# TMS320DM643
# Video/Imaging Fixed-Point Digital Signal Processor

**Check for Samples: TMS320DM643**

## 1 TMS320DM643 Video/Imaging Fixed-Point Digital Signal Processor

- **High-Performance Digital Media Processor**
  - **2-, 1.67-ns Instruction Cycle Time**
  - **500-, 600-MHz Clock Rate**
  - **Eight 32-Bit Instructions/Cycle**
  - **4000, 4800 MIPS**
  - **Fully Software-Compatible With C64x™**
- **VelociTI.2™ Extensions to VelociTI™ Advanced Very-Long-Instruction-Word (VLIW) TMS320C64x™ DSP Core**
  - **Eight Highly Independent Functional Units With VelociTI.2™ Extensions:**
    - **Six ALUs (32-/40-Bit), Each Supports Single 32-Bit, Dual 16-Bit, or Quad 8-Bit Arithmetic per Clock Cycle**
    - **Two Multipliers Support Four 16 x 16-Bit Multiplies (32-Bit Results) per Clock Cycle or Eight 8 x 8-Bit Multiplies (16-Bit Results) per Clock Cycle**
  - **Load-Store Architecture With Non-Aligned Support**
  - **64 32-Bit General-Purpose Registers**
  - **Instruction Packing Reduces Code Size**
  - **All Instructions Conditional**
- **Instruction Set Features**
  - **Byte-Addressable (8-/16-/32-/64-Bit Data)**
  - **8-Bit Overflow Protection**
  - **Bit-Field Extract, Set, Clear**
  - **Normalization, Saturation, Bit-Counting**
  - **VelociTI.2™ Increased Orthogonality**
- **L1/L2 Memory Architecture**
  - **128K-Bit (16K-Byte) L1P Program Cache (Direct Mapped)**
  - **128K-Bit (16K-Byte) L1D Data Cache (2-Way Set-Associative)**
  - **2M-Bit (256K-Byte) L2 Unified Mapped RAM/Cache (Flexible RAM/Cache Allocation)**
- **Endianess: Little Endian, Big Endian**
- **64-Bit External Memory Interface (EMIF)**
  - **Glueless Interface to Asynchronous Memories (SRAM and EPROM) and Synchronous Memories (SDRAM, SBSRAM, ZBT SRAM, and FIFO)**
  - **1024M-Byte Total Addressable External Memory Space**
- **Enhanced Direct-Memory-Access (EDMA) Controller (64 Independent Channels)**
- **10/100 Mb/s Ethernet MAC (EMAC)**
  - **IEEE 802.3 Compliant**
  - **Media Independent Interface (MII)**
  - **8 Independent Transmit (TX) Channels and 1 Receive (RX) Channel**
- **Management Data Input/Output (MDIO)**
- **Two Configurable Video Ports (VP1, VP2)**
  - **Providing a Glueless I/F to Common Video Decoder and Encoder Devices**
  - **Supports Multiple Resolutions/Video Stds**
- **VCXO Interpolated Control Port (VIC)**
  - **Supports Audio/Video Synchronization**
- **Host-Port Interface (HPI) [32-/16-Bit]**
- **Multichannel Audio Serial Port (McASP)**
  - **Eight Serial Data Pins**
  - **Wide Variety of $I^2S$ and Similar Bit Stream Format**
  - **Integrated Digital Audio I/F Transmitter Supports S/PDIF, IEC60958-1, AES-3, CP-430 Formats**
- **Inter-Integrated Circuit ( $I^2C$ Bus™)**
- **Multichannel Buffered Serial Port**
  - **CLKS Input Not Supported**
- **Three 32-Bit General-Purpose Timers**
- **Sixteen General-Purpose I/O (GPIO) Pins**
- **Flexible PLL Clock Generator**
- **IEEE-1149.1 (JTAG) Boundary-Scan-Compatible**
- **548-Pin Ball Grid Array (BGA) Package (GDK and ZDK Suffixes), 0.8-mm Ball Pitch**
- **548-Pin Ball Grid Array (BGA) Package (GNZ and ZNZ Suffixes), 1.0-mm Ball Pitch**
- **0.13-µm/6-Level Cu Metal Process (CMOS)**
- **3.3-V I/O, 1.2-V Internal (-500)**
- **3.3-V I/O, 1.4-V Internal (-600)**

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The TMS320C64x™ DSPs (including the TMS320DM643 device) are the highest-performance fixed-point DSP generation in the TMS320C6000™ DSP platform. The TMS320DM643 (DM643) device is based on the second-generation high-performance, advanced VelociTI™ very-long-instruction-word (VLIW) architecture (VelociTI.2™) developed by Texas Instruments (TI), making these DSPs an excellent choice for digital media applications. The C64x™ is a code-compatible member of the C6000™ DSP platform.

With performance of up to 4800 million instructions per second (MIPS) at a clock rate of 600 MHz, the DM643 device offers cost-effective solutions to high-performance DSP programming challenges. The DM643 DSP possesses the operational flexibility of high-speed controllers and the numerical capability of array processors. The C64x™ DSP core processor has 64 general-purpose registers of 32-bit word length and eight highly independent functional units—two multipliers for a 32-bit result and six arithmetic logic units (ALUs)—with VelociTI.2™ extensions. The VelociTI.2™ extensions in the eight functional units include new instructions to accelerate the performance in video and imaging applications and extend the parallelism of the VelociTI™ architecture. The DM643 can produce four 16-bit multiply-accumulates (MACs) per cycle for a total of 2400 million MACs per second (MMACS), or eight 8-bit MACs per cycle for a total of 4800 MMACS. The DM643 DSP also has application-specific hardware logic, on-chip memory, and additional on-chip peripherals similar to the other C6000™ DSP platform devices.

The DM643 uses a two-level cache-based architecture and has a powerful and diverse set of peripherals. The Level 1 program cache (L1P) is a 128-Kbit direct mapped cache and the Level 1 data cache (L1D) is a 128-Kbit 2-way set-associative cache. The Level 2 memory/cache (L2) consists of an 2-Mbit memory space that is shared between program and data space. L2 memory can be configured as mapped memory, cache, or combinations of the two. The peripheral set includes: two configurable video ports; a 10/100 Mb/s Ethernet MAC (EMAC); a management data input/output (MDIO) module; a VCXO interpolated control port (VIC); one multichannel buffered audio serial port (McASP0); an inter-integrated circuit (I2C) Bus module; one multichannel buffered serial port (McBSP); three 32-bit general-purpose timers; a user-configurable 16-bit or 32-bit host-port interface (HPI16/HPI32); a 16-pin general-purpose input/output port (GP0) with programmable interrupt/event generation modes; and a 64-bit glueless external memory interface (EMIFA), which is capable of interfacing to synchronous and asynchronous memories and peripherals.

The DM643 device has two configurable video port peripherals (VP1 and VP2). These video port peripherals provide a glueless interface to common video decoder and encoder devices. The DM643 video port peripherals support multiple resolutions and video standards (e.g., CCIR601, ITU-BT.656, BT.1120, SMPTE 125M, 260M, 274M, and 296M).

These two video port peripherals are configurable and can support either video capture and/or video display modes. Each video port consists of two channels — A and B with a 5120-byte capture/display buffer that is splittable between the two channels.

For more details on the Video Port peripherals, see the *TMS320C64x DSP Video Port/VCXO Interpolated Control (VIC) Port Reference Guide* (literature number SPRU629).

The McASP0 port supports one transmit and one receive clock zone, with eight serial data pins which can be individually allocated to any of the two zones. The serial port supports time-division multiplexing on each pin from 2 to 32 time slots. The DM643 has sufficient bandwidth to support all 8 serial data pins transmitting a 192-kHz stereo signal. Serial data in each zone may be transmitted and received on multiple serial data pins simultaneously and formatted in a multitude of variations on the Philips Inter-IC Sound ($I^2S$) format.

In addition, the McASP0 transmitter may be programmed to output multiple S/PDIF, IEC60958, AES-3, CP-430 encoded data channels simultaneously, with a single RAM containing the full implementation of user data and channel status fields.

McASP0 also provides extensive error-checking and recovery features, such as the bad clock detection circuit for each high-frequency master clock which verifies that the master clock is within a programmed frequency range.


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The VCXO interpolated control (VIC) port provides digital-to-analog conversion with resolution from 9-bits to up to 16-bits. The output of the VIC is a single bit interpolated D/A output.For more details on the VIC port, see the *TMS320C64x DSP Video Port/VCXO Interpolated Control (VIC) Port Reference Guide* (literature number SPRU629).

The ethernet media access controller (EMAC) provides an efficient interface between the DM643 DSP core processor and the network. The DM643 EMAC support both 10Base-T and 100Base-TX, or 10 Mbits/second (Mbps) and 100 Mbps in either half- or full-duplex, with hardware flow control and quality of service (QOS) support. The DM643 EMAC makes use of a custom interface to the DSP core that allows efficient data transmission and reception.For more details on the EMAC, see the *TMS320C6000 DSP Ethernet Media Access Controller (EMAC) / Management Data Input/Output (MDIO) Module Reference Guide* (literature number SPRU628).

The management data input/output (MDIO) module continuously polls all 32 MDIO addresses in order to enumerate all PHY devices in the system. Once a PHY candidate has been selected by the DSP, the MDIO module transparently monitors its link state by reading the PHY status register. Link change events are stored in the MDIO module and can optionally interrupt the DSP, allowing the DSP to poll the link status of the device without continuously performing costly MDIO accesses. For more details on the MDIO, see the *TMS320C6000 DSP Ethernet Media Access Controller (EMAC) / Management Data Input/Output (MDIO) Module Reference Guide* (literature number SPRU628).

The I2C0 port on the TMS320DM643 allows the DSP to easily control peripheral devices and communicate with a host processor. In addition, the standard multichannel buffered serial port (McBSP) may be used to communicate with serial peripheral interface (SPI) mode peripheral devices.

The DM643 has a complete set of development tools which includes: a new C compiler, an assembly optimizer to simplify programming and scheduling, and a Windows® debugger interface for visibility into source code execution.

## 1.1 Device Compatibility

The DM643 device is a code-compatible member of the C6000™ DSP platform.

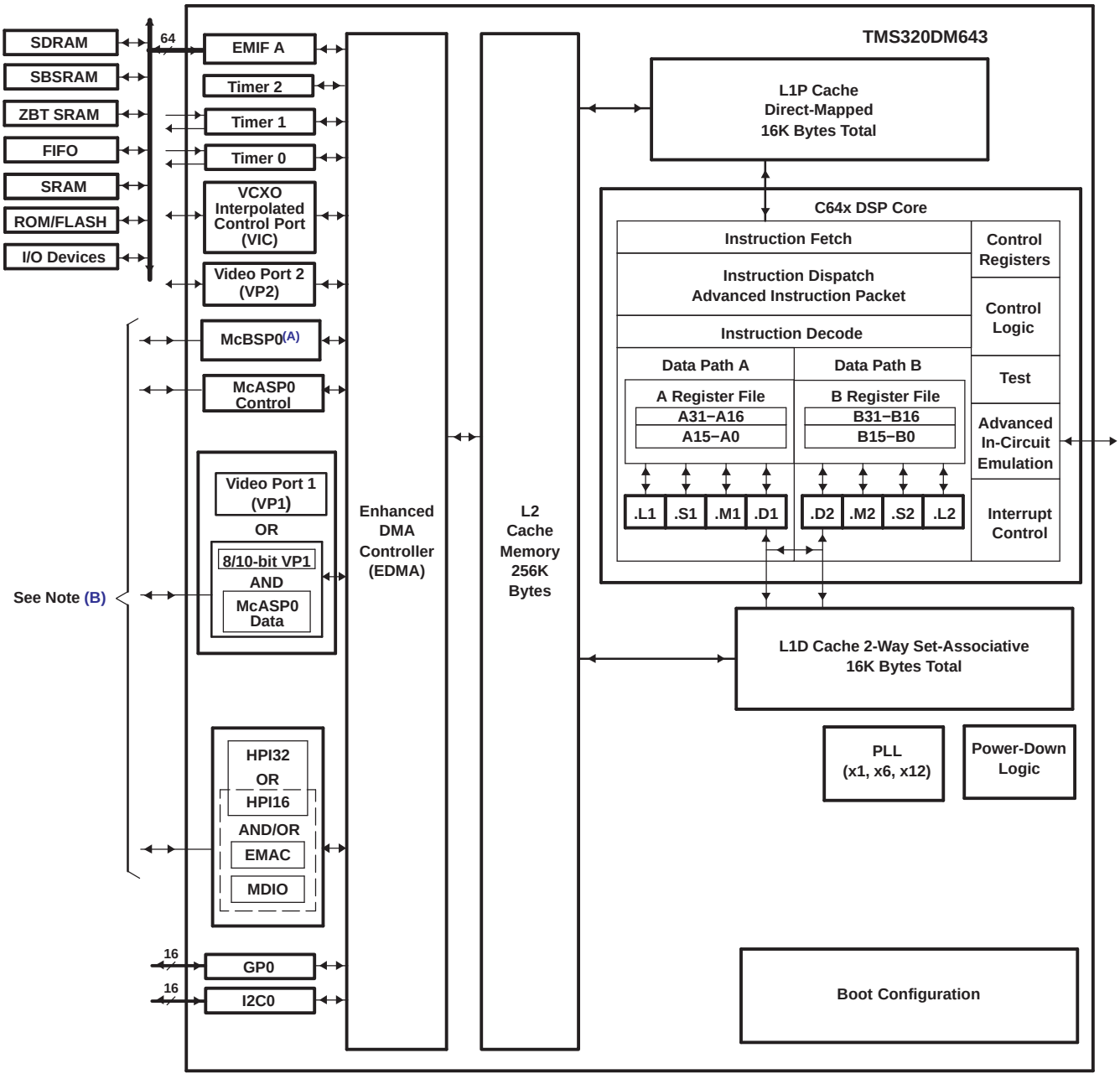
The C64x™ DSP generation of devices has a diverse and powerful set of peripherals.

For more detailed information on the device compatibility and similarities/differences among the DM642 and other C64x™ devices, see the *TMS320DM642 Technical Overview* (literature number SPRU615).

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## 1.2 Functional Block Diagram

Figure 1-1 shows the functional block diagram of the DM643 device.




A. McBSP: AC97 Devices; SPI Devices; Codecs

B. The Video Port 1 (VP1) peripheral is muxed with the McASP0 data pins. The HPI(32/16) peripheral is muxed with the EMAC and MDIO peripherals. For more details on the multiplexed pins of these peripherals, see the Device Configurations section of this data sheet.

**Figure 1-1. Functional Block Diagram**


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# 2 Device Overview

## 2.1 Device Characteristics

Table 2-1 provides an overview of the DM643 DSP. The table shows significant features of the DM643 device, including the capacity of on-chip RAM, the peripherals, the CPU frequency, and the package type with pin count.

**Table 2-1. Characteristics of the DM643 Processor**

| HARDWARE FEATURES | | DM643 |
|---|---|---|
| Peripherals<br>Not all peripherals pins are available at the same time (For more detail, see the Device Configuration section). | EMIFA (64-bit bus width)<br>(clock source = AECLKIN) | 1 |
| | EDMA (64 independent channels) | 1 |
| | McASP0 (uses Peripheral Clock [AUXCLK]) | 1 |
| | I2C0 (uses Peripheral Clock) | 1 |
| | HPI (32- or 16-bit user selectable) | 1 (HPI16 or HPI32) |
| | McBSP<br>(internal clock source = CPU/4 clock frequency) | 1 |
| | Configurable Video Ports (VP1 and VP2) | 2 |
| | 10/100 Ethernet MAC (EMAC) | 1 |
| | Management Data Input/Output (MDIO) | 1 |
| | VCXO Interpolated Control Port (VIC) | 1 |
| | 32-Bit Timers<br>(internal clock source = CPU/8 clock frequency) | 3 |
| | General-Purpose Input/Output Port (GP0) | 16 |
| On-Chip Memory | Size (Bytes) | 288K |
| | Organization | 16K-Byte (16KB) L1 Program (L1P) Cache<br>16KB L1 Data (L1D) Cache<br>256KB Unified Mapped RAM/Cache (L2) |
| CPU ID + CPU Rev ID | Control Status Register (CSR.[31:16]) | 0x0C01 |
| JTAG BSDL_ID | JTAGID register (address location: 0x01B3F008) | 0x0007902F |
| Frequency | MHz | 500, 600 |
| Cycle Time | ns | 2 ns (DM643-500)<br>[500 MHz CPU, 100 MHz EMIF(1)]<br>1.67 ns (DM643-600)<br>[600 MHz CPU, 133 MHz EMIF(1)] |
| Voltage | Core (V) | 1.2 V (-500)<br>1.4 V (-600) |
| | I/O (V) | 3.3 V |
| PLL Options | CLKIN frequency multiplier | Bypass (x1), x6, x12 |
| BGA Package | 23 x 23 mm | 548-Pin BGA (GDK and ZDK) |
| | 27 x 27 mm | 548-Pin BGA (GNZ and ZNZ) |
| Process Technology | µm | 0.13 µm |
| Product Status(2) | Product Preview (PP), Advance Information (AI), or Production Data (PD) | PD |

(1) On this DM64x™ device, the rated EMIF speed affects only the SDRAM interface on the EMIF. For more detailed information, see the EMIF device speed portion of this data sheet.
(2) PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

## 2.2 CPU (DSP Core) Description

The CPU fetches VelociTI™ advanced very-long instruction words (VLIWs) (256 bits wide) to supply up to eight 32-bit instructions to the eight functional units during every clock cycle. The VelociTI™ VLIW architecture features controls by which all eight units do not have to be supplied with instructions if they are not ready to execute. The first bit of every 32-bit instruction determines if the next instruction belongs


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to the same execute packet as the previous instruction, or whether it should be executed in the following clock as a part of the next execute packet. Fetch packets are always 256 bits wide; however, the execute packets can vary in size. The variable-length execute packets are a key memory-saving feature, distinguishing the C64x CPUs from other VLIW architectures. The C64x™ VelociTI.2™ extensions add enhancements to the TMS320C62x™ DSP VelociTI™ architecture. These enhancements include:

- Register file enhancements
- Data path extensions
- Quad 8-bit and dual 16-bit extensions with data flow enhancements
- Additional functional unit hardware
- Increased orthogonality of the instruction set
- Additional instructions that reduce code size and increase register flexibility

The CPU features two sets of functional units. Each set contains four units and a register file. One set contains functional units .L1, .S1, .M1, and .D1; the other set contains units .D2, .M2, .S2, and .L2. The two register files each contain 32 32-bit registers for a total of 64 general-purpose registers. In addition to supporting the packed 16-bit and 32-/40-bit fixed-point data types found in the C62x™ VelociTI™ VLIW architecture, the C64x™ register files also support packed 8-bit data and 64-bit fixed-point data types. The two sets of functional units, along with two register files, compose sides A and B of the CPU [see the functional block and CPU (DSP core) diagram, and Figure 2-1]. The four functional units on each side of the CPU can freely share the 32 registers belonging to that side. Additionally, each side features a "data cross path"—a single data bus connected to all the registers on the other side, by which the two sets of functional units can access data from the register files on the opposite side. The C64x CPU pipelines data-cross-path accesses over multiple clock cycles. This allows the same register to be used as a data-cross-path operand by multiple functional units in the same execute packet. All functional units in the C64x CPU can access operands via the data cross path. Register access by functional units on the same side of the CPU as the register file can service all the units in a single clock cycle. On the C64x CPU, a delay clock is introduced whenever an instruction attempts to read a register via a data cross path if that register was updated in the previous clock cycle.

In addition to the C62x™ DSP fixed-point instructions, the C64x™ DSP includes a comprehensive collection of quad 8-bit and dual 16-bit instruction set extensions. These VelociTI.2™ extensions allow the C64x CPU to operate directly on packed data to streamline data flow and increase instruction set efficiency. This is a key factor for video and imaging applications.

Another key feature of the C64x CPU is the load/store architecture, where all instructions operate on registers (as opposed to data in memory). Two sets of data-addressing units (.D1 and .D2) are responsible for all data transfers between the register files and the memory. The data address driven by the .D units allows data addresses generated from one register file to be used to load or store data to or from the other register file. The C64x .D units can load and store bytes (8 bits), half-words (16 bits), and words (32 bits) with a single instruction. And with the new data path extensions, the C64x .D unit can load and store doublewords (64 bits) with a single instruction. Furthermore, the non-aligned load and store instructions allow the .D units to access words and doublewords on any byte boundary. The C64x CPU supports a variety of indirect addressing modes using either linear- or circular-addressing with 5- or 15-bit offsets. All instructions are conditional, and most can access any one of the 64 registers. Some registers, however, are singled out to support specific addressing modes or to hold the condition for conditional instructions (if the condition is not automatically "true").

The two .M functional units perform all multiplication operations. Each of the C64x .M units can perform two 16 × 16-bit multiplies or four 8 × 8-bit multiplies per clock cycle. The .M unit can also perform 16 × 32-bit multiply operations, dual 16 × 16-bit multiplies with add/subtract operations, and quad 8 × 8-bit multiplies with add operations. In addition to standard multiplies, the C64x .M units include bit-count, rotate, Galois field multiplies, and bidirectional variable shift hardware.

The two .S and .L functional units perform a general set of arithmetic, logical, and branch functions with results available every clock cycle. The arithmetic and logical functions on the C64x CPU include single 32-bit, dual 16-bit, and quad 8-bit operations.

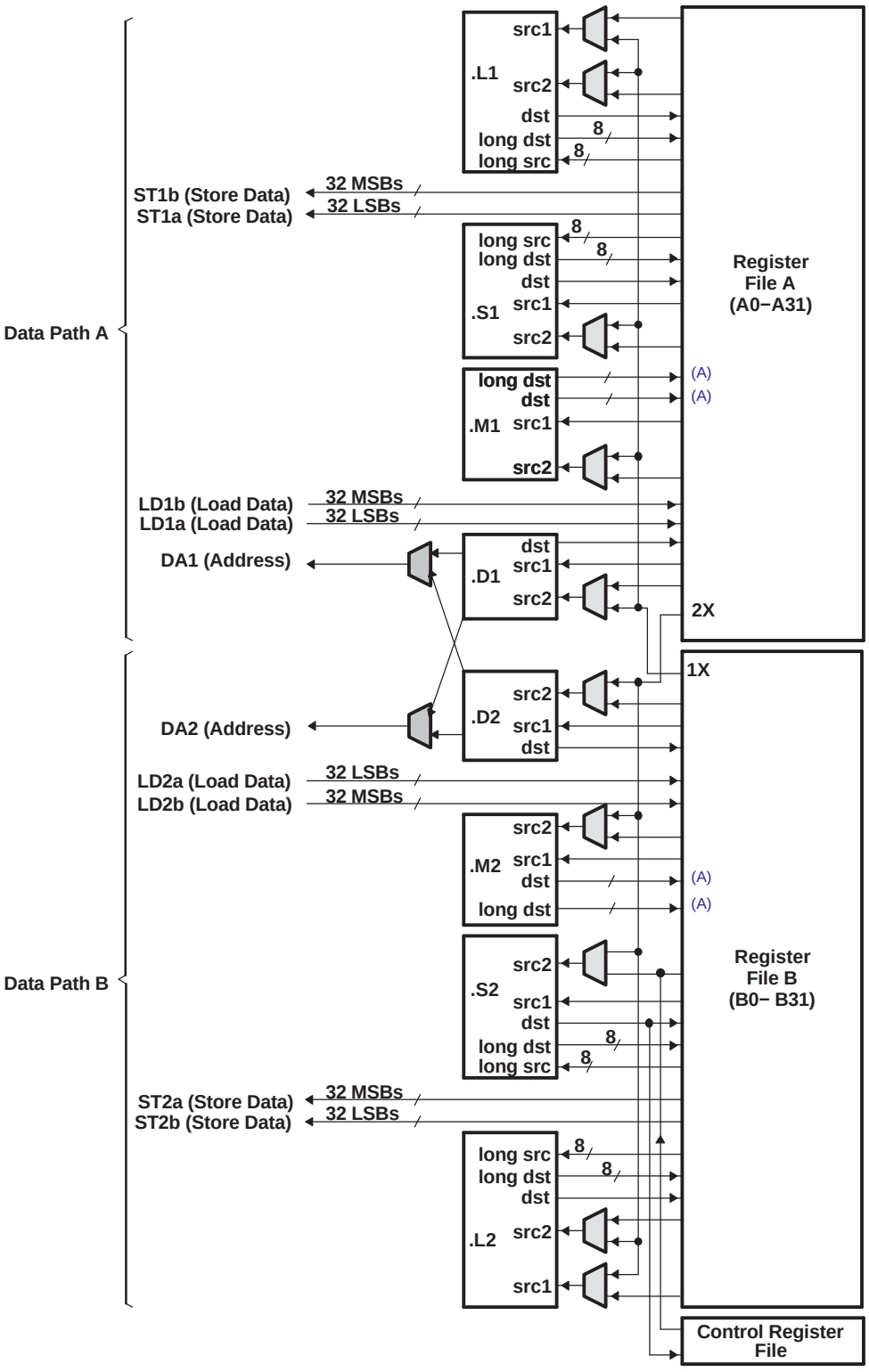
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The processing flow begins when a 256-bit-wide instruction fetch packet is fetched from a program memory. The 32-bit instructions destined for the individual functional units are "linked" together by "1" bits in the least significant bit (LSB) position of the instructions. The instructions that are "chained" together for simultaneous execution (up to eight in total) compose an execute packet. A "0" in the LSB of an instruction breaks the chain, effectively placing the instructions that follow it in the next execute packet. A C64x™ DSP device enhancement now allows execute packets to cross fetch-packet boundaries. In the TMS320C62x™/TMS320C67x™ DSP devices, if an execute packet crosses the fetch-packet boundary (256 bits wide), the assembler places it in the next fetch packet, while the remainder of the current fetch packet is padded with NOP instructions. In the C64x™ DSP device, the execute boundary restrictions have been removed, thereby, eliminating all of the NOPs added to pad the fetch packet, and thus, decreasing the overall code size. The number of execute packets within a fetch packet can vary from one to eight. Execute packets are dispatched to their respective functional units at the rate of one per clock cycle and the next 256-bit fetch packet is not fetched until all the execute packets from the current fetch packet have been dispatched. After decoding, the instructions simultaneously drive all active functional units for a maximum execution rate of eight instructions every clock cycle. While most results are stored in 32-bit registers, they can be subsequently moved to memory as bytes, half-words, or doublewords. All load and store instructions are byte-, half-word-, word-, or doubleword-addressable.

