHz) - ground  |             |
| V <sub>SSA_PLL1</sub> | H12    | GND                 |       |                             |                      |             | Analog Ground for PLL1              |             |
| V <sub>SSA_PLL2</sub> | J9     | GND                 |       |                             |                      |             | Analog Ground for PLL2              |             |
| V <sub>SS</sub>       | A5     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | A8     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | A19    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | B5     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | B8     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | B10    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | D1     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | E2     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | E15    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | G2     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | G9     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | H1     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | H2     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | H6     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | H11    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | H14    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | J2     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | J6     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | J10    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | J14    | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | K3     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | K9     | GND                 |       |                             |                      |             | Digital ground                      |             |
| V <sub>SS</sub>       | K10    | GND                 |       |                             |                      |             | Digital ground                      |             |

**Table 2-23. DM335 Pin Descriptions (continued)**

| Name            | BGA ID | Type <sup>(1)</sup> | Group | Power Supply <sup>(2)</sup> | PU PD <sup>(3)</sup> | Reset State | Description <sup>(4)</sup> | Mux Control |
|-----------------|--------|---------------------|-------|-----------------------------|----------------------|-------------|----------------------------|-------------|
| V <sub>SS</sub> | K14    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | L2     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | L9     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | L10    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | L14    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | M6     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | M7     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | M8     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | M14    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | M17    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | N1     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | N8     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | N9     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | N14    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | R2     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | R6     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | T2     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | T5     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | T15    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U1     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U2     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U3     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U4     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U9     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U14    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | U17    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | V1     | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | V18    | GND                 |       |                             |                      |             | Digital ground             |             |
| V <sub>SS</sub> | W1     | GND                 |       |                             |                      |             | Digital ground             |             |

## 2.21 Device Support

### 2.21.1 Development Tools

TI offers an extensive line of development tools for DM335 systems, including tools to evaluate the performance of the processors, generate code, develop algorithm implementations, and fully integrate and debug software and hardware modules. The tools support documentation is electronically available within the Code Composer Studio™ Integrated Development Environment (IDE).

The following products support development of DM335 based applications:

#### Software Development Tools:

Code Composer Studio™ Integrated Development Environment (IDE): including Editor  
C/C++/Assembly Code Generation, and Debug plus additional development tools

#### Hardware Development Tools:

Extended Development System (XDS™) Emulator (supports TMS320DM335 DMSoC multiprocessor system debug) EVM (Evaluation Module)

For a complete listing of development-support tools for the TMS320DM335 DMSoC platform, visit the Texas Instruments web site on the Worldwide Web at <http://www.ti.com>. For information on pricing and availability, contact the nearest TI field sales office or authorized distributor.

### 2.21.2 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all DSP devices and support tools. Each DSP commercial family member has one of three prefixes: TMX, TMP, or TMS (e.g., ). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMX/TMDX) through fully qualified production devices/tools (TMS/TMDS).

Device development evolutionary flow:

- TMX** Experimental device that is not necessarily representative of the final device's electrical specifications.
- TMP** Final silicon die that conforms to the device's electrical specifications but has not completed quality and reliability verification.
- TMS** Fully-qualified production device.

Support tool development evolutionary flow:

- TMDX** Development-support product that has not yet completed Texas Instruments internal qualification testing.
- TMDS** Fully qualified development-support product.

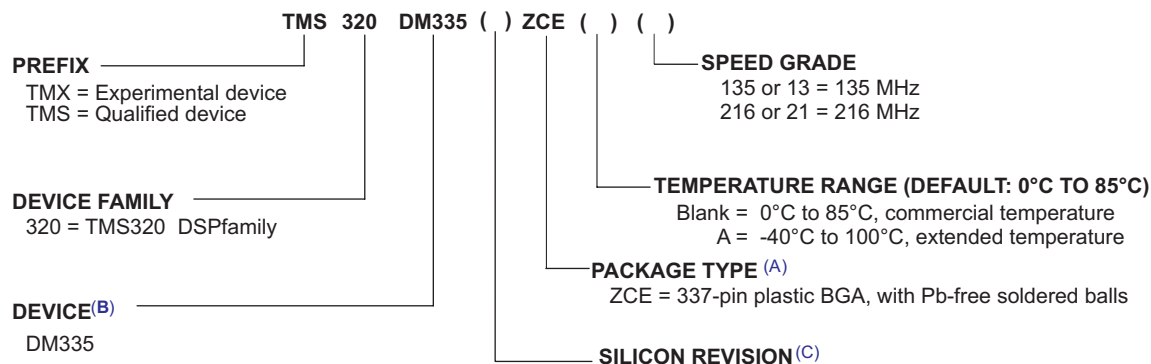
TMX and TMP devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

TMS devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (TMX or TMP) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate is undefined. Only qualified production devices are to be used in production.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, ZCE), the temperature range (for example, "Blank" is the commercial temperature range), and the device speed range in megahertz (for example, 202 is 202.5 MHz). The following figure provides a legend for reading the complete device name for any DM335 DMSoC platform member.



A. BGA = Ball Grid Array

B. For actual device part numbers (P/Ns) and ordering information, contact your nearest TI Sales representative.

C. For more information on silicon revision, see *TMS320DM335 DMSoC Silicon Errata* (literature number SPRZ287).

**Figure 2-5. Device Nomenclature**

### 2.21.3 Device Documentation

#### 2.21.3.1 Related Documentation From Texas Instruments

The following documents describe the TMS320DM335 Digital Media System-on-Chip (DMSoC). Copies of these documents are available on the internet at [www.ti.com](http://www.ti.com).

**[SPRS528](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) Data Manual*** This document describes the overall TMS320DM335 system, including device architecture and features, memory map, pin descriptions, timing characteristics and requirements, device mechanicals, etc.

**[SPRZ287](#) *TMS320DM335 DMSoC Silicon Errata*** Describes the known exceptions to the functional specifications for the TMS320DM335 DMSoC.

**[SPRUFX7](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide*** This document describes the ARM Subsystem in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The ARM subsystem is designed to give the ARM926EJ-S (ARM9) master control of the device. In general, the ARM is responsible for configuration and control of the device; including the components of the ARM Subsystem, the peripherals, and the external memories.

**[SPRUFZ1](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) Asynchronous External Memory Interface (EMIF) Reference Guide*** This document describes the asynchronous external memory interface (EMIF) in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The EMIF supports a glueless interface to a variety of external devices.

**[SPRUFY9](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) Universal Serial Bus (USB) Controller Reference Guide*** This document describes the universal serial bus (USB) controller in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The USB controller supports data throughput rates up to 480 Mbps. It provides a mechanism for data transfer between USB devices and also supports host negotiation.

**[SPRUFZ3](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) Audio Serial Port (ASP) Reference Guide*** This document describes the operation of the audio serial port (ASP) audio interface in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The primary audio modes that are supported by the ASP are the AC97 and IIS modes. In addition to the primary audio modes, the ASP supports general serial port receive and transmit operation, but is not intended to be used as a high-speed interface.

**[SPRUFY1](#) *TMS320DM335 Digital Media System-on-Chip (DMSoC) Serial Peripheral Interface (SPI)***

**Reference Guide** This document describes the serial peripheral interface (SPI) in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The SPI is a high-speed synchronous serial input/output port that allows a serial bit stream of programmed length (1 to 16 bits) to be shifted into and out of the device at a programmed bit-transfer rate. The SPI is normally used for communication between the DMSoC and external peripherals. Typical applications include an interface to external I/O or peripheral expansion via devices such as shift registers, display drivers, SPI EPROMs and analog-to-digital converters.

**[SPRUFY2](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) Universal Asynchronous Receiver/Transmitter (UART) Reference Guide** This document describes the universal asynchronous receiver/transmitter (UART) peripheral in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The UART peripheral performs serial-to-parallel conversion on data received from a peripheral device, and parallel-to-serial conversion on data received from the CPU.

**[SPRUFY3](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) Inter-Integrated Circuit (I2C) Peripheral Reference Guide** This document describes the inter-integrated circuit (I2C) peripheral in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The I2C peripheral provides an interface between the DMSoC and other devices compliant with the I2C-bus specification and connected by way of an I2C-bus. External components attached to this 2-wire serial bus can transmit and receive up to 8-bit wide data to and from the DMSoC through the I2C peripheral. This document assumes the reader is familiar with the I2C-bus specification.

**[SPRUFY5](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) Multimedia Card (MMC)/Secure Digital (SD) Card Controller Reference Guide** This document describes the multimedia card (MMC)/secure digital (SD) card controller in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The MMC/SD card is used in a number of applications to provide removable data storage. The MMC/SD controller provides an interface to external MMC and SD cards. The communication between the MMC/SD controller and MMC/SD card(s) is performed by the MMC/SD protocol.

**[SPRUFZ20](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) Enhanced Direct Memory Access (EDMA) Controller Reference Guide** This document describes the operation of the enhanced direct memory access (EDMA3) controller in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The EDMA controller's primary purpose is to service user-programmed data transfers between two memory-mapped slave endpoints on the DMSoC.

**[SPRUFY0](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) 64-bit Timer Reference Guide** This document describes the operation of the software-programmable 64-bit timers in the TMS320DM335 Digital Media System-on-Chip (DMSoC). Timer 0, Timer 1, and Timer 3 are used as general-purpose (GP) timers and can be programmed in 64-bit mode, dual 32-bit unchained mode, or dual 32-bit chained mode; Timer 2 is used only as a watchdog timer. The GP timer modes can be used to generate periodic interrupts or enhanced direct memory access (EDMA) synchronization events and Real Time Output (RTO) events (Timer 3 only). The watchdog timer mode is used to provide a recovery mechanism for the device in the event of a fault condition, such as a non-exiting code loop.

**[SPRUFY8](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) General-Purpose Input/Output (GPIO) Reference Guide** This document describes the general-purpose input/output (GPIO) peripheral in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The GPIO peripheral provides dedicated general-purpose pins that can be configured as either inputs or outputs. When configured as an input, you can detect the state of the input by reading the state of an internal register. When configured as an output, you can write to an internal register to control the state driven on the output pin.

**[SPRUFY6](#) TMS320DM335 Digital Media System-on-Chip (DMSoC) Pulse-Width Modulator (PWM)**

**Reference Guide** This document describes the pulse-width modulator (PWM) peripheral in the TMS320DM335 Digital Media System-on-Chip (DMSoC).

[\*\*SPRUFZ2\*\*](#) **TMS320DM335 Digital Media System-on-Chip (DMSoC) DDR2/Mobile DDR (DDR2/mDDR) Memory Controller Reference Guide** This document describes the DDR2/mDDR memory controller in the TMS320DM335 Digital Media System-on-Chip (DMSoC). The DDR2/mDDR memory controller is used to interface with JESD79D-2A standard compliant DDR2 SDRAM and mobile DDR devices.

[\*\*SPRUFX8\*\*](#) **TMS320DM335 Digital Media System-on-Chip (DMSoC) Video Processing Front End (VPFE) Reference Guide** This document describes the Video Processing Front End (VPFE) in the TMS320DM335 Digital Media System-on-Chip (DMSoC).

[\*\*SPRUFX9\*\*](#) **TMS320DM335 Digital Media System-on-Chip (DMSoC) Video Processing Back End (VPBE) Reference Guide** This document describes the Video Processing Back End (VPBE) in the TMS320DM335 Digital Media System-on-Chip (DMSoC).

[\*\*SPRUFY7\*\*](#) **TMS320DM335 Digital Media System-on-Chip (DMSoC) Real-Time Out (RTO) Controller Reference Guide** This document describes the Real Time Out (RTO) controller in the TMS320DM335 Digital Media System-on-Chip (DMSoC).

[\*\*SPRAAL2\*\*](#) **Implementing DDR2/mDDR PCB Layout on the TMS320DM335 DMSoC** This provides board design recommendations and guidelines for DDR2 and mobile DDR.

### 3 Detailed Device Description

This section provides a detailed overview of the DM335 device.

#### 3.1 ARM Subsystem Overview

The ARM Subsystem contains components required to provide the ARM926EJ-S (ARM) master control of the overall DM335 system, including the components of the ARM Subsystem, the peripherals, and the external memories.

The ARM is responsible for handling system functions such as system-level initialization, configuration, user interface, user command execution, connectivity functions, interface and control of the subsystem, etc. The ARM is master and performs these functions because it has a large program memory space and fast context switching capability, and is thus suitable for complex, multi-tasking, and general-purpose control tasks.

##### 3.1.1 Components of the ARM Subsystem

The ARM Subsystem in DM335 consists of the following components:

- ARM926EJ-S RISC processor, including:
  - coprocessor 15 (CP15)
  - MMU
  - 16KB Instruction cache
  - 8KB Data cache
  - Write Buffer
  - Java accelerator
- ARM Internal Memories
  - 32KB Internal RAM (32-bit wide access)
  - 8KB Internal ROM (ARM bootloader for non-AEMIF boot options)
- Embedded Trace Module and Embedded Trace Buffer (ETM/ETB)
- System Control Peripherals
  - ARM Interrupt Controller
  - PLL Controller
  - Power and Sleep Controller
  - System Control Module

The ARM also manages/controls all the device peripherals:

- DDR2 / mDDR EMIF Controller
- AEMIF Controller, including the OneNAND and NAND flash interface
- Enhanced DMA (EDMA)
- UART
- Timers
- Real Time Out (RTO)
- Pulse Width Modulator (PWM)
- Inter-IC Communication (I2C)
- Multi-Media Card/Secure Digital (MMC/SD)
- Audio Serial Port (ASP)
- Universal Serial Bus Controller (USB)
- Serial Port Interface (SPI)
- Video Processing Front End (VPFE)
  - CCD Controller (CCDC)

- Image Pipe (IPIPE)
- H3A Engine (Hardware engine for computing Auto-focus, Auto white balance, and Auto exposure)
- Video Processing Back End (VPBE)
  - On Screen Display (OSD)
  - Video Encoder Engine (VENC)

Figure 3-1 shows the functional block diagram of the DM335 ARM Subsystem.

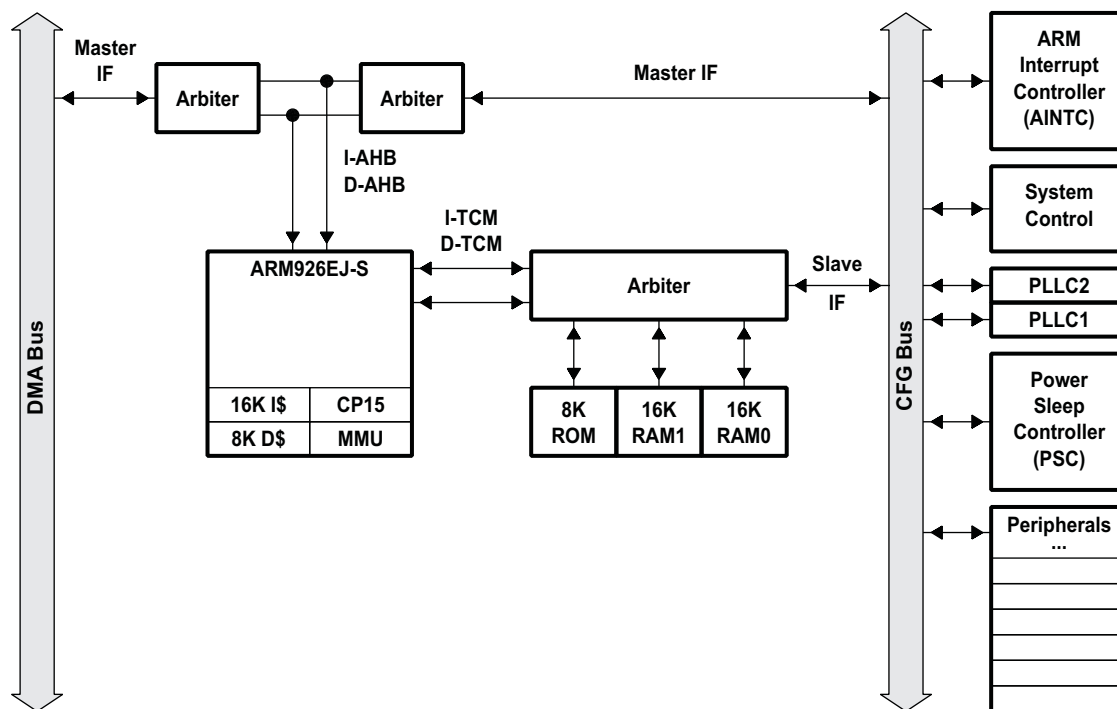


Figure 3-1. DM335 ARM Subsystem Block Diagram

### 3.2 ARM926EJ-S RISC CPU

The ARM Subsystem integrates the ARM926EJ-S processor. The ARM926EJ-S processor is a member of ARM9 family of general-purpose microprocessors. This processor is targeted at multi-tasking applications where full memory management, high performance, low die size, and low power are all important. The ARM926EJ-S processor supports the 32-bit ARM and 16 bit THUMB instruction sets, enabling the user to trade off between high performance and high code density. Specifically, the ARM926EJ-S processor supports the ARMv5TEJ instruction set, which includes features for efficient execution of Java byte codes, providing Java performance similar to Just in Time (JIT) Java interpreter, but without associated code overhead.

The ARM926EJ-S processor supports the ARM debug architecture and includes logic to assist in both hardware and software debug. The ARM926EJ-S processor has a Harvard architecture and provides a complete high performance subsystem, including:

- ARM926EJ -S integer core
- CP15 system control coprocessor
- Memory Management Unit (MMU)
- Separate instruction and data Caches
- Write buffer
- Separate instruction and data Tightly-Coupled Memories (TCMs) [internal RAM] interfaces
- Separate instruction and data AHB bus interfaces

- Embedded Trace Module and Embedded Trace Buffer (ETM/ETB)

For more complete details on the ARM9, refer to the ARM926EJ-S Technical Reference Manual, available at <http://www.arm.com>

### 3.2.1 CP15

The ARM926EJ-S system control coprocessor (CP15) is used to configure and control instruction and data caches, Tightly-Coupled Memories (TCMs), Memory Management Unit (MMU), and other ARM subsystem functions. The CP15 registers are programmed using the MRC and MCR ARM instructions, when the ARM in a privileged mode such as supervisor or system mode.

### 3.2.2 MMU

The ARM926EJ-S MMU provides virtual memory features required by operating systems such as Linux, WindowCE, ultron, ThreadX, etc. A single set of two level page tables stored in main memory is used to control the address translation, permission checks and memory region attributes for both data and instruction accesses. The MMU uses a single unified Translation Lookaside Buffer (TLB) to cache the information held in the page tables. The MMU features are:

- Standard ARM architecture v4 and v5 MMU mapping sizes, domains and access protection scheme.
- Mapping sizes are:
  - 1MB (sections)
  - 64KB (large pages)
  - 4KB (small pages)
  - 1KB (tiny pages)
- Access permissions for large pages and small pages can be specified separately for each quarter of the page (subpage permissions)
- Hardware page table walks
- Invalidate entire TLB, using CP15 register 8
- Invalidate TLB entry, selected by MVA, using CP15 register 8
- Lockdown of TLB entries, using CP15 register 10

### 3.2.3 Caches and Write Buffer

The size of the Instruction Cache is 16KB, Data cache is 8KB. Additionally, the Caches have the following features:

- Virtual index, virtual tag, and addressed using the Modified Virtual Address (MVA)
- Four-way set associative, with a cache line length of eight words per line (32-bytes per line) and with two dirty bits in the Dcache
- Dcache supports write-through and write-back (or copy back) cache operation, selected by memory region using the C and B bits in the MMU translation tables.
- Critical-word first cache refilling
- Cache lockdown registers enable control over which cache ways are used for allocation on a line fill, providing a mechanism for both lockdown, and controlling cache corruption
- Dcache stores the Physical Address TAG (PA TAG) corresponding to each Dcache entry in the TAG RAM for use during the cache line write-backs, in addition to the Virtual Address TAG stored in the TAG RAM. This means that the MMU is not involved in Dcache write-back operations, removing the possibility of TLB misses related to the write-back address.
- Cache maintenance operations provide efficient invalidation of, the entire Dcache or Icache, regions of the Dcache or Icache, and regions of virtual memory.

The write buffer is used for all writes to a noncachable bufferable region, write-through region and write misses to a write-back region. A separate buffer is incorporated in the Dcache for holding write-back for cache line evictions or cleaning of dirty cache lines. The main write buffer has 16-word data buffer and a four-address buffer. The Dcache write-back has eight data word entries and a single address entry.

### 3.2.4 ***Tightly Coupled Memory (TCM)***

ARM internal RAM is provided for storing real-time and performance-critical code/data and the Interrupt Vector table. ARM internal ROM boot options include—NAND (with SPI EEPROM Boot option), SPI, UART and MMC/SD. The RAM and ROM memories interfaced to the ARM926EJ-S via the tightly coupled memory interface that provides for separate instruction and data bus connections. Since the ARM TCM does not allow instructions on the D-TCM bus or data on the I-TCM bus, an arbiter is included so that both data and instructions can be stored in the internal RAM/ROM. The arbiter also allows accesses to the RAM/ROM from extra-ARM sources (e.g., EDMA or other masters). The ARM926EJ-S has built-in DMA support for direct accesses to the ARM internal memory from a non-ARM master. Because of the time-critical nature of the TCM link to the ARM internal memory, all accesses from non-ARM devices are treated as DMA transfers.

Instruction and Data accesses are differentiated via accessing different memory map regions, with the instruction region from 0x0000 through 0x7FFF and data from 0x10000 through 0x17FFF. Placing the instruction region at 0x0000 is necessary to allow the ARM Interrupt Vector table to be placed at 0x0000, as required by the ARM architecture. The internal 32-KB RAM is split into two physical banks of 16KB each, which allows simultaneous instruction and data accesses to be accomplished if the code and data are in separate banks.

### 3.2.5 ***Advanced High-performance Bus (AHB)***

The ARM Subsystem uses the AHB port of the ARM926EJ-S to connect the ARM to the configuration bus and the external memories. Arbiters are employed to arbitrate access to the separate D-AHB and I-AHB by the configuration bus and the external memories bus.

### 3.2.6 ***Embedded Trace Macrocell (ETM) and Embedded Trace Buffer (ETB)***

To support real-time trace, the ARM926EJ-S processor provides an interface to enable connection of an Embedded Trace Macrocell (ETM). The ARM926ES-J Subsystem in DM335 also includes the Embedded Trace Buffer (ETB). The ETM consists of two parts:

- Trace Port provides real-time trace capability for the ARM9.
- Triggering facilities provide trigger resources, which include address and data comparators, counter, and sequencers.

The DM335 trace port is not pinned out and is instead only connected to the Embedded Trace Buffer. The ETB has a 4KB buffer memory. ETB enabled debug tools are required to read/interpret the captured trace data.

## 3.3 **Memory Mapping**

The ARM memory map is shown in [Table 2-2](#) and [Table 2-3](#). This section describes the memories and interfaces within the ARM's memory map.

### 3.3.1 ***ARM Internal Memories***

The ARM has access to the following ARM internal memories:

- 32KB ARM Internal RAM on TCM interface, logically separated into two 16KB pages to allow simultaneous access on any given cycle if there are separate accesses for code (I-TCM bus) and data (D-TCM) to the different memory regions.
- 8KB ARM Internal ROM

### 3.3.2 External Memories

The ARM has access to the following External memories:

- DDR2 / mDDR Synchronous DRAM
- Asynchronous EMIF / OneNAND
- NAND Flash
- Flash card devices:
  - MMC/SD
  - xD
  - SmartMedia

### 3.3.3 Peripherals

The ARM has access to all of the peripherals on the DM335 device.

## 3.4 ARM Interrupt Controller (AINTC)

The DM335 ARM Interrupt Controller (AINTC) has the following features:

- Supports up to 64 interrupt channels (16 external channels)
- Interrupt mask for each channel
- Each interrupt channel can be mapped to a Fast Interrupt Request (FIQ) or to an Interrupt Request (IRQ) type of interrupt.
- Hardware prioritization of simultaneous interrupts
- Configurable interrupt priority (2 levels of FIQ and 6 levels of IRQ)
- Configurable interrupt entry table (FIQ and IRQ priority table entry) to reduce interrupt processing time

The ARM core supports two interrupt types: FIQ and IRQ. See the ARM926EJ-S Technical Reference Manual for detailed information about the ARM's FIQ and IRQ interrupts. Each interrupt channel is mappable to an FIQ or to an IRQ type of interrupt, and each channel can be enabled or disabled. The INTC supports user-configurable interrupt-priority and interrupt entry addresses. Entry addresses minimize the time spent jumping to interrupt service routines (ISRs). When an interrupt occurs, the corresponding highest priority ISR's address is stored in the INTC's ENTRY register. The IRQ or FIQ interrupt routine can read the ENTRY register and jump to the corresponding ISR directly. Thus, the ARM does not require a software dispatcher to determine the asserted interrupt.

### 3.4.1 Interrupt Mapping

The AINTC takes up to 64 ARM device interrupts and maps them to either the IRQ or to the FIQ of the ARM. Each interrupt is also assigned one of 8 priority levels (2 for FIQ, 6 for IRQ). For interrupts with the same priority level, the priority is determined by the hardware interrupt number (the lowest number has the highest priority). [Table 3-1](#) shows the connection of device interrupts to the ARM.

**Table 3-1. AINTC Interrupt Connections<sup>(1)</sup>**

| Interrupt Number | Acronym  | Source                                                         | Interrupt Number | Acronym | Source           |
|------------------|----------|----------------------------------------------------------------|------------------|---------|------------------|
| 0                | VPSSINT0 | VPSS - INT0,<br>Configurable via<br>VPSSBL register:<br>INTSEL | 32               | TINT0   | Timer 0 - TINT12 |
| 1                | VPSSINT1 | VPSS - INT1                                                    | 33               | TINT1   | Timer 0 - TINT34 |
| 2                | VPSSINT2 | VPSS - INT2                                                    | 34               | TINT2   | Timer 1 - TINT12 |

(1) The total number of interrupts in DM335 exceeds 64, which is the maximum value of the AINTC module. Therefore, several interrupts are multiplexed and you must use the register ARM\_INTMUX in the System Control Module to select the interrupt source for multiplexed interrupts. Refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for more information on the System Control Module register ARM\_INTMUX.

**Table 3-1. AINTC Interrupt Connections <sup>(1)</sup> (continued)**

| Interrupt Number | Acronym               | Source                                    | Interrupt Number | Acronym  | Source           |
|------------------|-----------------------|-------------------------------------------|------------------|----------|------------------|
| 3                | VPSSINT3              | VPSS - INT3                               | 35               | TINT3    | Timer 1 - TINT34 |
| 4                | VPSSINT4              | VPSS - INT4                               | 36               | PWMINT0  | PWM0             |
| 5                | VPSSINT5              | VPSS - INT5                               | 37               | PWMINT1  | PWM 1            |
| 6                | VPSSINT6              | VPSS - INT6                               | 38               | PWMINT2  | PWM2             |
| 7                | VPSSINT7              | VPSS - INT7                               | 39               | I2CINT   | I2C              |
| 8                | VPSSINT8              | VPSS - INT8                               | 40               | UARTINT0 | UART0            |
| 9                | Reserved              |                                           | 41               | UARTINT1 | UART1            |
| 10               | Reserved              |                                           | 42               | SPINT0-0 | SPI0             |
| 11               | Reserved              |                                           | 43               | SPINT0-1 | SPI0             |
| 12               | USBINT                | USB OTG Collector                         | 44               | GPIO0    | GPIO             |
| 13               | RTOINT or TINT4       | RTO or Timer 2 - TINT12<br>SYS.ARM_INTMUX | 45               | GPIO1    | GPIO             |
| 14               | UARTINT2 or TINT5     | UART2 or Timer 2 - TINT34                 | 46               | GPIO2    | GPIO             |
| 15               | TINT6                 | Timer 3 TINT12                            | 47               | GPIO3    | GPIO             |
| 16               | CCINT0                | EDMA CC Region 0                          | 48               | GPIO4    | GPIO             |
| 17               | SPINT1-0 or CCERRINT  | SPI1 or EDMA CC Error                     | 49               | GPIO5    | GPIO             |
| 18               | SPINT1-1 or TCERRINT0 | SPI1 or EDMA TC0 Error                    | 50               | GPIO6    | GPIO             |
| 19               | SPINT2-0 or TCERRINT1 | SPI2 or EDMA TC1 Error                    | 51               | GPIO7    | GPIO             |
| 20               | PSCINT                | PSC - ALLINT                              | 52               | GPIO8    | GPIO             |
| 21               | SPINT2-1              | SPI2                                      | 53               | GPIO9    | GPIO             |
| 22               | TINT7                 | Timer3 - TINT34                           | 54               | GPIOBNK0 | GPIO             |
| 23               | SDIOINT0              | MMC/SD0                                   | 55               | GPIOBNK1 | GPIO             |
| 24               | MBXINT0 or MBXINT1    | ASP0 or ASP1                              | 56               | GPIOBNK2 | GPIO             |
| 25               | MBRINT0 or MBRINT1    | ASP0 or ASP1                              | 57               | GPIOBNK3 | GPIO             |
| 26               | MMCINT0               | MMC/SD0                                   | 58               | GPIOBNK4 | GPIO             |
| 27               | MMCINT1               | MMC/SC1                                   | 59               | GPIOBNK5 | GPIO             |
| 28               | PWMINT3               | PWM3                                      | 60               | GPIOBNK6 | GPIO             |
| 29               | DDRINT                | DDR EMIF                                  | 61               | COMMTX   | ARMSS            |
| 30               | AEMIFINT              | Async EMIF                                | 62               | COMMRX   | ARMSS            |
| 31               | SDIOINT1              | SDIO1                                     | 63               | EMUINT   | E2ICE            |

## 3.5 Device Clocking

### 3.5.1 Overview

The DM335 requires one primary reference clock . The reference clock frequency may be generated either by crystal input or by external oscillator. The reference clock is the clock at the pins named MXI1/MXO1. The reference clock drives two separate PLL controllers (PLLC1 and PLLC2). PLLC1 generates the clocks required by the ARM, VPBE,VPSS, and peripherals. PLL2 generates the clock required by the DDR PHY. A block diagram of DM335's clocking architecture is shown in [Figure 3-2](#) . The PLLs are described further in [Section 3.6](#).

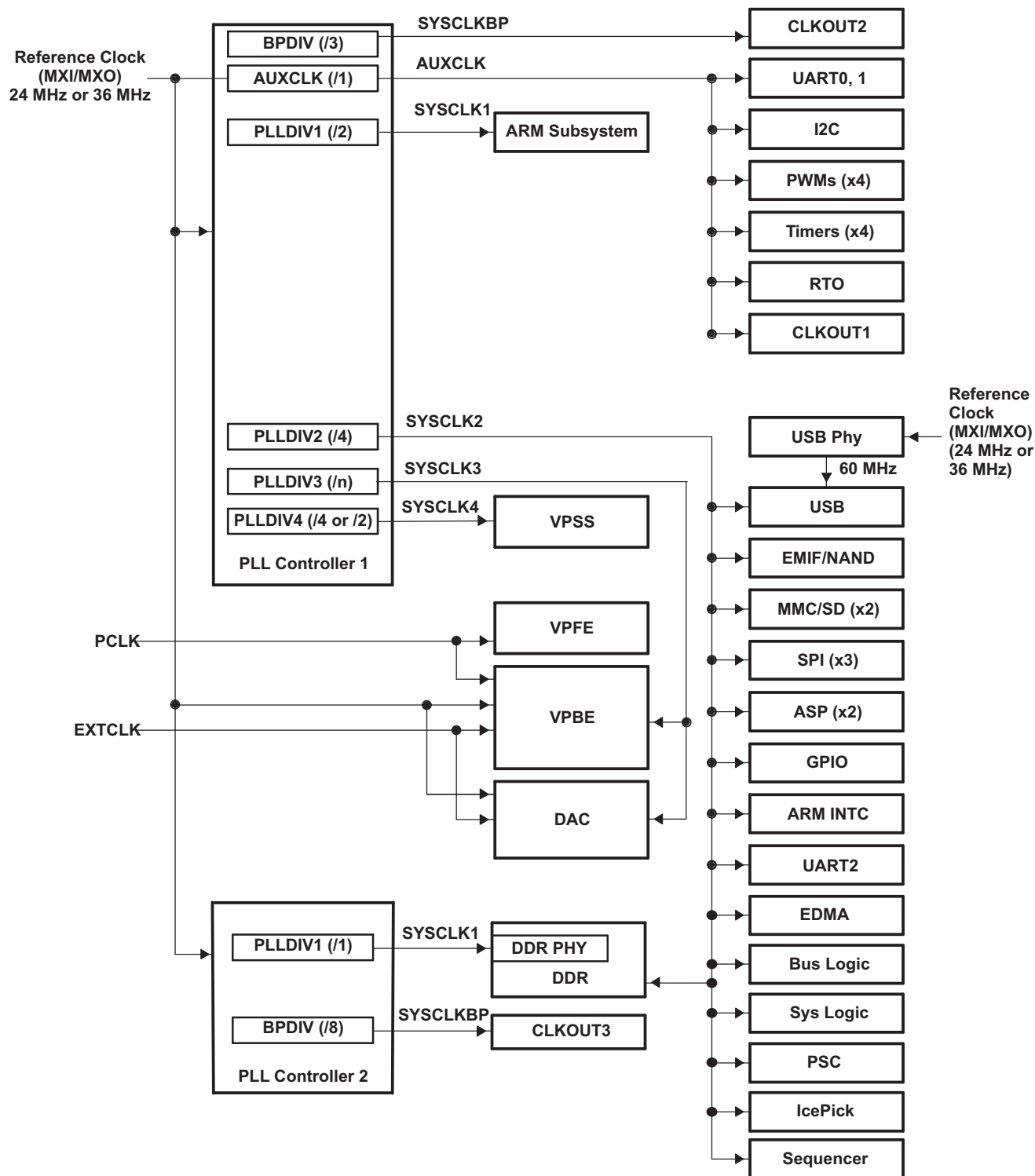


Figure 3-2. Device Clocking Block Diagram

### 3.5.2 Supported Clocking Configurations for DM335-135

This section describes the only supported device clocking configurations for DM335-135. The DM335 supports either 24 MHz (typical) or 36 MHz reference clock (crystal or external oscillator input). Configurations are shown for both cases.

#### 3.5.2.1 Supported Clocking Configurations for DM335-135 (24 MHz reference)

##### 3.5.2.1.1 DM335-135 PLL1 (24 MHz reference)

All supported clocking configurations for DM335-135 PLL1 with 24 MHz reference clock are shown in [Table 3-2](#).

**Table 3-2. PLL1 Supported Clocking Configurations for DM335-135 (24 MHz reference)**

| PREDIV     | PLLM             | POSTDIV                 | PLL1 VCO | ARM                |               | Peripherals        |               | VENC                      |               | VPSS                            |               |
|------------|------------------|-------------------------|----------|--------------------|---------------|--------------------|---------------|---------------------------|---------------|---------------------------------|---------------|
| (/8 fixed) | (m programmable) | (/2 or /1 programmable) | (MHz)    | PLLDIV1 (/2 fixed) | SYSCLK1 (MHz) | PLLDIV2 (/4 fixed) | SYSCLK2 (MHz) | PLLDIV3 (/n programmable) | SYSCLK3 (MHz) | PLLDIV4 (/4 or /2 programmable) | SYSCLK4 (MHz) |
| bypass     | bypass           | bypass                  | bypass   | 2                  | 12            | 4                  | 6             | 10                        | 2.4           | 4                               | 6             |
| 8          | 180              | 2                       | 270      | 2                  | 135           | 4                  | 67.5          | 10                        | 27            | 2                               | 135           |
| 8          | 162              | 2                       | 243      | 2                  | 121.5         | 4                  | 60.75         | 9                         | 27            | 2                               | 121.5         |
| 8          | 144              | 2                       | 216      | 2                  | 108           | 4                  | 54            | 8                         | 27            | 2                               | 108           |
| 8          | 126              | 2                       | 189      | 2                  | 94.5          | 4                  | 47.25         | 7                         | 27            | 2                               | 94.5          |
| 8          | 108              | 2                       | 162      | 2                  | 81            | 4                  | 40.5          | 6                         | 27            | 2                               | 81            |

##### 3.5.2.1.2 DM335-135 PLL2 (24 MHz reference)

All supported clocking configurations for DM335-135 PLL2 with 24 MHz reference clock are shown in [Table 3-3](#).

**Table 3-3. PLL2 Supported Clocking Configurations for DM335-135 (24 MHz reference)**

| PREDIV            | PLLM             | POSTDIV    | PLL2 VCO | DDR PHY            |               | DDR Clock     |
|-------------------|------------------|------------|----------|--------------------|---------------|---------------|
| (/n programmable) | (m programmable) | (/1 fixed) | (MHz)    | PLLDIV1 (/1 fixed) | SYSCLK1 (MHz) | DDR_CLK (MHz) |
| bypass            | bypass           | bypass     | bypass   | 1                  | 24            | 12            |
| 12                | 133              | 1          | 266      | 1                  | 266           | 133           |
| 12                | 100              | 1          | 200      | 1                  | 200           | 100           |
| 15                | 100              | 1          | 160      | 1                  | 160           | 80            |

#### 3.5.2.2 Supported Clocking Configurations for DM335-135 (36 MHz reference)

##### 3.5.2.2.1 DM335-135 PLL1 (36 MHz reference)

All supported clocking configurations for DM335-135 PLL1 with 36 MHz reference clock are shown in [Table 3-4](#).

**Table 3-4. PLL1 Supported Clocking Configurations DM335-135 (36 MHz reference)**

| PREDIV     | PLLM             | POSTDIV                 | PLL1 VCO | ARM coprocessor    |               | Peripherals        |               | VENC                      |               | VPSS                            |               |
|------------|------------------|-------------------------|----------|--------------------|---------------|--------------------|---------------|---------------------------|---------------|---------------------------------|---------------|
| (/8 fixed) | (m programmable) | (/2 or /1 programmable) | (MHz)    | PLLDIV1 (/2 fixed) | SYSCLK1 (MHz) | PLLDIV2 (/4 fixed) | SYSCLK2 (MHz) | PLLDIV3 (/n programmable) | SYSCLK3 (MHz) | PLLDIV4 (/4 or /2 programmable) | SYSCLK4 (MHz) |
| bypass     | bypass           | bypass                  | bypass   | 2                  | 18            | 4                  | 9             | 10                        | 3.6           | 4                               | 18            |
| 8          | 120              | 2                       | 270      | 2                  | 135           | 4                  | 67.5          | 10                        | 27            | 2                               | 135           |
| 8          | 108              | 2                       | 243      | 2                  | 121.5         | 4                  | 60.75         | 9                         | 27            | 2                               | 121.5         |
| 8          | 96               | 2                       | 216      | 2                  | 108           | 4                  | 54            | 8                         | 27            | 2                               | 108           |

### 3.5.2.2.2 DM335-135 PLL2 (36 MHz reference)

All supported clocking configurations for DM335-135 PLL2 with 36 MHz reference clock are shown in [Table 3-5](#).

**Table 3-5. PLL2 Supported Clocking Configurations for DM335-135 (36 MHz reference)**

| PREDIV<br>(/n programmable) | PLLM<br>(m programmable) | POSTDIV<br>(/1 fixed) | PLL2 VCO<br>(MHz) | DDR PHY               |                  | DDR Clock        |
|-----------------------------|--------------------------|-----------------------|-------------------|-----------------------|------------------|------------------|
|                             |                          |                       |                   | PLLDIV1<br>(/1 fixed) | SYSCLK1<br>(MHz) | DDR_CLK<br>(MHz) |
| bypass                      | bypass                   | bypass                | bypass            | 1                     | 36               | 18               |
| 18                          | 133                      | 1                     | 266               | 1                     | 266              | 133              |
| 27                          | 150                      | 1                     | 200               | 1                     | 200              | 100              |
| 27                          | 120                      | 1                     | 160               | 1                     | 160              | 80               |

### 3.5.3 Supported Clocking Configurations for DM335-216

This section describes the only supported device clocking configurations for DM335-216. The DM335 supports either 24 MHz (typical) or 36 MHz reference clock (crystal or external oscillator input). Configurations are shown for both cases.

#### 3.5.3.1 Supported Clocking Configurations for DM335-216 (24 MHz reference)

##### 3.5.3.1.1 DM335-216 PLL1 (24 MHz reference)

All supported clocking configurations for DM335-216 PLL1 with 24 MHz reference clock are shown in [Table 3-2](#).

**Table 3-6. PLL1 Supported Clocking Configurations for DM335-216 (24 MHz reference)**

| PREDIV     | PLLM             | POSTDIV                 | PLL1 VCO | ARM                |               | Peripherals        |               | VENC                      |               | VPSS                            |               |
|------------|------------------|-------------------------|----------|--------------------|---------------|--------------------|---------------|---------------------------|---------------|---------------------------------|---------------|
| (/8 fixed) | (m programmable) | (/2 or /1 programmable) | (MHz)    | PLLDIV1 (/2 fixed) | SYSCLK1 (MHz) | PLLDIV2 (/4 fixed) | SYSCLK2 (MHz) | PLLDIV3 (/n programmable) | SYSCLK3 (MHz) | PLLDIV4 (/4 or /2 programmable) | SYSCLK4 (MHz) |
| bypass     | bypass           | bypass                  | bypass   | 2                  | 12            | 4                  | 6             | 10                        | 2.4           | 4                               | 6             |
| 8          | 144              | 1                       | 432      | 2                  | 216           | 4                  | 108           | 16                        | 27            | 4                               | 108           |
| 8          | 135              | 1                       | 405      | 2                  | 202.5         | 4                  | 101.25        | 15                        | 27            | 4                               | 101.25        |
| 8          | 126              | 1                       | 378      | 2                  | 189           | 4                  | 94.5          | 14                        | 27            | 4                               | 94.5          |
| 8          | 117              | 1                       | 351      | 2                  | 175.5         | 4                  | 87.75         | 13                        | 27            | 4                               | 87.75         |
| 8          | 108              | 1                       | 324      | 2                  | 162           | 4                  | 81            | 12                        | 27            | 4                               | 81            |
| 8          | 99               | 1                       | 297      | 2                  | 148.5         | 4                  | 74.25         | 11                        | 27            | 4                               | 74.25         |
| 8          | 180              | 2                       | 270      | 2                  | 135           | 4                  | 67.5          | 10                        | 27            | 2                               | 135           |
| 8          | 162              | 2                       | 243      | 2                  | 121.5         | 4                  | 60.75         | 9                         | 27            | 2                               | 121.5         |
| 8          | 144              | 2                       | 216      | 2                  | 108           | 4                  | 54            | 8                         | 27            | 2                               | 108           |
| 8          | 126              | 2                       | 189      | 2                  | 94.5          | 4                  | 47.25         | 7                         | 27            | 2                               | 94.5          |
| 8          | 108              | 2                       | 162      | 2                  | 81            | 4                  | 40.5          | 6                         | 27            | 2                               | 81            |

##### 3.5.3.1.2 DM335-216 PLL2 (24 MHz reference)

All supported clocking configurations for DM335-216 PLL2 with 24 MHz reference clock are shown in [Table 3-3](#).

**Table 3-7. PLL2 Supported Clocking Configurations for DM335-216 (24 MHz reference)**

| PREDIV            | PLLM             | POSTDIV    | PLL2 VCO | DDR PHY            |               | DDR Clock     |
|-------------------|------------------|------------|----------|--------------------|---------------|---------------|
| (/n programmable) | (m programmable) | (/1 fixed) | (MHz)    | PLLDIV1 (/1 fixed) | SYSCLK1 (MHz) | DDR_CLK (MHz) |
| bypass            | bypass           | bypass     | bypass   | 1                  | 24            | 12            |
| 8                 | 114              | 1          | 342      | 1                  | 342           | 171           |
| 8                 | 108              | 1          | 324      | 1                  | 324           | 162           |
| 8                 | 102              | 1          | 306      | 1                  | 306           | 153           |
| 8                 | 96               | 1          | 288      | 1                  | 288           | 144           |
| 12                | 133              | 1          | 266      | 1                  | 266           | 133           |
| 12                | 100              | 1          | 200      | 1                  | 200           | 100           |
| 15                | 100              | 1          | 160      | 1                  | 160           | 80            |

### 3.5.3.2 Supported Clocking Configurations for DM335-216 (36 MHz reference)

#### 3.5.3.2.1 DM335-216 PLL1 (36 MHz reference)

All supported clocking configurations for DM335-216 PLL1 with 36 MHz reference clock are shown in [Table 3-4](#).

**Table 3-8. PLL1 Supported Clocking Configurations DM335-216 (36 MHz reference)**

| PREDIV     | PLLM             | POSTDIV                 | PLL1 VCO | ARM                   |                  | Peripherals           |                  | VENC                         |                  | VPSS                               |                  |
|------------|------------------|-------------------------|----------|-----------------------|------------------|-----------------------|------------------|------------------------------|------------------|------------------------------------|------------------|
| (/8 fixed) | (m programmable) | (/2 or /1 programmable) | (MHz)    | PLLDIV1<br>(/2 fixed) | SYSClk1<br>(MHz) | PLLDIV2<br>(/4 fixed) | SYSClk2<br>(MHz) | PLLDIV3<br>(/n programmable) | SYSClk3<br>(MHz) | PLLDIV4<br>(/4 or /2 programmable) | SYSClk4<br>(MHz) |
| bypass     | bypass           | bypass                  | bypass   | 2                     | 18               | 4                     | 9                | 10                           | 3.6              | 4                                  | 9                |
| 8          | 96               | 1                       | 432      | 2                     | 216              | 4                     | 108              | 16                           | 27               | 4                                  | 108              |
| 8          | 180              | 2                       | 405      | 2                     | 202.5            | 4                     | 101.25           | 15                           | 27               | 4                                  | 101.25           |
| 8          | 168              | 2                       | 378      | 2                     | 189              | 4                     | 94.5             | 14                           | 27               | 4                                  | 94.5             |
| 8          | 156              | 2                       | 351      | 2                     | 175.5            | 4                     | 87.75            | 13                           | 27               | 4                                  | 87.75            |
| 8          | 144              | 2                       | 324      | 2                     | 162              | 4                     | 81               | 12                           | 27               | 4                                  | 81               |
| 8          | 132              | 2                       | 297      | 2                     | 148.5            | 4                     | 74.25            | 11                           | 27               | 4                                  | 74.25            |
| 8          | 120              | 2                       | 270      | 2                     | 135              | 4                     | 67.5             | 10                           | 27               | 2                                  | 135              |
| 8          | 108              | 2                       | 243      | 2                     | 121.5            | 4                     | 60.75            | 9                            | 27               | 2                                  | 121.5            |
| 8          | 96               | 2                       | 216      | 2                     | 108              | 4                     | 54               | 8                            | 27               | 2                                  | 108              |

#### 3.5.3.2.2 DM335-216 PLL2 (36 MHz reference)

All supported clocking configurations for DM335-216 PLL2 with 36 MHz reference clock are shown in [Table 3-5](#).

**Table 3-9. PLL2 Supported Clocking Configurations for DM335-216 (36 MHz reference)**

| PREDIV            | PLLM             | POSTDIV    | PLL2 VCO | DDR PHY               |                  | DDR Clock        |
|-------------------|------------------|------------|----------|-----------------------|------------------|------------------|
| (/n programmable) | (m programmable) | (/1 fixed) | (MHz)    | PLLDIV1<br>(/1 fixed) | SYSClk1<br>(MHz) | DDR_CLK<br>(MHz) |
| bypass            | bypass           | bypass     | bypass   | 1                     | 36               | 18               |
| 12                | 114              | 1          | 342      | 1                     | 342              | 171              |
| 12                | 108              | 1          | 324      | 1                     | 324              | 162              |
| 12                | 102              | 1          | 306      | 1                     | 306              | 153              |
| 12                | 96               | 1          | 288      | 1                     | 288              | 144              |
| 18                | 133              | 1          | 266      | 1                     | 266              | 133              |
| 27                | 150              | 1          | 200      | 1                     | 200              | 100              |
| 27                | 120              | 1          | 160      | 1                     | 160              | 80               |

### 3.5.4 Peripheral Clocking Considerations

#### 3.5.4.1 Video Processing Back End Clocking

The Video Processing Back End (VPBE) is a sub-module of the Video Processing Subsystem (VPSS).

The VPBE is designed to interface with a variety of LCDs and an internal DAC module. There are two asynchronous clock domains in the VPBE: an internal clock domain and an external clock domain. The internal clock domain is driven by the VPSS clock (PLL1 SYSClk4). The external clock domain is configurable; you can select one of five source:

- 24 MHz crystal input at MXI1
- 27 MHz crystal input at MXI2 (optional feature, not typically used)
- PLL1 SYSClk3
- EXTCLK pin (external VPBE clock input pin)
- PCLK pin (VPFE pixel clock input pin)

See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Video Processing Back End (VPBE) Reference Guide* (literature number SPRUF9) for complete information on VPBE clocking.

### 3.5.4.2 USB Clocking

The USB Controller is driven by two clocks: an output clock of PLL1 (SYSCLK2) and an output clock of the USB PHY.

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#### NOTE

For proper USB 2.0 function, SYSCLK2 must be greater than 60 MHz.

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The USB PHY takes an input clock that is configurable by the USB PHY clock source bits (PHYCLKSRC) in the USB PHY control register (USB\_PHY\_CTL) in the System Control Module. When a 24 MHz crystal is used at MXI1/MXO1, set PHYCLKSRC to 0. This will present a 24 MHz clock to the USB PHY. When a 36 MHz crystal is used at MXI1/MXO1, set PHYCLKSRC to 1. This will present a 12 MHz clock (36 MHz divided internally by three) to the USB PHY. The USB PHY is capable of accepting only 24 MHz and 12 MHz; thus you must use either a 24 MHz or 36 MHz crystal at MXI1/MXO1. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Universal Serial Bus (USB) Controller Reference Guide* (literature number SPRUF9) for more information. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for more information on the System Control Module.

### 3.6 PLL Controller (PLLC)

This section describes the PLL Controllers for PLL1 and PLL2. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for more information on the PLL controllers.

#### 3.6.1 PLL Controller Module

The DM335 has two PLL controllers that provide clocks to different components of the chip. PLL controller 1 (PLLC1) provides clocks to most of the components of the chip. PLL controller 2 (PLLC2) provides clocks to the DDR PHY.

As a module, the PLL controller provides the following:

- Glitch-free transitions (on changing PLL settings)
- Domain clocks alignment
- Clock gating
- PLL bypass
- PLL power down

The various clock outputs given by the PLL controller are as follows:

- Domain clocks: SYSCLKn
- Bypass domain clock: SYSCLKBP
- Auxiliary clock from reference clock: AUXCLK

Various dividers that can be used are as follows:

- Pre-PLL divider: PREDIV
- Post-PLL divider: POSTDIV
- SYSCLK divider: PLLDIV1, ..., PLLDIVn
- SYSCLKBP divider: BPDIV

Multipliers supported are as follows:

- PLL multiplier control: PLLM

### 3.6.2 PLLC1

PLLC1 provides most of the DM335 clocks. Software controls PLLC1 operation through the PLLC1 registers. The following list, [Table 3-10](#), and [Figure 3-3](#) describe the customizations of PLLC1 in the DM335.

- Provides primary DM335 system clock
- Software configurable
- Accepts clock input or internal oscillator input
- PLL pre-divider value is fixed to (/8)
- PLL multiplier value is programmable
- PLL post-divider
- Only SYSCLK[4:1] are used
- SYSCLK1 divider value is fixed to (/2)
- SYSCLK2 divider value is fixed to (/4)
- SYSCLK3 divider value is programmable
- SYSCLK4 divider value is programmable to (/4) or (/2)
- SYSCLKBP divider value is fixed to (/3)
- SYSCLK1 is routed to the ARM Subsystem
- SYSCLK2 is routed to peripherals
- SYSCLK3 is routed to the VPBE module
- SYSCLK4 is routed to the VPSS module
- AUXCLK is routed to peripherals with fixed clock domain and also to the output pin CLKOUT1
- SYSCLKBP is routed to the output pin CLKOUT2

**Table 3-10. PLLC1 Output Clocks**

| Output Clock | Used By              | PLLDIV<br>Divider | Notes                                              |
|--------------|----------------------|-------------------|----------------------------------------------------|
| SYSCLK1      | ARM Subsystem        | /2                | Fixed divider                                      |
| SYSCLK2      | Peripherals          | /4                | Fixed divider                                      |
| SYSCLK3      | VPBE (VENC module)   | /n                | Programmable divider (used to get 27 MHz for VENC) |
| SYSCLK4      | VPSS                 | /4 or /2          | Programmable divider                               |
| AUXCLK       | Peripherals, CLKOUT1 | none              | No divider                                         |
| SYSCLKBP     | CLKOUT2              | /3                | Fixed divider                                      |

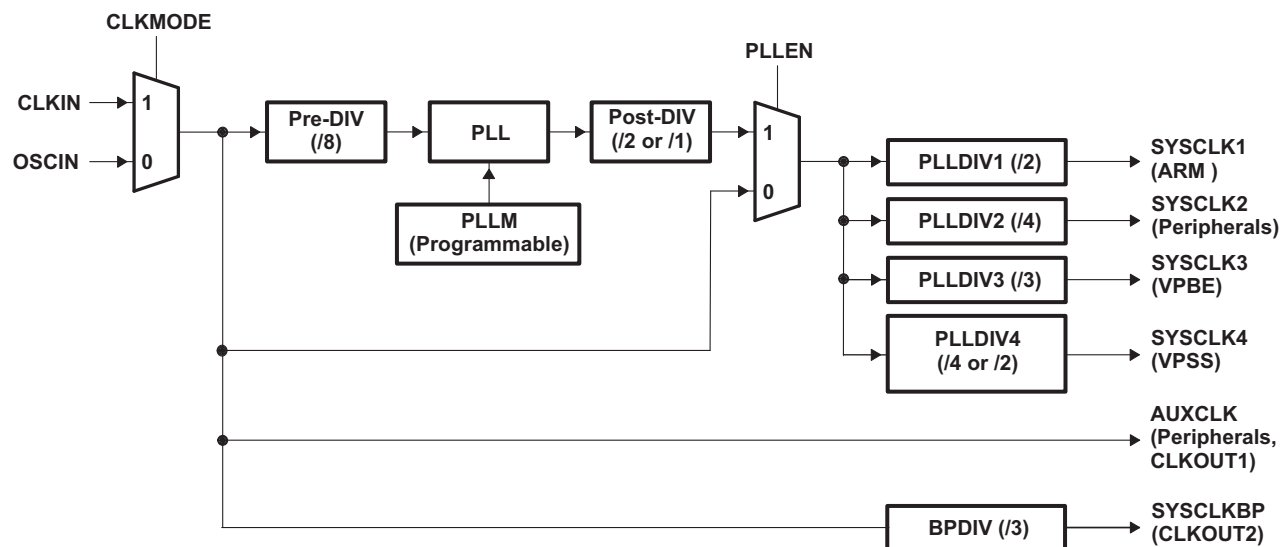


Figure 3-3. PLLC1 Configuration in DM335

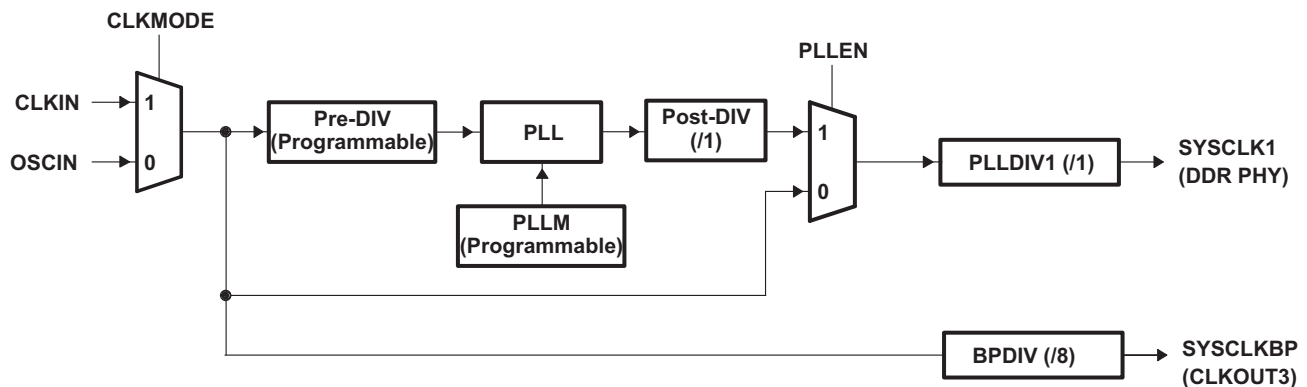
### 3.6.3 PLLC2

PLLC2 provides the DDR PHY clock and CLKOUT3. Software controls PLLC2 operation through the PLLC2 registers. The following list, [Table 3-11](#), and [Figure 3-4](#) describe the customizations of PLLC2 in the DM335.

- Provides DDR PHY clock and CLKOUT3
- Software configurable
- Accepts clock input or internal oscillator input (same input as PLLC1)
- PLL pre-divider value is programmable
- PLL multiplier value is programmable
- PLL post-divider value is fixed to (/1)
- Only SYSCLK[1] is used
- SYSCLK1 divider value is fixed to (/1)
- SYSCLKBP divider value is fixed to (/8)
- SYSCLK1 is routed to the DDR PHY
- SYSCLKBP is routed to the output pin CLKOUT3
- AUXCLK is not used.

**Table 3-11. PLLC2 Output Clocks**

| Output Clock | Used by | PLLDIV Divider | Notes         |
|--------------|---------|----------------|---------------|
| SYSCLK1      | DDR PHY | /1             | Fixed divider |
| SYSCLKBP     | CLKOUT3 | /8             | Fixed divider |



**Figure 3-4. PLLC2 Configuration in DM335**

### 3.7 Power and Sleep Controller (PSC)

In the DM335 system, the Power and Sleep Controller (PSC) is responsible for managing transitions of system power on/off, clock on/off, and reset. A block diagram of the PSC is shown in Figure 3-5. Many of the operations of the PSC are transparent to software, such as power-on-reset operations. However, the PSC provides you with an interface to control several important clock and reset operations.

The PSC includes the following features:

- Manages chip power-on/off, clock on/off, and resets
- Provides a software interface to:
  - Control module clock ON/OFF
  - Control module resets
- Supports IcePick emulation features: power, clock, and reset

For more information on the PSC, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7X7).

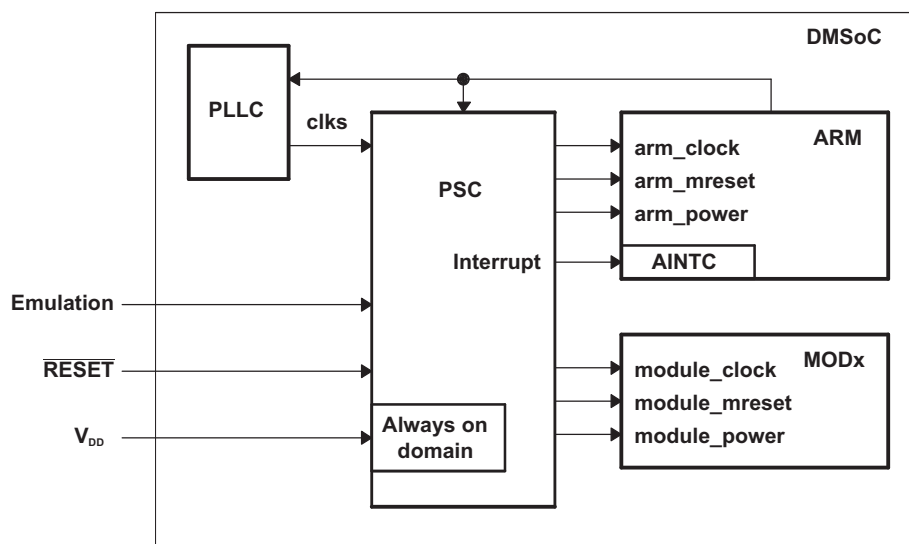


Figure 3-5. DM335 Power and Sleep Controller (PSC)

### 3.8 System Control Module

The DM335's system control module is a system-level module containing status and top-level control logic required by the device. The system control module consists of a miscellaneous set of status and control registers, accessible by the ARM and supporting all of the following system features and operations:

- Device identification
- Device configuration
  - Pin multiplexing control
  - Device boot configuration status
- ARM interrupt and EDMA event multiplexing control
- Special peripheral status and control
  - Timer64+
  - USB PHY control
  - VPSS clock and video DAC control and status
  - DDR VTP control
  - Clockout circuitry
  - GIO de-bounce control

- Power management
  - Deep sleep and fast NAND boot control
- Bandwidth Management
  - Bus master DMA priority control

For more information on the System Control Module refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7).

### 3.9 Pin Multiplexing

The DM335 makes extensive use of pin multiplexing to accommodate the large number of peripheral functions in the smallest possible package. In order to accomplish this, pin multiplexing is controlled using a combination of hardware configuration (at device reset) and software control. No attempt is made by the DM335 hardware to ensure that the proper pin muxing has been selected for the peripherals or interface mode being used, thus proper pin muxing configuration is the responsibility of the board and software designers. An overview of the pin multiplexing is shown in [Table 3-12](#).

**Table 3-12. Peripheral Pin Mux Overview**

| Peripheral       | Muxed With         | Primary Function | Secondary Function | Tertiary Function |
|------------------|--------------------|------------------|--------------------|-------------------|
| VPFE (video in)  | GPIO and SPI2      | VPFE (video in)  | SPI2               | GPIO              |
| VPBE (video out) | GPIO, PWM, and RTO | VPBE (video out) | PWM and RTO        | GPIO              |
| AEMIF            | GPIO               | AEMIF            | GPIO               | none              |
| ASP0             | GPIO               | ASP0             | GPIO               | none              |
| MMC/SD1          | GPIO and UART2     | MMC/SD1          | GPIO               | UART2             |
| CLKOUT           | GPIO               | CLKOUT           | GPIO               | none              |
| I2C              | GPIO               | I2C              | GPIO               | none              |
| UART1            | GPIO               | UART1            | GPIO               | none              |
| SPI1             | GPIO               | SPI1             | GPIO               | none              |
| SPI0             | GPIO               | SPI0             | GPIO               | none              |

#### 3.9.1 Hardware Controlled Pin Multiplexing

Use the Asynchronous EMIF configuration pins (AECFG[3:0]) for hardware pin mux control. AECFG[3:0] control the partitioning of the AEMIF addresses and GPIOs at reset, which allows you to properly configure the number of AEMIF address pins required by the boot device while unused addresses pins are available as GPIOs. These settings may be changed by software after reset by programming the PinMux2 register. The PinMux2 register is in the System Control Module. As shown in [Table 3-13](#), the number of address bits enabled on the AEMIF is selectable from 0 to 16. Pins that are not assigned to another peripheral and not enabled as address signals become GPIOs (except EM\_A[2:1]). The enabled address signals are always contiguous from EM\_BA[1] upwards; bits cannot be skipped. The exception to this are EM\_A[2:1]. These signals (can be used to) represent the ALE and CLE signals for the NAND Flash mode of the AEMIF and are always enabled. Note that EM\_A[0] does not represent the lowest AEMIF address bit. DM335 supports only 16-bit and 8-bit data widths for the AEMIF. In 16-bit mode, EM\_BA[1] represents the LS address bit (the half-word address) and EM\_BA[0] represents the MS address bit (A[14]). In 8-bit mode, EM\_BA[1:0] represent the 2 LS address bits. Note that additional selections are available by programming the PinMux2 register in software after boot. Note that AECFG selection of '0010' selects OneNAND interface. The AEMIF needs to operate in the half-rate mode (full\_rate = 0) to meet frequency requirements. Software should not change the PINMUX2 register setting to affect the AEMIF rate operation. A soft reset of the AEMIF should be performed any time a rate change is made.

**Table 3-13. AECFG (Async EMIF Configuration) Pin Mux Coding**

| 1101(NAND) | 1100     | 1010     | 1000 (8-bit SRAM) | 0010 (16-bit SRAM, OneNAND) | 0000     |
|------------|----------|----------|-------------------|-----------------------------|----------|
| GPIO[54]   | GPIO[54] | EM_A[14] | EM_BA[0]          | EM_A[14]                    | EM_BA[0] |
| GPIO[55]   | EM_BA[1] | EM_BA[1] | EM_BA[1]          | EM_BA[1]                    | EM_BA[1] |
| GPIO[56]   | EM_A[0]  | EM_A[0]  | EM_A[0]           | EM_A[0]                     | EM_A[0]  |
| EM_A[1]    | EM_A[1]  | EM_A[1]  | EM_A[1]           | EM_A[1]                     | EM_A[1]  |
| EM_A[2]    | EM_A[2]  | EM_A[2]  | EM_A[2]           | EM_A[2]                     | EM_A[2]  |
| GPIO[57]   | EM_A[3]  | EM_A[3]  | EM_A[3]           | EM_A[3]                     | EM_A[3]  |
| GPIO[58]   | EM_A[4]  | EM_A[4]  | EM_A[4]           | EM_A[4]                     | EM_A[4]  |
| GPIO[59]   | EM_A[5]  | EM_A[5]  | EM_A[5]           | EM_A[5]                     | EM_A[5]  |
| GPIO[60]   | EM_A[6]  | EM_A[6]  | EM_A[6]           | EM_A[6]                     | EM_A[6]  |
| GPIO[61]   | EM_A[7]  | EM_A[7]  | EM_A[7]           | EM_A[7]                     | EM_A[7]  |
| GPIO[62]   | EM_A[8]  | EM_A[8]  | EM_A[8]           | EM_A[8]                     | EM_A[8]  |
| GPIO[63]   | EM_A[9]  | EM_A[9]  | EM_A[9]           | EM_A[9]                     | EM_A[9]  |
| GPIO[64]   | EM_A[10] | EM_A[10] | EM_A[10]          | EM_A[10]                    | EM_A[10] |
| GPIO[65]   | EM_A[11] | EM_A[11] | EM_A[11]          | EM_A[11]                    | EM_A[11] |
| GPIO[66]   | EM_A[12] | EM_A[12] | EM_A[12]          | EM_A[12]                    | EM_A[12] |
| GPIO[67]   | EM_A[13] | EM_A[13] | EM_A[13]          | EM_A[13]                    | EM_A[13] |
| GPIO[46]   | GPIO[46] | GPIO[46] | GPIO[46]          | EM_D[8]                     | EM_D[8]  |
| GPIO[47]   | GPIO[47] | GPIO[47] | GPIO[47]          | EM_D[9]                     | EM_D[9]  |
| GPIO[48]   | GPIO[48] | GPIO[48] | GPIO[48]          | EM_D[10]                    | EM_D[10] |
| GPIO[49]   | GPIO[49] | GPIO[49] | GPIO[49]          | EM_D[11]                    | EM_D[11] |
| GPIO[50]   | GPIO[50] | GPIO[50] | GPIO[50]          | EM_D[12]                    | EM_D[12] |
| GPIO[51]   | GPIO[51] | GPIO[51] | GPIO[51]          | EM_D[13]                    | EM_D[13] |
| GPIO[52]   | GPIO[52] | GPIO[52] | GPIO[52]          | EM_D[14]                    | EM_D[14] |
| GPIO[53]   | GPIO[53] | GPIO[53] | GPIO[53]          | EM_D[15]                    | EM_D[15] |

### 3.9.2 Software Controlled Pin Multiplexing

All pin multiplexing options are configurable by software via pin mux registers that reside in the System Control Module. The PinMux0 Register controls the Video In muxing, PinMux1 register controls Video Out signals, PinMux2 register controls AEMIF signals, PinMux3 registers control the multiplexing of the GIO signals, the PinMux4 register controls the SPI and MMC/SD0 signals. Refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for complete descriptions of the pin mux registers.

### 3.10 Device Reset

There are five types of reset in DM335. The types of reset differ by how they are initiated and/or by their effect on the chip. Each type is briefly described in [Table 3-14](#). They are further described in the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7).

**Table 3-14. Reset Types**

| Type                 | Initiator                                                                                        | Effect                                                                                   |
|----------------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| POR (Power-On-Reset) | $\overline{\text{RESET}}$ pin low and $\overline{\text{TRST}}$ low                               | Total reset of the chip (cold reset). Resets all modules including memory and emulation. |
| Warm Reset           | $\overline{\text{RESET}}$ pin low and $\overline{\text{TRST}}$ high (initiated by ARM emulator). | Resets all modules including memory, except ARM emulation.                               |
| Max Reset            | ARM emulator or Watchdog Timer (WDT).                                                            | Same effect as warm reset.                                                               |

**Table 3-14. Reset Types (continued)**

| Type         | Initiator    | Effect                                                                                                                                                     |
|--------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| System Reset | ARM emulator | Resets all modules except memory and ARM emulation. It is a soft reset that maintains memory contents and does not affect or reset clocks or power states. |
| Module Reset | ARM software | Resets a specific module. Allows the ARM to independently reset any module. Module reset is intended as a debug tool not as a tool to use in production.   |

### 3.11 Default Device Configurations

After POR, warm reset, and max reset, the chip is in its default configuration. This section highlights the default configurations associated with PLLs, clocks, ARM boot mode, and AEMIF.

#### NOTE

Default configuration is the configuration immediately after POR, warm reset, and max reset and just before the boot process begins. The boot ROM updates the configuration. See [Section 3.12](#) for more information on the boot process.

#### 3.11.1 Device Configuration Pins

The device configuration pins are described in [Table 3-15](#). The device configuration pins are latched at reset and allow you to configure all of the following options at reset:

- ARM Boot Mode
- Asynchronous EMIF pin configuration

These pins are described further in the following sections.

#### NOTE

The device configuration pins are multiplexed with AEMIF pins. After the device configuration pins are sampled at reset, they automatically change to function as AEMIF pins. Pin multiplexing is described in [Section 3.8](#).

**Table 3-15. Device Configuration**

| Device Configuration Input | Function                                                                                                                                                           | Sampled Pin | Default Setting (by internal pull-up/pull-down) | Device Configuration Affected                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BTSEL[1:0]                 | Selects ARM boot mode<br>00 = Boot from ROM (NAND with SPI EEPROM boot option)<br>01 = Boot from AEMIF<br>10 = Boot from ROM (MMC/SD)<br>11 = Boot from ROM (UART) | EM_A[13:12] | 00<br>(NAND)                                    | If any ROM boot mode is selected, GIO61 is used to indicated boot status.<br>If NAND boot is selected, CE0 is used for NAND and SPI0 is used for SPI boot option. Use AECFG[3:0] to configure AEMIF pins for NAND.<br>If AEMIF boot is selected, CE0 is used for AEMIF device (OneNAND, ROM). Use AECFG[3:0] to configure AEMIF pins for NAND.<br>If MMC/SD boot is selected, MMC/SD0 is used. |
| AECFG[3:0]                 | Selects AEMIF pin configuration                                                                                                                                    | EM_A[11:8]  | 1101<br>(NAND)                                  | Selects the AEMIF pin configuration. Refer to pin-muxing information in <a href="#">Section 3.9.1</a> . Note that AECFG[3:0] affects both AEMIF (BTSEL[1:0]=01) and NAND (BTSEL[1:0]=00) boot modes.                                                                                                                                                                                           |

### 3.11.2 PLL Configuration

After POR, warm reset, and max reset, the PLLs and clocks are set to their default configurations. The PLLs are in bypass mode and disabled by default. This means that the input reference clock at MXI1 (typically 24 MHz) drives the chip after reset. For more information on device clocking, see [Section 3.5](#) and [Section 3.6](#). The default state of the PLLs is reflected in the default state of the register bits in the PLLC registers. Refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for PLLC register descriptions.

### 3.11.3 Power Domain and Module State Configuration

Only a subset of modules are enabled after reset by default. [Table 3-16](#) shows which modules are enabled after reset. [Table 3-16](#) as shows that the following modules are enabled depending on the sampled state of the device configuration pins: EDMA (CC and TC0), AEMIF, MMC/SD0, UART0, and Timer0. For example, UART0 is enabled after reset when the device configuration pins (BTSEL[1:0] = 11 - Enable UART) select UART boot mode. For more information on module configuration refer to .

**Table 3-16. Module Configuration**

| Module Number | Module Name | Power Domain | Default States     |                                                                                                                                                       |
|---------------|-------------|--------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |             |              | Power Domain State | Module State                                                                                                                                          |
| 0             | VPSS Master | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 1             | VPSS Slave  | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 2             | EDMA (CC)   | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – Enable (NAND, SPI)<br>BTSEL[1:0] = 01 – Enable (OneNAND)                                                                            |
| 3             | EDMA (TC0)  | AlwaysOn     | ON                 | BTSEL[1:0] = 10 – SyncRst (MMC/SD)                                                                                                                    |
| 4             | EDMA (TC1)  | AlwaysOn     | ON                 | BTSEL[1:0] = 11 – Enable (UART)                                                                                                                       |
| 5             | Timer3      | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 6             | SPI1        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 7             | MMC/SD1     | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 8             | ASP1        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 9             | USB         | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 10            | PWM3        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 11            | SPI2        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 12            | RTO         | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 13            | DDR EMIF    | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 14            | AEMIF       | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – Enable (NAND, SPI)<br>BTSEL[1:0] = 01 – Enable (OneNAND)<br>BTSEL[1:0] = 10 – SyncRst (MMC/SD)<br>BTSEL[1:0] = 11 – Enable (UART)   |
| 15            | MMC/SD0     | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – SyncRst (NAND, SPI)<br>BTSEL[1:0] = 01 – SyncRst (OneNAND)<br>BTSEL[1:0] = 10 – Enable (MMC/SD)<br>BTSEL[1:0] = 11 – SyncRst (UART) |
| 16            | Reserved    | Reserved     | Reserved           | Reserved                                                                                                                                              |
| 17            | ASP         | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 18            | I2C         | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 19            | UART0       | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – SyncRst (NAND, SPI)<br>BTSEL[1:0] = 01 – SyncRst (OneNAND)<br>BTSEL[1:0] = 10 – SyncRst (MMC/SD)<br>BTSEL[1:0] = 11 – Enable (UART) |
| 20            | UART1       | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 21            | UART2       | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 22            | SPI0        | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – Enable (NAND, SPI)<br>BTSEL[1:0] = 01 – SyncRst (OneNAND)<br>BTSEL[1:0] = 10 – Enable (MMC/SD)<br>BTSEL[1:0] = 11 – Enable (UART)   |
| 23            | PWM0        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 24            | PWM1        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 25            | PWM2        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 26            | GPIO        | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |
| 27            | TIMER0      | AlwaysOn     | ON                 | BTSEL[1:0] = 00 – Enable (NAND, SPI)<br>BTSEL[1:0] = 01 – Enable (OneNAND)<br>BTSEL[1:0] = 10 – Enable (MMC/SD)<br>BTSEL[1:0] = 11 – Enable (UART)    |
| 28            | TIMER1      | AlwaysOn     | ON                 | SyncRst                                                                                                                                               |

**Table 3-16. Module Configuration (continued)**

|    |               |           | Default States |          |
|----|---------------|-----------|----------------|----------|
|    |               |           | ON             | Enable   |
| 29 | TIMER2        | AlwaysOn  | ON             | Enable   |
| 30 | System Module | AlwaysOn  | ON             | Enable   |
| 31 | ARM           | AlwaysOn  | ON             | Enable   |
| 32 | BUS           | AlwaysOn  | ON             | Enable   |
| 33 | BUS           | AlwaysOn  | ON             | Enable   |
| 34 | BUS           | AlwaysOn  | ON             | Enable   |
| 35 | BUS           | AlwaysOn  | ON             | Enable   |
| 36 | BUS           | AlwaysOn  | ON             | Enable   |
| 37 | BUS           | AlwaysOn  | ON             | Enable   |
| 38 | BUS           | AlwaysOn  | ON             | Enable   |
| 39 | Reserved      | Reserved  | Reserved       | Reserved |
| 40 | VPSS DAC      | Always On | ON             | SyncRst  |

### 3.11.4 ARM Boot Mode Configuration

The input pins BTSEL[1:0] determine whether the ARM will boot from its ROM or from the Asynchronous EMIF (AEMIF). When ROM boot is selected (BTSEL[1:0] = 00, 10, or 11), a jump to the start of internal ROM (address 0x0000: 8000) is forced into the first fetched instruction word. The embedded ROM boot loader code (RBL) then performs certain configuration steps, reads the BOOTCFG register to determine the desired boot method, and branches to the appropriate boot routine (i.e., a NAND/SPI, MMC/SD, or UART loader routine).

If AEMIF boot is selected (BTSEL[1:0] = 01), a jump to the start of AEMIF (address 0x0200: 0000) is forced into the first fetched instruction word. The ARM then continues executing from external asynchronous memory using the default AEMIF timings until modified by software.

#### NOTE

For AEMIF boot, the OneNAND must be connected to the first AEMIF chip select space (EM\_CE0). Also, the AEMIF does not support direct execution from NAND Flash.

Boot modes are further described in [Section 3.12](#).

### 3.11.5 AEMIF Configuration

#### 3.11.5.1 AEMIF Pin Configuration

The input pins AECFG[3:0] determine the AEMIF configuration immediately after reset. Use AECFG[3:0] to properly configure the pins of the AEMIF. Refer to the section on pin multiplexing in [Section 3.9](#).

Also, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Asynchronous External Memory Interface (EMIF) Reference Guide* (SPRUZ1) for more information on the AEMIF.

#### 3.11.5.2 AEMIF Timing Configuration

When AEMIF is enabled, the wait state registers are reset to the slowest possible configuration, which is 88 cycles per access (16 cycles of setup, 64 cycles of strobe, and 8 cycles of hold). Thus, with a 24 MHz clock at MX11, the AEMIF is configured to run at 6 MHz/88 which equals approximately 68 kHz by default. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Asynchronous External Memory Interface (EMIF) Reference Guide* (SPRUZ1) for more information on the AEMIF.

## 3.12 Device Boot Modes

The DM335 ARM can boot from either Async EMIF (AEMIF/OneNand) or from ARM ROM, as determined by the setting of the device configuration pins BTSEL[1:0]. The BTSEL[1:0] pins can define the ROM boot mode further as well.

The boot selection pins (BTSEL[1:0]) determine the ARM boot process. After reset (POR, warm reset, or max reset), ARM program execution begins in ARM ROM at 0x0000: 8000, except when BTSEL[1:0] = 01, indicating AEMIF (AEMIF/OneNand) boot. See [Section 3.11.1](#) for information on the boot selection pins.

### 3.12.1 Boot Modes Overview

DM335's ARM ROM boot loader (RBL) executes when the BTSEL[1:0] pins indicate a condition other than the normal ARM EMIF boot.

- If BTSEL[1:0] = 01 - Asynchronous EMIF (AEMIF) boot. This mode is handled by hardware control and does not involve the ROM. In the case of OneNAND, the user is responsible for putting any necessary boot code in the OneNAND's boot page. This code shall configure the AEMIF module for the OneNAND device. After the AEMIF module is configured, booting will continue immediately after the OneNAND's boot page with the AEMIF module managing pages thereafter.
- The RBL supports 3 distinct boot modes:
  - BTSEL[1:0] = 00 - ARM NAND/SPI Boot
  - BTSEL[1:0] = 10 - ARM MMC/SD Boot
  - BTSEL[1:0] = 11 - ARM UART Boot
- In NAND mode if SPI boot fails, then NAND mode is tried. If NAND boot fails, then MMC/SD mode is tried.
- If MMC/SD boot fails, then MMC/SD boot is tried again.
- If UART boot fails, then UART boot is tried again.
- RBL uses GIO61 to indicate boot status (can use to blink LED):
  - After reset, GIO61 is initially driven low (e.g LED off)
  - If NAND boot fails, then GIO61 shall toggle at 4Hz while MMC/SD boot is tried.
  - If MMC/SD boot fails, then GIO61 shall toggle at 4Hz while MMC/SD boot is retried.
  - If UART boot fails, then GIO61 shall toggle at 2Hz while UART boot is retried.
  - When boot is successful, just before program control is given to UBL, GIO61 is driven high (e.g. LED on).
  - DM335 Timer0 shall be used to accurately toggle GIO61 at 4Hz and 2Hz.
- ARM ROM Boot - SPI boot in NAND Mode
  - No support for a full firmware boot. Instead, copies a second stage User Boot Loader (UBL) from SPI to ARM Internal RAM (AIM) and transfers control to the user software.
  - Support for 16 and 24 bit SPI EEPROMs
  - Support for up to 30KB UBL (32KB - ~2KB for RBL stack)
  - RBL will copy UBL to ARM Internal RAM (AIM) via SPI interface from a SPI peripheral like SPI EEPROM. RBL will then transfer control to the UBL.
- ARM ROM Boot - NAND Mode (See [Section 3.12.2](#) for a full explanation of the differences between Standard Mode and Compatibility Mode.):
  - No support for a full firmware boot. Instead, copies a second stage User Boot Loader (UBL) from NAND flash to ARM internal RAM (AIM) and transfers control to the user-defined UBL
  - Support for NAND with page sizes up to 8192 bytes in Standard Mode and 2048 bytes in Compatibility Mode

**Note:** At the time of documentation for this device, 8192-byte devices were not available for testing. The code does contain support for these devices; however, it has not yet been tested.