For more details on the C64x CPU functional units enhancements, see the following documents:

- *TMS320C6000 CPU and Instruction Set Reference Guide* (literature number SPRU189)
- *TMS320C64x Technical Overview* (literature number SPRU395)


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A. For the .M functional units, the long dst is 32 MSBs and the dst is 32 LSBs.

**Figure 2-1. TMS320C64x™ CPU (DSP Core) Data Paths**

### 2.2.1 CPU Core Registers

**Table 2-2. L2 Cache Registers (C64x)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0184 0000 | CCFG | Cache configuration register | |
| 0184 0004 – 0184 0FFC | – | Reserved | |
| 0184 1000 | EDMAWEIGHT | L2 EDMA access control register | |
| 0184 1004 – 0184 1FFC | – | Reserved | |
| 0184 2000 | L2ALLOC0 | L2 allocation register 0 | |
| 0184 2004 | L2ALLOC1 | L2 allocation register 1 | |
| 0184 2008 | L2ALLOC2 | L2 allocation register 2 | |
| 0184 200C | L2ALLOC3 | L2 allocation register 3 | |
| 0184 2010 – 0184 3FFC | – | Reserved | |
| 0184 4000 | L2WBAR | L2 writeback base address register | |
| 0184 4004 | L2WWC | L2 writeback word count register | |
| 0184 4010 | L2WIBAR | L2 writeback invalidate base address register | |
| 0184 4014 | L2WIWC | L2 writeback invalidate word count register | |
| 0184 4018 | L2IBAR | L2 invalidate base address register | |
| 0184 401C | L2IWC | L2 invalidate word count register | |
| 0184 4020 | L1PIBAR | L1P invalidate base address register | |
| 0184 4024 | L1PIWC | L1P invalidate word count register | |
| 0184 4030 | L1DWIBAR | L1D writeback invalidate base address register | |
| 0184 4034 | L1DWIWC | L1D writeback invalidate word count register | |
| 0184 4038 – 0184 4044 | – | Reserved | |
| 0184 4048 | L1DIBAR | L1D invalidate base address register | |
| 0184 404C | L1DIWC | L1D invalidate word count register | |
| 0184 4050 – 0184 4FFC | – | Reserved | |
| 0184 5000 | L2WB | L2 writeback all register | |
| 0184 5004 | L2WBINV | L2 writeback invalidate all register | |
| 0184 5008 – 0184 7FFC | – | Reserved | |
| 0184 8000 – 0184 81FC | MAR0 to MAR127 | Reserved | |
| 0184 8200 | MAR128 | Controls EMIFA CE0 range 8000 0000 – 80FF FFFF | |
| 0184 8204 | MAR129 | Controls EMIFA CE0 range 8100 0000 – 81FF FFFF | |
| 0184 8208 | MAR130 | Controls EMIFA CE0 range 8200 0000 – 82FF FFFF | |
| 0184 820C | MAR131 | Controls EMIFA CE0 range 8300 0000 – 83FF FFFF | |
| 0184 8210 | MAR132 | Controls EMIFA CE0 range 8400 0000 – 84FF FFFF | |
| 0184 8214 | MAR133 | Controls EMIFA CE0 range 8500 0000 – 85FF FFFF | |
| 0184 8218 | MAR134 | Controls EMIFA CE0 range 8600 0000 – 86FF FFFF | |
| 0184 821C | MAR135 | Controls EMIFA CE0 range 8700 0000 – 87FF FFFF | |
| 0184 8220 | MAR136 | Controls EMIFA CE0 range 8800 0000 – 88FF FFFF | |
| 0184 8224 | MAR137 | Controls EMIFA CE0 range 8900 0000 – 89FF FFFF | |
| 0184 8228 | MAR138 | Controls EMIFA CE0 range 8A00 0000 – 8AFF FFFF | |
| 0184 822C | MAR139 | Controls EMIFA CE0 range 8B00 0000 – 8BFF FFFF | |
| 0184 8230 | MAR140 | Controls EMIFA CE0 range 8C00 0000 – 8CFF FFFF | |
| 0184 8234 | MAR141 | Controls EMIFA CE0 range 8D00 0000 – 8DFF FFFF | |
| 0184 8238 | MAR142 | Controls EMIFA CE0 range 8E00 0000 – 8EFF FFFF | |
| 0184 823C | MAR143 | Controls EMIFA CE0 range 8F00 0000 – 8FFF FFFF | |
| 0184 8240 | MAR144 | Controls EMIFA CE1 range 9000 0000 – 90FF FFFF | |
| 0184 8244 | MAR145 | Controls EMIFA CE1 range 9100 0000 – 91FF FFFF | |


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**Table 2-2. L2 Cache Registers (C64x) (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0184 8248 | MAR146 | Controls EMIFA CE1 range 9200 0000 – 92FF FFFF | |
| 0184 824C | MAR147 | Controls EMIFA CE1 range 9300 0000 – 93FF FFFF | |
| 0184 8250 | MAR148 | Controls EMIFA CE1 range 9400 0000 – 94FF FFFF | |
| 0184 8254 | MAR149 | Controls EMIFA CE1 range 9500 0000 – 95FF FFFF | |
| 0184 8258 | MAR150 | Controls EMIFA CE1 range 9600 0000 – 96FF FFFF | |
| 0184 825C | MAR151 | Controls EMIFA CE1 range 9700 0000 – 97FF FFFF | |
| 0184 8260 | MAR152 | Controls EMIFA CE1 range 9800 0000 – 98FF FFFF | |
| 0184 8264 | MAR153 | Controls EMIFA CE1 range 9900 0000 – 99FF FFFF | |
| 0184 8268 | MAR154 | Controls EMIFA CE1 range 9A00 0000 – 9AFF FFFF | |
| 0184 826C | MAR155 | Controls EMIFA CE1 range 9B00 0000 – 9BFF FFFF | |
| 0184 8270 | MAR156 | Controls EMIFA CE1 range 9C00 0000 – 9CFF FFFF | |
| 0184 8274 | MAR157 | Controls EMIFA CE1 range 9D00 0000 – 9DFF FFFF | |
| 0184 8278 | MAR158 | Controls EMIFA CE1 range 9E00 0000 – 9EFF FFFF | |
| 0184 827C | MAR159 | Controls EMIFA CE1 range 9F00 0000 – 9FFF FFFF | |
| 0184 8280 | MAR160 | Controls EMIFA CE2 range A000 0000 – A0FF FFFF | |
| 0184 8284 | MAR161 | Controls EMIFA CE2 range A100 0000 – A1FF FFFF | |
| 0184 8288 | MAR162 | Controls EMIFA CE2 range A200 0000 – A2FF FFFF | |
| 0184 828C | MAR163 | Controls EMIFA CE2 range A300 0000 – A3FF FFFF | |
| 0184 8290 | MAR164 | Controls EMIFA CE2 range A400 0000 – A4FF FFFF | |
| 0184 8294 | MAR165 | Controls EMIFA CE2 range A500 0000 – A5FF FFFF | |
| 0184 8298 | MAR166 | Controls EMIFA CE2 range A600 0000 – A6FF FFFF | |
| 0184 829C | MAR167 | Controls EMIFA CE2 range A700 0000 – A7FF FFFF | |
| 0184 82A0 | MAR168 | Controls EMIFA CE2 range A800 0000 – A8FF FFFF | |
| 0184 82A4 | MAR169 | Controls EMIFA CE2 range A900 0000 – A9FF FFFF | |
| 0184 82A8 | MAR170 | Controls EMIFA CE2 range AA00 0000 – AAFF FFFF | |
| 0184 82AC | MAR171 | Controls EMIFA CE2 range AB00 0000 – ABFF FFFF | |
| 0184 82B0 | MAR172 | Controls EMIFA CE2 range AC00 0000 – ACFF FFFF | |
| 0184 82B4 | MAR173 | Controls EMIFA CE2 range AD00 0000 – ADFF FFFF | |
| 0184 82B8 | MAR174 | Controls EMIFA CE2 range AE00 0000 – AEFF FFFF | |
| 0184 82BC | MAR175 | Controls EMIFA CE2 range AF00 0000 – AFFF FFFF | |
| 0184 82C0 | MAR176 | Controls EMIFA CE3 range B000 0000 – B0FF FFFF | |
| 0184 82C4 | MAR177 | Controls EMIFA CE3 range B100 0000 – B1FF FFFF | |
| 0184 82C8 | MAR178 | Controls EMIFA CE3 range B200 0000 – B2FF FFFF | |
| 0184 82CC | MAR179 | Controls EMIFA CE3 range B300 0000 – B3FF FFFF | |
| 0184 82D0 | MAR180 | Controls EMIFA CE3 range B400 0000 – B4FF FFFF | |
| 0184 82D4 | MAR181 | Controls EMIFA CE3 range B500 0000 – B5FF FFFF | |
| 0184 82D8 | MAR182 | Controls EMIFA CE3 range B600 0000 – B6FF FFFF | |
| 0184 82DC | MAR183 | Controls EMIFA CE3 range B700 0000 – B7FF FFFF | |
| 0184 82E0 | MAR184 | Controls EMIFA CE3 range B800 0000 – B8FF FFFF | |
| 0184 82E4 | MAR185 | Controls EMIFA CE3 range B900 0000 – B9FF FFFF | |
| 0184 82E8 | MAR186 | Controls EMIFA CE3 range BA00 0000 – BAFF FFFF | |
| 0184 82EC | MAR187 | Controls EMIFA CE3 range BB00 0000 – BBFF FFFF | |
| 0184 82F0 | MAR188 | Controls EMIFA CE3 range BC00 0000 – BCFF FFFF | |
| 0184 82F4 | MAR189 | Controls EMIFA CE3 range BD00 0000 – BDFF FFFF | |
| 0184 82F8 | MAR190 | Controls EMIFA CE3 range BE00 0000 – BEFF FFFF | |
| 0184 82FC | MAR191 | Controls EMIFA CE3 range BF00 0000 – BFFF FFFF | |
| 0184 8300 – 0184 83FC | MAR192 to MAR255 | Reserved | |

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**Table 2-2. L2 Cache Registers (C64x) (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0184 8400 – 0187 FFFF | – | Reserved | |


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## 2.3 Memory Map Summary

Table 2-3 shows the memory map address ranges of the DM643 device. Internal memory is always located at address 0 and can be used as both program and data memory. The external memory address ranges in the DM643 device begin at the hex address location 0x8000 0000 for EMIFA.

**Table 2-3. TMS320DM643 Memory Map Summary**

| MEMORY BLOCK DESCRIPTION | BLOCK SIZE (BYTES) | HEX ADDRESS RANGE |
|---|---|---|
| Internal RAM (L2) | 256K | 0000 0000 – 0003 FFFF |
| Reserved | 768K | 0004 0000 – 000F FFFF |
| Reserved | 23M | 0010 0000 – 017F FFFF |
| External Memory Interface A (EMIFA) Registers | 256K | 0180 0000 – 0183 FFFF |
| L2 Registers | 256K | 0184 0000 – 0187 FFFF |
| HPI Registers | 256K | 0188 0000 – 018B FFFF |
| McBSP 0 Registers | 256K | 018C 0000 – 018F FFFF |
| Reserved | 256K | 0190 0000 – 0193 FFFF |
| Timer 0 Registers | 256K | 0194 0000 – 0197 FFFF |
| Timer 1 Registers | 256K | 0198 0000 – 019B FFFF |
| Interrupt Selector Registers | 256K | 019C 0000 – 019F FFFF |
| EDMA RAM and EDMA Registers | 256K | 01A0 0000 – 01A3 FFFF |
| Reserved | 512K | 01A4 0000 – 01AB FFFF |
| Timer 2 Registers | 256K | 01AC 0000 – 01AF FFFF |
| GP0 Registers | 256K – 4K | 01B0 0000 – 01B3 EFFF |
| Device Configuration Registers | 4K | 01B3 F000 – 01B3 FFFF |
| I2C0 Data and Control Registers | 16K | 01B4 0000 – 01B4 3FFF |
| Reserved | 32K | 01B4 4000 – 01B4 BFFF |
| McASP0 Control Registers | 16K | 01B4 C000 – 01B4 FFFF |
| Reserved | 192K | 01B5 0000 – 01B7 FFFF |
| Reserved | 256K | 01B8 0000 – 01BB FFFF |
| Emulation | 256K | 01BC 0000 – 01BF FFFF |
| Reserved | 256K | 01C0 0000 – 01C3 FFFF |
| Reserved | 16K | 01C4 0000 – 01C4 3FFF |
| VP1 Control | 16K | 01C4 4000 – 01C4 7FFF |
| VP2 Control | 16K | 01C4 8000 – 01C4 BFFF |
| VIC Control | 16K | 01C4 C000 – 01C4 FFFF |
| Reserved | 192K | 01C5 0000 – 01C7 FFFF |
| EMAC Control | 4K | 01C8 0000 – 01C8 0FFF |
| EMAC Wrapper | 8K | 01C8 1000 – 01C8 2FFF |
| EWRAP Registers | 2K | 01C8 3000 – 01C8 37FF |
| MDIO Control Registers | 2K | 01C8 3800 – 01C8 3FFF |
| Reserved | 3.5M | 01C8 4000 – 01FF FFFF |
| QDMA Registers | 52 | 0200 0000 – 0200 0033 |
| Reserved | 928M – 52 | 0200 0034 – 2FFF FFFF |
| McBSP 0 Data | 64M | 3000 0000 – 33FF FFFF |
| Reserved | 64M | 3400 0000 – 37FF FFFF |
| Reserved | 64M | 3800 0000 – 3BFF FFFF |
| McASP0 Data | 1M | 3C00 0000 – 3C0F FFFF |
| Reserved | 64M – 1M | 3C10 0000 – 3FFF FFFF |
| Reserved | 832M | 4000 0000 – 73FF FFFF |
| Reserved | 32M | 7400 0000 – 75FF FFFF |

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**Table 2-3. TMS320DM643 Memory Map Summary (continued)**

| MEMORY BLOCK DESCRIPTION | BLOCK SIZE (BYTES) | HEX ADDRESS RANGE |
|---|---|---|
| Reserved | 32M | 7600 0000 – 77FF FFFF |
| VP1 Channel A Data | 32M | 7800 0000 – 79FF FFFF |
| VP1 Channel B Data | 32M | 7A00 0000 – 7BFF FFFF |
| VP2 Channel A Data | 32M | 7C00 0000 – 7DFF FFFF |
| VP2 Channel B Data | 32M | 7E00 0000 – 7FFF FFFF |
| EMIFA CE0 | 256M | 8000 0000 – 8FFF FFFF |
| EMIFA CE1 | 256M | 9000 0000 – 9FFF FFFF |
| EMIFA CE2 | 256M | A000 0000 – AFFF FFFF |
| EMIFA CE3 | 256M | B000 0000 – BFFF FFFF |
| Reserved | 1G | C000 0000 – FFFF FFFF |


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### 2.3.1 L2 Architecture Expanded

Figure 2-2 shows the detail of the L2 architecture on the TMS320DM643 device. For more information on the L2MODE bits, see the cache configuration (CCFG) register bit field descriptions in the *TMS320C64x Two-Level Internal Memory Reference Guide* (literature number SPRU610).

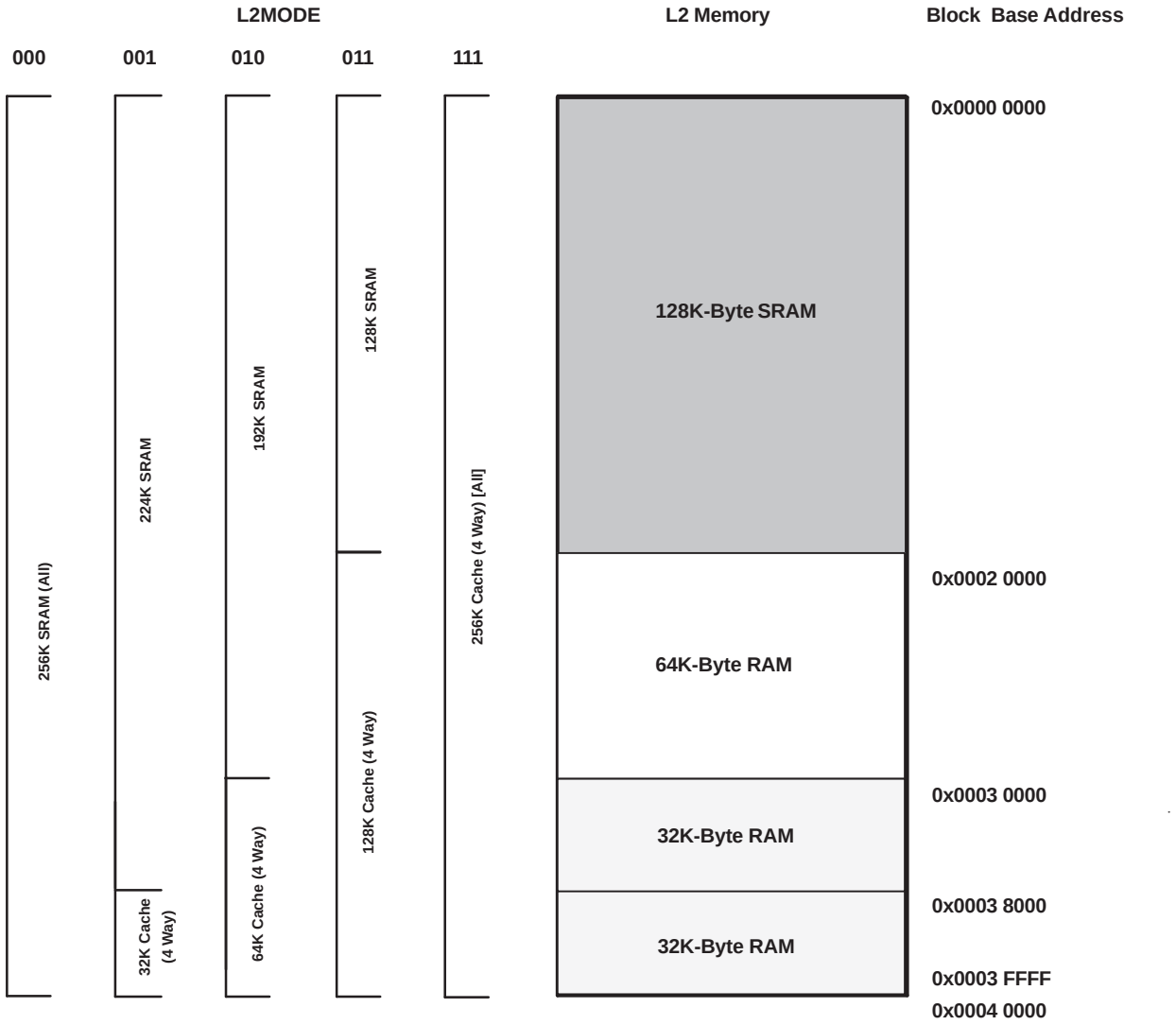



**Figure 2-2. TMS320DM643 L2 Architecture Memory Configuration**

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## 2.4 Bootmode

The DM643 device resets using the active-low signal RESET. While RESET is low, the device is held in reset and is initialized to the prescribed reset state. Refer to reset timing for reset timing characteristics and states of device pins during reset. The release of RESET starts the processor running with the prescribed device configuration and boot mode.

The DM643 has three types of boot modes:

- Host boot

  If host boot is selected, upon release of RESET, the CPU is internally "stalled" while the remainder of the device is released. During this period, an external host can initialize the CPU's memory space as necessary through the host interface, including internal configuration registers, such as those that control the EMIF or other peripherals. Once the host is finished with all necessary initialization, it must set the DSPINT bit in the HPIC register to complete the boot process. This transition causes the boot configuration logic to bring the CPU out of the "stalled" state. The CPU then begins execution from address 0. The DSPINT condition is not latched by the CPU, because it occurs while the CPU is still internally "stalled". Also, DSPINT brings the CPU out of the "stalled" state only if the host boot process is selected. All memory may be written to and read by the host. This allows for the host to verify what it sends to the DSP if required. After the CPU is out of the "stalled" state, the CPU needs to clear the DSPINT, otherwise, no more DSPINTs can be received.
- EMIF boot (using default ROM timings)

  Upon the release of RESET, the 1K-Byte ROM code located in the beginning of CE1 is copied to address 0 by the EDMA using the default ROM timings, while the CPU is internally "stalled". The data should be stored in the endian format that the system is using. In this case, the EMIF automatically assembles consecutive 8-bit bytes to form the 32-bit instruction words to be copied. The transfer is automatically done by the EDMA as a single-frame block transfer from the ROM to address 0. After completion of the block transfer, the CPU is released from the "stalled" state and starts running from address 0.
- No boot

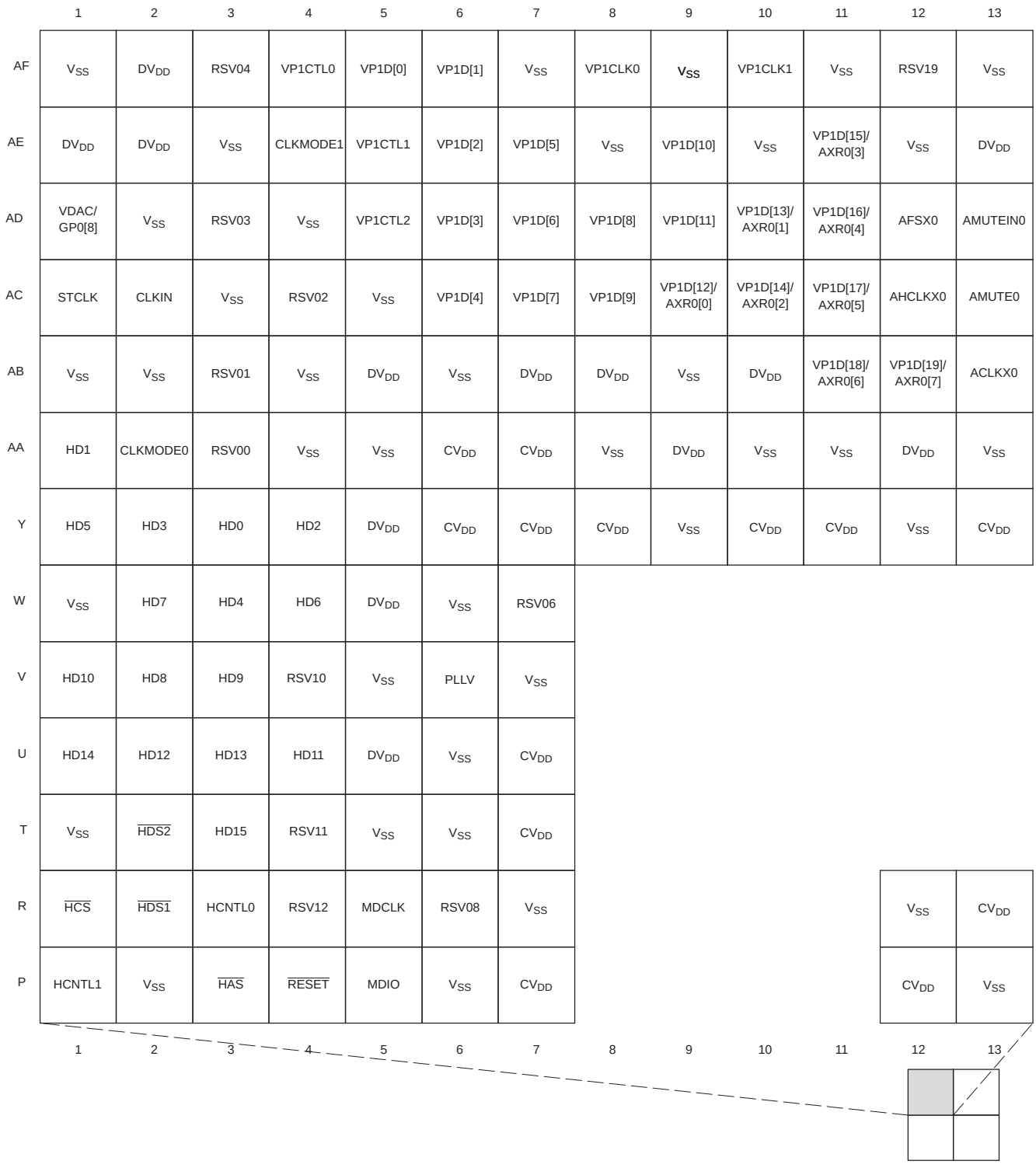
  With no boot, the CPU begins direct execution from the memory located at address 0. Note: operation is undefined if invalid code is located at address 0.