  - Support for magic number error detection and retry (up to 24 times) when loading UBL
  - Support for up to 30KB UBL (32KB IRAM - ~2KB for RBL stack)

- Optional, user-selectable, support for use of DMA and I-cache during RBL execution (i.e., while loading UBL)
- Supports booting from 8-bit NAND devices (16-bit NAND devices are not supported)
- Uses/Requires 4-bit HW ECC (NAND devices with ECC requirements  $\leq 4$  bits per 512 bytes are supported)
- Supports NAND flash that requires chip select to stay low during the tR read time

**Notes:**

- See [Section 3.12.2](#) for a full explanation of the differences between Standard Mode and Compatibility Mode.
- The GPIO000 pin **must** be held high during NAND boot for the boot process to function properly.
- ARM ROM Boot - MMC/SD Mode
  - No support for a full firmware boot. Instead, copies a second stage User Boot Loader (UBL) from MMC/SD to ARM Internal RAM (AIM) and transfers control to the user software.
  - Support for MMC/SD Native protocol (MMC/SD SPI protocol is not supported)
  - Support for descriptor error detection and retry (up to 24 times) when loading UBL
  - Support for up to 30KB UBL (32KB - ~2KB for RBL stack)
- ARM ROM Boot - UART mode
  - No support for a full firmware boot. Instead, loads a second stage User Boot Loader (UBL) via UART to ARM internal RAM (AIM) and transfers control to the user software.
  - Support for up to 30KB UBL (32KB - ~2KB for RBL stack)

The general boot sequence is shown in [Figure 3-6](#). For more information, refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUFX7).

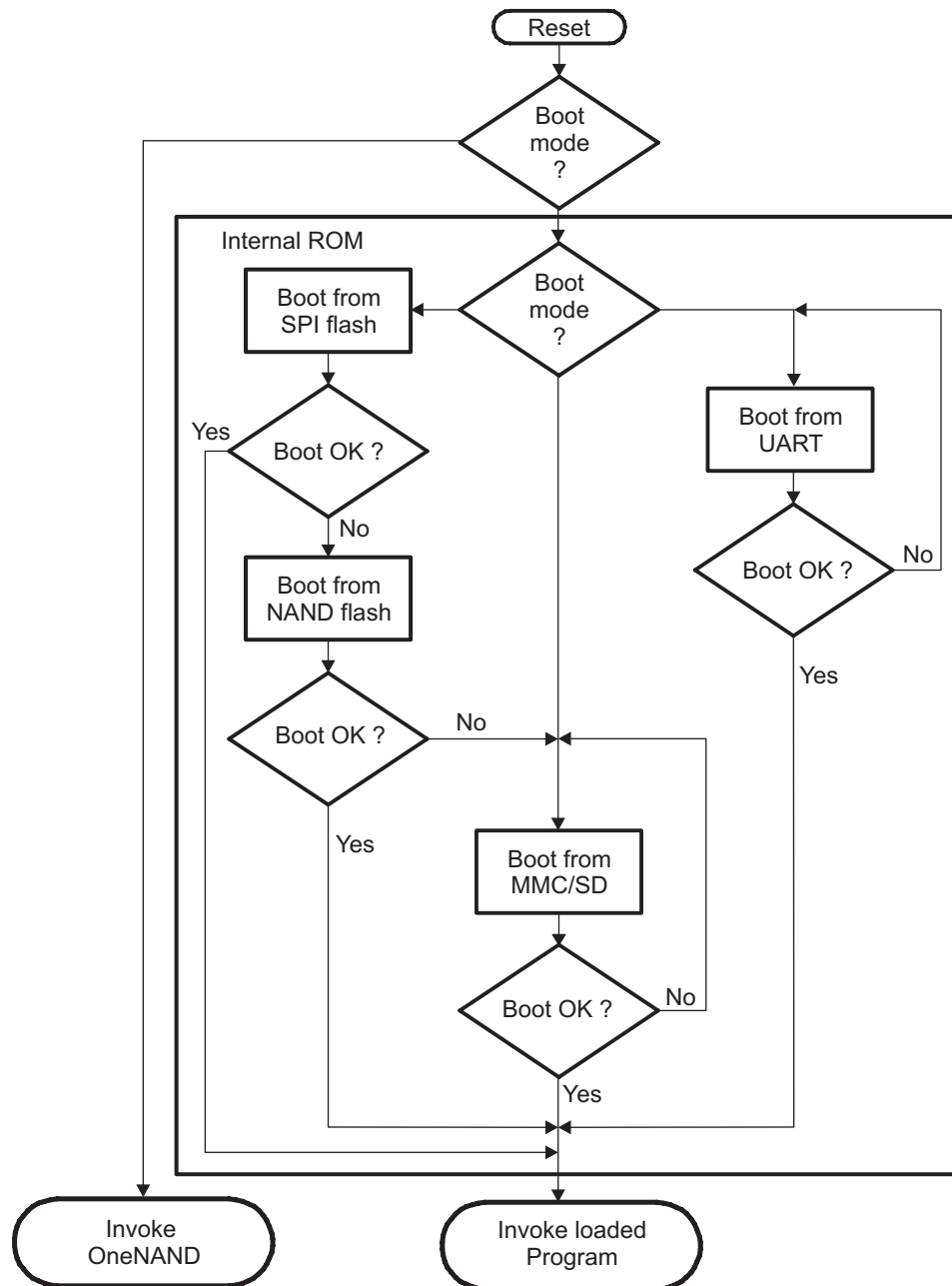


Figure 3-6. Boot Mode Functional Block Diagram

### 3.12.2 RBL NAND Boot Process

The RBL NAND boot process is described as follows:

- Upon NAND boot, if a SPI EEPROM is present, RBL reads first 32 bytes and look for magic pattern at offset 0x8. This magic number indicates if this is a SPI boot or beginning of NAND parameters.
- If SPI boot, then NAND boot is bypassed.
- Otherwise NAND boot is continued. If NAND parameters are found in the SPI EEPROM (as indicated by magic number), these parameters are used.
- Else the following steps are used to determine NAND parameters:
  - If the device is ONFI, read the parameters page. Else command is sent to the NAND device requesting four bytes (called the NAND READ\_ID) which contain the manufacturer, device and 4th

ID.

- The RBL contains an internal table with a list of known NAND devices. Table 3-23 shows the devices contained in the tables.
- If the device ID is not found in the table, then the RBL use the fourth byte of the NAND to decode this to obtain the necessary parameters.
- Once a device ID is identified, the first 24 blocks of the NAND are read sequentially starting with page 0 with an offset of 512 bytes. The purpose of the read is to locate a magic number which will identify the revision of the silicon. Table 3-18 contains magic numbers and their functions. In addition to the modes listed in Table 3-18, the magic number will determine whether the device runs in Standard or Compatibility mode. Magic numbers of the form 0xA1ACEDxx place the device in Compatibility mode, while magic numbers of the form 0xA1BCEDxx place the device in Standard mode. This should be kept in mind when reviewing the values in Table 3-18.
- If a Compatibility mode magic number is read, then the device enters compatibility mode. In compatibility mode, NAND layout is identical to that used in previous revisions of the silicon as shown in Table 3-19. Only 512-byte small blocks and 2048-byte big blocks are supported.
- If a Standard mode magic number is read, the NAND layout is as shown in Table 3-20: 512-bytes small block and 2048- and 4096- big block devices are supported. 8192-block devices are also supported. **Note:** At the time of production of this document revision, only 4096-block devices were available for testing.
- Once a magic number is identified, the User Boot Loader (UBL) is loaded from the NAND, stored to internal RAM, and executed.

**Table 3-17. NAND Devices in NAND Device ID Table**

| DEVICE ID           | PAGES PER BLOCK | BYTES PER PAGE | BLOCK SHIFT VALUE FOR ADDRESS | NUMBER OF ADDRESS CYCLES |
|---------------------|-----------------|----------------|-------------------------------|--------------------------|
| 0xE3                | 16              | 512+16         | 12                            | 3                        |
| 0xE5                | 16              | 512+16         | 12                            | 3                        |
| 0xE6                | 16              | 512+16         | 12                            | 3                        |
| 0x39 <sup>(1)</sup> | 16              | 512+16         | 13                            | 3                        |
| 0x6B                | 16              | 512+16         | 13                            | 3                        |
| 0x73                | 32              | 512+16         | 13                            | 3                        |
| 0x33                | 32              | 512+16         | 13                            | 3                        |
| 0x75                | 32              | 512+16         | 13                            | 3                        |
| 0x35                | 32              | 512+16         | 13                            | 3                        |
| 0x43                | 32              | 512+16         | 13                            | 4                        |
| 0x45                | 32              | 512+16         | 13                            | 4                        |
| 0x53                | 32              | 512+16         | 13                            | 4                        |
| 0x55                | 32              | 512+16         | 13                            | 4                        |
| 0x76                | 32              | 512+16         | 13                            | 4                        |
| 0x36                | 32              | 512+16         | 13                            | 4                        |
| 0x79                | 32              | 512+16         | 13                            | 4                        |
| 0x71                | 32              | 512+16         | 13                            | 4                        |
| 0x46                | 32              | 512+16         | 13                            | 4                        |
| 0x56                | 32              | 512+16         | 13                            | 4                        |
| 0x74                | 32              | 512+16         | 13                            | 4                        |
| 0xF1                | 64              | 2048+64        | 22                            | 4                        |
| 0xA1                | 64              | 2048+64        | 22                            | 4                        |
| 0xAA                | 64              | 2048+64        | 22                            | 5                        |
| 0xDA                | 64              | 2048+64        | 22                            | 5                        |

(1) Present only on silicon revision 1.1.

**Table 3-17. NAND Devices in NAND Device ID Table (continued)**

|      |    |         |    |   |
|------|----|---------|----|---|
| 0xAC | 64 | 2048+64 | 22 | 5 |
| 0xDC | 64 | 2048+64 | 22 | 5 |
| 0xB1 | 64 | 2048+64 | 22 | 5 |
| 0xC1 | 64 | 2048+64 | 22 | 5 |

**Table 3-18. UBL Signature and Special Modes for NAND Boot Mode**

| MODE                  | VALUE <sup>(1)</sup> | DESCRIPTION                         |
|-----------------------|----------------------|-------------------------------------|
| UBL_MAGIC_SAFE        | 0xA1AC ED00          | Safe boot mode                      |
| UBL_MAGIC_DMA         | 0xA1AC ED11          | DMA boot mode                       |
| UBL_MAGIC_IC          | 0xA1AC ED22          | I Cache boot mode                   |
| UBL_MAGIC_FAST        | 0xA1AC ED33          | Fast EMIF boot mode                 |
| UBL_MAGIC_DMA_IC      | 0xA1AC ED44          | DMA + I Cache boot mode             |
| UBL_MAGIC_DMA_IC_FAST | 0xA1AC ED55          | DMA + I Cache + Fast EMIF boot mode |
| UBL_MAGIC_SPI_PARAMS  | 0xA1AC EDAA          | NAND parameters from SPI EEPROM     |

(1) The values listed only apply when operating in compatibility mode. These values follow the form 0xA1BCEDxx when operating in standard mode.

**Example:** UBL\_MAGIC\_SAFE VALUE = 0xA1ACED00; Safe boot mode will configure the device to run in safe boot mode and in compatibility mode. However, when using standard mode, the value should be 0xA1BCD00.

**Table 3-19. NAND Layout (Compatibility Mode)**

| 512 Byte Page Size | 2048 Byte Page Size |
|--------------------|---------------------|
| 512 bytes Data     | 512 bytes Data      |
| 16 bytes ECC Data  | 16 bytes ECC Data   |
|                    | 512 bytes Data      |
|                    | 16 bytes ECC Data   |
|                    | 512 bytes Data      |
|                    | 16 bytes ECC Data   |
|                    | 512 bytes Data      |
|                    | 16 bytes ECC Data   |

**Table 3-20. NAND Layout (Standard Mode)**

| 512 Byte Page Size | 2048 Byte Page Size | 4096 Byte Page Size |
|--------------------|---------------------|---------------------|
| 512 bytes Data     | 2048 bytes Data     | 4096 bytes Data     |
| 16 bytes ECC Data  | 64 bytes ECC Data   | 128 bytes ECC Data  |

### 3.13 Power Management

The DM335 is designed for minimal power consumption. There are two components to power consumption: active power and leakage power. Active power is the power consumed to perform work and scales with clock frequency and the amount of computations being performed. Active power can be reduced by controlling the clocks in such a way as to either operate at a clock setting just high enough to complete the required operation in the required timeline or to run at a clock setting until the work is complete and then drastically cut the clocks (e.g. to PLL Bypass mode) until additional work must be performed. Leakage power is due to static current leakage and occurs regardless of the clock rate. Leakage, or standby power, is unavoidable while power is applied and scales roughly with the operating junction temperatures. Leakage power can only be avoided by removing power completely from a device or subsystem. The DM335 includes several power management features which are briefly described in Table 3-17. Refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) for more information on power management.

**Table 3-21. Power Management Features**

| <b>Power Management Features</b>  | <b>Description</b>                                                                                                                  |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>Clock Management</b>           |                                                                                                                                     |
| Module clock disable              | Module clocks can be disabled to reduce switching power                                                                             |
| Module clock frequency scaling    | Module clock frequency can be scaled to reduce switching power                                                                      |
| PLL power-down                    | The PLLs can be powered-down when not in use to reduce switching power                                                              |
| <b>ARM Sleep Mode</b>             |                                                                                                                                     |
| ARM Wait-for-Interrupt sleep mode | Disable ARM clock to reduce active power                                                                                            |
| <b>System Sleep Modes</b>         |                                                                                                                                     |
| Deep Sleep mode                   | Stop all device clocks and power down internal oscillators to reduce active power to a minimum. Registers and memory are preserved. |
| <b>I/O Management</b>             |                                                                                                                                     |
| USB Phy power-down                | The USB Phy can be powered-down to reduce USB I/O power                                                                             |
| DAC power-down                    | The DAC's can be powered-down to reduce DAC power                                                                                   |
| DDR self-refresh and power down   | The DDR / mDDR device can be put into self-refresh and power down states                                                            |

### 3.14 64-Bit Crossbar Architecture

The DM335 uses a 64-bit crossbar architecture to control access between device processors, subsystems and peripherals. It includes an EDMA Controller consisting of a DMA Transfer Controller (TC) and a DMA Channel Controller (CC). The TC provides two DMA channels for transfer between slave peripherals. The CC provides a user and event interface to the EDMA system. It includes up to 64 event channels to which all system synchronization events can be mapped and 8 auto submit “quick” channels (QDMA). In most ways, these channels are identical. A channel refers to a specific ‘event’ that can cause a transfer to be submitted to the TC as a Transfer Request.

#### 3.14.1 Crossbar Connections

There are five transfer masters (TCs have separate read and write connections) connected to the crossbar; ARM, the Video Processing Sub-system (VPSS), the master peripherals (USB), and two EDMA transfer controllers. These can be connected to four separate slave ports; ARM, the DDR EMIF, and CFG bus peripherals. Not all masters may connect to all slaves. Connection paths are indicated by √ at intersection points shown in [Table 3-22](#)

**Table 3-22. Crossbar Connection Matrix**

| DMA Master                   | Slave Module        |                                 |                 |
|------------------------------|---------------------|---------------------------------|-----------------|
|                              | ARM Internal Memory | Config Bus Registers and Memory | DDR EMIF Memory |
| ARM                          | √                   | √                               | √               |
| VPSS                         |                     |                                 | √               |
| DMA Master Peripherals (USB) | √                   | √                               | √               |
| EDMA3TC0                     | √                   | √                               | √               |
| EDMA3TC1                     | √                   | √                               | √               |

#### 3.14.2 EDMA Controller

The EDMA controller handles all data transfers between memories and the device slave peripherals on the DM335 device. These are summarized as follows:

- Transfer to/from on-chip memories
  - ARM program/data RAM
- Transfer to/from external storage
  - DDR2 / mDDR SDRAM
  - Asynchronous EMIF
  - OneNAND flash
  - NAND flash
  - Smart Media, SD, MMC, xD media storage
- Transfer to/from peripherals
  - ASP
  - SPI
  - I2C
  - PWM
  - RTO
  - GPIO
  - Timer/WDT
  - UART
  - MMC/SD

The EDMA Controller consists of two major blocks: the Transfer Controller (TC) and the Channel Controller (CC). The CC is a highly flexible Channel Controller that serves as the user interface and event interface for the EDMA system. The CC supports 64-event channels and 8 QDMA channels. The CC consists of a scalable Parameter RAM (PaRAM) that supports flexible ping-pong, circular buffering, channel-chaining, auto-reloading, and memory protection.

The EDMA Channel Controller has the following features:

- Fully orthogonal transfer description
  - Three transfer dimensions
  - A-synchronized transfers: one dimension serviced per event
  - AB- synchronized transfers: two dimensions serviced per event
  - Independent indexes on source and destination
  - Chaining feature allows 3-D transfer based on single event
- Flexible transfer definition
  - Increment and constant addressing modes
  - Linking mechanism allows automatic PaRAM set update
  - Chaining allows multiple transfers to execute with one event
- Interrupt generation for:
  - DMA completion
  - Error conditions
- Debug visibility
  - Queue watermarking/threshold
  - Error and status recording to facilitate debug
- 64 DMA channels
  - Event synchronization
  - Manual synchronization (CPU(s) write to event set register)
  - Chain synchronization (completion of one transfer chains to next)
- 8 QDMA channels
  - QDMA channels are triggered automatically upon writing to a PaRAM set entry
  - Support for programmable QDMA channel to PaRAM mapping
- 128 PaRAM sets
  - Each PaRAM set can be used for a DMA channel, QDMA channel, or link set (remaining)
- Two transfer controllers/event queues. The system-level priority of these queues is user programmable
- 16 event entries per event queue
- External events (for example, ASP TX Evt and RX Evt)

The EDMA Transfer Controller has the following features:

- Two transfer controllers
- 64-bit wide read and write ports per channel
- Up to four in-flight transfer requests (TR)
- Programmable priority level
- Supports two dimensional transfers with independent indexes on source and destination (EDMA3CC manages the 3rd dimension)
- Support for increment and constant addressing modes
- Interrupt and error support

Parameter RAM: Each EDMA is specified by an eight word (32-byte) parameter table contained in Parameter RAM (PaRAM) within the CC. DM335 provides 128 PaRAM entries, one for each of the 64 DMA channels and for 64 QDMA / Linked DMA entries.

DMA Channels: Can be triggered by: " External events (for example, ASP TX Evt and RX Evt), " Software writing a '1' to the given bit location, or channel, of the Event Set register, or, " Chaining to other DMAs.

QDMA: The Quick DMA (QDMA) function is contained within the CC. DM335 implements 8 QDMA channels. Each QDMA channel has a selectable PaRAM entry used to specify the transfer. A QDMA transfer is submitted immediately upon writing of the "trigger" parameter (as opposed to the occurrence of an event as with EDMA). The QDMA parameter RAM may be written by any Config bus master through the Config Bus and by DMAs through the Config Bus bridge.

QDMA Channels: Triggered by a configuration bus write to a designated 'QDMA trigger word'. QDMAs allow a minimum number of linear writes (optimized for GEM IDMA feature) to be issued to the CC to force a series of transfers to take place.

### 3.14.2.1 EDMA Channel Synchronization Events

The EDMA supports up to 64 EDMA channels which service peripheral devices and external memory. [Table 3-23](#) lists the source of EDMA synchronization events associated with each of the programmable EDMA channels. For the DM335 device, the association of an event to a channel is fixed; each of the EDMA channels has one specific event associated with it. These specific events are captured in the EDMA event registers (ER, ERH) even if the events are disabled by the EDMA event enable registers (EER, EERH). For more detailed information on the EDMA module and how EDMA events are enabled, captured, processed, linked, chained, and cleared, etc., see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Enhanced Direct Memory Access (EDMA) Controller Reference Guide* (literature number SPRUFZ20).

**Table 3-23. DM335 EDMA Channel Synchronization Events<sup>(1) (2)</sup>**

| EDMA CHANNEL | EVENT NAME                  | EVENT DESCRIPTION                                      |
|--------------|-----------------------------|--------------------------------------------------------|
| 0            | TIMER3: TINT6               | Timer 3 Interrupt (TINT6) Event                        |
| 1            | TIMER3 TINT7                | Timer 3 Interrupt (TINT7) Event                        |
| 2            | ASP0: XEVT                  | ASP0 Transmit Event                                    |
| 3            | ASP0: REVT                  | ASP0 Receive Event                                     |
| 4            | VPSS: EVT1                  | VPSS Event 1                                           |
| 5            | VPSS: EVT2                  | VPSS Event 2                                           |
| 6            | VPSS: EVT3                  | VPSS Event 3                                           |
| 7            | VPSS: EVT4                  | VPSS Event 4                                           |
| 8            | ASP1: XEVT or TIMER2: TINT4 | ASP1 Transmit Event or Timer 2 interrupt (TINT4) Event |
| 9            | ASP1: REVT or TIMER2: TINT5 | ASP1 Receive Event or Timer 2 interrupt (TINT5) Event  |
| 10           | SPI2: SPI2XEVT              | SPI2 Transmit Event                                    |
| 11           | SPI2: SPI2REVT              | SPI2 Receive Event                                     |
| 12           | Reserved                    |                                                        |
| 13           | Reserved                    |                                                        |
| 14           | SPI1: SPI1XEVT              | SPI1 Transmit Event                                    |
| 15           | SPI1: SPI1REVT              | SPI1 Receive Event                                     |
| 16           | SPI0: SPI0XEVT              | SPI0 Transmit Event                                    |
| 17           | SPI0: SPI0REVT              | SPI0 Receive Event                                     |
| 18           | UART0: URXEVT0              | UART 0 Receive Event                                   |

- (1) In addition to the events shown in this table, each of the 64 channels can also be synchronized with the transfer completion or intermediate transfer completion events. For more detailed information on EDMA event-transfer chaining, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Enhanced Direct Memory Access (EDMA) Controller Reference Guide* (literature number SPRUFZ20).
- (2) The total number of EDMA events in DM335 exceeds 64, which is the maximum value of the EDMA module. Therefore, several events are multiplexed and you must use the register EDMA\_EVTMUX in the System Control Module to select the event source for multiplexed events. Refer to the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUFX7) for more information on the System Control Module register EDMA\_EVTMUX.

**Table 3-23. DM335 EDMA Channel Synchronization Events <sup>(1)</sup> <sup>(2)</sup> (continued)**

| EDMA CHANNEL | EVENT NAME     | EVENT DESCRIPTION           |
|--------------|----------------|-----------------------------|
| 19           | UART0: UTXEVT0 | UART 0 Transmit Event       |
| 20           | UART1: URXEVT1 | UART 1 Receive Event        |
| 21           | UART1: UTXEVT1 | UART 1 Transmit Event       |
| 22           | UART2: URXEVT2 | UART 2 Receive Event        |
| 23           | UART2: UTXEVT2 | UART 2 Transmit Event       |
| 24           | Reserved       |                             |
| 25           | GPIO: GPINT9   | GPIO 9 Interrupt Event      |
| 26           | MMC0RXEVT      | MMC/SD0 Receive Event       |
| 27           | MMC0TXEVT      | MMC/SD0 Transmit Event      |
| 28           | I2CREVT        | I2C Receive Event           |
| 29           | I2CXEVT        | I2C Transmit Event          |
| 30           | MMC1RXEVT      | MMC/SD1 Receive Event       |
| 31           | MMC1TXEVT      | MMC/SD1 Transmit Event      |
| 32           | GPINT0         | GPIO 0 Interrupt Event      |
| 33           | GPINT1         | GPIO 1 Interrupt Event      |
| 34           | GPINT2         | GPIO 2 Interrupt Event      |
| 35           | GPINT3         | GPIO 3 Interrupt Event      |
| 36           | GPINT4         | GPIO 4 Interrupt Event      |
| 37           | GPINT5         | GPIO 5 Interrupt Event      |
| 38           | GPINT6         | GPIO 6 Interrupt Event      |
| 39           | GPINT7         | GPIO 7 Interrupt Event      |
| 40           | GPBANKINT0     | GPIO Bank 0 Interrupt Event |
| 41           | GPBANKINT1     | GPIO Bank 1 Interrupt Event |
| 42           | GPBANKINT2     | GPIO Bank 2 Interrupt Event |
| 43           | GPBANKINT3     | GPIO Bank 3 Interrupt Event |
| 44           | GPBANKINT4     | GPIO Bank 4 Interrupt Event |
| 45           | GPBANKINT5     | GPIO Bank 5 Interrupt Event |
| 46           | GPBANKINT6     | GPIO Bank 6 Interrupt Event |
| 47           | GPINT8         | GPIO 8 Interrupt Event      |
| 48           | TIMER0: TINT0  | Timer 0 Interrupt Event     |
| 49           | TIMER0: TINT1  | Timer 1 Interrupt Event     |
| 50           | TIMER1: TINT2  | Timer 2 Interrupt Event     |
| 51           | TIMER1: TINT3  | Timer 3 Interrupt Event     |
| 52           | PWM0           | PWM 0 Event                 |
| 53           | PWM1           | PWM 1 Event                 |
| 54           | PWM2           | PWM 2 Event                 |
| 55           | PWM3           | PWM 3 Event                 |
| 56 - 63      | Reserved       |                             |

## 4 Device Operating Conditions

### 4.1 Absolute Maximum Ratings Over Operating Case Temperature Range (Unless Otherwise Noted) <sup>(1)</sup> <sup>(2)</sup>

|                                                  |                                                |                  |
|--------------------------------------------------|------------------------------------------------|------------------|
| Supply voltage ranges                            | All 1.3 V supplies                             | -0.5 V to 1.7 V  |
|                                                  | All digital 1.8 V supplies                     | -0.5 V to 2.5 V  |
|                                                  | All analog 1.8 V supplies                      | -0.5 V to 1.89 V |
|                                                  | All 3.3 V supplies                             | -0.5 V to 4.4 V  |
| Input voltage ranges                             | All 1.8 V I/Os                                 | -0.5 V to 2.3 V  |
|                                                  | All 3.3 V I/Os                                 | -0.5 V to 3.8 V  |
|                                                  | VBUS                                           | 0.0 V to 5.5 V   |
| Clamp current for input or output <sup>(3)</sup> | $I_{\text{clamp}}$                             | -20 mA to 20 mA  |
| Operating case temperature ranges                | Commercial $T_c$                               | 0°C to 85 °C     |
|                                                  | Extended Temperature [A135/A216 devices] $T_c$ | -40°C to 100°C   |
| Storage temperature ranges                       | $T_{\text{stg}}$                               | -65°C to 150 °C  |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to  $V_{SS}$ .
- (3) Clamp current flows from an input or output pad to a supply rail through a clamp circuit or an intrinsic diode. Positive current results from an applied input or output voltage that is more than 0.5 V higher (more positive) than the supply voltage,  $V_{DD}/V_{DDA\_PLL1/2}/V_{DD\_USB}/V_{DD\_DDR}$  for dual-supply macros. Negative current results from an applied voltage that is more than 0.5 V less (more negative) than the  $V_{SS}$  voltage..

## 4.2 Recommended Operating Conditions

|                             | NAME                       | DESCRIPTION                                                                                         | MIN                          | NOM  | MAX                        | UNIT |
|-----------------------------|----------------------------|-----------------------------------------------------------------------------------------------------|------------------------------|------|----------------------------|------|
| Supply Voltage              | CV <sub>DD</sub>           | Supply voltage, Core                                                                                | 1.235                        | 1.3  | 1.365                      | V    |
|                             | V <sub>DDA_PLL1</sub>      | Supply voltage, PLL1                                                                                | 1.235                        | 1.3  | 1.365                      | V    |
|                             | V <sub>DDA_PLL2</sub>      | Supply voltage, PLL2                                                                                | 1.235                        | 1.3  | 1.365                      | V    |
|                             | V <sub>DDD13_USB</sub>     | Supply voltage, USB Digital                                                                         | 1.235                        | 1.3  | 1.365                      | V    |
|                             | V <sub>DDA13_USB</sub>     | Supply voltage, USB Analog                                                                          | 1.235                        | 1.3  | 1.365                      | V    |
|                             | V <sub>DDA33_USB</sub>     | Supply voltage, USB Analog                                                                          | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>DDA33_USB_PLL</sub> | Supply voltage, USB Common PLL                                                                      | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>DD_DDR</sub>        | Supply voltage, DDR2 / MDDR                                                                         | 1.71                         | 1.8  | 1.89                       | V    |
|                             | V <sub>DDA33_DDRDLL</sub>  | Supply voltage, DDR DLL Analog                                                                      | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>DD_VIN</sub>        | Supply voltage, Digital video In                                                                    | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>DD_VOUT</sub>       | Supply voltage, Digital Video Out                                                                   | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>DDA18_DAC</sub>     | Supply voltage, DAC Analog                                                                          | 1.71                         | 1.8  | 1.89                       | V    |
|                             | V <sub>DD</sub>            | Supply voltage, I/Os                                                                                | 3.135                        | 3.3  | 3.465                      | V    |
|                             | V <sub>SS</sub>            | Supply ground, Core, USB Digital                                                                    | 0                            | 0    | 0                          | V    |
| Supply Ground               | V <sub>SSA_PLL1</sub>      | Supply ground, PLL1                                                                                 | 0                            | 0    | 0                          | V    |
|                             | V <sub>SSA_PLL2</sub>      | Supply ground, PLL2                                                                                 | 0                            | 0    | 0                          | V    |
|                             | V <sub>SS_USB</sub>        | Supply ground, USB                                                                                  | 0                            | 0    | 0                          | V    |
|                             | V <sub>SSA_DLL</sub>       | Supply ground, DLL                                                                                  | 0                            | 0    | 0                          | V    |
|                             | V <sub>SSA_DAC</sub>       | Supply ground, DAC Analog                                                                           | 0                            | 0    | 0                          | V    |
|                             | V <sub>SS_MX1</sub>        | MX11 osc ground <sup>(1)</sup>                                                                      | 0                            | 0    | 0                          | V    |
|                             | V <sub>SS_MX2</sub>        | MX12 osc ground <sup>(1)</sup>                                                                      | 0                            | 0    | 0                          | V    |
| Voltage Input High          | V <sub>IH</sub>            | High-level input voltage <sup>(2)</sup>                                                             | 2                            |      |                            | V    |
| Voltage Input Low           | V <sub>IL</sub>            | Low-level input voltage <sup>(2)</sup>                                                              |                              |      | 0.8                        | V    |
| DAC <sup>(3)</sup>          | V <sub>REF</sub>           | DAC reference voltage                                                                               |                              | 450  |                            | mV   |
|                             | R <sub>BIAS</sub>          | DAC full-scale current adjust resistor                                                              |                              | 2550 |                            | Ω    |
|                             | R <sub>LOAD</sub>          | Output resistor                                                                                     |                              | 499  |                            | Ω    |
|                             | C <sub>BG</sub>            | Bypass capacitor                                                                                    |                              | 0.1  |                            | μF   |
| Video Buffer <sup>(3)</sup> | R <sub>OUT</sub>           | Output resistor (ROUT), between TVOUT and VFB pins                                                  |                              | 1070 |                            | Ω    |
|                             | R <sub>Fb</sub>            | Feedback resistor, between VFB and IOUT pins.                                                       |                              | 1000 |                            | Ω    |
|                             | R <sub>BIAS</sub>          | DAC full-scale current adjust resistor                                                              |                              | 2550 |                            | Ω    |
|                             | C <sub>BG</sub>            | Bypass capacitor                                                                                    |                              | 0.1  |                            | μA   |
| USB                         | USB_VBUS                   | USB external charge pump input                                                                      | 4.85                         | 5    | 5.25                       | V    |
|                             | R1                         | USB reference resistor <sup>(4)</sup>                                                               | 9.9                          | 10   | 10.1                       | kΩ   |
| Temperature                 | T <sub>c</sub>             | Operating case temperature range                                                                    | Commercial                   | 0    | 85                         | °C   |
|                             |                            |                                                                                                     | Extended [A135/A216 devices] | -40  | 100                        | °C   |
| Transition Time             | t <sub>t</sub>             | Transition time, 10% - 90%, All Inputs (unless otherwise specified in the electrical data sections) |                              |      | 0.25P or 10 <sup>(5)</sup> | ns   |

(1) Oscillator ground must be kept separate from other grounds and connected directly to the crystal load capacitor ground (see [Section 5.5.1](#)).

(2) These I/O specifications apply to regular 3.3 V I/Os and do not apply to DDR2/mDDR, USB I/Os. DDR2/mDDR I/Os are 1.8 V I/Os and adhere to JESD79-2A standard, USB I/Os adhere to USB2.0 spec.

(3) See [Section 5.9.2.4](#). Also, resistors should be E-96 spec line (3 digits with 1% accuracy).

(4) Connect USB\_R1 to V<sub>SS\_USB\_REF</sub> via 10K ohm, 1% resistor placed as close to the device as possible.

(5) Whichever is smaller. P = the period of the applied signal. Maintaining transition times as fast as possible is recommended to improve noise immunity on input signals.

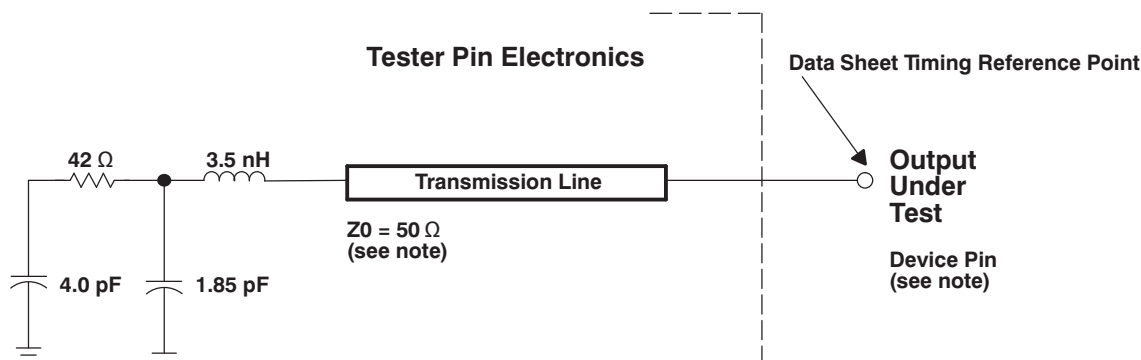
### 4.3 Electrical Characteristics Over Recommended Ranges of Supply Voltage and Operating Case Temperature (Unless Otherwise Noted)

| PARAMETER            |                          |                                                                      | TEST CONDITIONS <sup>(1)</sup>                                               | MIN  | TYP   | MAX   | UNIT |
|----------------------|--------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------|------|-------|-------|------|
| Voltage Output       | V <sub>OH</sub>          | High-level output voltage <sup>(2)</sup>                             | V <sub>DD</sub> =MIN, I <sub>OH</sub> =MAX                                   | 2.4  |       |       | V    |
|                      | V <sub>OL</sub>          | Low-level output voltage <sup>(2)</sup>                              | V <sub>DD</sub> =MIN, I <sub>OL</sub> =MAX                                   |      |       | 0.6   |      |
| Current Input/Output | I <sub>I</sub>           | Input current for I/O without internal pull-up/pull-down             | V <sub>I</sub> = V <sub>SS</sub> to V <sub>DD</sub>                          | -1   |       | 1     | μA   |
|                      | I <sub>I(pullup)</sub>   | Input current for I/O with internal pull-up <sup>(3) (4)</sup>       | V <sub>I</sub> = V <sub>SS</sub> to V <sub>DD</sub>                          | 40   |       | 190   |      |
|                      | I <sub>I(pulldown)</sub> | Input current for I/O with internal pull-down <sup>(3) (4)</sup>     | V <sub>I</sub> = V <sub>SS</sub> to V <sub>DD</sub>                          | -190 |       | -40   |      |
|                      | I <sub>OH</sub>          | Current sink of high-level output                                    | V <sub>OH</sub> = 2.4 V                                                      |      |       | -4000 |      |
|                      | I <sub>OL</sub>          | Current sink of low-level output                                     | V <sub>OL</sub> = 0.6 V                                                      |      |       | 4000  |      |
|                      | I <sub>OZ</sub>          | I/O off-state output current                                         | V <sub>O</sub> = V <sub>DD</sub> or V <sub>SS</sub> ; internal pull disabled |      |       | ±20   |      |
|                      |                          |                                                                      | V <sub>O</sub> = V <sub>DD</sub> or V <sub>SS</sub> ; internal pull enabled  |      | ±100  |       |      |
| Capacitance          | C <sub>I</sub>           | Input capacitance                                                    |                                                                              |      |       | 4     | pF   |
|                      | C <sub>O</sub>           | Output capacitance                                                   |                                                                              |      |       | 4     |      |
| DAC                  | Resolution               | Resolution                                                           |                                                                              |      | 10    |       | Bits |
|                      | INL                      | Integral non-linearity, best fit                                     | R <sub>LOAD</sub> = 499 Ω, Video buffer disabled                             |      | 1     |       | LSB  |
|                      | DNL                      | Differential non-linearity                                           | R <sub>LOAD</sub> = 499 Ω, Video buffer disabled                             |      | 0.5   |       | LSB  |
|                      | Compliance               | Output compliance range                                              | IFS = 1.4 mA, R <sub>LOAD</sub> = 499 Ω                                      | 0    |       | 0.700 | V    |
| Video Buffer         | V <sub>OH(VIDBUF)</sub>  | Output high voltage (top of 75% NTSC or PAL colorbar) <sup>(5)</sup> |                                                                              |      | 1.55  |       | V    |
|                      | V <sub>OL(VIDBUF)</sub>  | Output low voltage (bottom of sync tip)                              |                                                                              |      | 0.470 |       |      |

- (1) For test conditions shown as MIN, MAX, or NOM, use the appropriate value specified in the recommended operating conditions table.
- (2) These I/O specifications apply to regular 3.3 V I/Os and do not apply to DDR2/mDDR, USB I/Os. DDR2/mDDR I/Os are 1.8 V I/Os and adhere to JESD79-2A standard, USB I/Os adhere to USB2.0 spec.
- (3) This specification applies only to pins with an internal pullup (PU) or pulldown (PD). See [Section 2.4](#) or [Section 2.20](#) for pin descriptions.
- (4) To pull up a signal to the opposite supply rail, a 1 kΩ resistor is recommended.
- (5) 100% color bars are not supported. 100% color bars require 1.2 V peak-to-peak. The video buffer only provides 1.0 V peak-to-peak.

## 5 DM335 Peripheral Information and Electrical Specifications

### 5.1 Parameter Information Device-Specific Information



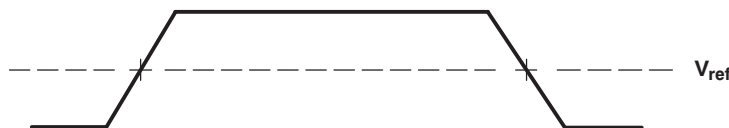
- A. The data sheet provides timing at the device pin. For output timing analysis, the tester pin electronics and its transmission line effects must be taken into account. A transmission line with a delay of 2 ns or longer can be used to produce the desired transmission line effect. The transmission line is intended as a load only. It is not necessary to add or subtract the transmission line delay (2 ns or longer) from the data sheet timings. Input requirements in this data sheet are tested with an input slew rate of < 4 Volts per nanosecond (4 V/ns) at the device pin.

**Figure 5-1. Test Load Circuit for AC Timing Measurements**

The load capacitance value stated is only for characterization and measurement of AC timing signals. This load capacitance value does not indicate the maximum load the device is capable of driving.

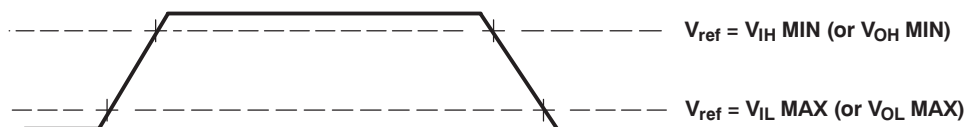
#### 5.1.1 Signal Transition Levels

All input and output timing parameters are referenced to  $V_{ref}$  for both "0" and "1" logic levels. For 3.3 V I/O,  $V_{ref} = 1.65$  V. For 1.8 V I/O,  $V_{ref} = 0.9$  V.



**Figure 5-2. Input and Output Voltage Reference Levels for AC Timing Measurements**

All rise and fall transition timing parameters are referenced to  $V_{IL}$  MAX and  $V_{IH}$  MIN for input clocks,  $V_{OL}$  MAX and  $V_{OH}$  MIN for output clocks.



**Figure 5-3. Rise and Fall Transition Time Voltage Reference Levels**

#### 5.1.2 Timing Parameters and Board Routing Analysis

The timing parameter values specified in this data sheet do *not* include delays by board routings. As a good board design practice, such delays must *always* be taken into account. Timing values may be adjusted by increasing/decreasing such delays. TI recommends utilizing the available I/O buffer information specification (IBIS) models to analyze the timing characteristics correctly. To properly use IBIS models to attain accurate timing analysis for a given system, see the *Using IBIS Models for Timing Analysis* application report (literature number SPRA839). If needed, external logic hardware such as buffers may be used to compensate any timing differences.

## 5.2 Recommended Clock and Control Signal Transition Behavior

All clocks and control signals should transition between  $V_{IH}$  and  $V_{IL}$  (or between  $V_{IL}$  and  $V_{IH}$ ) in a monotonic manner.

## 5.3 Power Supplies

The power supplies of DM335 are summarized in [Table 5-1](#).

**Table 5-1. Power Supplies**

| Customer Board Supply | Tolerance | Package Plane        | Chip Plane Name       | Description                               | Comments                                         |
|-----------------------|-----------|----------------------|-----------------------|-------------------------------------------|--------------------------------------------------|
| 1.3 V                 | ±5%       | 1.3 V                | $CV_{DD}$             | Core $V_{DD}$                             |                                                  |
|                       |           |                      | $V_{DDA\_PLL1}$       | PLL1 $V_{DDA}$                            |                                                  |
|                       |           |                      | $V_{DDA\_PLL2}$       | PLL2 $V_{DDA}$                            |                                                  |
|                       |           |                      | $V_{DDD13\_USB}$      | USB 1.3 V supply                          |                                                  |
|                       |           |                      | $V_{DDA13\_USB}$      | USB 1.3 V supply                          |                                                  |
| 3.3 V                 | ±5%       | 3.3 V                | $V_{DD}$              | IO $V_{DD}$ for LVCMOS                    | $V_{DDSHV}$                                      |
|                       |           |                      | $V_{DD}$              | IO $V_{DD}$ for MXI/O1                    | $V_{DDSHV}$                                      |
|                       |           |                      | $V_{DD}$              | IO $V_{DD}$ for MXI/O2                    | $V_{DDSHV1}$                                     |
|                       |           |                      | $V_{DD}$              | IO $V_{DD}$ for ISB DRVVBUS               | $V_{DDSHV2}$                                     |
|                       |           |                      | $V_{DDA33\_DDRDL1}$   | DDR DLL analog $V_{DD}$                   |                                                  |
|                       |           |                      | $V_{DDA33\_USB}$      | Analog 3.3 V power USB PHY                |                                                  |
|                       |           |                      | $V_{DDA33\_USB\_PLL}$ | Common mode 3.3 V power for USB PHY (PLL) |                                                  |
| 3.3 V                 | ±5%       | 3.3 V                | $V_{DD}$              | IO $V_{DD}$ for peripherals               |                                                  |
|                       |           |                      | $V_{DD\_VIN}$         | IO $V_{DD}$ for VideoIN I/F               |                                                  |
|                       |           |                      | $V_{DD\_VOUT}$        | IO $V_{DD}$ for VideoOUT I/F              |                                                  |
| 1.8 V                 | ±5%       | 1.8 V                | $V_{DD\_DDR}$         |                                           |                                                  |
| 1.8 V                 | ±5%       | 1.8 V                | $V_{DDA18}$           |                                           | Analog 1.8 V power                               |
| 1.8 V                 | ±5%       | 1.8 V                | $V_{DDA18\_DAC}$      |                                           | Place decoupling caps (0.1μF/10μf) close to chip |
| 0 V                   | n/a       | 0 V                  | $V_{SS\_MX1}$         |                                           | Connect to external crystal capacitor ground     |
| 0 V                   | n/a       | 0 V                  | $V_{SS\_MX2}$         |                                           | Connect to external crystal capacitor ground     |
| 0 V                   | n/a       | 0 V                  | $V_{SS}$              | Chip ground                               |                                                  |
|                       |           |                      |                       | USB ESD ground                            |                                                  |
|                       |           |                      |                       | ground                                    | $V_{SS}$                                         |
| 0 V                   | n/a       | 0 V                  | $V_{SSA}$             | ground                                    | Keep separate from digital ground $V_{SS}$       |
| 0 V                   | n/a       | 0 V                  | $V_{SSA\_PLL1}$       | PLL1 $V_{SSA}$                            |                                                  |
| 0 V                   | n/a       | 0 V                  | $V_{SSA\_PLL2}$       | PLL2 $V_{SSA}$                            |                                                  |
| 0 V                   | n/a       | 0 V                  | $V_{SSA\_DLL}$        | DLL ground                                |                                                  |
| 0 V                   | n/a       | 0 V                  | $V_{SS\_USB}$         | USB ground                                | $V_{SSA13\_USB}$                                 |
|                       |           |                      |                       |                                           | $V_{SSA13\_USB}$                                 |
|                       |           |                      |                       |                                           | $V_{SSA33\_USB}$                                 |
|                       |           |                      |                       |                                           | $V_{SSA33\_USB\_PLL}$                            |
| 0 V                   | n/a       | 0 V                  | $V_{SS\_USB\_REF}$    | USB PHY reference ground                  | $V_{SSREF}$                                      |
| 0 V                   | n/a       | 0 V                  | $V_{SSA\_DAC}$        | DAC ground                                | Keep separate from digital ground $V_{SS}$       |
| $V_{DDS} \times 0.5$  |           | $V_{DDS} \times 0.5$ | $V_{REFSSTL}$         | DRR ref voltage                           | $V_{DDS}$ divided by 2, through board resistors  |
| 5 V                   |           | 5 V                  | $USB\_VBUS$           | VBUS                                      | Connect to external charge pump                  |

### 5.3.1 Power-Supply Sequencing

In order to ensure device reliability, the DM335 requires the following power supply power-on and power-off sequences. See table [Table 5-1](#) for a description of DM335 power supplies.

Power-On:

1. Power on 1.3 V:  $CV_{DD}$ ,  $V_{DDA\_PLL1/2}$ ,  $V_{DDD13\_USB}$ ,  $V_{DDA13\_USB}$
2. Power on 1.8 V:  $V_{DD\_DDR}$ ,  $V_{DDA18\_DAC}$
3. Power on 3.3 V:  $D_{VDD}$ ,  $V_{DDA33\_DDRLL}$ ,  $V_{DDA33\_USB}$ ,  $V_{DDA33\_USB\_PLL}$ ,  $V_{DD\_VIN}$ ,  $V_{DD\_VOUT}$

You may power-on the 1.8 V and 3.3 V power supplies simultaneously.

Power-Off:

1. Power off 3.3 V:  $D_{VDD}$ ,  $V_{DDA33\_DDRLL}$ ,  $V_{DDA33\_USB}$ ,  $V_{DDA33\_USB\_PLL}$ ,  $V_{DD\_VIN}$ ,  $V_{DD\_VOUT}$
2. Power off 1.8 V:  $V_{DD\_DDR}$ ,  $V_{DDA18\_DAC}$
3. Power off 1.3 V:  $CV_{DD}$ ,  $V_{DDA\_PLL1/2}$ ,  $V_{DDD13\_USB}$ ,  $V_{DDA13\_USB}$

You may power-off the 1.8 V and 3.3 V power supplies simultaneously.

Power-off the 1.8V/3.3V supply before or within 10μsec of power-off of the 1.3 V supply.

Note that when booting the DM335 from OneNAND, you must ensure that the OneNAND device is ready with valid program instructions before the DM335 attempts to read program instructions from it. In particular, before you release DM335 reset, you must allow time for OneNAND device power to stabilize and for the OneNAND device to complete its internal copy routine. During the internal copy routine, the OneNAND device copies boot code from its internal non-volatile memory to its internal boot memory section. Board designers typically achieve this requirement by design of the system power and reset supervisor circuit. Refer to your OneNAND device datasheet for OneNAND power ramp and stabilization times and for OneNAND boot copy times.

#### 5.3.1.1 Power-Supply Design Considerations

Core and I/O supply voltage regulators should be located close to the DM335 to minimize inductance and resistance in the power delivery path. Additionally, when designing for high-performance applications utilizing the DM335 device, the PC board should include separate power planes for core, I/O, and ground, all bypassed with high-quality low-ESL/ESR capacitors.

#### 5.3.1.2 Power-Supply Decoupling

In order to properly decouple the supply planes from system noise, place as many capacitors (caps) as possible close to DM335. These caps need to be close to the DM335 power pins, no more than 1.25 cm maximum distance to be effective. Physically smaller caps, such as 0402, are better because of their lower parasitic inductance. Proper capacitance values are also important. Small bypass caps (near 560 pF) should be closest to the power pins. Medium bypass caps (220 nF or as large as can be obtained in a small package) should be next closest. TI recommends no less than 8 small and 8 medium caps per supply be placed immediately next to the BGA vias, using the "interior" BGA space and at least the corners of the "exterior".

Larger caps for each supply can be placed further away for bulk decoupling. Large bulk caps (on the order of 100 μF) should be furthest away, but still as close as possible. Large caps for each supply should be placed outside of the BGA footprint.

Any cap selection needs to be evaluated from a yield/manufacturing point-of-view. As with the selection of any component, verification of capacitor availability over the product's production lifetime should be considered. See also [Section 5.5.1](#) and [Section 5.5.2](#) for additional recommendations on power supplies for the oscillator/PLL supplies.

## 5.4 Reset

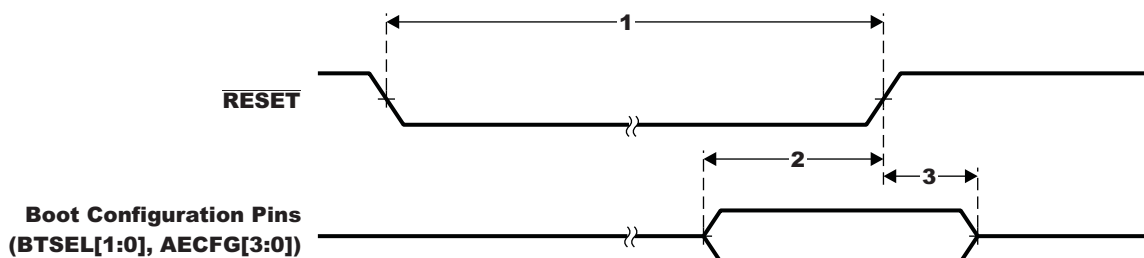
### 5.4.1 Reset Electrical Data/Timing

**Table 5-2. Timing Requirements for Reset** <sup>(1)</sup> <sup>(2)</sup> (see [Figure 5-4](#))

| NO. | PARAMETER                                                                                                 | DM335 |     | UNIT |
|-----|-----------------------------------------------------------------------------------------------------------|-------|-----|------|
|     |                                                                                                           | MIN   | MAX |      |
| 1   | $t_{w(RES\overline{ET})}$ Active low width of the $\overline{RES\overline{ET}}$ pulse                     | 12C   |     | ns   |
| 2   | $t_{su(BOOT)}$ Setup time, boot configuration pins valid before $\overline{RES\overline{ET}}$ rising edge | 12C   |     | ns   |
| 3   | $t_{h(BOOT)}$ Hold time, boot configuration pins valid after $\overline{RES\overline{ET}}$ rising edge    | 12C   |     | ns   |

(1) BTSEL[1:0] and AECFG[4:0] are the boot configuration pins during device reset.

(2) C = MXI/CLKIN cycle time in ns. For example, when MXI/CLKIN frequency is 24 MHz use C = 41.6 ns.



**Figure 5-4. Reset Timing**

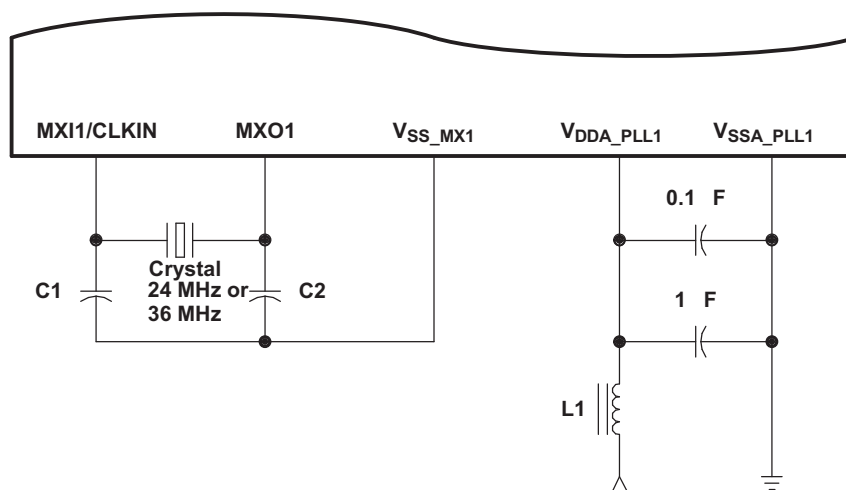
## 5.5 Oscillators and Clocks

DM335 has two oscillator input/output pairs (MXI1/MXO1 and MXI2/MXO2) usable with external crystals or ceramic resonators to provide clock inputs. The optimal frequencies for the crystals are 24 MHz (MXI1/MXO1) and 27 MHz (MXI2/MXO2). Optionally, the oscillator inputs are configurable for use with external clock oscillators. If external clock oscillators are used, to minimize the clock jitter, a single clean power supply should power both the DM335 and the external oscillator circuit and the minimum CLKIN rise and fall times must be observed. The electrical requirements and characteristics are described in this section.

The timing parameters for CLKOUT[3:1] are also described in this section. The DM335 has three output clock pins (CLKOUT[3:1]). See [Section 3.5](#) and [Section 3.6](#) for more information on CLKOUT[3:1].

### 5.5.1 MXI1 (24-MHz) Oscillator

The MXI1 (typically 24 MHz, can also be 36 MHz) oscillator provides the primary reference clock for the DM335 device. The on-chip oscillator requires an external crystal connected across the MXI1 and MXO1 pins, along with two load capacitors, as shown in [Figure 5-5](#). The external crystal load capacitors **must** be connected only to the oscillator ground pin ( $V_{SS\_MX1}$ ). **Do not** connect to board ground ( $V_{SS}$ ). Also, the PLL power pin ( $V_{DDA\_PLL1}$ ) should be connected to the power supply through a ferrite bead, L1 in the example circuit shown in [Figure 5-5](#).



**Figure 5-5. MXI1 (24-MHz) Oscillator**

The load capacitors, C1 and C2, should be chosen such that the equation is satisfied (typical values are  $C_1 = C_2 = 10$  pF).  $C_L$  in the equation is the load specified by the crystal manufacturer. All discrete components used to implement the oscillator circuit should be placed as close as possible to the associated oscillator pins (MXI1 and MXO1) and to the  $V_{SS\_MX1}$  pin.

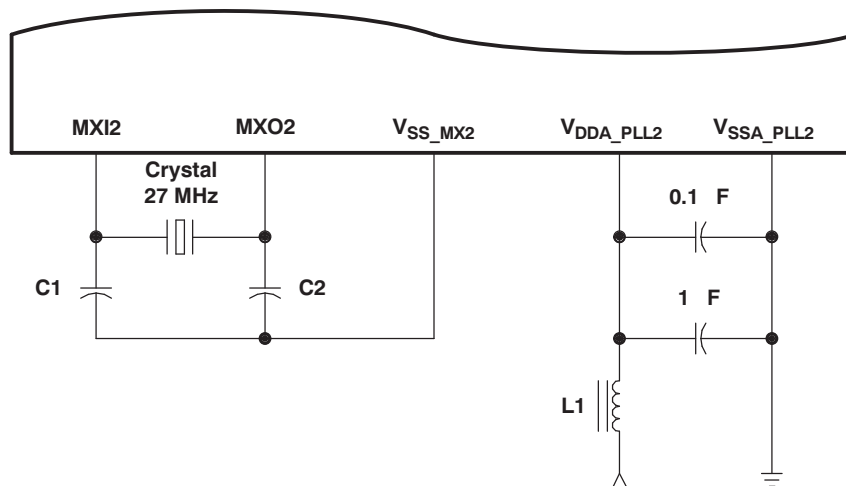
$$C_L = \frac{C_1 C_2}{(C_1 + C_2)}$$

**Table 5-3. Switching Characteristics Over Recommended Operating Conditions for 24-MHz System Oscillator**

| PARAMETER                                                           | MIN | TYP      | MAX   | UNIT |
|---------------------------------------------------------------------|-----|----------|-------|------|
| Start-up time (from power up until oscillating at stable frequency) |     |          | 4     | ms   |
| Oscillation frequency                                               |     | 24 or 36 |       | MHz  |
| ESR                                                                 |     |          | 60    | Ω    |
| Frequency stability                                                 |     |          | +/-50 | ppm  |

### 5.5.2 MXI2 (27-MHz) Oscillator (optional oscillator)

The MXI2 (27 MHz) oscillator provides an optional reference clock for the DM335's VPSS module. The on-chip oscillator requires an external 27-MHz crystal connected across the MXI2 and MXO2 pins, along with two load capacitors, as shown in Figure 5-6. The external crystal load capacitors **must** be connected only to the 27-MHz oscillator ground pin (V<sub>SS\_MX2</sub>). **Do not** connect to board ground (V<sub>SS</sub>). Also, the PLL power pin (V<sub>DDA\_PLL2</sub>) should be connected to the power supply through a ferrite bead, L1 in the example circuit shown in Figure 5-6.


**Figure 5-6. MXI2 (27-MHz) System Oscillator**

The load capacitors, C1 and C2, should be chosen such that the equation is satisfied (typical values are C1 = C2 = 10 pF). CL in the equation is the load specified by the crystal manufacturer. All discrete components used to implement the oscillator circuit should be placed as close as possible to the associated oscillator pins (MXI and MXO) and to the V<sub>SS\_MX2</sub> pin.

$$C_L = \frac{C_1 C_2}{(C_1 + C_2)}$$

**Table 5-4. Switching Characteristics Over Recommended Operating Conditions for 27-MHz System Oscillator**

| PARAMETER                                                           | MIN | TYP | MAX   | UNIT |
|---------------------------------------------------------------------|-----|-----|-------|------|
| Start-up time (from power up until oscillating at stable frequency) |     |     | 4     | ms   |
| Oscillation frequency                                               |     | 27  |       | MHz  |
| ESR                                                                 |     |     | 60    | Ω    |
| Frequency stability                                                 |     |     | +/-50 | ppm  |

### 5.5.3 Clock PLL Electrical Data/Timing (Input and Output Clocks)

**Table 5-5. Timing Requirements for MXI1/CLKIN1<sup>(1) (2)</sup> (see Figure 5-7)**

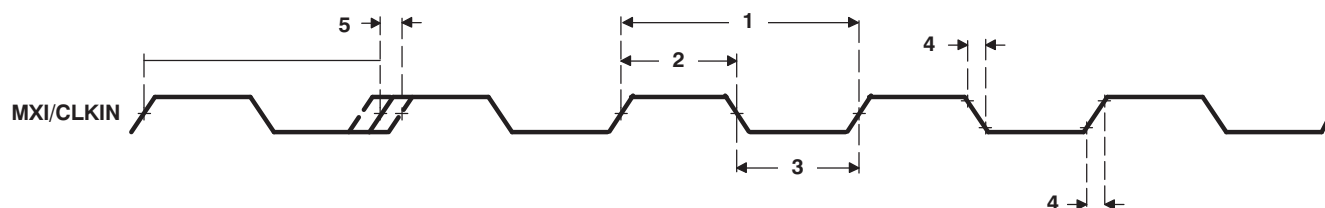
| NO. | PARAMETER                                       | DM335               |     |                            | UNIT |
|-----|-------------------------------------------------|---------------------|-----|----------------------------|------|
|     |                                                 | MIN                 | TYP | MAX                        |      |
| 1   | $t_{c(MXI1)}$ Cycle time, MXI1/CLKIN1           | 27.7 <sup>(3)</sup> |     | 41.6 <sup>(3)</sup>        | ns   |
| 2   | $t_{w(MXI1H)}$ Pulse duration, MXI1/CLKIN1 high | 0.45C               |     | 0.55C                      | ns   |
| 3   | $t_{w(MXI1L)}$ Pulse duration, MXI1/CLKIN1 low  | 0.45C               |     | 0.55C                      | ns   |
| 4   | $t_{t(MXI1)}$ Transition time, MXI1/CLKIN1      |                     |     | 0.25C or 10 <sup>(4)</sup> | ns   |
| 5   | $t_{j(MXI1)}$ Period jitter, MXI1/CLKIN1        |                     |     | 0.02C                      | ns   |

(1) The reference points for the rise and fall transitions are measured at  $V_{IL}$  MAX and  $V_{IH}$  MIN.

(2) C = MXI1/CLKIN1 cycle time in ns. For example, when MXI1/CLKIN1 frequency is 24 MHz use C = 41.6 ns.

(3)  $t_{c(MXI1)} = 41.6$  ns and  $t_{c(MXI1)} = 27.7$  ns are the only supported cycle times for MXI1/CLKIN1.

(4) Whichever is smaller. C = the period of the applied signal. Maintaining transition times as fast as possible is recommended to improve noise immunity on input signals.



**Figure 5-7. MXI1/CLKIN1 Timing**

**Table 5-6. Timing Requirements for MXI2/CLKIN2<sup>(1) (2)</sup> (see Figure 5-7)**

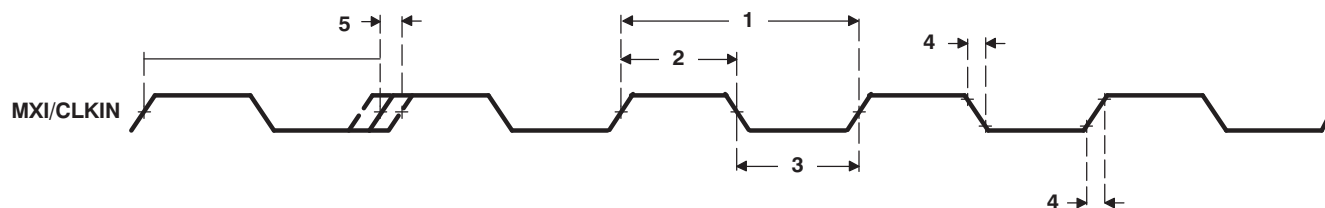
| NO. | PARAMETER                                       | DM335                 |     |                            | UNIT |
|-----|-------------------------------------------------|-----------------------|-----|----------------------------|------|
|     |                                                 | MIN                   | TYP | MAX                        |      |
| 1   | $t_{c(MXI2)}$ Cycle time, MXI2/CLKIN2           | 37.037 <sup>(3)</sup> |     | 37.037 <sup>(3)</sup>      | ns   |
| 2   | $t_{w(MXI2H)}$ Pulse duration, MXI2/CLKIN2 high | 0.45C                 |     | 0.55C                      | ns   |
| 3   | $t_{w(MXI2L)}$ Pulse duration, MXI2/CLKIN2 low  | 0.45C                 |     | 0.55C                      | ns   |
| 4   | $t_{t(MXI2)}$ Transition time, MXI2/CLKIN2      |                       |     | 0.25C or 10 <sup>(4)</sup> | ns   |
| 5   | $t_{j(MXI2)}$ Period jitter, MXI2/CLKIN2        |                       |     | 0.02C                      | ns   |

(1) The reference points for the rise and fall transitions are measured at  $V_{IL}$  MAX and  $V_{IH}$  MIN.

(2) C = MXI2/CLKIN2 cycle time in ns. For example, when MXI2/CLKIN2 frequency is 27 MHz use C = 37.037 ns.

(3)  $t_{c(MXI2)} = 37.037$  ns is the only supported cycle time for MXI2/CLKIN2.

(4) Whichever is smaller. C = the period of the applied signal. Maintaining transition times as fast as possible is recommended to improve noise immunity on input signals.



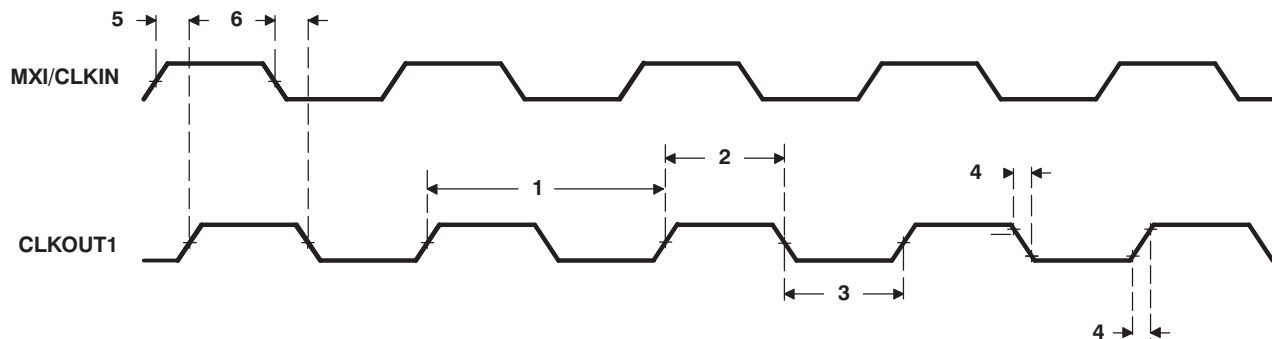
**Figure 5-8. MXI2/CLKIN2 Timing**

**Table 5-7. Switching Characteristics Over Recommended Operating Conditions for CLKOUT1<sup>(1)</sup> <sup>(2)</sup> (see Figure 5-9)**

| NO. | PARAMETER                                                                   | DM335                |     |       | UNIT |
|-----|-----------------------------------------------------------------------------|----------------------|-----|-------|------|
|     |                                                                             | MIN                  | TYP | MAX   |      |
| 1   | $t_{C}(\text{CLKOUT1})$ Cycle time, CLKOUT1                                 | $t_{C}(\text{MXI1})$ |     |       | ns   |
| 2   | $t_{W}(\text{CLKOUT1H})$ Pulse duration, CLKOUT1 high                       | 0.45P                |     | 0.55P | ns   |
| 3   | $t_{W}(\text{CLKOUT1L})$ Pulse duration, CLKOUT1 low                        | 0.45P                |     | 0.55P | ns   |
| 4   | $t_{I}(\text{CLKOUT1})$ Transition time, CLKOUT1                            |                      |     | 0.05P | ns   |
| 5   | $t_{d}(\text{MXI1H-CLKOUT1H})$ Delay time, MXI1/CLKIN1 high to CLKOUT1 high | 1                    |     | 8     | ns   |
| 6   | $t_{d}(\text{MXI1L-CLKOUT1L})$ Delay time, MXI1/CLKIN1 low to CLKOUT1 low   | 1                    |     | 8     | ns   |

(1) The reference points for the rise and fall transitions are measured at  $V_{OL\ MAX}$  and  $V_{OH\ MIN}$ .

(2)  $P = 1/\text{CLKOUT1}$  clock frequency in nanoseconds (ns). For example, when CLKOUT1 frequency is 24 MHz use  $P = 41.6\ \text{ns}$ .



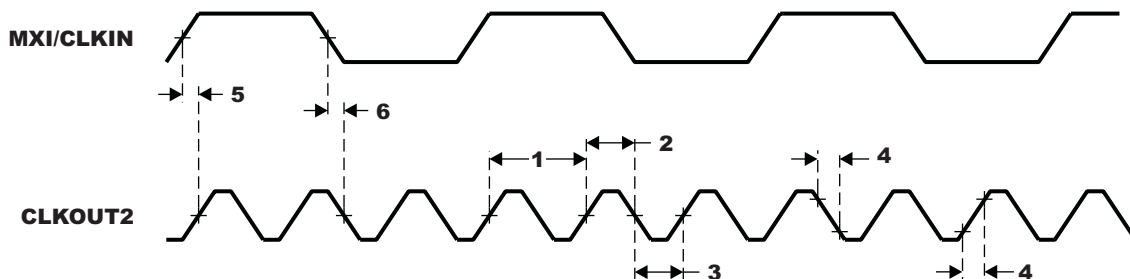
**Figure 5-9. CLKOUT1 Timing**

**Table 5-8. Switching Characteristics Over Recommended Operating Conditions for CLKOUT2<sup>(1)</sup> <sup>(2)</sup> (see Figure 5-10)**

| NO. | PARAMETER                                                                   | DM335                    |     |       | UNIT |
|-----|-----------------------------------------------------------------------------|--------------------------|-----|-------|------|
|     |                                                                             | MIN                      | TYP | MAX   |      |
| 1   | $t_{C}(\text{CLKOUT2})$ Cycle time, CLKOUT2                                 | $t_{C}(\text{MXI1}) / 3$ |     |       |      |
| 2   | $t_{W}(\text{CLKOUT2H})$ Pulse duration, CLKOUT2 high                       | 0.45P                    |     | 0.55P | ns   |
| 3   | $t_{W}(\text{CLKOUT2L})$ Pulse duration, CLKOUT2 low                        | 0.45P                    |     | 0.55P | ns   |
| 4   | $t_{I}(\text{CLKOUT2})$ Transition time, CLKOUT2                            |                          |     | 0.05P | ns   |
| 5   | $t_{d}(\text{MXI1H-CLKOUT2H})$ Delay time, MXI1/CLKIN1 high to CLKOUT2 high | 1                        |     | 8     | ns   |
| 6   | $t_{d}(\text{MXI1L-CLKOUT2L})$ Delay time, MXI1/CLKIN1 low to CLKOUT2 low   | 1                        |     | 8     | ns   |

(1) The reference points for the rise and fall transitions are measured at  $V_{OL\ MAX}$  and  $V_{OH\ MIN}$ .

(2)  $P = 1/\text{CLKOUT2}$  clock frequency in nanoseconds (ns). For example, when CLKOUT2 frequency is 8 MHz use  $P = 125\ \text{ns}$ .



**Figure 5-10. CLKOUT2 Timing**

**Table 5-9. Switching Characteristics Over Recommended Operating Conditions for CLKOUT3<sup>(1)</sup> <sup>(2)</sup> (see**

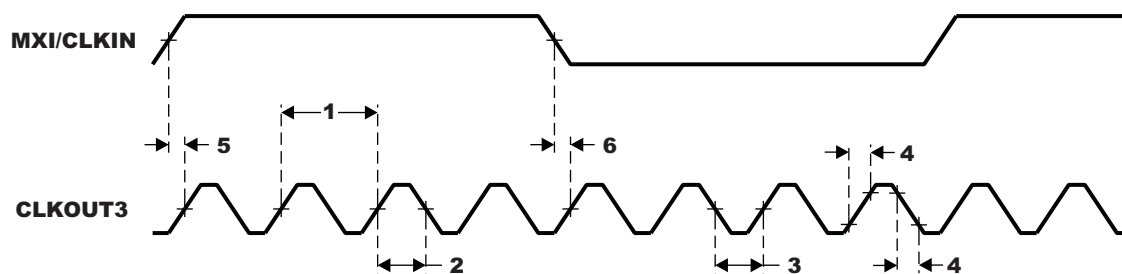
(1) The reference points for the rise and fall transitions are measured at  $V_{OL\ MAX}$  and  $V_{OH\ MIN}$ .

(2)  $P = 1/\text{CLKOUT3}$  clock frequency in nanoseconds (ns). For example, when CLKOUT3 frequency is 3 MHz use  $P = 333.3\ \text{ns}$ .

**Table 5-9. Switching Characteristics Over Recommended Operating Conditions for CLKOUT3 <sup>(1)</sup> <sup>(2)</sup> (see Figure 5-11 ) (continued)**

**Figure 5-11)**

| NO. | PARAMETER                                                                 | DM335                    |     |       | UNIT |
|-----|---------------------------------------------------------------------------|--------------------------|-----|-------|------|
|     |                                                                           | MIN                      | TYP | MAX   |      |
| 1   | $t_{C(\text{CLKOUT3})}$ Cycle time, CLKOUT3                               | $t_{C(\text{MXI1})} / 8$ |     |       |      |
| 2   | $t_{W(\text{CLKOUT3H})}$ Pulse duration, CLKOUT3 high                     | 0.45P                    |     | 0.55P | ns   |
| 3   | $t_{W(\text{CLKOUT3L})}$ Pulse duration, CLKOUT3 low                      | 0.45P                    |     | 0.55P | ns   |
| 4   | $t_t(\text{CLKOUT3})$ Transition time, CLKOUT3                            |                          |     | 0.05P | ns   |
| 5   | $t_{d(\text{MXI2H-CLKOUT3H})}$ Delay time, CLKIN/MXI high to CLKOUT3 high | 1                        |     | 8     | ns   |
| 6   | $t_{d(\text{MXI2L-CLKOUT3L})}$ Delay time, CLKIN/MXI low to CLKOUT3 low   | 1                        |     | 8     | ns   |



**Figure 5-11. CLKOUT3 Timing**

## 5.6 General-Purpose Input/Output (GPIO)

The GPIO peripheral provides general-purpose pins that can be configured as either inputs or outputs. When configured as an output, a write to an internal register can control the state driven on the output pin. When configured as an input, the state of the input is detectable by reading the state of an internal register. In addition, the GPIO peripheral can produce CPU interrupts and EDMA events in different interrupt/event generation modes. The GPIO peripheral provides generic connections to external devices. The GPIO pins are grouped into banks of 16 pins per bank (i.e., bank 0 consists of GPIO [0:15]). There are a total of 7 GPIO banks in the DM335, because the DM335 has 104 GPIOs.

The DM335 GPIO peripheral supports the following:

- Up to 104 3.3v GPIO pins, GPIO[103:0]
- Interrupts:
  - Up to 10 unique GPIO[9:0] interrupts from Bank 0
  - Up to 7 GPIO (bank aggregated) interrupt signals, one from each of the 7 banks of GPIOs
  - Interrupts can be triggered by rising and/or falling edge, specified for each interrupt capable GPIO signal
- DMA events:
  - Up to 10 unique GPIO DMA events from Bank 0
  - Up to 7 GPIO (bank aggregated) DMA event signals, one from each of the 7 banks of GPIOs
- Set/clear functionality: Firmware writes 1 to corresponding bit position(s) to set or to clear GPIO signal(s). This allows multiple firmware processes to toggle GPIO output signals without critical section protection (disable interrupts, program GPIO, re-enable interrupts, to prevent context switching to another process during GPIO programming).
- Separate Input/Output registers
- Output register in addition to set/clear so that, if preferred by firmware, some GPIO output signals can be toggled by direct write to the output register(s).
- Output register, when read, reflects output drive status. This, in addition to the input register reflecting pin status and open-drain I/O cell, allows wired logic be implemented.

For more detailed information on GPIOs, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) General-Purpose Input/Output (GPIO) Reference Guide* (literature number SPRUFY8).

### 5.6.1 GPIO Peripheral Input/Output Electrical Data/Timing

**Table 5-10. Timing Requirements for GPIO Inputs (see Figure 5-12)**

| NO. | PARAMETER                               | DM335 |     | UNIT |
|-----|-----------------------------------------|-------|-----|------|
|     |                                         | MIN   | MAX |      |
| 1   | $t_{W(GPIH)}$ Pulse duration, GPIx high | 52    |     | ns   |
| 2   | $t_{W(GPIL)}$ Pulse duration, GPIx low  | 52    |     | ns   |

**Table 5-11. Switching Characteristics Over Recommended Operating Conditions for GPIO Outputs (see Figure 5-12)**

| NO. | PARAMETER                               | DM335             |     | UNIT |
|-----|-----------------------------------------|-------------------|-----|------|
|     |                                         | MIN               | MAX |      |
| 3   | $t_{W(GPOH)}$ Pulse duration, GPOx high | 26 <sup>(1)</sup> |     | ns   |
| 4   | $t_{W(GPOL)}$ Pulse duration, GPOx low  | 26 <sup>(1)</sup> |     | ns   |

- (1) This parameter value should not be used as a maximum performance specification. Actual performance of back-to-back accesses of the GPIO is dependent upon internal bus activity.

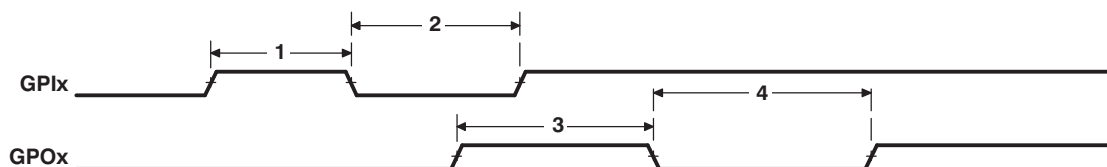


Figure 5-12. GPIO Port Timing

### 5.6.2 GPIO Peripheral External Interrupts Electrical Data/Timing

**Table 5-12. Timing Requirements for External Interrupts/EDMA Events<sup>(1)</sup>** (see [Figure 5-13](#))

| NO. | PARAMETER      |                                            | DM335 |     | UNIT |
|-----|----------------|--------------------------------------------|-------|-----|------|
|     |                |                                            | MIN   | MAX |      |
| 1   | $t_{w(ILOW)}$  | Width of the external interrupt pulse low  | 52    |     | ns   |
| 2   | $t_{w(IHIGH)}$ | Width of the external interrupt pulse high | 52    |     | ns   |

- (1) The pulse width given is sufficient to generate an interrupt or an EDMA event. However, if a user wants to have DM335 to recognize the GPIO changes through software polling of the GPIO register, the GPIO duration must be extended to allow DM335 enough time to access the GPIO register through the internal bus.

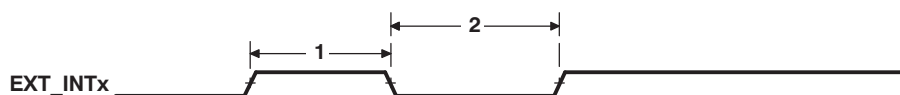


Figure 5-13. GPIO External Interrupt Timing

## **5.7 External Memory Interface (EMIF)**

DM335 supports several memory and external device interfaces, including:

- Asynchronous EMIF (AEMIF) for interfacing to SRAM.
  - OneNAND flash memories
  - NAND flash memories
- DDR2/mDDR Memory Controller for interfacing to SDRAM.

### **5.7.1 Asynchronous EMIF (AEMIF)**

The EMIF supports the following features:

- SRAM, etc. on up to 2 asynchronous chip selects addressable up to 64KB each
- Supports 8-bit or 16-bit data bus widths
- Programmable asynchronous cycle timings
- Supports extended wait mode
- Supports Select Strobe mode

#### **5.7.1.1 NAND (NAND, SmartMedia, xD)**

The NAND features of the EMIF are as follows:

- NAND flash on up to 2 asynchronous chip selects
- 8 and 16-bit data bus widths
- Programmable cycle timings
- Performs 1-bit and 4-bit ECC calculation
- NAND Mode also supports SmartMedia/SSFDC (Solid State Floppy Disk Controller) and xD memory cards

#### **5.7.1.2 OneNAND**

The OneNAND features supported are as follows.