## 2.5 Pin Assignments

### *2.5.1 Pin Map*

Figure 2-3 through Figure 2-6 show the DM643 pin assignments in four quadrants (A, B, C, and D).


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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AF | $V_{SS}$ | $DV_{DD}$ | RSV04 | VP1CTL0 | VP1D[0] | VP1D[1] | $V_{SS}$ | VP1CLK0 | $V_{SS}$ | VP1CLK1 | $V_{SS}$ | RSV19 | $V_{SS}$ |
| AE | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | CLKMODE1 | VP1CTL1 | VP1D[2] | VP1D[5] | $V_{SS}$ | VP1D[10] | $V_{SS}$ | VP1D[15]/ AXR0[3] | $V_{SS}$ | $DV_{DD}$ |
| AD | VDAC/ GP0[8] | $V_{SS}$ | RSV03 | $V_{SS}$ | VP1CTL2 | VP1D[3] | VP1D[6] | VP1D[8] | VP1D[11] | VP1D[13]/ AXR0[1] | VP1D[16]/ AXR0[4] | AFSX0 | AMUTEIN0 |
| AC | STCLK | CLKIN | $V_{SS}$ | RSV02 | $V_{SS}$ | VP1D[4] | VP1D[7] | VP1D[9] | VP1D[12]/ AXR0[0] | VP1D[14]/ AXR0[2] | VP1D[17]/ AXR0[5] | AHCLKX0 | AMUTE0 |
| AB | $V_{SS}$ | $V_{SS}$ | RSV01 | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | VP1D[18]/ AXR0[6] | VP1D[19]/ AXR0[7] | ACLKX0 |
| AA | HD1 | CLKMODE0 | RSV00 | $V_{SS}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ |
| Y | HD5 | HD3 | HD0 | HD2 | $DV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ |
| W | $V_{SS}$ | HD7 | HD4 | HD6 | $DV_{DD}$ | $V_{SS}$ | RSV06 | | | | | | |
| V | HD10 | HD8 | HD9 | RSV10 | $V_{SS}$ | PLLV | $V_{SS}$ | | | | | | |
| U | HD14 | HD12 | HD13 | HD11 | $DV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | | | | | | |
| T | $V_{SS}$ | $\overline{HDS2}$ | HD15 | RSV11 | $V_{SS}$ | $V_{SS}$ | $CV_{DD}$ | | | | | | |
| R | $\overline{HCS}$ | $\overline{HDS1}$ | HCNTL0 | RSV12 | MDCLK | RSV08 | $V_{SS}$ | | | | | $V_{SS}$ | $CV_{DD}$ |
| P | HCNTL1 | $V_{SS}$ | $\overline{HAS}$ | $\overline{RESET}$ | MDIO | $V_{SS}$ | $CV_{DD}$ | | | | | $CV_{DD}$ | $V_{SS}$ |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

**Figure 2-3. DM643 Pin Map [Quadrant A]**

| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RSV18 | $V_{SS}$ | FSX0 | CLKX0 | RSV13 | $V_{SS}$ | AED50 | AED54 | $V_{SS}$ | AED62 | AED63 | $DV_{DD}$ | $V_{SS}$ | AF |
| $V_{SS}$ | CLKR0 | DX0 | RSV20 | RSV14 | $V_{SS}$ | AED52 | AED56 | AED58 | AED61 | $V_{SS}$ | $DV_{DD}$ | $DV_{DD}$ | AE |
| ACLKR0 | RSV15 | RSV23 | RSV22 | $V_{SS}$ | AED48 | AED53 | AED57 | AED59 | AED60 | $DV_{DD}$ | AED33 | AED32 | AD |
| AFSR0 | RSV16 | DR0 | RSV21 | $V_{SS}$ | AED49 | AED51 | AED55 | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | AED34 | AED35 | AC |
| AHCLKR0 | RSV17 | FSR0 | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | AED38 | AED36 | AED37 | $V_{SS}$ | AB |
| $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | AED41 | AED39 | AED40 | AED42 | AA |
| $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $DV_{DD}$ | AED45 | AED43 | AED44 | AED46 | Y |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | AED47 | $\overline{AHOLD}$ | $DV_{DD}$ | $V_{SS}$ | W |
| | | | | | | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | AEA18 | AEA21 | AEA20 | AEA19 | V |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | AEA22 | AEA17 | AEA16 | AEA15 | U |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | $\overline{ABE7}$ | $\overline{ABE6}$ | AEA14 | AEA13 | $V_{SS}$ | T |
| $V_{SS}$ | $CV_{DD}$ | | | | | $V_{SS}$ | $DV_{DD}$ | $\overline{ASOE3}$ | AEA12 | AEA11 | $\overline{ABE5}$ | $\overline{ABE4}$ | R |
| $CV_{DD}$ | $V_{SS}$ | | | | | $CV_{DD}$ | $V_{SS}$ | ABUSREQ | AEA10 | AEA9 | $DV_{DD}$ | AEA8 | P |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | |

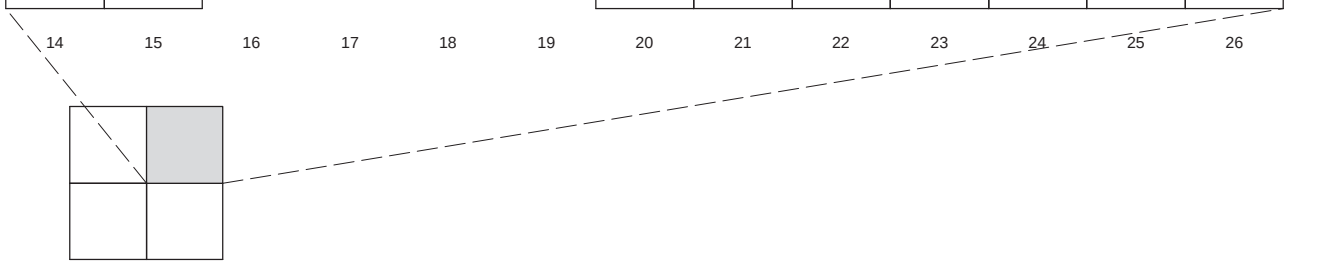
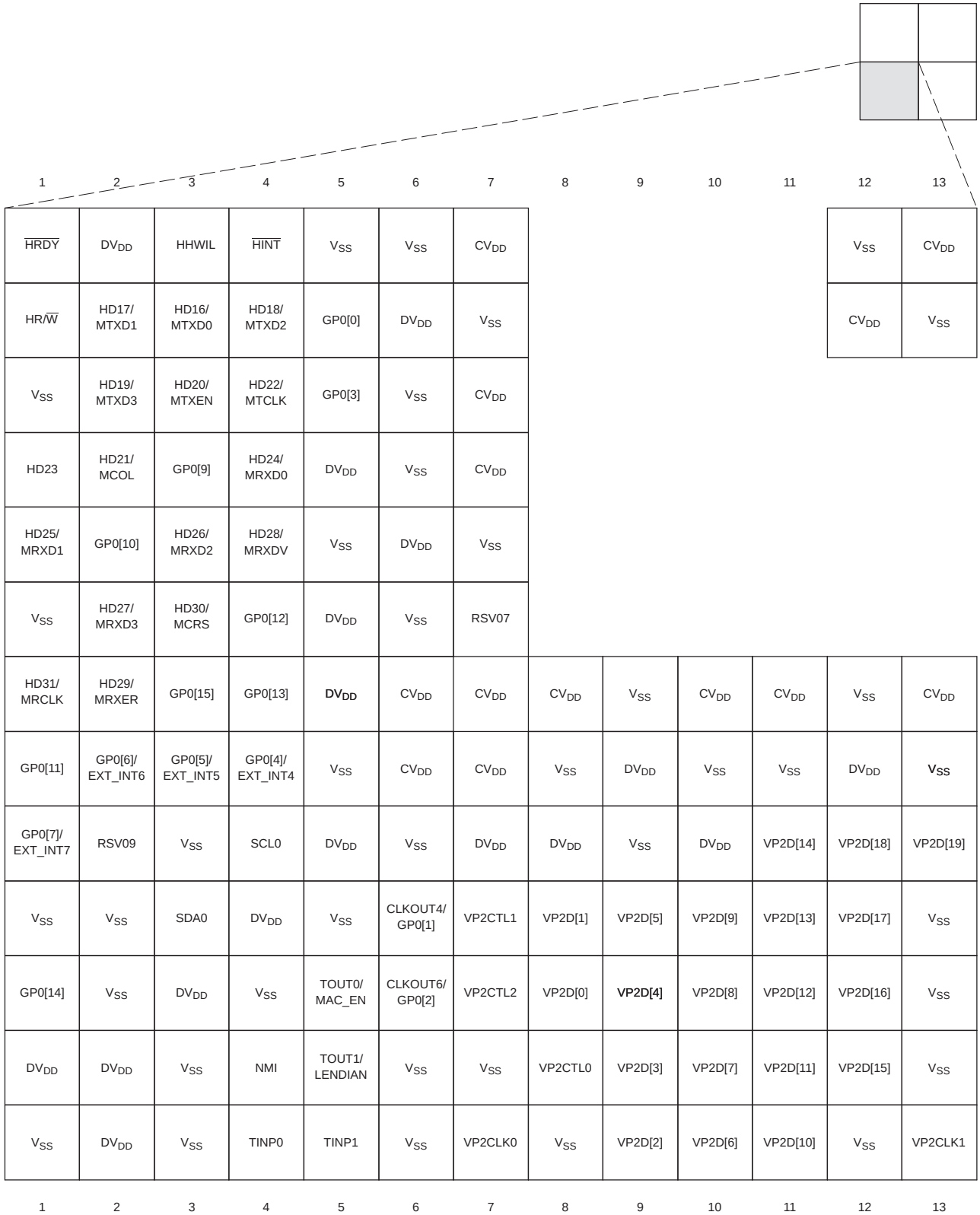


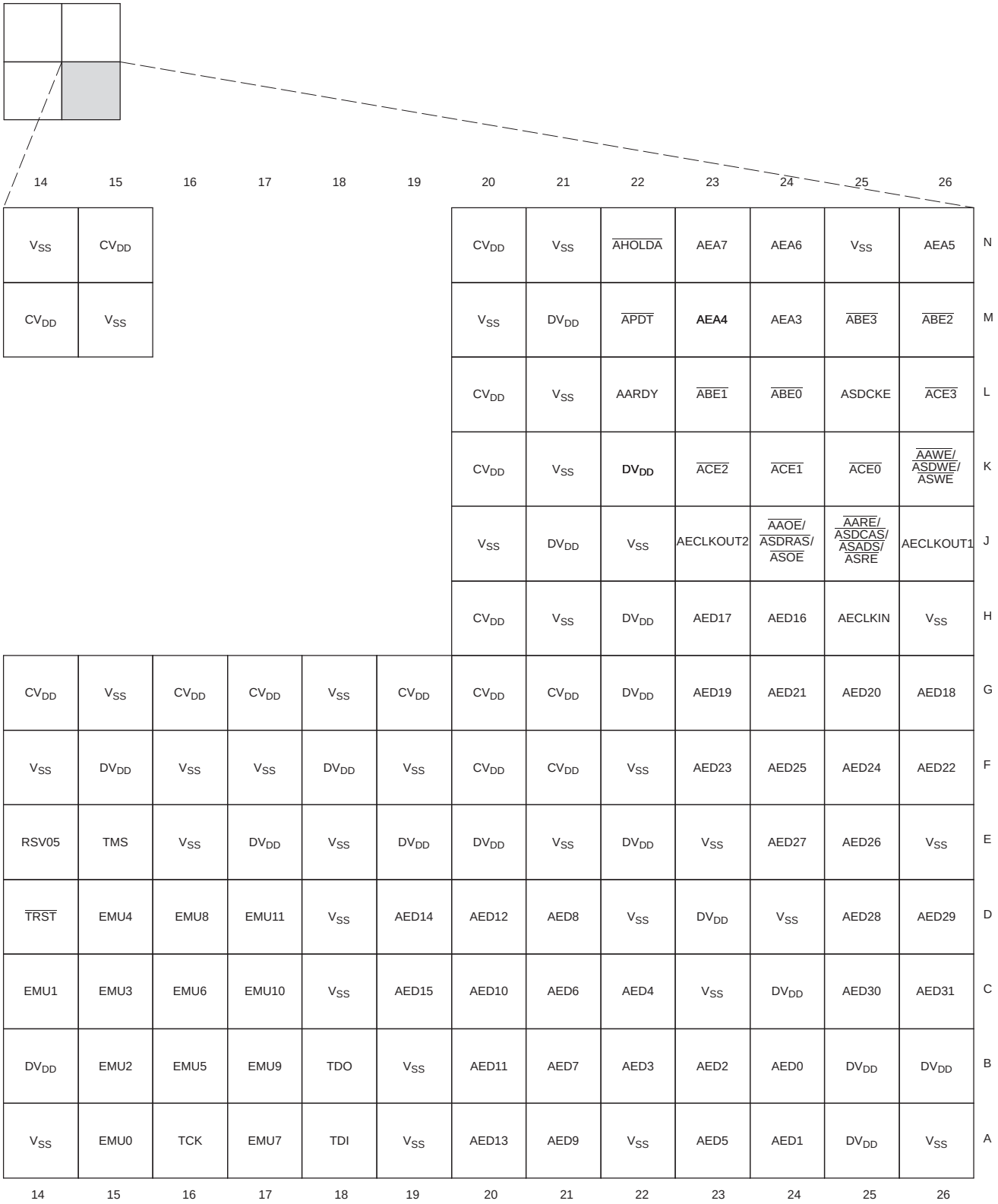
**Figure 2-4. DM643 Pin Map [Quadrant B]**


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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | $\overline{HRDY}$ | $DV_{DD}$ | HHWIL | $\overline{HINT}$ | $V_{SS}$ | $V_{SS}$ | $CV_{DD}$ | | | | | $V_{SS}$ | $CV_{DD}$ |
| M | HR/$\overline{W}$ | HD17/ MTXD1 | HD16/ MTXD0 | HD18/ MTXD2 | GP0[0] | $DV_{DD}$ | $V_{SS}$ | | | | | $CV_{DD}$ | $V_{SS}$ |
| L | $V_{SS}$ | HD19/ MTXD3 | HD20/ MTXEN | HD22/ MTCLK | GP0[3] | $V_{SS}$ | $CV_{DD}$ | | | | | | |
| K | HD23 | HD21/ MCOL | GP0[9] | HD24/ MRXD0 | $DV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | | | | | | |
| J | HD25/ MRXD1 | GP0[10] | HD26/ MRXD2 | HD28/ MRXDV | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | | | | | | |
| H | $V_{SS}$ | HD27/ MRXD3 | HD30/ MCRS | GP0[12] | $DV_{DD}$ | $V_{SS}$ | RSV07 | | | | | | |
| G | HD31/ MRCLK | HD29/ MRXER | GP0[15] | GP0[13] | $DV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ |
| F | GP0[11] | GP0[6]/ EXT_INT6 | GP0[5]/ EXT_INT5 | GP0[4]/ EXT_INT4 | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ |
| E | GP0[7]/ EXT_INT7 | RSV09 | $V_{SS}$ | SCL0 | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | VP2D[14] | VP2D[18] | VP2D[19] |
| D | $V_{SS}$ | $V_{SS}$ | SDA0 | $DV_{DD}$ | $V_{SS}$ | CLKOUT4/ GP0[1] | VP2CTL1 | VP2D[1] | VP2D[5] | VP2D[9] | VP2D[13] | VP2D[17] | $V_{SS}$ |
| C | GP0[14] | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | TOUT0/ MAC_EN | CLKOUT6/ GP0[2] | VP2CTL2 | VP2D[0] | VP2D[4] | VP2D[8] | VP2D[12] | VP2D[16] | $V_{SS}$ |
| B | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | NMI | TOUT1/ LENDIAN | $V_{SS}$ | $V_{SS}$ | VP2CTL0 | VP2D[3] | VP2D[7] | VP2D[11] | VP2D[15] | $V_{SS}$ |
| A | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | TINP0 | TINP1 | $V_{SS}$ | VP2CLK0 | $V_{SS}$ | VP2D[2] | VP2D[6] | VP2D[10] | $V_{SS}$ | VP2CLK1 |

**Figure 2-5. DM643 Pin Map [Quadrant C]**

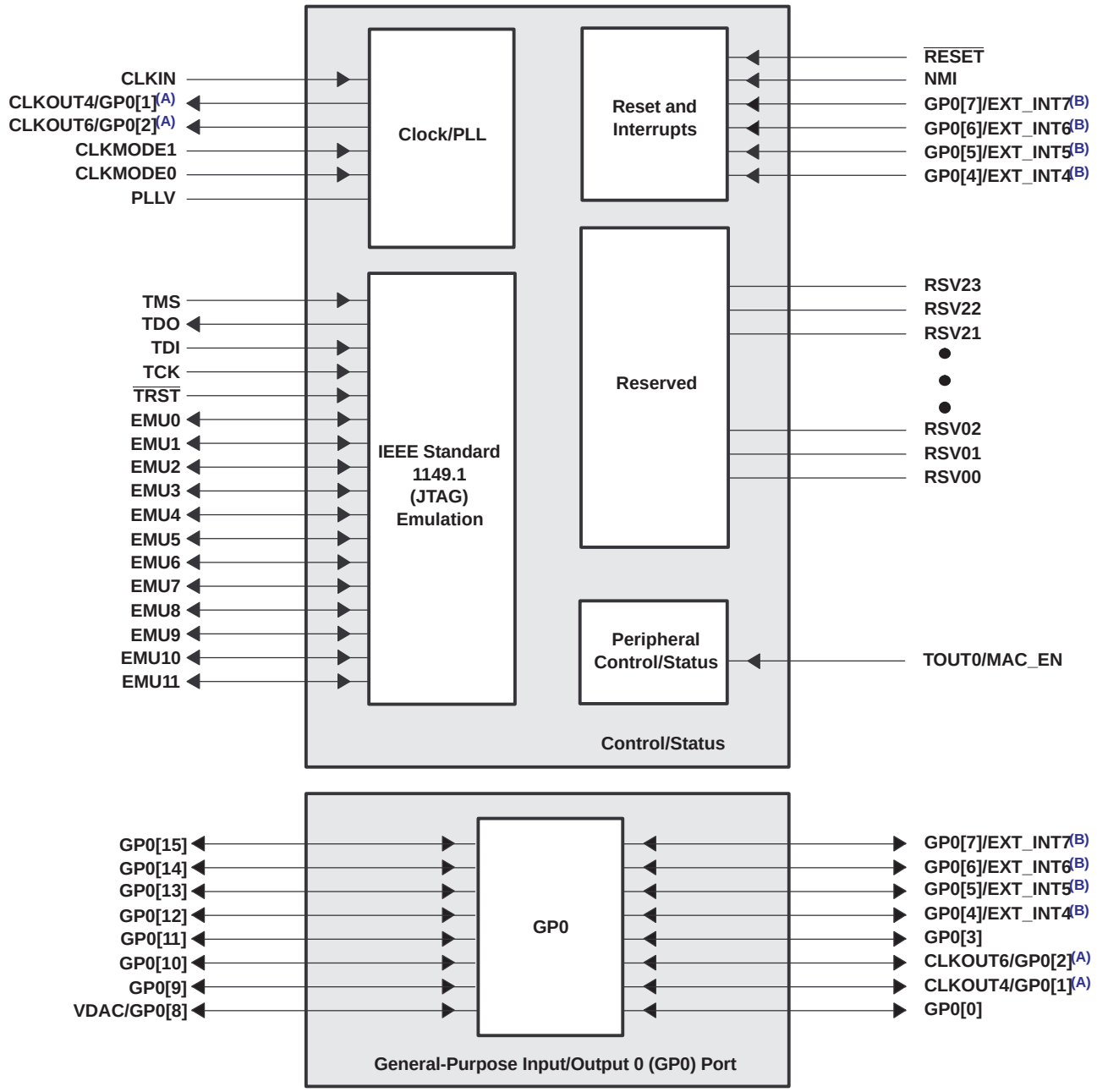


| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{SS}$ | $CV_{DD}$ | | | | | $CV_{DD}$ | $V_{SS}$ | $\overline{AHOLDA}$ | AEA7 | AEA6 | $V_{SS}$ | AEA5 | N |
| $CV_{DD}$ | $V_{SS}$ | | | | | $V_{SS}$ | $DV_{DD}$ | $\overline{APDT}$ | **AEA4** | AEA3 | $\overline{ABE3}$ | $\overline{ABE2}$ | M |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | AARDY | $\overline{ABE1}$ | $\overline{ABE0}$ | ASDCKE | $\overline{ACE3}$ | L |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $\overline{ACE2}$ | $\overline{ACE1}$ | $\overline{ACE0}$ | $\overline{AAWE}$/ $\overline{ASDWE}$/ ASWE | K |
| | | | | | | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | AECLKOUT2 | $\overline{AAOE}$/ $\overline{ASDRAS}$/ $\overline{ASOE}$ | $\overline{AARE}$/ $\overline{ASDCAS}$/ $\overline{ASADS}$/ $\overline{ASRE}$ | AECLKOUT1 | J |
| | | | | | | $CV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | AED17 | AED16 | AECLKIN | $V_{SS}$ | H |
| $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $CV_{DD}$ | $DV_{DD}$ | AED19 | AED21 | AED20 | AED18 | G |
| $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $CV_{DD}$ | $CV_{DD}$ | $V_{SS}$ | AED23 | AED25 | AED24 | AED22 | F |
| RSV05 | TMS | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $DV_{DD}$ | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | AED27 | AED26 | $V_{SS}$ | E |
| $\overline{TRST}$ | EMU4 | EMU8 | EMU11 | $V_{SS}$ | AED14 | AED12 | AED8 | $V_{SS}$ | $DV_{DD}$ | $V_{SS}$ | AED28 | AED29 | D |
| EMU1 | EMU3 | EMU6 | EMU10 | $V_{SS}$ | AED15 | AED10 | AED6 | AED4 | $V_{SS}$ | $DV_{DD}$ | AED30 | AED31 | C |
| $DV_{DD}$ | EMU2 | EMU5 | EMU9 | TDO | $V_{SS}$ | AED11 | AED7 | AED3 | AED2 | AED0 | $DV_{DD}$ | $DV_{DD}$ | B |
| $V_{SS}$ | EMU0 | TCK | EMU7 | TDI | $V_{SS}$ | AED13 | AED9 | $V_{SS}$ | AED5 | AED1 | $DV_{DD}$ | $V_{SS}$ | A |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | |

**Figure 2-6. DM643 Pin Map [Quadrant D]**


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### 2.5.2 Signal Groups Description




A. These pins are muxed with the GP0 pins and by default these signals function as clocks (CLKOUT4 or CLKOUT6). To use these muxed pins as GPIO signals, the appropriate GPIO register bits (GPxEN and GPxDIR) must be properly enabled and configured. For more details, see the Device Configurations section of this data sheet.

B. These pins are GP0 pins that can also function as external interrupt sources (EXT_INT[7:4]). Default after reset is EXT_INTx or GPIO as input-only.