- NAND flash on up to 2 asynchronous chip selects
- Only 16-bit data bus widths
- Supports asynchronous writes and reads
- Supports synchronous reads with continuous linear burst mode (Does not support synchronous reads with wrap burst modes)
- Programmable cycle timings for each chip select in asynchronous mode

### 5.7.1.3 AEMIF Electrical Data/Timing

**Table 5-13. Timing Requirements for Asynchronous Memory Cycles for AEMIF Module<sup>(1)</sup> (see Figure 5-14 and Figure 5-15)**

| NO<br>.                                | PARAMETER                       |                                                                             | DM335 |     |     | UNIT |
|----------------------------------------|---------------------------------|-----------------------------------------------------------------------------|-------|-----|-----|------|
|                                        |                                 |                                                                             | MIN   | Nom | MAX |      |
| READS and WRITES                       |                                 |                                                                             |       |     |     |      |
| 2                                      | $t_{w(EM\_WAIT)}$               | Pulse duration, EM_WAIT assertion and deassertion                           | 2E    |     |     | ns   |
| READS                                  |                                 |                                                                             |       |     |     |      |
| 12                                     | $t_{su(EMDV-EMOE\overline{H})}$ | Setup time, EM_D[15:0] valid before $\overline{EM\_OE}$ high                | 5     |     |     | ns   |
| 13                                     | $t_{h(EMOE\overline{H}-EMDIV)}$ | Hold time, EM_D[15:0] valid after $\overline{EM\_OE}$ high                  | 0     |     |     | ns   |
| 14                                     | $t_{su(EMOEL-EMWAIT)}$          | Setup time EM_WAIT asserted before $\overline{EM\_OE}$ high <sup>(2)</sup>  |       | 4E  |     | ns   |
| READS (OneNAND Synchronous Burst Read) |                                 |                                                                             |       |     |     |      |
| 30                                     | $t_{su(EMDV-EMCLKH)}$           | Setup time, EM_D[15:0] valid before EM_CLK high                             | 4     |     |     | ns   |
| 31                                     | $t_{h(EMCLKH-EMDIV)}$           | Hold time, EM_D[15:0] valid after EM_CLK high                               | 4     |     |     | ns   |
| WRITES                                 |                                 |                                                                             |       |     |     |      |
| 28                                     | $t_{su(EMWEL-EMWAIT)}$          | Setup time, EM_WAIT asserted before $\overline{EM\_WE}$ high <sup>(2)</sup> |       | 4E  |     | ns   |

- (1) E = PLLC1 SYSCLK2 period in ns. SYSCLK2 is the EMIF peripheral clock. SYSCLK2 is one-fourth the PLLC output clock. For example, when PLLC output clock = 432 MHz, E = 9.259 ns. See Section 3.5 for more information.
- (2) Setup before end of STROBE phase (if no extended wait states are inserted) by which EM\_WAIT must be asserted to add extended wait states. Figure 5-16 and Figure 5-17 describe EMIF transactions that include extended wait states inserted during the STROBE phase. However, cycles inserted as part of this extended wait period should not be counted; the 4E requirement is to the start of where the HOLD phase would begin if there were no extended wait cycles.

**Table 5-14. Switching Characteristics Over Recommended Operating Conditions for Asynchronous Memory Cycles for AEMIF Module<sup>(1) (2) (3)</sup> (see Figure 5-14 and Figure 5-15)**

| NO.              | PARAMETER                                                  |                                                                                      | DM335 |                        |     | UNIT |
|------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------|-------|------------------------|-----|------|
|                  |                                                            |                                                                                      | MIN   | Nom                    | MAX |      |
| READS and WRITES |                                                            |                                                                                      |       |                        |     |      |
| 1                | t <sub>d</sub> (TURNAROUND)                                | Turn around time                                                                     |       | (TA)*E                 |     | ns   |
| READS            |                                                            |                                                                                      |       |                        |     |      |
| 3                | t <sub>c</sub> (EMRCYCLE)                                  | EMIF read cycle time (EW = 0)                                                        |       | (RS+RST+RH)*E          |     | ns   |
|                  |                                                            | EMIF read cycle time (EW = 1)                                                        |       | (RS+RST+RH+(EWC*16))*E |     | ns   |
| 4                | t <sub>su</sub> (EMCEL-EMOEL)                              | Output setup time, $\overline{EM\_CE}[1:0]$ low to $\overline{EM\_OE}$ low (SS = 0)  |       | (RS)*E                 |     | ns   |
|                  |                                                            | Output setup time, $\overline{EM\_CE}[1:0]$ low to $\overline{EM\_OE}$ low (SS = 1)  |       | 0                      |     | ns   |
| 5                | t <sub>h</sub> (EMOE $\overline{H}$ -EMCE $\overline{H}$ ) | Output hold time, $\overline{EM\_OE}$ high to $\overline{EM\_CE}[1:0]$ high (SS = 0) |       | (RH)*E                 |     | ns   |
|                  |                                                            | Output hold time, $\overline{EM\_OE}$ high to $\overline{EM\_CE}[1:0]$ high (SS = 1) |       | 0                      |     | ns   |

- (1) TA = Turn around, RS = Read setup, RST = Read strobe, RH = Read hold, WS = Write setup, WST = Write strobe, WH = Write hold, MEWC = Maximum external wait cycles. These parameters are programmed via the Asynchronous Bank and Asynchronous Wait Cycle Configuration Registers. These support the following range of values: TA[4-1], RS[16-1], RST[64-1], RH[8-1], WS[16-1], WST[64-1], WH[8-1], and MEW[1-256]. See the TMS320DM335 Digital Media System-on-Chip (DMSoC) Asynchronous External Memory Interface (EMIF) Reference Guide (SPRUZF1) for more information.
- (2) E = PLLC1 SYSCLK2 period in ns. SYSCLK2 is the EMIF peripheral clock. SYSCLK2 is one-fourth the PLLC output clock. For example, when PLLC output clock = 432 MHz, E = 9.259 ns. See Section 3.5 for more information.
- (3) EWC = external wait cycles determined by EM\_WAIT input signal. EWC supports the following range of values EWC[256-1]. Note that the maximum wait time before timeout is specified by bit field MEWC in the Asynchronous Wait Cycle Configuration Register. See the TMS320DM335 Digital Media System-on-Chip (DMSoC) Asynchronous External Memory Interface (EMIF) Reference Guide (SPRUZF1).

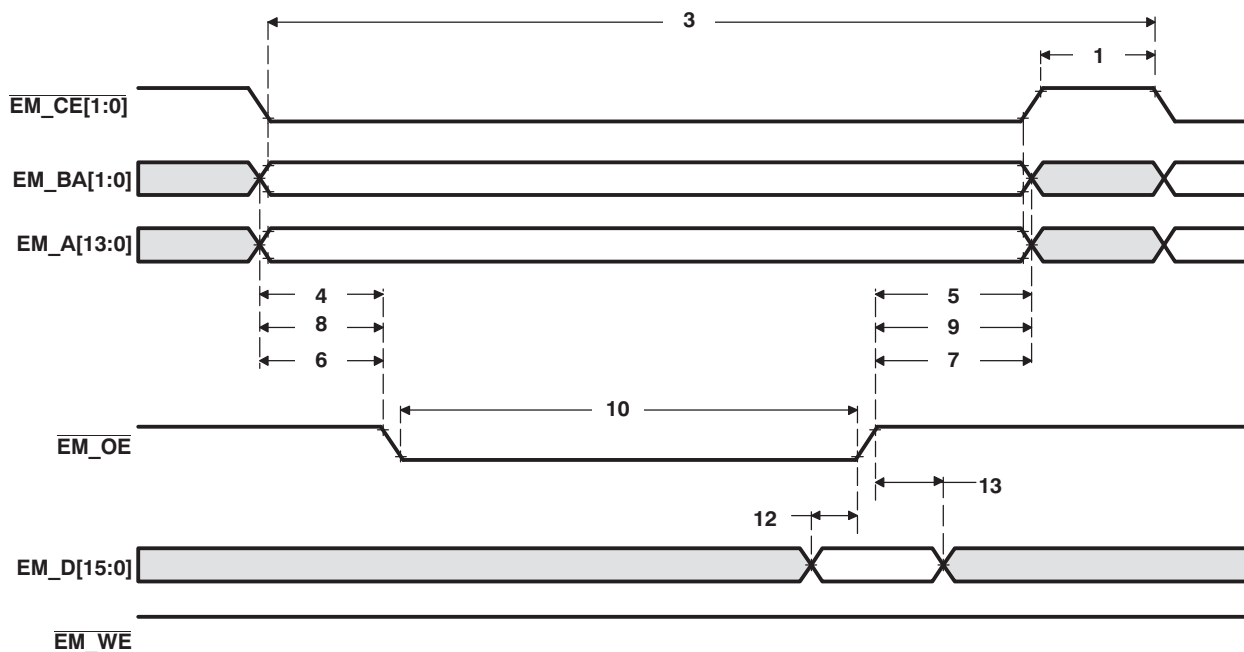
**Table 5-14. Switching Characteristics Over Recommended Operating Conditions for Asynchronous Memory Cycles for AEMIF Module <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup> (see Figure 5-14 and Figure 5-15 ) (continued)**

| NO.                                                         | PARAMETER                  |                                                                                      | DM335            |                        |      | UNIT |
|-------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------|------------------|------------------------|------|------|
|                                                             |                            |                                                                                      | MIN              | Nom                    | MAX  |      |
| 6                                                           | $t_{su}(EMBAV-EMOEL)$      | Output setup time, $\overline{EM\_BA}[1:0]$ valid to $\overline{EM\_OE}$ low         |                  | (RS)*E                 |      | ns   |
| 7                                                           | $t_h(EMOEH-EMBAIV)$        | Output hold time, $\overline{EM\_OE}$ high to $\overline{EM\_BA}[1:0]$ invalid       |                  | (RH)*E                 |      | ns   |
| 8                                                           | $t_{su}(EMBAV-EMOEL)$      | Output setup time, $\overline{EM\_A}[13:0]$ valid to $\overline{EM\_OE}$ low         |                  | (RS)*E                 |      | ns   |
| 9                                                           | $t_h(EMOEH-EMBAIV)$        | Output hold time, $\overline{EM\_OE}$ high to $\overline{EM\_A}[13:0]$ invalid       |                  | (RH)*E                 |      | ns   |
| 10                                                          | $t_w(EMOEL)$               | $\overline{EM\_OE}$ active low width (EW = 0)                                        |                  | (RST)*E                |      | ns   |
|                                                             |                            | $\overline{EM\_OE}$ active low width (EW = 1)                                        |                  | (RST+(EWC*16))*E       |      | ns   |
| 11                                                          | $t_d(EMWAITH-EMOEH)$       | Delay time from EM_WAIT deasserted to $\overline{EM\_OE}$ high                       |                  | 4E                     |      | ns   |
| <b>READS (OneNAND Synchronous Burst Read)<sup>(4)</sup></b> |                            |                                                                                      |                  |                        |      |      |
| 32                                                          | $f_c(EM\_CLK)$             | Frequency, EM_CLK                                                                    | 1                |                        | 66   | MHz  |
| 33                                                          | $t_c(EM\_CLK)$             | Cycle time, EM_CLK                                                                   | 15               |                        | 1000 | ns   |
| 34                                                          | $t_{su}(EM\_ADV-EM\_CLKH)$ | Output setup time, EM_ADV valid before EM_CLK high                                   | 5                |                        |      | ns   |
| 35                                                          | $t_h(EM\_CLKH-EM\_ADV)$    | Output hold time, EM_CLK high to EM_ADV invalid                                      | 6                |                        |      | ns   |
| 36                                                          | $t_{su}(EM\_AV-EM\_CLKH)$  | Output setup time, EM_A[13:0]/EM_BA[1] valid before EM_CLK high                      | 5                |                        |      | ns   |
| 37                                                          | $t_h(EM\_CLKH-EM\_AIV)$    | Output hold time, EM_CLK high to EM_A[13:0]/EM_BA[1] invalid                         | 6                |                        |      | ns   |
| 38                                                          | $t_w(EM\_CLKH)$            | Pulse duration, EM_CLK high                                                          | $t_c(EM\_CLK)/3$ |                        |      | ns   |
| 39                                                          | $t_w(EM\_CLKL)$            | Pulse duration, EM_CLK low                                                           | $t_c(EM\_CLK)/3$ |                        |      | ns   |
| <b>WRITES</b>                                               |                            |                                                                                      |                  |                        |      |      |
| 15                                                          | $t_c(EMWCYCLE)$            | EMIF write cycle time (EW = 0)                                                       |                  | (WS+WST+WH)*E          |      | ns   |
|                                                             |                            | EMIF write cycle time (EW = 1)                                                       |                  | (WS+WST+WH+(EWC*16))*E |      | ns   |
| 16                                                          | $t_{su}(EMCEL-EMWEL)$      | Output setup time, $\overline{EM\_CE}[1:0]$ low to $\overline{EM\_WE}$ low (SS = 0)  |                  | (WS)*E                 |      | ns   |
|                                                             |                            | Output setup time, $\overline{EM\_CE}[1:0]$ low to $\overline{EM\_WE}$ low (SS = 1)  |                  | 0                      |      | ns   |
| 17                                                          | $t_h(EMWEH-EMCEH)$         | Output hold time, $\overline{EM\_WE}$ high to $\overline{EM\_CE}[1:0]$ high (SS = 0) |                  | (WH)*E                 |      | ns   |
|                                                             |                            | Output hold time, $\overline{EM\_WE}$ high to $\overline{EM\_CE}[1:0]$ high (SS = 1) |                  | 0                      |      | ns   |
| 20                                                          | $t_{su}(EMBAV-EMWEL)$      | Output setup time, $\overline{EM\_BA}[1:0]$ valid to $\overline{EM\_WE}$ low         |                  | (WS)*E                 |      | ns   |
| 21                                                          | $t_h(EMWEH-EMBAIV)$        | Output hold time, $\overline{EM\_WE}$ high to $\overline{EM\_BA}[1:0]$ invalid       |                  | (WH)*E                 |      | ns   |
| 22                                                          | $t_{su}(EMAV-EMWEL)$       | Output setup time, $\overline{EM\_A}[13:0]$ valid to $\overline{EM\_WE}$ low         |                  | (WS)*E                 |      | ns   |
| 23                                                          | $t_h(EMWEH-EMBAIV)$        | Output hold time, $\overline{EM\_WE}$ high to $\overline{EM\_A}[13:0]$ invalid       |                  | (WH)*E                 |      | ns   |
| 24                                                          | $t_w(EMWEL)$               | $\overline{EM\_WE}$ active low width (EW = 0)                                        |                  | (WST)*E                |      | ns   |
|                                                             |                            | $\overline{EM\_WE}$ active low width (EW = 1)                                        |                  | (WST+(EWC*16))*E       |      | ns   |
| 25                                                          | $t_d(EMWAITH-EMWEH)$       | Delay time from EM_WAIT deasserted to $\overline{EM\_WE}$ high                       |                  | 4E                     |      | ns   |

(4) During OneNAND Mode the EM\_CLK is driven by 1/2 PLLC1SYSCLK2 clk.

**Table 5-14. Switching Characteristics Over Recommended Operating Conditions for Asynchronous Memory Cycles for AEMIF Module <sup>(1) (2) (3)</sup> (see Figure 5-14 and Figure 5-15 ) (continued)**

| NO. | PARAMETER                                                                                           | DM335 |        |     | UNIT |
|-----|-----------------------------------------------------------------------------------------------------|-------|--------|-----|------|
|     |                                                                                                     | MIN   | Nom    | MAX |      |
| 26  | $t_{su(EMDV-EMWEL)}$ Output setup time, $\overline{EM\_D[15:0]}$ valid to $\overline{EM\_WE}$ low   |       | (WS)*E |     | ns   |
| 27  | $t_{h(EMWEH-EMDIV)}$ Output hold time, $\overline{EM\_WE}$ high to $\overline{EM\_D[15:0]}$ invalid |       | (WH)*E |     | ns   |


**Figure 5-14. Asynchronous Memory Read Timing for EMIF**

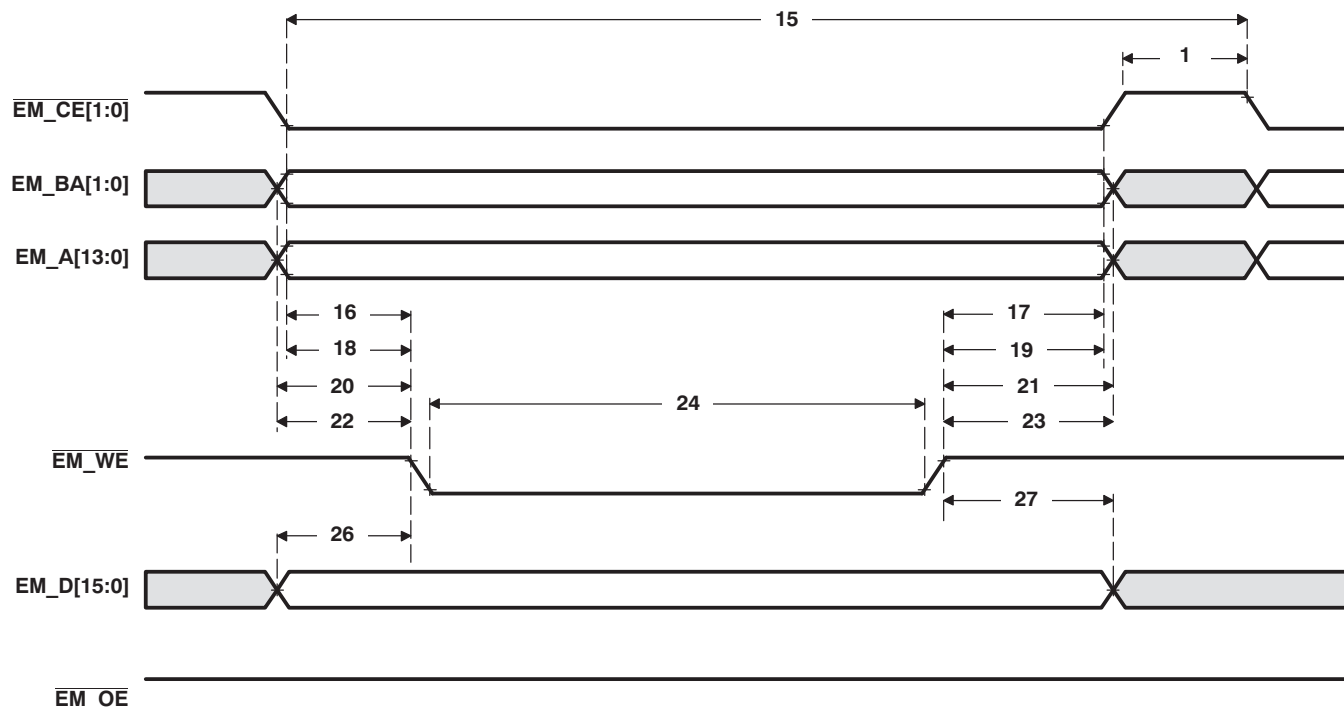


Figure 5-15. Asynchronous Memory Write Timing for EMIF

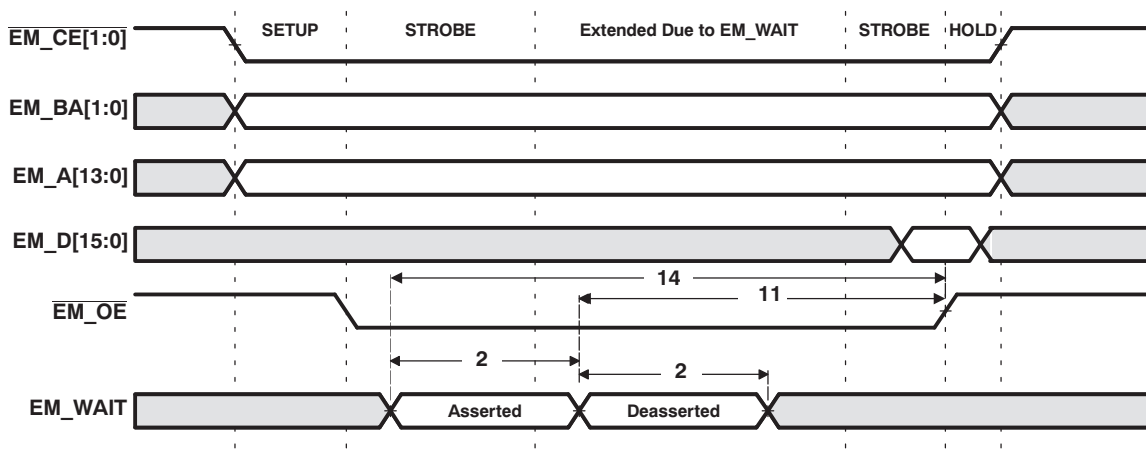


Figure 5-16. EM\_WAIT Read Timing Requirements

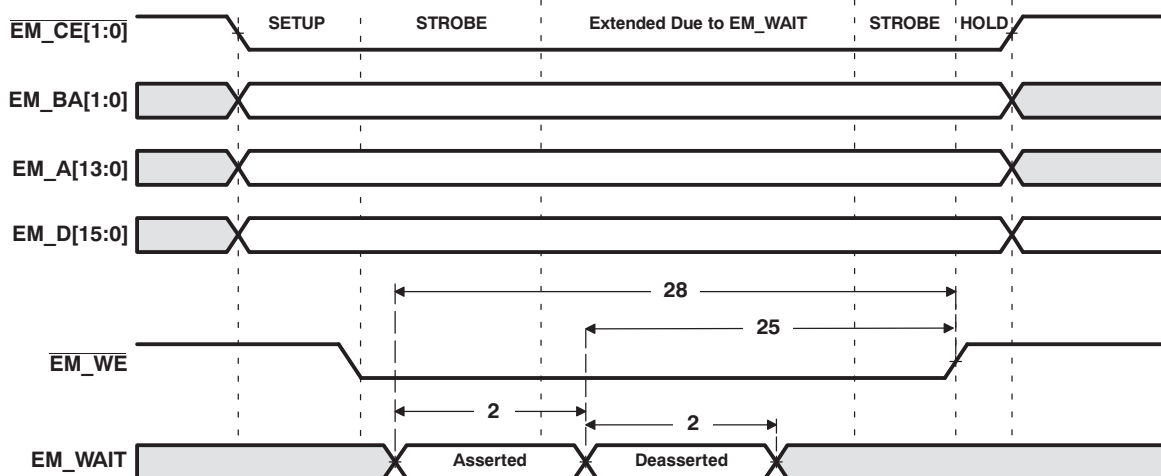


Figure 5-17. EM\_WAIT Write Timing Requirements

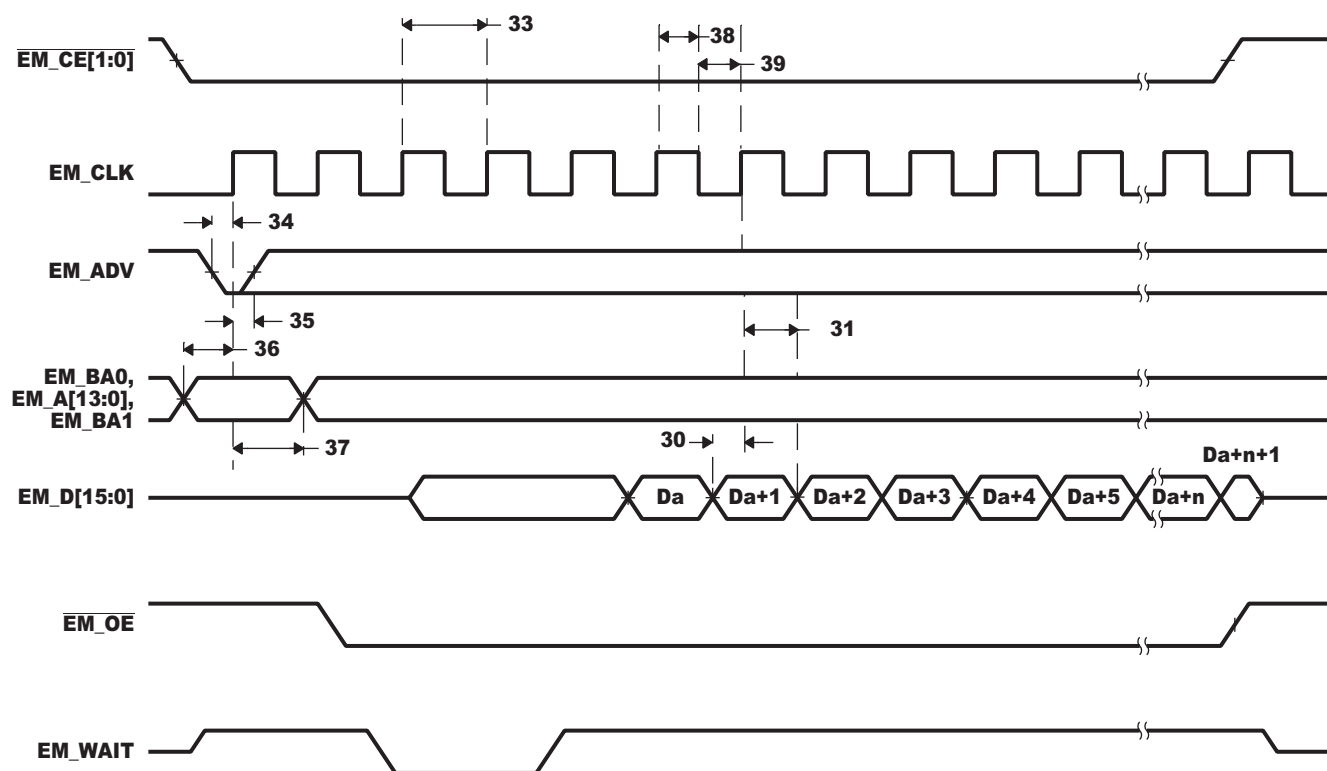


Figure 5-18. Synchronous OneNAND Flash Read Timing

### 5.7.2 DDR2/mDDR Memory Controller

The DDR2 / mDDR Memory Controller is a dedicated interface to DDR2 / mDDR SDRAM. It supports JESD79D-2A standard compliant DDR2 SDRAM devices and compliant Mobile DDR SDRAM devices. DDR2 / mDDR SDRAM plays a key role in a DM335-based system. Such a system is expected to require a significant amount of high-speed external memory for all of the following functions:

- Buffering of input image data from sensors or video sources
- Intermediate buffering for processing/resizing of image data in the VPFE
- Numerous OSD display buffers
- Intermediate buffering for large raw Bayer data image files while performing image processing functions
- Buffering for intermediate data while performing video encode and decode functions
- Storage of executable code for the ARM

The DDR2 / mDDR Memory Controller supports the following features:

- JESD79D-2A standard compliant DDR2 SDRAM
- Mobile DDR SDRAM
- 256 MByte memory space
- Data bus width 16 bits
- CAS latencies:
  - DDR2: 2, 3, 4, and 5
  - mDDR: 2 and 3
- Internal banks:
  - DDR2: 1, 2, 4, and 8
  - mDDR: 1, 2, and 4
- Burst length: 8
- Burst type: sequential
- 1 CS signal
- Page sizes: 256, 512, 1024, and 2048
- SDRAM autoinitialization
- Self-refresh mode
- Partial array self-refresh (for mDDR)
- Power down mode
- Prioritized refresh
- Programmable refresh rate and backlog counter
- Programmable timing parameters
- Little endian

For details on the DDR2 Memory Controller, refer to *TMS320DM335 Digital Media System-on-Chip (DMSoC) DDR2/Mobile DDR (DDR2/mDDR) Memory Controller Reference Guide* (literature number SPRUFZ2).

#### 5.7.2.1 DDR2/mDDR Memory Controller Electrical Data/Timing

The *Implementing DDR2/mDDR PCB Layout on the TMS320DM335 DMSoC* Application Report (literature number SPRAAL2) specifies a complete DDR2 and mDDR interface solution for the DM335 as well as a list of compatible DDR2/mDDR devices. TI has performed the simulation and system characterization to ensure all DDR2 and mDDR interface timings in this solution are met.

TI only supports board designs that follow the guidelines outlined in the *implementing DDR2/mDDR PCB Layout on the TMS320DM335 DMSoC* Application Report (literature number SPRAAL2).

## 5.8 MMC/SD

The DM335 includes two separate MMC/SD Controllers which are compliant with MMC V3.31, Secure Digital Part 1 Physical Layer Specification V1.1 and Secure Digital Input Output (SDIO) V1.0 specifications.

The DM335 MMC/SD Controller has following features:

- MultiMediaCard (MMC).
- Secure Digital (SD) Memory Card.
- MMC/SD protocol support.
- SDIO protocol support.
- Programmable clock frequency.
- 256 bit Read/Write FIFO to lower system overhead.
- Slave EDMA transfer capability.

The DM335 MMC/SD Controller does not support SPI mode.

### 5.8.1 MMC/SD Electrical Data/Timing

**Table 5-15. Timing Requirements for MMC/SD Module**  
(see [Figure 5-20](#) and [Figure 5-22](#))

| NO. | PARAMETER           |                                              | DM335              |     |               |     | UNIT |
|-----|---------------------|----------------------------------------------|--------------------|-----|---------------|-----|------|
|     |                     |                                              | FAST MODE          |     | STANDARD MODE |     |      |
|     |                     |                                              | MIN                | MAX | MIN           | MAX |      |
| 1   | $t_{su}(CMDV-CLKH)$ | Setup time, SD_CMD valid before SD_CLK high  | 6                  |     | 5             |     | ns   |
| 2   | $t_h(CLKH-CMDV)$    | Hold time, SD_CMD valid after SD_CLK high    | 2.5 <sup>(1)</sup> |     | 5             |     | ns   |
| 3   | $t_{su}(DATV-CLKH)$ | Setup time, SD_DATx valid before SD_CLK high | 6                  |     | 5             |     | ns   |
| 4   | $t_h(CLKH-DATV)$    | Hold time, SD_DATx valid after SD_CLK high   | 2.5                |     | 5             |     | ns   |

- (1) For this parameter, you may include margin in your board design so that the  $t_{oh} = 2.5$  ns of the MMC/SD device is not degraded at the DM335 input pin.

**Table 5-16. Switching Characteristics Over Recommended Operating Conditions for MMC/SD Module**  
(see [Figure 5-19](#) through [Figure 5-22](#))

| NO. | PARAMETER                |                                              | DM335     |     |               |     | UNIT |
|-----|--------------------------|----------------------------------------------|-----------|-----|---------------|-----|------|
|     |                          |                                              | FAST MODE |     | STANDARD MODE |     |      |
|     |                          |                                              | MIN       | MAX | MIN           | MAX |      |
| 7   | f <sub>(CLK)</sub>       | Operating frequency, SD_CLK                  | 0         | 50  | 0             | 25  | MHz  |
| 8   | f <sub>(CLK_ID)</sub>    | Identification mode frequency, SD_CLK        | 0         | 400 | 0             | 400 | KHz  |
| 9   | t <sub>W(CLKL)</sub>     | Pulse width, SD_CLK low                      | 7         |     | 10            |     | ns   |
| 10  | t <sub>W(CLKH)</sub>     | Pulse width, SD_CLK high                     | 7         |     | 10            |     | ns   |
| 11  | t <sub>r(CLK)</sub>      | Rise time, SD_CLK                            |           | 3   |               | 10  | ns   |
| 12  | t <sub>f(CLK)</sub>      | Fall time, SD_CLK                            |           | 3   |               | 10  | ns   |
| 13  | t <sub>d(CLKL-CMD)</sub> | Delay time, SD_CLK low to SD_CMD transition  | -7.5      | 4   | -7.5          | 14  | ns   |
| 14  | t <sub>d(CLKL-DAT)</sub> | Delay time, SD_CLK low to SD_DATx transition | -7.5      | 4   | -7.5          | 14  | ns   |

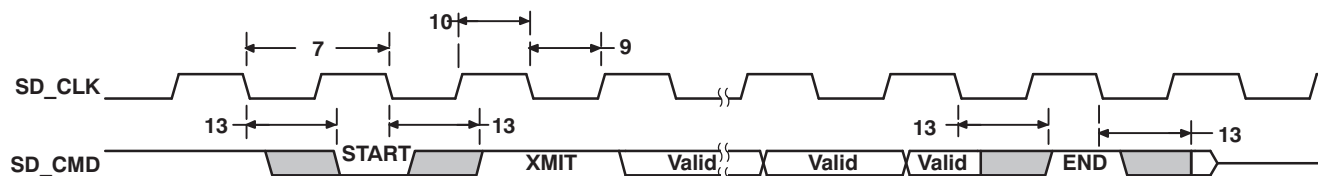


Figure 5-19. MMC/SD Host Command Timing

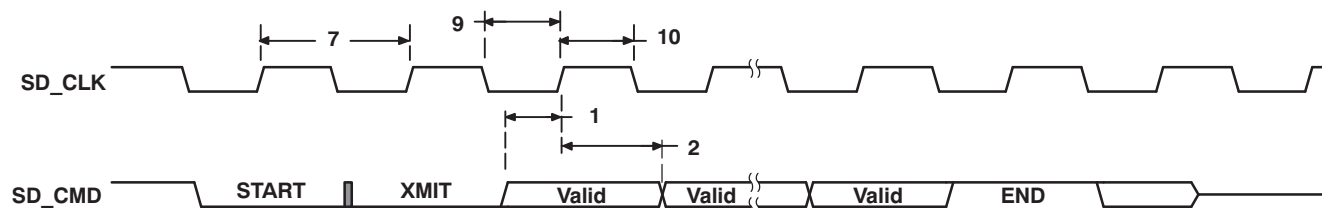


Figure 5-20. MMC/SD Card Response Timing

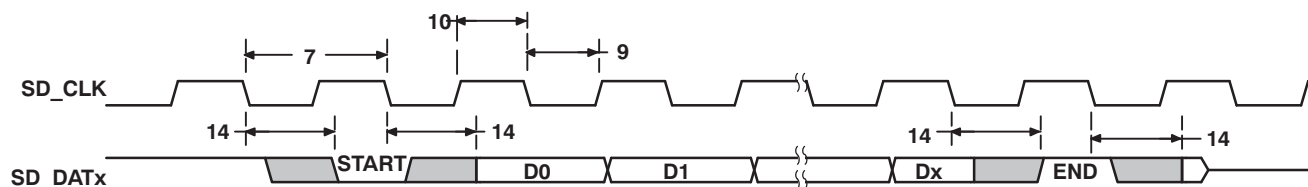


Figure 5-21. MMC/SD Host Write Timing

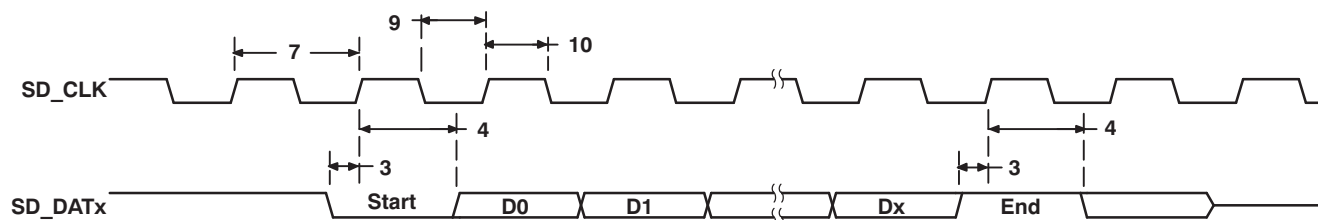


Figure 5-22. MMC/SD Host Read and Card CRC Status Timing

## 5.9 Video Processing Sub-System (VPSS) Overview

The DM335 contains a Video Processing Sub-System (VPSS) that provides an input interface (Video Processing Front End or VPFE) for external imaging peripherals such as image sensors, video decoders, etc.; and an output interface (Video Processing Back End or VPBE) for display devices, such as analog SDTV displays, digital LCD panels, HDTV video encoders, etc.

In addition to these peripherals, there is a set of common buffer memory and DMA control to ensure efficient use of the DDR2 burst bandwidth. The shared buffer logic/memory is a unique block that is tailored for seamlessly integrating the VPSS into an image/video processing system. It acts as the primary source or sink to all the VPFE and VPBE modules that are either requesting or transferring data from/to DDR2. In order to efficiently utilize the external DDR2 bandwidth, the shared buffer logic/memory interfaces with the DMA system via a high bandwidth bus (64-bit wide). The shared buffer logic/memory also interfaces with all the VPFE and VPBE modules via a 128-bit wide bus. The shared buffer logic/memory (divided into the read & write buffers and arbitration logic) is capable of performing the following functions. It is imperative that the VPSS utilize DDR2 bandwidth efficiently due to both its large bandwidth requirements and the real-time requirements of the VPSS modules. Because it is possible to configure the VPSS modules in such a way that DDR2 bandwidth is exceeded, a set of user accessible registers is provided to monitor overflows or failures in data transfers.

### 5.9.1 Video Processing Front-End (VPFE)

The VPFE or Video Processing Front-End block is comprised of the CCD Controller (CCDC), Image Pipe (IPIPE), and Hardware 3A Statistic Generator (H3A). These modules are described in the sections that follow.

#### 5.9.1.1 CCD Controller (CCDC)

The CCDC is responsible for accepting raw (unprocessed) image/video data from a sensor (CMOS or CCD). In addition, the CCDC can accept YUV video data in numerous formats, typically from so-called video decoder devices. In the case of raw inputs, the CCDC output requires additional image processing to transform the raw input image to the final processed image. This processing can be done either on-the-fly in the Preview Engine hardware ISP or in software on the ARM. In parallel, raw data input to the CCDC can also be used for computing various statistics (3A, Histogram) to eventually control the image/video tuning parameters. The CCDC is programmed via control and parameter registers. The following features are supported by the CCDC module.

- Support for conventional Bayer pattern.
- Generates HD/VD timing signals and field ID to an external timing generator or can synchronize to the external timing generator.
- Support for progressive and interlaced sensors (hardware support for up to 2 fields and firmware support for higher number of fields, typically 3-, 4-, and 5-field sensors).
- Support for up to 75-MHZ sensor pixel clock if H3A is not used, otherwise the pixel clock must be less than 67.5 MHz
- Support for ITU-R BT.656 standard format, either 8-bit or 16-bit.
- Support for YCbCr 422 format, either 8- or 16-bit with discrete HSYNC and VSYNC signals.
- Support for up to 14-bit input.
- Support for color space conversion
- Generates optical black clamping signals.
- Support for shutter signal control.
- Support for digital clamping and black level compensation.
- Fault pixel correction based on a lookup table that contains row and column position of the pixel to be corrected.
- Support for program lens shading correction.
- Support for 10-bit to 8-bit A-law compression.

- Support for a low-pass filter prior to writing to SDRAM. If this filter is enabled, 2 pixels each in the left and right edges of each line are cropped from the output.
- Support for generating output to range from 14-bits to 8-bits wide (8-bits wide allows for 50% saving in storage area).
- Support for down sampling via programmable culling patterns.
- Ability to control output to the DDR2 via an external write enable signal.
- Support for up to 32K pixels (image size) in both the horizontal and vertical direction.

### 5.9.1.2 IPIPE - Image Pipe

The hardware Image Pipe (IPIPE) is a programmable hardware image processing module that is responsible for transforming raw (unprocessed) image/video data from a sensor (CMOS or CCD) into YCbCr 422 data that is amenable for compression or display. The IPIPE can also be configured to operate in a resize only mode, which allows YCbCr 422 to be resized without applying the processing of every module in the IPIPE. Typically, the output of the IPIPE is used for both video compression and displaying it on an external display device such as a NTSC/PAL analog encoder or a digital LCD. The IPIPE is programmed via control and parameter registers. The following features are supported by the IPIPE.

- The input interface extracts valid raw data from the CCD raw data, and then various modules in IPIPE process the raw CCD data.
- The 2D noise filter module reduces impulse noise in the raw data and adjusts the resolution of the input image.
- The 2D pre-filter adjusts the resolution of the input image and remove line crawl noise.
- The white balance module applies two gain adjustments to the data: a digital gain (total gain) and a white balance gain.
- The Color Filter Array (CFA) interpolation module implements CFA interpolation. The output from the CFA interpolation module is always RGB formatted data.
- The RGB2RGB blending module applies a 3x3 matrix transform to the RGB data generated by the CFA interpolation module.
- The gamma correction module independently applies gamma correction to each RGB component. Gamma is implemented using a piece-wise linear interpolation approach with a 512 entry look up table for each color.
- The RGB2YCbCr conversion module applies 3x3 matrix transformation to the RGB data to convert it to YCbCr data. This module also implements offset.
- The 4:2:2 conversion module applies the chroma low pass filter and down samples Cb and Cr, so that IPIPE output data is in YCbCr-4:2:2 format.
- The 2D edge enhancer module improves image clarity with luminance non-linear filter. This module also has contrast and brightness adjustment functions.
- The chroma suppression module reduces faulty-color using luminance (Y) value or high-pass-filtering Y value. The H-resizer and V-resizer modules resize horizontal and vertical image sizes, respectively.
- The output interface module transfers data from IPIPE to SDRAM, in the form of YCbCr-422 or RGB (32bit/16bit).
- The histogram function can record histograms of up to 4 distinct areas into up to 256 bins.
- IPIPE has three different processing paths:
  - Case 1: The CCD raw data directly leads to IPIPE and stores the YCbCr (or RGB) data to SDRAM.
  - Case 2: IPIPE reads CCD raw data and stores the Bayer pattern data after white balance to SDRAM.
  - Case 3: IPIPE reads YCbCr-422 data and apply edge enhance, chroma suppression and Resize to output YCbCr (or RGB) data to SDRAM.

### 5.9.1.3 Hardware 3A (H3A)

The H3A module is designed to support the control loops for Auto Focus, Auto White Balance and Auto Exposure by collecting metrics about the imaging/video data. The metrics are to adjust the various parameters for processing the imaging/video data. There are 2 main blocks in the H3A module:

- Auto Focus (AF) engine
- Auto Exposure (AE) Auto White Balance (AWB) engine

The AF engine extracts and filters the red, green, and blue data from the input image/video data and provides either the accumulation or peaks of the data in a specified region. The specified region is a two-dimensional block of data and is referred to as a "paxel" for the case of AF.

The AE/AWB Engine accumulates the values and checks for saturated values in a sub sampling of the video data. In the case of the AE/AWB, the two-dimensional block of data is referred to as a "window". Thus, other than referring them by different names, a paxel and a window are essentially the same thing. However, the number, dimensions, and starting position of the AF paxels and the AE/AWB windows are separately programmable.

The following features are supported by the AF engine:

- Support for input from DDR2 / mDDR SDRAM (in addition to the CCDC port)
- Support for a Peak Mode in a Paxel (a Paxel is defined as a two dimensional block of pixels).
- Accumulate the maximum Focus Value of each line in a Paxel
- Support for an Accumulation/Sum Mode (instead of Peak mode).
- Accumulate Focus Value in a Paxel.
- Support for up to 36 Paxels in the horizontal direction and up to 128 Paxels in the vertical direction. The number of horizontal paxels is limited by the memory size (and cost), while the vertical number of paxels is not. Therefore, the number of paxels in horizontal direction is smaller than the number of paxels in vertical direction.
- Programmable width and height for the Paxel. All paxels in the frame will be of same size.
- Programmable red, green, and blue position within a 2x2 matrix.
- Separate horizontal start for paxel and filtering.
- Programmable vertical line increments within a paxel.
- Parallel IIR filters configured in a dual-biquad configuration with individual coefficients (2 filters with 11 coefficients each). The filters are intended to compute the sharpness/peaks in the frame to focus on.

The following features are supported by the AE/AWB engine:

- Support for input from DDR2 / mDDR SDRAM (in addition to the CCDC port)
- Accumulate clipped pixels along with all non-saturated pixels
- Support for up to 36 horizontal windows.
- Support for up to 128 vertical windows.
- Programmable width and height for the windows. All windows in the frame will be of same size.
- Separate vertical start co-ordinate and height for a black row of paxels that is different than the remaining color paxels.
- Programmable Horizontal Sampling Points in a window
- Programmable Vertical Sampling Points in a window

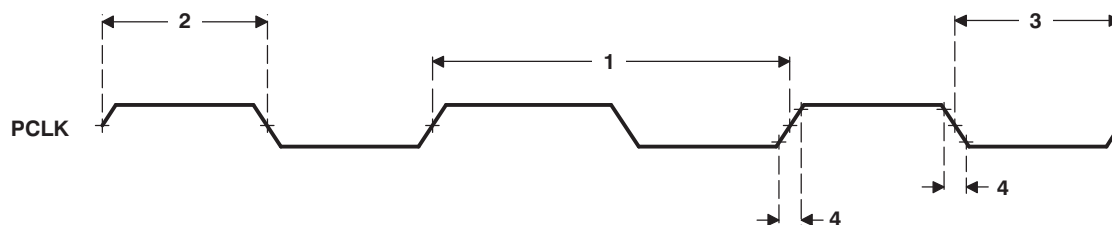
### 5.9.1.4 VPFE Electrical Data/Timing

**Table 5-17. Timing Requirements for VPFE PCLK Master/Slave Mode<sup>(1)</sup> (see Figure 5-23)**

| NO. | PARAMETER      |                           | MIN          | MAX                       | UNIT |
|-----|----------------|---------------------------|--------------|---------------------------|------|
| 1   | $t_{c(PCLK)}$  | Cycle time, PCLK          | H3A not used | 13.33 or P <sup>(2)</sup> | ns   |
|     |                |                           | H3A used     | 2P + 1                    | ns   |
| 2   | $t_{w(PCLKH)}$ | Pulse duration, PCLK high | 5.7          |                           | ns   |
| 3   | $t_{w(PCLKL)}$ | Pulse duration, PCLK low  | 5.7          |                           | ns   |
| 4   | $t_t(PCLK)$    | Transition time, PCLK     |              | 3                         | ns   |

(1) P = 1/SYSCLK4 in nanoseconds (ns). For example, if the SYSCLK4 frequency is 216 MHz, use P = 4.63 ns. See [Section 3.5](#), *Device Clocking*, for more information on the supported clock configurations of the DM335.

(2) Use whichever value is greater.



**Figure 5-23. VPFE PCLK Timing**

**Table 5-18. Timing Requirements for VPFE (CCD) Slave Mode (see Figure 5-24)**

| NO. | PARAMETER                       |                                                  | DM335 |     | UNIT |
|-----|---------------------------------|--------------------------------------------------|-------|-----|------|
|     |                                 |                                                  | MIN   | MAX |      |
| 5   | $t_{su(CCDV-PCLK)}$             | Setup time, CCD valid before PCLK edge           | 3     |     | ns   |
| 6   | $t_h(PCLK-CCDV)$                | Hold time, CCD valid after PCLK edge             | 2     |     | ns   |
| 7   | $t_{su(HDV-PCLK)}$              | Setup time, HD valid before PCLK edge            | 3     |     | ns   |
| 8   | $t_h(PCLK-HDV)$                 | Hold time, HD valid after PCLK edge              | 2     |     | ns   |
| 9   | $t_{su(VDV-PCLK)}$              | Setup time, VD valid before PCLK edge            | 3     |     | ns   |
| 10  | $t_h(PCLK-VDV)$                 | Hold time, VD valid after PCLK edge              | 2     |     | ns   |
| 11  | $t_{su(CAM\_WEN\_FIELDV-PCLK)}$ | Setup time, CAM_WEN_FIELD valid before PCLK edge | 3     |     | ns   |
| 12  | $t_h(CAM\_WEN\_FIELDV-PCLK)$    | Hold time, C_WEN_FIELD valid after PCLK edge     | 2     |     | ns   |

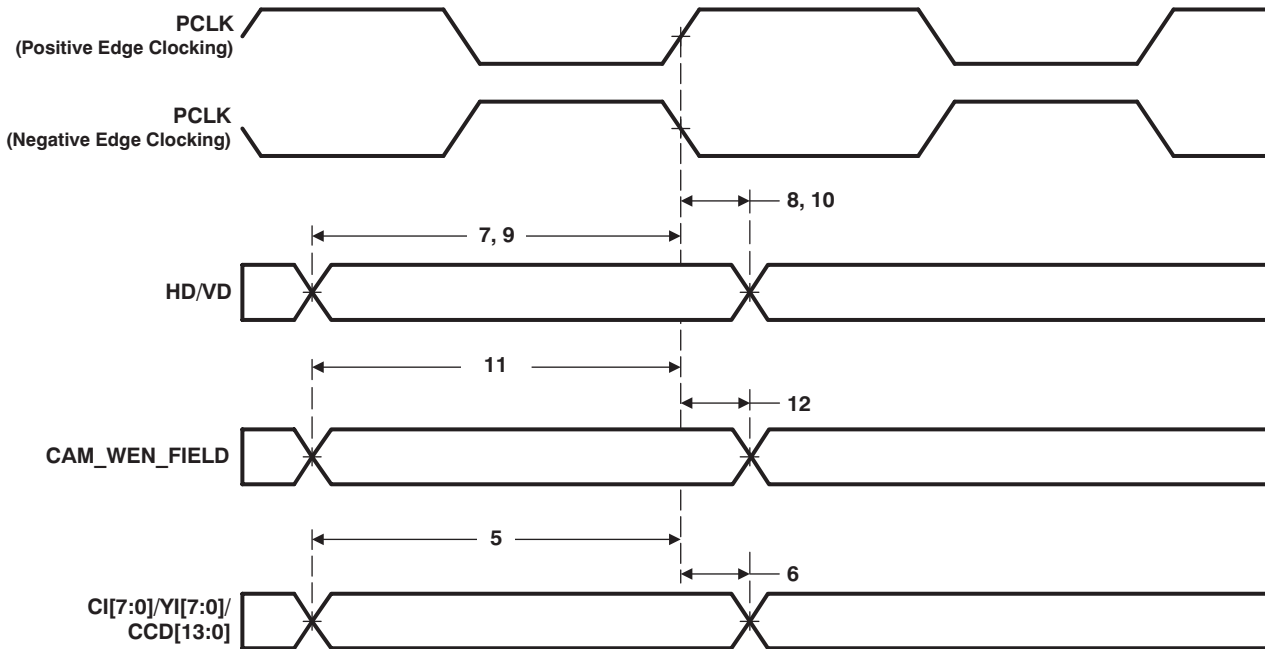


Figure 5-24. VPFE (CCD) Slave Mode Input Data Timing

Table 5-19. Timing Requirements for VPFE (CCD) Master Mode<sup>(1)</sup> (see Figure 5-25)

| NO. | PARAMETER                                                                        | DM335 |     | UNIT |
|-----|----------------------------------------------------------------------------------|-------|-----|------|
|     |                                                                                  | MIN   | MAX |      |
| 15  | $t_{su}(CCDV-PCLK)$ Setup time, CCD valid before PCLK edge                       | 3     |     | ns   |
| 16  | $t_h(PCLK-CCDV)$ Hold time, CCD valid after PCLK edge                            | 2     |     | ns   |
| 23  | $t_{su}(CAM\_WEN\_FIELDV-PCLK)$ Setup time, CAM_WEN_FIELD valid before PCLK edge | 3     |     | ns   |
| 24  | $t_h(PCLK-CAM\_WEN\_FIELDV)$ Hold time, CAM_WEN_FIELD valid after PCLK edge      | 2     |     | ns   |

(1) The VPFE may be configured to operate in either positive or negative edge clocking mode. When in positive edge clocking mode the rising edge of PCLK is referenced. When in negative edge clocking mode the falling edge of PCLK is referenced.

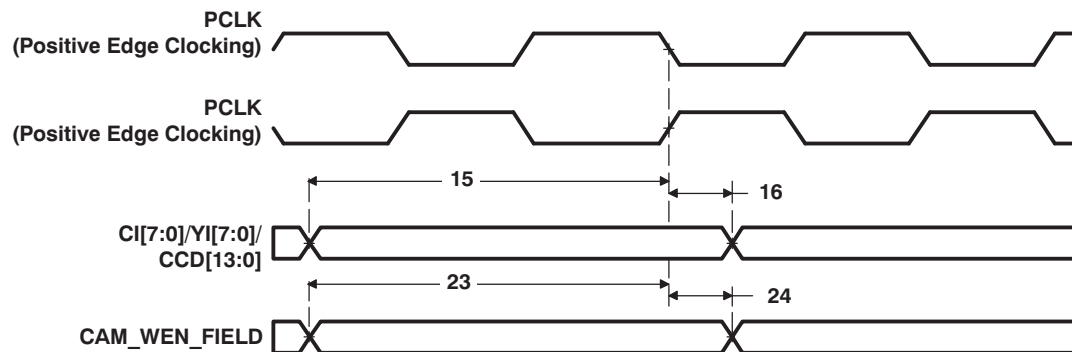
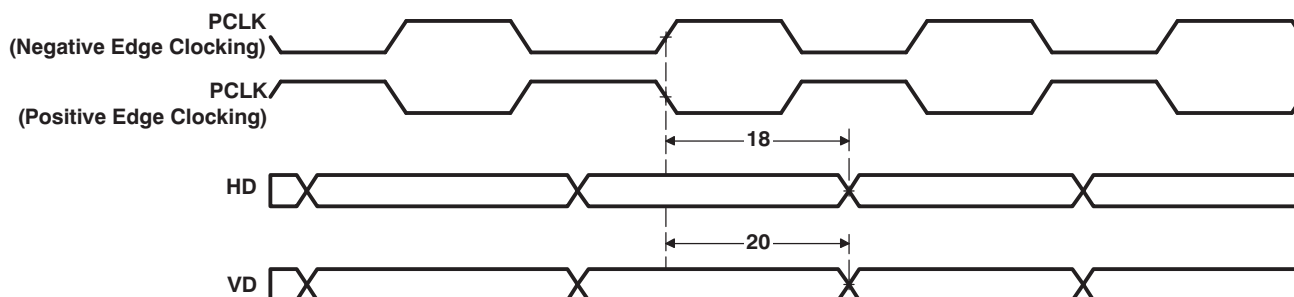


Figure 5-25. VPFE (CCD) Master Mode Input Data Timing

**Table 5-20. Switching Characteristics Over Recommended Operating Conditions for VPFE (CCD) Master Mode (see Figure 5-26)**

| NO. | PARAMETER                                               | DM335 |     | UNIT |
|-----|---------------------------------------------------------|-------|-----|------|
|     |                                                         | MIN   | MAX |      |
| 18  | $t_{d(PCLKL-HDIV)}$ Delay time, PCLK edge to HD invalid | 3     | 11  | ns   |
| 20  | $t_{d(PCLKL-VDIV)}$ Delay time, PCLK edge to VD invalid | 3     | 11  | ns   |


**Figure 5-26. VPFE (CCD) Master Mode Control Output Data Timing**

## 5.9.2 Video Processing Back-End (VPBE)

The Video Processing Back-End of VPBE module is comprised of the On Screen Display (OSD) module and the Video Encoder / Digital LCD Controller (VENC/DLCD).

### 5.9.2.1 On-Screen Display (OSD)

The primary function of the OSD module is to gather and blend video data and display/bitmap data and then pass it to the Video Encoder (VENC) in YCbCr format. The video and display data is read from external DDR2/mDDR memory. The OSD is programmed via control and parameter registers. The following are the primary features that are supported by the OSD.

- Support for two video windows and two OSD bitmapped windows that can be displayed simultaneously (VIDWIN0/VIDWIN1 and OSDWIN0/OSDWIN1).
- Video windows supports YCbCr data in 422 format from external memory, with the ability to interchange the order of the CbCr component in the 32-bit word
- OSD bitmap windows support 1/2/4/8 bit width index data of color palette
- In addition one OSD bitmap window at a time can be configured to one of the following:
  - YUV422 (same as video data)
  - RGB format data in 16-bit mode (R=5bit, G=6bit, B=5bit)
  - 24-bit mode (each R/G/B=8bit) with pixel level blending with video windows
- Programmable color palette with the ability to select between a RAM/ROM table with support for 256 colors.
- Support for 2 ROM tables, one of which can be selected at a given time
- Separate enable/disable control for each window
- Programmable width, height, and base starting coordinates for each window
- External memory address and offset registers for each window
- Support for x2 and x4 zoom in both the horizontal and vertical direction
- Pixel-level blending/transparency/blinking attributes can be defined for OSDWIN0 when OSDWIN1 is configured as an attribute window for OSDWIN0.
- Support for blinking intervals to the attribute window
- Ability to select either field/frame mode for the windows (interlaced/progressive)
- An eight step blending process between the bitmap and video windows
- Transparency support for the bitmap and video data (when a bitmap pixel is zero, there will be no

blending for that corresponding video pixel)

- Ability to resize from VGA to NTSC/PAL (640x480 to 720x576) for both the OSD and video windows
- Horizontal rescaling x1.5 is supported
- Support for a rectangular cursor window and a programmable background color selection.
- The width, height, and color of the cursor is selectable
- The display priority is: Rectangular-Cursor > OSDWIN1 > OSDWIN0 > VIDWIN1 > VIDWIN0 > background color
- Support for attenuation of the YCbCr values for the REC601 standard.

The following restrictions exist in the OSD module.

- If the vertical resize filter is enabled for either of the video windows, the maximum horizontal window dimension cannot be greater than 720 currently. This is due to the limitation in the size of the line memory.
- It is not possible to use both of the CLUT ROMs at the same time. However, a window can use RAM while another uses ROM.

### 5.9.2.2 Video Encoder / Digital LCD Controller (VENC/DLCD)

The VENC/DLCD consists of three major blocks; a) the video encoder that generates analog video output, b) the digital LCD controller that generates digital RGB/YCbCr data output and timing signals, and c) the timing generator.

The video encoder for analog video supports the following features:

- Master Clock Input - 27 MHz (x2 Upsampling)
- Programmable Timing Generator
- SDTV Support
  - Composite NTSC-M, PAL-B/D/G/H/I
  - Non-Interlace option
  - CGMS/WSS
  - Line 21 Closed Caption Data Encoding
  - Chroma Low Pass Filter 1.5MHz/3MHz
  - Programmable SC-H phase
- 10-bit Over-Sampling D/A Converter (27MHz)
- Internal analog video buffer
- Optional 7.5% Pedestal
- 16-235/0-255 Input Amplitude Selectable
- Programmable Luma Delay
- Master/Slave Operation
- Internal Color Bar Generation (75%)

The digital LCD controller supports the following features:

- Programmable DCLK
- Programmable Timing Generator
- Various Output Format
  - YCbCr 16bit
  - YCbCr 8bit
  - ITU-R BT. 656
  - Parallel RGB 16-bit/18-bit
  - Serial 8-bit RGB
- Low Pass Filter for Digital RGB Output

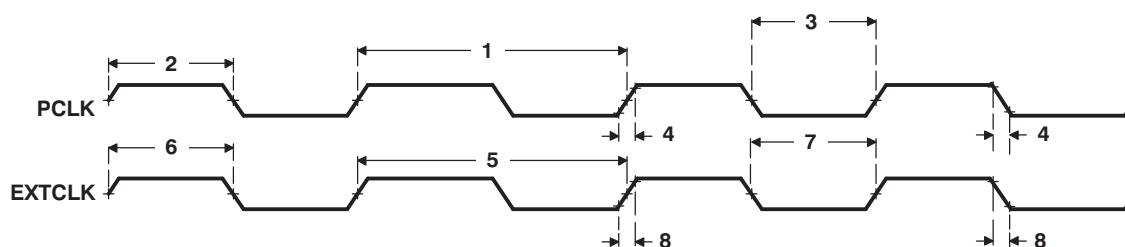
- Master/Slave Operation
- Internal Color Bar Generation (100%/75%)
- YUV/RGB modes support HDTV output (720p/1080i) with 74.25 MHz external clock input

### 5.9.2.3 VPBE Electrical Data/Timing

**Table 5-21. Timing Requirements for VPBE CLK Inputs (see [Figure 5-27](#))**

| NO. | PARAMETER                                     | DM335 |     | UNIT |
|-----|-----------------------------------------------|-------|-----|------|
|     |                                               | MIN   | MAX |      |
| 1   | $t_{c(PCLK)}$ Cycle time, PCLK <sup>(1)</sup> | 13.33 | 160 | ns   |
| 2   | $t_{w(PCLKH)}$ Pulse duration, PCLK high      | 5.7   |     | ns   |
| 3   | $t_{w(PCLKL)}$ Pulse duration, PCLK low       | 5.7   |     | ns   |
| 4   | $t_t(PCLK)$ Transition time, PCLK             |       | 3   | ns   |
| 5   | $t_{c(EXTCLK)}$ Cycle time, EXTCLK            | 13.33 | 160 | ns   |
| 6   | $t_{w(EXTCLKH)}$ Pulse duration, EXTCLK high  | 5.7   |     | ns   |
| 7   | $t_{w(EXTCLKL)}$ Pulse duration, EXTCLK low   | 5.7   |     | ns   |
| 8   | $t_t(EXTCLK)$ Transition time, EXTCLK         |       | 3   | ns   |

(1) For timing specifications relating to PCLK see [Table 5-17](#), *Timing Requirements for VPFE PCLK Master/Slave Mode*.

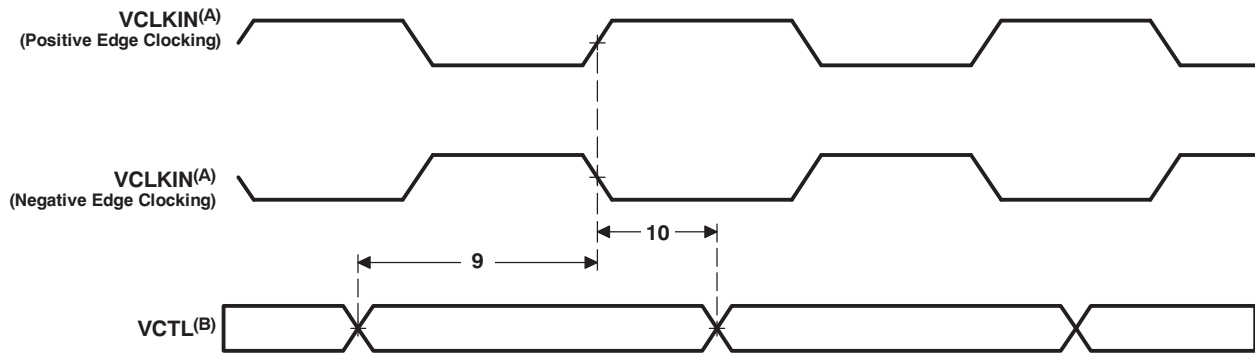


**Figure 5-27. VPBE PCLK and EXTCLK Timing**

**Table 5-22. Timing Requirements for VPBE Control Input With Respect to PCLK and EXTCLK<sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup> (see [Figure 5-28](#))**

| NO. | PARAMETER                                                        | DM335 |     | UNIT |
|-----|------------------------------------------------------------------|-------|-----|------|
|     |                                                                  | MIN   | MAX |      |
| 9   | $t_{su(VCTLV-VCLKIN)}$ Setup time, VCTL valid before VCLKIN edge | 2     |     | ns   |
| 10  | $t_h(VCLKIN-VCTLV)$ Hold time, VCTL valid after VCLKIN edge      | 1     |     | ns   |

- (1) The VPBE may be configured to operate in either positive or negative edge clocking mode. When in positive edge clocking mode, the rising edge of VCLKIN is referenced. When in negative edge clocking mode, the falling edge of VCLKIN is referenced.
- (2) VCTL = HSYNC, VSYNC, and FIELD
- (3) VCLKIN = PCLK or EXTCLK



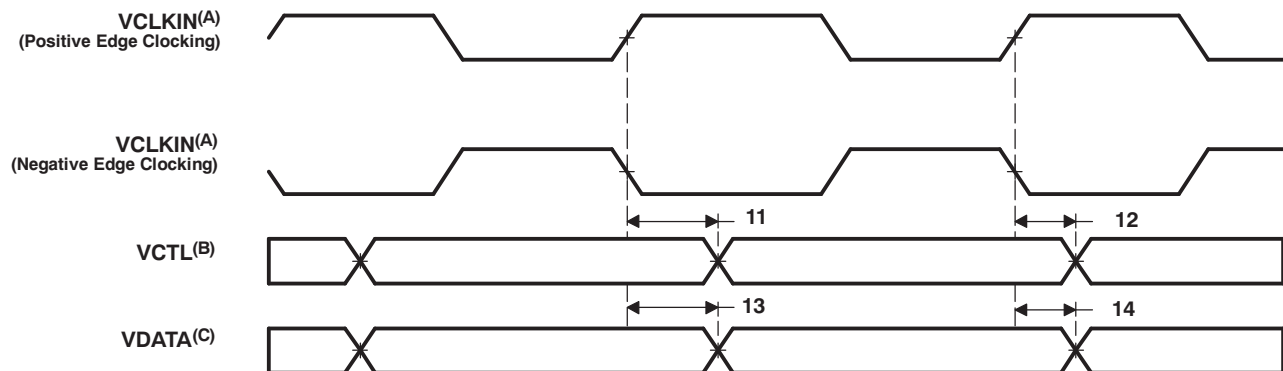
- A. VCLKIN = PCLK or EXTCLK  
B. VCTL = HSYNC, VSYNC, and FIELD

Figure 5-28. VPBE Input Timing With Respect to PCLK and EXTCLK

Table 5-23. Switching Characteristics Over Recommended Operating Conditions for VPBE Control and Data Output With Respect to PCLK and EXTCLK<sup>(1) (2) (3)</sup> (see Figure 5-29)

| NO. | PARAMETER                                                        | DM335 |      | UNIT |
|-----|------------------------------------------------------------------|-------|------|------|
|     |                                                                  | MIN   | MAX  |      |
| 11  | $t_{d(VCLKIN-VCTLV)}$ Delay time, VCLKIN edge to VCTL valid      |       | 13.3 | ns   |
| 12  | $t_{d(VCLKIN-VCTLIV)}$ Delay time, VCLKIN edge to VCTL invalid   | 2     |      | ns   |
| 13  | $t_{d(VCLKIN-VDATAV)}$ Delay time, VCLKIN edge to VDATA valid    |       | 13.3 | ns   |
| 14  | $t_{d(VCLKIN-VDATAIV)}$ Delay time, VCLKIN edge to VDATA invalid | 2     |      | ns   |

- (1) The VPBE may be configured to operate in either positive or negative edge clocking mode. When in positive edge clocking mode, the rising edge of VCLKIN is referenced. When in negative edge clocking mode, the falling edge of VCLKIN is referenced.  
(2) VCLKIN = PCLK or EXTCLK  
(3) VCTL = HSYNC, VSYNC, FIELD, and LCD\_OE



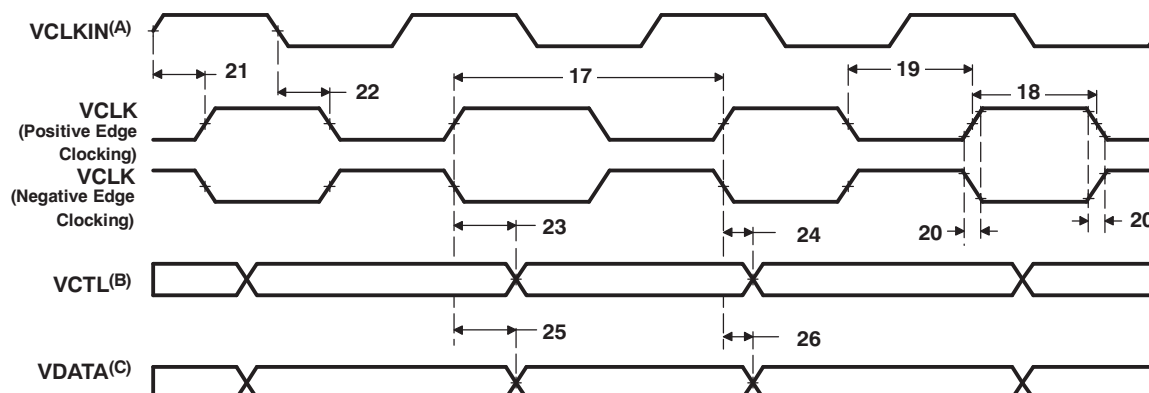
- A. VCLKIN = PCLK or EXTCLK  
B. VCTL = HSYNC, VSYNC, FIELD, and LCD\_OE  
C. VDATA = COUT[7:0], YOUT[7:0], R[7:3], G[7:2], and B[7:3]

Figure 5-29. VPBE Control and Data Output With Respect to PCLK and EXTCLK

**Table 5-24. Switching Characteristics Over Recommended Operating Conditions for VPBE Control and Data Output With Respect to VCLK<sup>(1) (2)</sup> (see Figure 5-30)**

| NO. | PARAMETER                                                         | DM335 |     | UNIT |
|-----|-------------------------------------------------------------------|-------|-----|------|
|     |                                                                   | MIN   | MAX |      |
| 17  | $t_c(\text{VCLK})$ Cycle time, VCLK                               | 13.33 | 160 | ns   |
| 18  | $t_w(\text{VCLKH})$ Pulse duration, VCLK high                     | 5.7   |     | ns   |
| 19  | $t_w(\text{VCLKL})$ Pulse duration, VCLK low                      | 5.7   |     | ns   |
| 20  | $t_t(\text{VCLK})$ Transition time, VCLK                          |       | 3   | ns   |
| 21  | $t_d(\text{VCLKINH-VCLKH})$ Delay time, VCLKIN high to VCLK high  | 2     | 12  | ns   |
| 22  | $t_d(\text{VCLKINL-VCLKL})$ Delay time, VCLKIN low to VCLK low    | 2     | 12  | ns   |
| 23  | $t_d(\text{VCLK-VCTLV})$ Delay time, VCLK edge to VCTL valid      |       | 4   | ns   |
| 24  | $t_d(\text{VCLK-VCTLV})$ Delay time, VCLK edge to VCTL invalid    | 0     |     | ns   |
| 25  | $t_d(\text{VCLK-VDATAV})$ Delay time, VCLK edge to VDATA valid    |       | 4   | ns   |
| 26  | $t_d(\text{VCLK-VDATAIV})$ Delay time, VCLK edge to VDATA invalid | 0     |     | ns   |

- (1) The VPBE may be configured to operate in either positive or negative edge clocking mode. When in positive edge clocking mode, the rising edge of VCLK is referenced. When in negative edge clocking mode, the falling edge of VCLK is referenced.
- (2) VCLKIN = PCLK or EXTCLK. For timing specifications relating to PCLK, see Table 5-17, *Timing Requirements for VPFE PCLK Master/Slave Mode*.

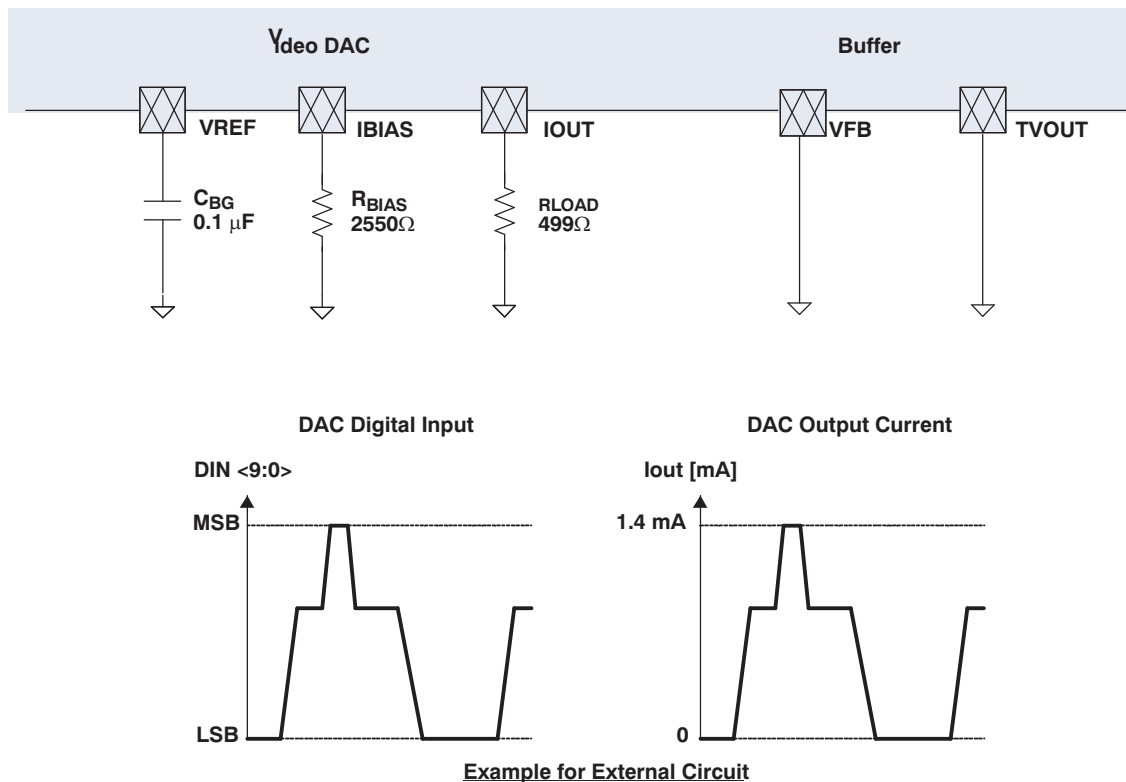


- A. VCLKIN = PCLK or EXTCLK  
 B. VCTL = HSYNC, VSYNC, FIELD, and LCD\_OE  
 C. VDATA = COUT[7:0], YOUT[7:0], R[7:3], G[7:2], and B[7:3]

**Figure 5-30. VPBE Control and Data Output Timing With Respect to VCLK**

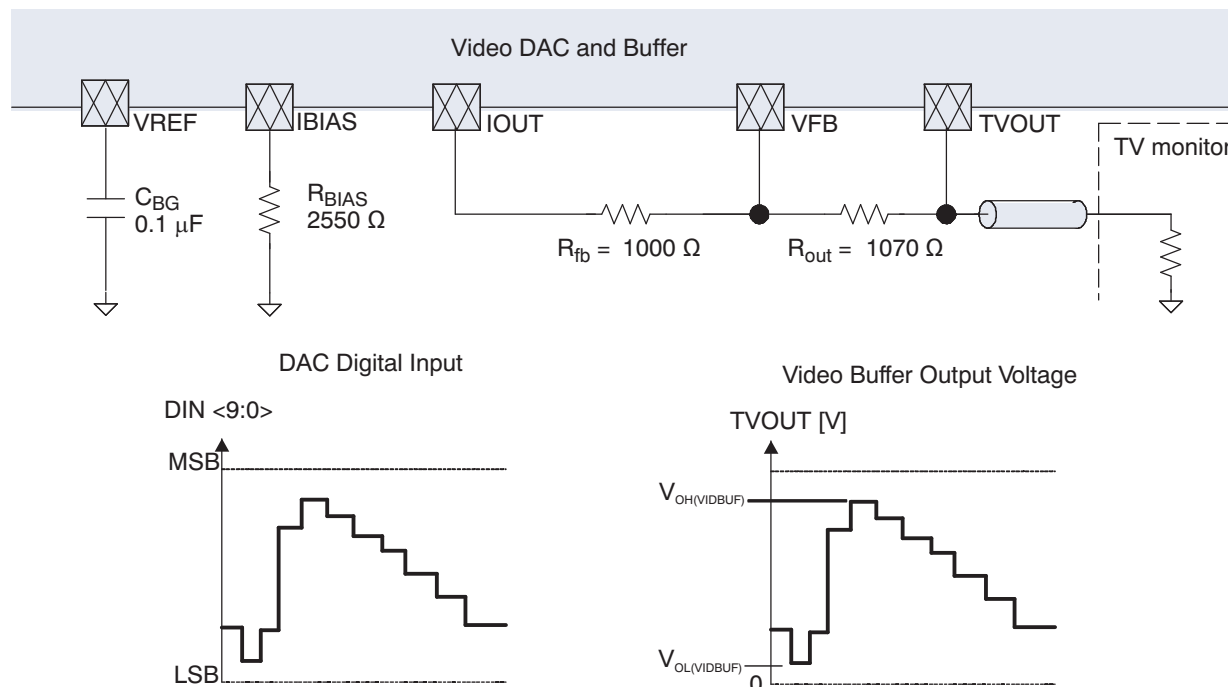
#### 5.9.2.4 DAC and Video Buffer Electrical Data/Timing

The DAC and video buffer can be configured in a DAC only configuration or in a DAC and video buffer configuration. In the DAC only configuration the internal video buffer is not used and an external video buffer is attached to the DAC. In the DAC and video buffer configuration, the DAC and internal video buffer are both used and a TV cable may be attached directly to the output of the video buffer. See Figure 5-31 and Figure 5-32 for recommended circuits for each configuration.



- Connect IOOUT to a high-impedance video buffer device.
- Place capacitors and resistors as close as possible to the DM335.
- Configure the VDAC\_CONFIG register in the system control module as follows: DINV = 0, PWD\_GBZ = 1, PWD\_VBUFZ = 0, ACCUP\_EN = X. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) and the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Video Processing Back End (VPBE) Reference Guide* (literature number SPRUF9) for more information on VDAC\_CONFIG.

**Figure 5-31. DAC Only Application Example**



- A. Place capacitors and resistors as close as possible to the DM335.
- B. You must use the circuit shown in this diagram. Also you must configure the VDAC\_CONFIG register in the System Control module as follows: TRESB4R4 = 0x3, TRESB4R2 = 0x8, TRESB4R1 = 0x8, TRIMBITS = 0x34, PWD\_BGZ = 1 (power up VREF), SPEED = 1 (faster), TVINT = don't care, PWD\_VBUFZ = 1 (power up video buffer), VREFSET = don't care, ACCUP\_EN = 0 (no A/C coupling), DINV = 1 (invert). See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) ARM Subsystem Reference Guide* (literature number SPRUF7) and the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Video Processing Back End (VPBE) Reference Guide* (literature number SPRUF9) for more information on the VDAC\_CONFIG register and Video Buffer.
- C. For proper TVOUT voltage, you must connect the pin TVOUT directly to the TV. No A/C coupling capacitor or termination resistor is necessary on your DM335 board. Also, it is assumed that the TV has no internal A/C coupling capacitor but does have an internal termination resistor, as shown in this diagram. TVOUT voltage will range from  $V_{OL(VIDBUF)}$  to  $V_{OH(VIDBUF)}$ . See [Section 4.3](#) for the voltage specifications.

**Figure 5-32. DAC With Buffer Circuit**

## 5.10 USB 2.0

The DM335 USB2.0 peripheral supports the following features:

- USB 2.0 peripheral at speeds high speed (HS: 480 Mb/s) and full speed (FS: 12 Mb/s)
- USB 2.0 host at speeds HS, FS, and low speed (LS: 1.5 Mb/s)
- All transfer modes (control, bulk, interrupt, and isochronous)
- Four Transmit (TX) and four Receive (RX) endpoints in addition to endpoint 0
- FIFO RAM
  - 4K bytes shared by all endpoints.
  - Programmable FIFO size
- Includes a DMA sub-module that supports four TX and four RX channels of CPPI 3.0 DMAs
- RNDIS mode for accelerating RNDIS type protocols using short packet termination over USB
- USB OTG extensions, i.e. session request protocol (SRP) and host negotiation protocol (HNP)

The DM335 USB2.0 peripheral does not support the following features:

- On-chip charge pump
- High bandwidth ISO mode is not supported (triple buffering)
- RNDIS mode acceleration for USB sizes that are not multiples of 64 bytes
- Endpoint max USB packet sizes that do not conform to the USB 2.0 spec (for FS/LS: 8, 16, 32, 64, and 1023 are defined; for HS: 64, 128, 512, and 1024 are defined)

### 5.10.1 USB2.0 Electrical Data/Timing

**Table 5-25. Switching Characteristics Over Recommended Operating Conditions for USB2.0 (see Figure 5-33)**

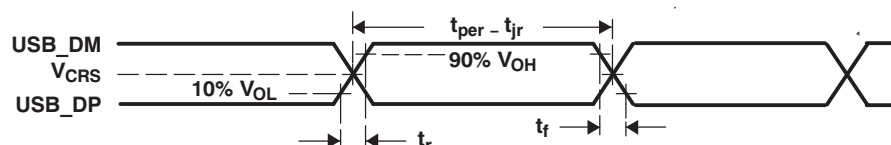
| NO. | PARAMETER                 |                                                               | DM335                 |      |                       |        |                                       |      | UNIT |
|-----|---------------------------|---------------------------------------------------------------|-----------------------|------|-----------------------|--------|---------------------------------------|------|------|
|     |                           |                                                               | LOW SPEED<br>1.5 Mbps |      | FULL SPEED<br>12 Mbps |        | HIGH SPEED <sup>(1)</sup><br>480 Mbps |      |      |
|     |                           |                                                               | MIN                   | MAX  | MIN                   | MAX    | MIN                                   | MAX  |      |
| 1   | t <sub>r(D)</sub>         | Rise time, USB_DP and USB_DM signals <sup>(2)</sup>           | 75                    | 300  | 4                     | 20     | 0.5                                   |      | ns   |
| 2   | t <sub>f(D)</sub>         | Fall time, USB_DP and USB_DM signals <sup>(2)</sup>           | 75                    | 300  | 4                     | 20     | 0.5                                   |      | ns   |
| 3   | t <sub>rrfm</sub>         | Rise/Fall time, matching <sup>(3)</sup>                       | 80                    | 125  | 90                    | 111.11 |                                       |      | %    |
| 4   | V <sub>CRS</sub>          | Output signal cross-over voltage <sup>(2)</sup>               | 1.3                   | 2    | 1.3                   | 2      |                                       |      | V    |
| 5   | t <sub>jr(source)NT</sub> | Source (Host) Driver jitter, next transition                  |                       | 2    |                       | 2      |                                       |      | ns   |
|     | t <sub>j(FUNC)NT</sub>    | Function Driver jitter, next transition                       |                       | 25   |                       | 2      |                                       |      | ns   |
| 6   | t <sub>jr(source)PT</sub> | Source (Host) Driver jitter, paired transition <sup>(4)</sup> |                       | 1    |                       | 1      |                                       |      | ns   |
|     | t <sub>j(FUNC)PT</sub>    | Function Driver jitter, paired transition                     |                       | 10   |                       | 1      |                                       |      | ns   |
| 7   | t <sub>w(EOPT)</sub>      | Pulse duration, EOP transmitter                               | 1250                  | 1500 | 160                   | 175    |                                       |      | ns   |
| 8   | t <sub>w(EOPR)</sub>      | Pulse duration, EOP receiver                                  | 670                   |      | 82                    |        |                                       |      | ns   |
| 9   | t <sub>(DRATE)</sub>      | Data Rate                                                     |                       | 1.5  |                       | 12     |                                       | 480  | Mb/s |
| 10  | Z <sub>DRV</sub>          | Driver Output Resistance                                      | —                     | —    | 28                    | 49.5   | 40.5                                  | 49.5 | Ω    |

(1) For more detailed specification information, see the Universal Serial Bus Specification Revision 2.0, Chapter 7. Electrical.