**Figure 2-7. CPU and Peripheral Signals**

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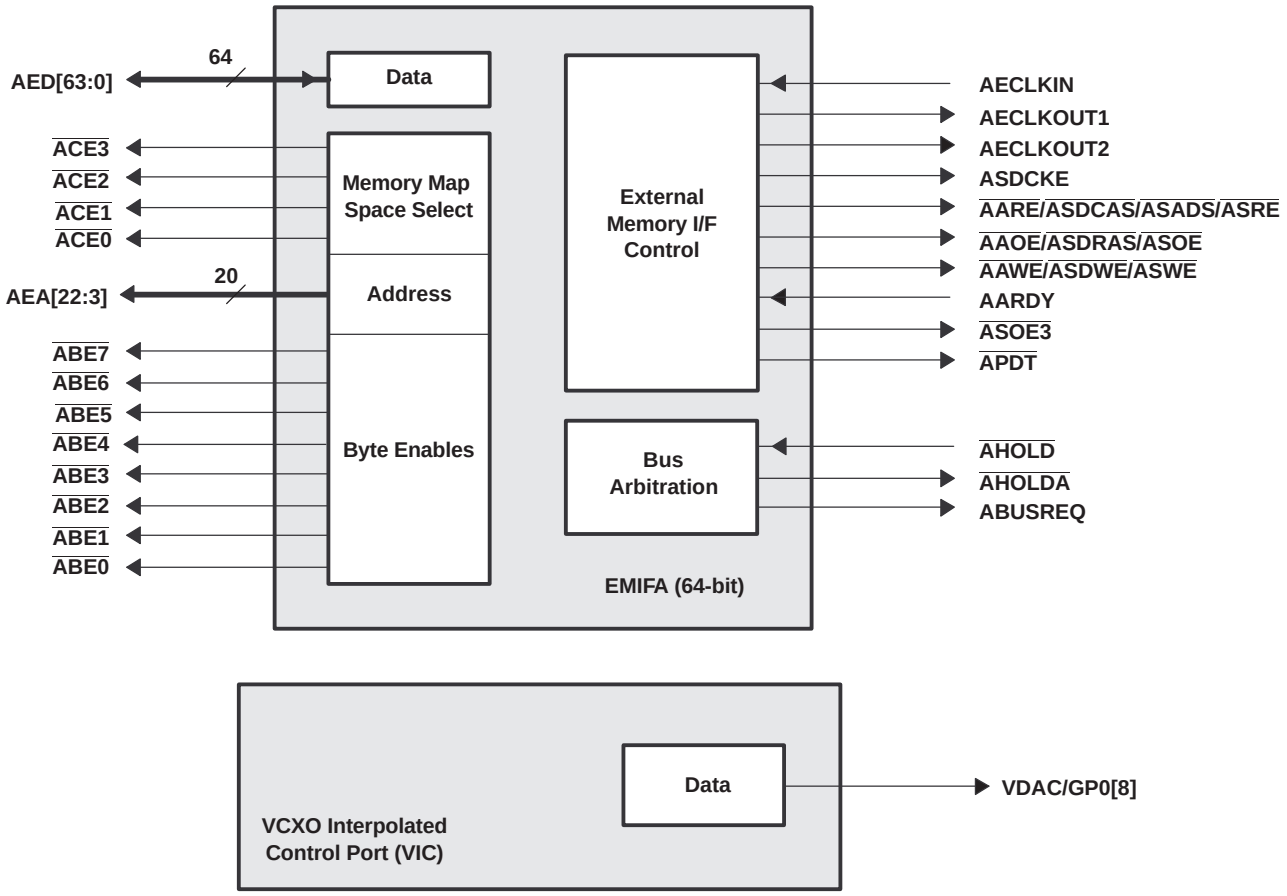
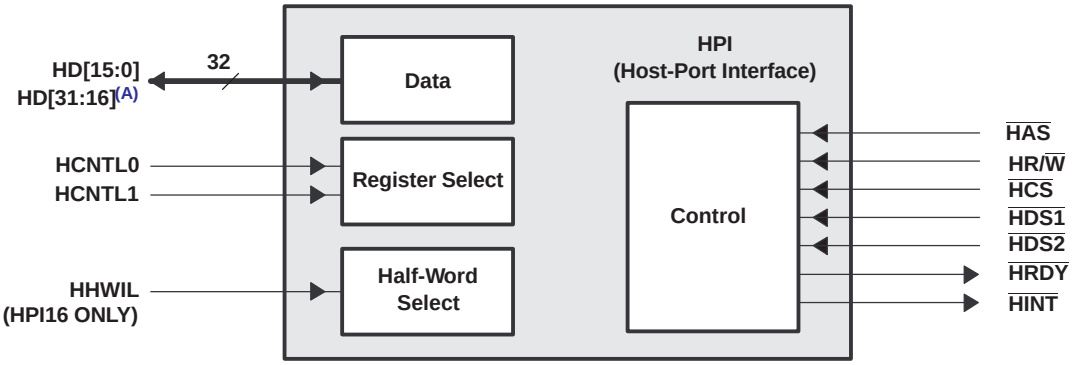



**Figure 2-8. EMIFA/VIC Peripheral Signals**




A. These HPI data pins (HD[31:16], excluding HD[23]) are muxed with the EMAC peripheral. By default, these pins function as HPI. For more details on the EMAC pin functions, see the Ethernet MAC (EMAC) peripheral signals section and the terminal functions table portions of this data sheet.

**Figure 2-9. HPI Peripheral Signals**


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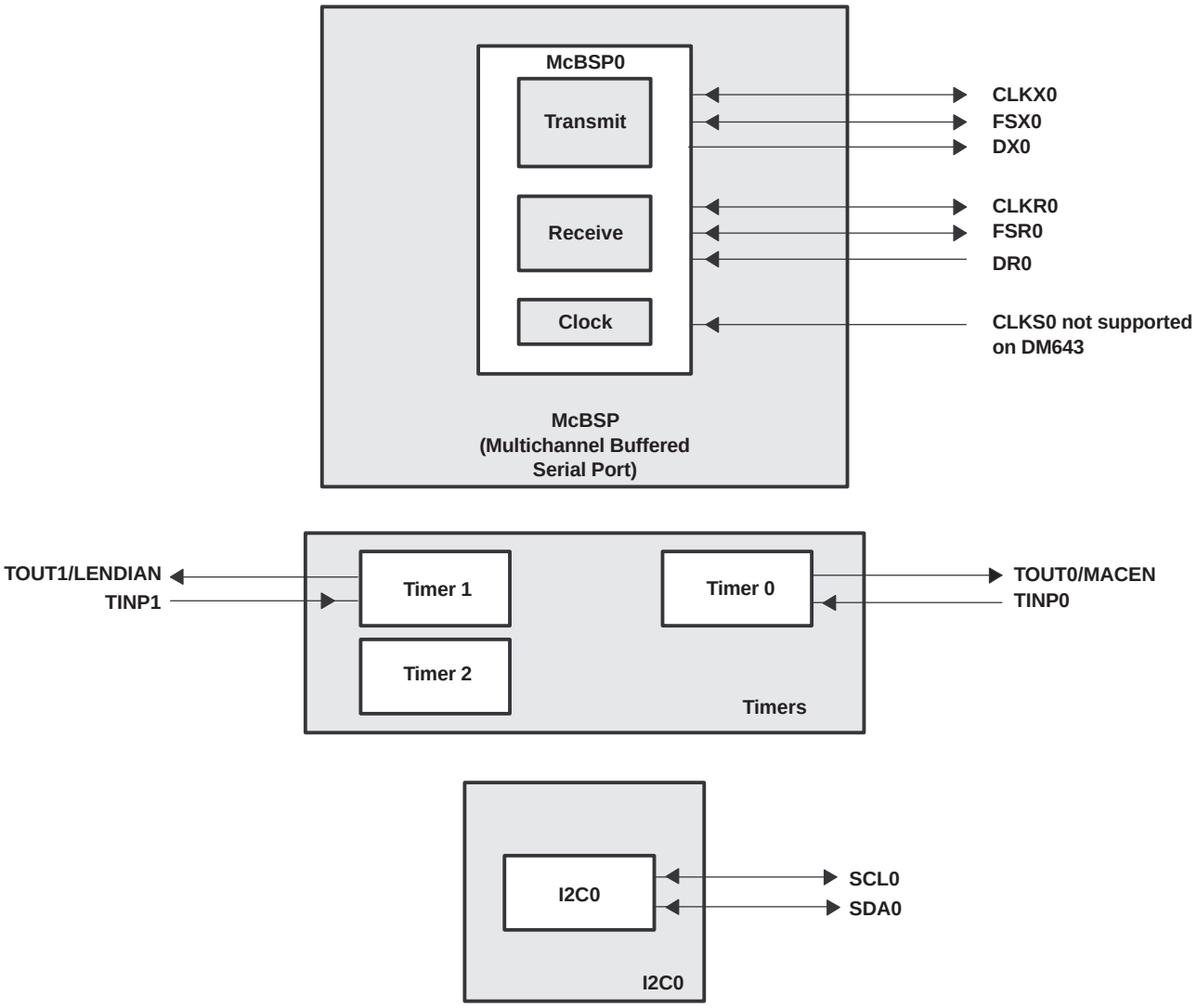
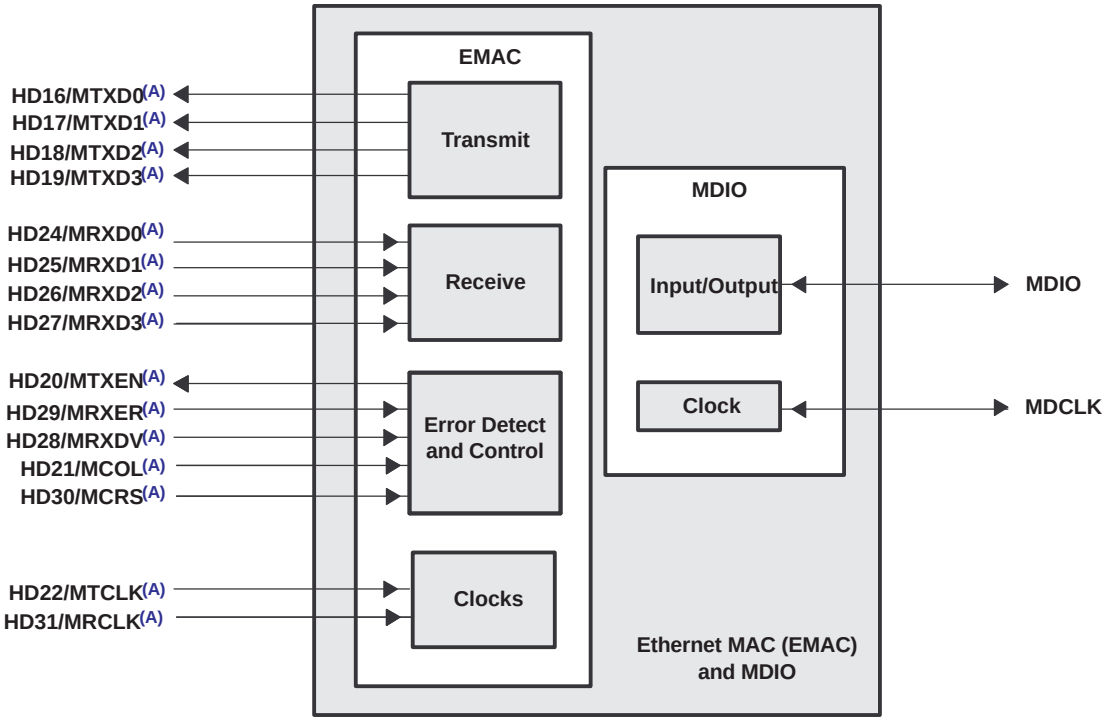


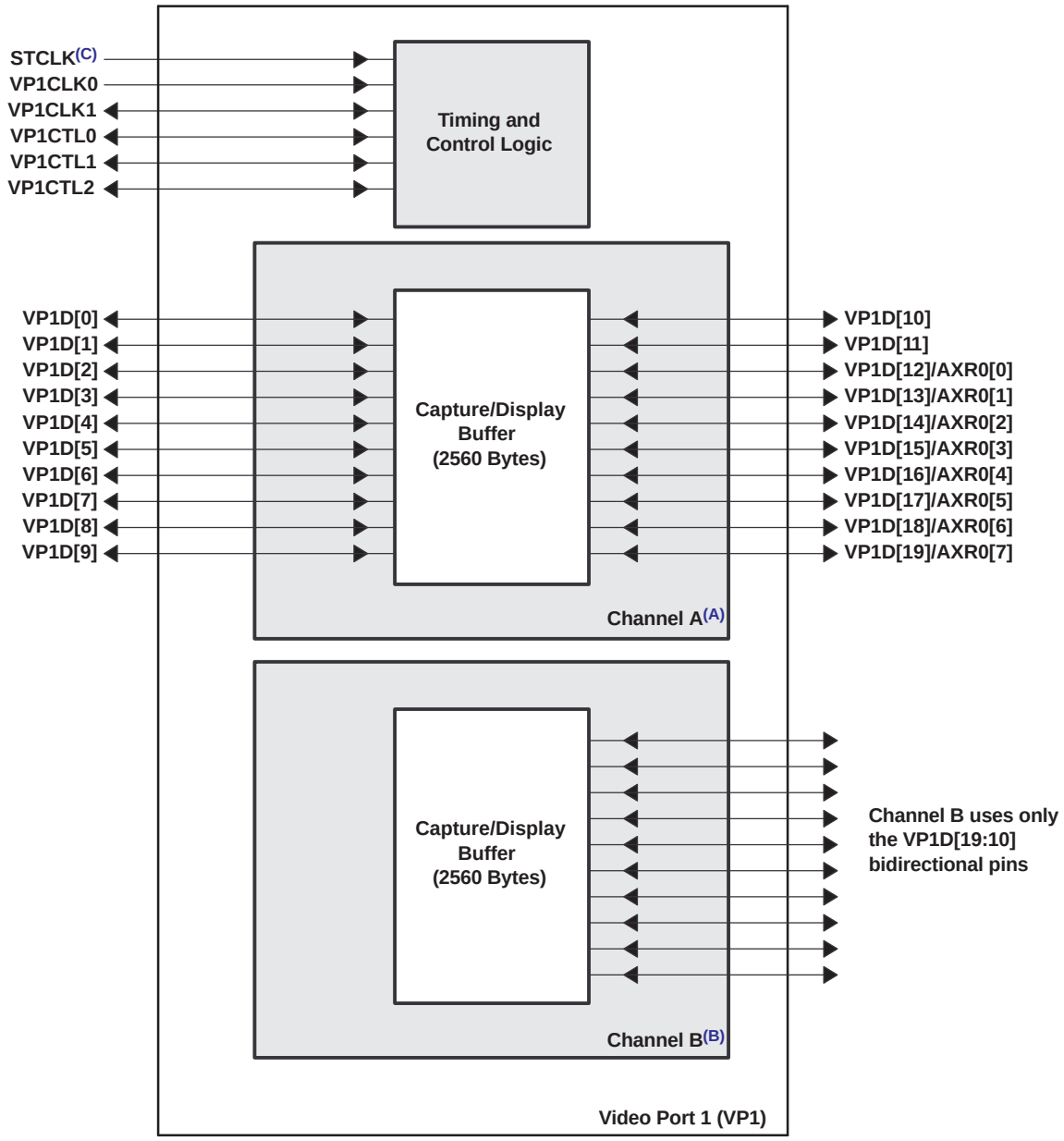

**Figure 2-10. McBSP/Timer/I2C0 Peripheral Signals**




A. These EMAC pins are muxed with the upper data pins of the HPI peripheral. By default, these signals function as HPI. For more details on these muxed pins, see the Device Configurations section of this data sheet.

**Figure 2-11. EMAC/MDIO Peripheral Signals**


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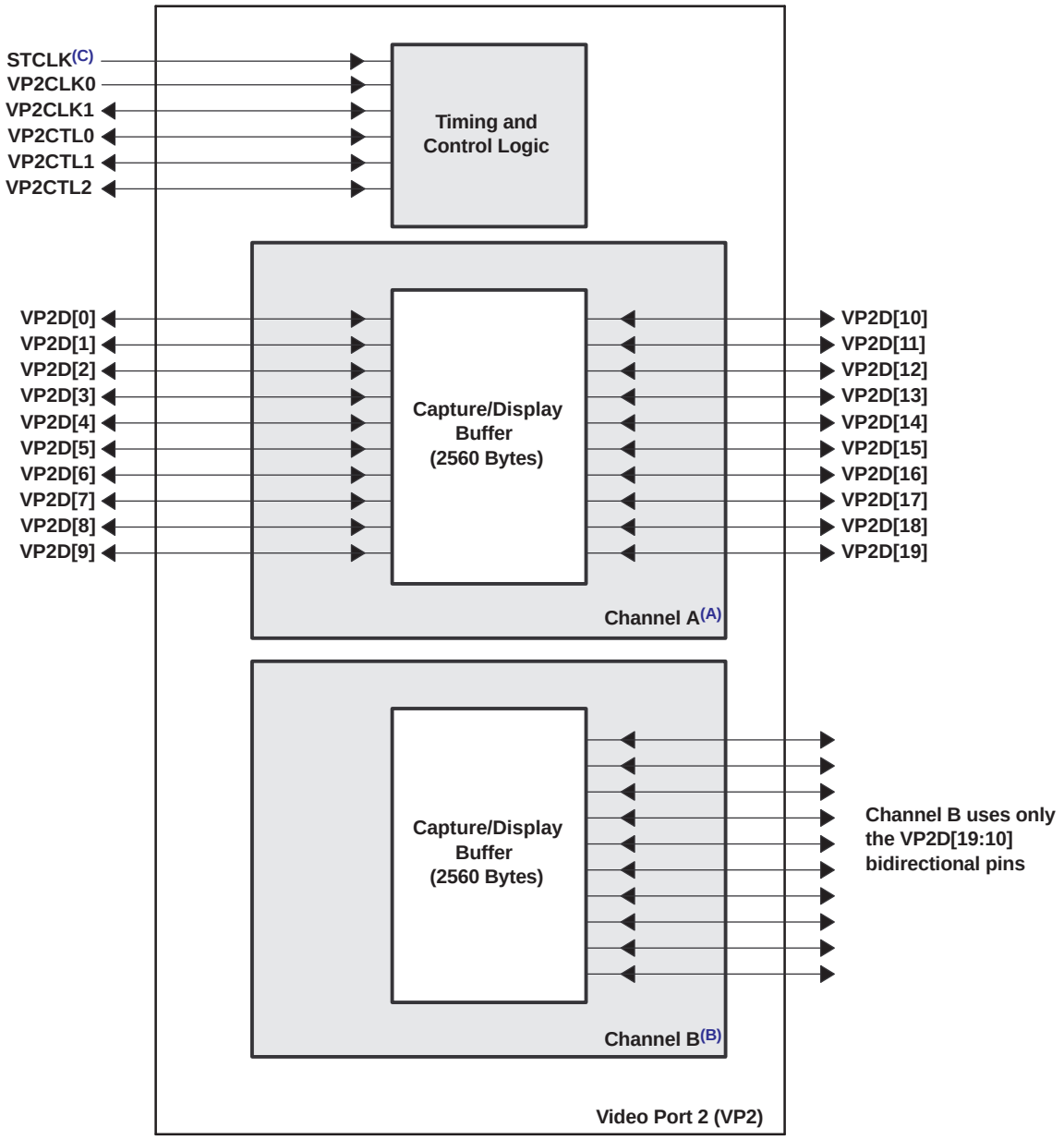

A. Channel A supports: BT.656 (8/10-bit), Y/C Video (16/20-bit), RAW Video (16/20-bit) display modes and BT.656 (8/10-bit), Y/C Video (16/20-bit), RAW Video (16/20-bit) capture modes [TSI (8-bit) capture mode].

B. Channel B supports: BT.656 (8/10-bit), RAW Video (8/10-bit) capture modes and can display synchronized RAW Video data with Channel A.

C. The same STCLK signal is used for both video ports (VP1 and VP2).

**Figure 2-12. Video Port 1 Peripheral Signals**

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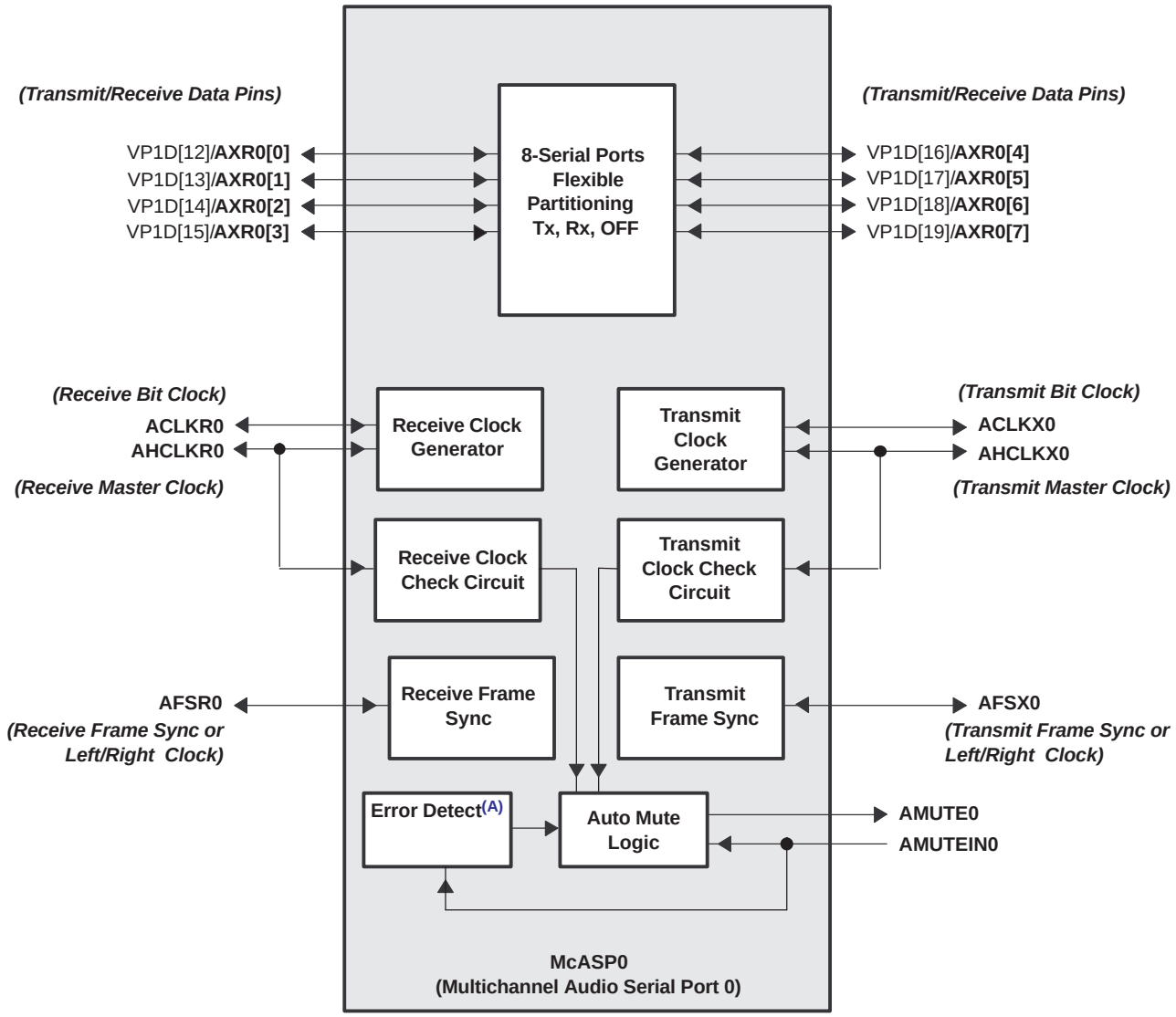

A. Channel A supports: BT.656 (8/10-bit), Y/C Video (16/20-bit), RAW Video (16/20-bit) display modes and BT.656 (8/10-bit), Y/C Video (16/20-bit), RAW Video (16/20-bit) capture modes [TSI (8-bit) capture mode].

B. Channel B supports: BT.656 (8/10-bit), RAW Video (8/10-bit) capture modes and can display synchronized RAW Video data with Channel A.

C. The same STCLK signal is used for both video ports (VP1 and VP2).

**Figure 2-13. Video Port 2 Peripheral Signals**


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NOTES: On multiplexed pins, bolded text denotes the active function of the pin for that particular peripheral module.
Bolded and italicized text within parentheses denotes the function of the pins in an audio system.

A. The McASP's Error Detect function detects underruns, overruns, early/late frame syncs, DMA errors, and external mute input.

**Figure 2-14. McASP0 Peripheral Signals**

### 2.5.3 Terminal Functions

Table 2-4, the terminal functions table, identifies the external signal names, the associated pin (ball) numbers along with the mechanical package designator, the pin type (I, O/Z, or I/O/Z), whether the pin has any internal pullup/pulldown resistors and a functional pin description. For more detailed information on device configuration, peripheral selection, multiplexed/shared pins, and debugging considerations, see the Device Configurations section of this data sheet.