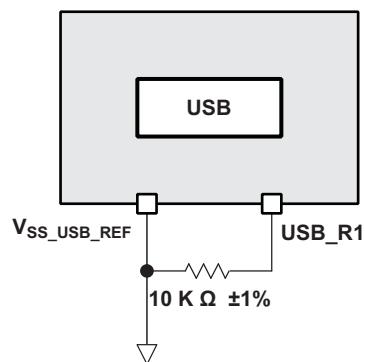
(2) Low Speed:  $C_L = 200$  pF, Full Speed:  $C_L = 50$  pF, High Speed:  $C_L = 50$  pF

(3)  $t_{frfm} = (t_r/t_f) \times 100$ . [Excluding the first transaction from the Idle state.]

(4)  $t_{jr} = t_{px(1)} - t_{px(0)}$



**Figure 5-33. USB2.0 Integrated Transceiver Interface Timing**

**Figure 5-34. USB Reference Resistor Routing**

## 5.11 Universal Asynchronous Receiver/Transmitter (UART)

The DM335 contains 3 separate UART modules (1 with hardware flow control). These modules performs serial-to-parallel conversion on data received from a peripheral device or modem, and parallel-to-serial conversion on data received from the CPU. Each UART also includes a programmable baud rate generator capable of dividing the 24MHz reference clock by divisors from 1 to 65,535 to produce a 16 x clock driving the internal logic. The UART modules support the following features:

- Frequency pre-scale values from 1 to 65,535 to generate appropriate baud rates
- 16-byte storage space for both the transmitter and receiver FIFOs
- Unique interrupts, one for each UART
- Unique EDMA events, both received and transmitted data for each UART
- 1, 4, 8, or 14 byte selectable receiver FIFO trigger level for autoflow control and DMA
- Programmable auto-rts and auto-cts for autoflow control (supported on UART2)
- Programmable serial data formats
  - 5, 6, 7, or 8-bit characters
  - Even, odd, or no parity bit generation and detection
  - 1, 1.5, or 2 stop bit generation
- False start bit detection
- Line break generation and detection
- Internal diagnostic capabilities
  - Loopback controls for communications link fault isolation
  - Break, parity, overrun, and framing error simulation
- Modem control functions: CTS, RTS (supported on UART2)

### 5.11.1 UART Electrical Data/Timing

**Table 5-26. Timing Requirements for UARTx Receive (see Figure 5-35)**

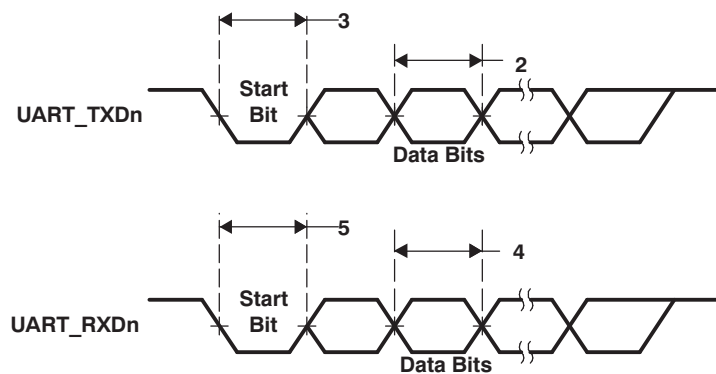
| NO. |                                                        | DM335         |               | UNIT |
|-----|--------------------------------------------------------|---------------|---------------|------|
|     |                                                        | MIN           | MAX           |      |
| 4   | $t_{w(URXDB)}$ Pulse duration, receive data bit (RXDn) | $0.99U^{(1)}$ | $1.05U^{(1)}$ | ns   |
| 5   | $t_{w(URXSB)}$ Pulse duration, receive start bit       | $0.99U^{(1)}$ | $1.05U^{(1)}$ | ns   |

(1)  $U$  = UART baud time =  $1/\text{programmed baud rate}$ .

**Table 5-27. Switching Characteristics Over Recommended Operating Conditions for UARTx Transmit (see Figure 5-35)**

| NO. | PARAMETER                                                  | DM335         |               | UNIT |
|-----|------------------------------------------------------------|---------------|---------------|------|
|     |                                                            | MIN           | MAX           |      |
| 1   | $f_{(\text{baud})}$ UART0/1 Maximum programmable baud rate |               | 1.5           | MHz  |
|     | UART2 Maximum programmable baud rate                       |               | 5             |      |
| 2   | $t_{w(UTXDB)}$ Pulse duration, transmit data bit (TXDn)    | $U - 2^{(1)}$ | $U + 2^{(1)}$ | ns   |
| 3   | $t_{w(UTXSB)}$ Pulse duration, transmit start bit          | $U - 2^{(1)}$ | $U + 2^{(1)}$ | ns   |

(1)  $U$  = UART baud time =  $1/\text{programmed baud rate}$ .

**Figure 5-35. UART Transmit/Receive Timing**

## 5.12 Serial Port Interface (SPI)

The DM335 contains 3 separate SPI modules. These modules provide a programmable length shift register which allows serial communication with other SPI devices through a 3 or 4 wire interface (Clock, Data In, Data Out, and Enable). The SPI supports the following features:

- Master mode operation
- 2 chip selects for interfacing to multiple slave SPI devices.
- 3 or 4 wire interface (Clock, Data In, Data Out, and Enable)
- Unique interrupt for each SPI port
- Separate DMA events for SPI Receive and Transmit
- 16-bit shift register
- Receive buffer register
- Programmable character length (2 to 16 bits)
- Programmable SPI clock frequency range
- 8-bit clock prescaler
- Programmable clock phase (delay or no delay)
- Programmable clock polarity

The SPI modules do not support the following features:

- Slave mode. Only Master mode is supported in DM335 (Master mode means that DM335 provides the serial clock).
- GPIO mode. GPIO functionality is supported by the GIO modules for those SPI pins that are multiplexed with GPIO signals.

### 5.12.1 SPI Electrical Data/Timing

Table 5-28. Timing Requirements for SPI (All Modes)<sup>(1)</sup> (see Figure 5-36)

| NO. |                                                               | DM335     |        | UNIT |
|-----|---------------------------------------------------------------|-----------|--------|------|
|     |                                                               | MIN       | MAX    |      |
| 1   | $t_{c(CLK)}$ Cycle time, SPI_CLK                              | 37.037 ns |        | ns   |
| 2   | $t_{w(CLKH)}$ Pulse duration, SPI_CLK high (All Master Modes) | 0.45*T    | 0.55*T | ns   |
| 3   | $t_{w(CLKL)}$ Pulse duration, SPI_CLK low (All Master Modes)  | 0.45*T    | 0.55*T | ns   |

(1)  $T = t_{c(CLK)}$  = SPI\_CLK period is equal to the SPI module clock divided by a configurable divider.

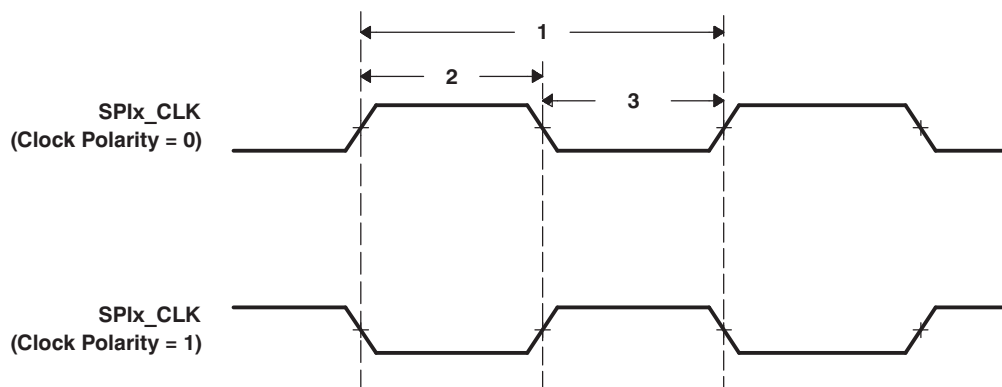


Figure 5-36. SPI\_CLK Timing

**SPI Master Mode Timings (Clock Phase = 0)****Table 5-29. Timing Requirements for SPI Master Mode [Clock Phase = 0] <sup>(1)</sup>(see Figure 5-37)**

| NO. |                    |                                                                       | DM335              |          | UNIT |
|-----|--------------------|-----------------------------------------------------------------------|--------------------|----------|------|
|     |                    |                                                                       | MIN                | MAX      |      |
| 4   | $t_{su(DIV-CLKL)}$ | Setup time, SPI_DI (input) valid before SPI_CLK (output) falling edge | Clock Polarity = 0 | .5P + 3  | ns   |
| 5   | $t_{su(DIV-CLKH)}$ | Setup time, SPI_DI (input) valid before SPI_CLK (output) rising edge  | Clock Polarity = 1 | .5P + 3  | ns   |
| 6   | $t_{h(CLKL-DIV)}$  | Hold time, SPI_DI (input) valid after SPI_CLK (output) falling edge   | Clock Polarity = 0 | .5P + 3  | ns   |
| 7   | $t_{h(CLKH-DIV)}$  | Hold time, SPI_DI (input) valid after SPI_CLK (output) rising edge    | Clock Polarity = 1 | 2.5P + 3 | ns   |

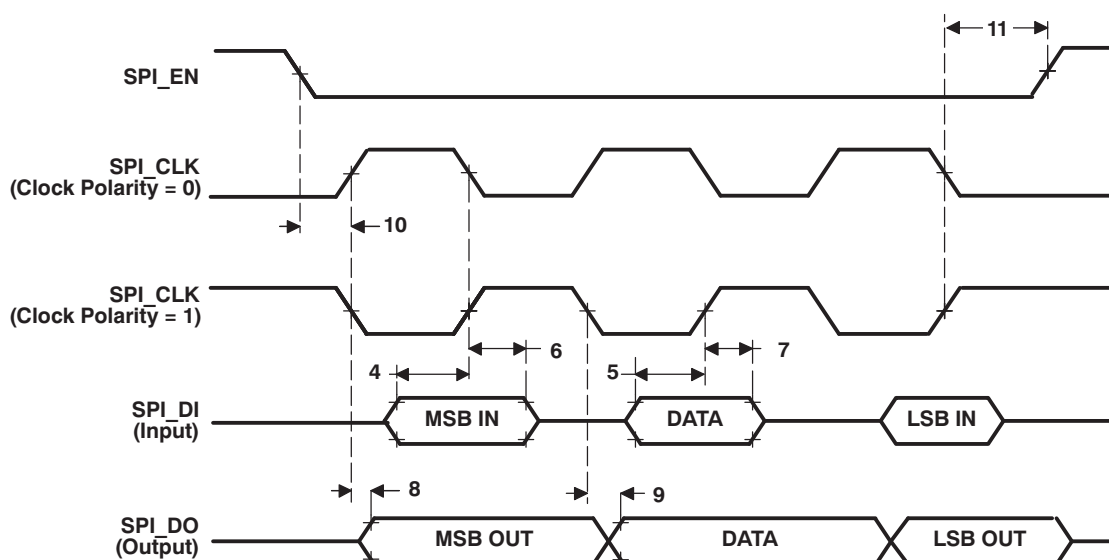
(1) P = 1/SYSCCLK2 in nanoseconds (ns). For example, if the SYSCCLK2 frequency is 216 MHz, use P = 4.63 ns. See [Section 3.5](#), *Device Clocking*, for more information on the supported clock configurations of the DM335.

**Table 5-30. Switching Characteristics Over Recommended Operating Conditions for SPI Master Mode [Clock Phase = 0] (see Figure 5-37)**

| NO. | PARAMETER                   |                                                                                                |                    | DM335                |     | UNIT |
|-----|-----------------------------|------------------------------------------------------------------------------------------------|--------------------|----------------------|-----|------|
|     |                             |                                                                                                |                    | MIN                  | MAX |      |
| 8   | t <sub>d</sub> (CLKH-DOV)   | Delay time, SPI_CLK (output) rising edge to SPI_DO (output) transition                         | Clock Polarity = 0 | -4                   | 5   | ns   |
| 9   | t <sub>d</sub> (CLKL-DOV)   | Delay time, SPI_CLK (output) falling edge to SPI_DO (output) transition                        | Clock Polarity = 1 | -4                   | 5   | ns   |
| 10  | t <sub>d</sub> (ENL-CLKH/L) | Delay time, SPI_EN[1:0] (output) falling edge to first SPI_CLK (output) rising or falling edge |                    | 2P <sup>(1)</sup>    | (1) | ns   |
| 11  | t <sub>d</sub> (CLKH/L-ENH) | Delay time, SPI_CLK (output) rising or falling edge to SPI_EN[1:0] (output) rising edge        |                    | P+.5C <sup>(2)</sup> | (2) | ns   |

(1) The delay time can be adjusted using the SPI module register C2TDELAY. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Serial Peripheral Interface (SPI) Reference Guide* ( literature number SPRUFY1).

(2) The delay time can be adjusted using the SPI module register T2CDELAY. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Serial Peripheral Interface (SPI) Reference Guide* ( literature number SPRUFY1).

**Figure 5-37. SPI Master Mode External Timing (Clock Phase = 0)**

**SPI Master Mode Timings (Clock Phase = 1)**

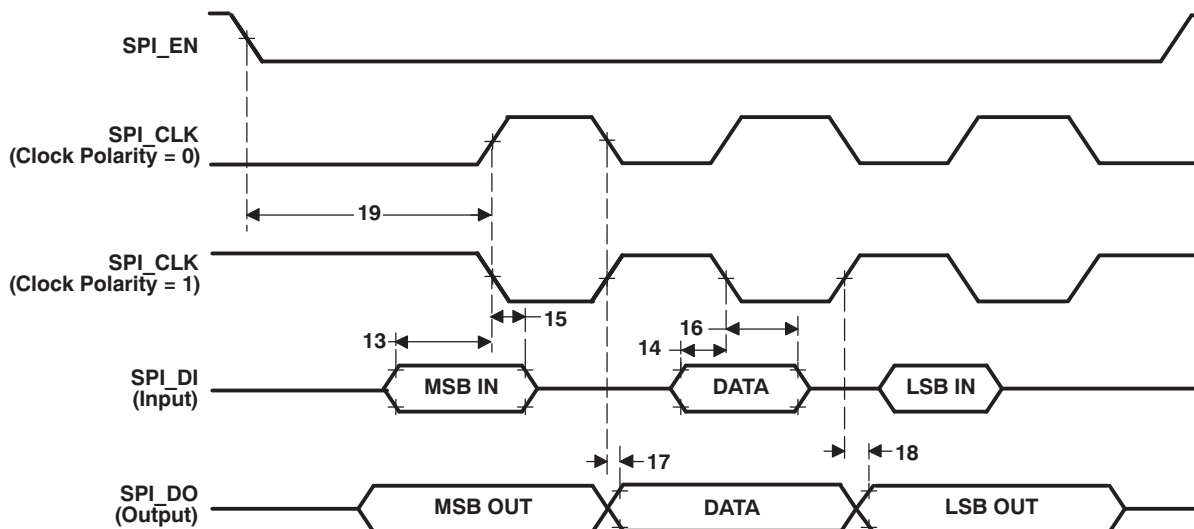
**Table 5-31. Timing Requirements for SPI Master Mode [Clock Phase = 1] (see Figure 5-38)**

| NO. |                    |                                                                       |                    | DM335   |     | UNIT |
|-----|--------------------|-----------------------------------------------------------------------|--------------------|---------|-----|------|
|     |                    |                                                                       |                    | MIN     | MAX |      |
| 13  | $t_{su(DIV-CLKL)}$ | Setup time, SPI_DI (input) valid before SPI_CLK (output) rising edge  | Clock Polarity = 0 | .5P + 3 |     | ns   |
| 14  | $t_{su(DIV-CLKH)}$ | Setup time, SPI_DI (input) valid before SPI_CLK (output) falling edge | Clock Polarity = 1 | .5P + 3 |     | ns   |
| 15  | $t_h(CLKL-DIV)$    | Hold time, SPI_DI (input) valid after SPI_CLK (output) rising edge    | Clock Polarity = 0 | .5P + 3 |     | ns   |
| 16  | $t_h(CLKH-DIV)$    | Hold time, SPI_DI (input) valid after SPI_CLK (output) falling edge   | Clock Polarity = 1 | .5P + 3 |     | ns   |

**Table 5-32. Switching Characteristics Over Recommended Operating Conditions for SPI Master Mode [Clock Phase = 1] (see Figure 5-38)**

| NO. | PARAMETER            |                                                                                                |                    | DM335         |     | UNIT |
|-----|----------------------|------------------------------------------------------------------------------------------------|--------------------|---------------|-----|------|
|     |                      |                                                                                                |                    | MIN           | MAX |      |
| 17  | $t_{d(CLKL-DOV)}$    | Delay time, SPI_CLK (output) falling edge to SPI_DO (output) transition                        | Clock Polarity = 0 | -4            | 5   | ns   |
| 18  | $t_{d(CLKH-DOV)}$    | Delay time, SPI_CLK (output) rising edge to SPI_DO (output) transition                         | Clock Polarity = 1 | -4            | 5   | ns   |
| 19  | $t_{d(ENL-CLKH/L)}$  | Delay time, SPI_EN[1:0] (output) falling edge to first SPI_CLK (output) rising or falling edge |                    | 2P+.5C<br>(1) | (1) | ns   |
| 20  | $t_{d(CLKL/H-DOH2)}$ | Delay time, SPI_CLK (output) falling or rising edge to SPI_DO (output) high impedance          |                    | P(2)          | (2) | ns   |

- (1) The delay time can be adjusted using the SPI module register C2TDELAY. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Serial Peripheral Interface (SPI) Reference Guide* (literature number SPRUFY1).
- (2) The delay time can be adjusted using the SPI module register T2CDELAY. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Serial Peripheral Interface (SPI) Reference Guide* (literature number SPRUFY1).



**Figure 5-38. SPI Master Mode External Timing (Clock Phase = 1)**

### 5.13 Inter-Integrated Circuit (I2C)

The inter-integrated circuit (I2C) module provides an interface between DM335 and other devices compliant with Philips Semiconductors Inter-IC bus (I<sup>2</sup>C-bus) specification version 2.1 and connected by way of an I<sup>2</sup>C-bus. External components attached to this 2-wire serial bus can transmit/receive up to 8-bit data to/from the DM335 through the I2C module.

The I2C port supports:

- Compatible with Philips I2C Specification Revision 2.1 (January 2000)
- Fast Mode up to 400 Kbps (no fail-safe I/O buffers)
- Noise Filter to Remove Noise 50 ns or less
- Seven- and Ten-Bit Device Addressing Modes
- Master (Transmit/Receive) and Slave (Transmit/Receive) Functionality
- Events: DMA, Interrupt, or Polling
- Slew-Rate Limited Open-Drain Output Buffers

For more detailed information on the I2C peripheral, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Inter-Integrated Circuit (I2C) Peripheral Reference Guide* (literature number SPRUFY3).

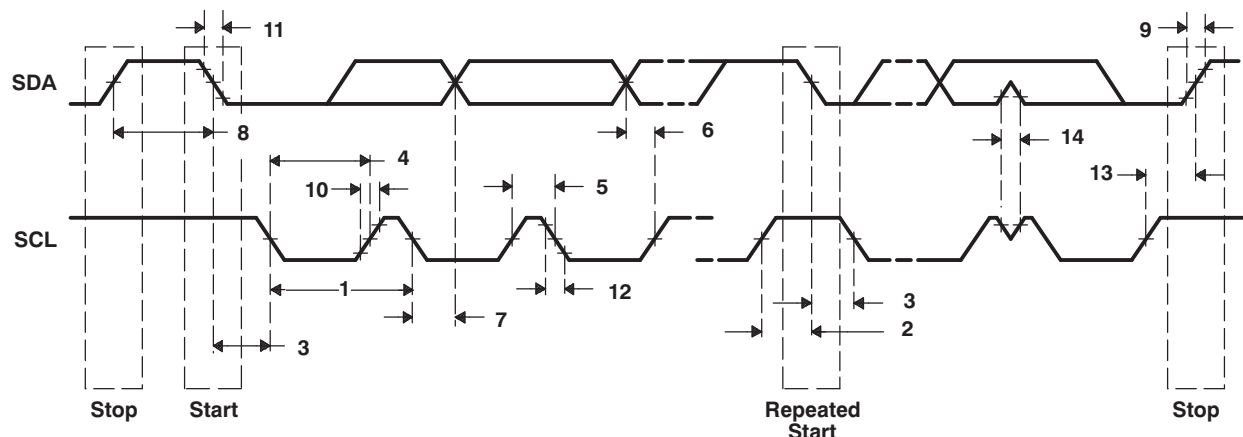
### 5.13.1 I2C Electrical Data/Timing

#### 5.13.1.1 Inter-Integrated Circuits (I2C) Timing

**Table 5-33. Timing Requirements for I2C Timings<sup>(1)</sup> (see Figure 5-39)**

| NO. |                            |                                                                               | DM335         |      |                     |             | UNIT          |
|-----|----------------------------|-------------------------------------------------------------------------------|---------------|------|---------------------|-------------|---------------|
|     |                            |                                                                               | STANDARD MODE |      | FAST MODE           |             |               |
|     |                            |                                                                               | MIN           | MAX  | MIN                 | MAX         |               |
| 1   | $t_c(\text{SCL})$          | Cycle time, SCL                                                               | 10            |      | 2.5                 |             | $\mu\text{S}$ |
| 2   | $t_{su}(\text{SCLH-SDAL})$ | Setup time, SCL high before SDA low (for a repeated START condition)          | 4.7           |      | 0.6                 |             | $\mu\text{S}$ |
| 3   | $t_h(\text{SCLL-SDAL})$    | Hold time, SCL low after SDA low (for a START and a repeated START condition) | 4             |      | 0.6                 |             | $\mu\text{S}$ |
| 4   | $t_w(\text{SCLL})$         | Pulse duration, SCL low                                                       | 4.7           |      | 1.3                 |             | $\mu\text{S}$ |
| 5   | $t_w(\text{SCLH})$         | Pulse duration, SCL high                                                      | 4             |      | 0.6                 |             | $\mu\text{S}$ |
| 6   | $t_{su}(\text{SDAV-SCLH})$ | Setup time, SDA valid before SCL high                                         | 250           |      | $100^{(2)}$         |             | ns            |
| 7   | $t_h(\text{SDA-SCLL})$     | Hold time, SDA valid after SCL low (For I <sup>2</sup> C bus devices)         | $0^{(3)}$     |      | $0^{(3)}$           | $0.9^{(4)}$ | $\mu\text{S}$ |
| 8   | $t_w(\text{SDAH})$         | Pulse duration, SDA high between STOP and START conditions                    | 4.7           |      | 1.3                 |             | $\mu\text{S}$ |
| 9   | $t_r(\text{SDA})$          | Rise time, SDA                                                                |               | 1000 | $20 + 0.1C_b^{(5)}$ | 300         | ns            |
| 10  | $t_r(\text{SCL})$          | Rise time, SCL                                                                |               | 1000 | $20 + 0.1C_b^{(5)}$ | 300         | ns            |
| 11  | $t_f(\text{SDA})$          | Fall time, SDA                                                                |               | 300  | $20 + 0.1C_b^{(5)}$ | 300         | ns            |
| 12  | $t_f(\text{SCL})$          | Fall time, SCL                                                                |               | 300  | $20 + 0.1C_b^{(5)}$ | 300         | ns            |
| 13  | $t_{su}(\text{SCLH-SDAH})$ | Setup time, SCL high before SDA high (for STOP condition)                     | 4             |      | 0.6                 |             | $\mu\text{S}$ |
| 14  | $t_w(\text{SP})$           | Pulse duration, spike (must be suppressed)                                    |               |      | 0                   | 50          | ns            |
| 15  | $C_b^{(5)}$                | Capacitive load for each bus line                                             |               | 400  |                     | 400         | pF            |

- (1) The I2C pins SDA and SCL do not feature fail-safe I/O buffers. These pins could potentially draw current when the device is powered down.
- (2) A Fast-mode I<sup>2</sup>C-bus device can be used in a Standard-mode I<sup>2</sup>C-bus system, but the requirement  $t_{su(SDA-SCLH)} \geq 250$  ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line  $t_r$  max +  $t_{su(SDA-SCLH)} = 1000 + 250 = 1250$  ns (according to the Standard-mode I<sup>2</sup>C-Bus Specification) before the SCL line is released.
- (3) A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the  $V_{IHmin}$  of the SCL signal) to bridge the undefined region of the falling edge of SCL.
- (4) The maximum  $t_{h(SDA-SCLL)}$  has only to be met if the device does not stretch the low period [ $t_{w(SCLL)}$ ] of the SCL signal.
- (5)  $C_b$  = total capacitance of one bus line in pF. If mixed with HS-C-bus devices, faster fall-times are allowed.



**Figure 5-39. I2C Receive Timings**

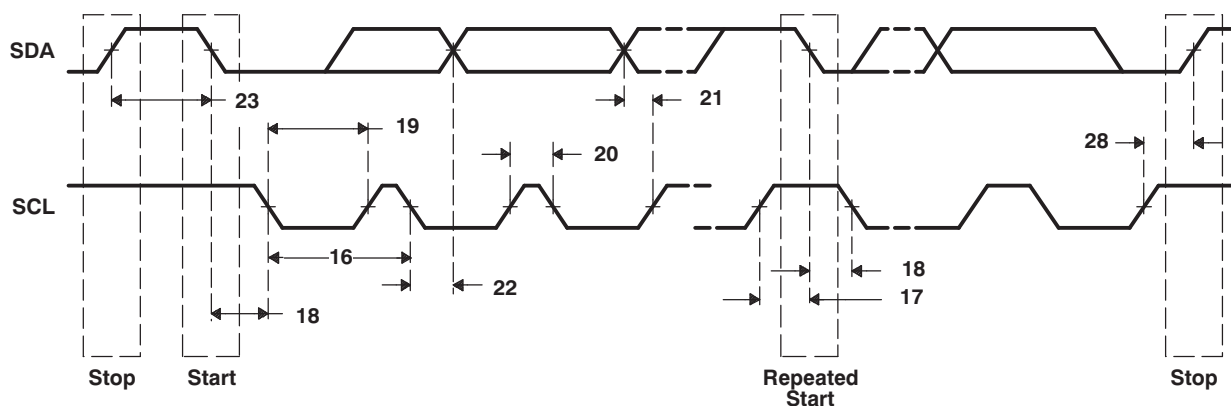
**Table 5-34. Switching Characteristics for I2C Timings<sup>(1)</sup>** (see [Figure 5-40](#))

| NO. | PARAMETER                 |                                                                             | DM335         |     |           |     | UNIT |
|-----|---------------------------|-----------------------------------------------------------------------------|---------------|-----|-----------|-----|------|
|     |                           |                                                                             | STANDARD MODE |     | FAST MODE |     |      |
|     |                           |                                                                             | MIN           | MAX | MIN       | MAX |      |
| 16  | t <sub>c(SCL)</sub>       | Cycle time, SCL                                                             | 10            |     | 2.5       |     | μS   |
| 17  | t <sub>d(SCLH-SDAL)</sub> | Delay time, SCL high to SDA low (for a repeated START condition)            | 4.7           |     | 0.6       |     | μS   |
| 18  | t <sub>d(SDAL-SCLL)</sub> | Delay time, SDA low to SCL low (for a START and a repeated START condition) | 4             |     | 0.6       |     | μS   |
| 19  | t <sub>w(SCLL)</sub>      | Pulse duration, SCL low                                                     | 4.7           |     | 1.3       |     | μS   |
| 20  | t <sub>w(SCLH)</sub>      | Pulse duration, SCL high                                                    | 4             |     | 0.6       |     | μS   |
| 21  | t <sub>d(SDAV-SCLH)</sub> | Delay time, SDA valid to SCL high                                           | 250           |     | 100       |     | ns   |
| 22  | t <sub>v(SCLL-SDAV)</sub> | Valid time, SDA valid after SCL low (For I2C devices)                       | 0             |     | 0         | 0.9 | μS   |
| 23  | t <sub>w(SDAH)</sub>      | Pulse duration, SDA high between STOP and START conditions                  | 4.7           |     | 1.3       |     | μS   |
| 28  | t <sub>d(SCLH-SDAH)</sub> | Delay time, SCL high to SDA high (for STOP condition)                       | 4             |     | 0.6       |     | μS   |
| 29  | C <sub>p</sub>            | Capacitance for each I2C pin                                                |               | 10  |           | 10  | pF   |

(1)  $C_b$  = total capacitance of one bus line in pF. If mixed with HS-mode devices, faster fall-times are allowed.

**CAUTION**

The DM335 I<sup>2</sup>C pins use a standard  $\pm 4$ -mA LVCMOS buffer, not the slow I/O buffer defined in the I<sup>2</sup>C specification. Series resistors may be necessary to reduce noise at the system level.

**Figure 5-40. I2C Transmit Timings**

## 5.14 Audio Serial Port (ASP)

DM335 includes two separate ASP controllers. The primary use for the audio serial port (ASP) is for audio interface purposes. The primary audio modes that are supported by the ASP are the AC97 and IIS modes. In addition to the primary audio modes, the ASP supports general serial port receive and transmit operation, but is not intended to be used as a high-speed interface. The ASP is backward compatible with other TI ASPs. The ASP supports the following features:

- Full-duplex communication
- Double-buffered data registers, which allow a continuous data stream
- Independent framing and clocking for receive and transmit
- External shift clock generation or an internal programmable frequency shift clock
- Double-buffered data registers, which allow a continuous data stream
- Independent framing and clocking for receive and transmit
- Direct interface to industry-standard codecs, analog interface chips (AICs), and other serially connected analog-to-digital (A/D) and digital-to-analog (D/A) devices
- Direct interface to AC97 compliant devices (the necessary multiphase frame synchronization capability is provided)
- Direct interface to IIS compliant devices
- Direct interface to SPI protocol in master mode only
- A wide selection of data sizes, including 8, 12, 16, 20, 24, and 32 bits
- $\mu$ -Law and A-Law companding
- 8-bit data transfers with the option of LSB or MSB first
- Programmable polarity for both frame synchronization and data clocks
- Highly programmable internal clock and frame generation

For more detailed information on the ASP peripheral, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) Audio Serial Port (ASP) Reference Guide* (literature number SPRUFZ3).

## 5.14.1 ASP Electrical Data/Timing

### 5.14.1.1 Audio Serial Port (ASP) Timing

**Table 5-35. Timing Requirements for ASP<sup>(1)</sup> (see [Figure 5-41](#))**

| NO. |                            |                                               |          | DM335                                   |     | UNIT |
|-----|----------------------------|-----------------------------------------------|----------|-----------------------------------------|-----|------|
|     |                            |                                               |          | MIN                                     | MAX |      |
| 15  | tc(CLK)                    | Cycle time, CLK                               | CLK ext  | 38.5 or<br>2P <sup>(2)</sup> (3)        |     | ns   |
| 16  | OTG(CLKS)                  | Pulse duration, CLKR/X high or CLKR/X low     | CLKS ext | 19.25 or<br>P <sup>(2)</sup> (3)<br>(4) |     | ns   |
| 5   | t <sub>su</sub> (FRH-CKRL) | Setup time, external FSR high before CLKR low | CLKR int | 21                                      |     | ns   |
|     |                            |                                               | CLKR ext | 6                                       |     |      |
| 6   | t <sub>h</sub> (CKRL-FRH)  | Hold time, external FSR high after CLKR low   | CLKR int | 0                                       |     | ns   |
|     |                            |                                               | CLKR ext | 6                                       |     |      |
| 7   | t <sub>su</sub> (DRV-CKRL) | Setup time, DR valid before CLKR low          | CLKR int | 21                                      |     | ns   |
|     |                            |                                               | CLKR ext | 6                                       |     |      |
| 8   | t <sub>h</sub> (CKRL-DRV)  | Hold time, DR valid after CLKR low            | CLKR int | 0                                       |     | ns   |
|     |                            |                                               | CLKR ext | 6                                       |     |      |
| 10  | t <sub>su</sub> (FXH-CKXL) | Setup time, external FSX high before CLKX low | CLKX int | 21                                      |     | ns   |
|     |                            |                                               | CLKX ext | 6                                       |     |      |
| 11  | t <sub>h</sub> (CKXL-FXH)  | Hold time, external FSX high after CLKX low   | CLKX int | 0                                       |     | ns   |
|     |                            |                                               | CLKX ext | 10                                      |     |      |

(1) CLKRP = CLKXP = FSRP = FSXP = 0. If polarity of any of the signals is inverted, then the timing references of that signal are also inverted.

(2) P = (1/SYSCLK2), where SYSCLK2 is an output clock of PLLC1 (see [Section 3.5](#)).

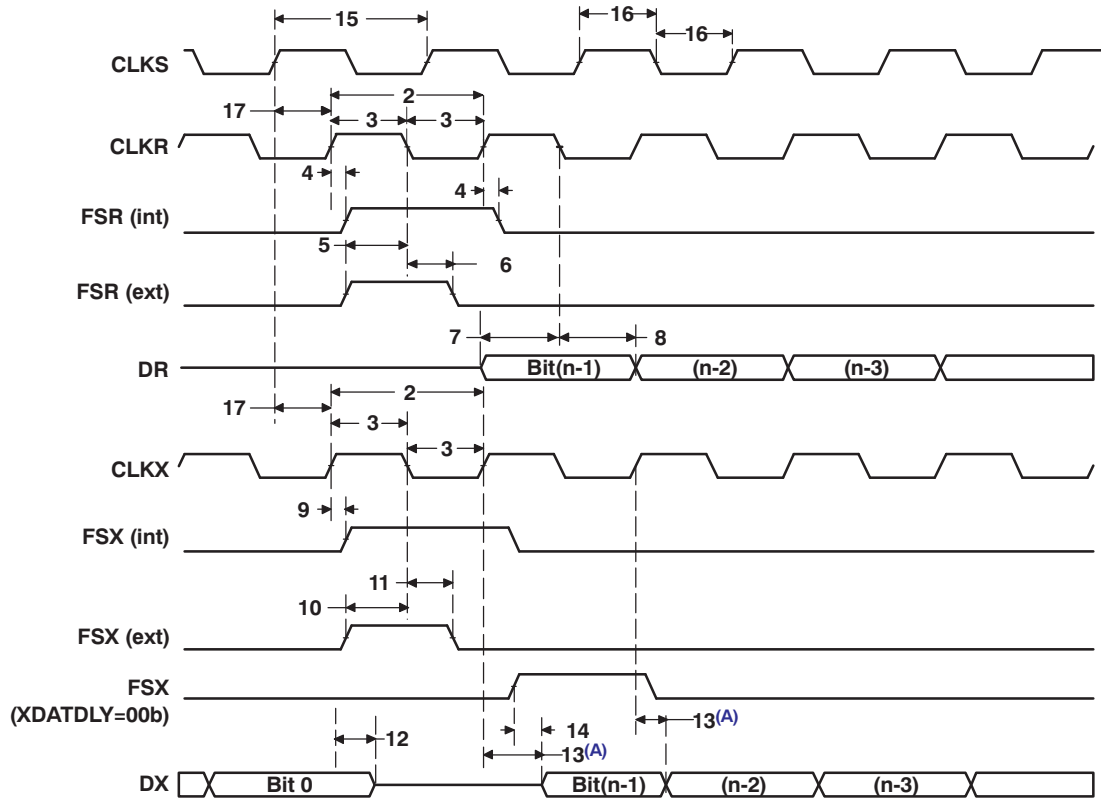
(3) Use which ever value is greater.

(4) The ASP does not have a duty cycle specification, just ensure that the minimum pulse duration specification is met.

**Table 5-36. Switching Characteristics Over Recommended Operating Conditions for ASP<sup>(1)</sup> (2)**  
(see [Figure 5-41](#))

| NO. | PARAMETER            |                                                                                               |            | DM335                                   |                      | UNIT |
|-----|----------------------|-----------------------------------------------------------------------------------------------|------------|-----------------------------------------|----------------------|------|
|     |                      |                                                                                               |            | MIN                                     | MAX                  |      |
| 2   | $t_{c(CKRX)}$        | Cycle time, CLKR/X                                                                            | CLKR/X int | 38.5 or<br>2P <sup>(3)</sup> (4)<br>(5) |                      | ns   |
| 17  | $t_d(CLKS-CLKRX)$    | Delay time, CLKS high to internal CLKR/X                                                      | CLKR/X int | 1                                       | 24                   |      |
| 3   | $t_w(CKRX)$          | Pulse duration, CLKR/X high or CLKR/X low                                                     | CLKR/X int | C - 1 <sup>(6)</sup>                    | C + 1 <sup>(6)</sup> | ns   |
| 4   | $t_d(CKRH-FRV)$      | Delay time, CLKR high to internal FSR valid                                                   | CLKR int   | 3                                       | 25                   | ns   |
|     |                      |                                                                                               | CLKR ext   | 3                                       | 25                   |      |
| 9   | $t_d(CKXH-FXV)$      | Delay time, CLKX high to internal FSX valid                                                   | CLKX int   | -4                                      | 8                    | ns   |
|     |                      |                                                                                               | CLKX ext   | 3                                       | 25                   |      |
| 12  | $t_{dis}(CKXH-DXHZ)$ | Disable time, DX high impedance following last data bit from CLKX high                        | CLKX int   |                                         | 12                   | ns   |
|     |                      |                                                                                               | CLKX ext   |                                         | 12                   | ns   |
| 13  | $t_d(CKXH-DXV)$      | Delay time, CLKX high to DX valid                                                             | CLKX int   | -5                                      | 12                   | ns   |
|     |                      |                                                                                               | CLKX ext   | 3                                       | 25                   | ns   |
| 14  | $t_d(FXH-DXV)$       | Delay time, FSX high to DX valid<br>ONLY applies when in data<br>delay 0 (XDATDLY = 00b) mode | FSX int    |                                         | 14                   | ns   |
|     |                      |                                                                                               | FSX ext    |                                         | 25                   |      |

- (1) CLKRP = CLKXP = FSRP = FSXP = 0. If polarity of any of the signals is inverted, then the timing references of that signal are also inverted.
- (2) Minimum delay times also represent minimum output hold times.
- (3) Minimum CLKR/X cycle times must be met, even when CLKR/X is generated by an internal clock source. Minimum CLKR/X cycle times are based on internal logic speed; the maximum usable speed may be lower due to EDMA limitations and AC timing requirements.
- (4)  $P = (1/SYSCLK2)$ , where SYSCLK2 is an output clock of PLLC1 (see [Section 3.5](#)).
- (5) Use which ever value is greater.
- (6) C = H or L  
S = sample rate generator input clock = P if CLKSM = 1 ( $P = 1/SYSCLK2$ , where SYSCLK2 is an output of PLLC1 (see [Section 3.5](#)))  
S = sample rate generator input clock = CLKS if CLKSM = 0  
H = CLKX high pulse width =  $(CLKGDV/2 + 1) * S$  if CLKGDV is even  
H =  $(CLKGDV + 1)/2 * S$  if CLKGDV is odd or zero  
L = CLKX low pulse width =  $(CLKGDV/2) * S$  if CLKGDV is even  
L =  $(CLKGDV + 1)/2 * S$  if CLKGDV is odd or zero  
CLKGDV should be set appropriately to ensure the ASP bit rate *does not* exceed the maximum limit (see footnote (3) above).