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## Table 2-4. Terminal Functions

| SIGNAL NAME | NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| **CLOCK/PLL CONFIGURATION** | | | | |
| CLKIN | AC2 | I | | Clock Input. This clock is the input to the on-chip PLL. |
| CLKOUT4/GP0[1](3) | D6 | I/O/Z | IPU | Clock output at 1/4 of the device speed (**O/Z**) [default] or this pin can be programmed as a GP0 1 pin (**I/O/Z**). |
| CLKOUT6/GP0[2](3) | C6 | I/O/Z | IPU | Clock output at 1/6 of the device speed (**O/Z**) [default] or this pin can be programmed as a GP0 2 pin (**I/O/Z**). |
| CLKMODE1 | AE4 | I | IPD | Clock mode select<br>• Selects whether the CPU clock frequency = input clock frequency x1 (Bypass), x6, or x12.<br>For more details on the CLKMODE pins and the PLL multiply factors, see the Clock PLL section of this data sheet. |
| CLKMODE0 | AA2 | I | IPD | |
| PLLV(4) | V6 | A(1) | | PLL voltage supply |
| **JTAG EMULATION** | | | | |
| TMS | E15 | I | IPU | JTAG test-port mode select |
| TDO | B18 | O/Z | IPU | JTAG test-port data out |
| TDI | A18 | I | IPU | JTAG test-port data in |
| TCK | A16 | I | IPU | JTAG test-port clock |
| $\overline{\text{TRST}}$ | D14 | I | IPD | JTAG test-port reset. For IEEE 1149.1 JTAG compatibility, see the IEEE 1149.1 JTAG compatibility statement portion of this data sheet. |
| EMU11 | D17 | I/O/Z | IPU | Emulation pin 11. Reserved for future use, leave unconnected. |
| EMU10 | C17 | I/O/Z | IPU | Emulation pin 10. Reserved for future use, leave unconnected. |
| EMU9 | B17 | I/O/Z | IPU | Emulation pin 9. Reserved for future use, leave unconnected. |
| EMU8 | D16 | I/O/Z | IPU | Emulation pin 8. Reserved for future use, leave unconnected. |
| EMU7 | A17 | I/O/Z | IPU | Emulation pin 7. Reserved for future use, leave unconnected. |
| EMU6 | C16 | I/O/Z | IPU | Emulation pin 6. Reserved for future use, leave unconnected. |
| EMU5 | B16 | I/O/Z | IPU | Emulation pin 5. Reserved for future use, leave unconnected. |
| EMU4 | D15 | I/O/Z | IPU | Emulation pin 4. Reserved for future use, leave unconnected. |
| EMU3 | C15 | I/O/Z | IPU | Emulation pin 3. Reserved for future use, leave unconnected. |
| EMU2 | B15 | I/O/Z | IPU | Emulation pin 2. Reserved for future use, leave unconnected. |
| EMU1 | C14 | I/O/Z | IPU | Emulation pin 1 (5) |
| EMU0 | A15 | I/O/Z | IPU | Emulation pin 0 (5) |
| **RESETS, INTERRUPTS, AND GENERAL-PURPOSE INPUT/OUTPUTS** | | | | |
| $\overline{\text{RESET}}$ | P4 | I | | Device reset |
| NMI | B4 | I | IPD | Nonmaskable interrupt, edge-driven (rising edge)<br>**Note:** Any noise on the NMI pin may trigger an NMI interrupt; therefore, if the NMI pin is not used, it is recommended that the NMI pin be grounded versus relying on the IPD. |
| GP0[7]/EXT_INT7 | E1 | I/O/Z | IPU | General-purpose input/output (GPIO) pins (**I/O/Z**) or external interrupts (**input only**). The default after reset setting is GPIO enabled as input-only.<br>• When these pins function as External Interrupts [by selecting the corresponding interrupt enable register bit (IER.[7:4])], they are edge-driven and the polarity can be independently selected via the External Interrupt Polarity Register bits (EXTPOL.[3:0]). |
| GP0[6]/EXT_INT6 | F2 | I/O/Z | IPU | |
| GP0[5]/EXT_INT5 | F3 | I/O/Z | IPU | |
| GP0[4]/EXT_INT4 | F4 | I/O/Z | IPU | |

(1) I = Input, O = Output, Z = High impedance, S = Supply voltage, GND = Ground, A = Analog signal
(2) IPD = Internal pulldown, IPU = Internal pullup. (These IPD/IPU signal pins feature a 30-kΩ IPD or IPU resistor. To pull up a signal to the opposite supply rail, a 1-kΩ resistor should be used.)
(3) These pins are multiplexed pins. For more details, see the Device Configurations section of this data sheet.
(4) PLLV is not part of external voltage supply. See the Clock PLL section for information on how to connect this pin.
(5) The EMU0 and EMU1 pins are internally pulled up with 30-kΩ resistors; therefore, for emulation and normal operation, no external pullup/pulldown resistors are necessary. However, for boundary scan operation, pull down the EMU1 and EMU0 pins with a dedicated 1-kΩ resistor.


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| GP0[15] | G3 | I/O/Z | | General-purpose input/output GP0[15:9] pins (**I/O/Z**).<br>**Note:** By default, no function is enabled upon reset. To configure these pins, see the Device Configuration section of this data sheet. |
| GP0[14] | C1 | | | |
| GP0[13] | G4 | | | |
| GP0[12] | H4 | | | |
| GP0[11] | F1 | | | |
| GP0[10] | J2 | | | |
| GP0[9] | K3 | | | |
| GP0[3] | L5 | | IPD | GP0 3 pin (**I/O/Z**) |
| GP0[0] | M5 | I/O/Z | IPD | General-purpose 0 pin (GP0[0]) (**I/O/Z**) [default]<br>This pin can be programmed as GPIO 0 (**input only**) [default] or as GP0[0] (**output only**) pin or output as a general-purpose interrupt (GP0INT) signal (**output only**).<br>**Note:** This pin ***must*** remain low during device reset. |
| VDAC/GP0[8](3) | AD1 | I/O/Z | IPD | VCXO Interpolated Control Port (VIC) single-bit digital-to-analog converter (VDAC) output [**output only**] [default] or this pin can be programmed as a GP0 8 pin (**I/O/Z**). |
| CLKOUT6/GP0[2](3) | C6 | I/O/Z | IPD | Clock output at 1/6 of the device speed (**O/Z**) [default] or this pin can be programmed as a GP0 2 pin (**I/O/Z**). |
| CLKOUT4/GP0[1](3) | D6 | I/O/Z | IPD | Clock output at 1/4 of the device speed (**O/Z**) [default] or this pin can be programmed as a GP0 1 pin (**I/O/Z**). |
| **HOST-PORT INTERFACE (HPI) or EMAC** | | | | |
| $\overline{\text{HINT}}$ | N4 | O/Z | | Host interrupt from DSP to host (**O**). |
| HCNTL1 | P1 | I | | Host control – selects between control, address, or data registers (**I**). |
| HCNTL0 | R3 | I | | Host control – selects between control, address, or data registers (**I**). |
| HHWIL | N3 | I | | Host half-word select – first or second half-word (not necessarily high or low order). [For HPI16 bus width selection only] (**I**). |
| HR/$\overline{\text{W}}$ | M1 | I | | Host read or write select (**I**). |
| $\overline{\text{HAS}}$ | P3 | I | | Host address strobe (**I**)<br>Host chip select (**I**)<br>Host data strobe 1 (**I**)<br>Host data strobe 2 (**I**)<br>**Note:** If unused, the following HPI control signals should be externally pulled high. |
| $\overline{\text{HCS}}$ | R1 | I | | |
| $\overline{\text{HDS1}}$ | R2 | I | | |
| $\overline{\text{HDS2}}$ | T2 | I | | |
| $\overline{\text{HRDY}}$ | N1 | O/Z | | Host ready from DSP to host (**O**) |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | SIGNAL NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| HD31/MRCLK(6) | G1 | I/O/Z | | Host-port data (**I/O/Z**) [default] or EMAC transmit/receive or control pins<br>As HPI data bus<br>• Used for transfer of data, address, and control<br>• Host-Port bus width user-configurable at device reset via a 10-kΩ resistor pullup/pulldown resistor on the HD5 pin:<br>Note: If a configuration pin must be routed out from the device, the internal pullup/pulldown (IPU/IPD) resistor should not be relied upon; TI recommends the use of an external pullup/pulldown resistor.<br>**Boot Configuration:**<br>• HD5 pin = 0: HPI operates as an HPI16.<br>(HPI bus is 16 bits wide. HD[15:0] pins are used and the remaining HD[31:16] pins are reserved pins in the high-impedance state.)<br>• HD5 pin = 1: HPI operates as an HPI32.<br>(HPI bus is 32 bits wide. All HD[31:0] pins are used for host-port operations.)<br>For superset devices like DM643, the HD31 through HD16 pins can also function as EMAC transmit/receive or control pins (when MAC_EN pin = 1). For more details on the EMAC pin functions, see the *Ethernet MAC (EMAC) peripheral* section of this table and for more details on how to configure the EMAC pin functions, see the device configuration section of this data sheet. |
| HD30/MCRS(6) | H3 | | | |
| HD29/MRXER(6) | G2 | | | |
| HD28/MRXDV(6) | J4 | | | |
| HD27/MRXD3(6) | H2 | | | |
| HD26/MRXD2(6) | J3 | | | |
| HD25/MRXD1(6) | J1 | | | |
| HD24/MRXD0(6) | K4 | | | |
| HD23 | K1 | | | |
| HD22/MTCLK(6) | L4 | | | |
| HD21/MCOL(6) | K2 | | | |
| HD20/MTXEN(6) | L3 | | | |
| HD19/MTXD3(6) | L2 | | | |
| HD18/MTXD2(6) | M4 | | | |
| HD17/MTXD1(6) | M2 | | | |
| HD16/MTXD0(6) | M3 | | | |
| HD15 | T3 | | | |
| HD14 | U1 | | | |
| HD13 | U3 | | | |
| HD12 | U2 | | | |
| HD11 | U4 | | | |
| HD10 | V1 | | | |
| HD9 | V3 | | | |
| HD8 | V2 | | | |
| HD7 | W2 | | | |
| HD6 | W4 | | | |
| HD5 | Y1 | | | |
| HD4 | W3 | | | |
| HD3 | Y2 | | | |
| HD2 | Y4 | | | |
| HD1 | AA1 | | | |
| HD0 | Y3 | | | |
| **EMIFA (64-bit) – CONTROL SIGNALS COMMON TO ALL TYPES OF MEMORY** | | | | |
| $\overline{ACE3}$ | L26 | O/Z | IPU | EMIFA memory space enables<br>• Enabled by bits 28 through 31 of the word address<br>• Only one pin is asserted during any external data access |
| $\overline{ACE2}$ | K23 | O/Z | IPU | |
| $\overline{ACE1}$ | K24 | O/Z | IPU | |
| $\overline{ACE0}$ | K25 | O/Z | IPU | |
| $\overline{ABE7}$ | T22 | O/Z | IPU | EMIFA byte-enable control<br>• Decoded from the low-order address bits. The number of address bits or byte enables used depends on the width of external memory.<br>• Byte-write enables for most types of memory<br>• Can be directly connected to SDRAM read and write mask signal (SDQM) |
| $\overline{ABE6}$ | T23 | O/Z | IPU | |
| $\overline{ABE5}$ | R25 | O/Z | IPU | |
| $\overline{ABE4}$ | R26 | O/Z | IPU | |
| $\overline{ABE3}$ | M25 | O/Z | IPU | |
| $\overline{ABE2}$ | M26 | O/Z | IPU | |
| $\overline{ABE1}$ | L23 | O/Z | IPU | |
| $\overline{ABE0}$ | L24 | O/Z | IPU | |

(6) These pins are multiplexed pins. For more details, see the Device Configurations section of this data sheet.


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| $\overline{\text{APDT}}$ | M22 | O/Z | IPU | EMIFA peripheral data transfer, allows direct transfer between external peripherals |
| **EMIFA (64-bit) – BUS ARBITRATION** | | | | |
| $\overline{\text{AHOLDA}}$ | N22 | O | IPU | EMIFA hold-request-acknowledge to the host |
| $\overline{\text{AHOLD}}$ | W24 | I | IPU | EMIFA hold request from the host |
| ABUSREQ | P22 | O | IPU | EMIFA bus request output |
| **EMIFA (64-bit) – ASYNCHRONOUS/SYNCHRONOUS MEMORY CONTROL** | | | | |
| AECLKIN | H25 | I | IPD | EMIFA external input clock. The EMIFA input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) is selected at reset via the pullup/pulldown resistors on the AEA[20:19] pins.<br>AECLKIN is the default for the EMIFA input clock. |
| AECLKOUT2 | J23 | O/Z | IPD | EMIFA output clock 2. Programmable to be EMIFA input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) frequency divided-by-1, -2, or -4. |
| AECLKOUT1 | J26 | O/Z | IPD | EMIFA output clock 1 [at EMIFA input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) frequency]. |
| $\overline{\text{AARE}}$/ $\overline{\text{ASDCAS}}$/ ASADS/$\overline{\text{ASRE}}$ | J25 | O/Z | IPU | EMIFA asynchronous memory read-enable/SDRAM column-address strobe/programmable synchronous interface-address strobe or read-enable<br>• For programmable synchronous interface, the RENEN field in the CE Space Secondary Control Register (CExSEC) selects between $\overline{\text{ASADS}}$ and $\overline{\text{ASRE}}$:<br>If RENEN = 0, then the $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$ signal functions as the $\overline{\text{ASADS}}$ signal.<br>If RENEN = 1, then the $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$ signal functions as the $\overline{\text{ASRE}}$ signal. |
| $\overline{\text{AAOE}}$/ $\overline{\text{ASDRAS}}$/ $\overline{\text{ASOE}}$ | J24 | O/Z | IPU | EMIFA asynchronous memory output-enable/SDRAM row-address strobe/programmable synchronous interface output-enable |
| $\overline{\text{AAWE}}$/ $\overline{\text{ASDWE}}$/ $\overline{\text{ASWE}}$ | K26 | O/Z | IPU | EMIFA asynchronous memory write-enable/SDRAM write-enable/programmable synchronous interface write-enable |
| ASDCKE | L25 | O/Z | IPU | EMIFA SDRAM clock-enable (used for self-refresh mode).<br>• If SDRAM is not in system, ASDCKE can be used as a general-purpose output. |
| $\overline{\text{ASOE3}}$ | R22 | O/Z | IPU | EMIFA synchronous memory output-enable for $\overline{\text{ACE3}}$ (for glueless FIFO interface) |
| AARDY | L22 | I | IPU | Asynchronous memory ready input |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | SIGNAL NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **EMIFA (64-bit) – ADDRESS** | | | | |
| AEA22 | U23 | O/Z | IPD | EMIFA external address (doubleword address)<br>EMIFA address numbering for the DM643 device starts with AEA3 to maintain signal name compatibility with other C64x™ devices (e.g., C6414, C6415, and C6416) [see the 64-bit EMIF addressing scheme in the *TMS320C6000 DSP External Memory Interface (EMIF) Reference Guide* (literature number SPRU266)].<br>Note: If a configuration pin must be routed out from the device, the internal pullup/pulldown (IPU/IPD) resistor should not be relied upon; TI recommends the use of an external pullup/pulldown resistor.<br>**Boot Configuration:**<br>• Controls initialization of DSP modes at reset (**I**) via pullup/pulldown resistors<br>– Boot mode (AEA[22:21]):<br>00 - No boot (default mode)<br>01 - HPI boot<br>10 - Reserved<br>11 - EMIFA 8-bit ROM boot<br>– EMIF clock select AEA[20:19]:<br>Clock mode select for EMIFA (AECLKIN_SEL[1:0])<br>00 - AECLKIN (default mode)<br>01 - CPU/4 Clock Rate<br>10 - CPU/6 Clock Rate<br>11 - Reserved<br>For more details, see the Device Configurations section of this data sheet. |
| AEA21 | V24 | | | |
| AEA20 | V25 | | | |
| AEA19 | V26 | | | |
| AEA18 | V23 | | | |
| AEA17 | U24 | | | |
| AEA16 | U25 | | | |
| AEA15 | U26 | | | |
| AEA14 | T24 | | | |
| AEA13 | T25 | | | |
| AEA12 | R23 | | | |
| AEA11 | R24 | | | |
| AEA10 | P23 | | | |
| AEA9 | P24 | | | |
| AEA8 | P26 | | | |
| AEA7 | N23 | | | |
| AEA6 | N24 | | | |
| AEA5 | N26 | | | |
| AEA4 | M23 | | | |
| AEA3 | M24 | | | |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | SIGNAL NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **EMIFA (64-bit) – DATA** | | | | |
| AED63 | AF24 | I/O/Z | IPU | EMIFA external data |
| AED62 | AF23 | | | |
| AED61 | AE23 | | | |
| AED60 | AD23 | | | |
| AED59 | AD22 | | | |
| AED58 | AE22 | | | |
| AED57 | AD21 | | | |
| AED56 | AE21 | | | |
| AED55 | AC21 | | | |
| AED54 | AF21 | | | |
| AED53 | AD20 | | | |
| AED52 | AE20 | | | |
| AED51 | AC20 | | | |
| AED50 | AF20 | | | |
| AED49 | AC19 | | | |
| AED48 | AD19 | | | |
| AED47 | W23 | | | |
| AED46 | Y26 | | | |
| AED45 | Y23 | | | |
| AED44 | Y25 | | | |
| AED43 | Y24 | | | |
| AED42 | AA26 | | | |
| AED41 | AA23 | | | |
| AED40 | AA25 | | | |
| AED39 | AA24 | | | |
| AED38 | AB23 | | | |
| AED37 | AB25 | | | |
| AED36 | AB24 | | | |
| AED35 | AC26 | | | |
| AED34 | AC25 | | | |
| AED33 | AD25 | | | |
| AED32 | AD26 | | | |
| AED31 | C26 | | | |
| AED30 | C25 | | | |
| AED29 | D26 | | | |
| AED28 | D25 | | | |
| AED27 | E24 | | | |
| AED26 | E25 | | | |
| AED25 | F24 | | | |
| AED24 | F25 | | | |
| AED23 | F23 | | | |
| AED22 | F26 | | | |
| AED21 | G24 | | | |
| AED20 | G25 | | | |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | SIGNAL NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| AED19 | G23 | I/O/Z | IPU | EMIFA external data |
| AED18 | G26 | | | |
| AED17 | H23 | | | |
| AED16 | H24 | | | |
| AED15 | C19 | | | |
| AED14 | D19 | | | |
| AED13 | A20 | | | |
| AED12 | D20 | | | |
| AED11 | B20 | | | |
| AED10 | C20 | | | |
| AED9 | A21 | | | |
| AED8 | D21 | | | |
| AED7 | B21 | | | |
| AED6 | C21 | | | |
| AED5 | A23 | | | |
| AED4 | C22 | | | |
| AED3 | B22 | | | |
| AED2 | B23 | | | |
| AED1 | A24 | | | |
| AED0 | B24 | | | |
| **MANAGEMENT DATA INPUT/OUTPUT (MDIO)** | | | | |
| MDCLK | R5 | I/O/Z | IPD | MDIO serial clock input/output (**I/O/Z**). |
| MDIO | P5 | I/O/Z | IPU | MDIO serial data input/output (**I/O/Z**). |
| **VCXO INTERPOLATED CONTROL PORT (VIC)** | | | | |
| VDAC/GP0[8][3] | AD1 | I/O/Z | IPD | VCXO Interpolated Control Port (VIC) single-bit digital-to-analog converter (VDAC) output [**output only**] [default] or this pin can be programmed as a GP0 8 pin (**I/O/Z**) |
| **VIDEO PORTS (VP1 AND VP2)** | | | | |
| STCLK | AC1 | I | IPD | The STCLK signal drives the hardware counter on the video ports. |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | SIGNAL NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **VIDEO PORT 2 (VP2)** | | | | |
| VP2D[19] | E13 | I/O/Z | IPD | Video port 2 (VP2) data input/output (**I/O/Z**)<br>**Note:** By default, no function is enabled upon reset. To configure these pins, see the Device Configuration section of this data sheet. |
| VP2D[18] | E12 | | | |
| VP2D[17] | D12 | | | |
| VP2D[16] | C12 | | | |
| VP2D[15] | B12 | | | |
| VP2D[14] | E11 | | | |
| VP2D[13] | D11 | | | |
| VP2D[12] | C11 | | | |
| VP2D[11] | B11 | | | |
| VP2D[10] | A11 | | | |
| VP2D[9] | D10 | | | |
| VP2D[8] | C10 | | | |
| VP2D[7] | B10 | | | |
| VP2D[6] | A10 | | | |
| VP2D[5] | D9 | | | |
| VP2D[4] | C9 | | | |
| VP2D[3] | B9 | | | |
| VP2D[2] | A9 | | | |
| VP2D[1] | D8 | | | |
| VP2D[0] | C8 | | | |
| VP2CLK1 | A13 | I/O/Z | IPD | VP2 clock 1 (**I/O/Z**) |
| VP2CLK0 | A7 | I | IPD | VP2 clock 0 (**I**) |
| VP2CTL2 | C7 | I/O/Z | IPD | VP2 control 2 (**I/O/Z**) |
| VP2CTL1 | D7 | | | VP2 control 1 (**I/O/Z**) |
| VP2CTL0 | B8 | | | VP2 control 0 (**I/O/Z**) |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **VIDEO PORT 1 (VP1) OR McASP0 DATA** | | | | |
| VP1D[19]/AXR0[7][3] | AB12 | I/O/Z | IPD | Video port 1 (VP1) data input/output (**I/O/Z**) or McASP0 data pins (**I/O/Z**)<br>By default, standalone VP1 data input/output pins have no function enabled upon reset. To configure these pins, see the Device Configuration section of this data sheet.<br>For more details on the McASP0 data pin functions, see *McASP0 data* section of this table and the Device Configurations section of this data sheet. |
| VP1D[18]/AXR0[6][3] | AB11 | | | |
| VP1D[17]/AXR0[5][3] | AC11 | | | |
| VP1D[16]/AXR0[4][3] | AD11 | | | |
| VP1D[15]/AXR0[3][3] | AE11 | | | |
| VP1D[14]/AXR0[2][3] | AC10 | | | |
| VP1D[13]/AXR0[1][3] | AD10 | | | |
| VP1D[12]/AXR0[0][3] | AC9 | | | |
| VP1D[11] | AD9 | | | |
| VP1D[10] | AE9 | | | |
| VP1D[9] | AC8 | | | |
| VP1D[8] | AD8 | | | |
| VP1D[7] | AC7 | | | |
| VP1D[6] | AD7 | | | |
| VP1D[5] | AE7 | | | |
| VP1D[4] | AC6 | | | |
| VP1D[3] | AD6 | | | |
| VP1D[2] | AE6 | | | |
| VP1D[1] | AF6 | | | |
| VP1D[0] | AF5 | | | |
| VP1CLK1 | AF10 | I/O/Z | IPD | VP1 clock 1 (**I/O/Z**) |
| VP1CLK0 | AF8 | I | IPD | VP1 clock 0 (**I**) |
| VP1CTL2 | AD5 | I/O/Z | IPD | VP1 control 2 (**I/O/Z**) |
| VP1CTL1 | AE5 | | | VP1 control 1 (**I/O/Z**) |
| VP1CTL0 | AF4 | | | VP1 control 0 (**I/O/Z**) |
| **TIMER 2** | | | | |
| | – | | | No external pins. The timer 2 peripheral pins are ***not*** pinned out as external pins. |
| **TIMER 1** | | | | |
| TOUT1 | B5 | O/Z | IPU | Timer 1 output (**O/Z**)<br>**Boot Configuration:** Device endian mode [LENDIAN] (**I**)<br>Controls initialization of DSP modes at reset via pullup/pulldown resistors<br>• Device Endian mode<br>0 - Big Endian<br>1 - Little Endian (default)<br>For more details on LENDIAN, see the Device Configurations section of this data sheet.<br>Note: If a configuration pin must be routed out from the device, the internal pullup/pulldown (IPU/IPD) resistor should not be relied upon; TI recommends the use of an external pullup/pulldown resistor. |
| TINP1 | A5 | I | IPD | Timer 1 or general-purpose input |
| **TIMER 0** | | | | |
| TOUT0 | C5 | O/Z | IPD | Timer 0 output (**O/Z**)<br>**Boot Configuration:** MAC enable pin [**MAC_EN**] (**I**)<br>The MAC_EN pin controls the selection (enable/disable) of the HPI, EMAC and MDIO peripherals.<br>For more details, see the Device Configurations section of this data sheet.<br>Note: If a configuration pin must be routed out from the device, the internal pullup/pulldown (IPU/IPD) resistor should not be relied upon; TI recommends the use of an external pullup/pulldown resistor. |
| TINP0 | A4 | I | IPD | Timer 0 or general-purpose input |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| **INTER-INTEGRATED CIRCUIT 0 (I2C0)** | | | | |
| SCL0 | E4 | I/O/Z | — | I2C0 clock. |
| SDA0 | D3 | I/O/Z | — | I2C0 data. |
| **MULTICHANNEL BUFFERED SERIAL PORT 0 (McBSP0)** | | | | |
| CLKR0 | AE15 | I/O/Z | IPD | McBSP0 receive clock (**I/O/Z**) |
| FSR0 | AB16 | I/O/Z | IPD | McBSP0 receive frame sync (**I/O/Z**) |
| DR0 | AC16 | I | IPD | McBSP0 receive data (**I**) |
| DX0 | AE16 | O/Z | IPD | McBSP0 transmit data (**O/Z**) |
| FSX0 | AF16 | I/O/Z | IPD | McBSP0 transmit frame sync (**I/O/Z**) |
| CLKX0 | AF17 | I/O/Z | IPD | McBSP0 transmit clock (**I/O/Z**) |
| **ETHERNET MAC (EMAC)** | | | | |
| HD31/MRCLK(3) | G1 | I | | Host-port data (**I/O/Z**) [default] or EMAC transmit/receive or control pins (**I**) (**O/Z**) HPI pin functions are default, see the Device Configurations section of this data sheet. EMAC Media Independent I/F (MII) data, clocks, and control pins for Transmit/Receive.<br>• MII transmit clock (MTCLK),<br>Transmit clock source from the attached PHY.<br>• MII transmit data (MTXD[3:0]),<br>Transmit data nibble synchronous with transmit clock (MTCLK).<br>• MII transmit enable (MTXEN),<br>This signal indicates a valid transmit data on the transmit data pins (MTDX[3:0]).<br>• MII collision sense (MCOL)<br>Assertion of this signal during half-duplex operation indicates network collision.<br>During full-duplex operation, transmission of new frames will not begin if this pin is asserted.<br>• MII carrier sense (MCRS)<br>Indicates a frame carrier signal is being received.<br>• MII receive data (MRXD[3:0]),<br>Receive data nibble synchronous with receive clock (MRCLK).<br>• MII receive clock (MRCLK),<br>Receive clock source from the attached PHY.<br>• MII receive data valid (MRXDV),<br>This signal indicates a valid data nibble on the receive data pins (MRDX[3:0]) and<br>• MII receive error (MRXER),<br>Indicates reception of a coding error on the receive data. |
| HD30/MCRS(3) | H3 | I | | |
| HD29/MRXER(3) | G2 | I | | |
| HD28/MRXDV(3) | J4 | I | | |
| HD27/MRXD3(3) | H2 | I | | |
| HD26/MRXD2(3) | J3 | I | | |
| HD25/MRXD1(3) | J1 | I | | |
| HD24/MRXD0(3) | K4 | I | | |
| HD22/MTCLK(3) | L4 | I | | |
| HD21/MCOL(3) | K2 | I | | |
| HD20/MTXEN(3) | L3 | O/Z | | |
| HD19/MTXD3(3) | L2 | O/Z | | |
| HD18/MTXD2(3) | M4 | O/Z | | |
| HD17/MTXD1(3) | M2 | O/Z | | |
| HD16/MTXD0(3) | M3 | O/Z | | |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **MULTICHANNEL AUDIO SERIAL PORT 0 (McASP0) CONTROL** | | | | |
| AHCLKX0 | AC12 | I/O/Z | IPD | McASP0 transmit high-frequency master clock (I/O/Z). |
| AFSX0 | AD12 | I/O/Z | IPD | McASP0 transmit frame sync or left/right clock (LRCLK) (I/O/Z). |
| ACLKX0 | AB13 | I/O/Z | IPD | McASP0 transmit bit clock (I/O/Z). |
| AMUTE0 | AC13 | O/Z | IPD | McASP0 mute output (O/Z). |
| AMUTEIN0 | AD13 | I/O/Z | IPD | McASP0 mute input (I/O/Z). |
| AHCLKR0 | AB14 | I/O/Z | IPD | McASP0 receive high-frequency master clock (I/O/Z). |
| AFSR0 | AC14 | I/O/Z | IPD | McASP0 receive frame sync or left/right clock (LRCLK) (I/O/Z). |
| ACLKR0 | AD14 | I/O/Z | IPD | McASP0 receive bit clock (I/O/Z). |
| **MULTICHANNEL AUDIO SERIAL PORT 0 (McASP0) DATA** | | | | |
| VP1D[19]/AXR0[7][3] | AB12 | I/O/Z | IPD | VP1 input/output data pins [19:12] (**I/O/Z**) or McASP0 TX/RX data pins [7:0] (**I/O/Z**) [default]. |
| VP1D[18]/AXR0[6][3] | AB11 | | | |
| VP1D[17]/AXR0[5][3] | AC11 | | | |
| VP1D[16]/AXR0[4][3] | AD11 | | | |
| VP1D[15]/AXR0[3][3] | AE11 | | | |
| VP1D[14]/AXR0[2][3] | AC10 | | | |
| VP1D[13]/AXR0[1][3] | AD10 | | | |
| VP1D[12]/AXR0[0][3] | AC9 | | | |
| **RESERVED FOR TEST** | | | | |
| RSV07 | H7 | A | — | Reserved. This pin must be connected directly to $CV_{DD}$ for proper operation. |
| RSV08 | R6 | A | — | Reserved. This pin must be connected directly to $DV_{DD}$ for proper operation. |
| RSV05 | E14 | I | IPD | Reserved (leave unconnected, ***do not*** connect to power or ground. If the signal must be routed out from the device, the internal pull-up/down resistance should not be relied upon and an external pull-up/down should be used.) |
| RSV06 | W7 | A | — | |
| RSV00 | AA3 | A | — | |
| RSV01 | AB3 | I | — | |
| RSV02 | AC4 | O/Z | — | |
| RSV03 | AD3 | O/Z | — | |
| RSV04 | AF3 | O | IPU | |
| **ADDITIONAL RESERVED FOR TEST** | | | | |
| RSV09 | E2 | I | IPD | Reserved. For proper DM643 device operation, this pin at device reset ***must be*** pulled down via a 10-kΩ external resistor. |
| RSV10 | V4 | I/O/Z | — | Reserved. This pin ***must be*** pulled down via a 10-kΩ external resistor. |
| RSV12 | R4 | I | IPU | Reserved (leave unconnected, ***do not*** connect to power or ground. If the signal must be routed out from the device, the internal pull-up/down resistance should not be relied upon and an external pull-up/down should be used.) |
| RSV11 | T4 | O | IPD | |
| RSV17 | AB15 | I/O/Z | IPD | |
| RSV16 | AC15 | I/O/Z | IPD | |
| RSV21 | AC17 | I/O/Z | IPD | |
| RSV15 | AD15 | I/O/Z | IPD | |
| RSV23 | AD16 | I | IPD | |
| RSV22 | AD17 | I/O/Z | IPD | |
| RSV20 | AE17 | I/O/Z | IPD | |
| RSV14 | AE18 | I/O/Z | IPD | |
| RSV19 | AF12 | I/O/Z | IPD | |
| RSV18 | AF14 | I | IPD | |
| RSV13 | AF18 | I/O/Z | IPD | |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| **SUPPLY VOLTAGE PINS** | | | | |
| $DV_{DD}$ | A2 | S | | 3.3-V supply voltage<br>(see the Power-Supply Decoupling section of this data sheet) |
| | A25 | | | |
| | B1 | | | |
| | B2 | | | |
| | B14 | | | |
| | B25 | | | |
| | B26 | | | |
| | C3 | | | |
| | C24 | | | |
| | D4 | | | |
| | D23 | | | |
| | E5 | | | |
| | E7 | | | |
| | E8 | | | |
| | E10 | | | |
| | E17 | | | |
| | E19 | | | |
| | E20 | | | |
| | E22 | | | |
| | F9 | | | |
| | F12 | | | |
| | F15 | | | |
| | F18 | | | |
| | G5 | | | |
| | G22 | | | |
| | H5 | | | |
| | H22 | | | |
| | J6 | | | |
| | J21 | | | |
| | K5 | | | |
| | K22 | | | |
| | M6 | | | |
| | M21 | | | |
| | N2 | | | |
| | P25 | | | |
| | R21 | | | |
| | U5 | | | |
| | U22 | | | |
| | V21 | | | |
| | W5 | | | |
| | W22 | | | |
| | W25 | | | |
| | Y5 | | | |
| | Y22 | | | |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| $DV_{DD}$ | AA9 | S | | 3.3-V supply voltage (see the Power-Supply Decoupling section of this data sheet) |
| | AA12 | | | |
| | AA15 | | | |
| | AA18 | | | |
| | AB5 | | | |
| | AB7 | | | |
| | AB8 | | | |
| | AB10 | | | |
| | AB17 | | | |
| | AB19 | | | |
| | AB20 | | | |
| | AB22 | | | |
| | AC23 | | | |
| | AD24 | | | |
| | AE1 | | | |
| | AE2 | | | |
| | AE13 | | | |
| | AE25 | | | |
| | AE26 | | | |
| | AF2 | | | |
| | AF25 | | | |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| $CV_{DD}$ | F6 | S | | 1.2-V supply voltage (-500 device)<br>1.4 V supply voltage (-600 device)<br>(see the Power-Supply Decoupling section of this data sheet) |
| | F7 | | | |
| | F20 | | | |
| | F21 | | | |
| | G6 | | | |
| | G7 | | | |
| | G8 | | | |
| | G10 | | | |
| | G11 | | | |
| | G13 | | | |
| | G14 | | | |
| | G16 | | | |
| | G17 | | | |
| | G19 | | | |
| | G20 | | | |
| | G21 | | | |
| | H20 | | | |
| | K7 | | | |
| | K20 | | | |
| | L7 | | | |
| | L20 | | | |
| | M12 | | | |
| | M14 | | | |
| | N7 | | | |
| | N13 | | | |
| | N15 | | | |
| | N20 | | | |
| | P7 | | | |
| | P12 | | | |
| | P14 | | | |
| | P20 | | | |
| | R13 | | | |
| | R15 | | | |
| | T7 | | | |
| | T20 | | | |
| | U7 | | | |
| | U20 | | | |
| | W20 | | | |
| | Y6 | | | |
| | Y7 | | | |
| | Y8 | | | |
| | Y10 | | | |
| | Y11 | | | |
| | Y13 | | | |
| | Y14 | | | |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| $CV_{DD}$ | Y16 | S | | 1.2-V supply voltage (-500 device)<br>1.4 V supply voltage (-600 device)<br>(see the Power-Supply Decoupling section of this data sheet) |
| | Y17 | | | |
| | Y19 | | | |
| | Y20 | | | |
| | Y21 | | | |
| | AA6 | | | |
| | AA7 | | | |
| | AA20 | | | |
| | AA21 | | | |
| **GROUND PINS** | | | | |
| $V_{SS}$ | A1 | GND | | Ground pins |
| | A3 | | | |
| | A6 | | | |
| | A8 | | | |
| | A12 | | | |
| | A14 | | | |
| | A19 | | | |
| | A22 | | | |
| | A26 | | | |
| | B3 | | | |
| | B6 | | | |
| | B7 | | | |
| | B13 | | | |
| | B19 | | | |
| | C2 | | | |
| | C4 | | | |
| | C13 | | | |
| | C18 | | | |
| | C23 | | | |
| | D1 | | | |
| | D2 | | | |
| | D5 | | | |
| | D13 | | | |
| | D18 | | | |
| | D22 | | | |
| | D24 | | | |
| | E3 | | | |
| | E6 | | | |
| | E9 | | | |
| | E16 | | | |
| | E18 | | | |
| | E21 | | | |
| | E23 | | | |
| | E26 | | | |
| | F5 | | | |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE(1) | IPD/ IPU(2) | DESCRIPTION |
|---|---|---|---|---|
| | F8 | | | |
| | F10 | | | |
| | F11 | | | |
| | F13 | | | |
| | F14 | | | |
| | F16 | | | |
| | F17 | | | |
| | F19 | | | |
| | F22 | | | |
| | G9 | | | |
| | G12 | | | |
| | G15 | | | |
| | G18 | | | |
| | H1 | | | |
| | H6 | | | |
| | H21 | | | |
| | H26 | | | |
| | J5 | | | |
| | J7 | | | |
| | J20 | | | |
| | J22 | | | |
| | K6 | | | |
| $V_{SS}$ | K21 | GND | | Ground pins |
| | L1 | | | |
| | L6 | | | |
| | L21 | | | |
| | M7 | | | |
| | M13 | | | |
| | M15 | | | |
| | M20 | | | |
| | N5 | | | |
| | N6 | | | |
| | N12 | | | |
| | N14 | | | |
| | N21 | | | |
| | N25 | | | |
| | P2 | | | |
| | P6 | | | |
| | P13 | | | |
| | P15 | | | |
| | P21 | | | |
| | R7 | | | |
| | R12 | | | |
| | R14 | | | |
| | R20 | | | |

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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| $V_{SS}$ | T1 | GND | | Ground pins |
| | T5 | | | |
| | T6 | | | |
| | T21 | | | |
| | T26 | | | |
| | U6 | | | |
| | U21 | | | |
| | V5 | | | |
| | V7 | | | |
| | V20 | | | |
| | V22 | | | |
| | W1 | | | |
| | W6 | | | |
| | W21 | | | |
| | W26 | | | |
| | Y9 | | | |
| | Y12 | | | |
| | Y15 | | | |
| | Y18 | | | |
| | AA4 | | | |
| | AA5 | | | |
| | AA8 | | | |
| | AA10 | | | |
| | AA11 | | | |
| | AA13 | | | |
| | AA14 | | | |
| | AA16 | | | |
| | AA17 | | | |
| | AA19 | | | |
| | AA22 | | | |
| | AB1 | | | |
| | AB2 | | | |
| | AB4 | | | |
| | AB6 | | | |
| | AB9 | | | |
| | AB18 | | | |
| | AB21 | | | |
| | AB26 | | | |
| | AC3 | | | |
| | AC5 | | | |
| | AC18 | | | |
| | AC22 | | | |
| | AC24 | | | |
| | AD2 | | | |
| | AD4 | | | |


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**Table 2-4. Terminal Functions (continued)**

| SIGNAL NAME | NO. | TYPE[1] | IPD/ IPU[2] | DESCRIPTION |
|---|---|---|---|---|
| $V_{SS}$ | AD18 | GND | | Ground pins |
| | AE3 | | | |
| | AE8 | | | |
| | AE10 | | | |
| | AE12 | | | |
| | AE14 | | | |
| | AE19 | | | |
| | AE24 | | | |
| | AF1 | | | |
| | AF7 | | | |
| | AF9 | | | |
| | AF11 | | | |
| | AF13 | | | |
| | AF15 | | | |
| | AF19 | | | |
| | AF22 | | | |
| | AF26 | | | |

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## 2.6 Development

### 2.6.1 Development Support

TI offers an extensive line of development tools for the TMS320C6000™ DSP platform, including tools to evaluate the performance of the processors, generate code, develop algorithm implementations, and fully integrate and debug software and hardware modules.

The following products support development of C6000™ DSP-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

Scalable, Real-Time Foundation Software (DSP/BIOS™), which provides the basic run-time target software needed to support any DSP application.

**Hardware Development Tools:**

Extended Development System (XDS™) Emulator (supports C6000™ DSP multiprocessor system debug) EVM (Evaluation Module)

For a complete listing of development-support tools for the TMS320C6000™ DSP platform, visit the Texas Instruments web site on the Worldwide Web at http://www.ti.com uniform resource locator (URL). For information on pricing and availability, contact the nearest TI field sales office or authorized distributor.

### 2.6.2 Device Support

#### 2.6.2.1 Device and Development-Support Tool 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., **TMS**320DM643GDK500). 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.

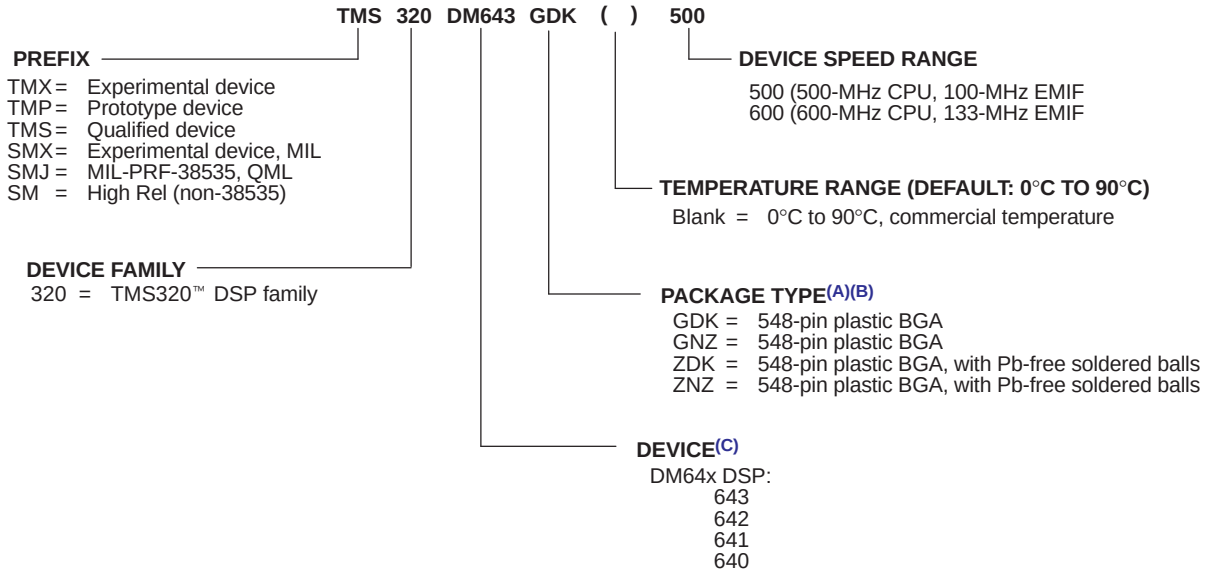

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Predictions show that prototype devices (TMX or TMP) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate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

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, GDK), the temperature range (for example, "blank" is the default commercial temperature range), and the device speed range in megahertz (for example, 500 is 500 MHz). Figure 2-15 provides a legend for reading the complete device name for any TMS320C6000™ DSP platform member.

The ZDK package, like the GDK package, is a 548-ball plastic BGA *only* with Pb-free balls. The ZNZ is the Pb-free package version of the GNZ package.

For device part numbers and further ordering information for TMS320DM643 in the GDK, GNZ, ZDK, and ZNZ package types, see the TI website (http://www.ti.com) or contact your TI sales representative.




A. BGA = Ball Grid Array

B. The ZDK and ZNZ mechanical package designators represent the version of the GDK and GLZ packages, respectively, with Pb-free balls. For more detailed information, see the *Mechanical Data* section of this document.

C. For actual device part numbers (P/Ns) and ordering information, see the TI website (www.ti.com).

**Figure 2-15. TMS320DM64x™ DSP Device Nomenclature (Including the TMS320DM643 Device)**

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### 2.6.2.2 Documentation Support

Extensive documentation supports all TMS320™ DSP family generations of devices from product announcement through applications development. The types of documentation available include: data sheets, such as this document, with design specifications; complete user's reference guides for all devices and tools; technical briefs; development-support tools; on-line help; and hardware and software applications. The following is a brief, descriptive list of support documentation specific to the C6000™ DSP devices:

The *TMS320C6000 CPU and Instruction Set Reference Guide* (literature number SPRU189) describes the C6000™ DSP CPU (core) architecture, instruction set, pipeline, and associated interrupts.

The *TMS320C6000 DSP Peripherals Overview Reference Guide* (literature number SPRU190) provides an overview and briefly describes the functionality of the peripherals available on the C6000™ DSP platform of devices. This document also includes a table listing the peripherals available on the C6000 devices along with literature numbers and hyperlinks to the associated peripheral documents.

The *TMS320C64x Technical Overview* (literature number SPRU395) gives an introduction to the C64x™ digital signal processor, and discusses the application areas that are enhanced by the C64x™ DSP VelociTI.2™ VLIW architecture.

The *TMS320C64x DSP Video Port/VCXO Interpolated Control (VIC) Port Reference Guide* (literature number SPRU629) describes the functionality of the Video Port and VIC Port peripherals.

The *TMS320C6000 DSP Multichannel Audio Serial Port (McASP) Reference Guide* (literature number SPRU041) describes the functionality of the McASP peripheral.

*TMS320C6000 DSP Inter-Integrated Circuit (I2C) Module Reference Guide* (literature number SPRU175) describes the functionality of the $I^2C$ peripheral.

*TMS320C6000 DSP Ethernet Media Access Controller (EMAC)/ Management Data Input/Output (MDIO) Module Reference Guide* (literature number SPRU628) describes the functionality of the EMAC and MDIO peripherals.

The *Using IBIS Models for Timing Analysis* application report (literature number SPRA839) describes how to properly use IBIS models to attain accurate timing analysis for a given system.

The tools support documentation is electronically available within the Code Composer Studio™ Integrated Development Environment (IDE). For a complete listing of C6000™ DSP latest documentation, visit the Texas Instruments web site on the Worldwide Web at http://www.ti.com uniform resource locator (URL).

### 2.6.2.3 Device Silicon Revision

This data manual supports the initial release of the DM643 device; therefore, no device-specific silicon errata document is currently available.


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# 3 Device Configurations

On the DM643 device, bootmode and certain device configurations/peripheral selections are determined at device reset, while other device configurations/peripheral selections are software-configurable via the peripheral configurations register (PERCFG) [address location 0x01B3F000] after device reset.

## 3.1 Configurations at Reset

For proper DM643 device operation, the following external pins must be configured correctly:

- The GP0[0] (pin M5) ***must*** remain low, ***do not*** oppose the internal pulldown (IPD).
- The RSV09 (pin E2) at device reset ***must be*** pulled down via a 10-kΩ resistor.

### *3.1.1 Peripheral Selection at Device Reset*

Some DM643 peripherals share the same pins (internally muxed) and are mutually exclusive (i.e., HPI, EMAC, and MDIO). Other DM643 peripherals (i.e., the Timers, I2C0, GP0, McBSP0, and VP2), are always available.

- HPI, EMAC, and MDIO peripherals

  The MAC_EN pin is latched at reset and determines specific peripheral selection, summarized in Table 3-1. For further clarification of the HPI vs. EMAC configuration, see Table 3-2.

**Table 3-1. HD5, and MAC_EN Peripheral Selection (HPI, EMAC, and MDIO)**

| PERIPHERAL SELECTION | | PERIPHERALS SELECTED | | |
|---|---|---|---|---|
| HD5 Pin [Y1] | MAC_EN Pin [C5] | HPI Data Lower | HPI Data Upper | EMAC and MDIO |
| 0 | 0 | √ | Hi-Z | Disabled |
| 0 | 1 | √ | Hi-Z | √ |
| 1 | 0 | √ | √ | Disabled |
| 1 | 1 | Disabled | | √ |

- The HPI peripheral is enabled and based on the HD5 and MAC_EN pin configuration at reset, HPI16 mode or EMAC and MDIO can be selected.
- The MAC_EN pin, in combination with the HD5 pin, controls the selection of the EMAC and MDIO peripherals (for more details, see Table 3-2).

**Table 3-2. HPI vs. EMAC Peripheral Pin Selection**

| CONFIGURATION SELECTION | | | PERIPHERALS SELECTED | |
|---|---|---|---|---|
| GP0[0] (Pin [M5])(1) | HD5 (Pin [Y1]) | MAC_EN (Pin [C5]) | HD[15:0] | HD[31:16] |
| 0 | 0 | 0 | HPI16 | Hi-Z |
| 0 | 0 | 1 | HPI16 | used for EMAC |
| 0 | 1 | 0 | HPI32 (HD[31:0]) | |
| 0 | 1 | 1 | Hi-Z | used for EMAC |
| 1 | x | x | (1) Invalid configuration. The GP0[0] pin ***must*** remain low during device reset. | |

### *3.1.2 Device Configuration at Device Reset*

Table 3-3 describes the DM643 device configuration pins, which are set up via external pullup/pulldown resistors through the specified EMIFA address bus pins (AEA[22:19]), and the TOUT1/LENDIAN, and the HD5 pins (all of which are latched during device reset).

Note: If a configuration pin must be routed out from the device, the internal pullup/pulldown (IPU/IPD) resistor should not be relied upon; TI recommends the use of an external pullup/pulldown resistor.