A. Parameter No. 13 applies to the first data nibble when XDATDLY  $\neq$  0.

**Figure 5-41. ASP Timing**

**Table 5-37. ASP as SPI Timing Requirements**

CLKSTP = 10b, CLKXP = 0 (see [Figure 5-42](#))

| NO. | PARAMETER                                               | MASTER |     | UNIT |
|-----|---------------------------------------------------------|--------|-----|------|
|     |                                                         | MIN    | MAX |      |
| M30 | $t_{su}(DRV-CKXL)$ Setup time, DR valid before CLKX low | 11     |     | ns   |
| M31 | $t_h(CKXL-DRV)$ Hold time, DR valid after CLKX low      | 0      |     | ns   |

**Table 5-38. ASP as SPI Switching Characteristics<sup>(1) (2)</sup>**

CLKSTP = 10b, CLKXP = 0 (see [Figure 5-42](#))

| NO. | PARAMETER                                                                                  | MASTER                 |           | UNIT |
|-----|--------------------------------------------------------------------------------------------|------------------------|-----------|------|
|     |                                                                                            | MIN                    | MAX       |      |
| M33 | $t_c(CKX)$ Cycle time, CLKX                                                                | 38.5 or $2P^{(1) (3)}$ |           | ns   |
| M24 | $t_d(CKXL-FXH)$ Delay time, CLKX low to FSX high <sup>(2)</sup>                            | $T - 2$                | $T + 3$   | ns   |
| M25 | $t_d(FXL-CKXH)$ Delay time, FSX low to CLKX high <sup>(4)</sup>                            | $L_1 - 2$              | $L_1 + 2$ | ns   |
| M26 | $t_d(CKXH-DXV)$ Delay time, CLKX high to DX valid                                          | -2                     | 6         | ns   |
| M27 | $t_{dis}(CKXL-DXHZ)$ Disable time, DX high impedance following last data bit from CLKX low | $L_1 - 3$              | $L_1 + 3$ | ns   |

(1)  $P = (1/SYSCLK2)$ , where SYSCLK2 is an output clock of PLLC1 (see [Section 3.5](#)).

(2)  $T = CLKX$  period =  $(1 + CLKGDV) \times 2P$

$L_1 = CLKX$  low pulse width =  $T/2$  when CLKGDV is odd or zero and =  $(CLKGDV/2) \times 2P$  when CLKGDV is even

(3) Use which ever value is greater.

(4) FSX should be low before the rising edge of clock to enable slave devices and then begin a SPI transfer at the rising edge of the master clock (CLKX).

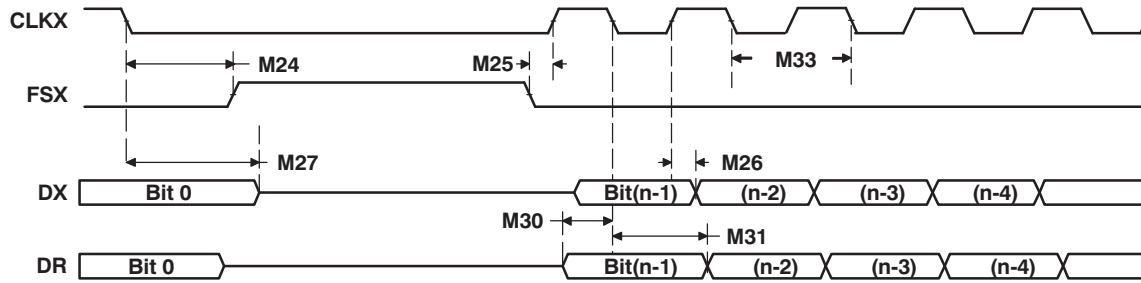


Figure 5-42. ASP as SPI: CLKSTP = 10b, CLKXP = 0

**Table 5-39. ASP as SPI Timing Requirements**

CLKSTP = 11b, CLKXP = 0

| NO. | PARAMETER                                                | MASTER |     | UNIT |
|-----|----------------------------------------------------------|--------|-----|------|
|     |                                                          | MIN    | MAX |      |
| M39 | $t_{su}(DRV-CKXH)$ Setup time, DR valid before CLKX high | 11     |     | ns   |
| M40 | $t_h(CKXH-DRV)$ Hold time, DR valid after CLKX high      | 1      |     | ns   |

**Table 5-40. ASP as SPI Switching Characteristics<sup>(1) (2)</sup>**

CLKSTP = 11b, CLKXP = 0 (see Figure 5-43)

| NO. | PARAMETER                                                                                  | MASTER                    |            | UNIT |
|-----|--------------------------------------------------------------------------------------------|---------------------------|------------|------|
|     |                                                                                            | MIN                       | MAX        |      |
| M42 | $t_c(CKX)$ Cycle time, CLKX                                                                | 38.5 or $2P^{(1)}$<br>(3) |            | ns   |
| M34 | $t_d(CKXL-FXH)$ Delay time, CLKX low to FSX high <sup>(4)</sup>                            | $L_1 - 2$                 | $L_1 + 3$  | ns   |
| M35 | $t_d(FXL-CKXH)$ Delay time, FSX low to CLKX high <sup>(5)</sup>                            | $T - 2$                   | $T + 2$    | ns   |
| M36 | $t_d(CKXL-DXV)$ Delay time, CLKX low to DX valid                                           | -2                        | 6          | ns   |
| M37 | $t_{dis}(CKXL-DXHZ)$ Disable time, DX high impedance following last data bit from CLKX low | -3                        | 3          | ns   |
| M38 | $t_d(FXL-DXV)$ Delay time, FSX low to DX valid                                             | $H_1 - 2$                 | $H_1 + 10$ | ns   |

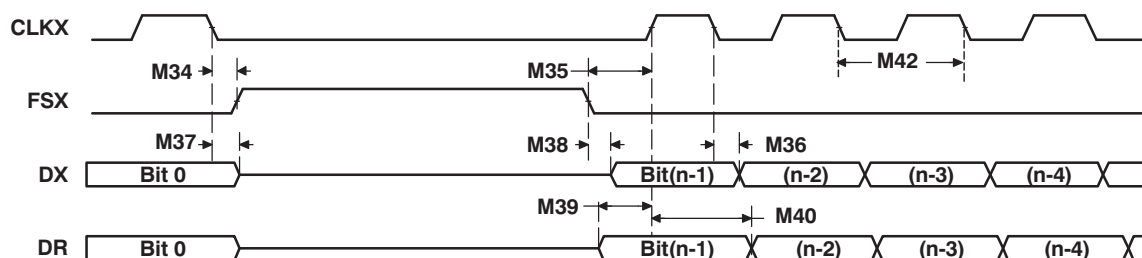
(1)  $P = (1/SYSCLK2)$ , where SYSCLK2 is an output clock of PLLC1 (see Section 3.5).(2)  $T = CLKX \text{ period} = (1 + CLKGDV) \times 2P$  $L_1 = CLKX \text{ low pulse width} = T/2$  when CLKGDV is odd or zero and  $= (CLKGDV/2) \times 2P$  when CLKGDV is even $H_1 = CLKX \text{ high pulse width} = T/2$  when CLKGDV is odd or zero and  $= (CLKGDV/2 + 1) \times 2P$  when CLKGDV is even

(3) Use which ever value is greater.

(4) FSRP = FSXP = 1. As a SPI master, FSX is inverted to provide active-low slave-enable output.

CLKXM = FSXM = 1, CLKRM = FSRM = 0 for master ASP

(5) FSX should be low before the rising edge of clock to enable slave devices and then begin a SPI transfer at the rising edge of the master clock (CLKX).

**Figure 5-43. ASP as SPI: CLKSTP = 11b, CLKXP = 0**

**Table 5-41. ASP as SPI Timing Requirements**

CLKSTP = 10b, CLKXP = 1 (see Figure 5-44)

| NO. | PARAMETER                                                | MASTER |     | UNIT |
|-----|----------------------------------------------------------|--------|-----|------|
|     |                                                          | MIN    | MAX |      |
| M49 | $t_{su(DRV-CKXH)}$ Setup time, DR valid before CLKX high | 11     |     | ns   |
| M50 | $t_h(CKXH-DRV)$ Hold time, DR valid after CLKX high      | 0      |     | ns   |

**Table 5-42. ASP as SPI Switching Characteristics<sup>(1) (2)</sup>**

CLKSTP = 10b, CLKXP = 1 (see Figure 5-44)

| NO. | PARAMETER                                                                                   | MASTER                           |                    | UNIT |
|-----|---------------------------------------------------------------------------------------------|----------------------------------|--------------------|------|
|     |                                                                                             | MIN                              | MAX                |      |
| M52 | $t_c(CKX)$ Cycle time, CLKX                                                                 | 38.5 or 2P <sup>(1)</sup><br>(3) |                    | ns   |
| M43 | $t_d(CKXH-FXH)$ Delay time, CLKX high to FSX high <sup>(4)</sup>                            | T – 1                            | T + 3              | ns   |
| M44 | $t_d(FXL-CKXL)$ Delay time, FSX low to CLKX low <sup>(5)</sup>                              | H <sub>1</sub> – 2               | H <sub>1</sub> + 2 | ns   |
| M45 | $t_d(CKXL-DXV)$ Delay time, CLKX low to DX valid                                            | –2                               | 6                  | ns   |
| M46 | $t_{dis}(CKXH-DXHZ)$ Disable time, DX high impedance following last data bit from CLKX high | H <sub>1</sub> – 3               | H <sub>1</sub> + 3 | ns   |

(1) P = (1/SYSCLOCK2), where SYSCLOCK2 is an output clock of PLLC1 (see Section 3.5) .

(2) T = CLKX period = (1 + CLKGDV) × 2P

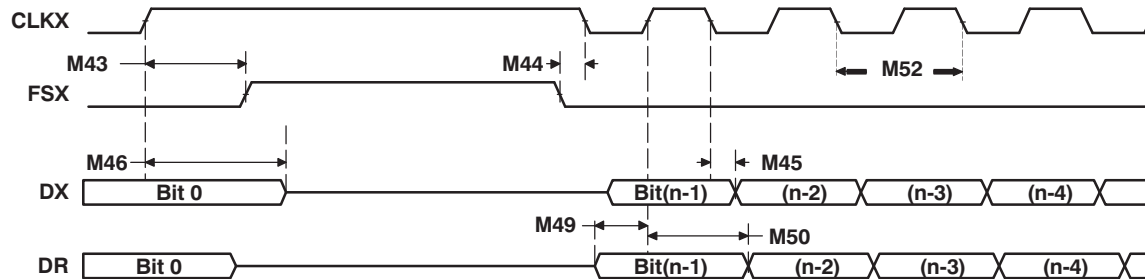
H<sub>1</sub> = CLKX high pulse width = T/2 when CLKGDV is odd or zero and = (CLKGDV/2 + 1) × 2P when CLKGDV is even

(3) Use which ever value is greater.

(4) FSRP = FSXP = 1. As a SPI master, FSX is inverted to provide active-low slave-enable output.

CLKXM = FSXM = 1, CLKRM = FSRM = 0 for master ASP

(5) FSX should be low before the rising edge of clock to enable slave devices and then begin a SPI transfer at the rising edge of the master clock (CLKX).



**Figure 5-44. ASP as SPI: CLKSTP = 10b, CLKXP = 1**

**Table 5-43. ASP as SPI Timing Requirements**

CLKSTP = 11b, CLKXP = 1 (see Figure 5-45)

| NO. | PARAMETER                                               | MASTER |     | UNIT |
|-----|---------------------------------------------------------|--------|-----|------|
|     |                                                         | MIN    | MAX |      |
| M58 | $t_{su}(DRV-CKXL)$ Setup time, DR valid before CLKX low | 11     |     | ns   |
| M59 | $t_h(CKXL-DRV)$ Hold time, DR valid after CLKX low      | 0      |     | ns   |

**Table 5-44. ASP as SPI Switching Characteristics<sup>(1) (2)</sup>**

CLKSTP = 11b, CLKXP = 1 (see Figure 5-45)

| NO. | PARAMETER                                                                                   | MASTER                    |            | UNIT |
|-----|---------------------------------------------------------------------------------------------|---------------------------|------------|------|
|     |                                                                                             | MIN                       | MAX        |      |
| M62 | $t_c(CKX)$ Cycle time, CLKX                                                                 | 38.5 or $2P^{(3)}$<br>(3) |            | ns   |
| M53 | $t_d(CKXH-FXH)$ Delay time, CLKX high to FSX high <sup>(4)</sup>                            | $H_1 - 1$                 | $H_1 + 3$  | ns   |
| M54 | $t_d(FXL-CKXL)$ Delay time, FSX low to CLKX low <sup>(5)</sup>                              | $T - 2$                   | $T + 2$    | ns   |
| M55 | $t_d(CKXL-DXV)$ Delay time, CLKX low to DX valid                                            | -2                        | 6          | ns   |
| M56 | $t_{dis}(CKXH-DXHZ)$ Disable time, DX high impedance following last data bit from CLKX high | -3                        | +3         | ns   |
| M57 | $t_d(FXL-DXV)$ Delay time, FSX low to DX valid                                              | $L_1 - 1$                 | $L_1 + 10$ | ns   |

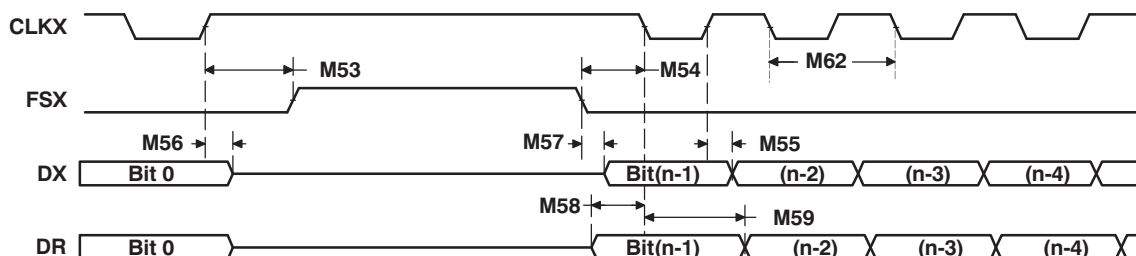
(1)  $P = (1/SYSCLK2)$ , where SYSCLK2 is an output clock of PLLC1 (see Section 3.5).(2)  $T = CLKX$  period =  $(1 + CLKGDV) \times 2P$  $L_1 = CLKX$  low pulse width =  $T/2$  when CLKGDV is odd or zero and =  $(CLKGDV/2) \times 2P$  when CLKGDV is even $H_1 = CLKX$  high pulse width =  $T/2$  when CLKGDV is odd or zero and =  $(CLKGDV/2 + 1) \times 2P$  when CLKGDV is even

(3) Use which ever value is greater.

(4) FSRP = FSXP = 1. As a SPI master, FSX is inverted to provide active-low slave-enable output.

CLKXM = FSXM = 1, CLKRM = FSRM = 0 for master ASP

(5) FSX should be low before the rising edge of clock to enable slave devices and then begin a SPI transfer at the rising edge of the master clock (CLKX).

**Figure 5-45. ASP as SPI: CLKSTP = 11b, CLKXP = 1**

## 5.15 Timer

The DM335 contains four software-programmable timers. Timer 0, Timer 1, and Timer 3 (general-purpose timers) can be programmed in 64-bit mode, dual 32-bit unchained mode, or dual 32-bit chained mode. Timer 3 supports additional features over the other timers: external clock/event input, period reload, output event tied to Real Time Out (RTO) module, external event capture, and timer counter register read reset. Timer 2 is used only as a watchdog timer. Timer 2 is tied to device reset.

- 64-bit count-up counter
- Timer modes:
  - 64-bit general-purpose timer mode (Timer 0, 1, 3)
  - Dual 32-bit general-purpose timer mode (Timer 0, 1, 3)
  - Watchdog timer mode (Timer 2)
- Two possible clock sources:
  - Internal clock
  - External clock/event input via timer input pins (Timer 3)
- Three possible operation modes:
  - One-time operation (timer runs for one period then stops)
  - Continuous operation (timer automatically resets after each period)
  - Continuous operation with period reload (Timer 3)
- Generates interrupts to the ARM CPU
- Generates sync event to EDMA
- Generates output event to device reset (Timer 2)
- Generates output event to Real Timer Out (RTO) module (Timer 3)
- External event capture via timer input pins (Timer 3)

For more detailed information, see the *TMS320DM335 Digital Media System-on-Chip (DMSoC) 64-bit Timer Reference Guide* (literature number SPRUFY0).

### 5.15.1 Timer Electrical Data/Timing

**Table 5-45. Timing Requirements for Timer Input<sup>(1) (2) (3)</sup> (see Figure 5-46)**

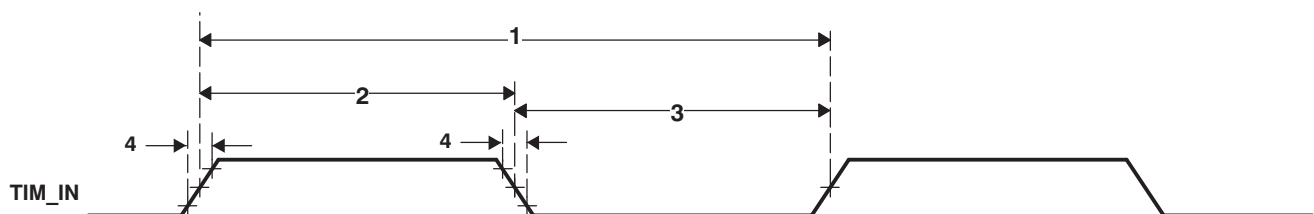
| NO. | PARAMETER                                  | DM335 |                            | UNIT |
|-----|--------------------------------------------|-------|----------------------------|------|
|     |                                            | MIN   | MAX                        |      |
| 1   | $t_{c(TIN)}$ Cycle time, TIM_IN            | 4P    |                            | ns   |
| 2   | $t_{w(TINPH)}$ Pulse duration, TIM_IN high | 0.45C | 0.55C                      | ns   |
| 3   | $t_{w(TINPL)}$ Pulse duration, TIM_IN low  | 0.45C | 0.55C                      | ns   |
| 4   | $t_{t(TIN)}$ Transition time, TIM_IN       |       | 0.25C or 10 <sup>(4)</sup> | ns   |

(1) GPIO000, GPIO001, GPIO002, and GPIO003 can be used as external clock inputs for Timer 3. See the *TMS320DM335 Digital Media System-on-Chip (DMSoC) 64-bit Timer Reference Guide* (literature number SPRUFY0).

(2) P = MXI1/CLKIN cycle time in ns. For example, when MXI1/CLKIN frequency is 24 MHz use P = 41.6 ns.

(3) C = TIM\_IN cycle time in ns. For example, when TIM\_IN frequency is 24 MHz use C = 41.6 ns

(4) Whichever is smaller. C = the period of the applied signal. Maintaining transition times as fast as possible is recommended to improve noise immunity on input signals.



**Figure 5-46. Timer Input Timing**

## 5.16 Pulse Width Modulator (PWM)

The DM335 contains 4 separate Pulse Width Modulator (PWM) modules. The pulse width modulator (PWM) feature is very common in embedded systems. It provides a way to generate a pulse periodic waveform for motor control or can act as a digital-to-analog converter with some external components. This PWM peripheral is basically a timer with a period counter and a first-phase duration comparator, where bit width of the period and first-phase duration are both programmable. The Pulse Width Modulator (PWM) modules support the following features:

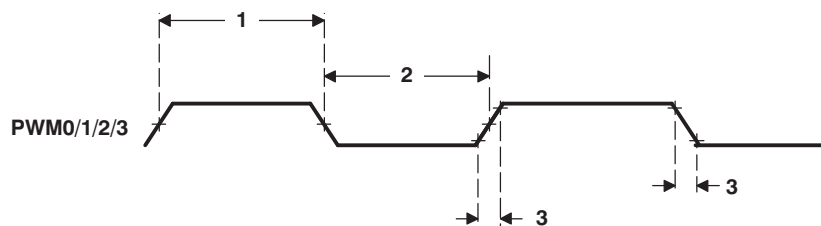
- 32-bit period counter
- 32-bit first-phase duration counter
- 8-bit repeat count for one-shot operation. One-shot operation will produce  $N + 1$  periods of the waveform, where  $N$  is the repeat counter value.
- Configurable to operate in either one-shot or continuous mode
- Buffered period and first-phase duration registers
- One-shot operation triggerable by hardware events with programmable edge transitions. (low-to-high or high-to-low).
- One-shot operation triggerable by the CCD VSYNC output of the video processing subsystem (VPSS), which allows any of the PWM instantiations to be used as a CCD timer. This allows the DM335 module to support the functions provided by the CCD timer feature (generating strobe and shutter signals).
- One-shot operation generates  $N+1$  periods of waveform,  $N$  being the repeat count register value
- Configurable PWM output pin inactive state
- Interrupt and EDMA synchronization events

### 5.16.1 PWM0/1/2/3 Electrical/Timing Data

**Table 5-46. Switching Characteristics Over Recommended Operating Conditions for PWM0/1/2/3 Outputs<sup>(1)</sup>** (see [Figure 5-47](#) and [Figure 5-48](#))

| NO. | PARAMETER                                                                | DM335 |      | UNIT |
|-----|--------------------------------------------------------------------------|-------|------|------|
|     |                                                                          | MIN   | MAX  |      |
| 1   | $t_w(\text{PWMH})$ Pulse duration, PWMx high                             | P     |      | ns   |
| 2   | $t_w(\text{PWML})$ Pulse duration, PWMx low                              | P     |      | ns   |
| 3   | $t_t(\text{PWM})$ Transition time, PWMx                                  |       | .05P | ns   |
| 4   | $t_d(\text{CCDC-PWMV})$ Delay time, CCDC(VD) trigger event to PWMx valid |       | 10   | ns   |

(1) P = MXI1/CLKIN cycle time in ns. For example, when MXI1/CLKIN frequency is 24 MHz use  $P = 41.\bar{6}$  ns.



**Figure 5-47. PWM Output Timing**

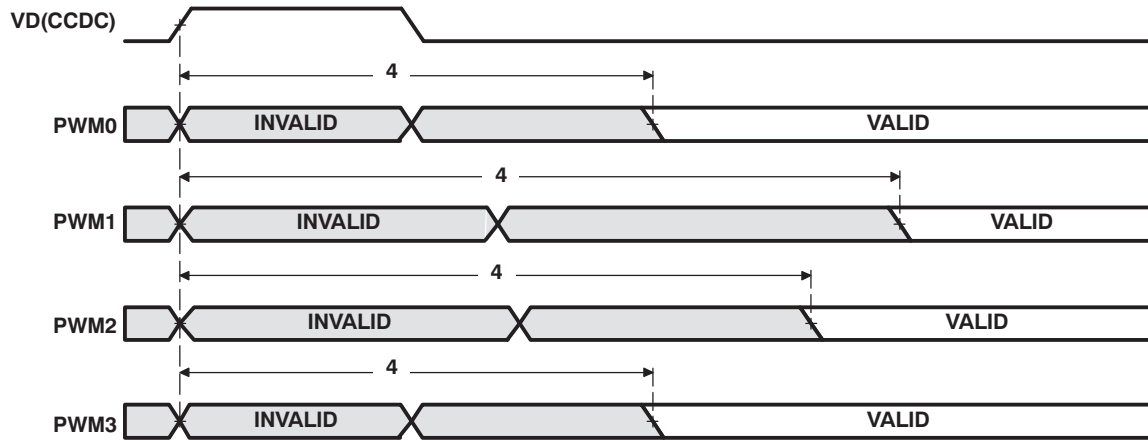


Figure 5-48. PWM Output Delay Timing

## 5.17 Real Time Out (RTO)

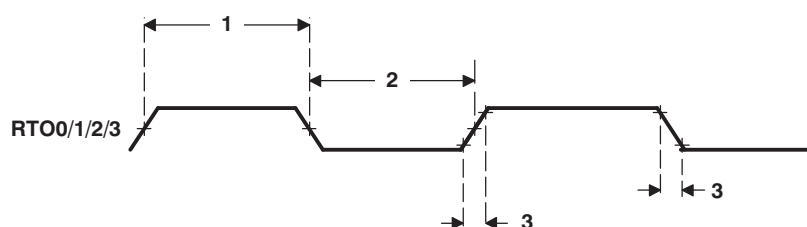
The DM335 Real Time Out (RTO) peripheral supports the following features:

- Four separate outputs
- Trigger on Timer3 event

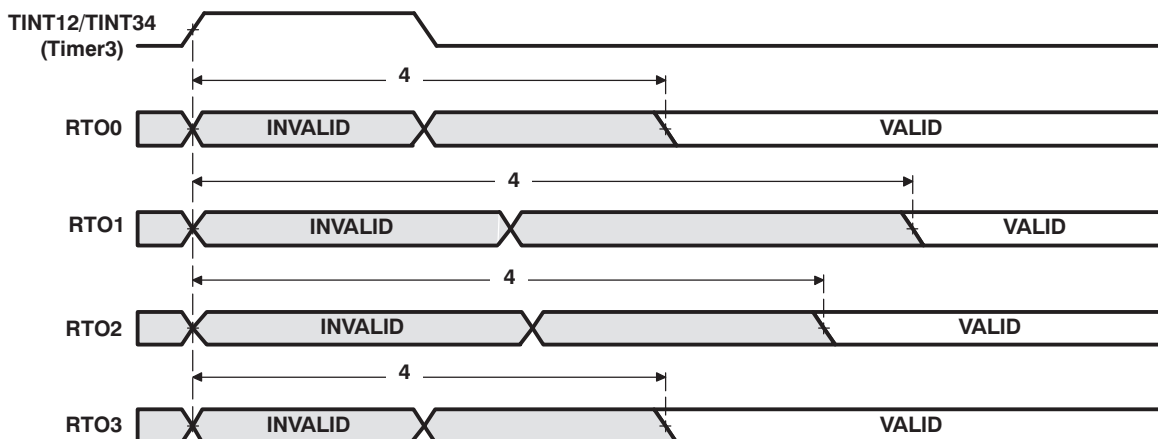
### 5.17.1 RTO Electrical/Timing Data

**Table 5-47. Switching Characteristics Over Recommended Operating Conditions for RTO Outputs (see Figure 5-49 and Figure 5-50)**

| NO. | PARAMETER                                                                               | DM335 |     | UNIT |
|-----|-----------------------------------------------------------------------------------------|-------|-----|------|
|     |                                                                                         | MIN   | MAX |      |
| 1   | $t_{w(RTOH)}$ Pulse duration, RTOx high                                                 | P     |     | ns   |
| 2   | $t_{w(RTOL)}$ Pulse duration, RTOx low                                                  | P     |     | ns   |
| 3   | $t_{t(RTO)}$ Transition time, RTOx                                                      |       | .1P | ns   |
| 4   | $t_{d(TIMER3-RTOV)}$ Delay time, Timer 3 (TINT12 or TINT34) trigger event to RTOx valid |       | 10  | ns   |



**Figure 5-49. RTO Output Timing**



**Figure 5-50. RTO Output Delay Timing**

## 5.18 IEEE 1149.1 JTAG

The JTAG<sup>(1)</sup> interface is used for BSDL testing and emulation of the DM335 device.

The DM335 device requires that both  $\overline{\text{TRST}}$  and  $\overline{\text{RESET}}$  be asserted upon power up to be properly initialized. While  $\overline{\text{RESET}}$  initializes the device,  $\overline{\text{TRST}}$  initializes the device's emulation logic. Both resets are required for proper operation.

While both  $\overline{\text{TRST}}$  and  $\overline{\text{RESET}}$  need to be asserted upon power up, only  $\overline{\text{RESET}}$  needs to be released for the device to boot properly.  $\overline{\text{TRST}}$  may be asserted indefinitely for normal operation, keeping the JTAG port interface and device's emulation logic in the reset state.

$\overline{\text{TRST}}$  only needs to be released when it is necessary to use a JTAG controller to debug the device or exercise the device's boundary scan functionality. Note:  $\overline{\text{TRST}}$  is synchronous and **must** be clocked by TCK; otherwise, the boundary scan logic may not respond as expected after  $\overline{\text{TRST}}$  is asserted.

$\overline{\text{RESET}}$  must be released only in order for boundary-scan JTAG to read the variant field of IDCODE correctly. Other boundary-scan instructions work correctly independent of current state of  $\overline{\text{RESET}}$ .

For maximum reliability, DM335 includes an internal pulldown (PD) on the  $\overline{\text{TRST}}$  pin to ensure that  $\overline{\text{TRST}}$  will always be asserted upon power up and the device's internal emulation logic will always be properly initialized.

JTAG controllers from Texas Instruments actively drive  $\overline{\text{TRST}}$  high. However, some third-party JTAG controllers may not drive  $\overline{\text{TRST}}$  high but expect the use of a pullup resistor on  $\overline{\text{TRST}}$ .

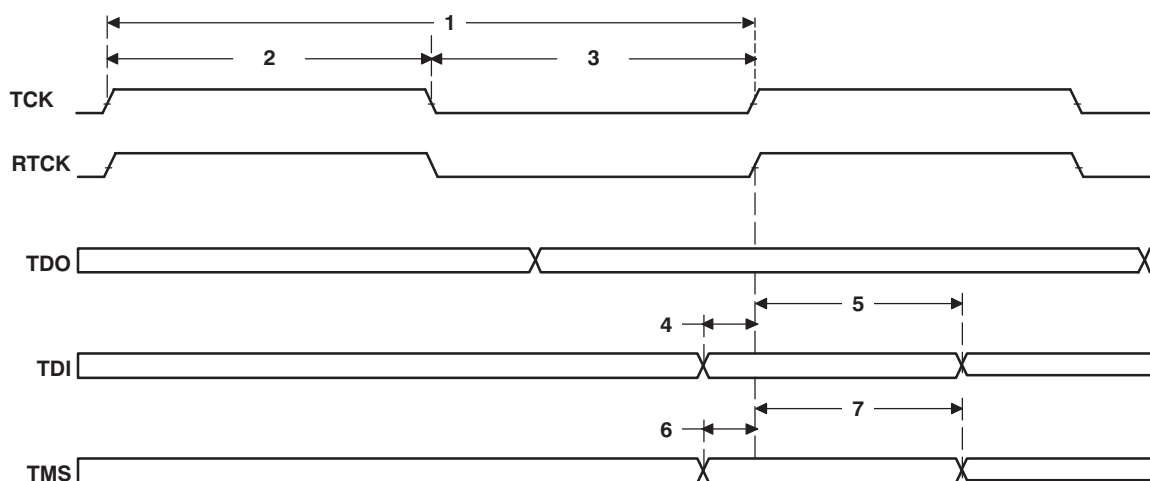
When using this type of JTAG controller, assert  $\overline{\text{TRST}}$  to initialize the device after powerup and externally drive  $\overline{\text{TRST}}$  high before attempting any emulation or boundary scan operations. Following the release of  $\overline{\text{RESET}}$ , the low-to-high transition of  $\overline{\text{TRST}}$  must be "seen" to latch the state of EMU1 and EMU0. The EMU[1:0] pins configure the device for either Boundary Scan mode or Emulation mode. For more detailed information, see the terminal functions section of this data sheet.

(1) IEEE Standard 1149.1-1990 Standard-Test-Access Port and Boundary Scan Architecture.

### 5.18.1 JTAG Test-Port Electrical Data/Timing

**Table 5-48. Timing Requirements for JTAG Test Port (see Figure 5-51)**

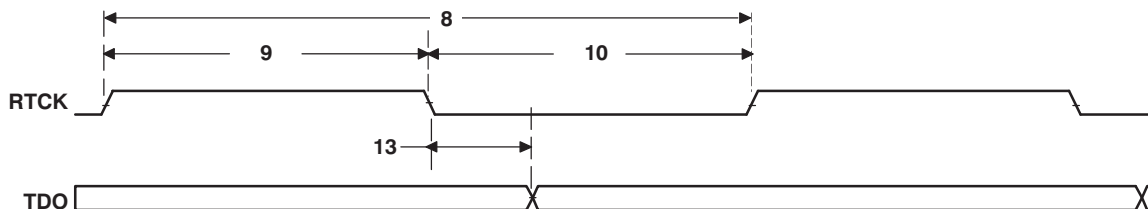
| NO. | PARAMETER            |                                        | DM335 |     | UNIT |
|-----|----------------------|----------------------------------------|-------|-----|------|
|     |                      |                                        | MIN   | MAX |      |
| 1   | $t_{c(TCK)}$         | Cycle time, TCK                        | 20    |     | ns   |
| 2   | $t_{w(TCKH)}$        | Pulse duration, TCK high               | 8     |     | ns   |
| 3   | $t_{w(TCKL)}$        | Pulse duration, TCK low                | 8     |     | ns   |
| 4   | $t_{su(TDIV-RTCKH)}$ | Setup time, TDI valid before RTCK high | 10    |     | ns   |
| 5   | $t_{h(RTCKH-TDIV)}$  | Hold time, TDI valid after RTCK high   | 9     |     | ns   |
| 6   | $t_{su(TMSV-RTCKH)}$ | Setup time, TMS valid before RTCK high | 2     |     | ns   |
| 7   | $t_{h(RTCKH-TMSV)}$  | Hold time, TMS valid after RTCK high   | 5     |     | ns   |



**Figure 5-51. JTAG Input Timing**

**Table 5-49. Switching Characteristics Over Recommended Operating Conditions for JTAG Test Port**  
(see [Figure 5-51](#))

| NO. | PARAMETER                                                  | DM335 |                        | UNIT |
|-----|------------------------------------------------------------|-------|------------------------|------|
|     |                                                            | MIN   | MAX                    |      |
| 8   | $t_{c(RTCK)}$ Cycle time, RTCK                             | 20    |                        | ns   |
| 9   | $t_w(RTCKH)$ Pulse duration, RTCK high                     | 10    |                        |      |
| 10  | $t_w(RTCKL)$ Pulse duration, RTCK low                      | 10    |                        |      |
| 11  | $t_r(\text{all JTAG outputs})$ Rise time, all JTAG outputs |       | 1.3                    | ns   |
| 12  | $t_f(\text{all JTAG outputs})$ Fall time, all JTAG outputs |       | 1.3                    | ns   |
| 13  | $t_d(RTCKL\text{-}TDOV)$ Delay time, TCK low to TDO valid  | 0     | $0.25 \cdot t_c(RTCK)$ | ns   |



**Figure 5-52. JTAG Output Timing**

## 6 Mechanical Data

The following table(s) show the thermal resistance characteristics for the PBGA – ZCE mechanical package. Note that micro-vias are not required. Contact your TI representative for routing recommendations.

### 6.1 Thermal Data for ZCE

The following table shows the thermal resistance characteristics for the PBGA – ZCE mechanical package.

**Table 6-1. Thermal Resistance Characteristics (PBGA Package) [ZCE]**

| NO. |                                      | °C/W <sup>(1)</sup> |
|-----|--------------------------------------|---------------------|
| 1   | R $\Theta_{JC}$ Junction-to-case     | 7.2                 |
| 2   | R $\Theta_{JB}$ Junction-to-board    | 11.4                |
| 3   | R $\Theta_{JA}$ Junction-to-free air | 27.0                |
| 4   | PSi $_{JT}$ Junction-to-package top  | 0.1                 |
| 5   | PSi $_{JB}$ Junction-to-board        | 11.3                |

- (1) The junction-to-case measurement was conducted in a JEDEC defined 2S2P system and will change based on environment as well as application. For more information, see these three EIA/JEDEC standards:
- EIA/JESD51-2, Integrated Circuits Thermal Test Method Environment Conditions - Natural Convection (Still Air)
  - EIA/JESD51-3, Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages
  - JESD51-7, High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages

### 6.2 Packaging Information

The following packaging information and addendum reflect the most current data available for the designated device(s). This data is subject to change without notice and without revision of this document. Note that micro-vias are not required for this package.

## PACKAGING INFORMATION

| Orderable Device   | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)   | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                     | Samples                 |
|--------------------|---------------|--------------|--------------------|------|----------------|-------------------|------------------|----------------------|--------------|---------------------------------------------|-------------------------|
| TMS320DM335CZCE216 | NRND          | NFBGA        | ZCE                | 337  | 160            | Pb-Free<br>(RoHS) | SNAGCU           | Level-3-260C-168 HR  |              | DM335CZCE<br>216<br>TMS320<br>DM355ZCE 216  |                         |
| TMS320DM335DZCE135 | ACTIVE        | NFBGA        | ZCE                | 337  |                | Pb-Free<br>(RoHS) | SNAGCU           | Level-3-260C-168 HR  | 0 to 85      | DM335DZCE<br>135<br>TMS320                  | <a href="#">Samples</a> |
| TMS320DM335DZCE216 | ACTIVE        | NFBGA        | ZCE                | 337  | 160            | Pb-Free<br>(RoHS) | SNAGCU           | Level-3-260C-168 HR  | 0 to 85      | DM335DZCE<br>216<br>TMS320                  | <a href="#">Samples</a> |
| TMS320DM335ZCEA135 | OBSOLETE      | NFBGA        | ZCE                | 337  |                | TBD               | Call TI          | Call TI              | -40 to 100   | DM335ZCE<br>A135<br>TMS320<br>DM335ZCE A135 |                         |
| TMS320DM335ZCEA216 | OBSOLETE      | NFBGA        | ZCE                | 337  |                | TBD               | Call TI          | Call TI              | -40 to 100   | DM335ZCE<br>A216<br>TMS320<br>DM335ZCE A216 |                         |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

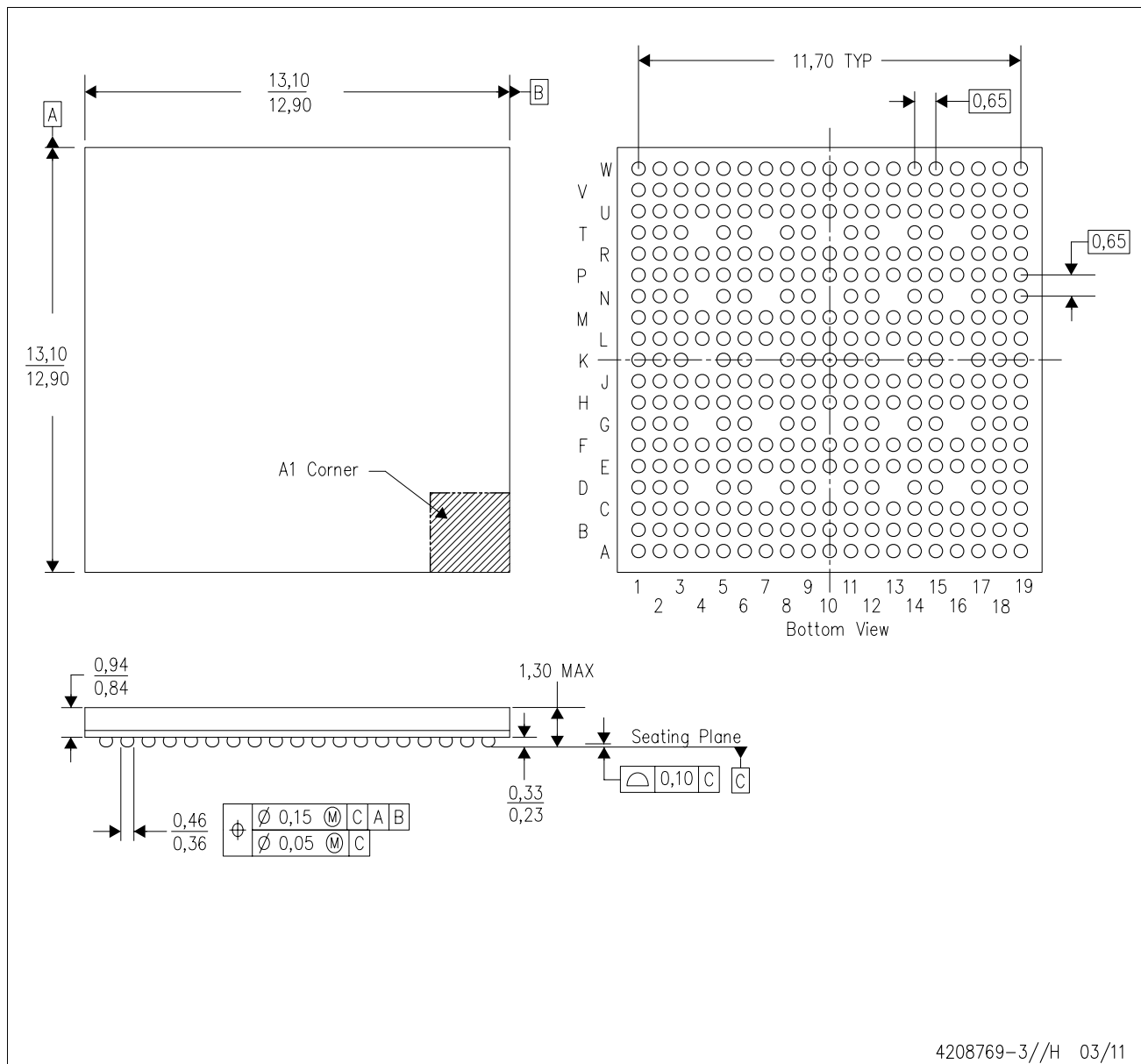
<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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ZCE (S-PBGA-N337)

PLASTIC BALL GRID ARRAY



NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.  
 B. This drawing is subject to change without notice.  
 C. This is a Pb-free solder ball design.

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