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**Table 3-3. DM643 Device Configuration Pins (TOUT1/LENDIAN, AEA[22:19], HD5, and MAC_EN)**

| CONFIGURATION PIN | NO. | FUNCTIONAL DESCRIPTION |
|---|---|---|
| TOUT1/**LENDIAN** | B5 | Device Endian mode (LEND)<br>0 - System operates in Big Endian mode<br>1 - System operates in Little Endian mode (default) |
| **AEA[22:21]** | [U23, V24] | Bootmode [1:0]<br>00 - No boot (default mode)<br>01 - HPI boot<br>10 - Reserved<br>11 - EMIFA 8-bit ROM boot |
| **AEA[20:19]** | [V25, V26] | EMIFA input clock select<br>Clock mode select for EMIFA (AECLKIN_SEL[1:0])<br>00 - AECLKIN (default mode)<br>01 - CPU/4 Clock Rate<br>10 - CPU/6 Clock Rate<br>11 - Reserved |
| **HD5** | Y1 | HPI peripheral bus width (HPI_WIDTH)<br>0 - HPI operates as an HPI16.<br>(HPI bus is 16 bits wide. HD[15:0] pins are used and the remaining HD[31:16] pins are reserved pins in the Hi-Z state.)<br>1 - HPI operates as an HPI32.<br>(HPI bus is 32 bits wide. All HD[31:0] pins are used for host-port operations.)<br>(Also see the TOUT0/MAC_EN functional description in this table) |
| TOUT0/**MAC_EN** | C5 | Peripheral Selection<br>0 - EMAC and MDIO disabled; HPI16 enabled (default mode) [HPI32, if HD5 = 1; HPI16 if HD5 = 0]<br>1 - EMAC and MDIO enabled; HPI16 enabled, if HD5 = 0; HPI32 disabled, if HD5 = 1 |

## 3.2 Configurations After Reset

### *3.2.1 Peripheral Selection After Device Reset*

Video Ports, McBSP0, McASP0 and I2C0

The DM643 device has designated registers for peripheral configuration (PERCFG), device status (DEVSTAT), and JTAG identification (JTAGID). These registers are part of the Device Configuration module and are mapped to a 4K block memory starting at 0x01B3F000. The CPU accesses these registers via the CFGBUS.

The peripheral configuration register (PERCFG), allows the user to control the peripheral selection of the Video Ports (VP1 and VP2) McBSP0, McASP0, and I2C0 peripherals. For more detailed information on the PERCFG register control bits, see Figure 3-1 and Table 3-4.


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| 31 | | | | | | | 24 |
|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | |
| R-0 | | | | | | | |
| 23 | | | | | | | 16 |
| Reserved | | | | | | | |
| R-0 | | | | | | | |
| 15 | | | | | | | 8 |
| Reserved | | | | | | | |
| R-0 | | | | | | | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserved | VP2EN | VP1EN | Reserved | I2C0EN | MCBSP1EN(1) | MCBSP0EN | MCASP0EN |
| R-0 | R/W-0 | R/W-0 | R-0 | R/W-0 | **R/W-1** | **R/W-1** | R/W-0 |

**Legend**: R = Read only, R/W = Read/Write, -*n* = value after reset

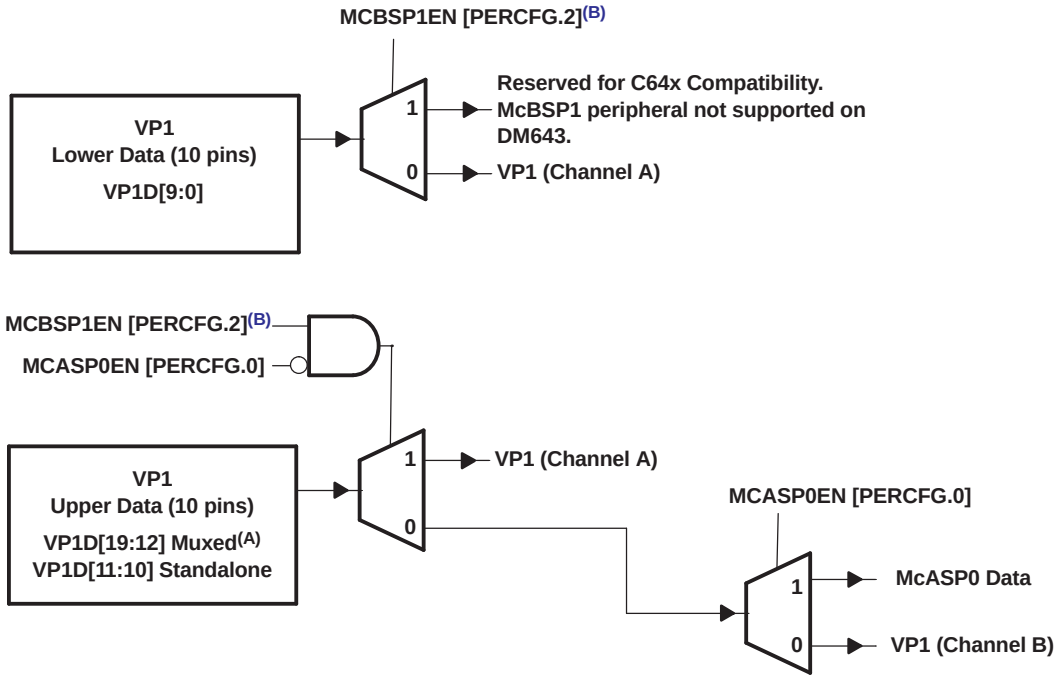
(1) The DM643 device ***does not*** support the McBSP1 peripheral.

**Figure 3-1. Peripheral Configuration Register (PERCFG) [Address Location: 0x01B3F000 - 0x01B3F003]**

**Table 3-4. Peripheral Configuration (PERCFG) Register Selection Bit Descriptions**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 31:7 | Reserved | Reserved. Read-only, writes have no effect. |
| 6 | VP2EN | VP2 Enable bit.<br>Determines whether the VP2 peripheral is enabled or disabled.<br>0 = VP2 is disabled, the module is powered down (default).<br>(This feature allows power savings by disabling the peripheral when not in use.)<br>1 = VP2 is enabled. |
| 5 | VP1EN | VP1 Enable bit.<br>Determines whether the VP1 peripheral is enabled or disabled.<br>0 = VP1 is disabled, the module is powered down (default).<br>(This feature allows power savings by disabling the peripheral when not in use.)<br>1 = VP1 is enabled.<br>**Note:** For proper DM643 device operation, the MCBSP1EN bit ***must be*** set to **zero** (0). |
| 4 | Reserved | Reserved. Read-only, writes have no effect. |
| 3 | I2C0EN | Inter-integrated circuit 0 (I2C0) enable bit.<br>Selects whether I2C0 peripheral is enabled or disabled (default).<br>0 = I2C0 is disabled, the module is powered down (default).<br>1 = I2C0 is enabled. |
| 2 | MCBSP1EN | For C64x compatibility and possible future expansion, at device reset this bit is a one (1). The DM643 device ***does not*** support the McBSP1 peripheral.<br>**Note:** For proper DM643 device operation, this bit ***must be*** set to **zero** (0). |
| 1 | MCBSP0EN | McBSP0 Enable bit.<br>Determines whether the McBSP0 peripheral is enabled or disabled.<br>0 = McBSP0 is disabled, the module is powered down.<br>(This feature allows power savings by disabling the peripheral when not in use.)<br>1 = McBSP0 is enabled (default).<br>For a graphic (logic) representation of this Peripheral Configuration (PERCFG) Register selection bit and the signal pins controlled/selected, see Figure 3-2. |
| 0 | MCASP0EN | McASP0 vs. VP1 upper-data pins select bit.<br>Selects whether the McASP0 peripheral or the VP1 upper-data pins are enabled.<br>0 = McASP0 is disabled; VP1 upper-data pins are enabled; and the VP1lower-data pins are dependent on the MCSBP1EN and VP1EN bits (default).<br>1 = McASP0 is enabled; VP1 upper-data pins are disabled; and the VP1 lower-data pins are dependent on the MCSBP1EN and VP1EN bits.<br>For a graphic (logic) representation of this Peripheral Configuration (PERCFG) Register selection bit and the signal pins controlled/selected, see Figure 3-2. |

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A. Consists of: VP1D[19:12]/AXR0[7:0]

B. McBSP1 peripheral not supported on DM643. For proper DM643 device operation, the MCBSP1EN bit ***must*** be set to zero.

**Figure 3-2. VP1, McBSP1, McBSP0, and McASP0 Data/Control Pin Muxing**


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## 3.3 Peripheral Configuration Lock

By default, the McASP0, VP1, VP2, and I2C peripherals are disabled on power up. In order to use these peripherals on the DM643 device, the peripheral must first be enabled in the Peripheral Configuration register (PERCFG). **Software muxed pins should not be programmed to switch functionalities during run-time. Care should also be taken to ensure that no accesses are being performed before disabling the peripherals.** To help minimize power consumption in the DM643 device, unused peripherals may be disabled.

Figure 3-3 shows the flow needed to enable (or disable) a given peripheral on the DM643 device.

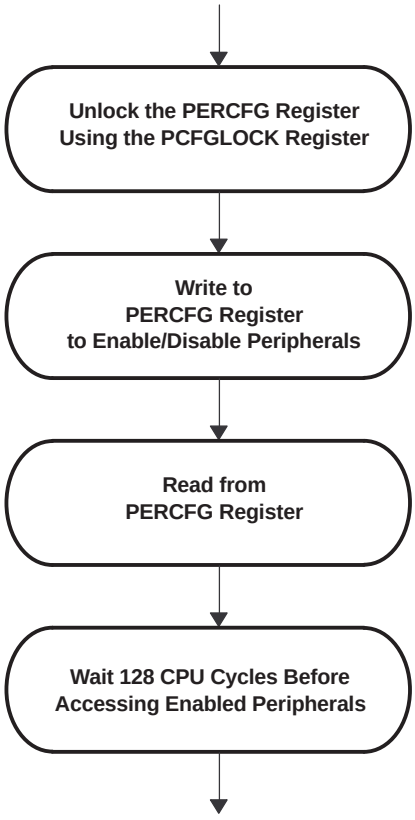



**Figure 3-3. Peripheral Enable/Disable Flow Diagram**

A 32-bit key (value = 0x10C0010C) must be written to the Peripheral Configuration Lock register (PCFGLOCK) in order to unlock access to the PERCFG register. Reading the PCFGLOCK register determines whether the PERCFG register is currently locked (LOCKSTAT bit = 1) or unlocked (LOCKSTAT bit = 0), see Figure 3-4. A peripheral can only be enabled when the PERCFG register is "unlocked" (LOCKSTAT bit = 0).

**Read Accesses**

| 31 | 1 | 0 |
|---|---|---|
| Reserved | | LOCKSTAT |
| R-0 | | R-1 |

**Write Accesses**

| 31 | 0 |
|---|---|
| LOCK | |
| W-0 | |

**Legend**: R = Read only, R/W = Read/Write, -*n* = value after reset

**Figure 3-4. PCFGLOCK Register Diagram [Address Location: 0x01B3 F018] - Read/Write Accesses**

**Table 3-5. PCFGLOCK Register Selection Bit Descriptions - Read Accesses**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 31:1 | Reserved | Reserved. Read-only, writes have no effect. |
| 0 | LOCKSTAT | Lock status bit.<br>Determines whether the PERCFG register is locked or unlocked.<br>0 = Unlocked, read accesses to the PERCFG register allowed.<br>1 = Locked, write accesses to the PERCFG register do ***not*** modify the register state [default].<br>Reads are unaffected by Lock Status. |

**Table 3-6. PCFGLOCK Register Selection Bit Descriptions - Write Accesses**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 31:0 | LOCK | Lock bits.<br>0x10C0010C = Unlocks PERCFG register accesses. |

Any write to the PERCFG register will automatically relock the register. In order to avoid the unnecessary overhead of multiple unlock/enable sequences, all peripherals should be enabled with a single write to the PERCFG register with the necessary enable bits set.

Prior to waiting 128 CPU cycles, the PERCFG register should be read. There is no direct correlation between the CPU issuing a write to the PERCFG register and the write actually occurring. Reading the PERCFG register after the write is issued forces the CPU to wait for the write to the PERCFG register to occur.

Once a peripheral is enabled, the DSP (or other peripherals such as the HPI) must wait a minimum of 128 CPU cycles before accessing the enabled peripheral. The user *must* ensure that no accesses are performed to a peripheral while it is disabled.


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## 3.4 Device Status Register Description

The device status register depicts the status of the device peripheral selection. For the actual register bit names and their associated bit field descriptions, see Figure 3-5 and Table 3-7.

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | |
| R-0 | | | | | | | |

| 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | |
| R-0 | | | | | | | |

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Reserved | | | | MAC_EN | HPI_WIDTH | Reserved | Reserved |
| R-0 | | | | R-x | R-x | R-x | R-x |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserved | CLKMODE1 | CLKMODE0 | LENDIAN | BOOTMODE1 | BOOTMODE0 | AECLKINSEL1 | AECLKINSEL0 |
| R-x | R-x | R-x | R-x | R-x | R-x | R-x | R-x |

**Legend**: R = Read only, R/W = Read/Write, *-n* = value after reset

**Figure 3-5. Device Status Register (DEVSTAT) Description - 0x01B3 F004**

**Table 3-7. Device Status (DEVSTAT) Register Selection Bit Descriptions**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 31:12 | Reserved | Reserved. Read-only, writes have no effect. |
| 11 | MAC_EN | EMAC enable bit.<br>Shows the status of whether EMAC peripheral is enabled or disabled (default).<br>0 = EMAC is disabled, and the module is powered down (default).<br>1 = EMAC is enabled. |
| 10 | HPI_WIDTH | HPI bus width control bit.<br>Shows the status of whether the HPI bus operates in 32-bit mode or in 16-bit mode (default).<br>0 = HPI operates in 16-bit mode. (default).<br>1 = HPI operates in 32-bit mode. |
| 9:7 | Reserved | Reserved. Read-only, writes have no effect. |
| 6 | CLKMODE1 | Clock mode select bits<br>Shows the status of whether the CPU clock frequency equals the input clock frequency X1 (Bypass), x6, or x12.<br>Clock mode select for CPU clock frequency (CLKMODE[1:0])<br>00 - Bypass (x1) (default mode)<br>01 - x6<br>10 - x12<br>11 - Reserved<br>For more details on the CLKMODE pins and the PLL multiply factors, see the Clock PLL section of this data sheet. |
| 5 | CLKMODE0 | |
| 4 | LENDIAN | Device Endian mode (LEND)<br>Shows the status of whether the system is operating in Big Endian mode or Little Endian mode (default).<br>0 - System is operating in Big Endian mode<br>1 - System is operating in Little Endian mode (default) |
| 3 | BOOTMODE1 | Bootmode configuration bits<br>Shows the status of what device bootmode configuration is operational.<br>Bootmode [1:0]<br>00 - No boot (default mode)<br>01 - HPI boot<br>10 - Reserved<br>11 - EMIFA 8-bit ROM boot |
| 2 | BOOTMODE0 | |
| 1 | AECLKINSEL1 | EMIFA input clock select<br>Shows the status of what clock mode is enabled or disabled for the EMIF.<br>Clock mode select for EMIFA (AECLKIN_SEL[1:0])<br>00 - AECLKIN (default mode)<br>01 - CPU/4 Clock Rate<br>10 - CPU/6 Clock Rate<br>11 - Reserved |
| 0 | AECLKINSEL0 | |

## 3.5 Multiplexed Pin Configurations

Multiplexed pins are pins that are shared by more than one peripheral and are internally multiplexed. Some of these pins are configured by software, and the others are configured by external pullup/pulldown resistors only at reset. Those muxed pins that are configured by software should ***not*** be programmed to switch functionalities during run-time. Those muxed pins that are configured by external pullup/pulldown resistors are mutually exclusive; only one peripheral has primary control of the function of these pins after reset. Table 3-8 identifies the multiplexed pins on the DM643 device; shows the default (primary) function and the default settings after reset; and describes the pins, registers, etc. necessary to configure specific multiplexed functions.


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**Table 3-8. DM643 Device Multiplexed Pin Configurations**

| MULTIPLEXED PINS NAME | MULTIPLEXED PINS NO. | DEFAULT FUNCTION | DEFAULT SETTING | DESCRIPTION |
|---|---|---|---|---|
| CLKOUT4/GP0[1] | D6 | CLKOUT4 | GP1EN = 0 (disabled) | These pins are software-configurable. To use these pins as GPIO pins, the GPxEN bits in the GPIO Enable Register and the GPxDIR bits in the GPIO Direction Register must be properly configured.<br>GPxEN = 1: GPx pin enabled<br>GPxDIR = 0: GPx pin is an input<br>GPxDIR = 1: GPx pin is an output |
| CLKOUT6/GP0[2] | C6 | CLKOUT6 | GP2EN = 0 (disabled) | |
| VDAC/GP0[8] | AD1 | None | GP8EN = 0 (disabled)<br>MAC_EN = 0 (disabled) | The VDAC output pin function is default.<br>To use GP0[8] as a GPIO pin, the GPxEN bits in the GPIO Enable Register and the GPxDIR bits in the GPIO Direction Register must be properly configured.<br>GP8EN = 1: GP8 pin enabled<br>GP8DIR = 0: GP8 pin is an input<br>GP8DIR = 1: GP8 pin is an output |
| VP1D[19]/AXR0[7] | AB12 | None | VP1EN bit = 0 (disabled)<br>MCASP0EN bit = 0 (disabled) | By default, no function is enabled upon reset.<br>To enable the Video Port 1 data pins, the VP1EN bit in the PERCFG register must be set to a 1. (McASP0 data pins are disabled).<br>To enable the McASP0[7:0] data pins, the MCASP0EN bit in the PERCFG register must be set to a 1. (VP1 upper data pins are disabled). |
| VP1D[18]/AXR0[6] | AB11 | | | |
| VP1D[17]/AXR0[5] | AC11 | | | |
| VP1D[16]/AXR0[4] | AD11 | | | |
| VP1D[15]/AXR0[3] | AE11 | | | |
| VP1D[14]/AXR0[2] | AC10 | | | |
| VP1D[13]/AXR0[1] | AD10 | | | |
| VP1D[12]/AXR0[0] | AC9 | | | |
| HD31/MRCLK | G1 | HD31 | MAC_EN = 0 (disabled) | To enable the EMAC peripheral, an external pullup resistor (1 kΩ) must be provided on the MAC_EN pin (setting MAC_EN = 1 at reset). |
| HD30/MCRS | H3 | HD30 | | |
| HD29/MRXER | G2 | HD29 | | |
| HD28/MRXDV | J4 | HD28 | | |
| HD27/MRXD3 | H2 | HD27 | | |
| HD26/MRXD2 | J3 | HD26 | | |
| HD25/MRXD1 | J1 | HD25 | | |
| HD24/MRXD0 | K4 | HD24 | | |
| HD22/MTCLK | L4 | HD22 | | |
| HD21/MCOL | K2 | HD21 | | |
| HD20/MTXEN | L3 | HD20 | | |
| HD19/MTXD3 | L2 | HD19 | | |
| HD18/MTXD2 | M4 | HD18 | | |
| HD17/MTXD1 | M2 | HD17 | | |
| HD16/MTXD0 | M3 | HD16 | | |

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## 3.6 Debugging Considerations

It is recommended that external connections be provided to device configuration pins, including TOUT1/LENDIAN, AEA[22:19], HD5, and TOUT0/MAC_EN. Although internal pullup/pulldown resistors exist on these pins, providing external connectivity adds convenience to the user in debugging and flexibility in switching operating modes.

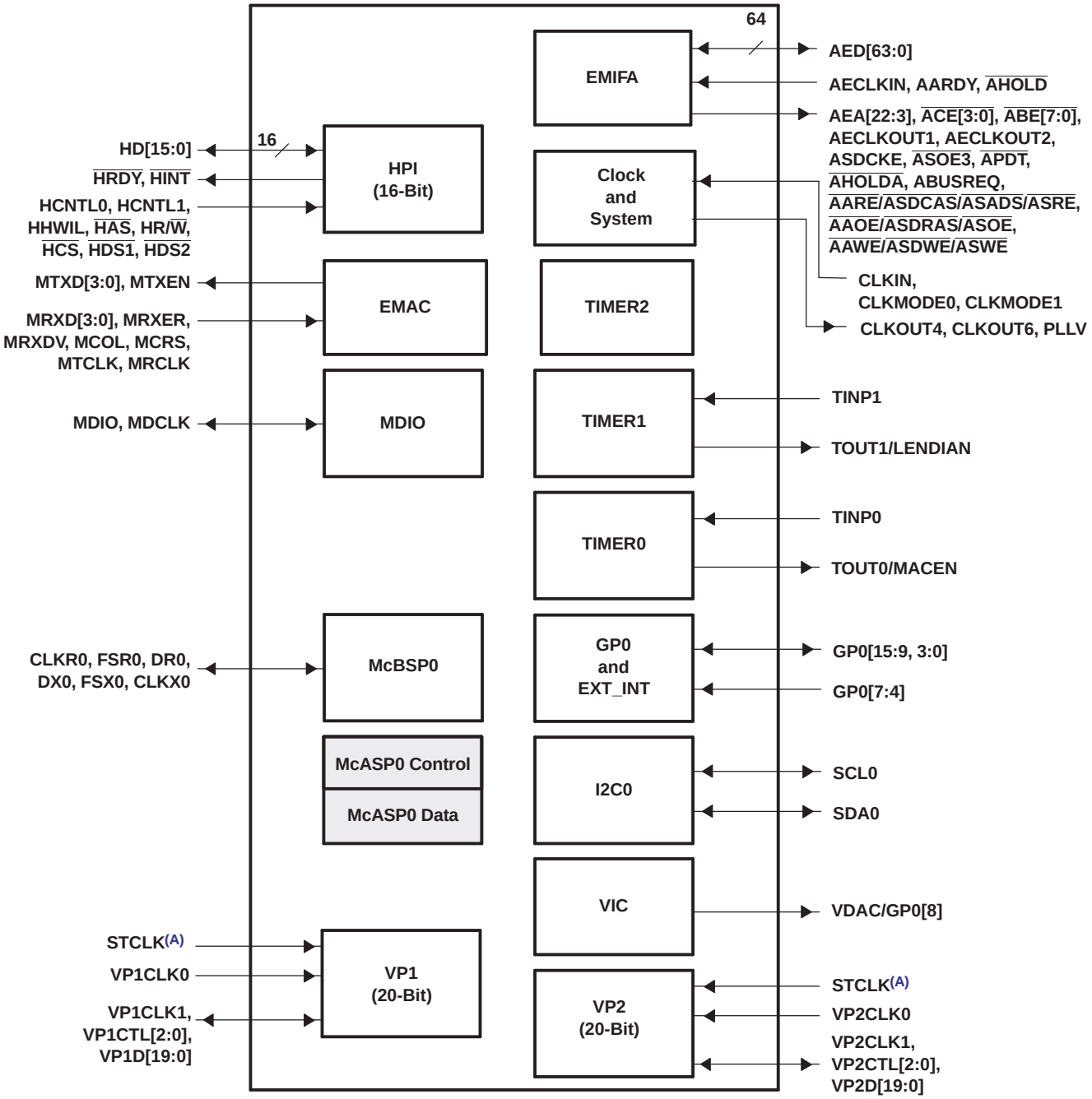
Internal pullup/pulldown resistors also exist on the non-configuration pins on the AEA bus (AEA[18:0]). Do ***not*** oppose the internal pullup/pulldown resistors on these non-configuration pins with external pullup/pulldown resistors. If an external controller provides signals to these non-configuration pins, these signals must be driven to the default state of the pins at reset, or not be driven at all.

For the internal pullup/pulldown resistors for all device pins, see the terminal functions table.

## 3.7 Configuration Examples

Figure 3-6 through Figure 3-8 illustrate examples of peripheral selections that are configurable on the DM643 device.


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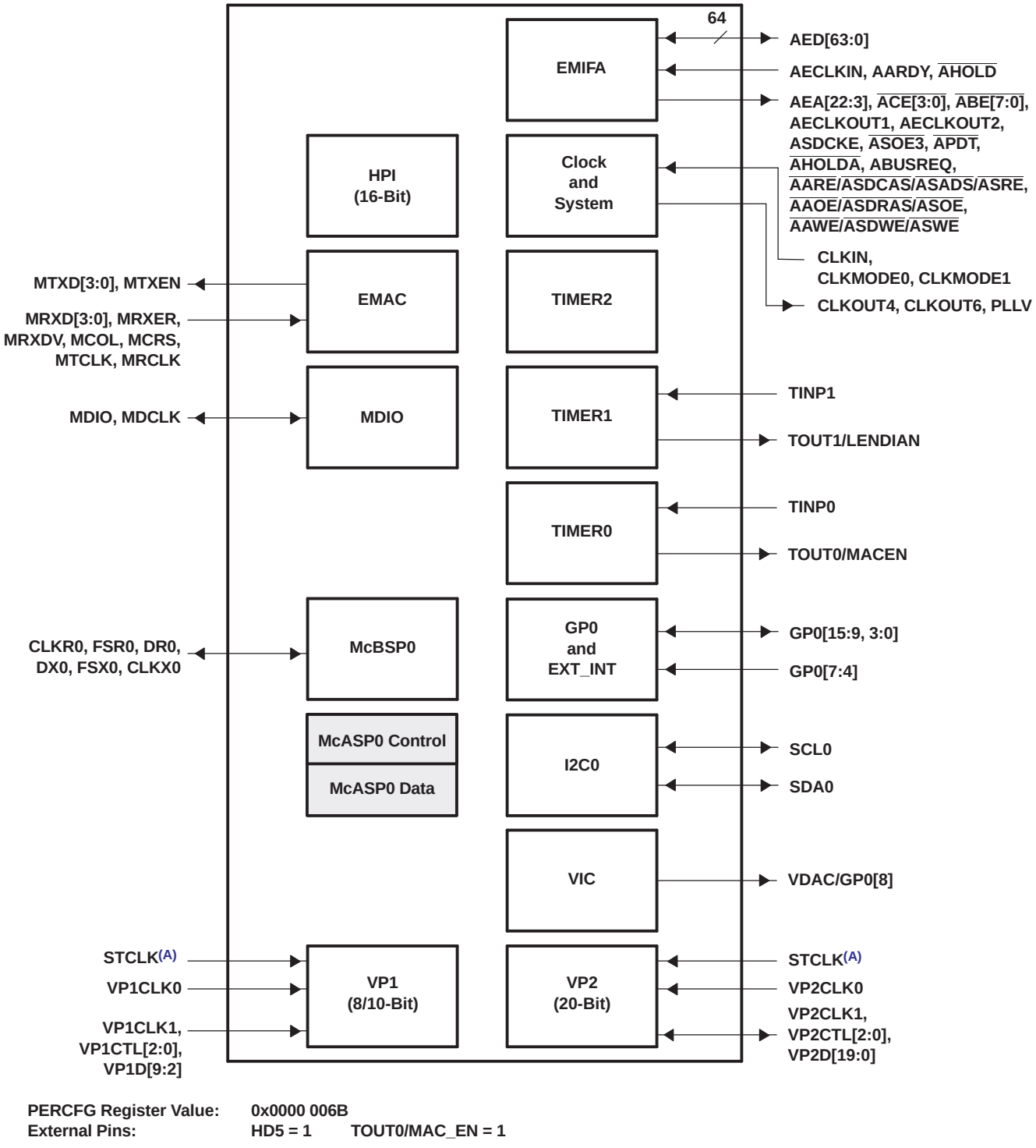



**PERCFG Register Value:** 0x0000 006A
**External Pins:** HD5 = 0 TOUT0/MAC_EN = 1

Shading denotes a peripheral module not available for this configuration.

A. STCLK supports both video ports (VP2 and VP1).

**Figure 3-6. Configuration Example A (2 20-Bit Video Ports + 1 McBSP + HPI + EMAC + MDIO + I2C0 + EMIF + 3 Timers) [TBD]**



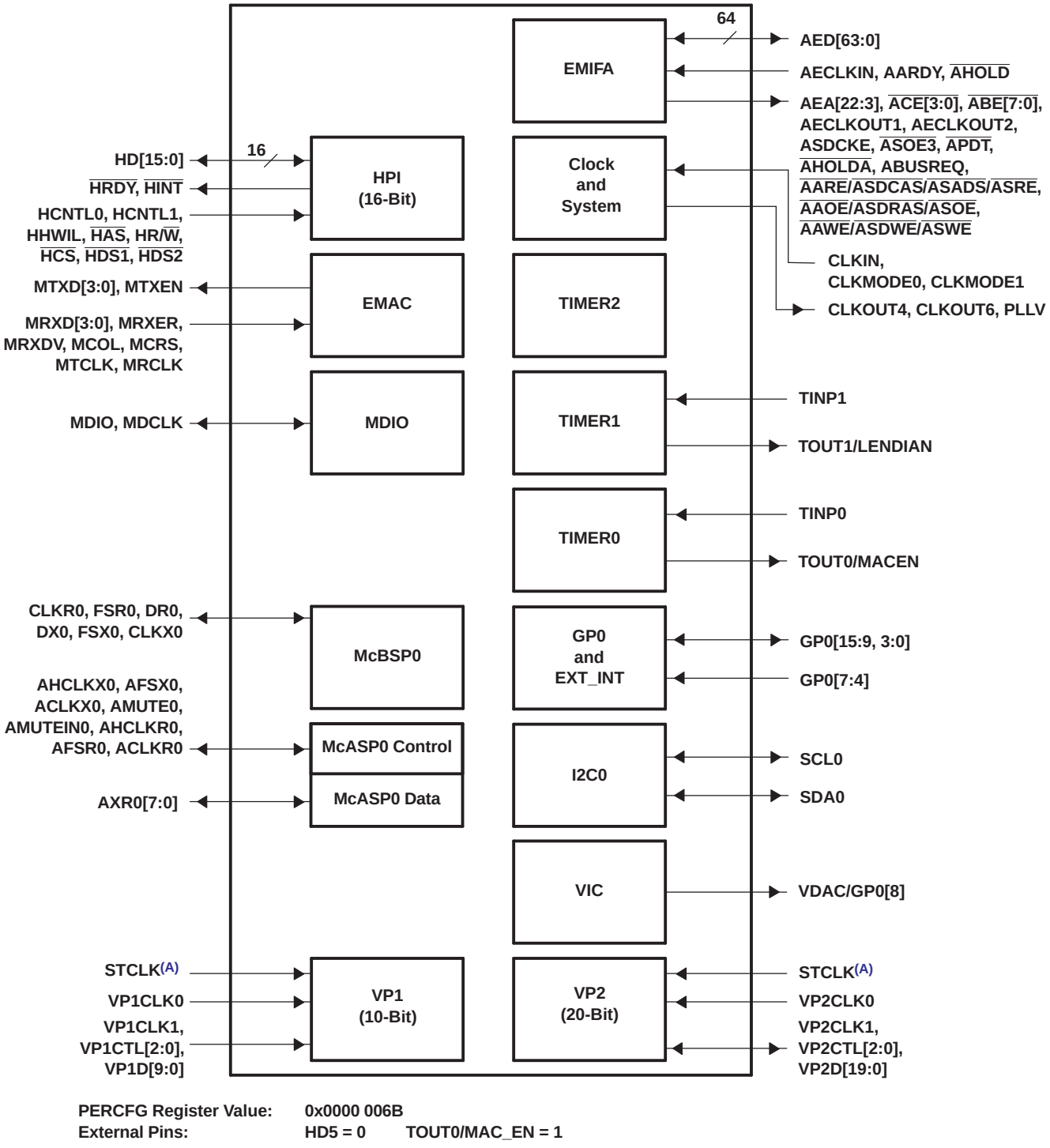

**PERCFG Register Value:** 0x0000 006B
**External Pins:** HD5 = 1 TOUT0/MAC_EN = 1

Shading denotes a peripheral module not available for this configuration.

A. STCLK supports both video ports (VP2 and VP1)

**Figure 3-7. Configuration Example B**
**(1 20-Bit Video Port + 1 10-Bit Video Port + 1 McBSP + EMAC + MDIO + I2C0 + EMIF)**
**[Possible Video IP Phone Applications]**


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Shading denotes a peripheral module not available for this configuration.

A. STCLK supports both video ports (VP2 and VP1).

**Figure 3-8. Configuration Example C**
**(1 20-Bit Video Port, 1 10-Bit Video Port + 1 McBSP + 1 McASP0 + VIC + I2C0 + EMIF)**
**[TBD]**

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# 4 Device Operating Conditions

## 4.1 Absolute Maximum Ratings Over Operating Case Temperature Range (Unless Otherwise Noted) (1)

| | | |
|---|---|---|
| Supply voltage ranges: | $CV_{DD}$ (2) | –0.3 V to 1.8 V |
| | $DV_{DD}$ (2) | –0.3 V to 4 V |
| Input voltage ranges: | $V_I$ | –0.3 V to 4 V |
| Output voltage ranges: | $V_O$ | –0.3 V to 4 V |
| Operating case temperature ranges, $T_C$: | (default) | 0°C to 90°C |
| Storage temperature range, $T_{stg}$: | | –65°C to 150°C |
| Package Temperature Cycling: | Temperature Range | –40°C to 125°C |
| | Number of Cycles | 500 |

(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 $V_{SS}$.

## 4.2 Recommended Operating Conditions

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $CV_{DD}$ | Supply voltage, Core (-500 device) (1) | | 1.14 | 1.2 | 1.26 | V |
| | Supply voltage, Core (-600 device) (1) | | 1.36 | 1.4 | 1.44 | V |
| $DV_{DD}$ | Supply voltage, I/O | | 3.14 | 3.3 | 3.46 | V |
| $V_{SS}$ | Supply ground | | 0 | 0 | 0 | V |
| $V_{IH}$ | High-level input voltage | | 2 | | | V |
| $V_{IL}$ | Low-level input voltage | | | | 0.8 | V |
| $V_{OS}$ | Maximum voltage during overshoot | | | | 4.3(2) | V |
| $V_{US}$ | Maximum voltage during undershoot | | –1.0 (2) | | | V |
| $T_C$ | Operating case temperature | Default | 0 | | 90 | °C |

(1) Future variants of the C64x DSPs may operate at voltages ranging from 0.9 V to 1.4 V to provide a range of system power/performance options. TI highly recommends that users design-in a supply that can handle multiple voltages within this range (i.e., 1.2 V, 1.25 V, 1.3 V, 1.35 V, 1.4 V with ± 3% tolerances) by implementing simple board changes such as reference resistor values or input pin configuration modifications. Examples of such supplies include the PT4660, PT5500, PT5520, PT6440, and PT6930 series from Power Trends, a subsidiary of Texas Instruments. Not incorporating a flexible supply may limit the system's ability to easily adapt to future versions of C64x devices.
(2) The absolute maximum ratings should *not* be exceeded for more than 30% of the cycle period.


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

| PARAMETER | | TEST CONDITIONS (1) | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $DV_{DD}$ = MIN, $I_{OH}$ = MAX (2) | 2.4 | | | V |
| $V_{OL}$ | Low-level output voltage | $DV_{DD}$ = MIN, $I_{OL}$ = MAX (2) | | | 0.4 | V |
| $I_I$ | Input current | $V_I$ = $V_{SS}$ to $DV_{DD}$ no opposing internal resistor | | | ±10 | uA |
| | | $V_I$ = $V_{SS}$ to $DV_{DD}$ opposing internal pullup resistor (3) | 50 | 100 | 150 | uA |
| | | $V_I$ = $V_{SS}$ to $DV_{DD}$ opposing internal pulldown resistor (3) | –150 | –100 | –50 | uA |
| $I_{OH}$ | High-level output current | EMIF, CLKOUT4, CLKOUT6, EMUx | | | –16 | mA |
| | | Video Ports, Timer, TDO, GPIO (Excluding GP0[2:1]), McBSP | | | –8 | mA |
| | | HPI | | | –0.5 (3) | mA |
| $I_{OL}$ | Low-level output current | EMIF, CLKOUT4, CLKOUT6, EMUx | | | 16 | mA |
| | | Video Ports, Timer, TDO, GPIO (Excluding GP0[2:1]), McBSP | | | 8 | mA |
| | | SCL0 and SDA0 | | | 3 | mA |
| | | HPI | | | 1.5 (3) | mA |
| $I_{OZ}$ | Off-state output current | $V_O$ = $DV_{DD}$ or 0 V | | | ±10 | uA |
| $I_{CDD}$ | Core supply current (4) | $CV_{DD}$ = 1.4 V, CPU clock = 600 MHz | | 890 | | mA |
| | | $CV_{DD}$ = 1.2 V, CPU clock = 500 MHz | | 620 | | mA |
| $I_{DDD}$ | I/O supply current (4) | $DV_{DD}$ = 3.3 V, CPU clock = 600 MHz | | 210 | | mA |
| | | $DV_{DD}$ = 3.3 V, CPU clock = 500 MHz | | 165 | | mA |
| $C_i$ | Input capacitance | | | | 10 | pF |
| $C_o$ | Output capacitance | | | | 10 | pF |

(1) For test conditions shown as MIN, MAX, or NOM, use the appropriate value specified in the recommended operating conditions table.
(2) Single pin driving $I_{OH}/I_{OL}$ = MAX.
(3) Applies only to pins with an internal pullup (IPU) or pulldown (IPD) resistor.
(4) Measured with average activity (50% high/50% low power) at 25°C case temperature and 133-MHz EMIF for -600 speed (100-MHz EMIF for -500 speed). This model represents a device performing high-DSP-activity operations 50% of the time, and the remainder performing low-DSP-activity operations. The high/low-DSP-activity models are defined as follows:
- High-DSP-Activity Model:
  - CPU: 8 instructions/cycle with 2 LDDW instructions [L1 Data Memory: 128 bits/cycle via LDDW instructions; L1 Program Memory: 256 bits/cycle; L2/EMIF EDMA: 50% writes, 50% reads to/from SDRAM (50% bit-switching)]
  - McBSP: 1 channel at 2.048 MHz
  - Timers: 2 timers at maximum rate
- Low-DSP-Activity Model:
  - CPU: 2 instructions/cycle with 1 LDH instruction [L1 Data Memory: 16 bits/cycle; L1 Program Memory: 256 bits per 4 cycles; L2/EMIF EDMA: None]
  - McBSP: 1 channel at 2.048 MHz
  - Timers: 2 timers at maximum rate

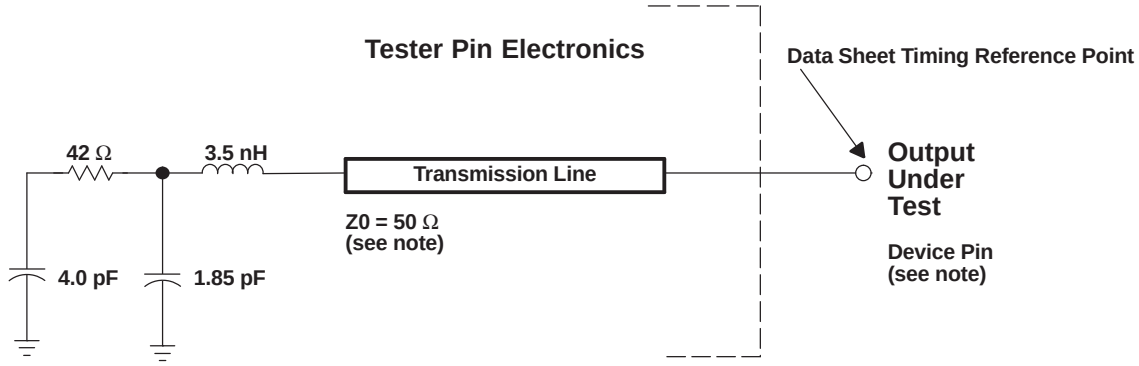
The actual current draw is highly application-dependent. For more details on core and I/O activity, refer to the *TMS320DMx Power Consumption Summary* application report (literature number SPRA962).

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# 5 DM643 Peripheral Information and Electrical Specifications

## 5.1 Parameter Information

### *5.1.1 Parameter Information Device-Specific Information*




NOTE: 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.

#### 5.1.1.1 Signal Transition Levels

All input and output timing parameters are referenced to 1.5 V for both "0" and "1" logic levels.

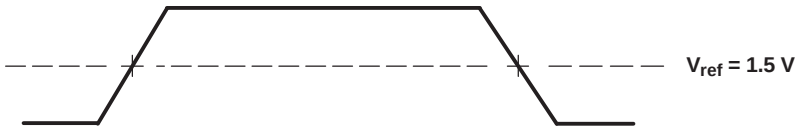



**Figure 5-2. Input and Output Voltage Reference Levels for AC Timing Measurements**

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.

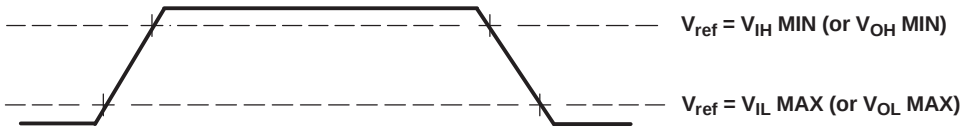
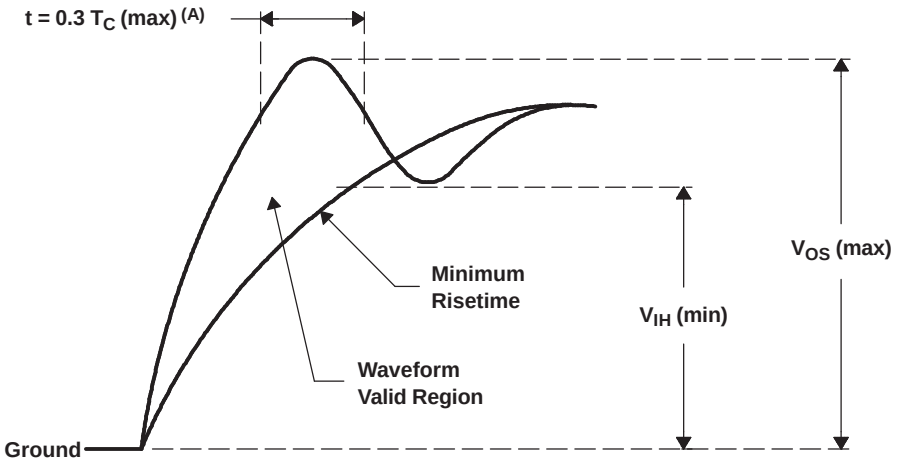



**Figure 5-3. Rise and Fall Transition Time Voltage Reference Levels**

#### 5.1.1.2 AC Transient Rise/Fall Time Specifications

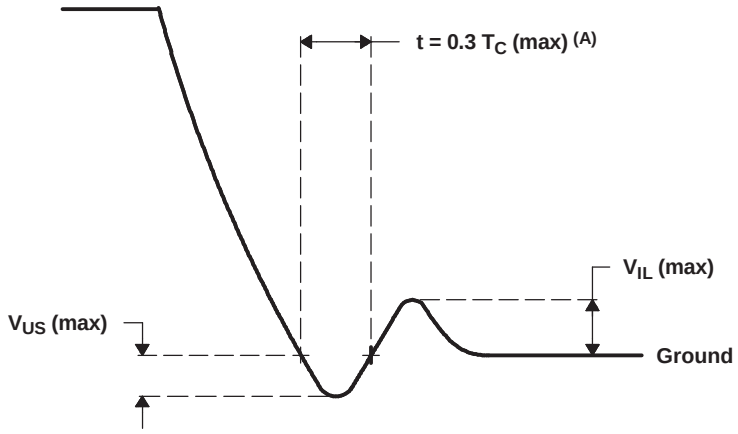
Figure 5-4 and Figure 5-5 show the AC transient specifications for Rise and Fall time. For device-specific information on these values, refer to the Recommended Operating Conditions section of this Data Sheet.


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A. $t_c$ = the peripheral cycle time.

**Figure 5-4. AC Transient Specification Rise Time**




A. $t_c$ = the peripheral cycle time.

**Figure 5-5. AC Transient Specification Fall Time**

### 5.1.1.3 Signal Transition Rates

All timings are tested with an input edge rate of 4 Volts per nanosecond (4 V/ns).

### 5.1.1.4 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.

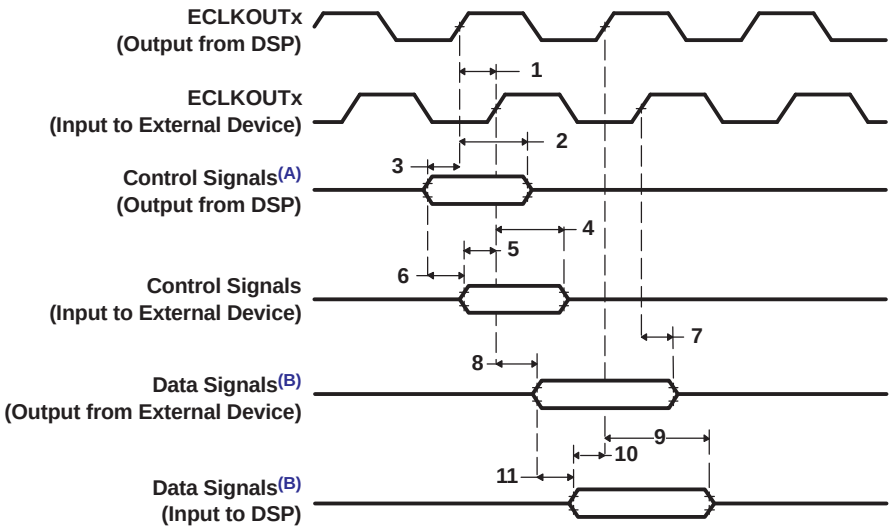
For inputs, timing is most impacted by the round-trip propagation delay from the DSP to the external device and from the external device to the DSP. This round-trip delay tends to negatively impact the input setup time margin, but also tends to improve the input hold time margins (see Table 5-1 and Figure 5-6).

Figure 5-6 represents a general transfer between the DSP and an external device. The figure also represents board route delays and how they are perceived by the DSP and the external device.

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**Table 5-1. Board-Level Timing Example (see Figure 5-6)**

| NO. | DESCRIPTION |
|---|---|
| 1 | Clock route delay |
| 2 | Minimum DSP hold time |
| 3 | Minimum DSP setup time |
| 4 | External device hold time requirement |
| 5 | External device setup time requirement |
| 6 | Control signal route delay |
| 7 | External device hold time |
| 8 | External device access time |
| 9 | DSP hold time requirement |
| 10 | DSP setup time requirement |
| 11 | Data route delay |




A. Control signals include data for Writes.

B. Data signals are generated during Reads from an external device.

**Figure 5-6. Board-Level Input/Output Timings**

## 5.2 Recommended Clock and Control Signal Transition Behavior

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

## 5.3 Power Supplies

For more information regarding TI's power management products and suggested devices to power TI DSPs, visit www.ti.com/dsppower.

### *5.3.1 Power-Supply Sequencing*

TI DSPs do not require specific power sequencing between the core supply and the I/O supply. However, systems should be designed to ensure that neither supply is powered up for extended periods of time (>1 second) if the other supply is below the proper operating voltage.


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### 5.3.2 Power-Supply Design Considerations

A dual-power supply with simultaneous sequencing can be used to eliminate the delay between core and I/O power up. A Schottky diode can also be used to tie the core rail to the I/O rail (see Figure 5-7).

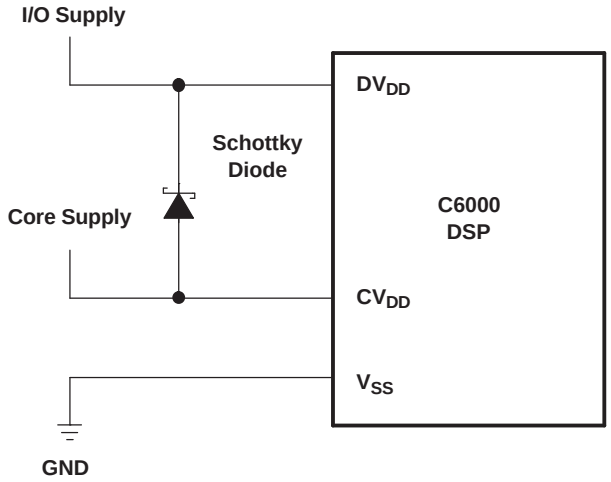



**Figure 5-7. Schottky Diode Diagram**

Core and I/O supply voltage regulators should be located close to the DSP (or DSP array) to minimize inductance and resistance in the power delivery path. Additionally, when designing for high-performance applications utilizing the C6000™ platform of DSPs, the PC board should include separate power planes for core, I/O, and ground, all bypassed with high-quality low-ESL/ESR capacitors.

### 5.3.3 Power-Supply Decoupling

In order to properly decouple the supply planes from system noise, place as many capacitors (caps) as possible close to the DSP. Assuming 0603 caps, the user should be able to fit a total of 60 caps, 30 for the core supply and 30 for the I/O supply. These caps need to be close to the DSP 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 (32 total) be placed immediately next to the BGA vias, using the "interior" BGA space and at least the corners of the "exterior".

Eight larger caps (4 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). No less than 4 large caps per supply (8 total) should be placed outside of the BGA.

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.

### 5.3.4 Peripheral Power-Down Operation

The DM643 device can be powered down in three ways:

- Power-down due to pin configuration
- Power-down due to software configuration – relates to the default state of the peripheral configuration bits in the PERCFG register.
- Power-down during run-time via software configuration

On the DM643 device, the HPI and EMAC and MDIO peripherals are controlled (selected) at the pin level during chip reset (e.g., HD5 and MAC_EN pins).

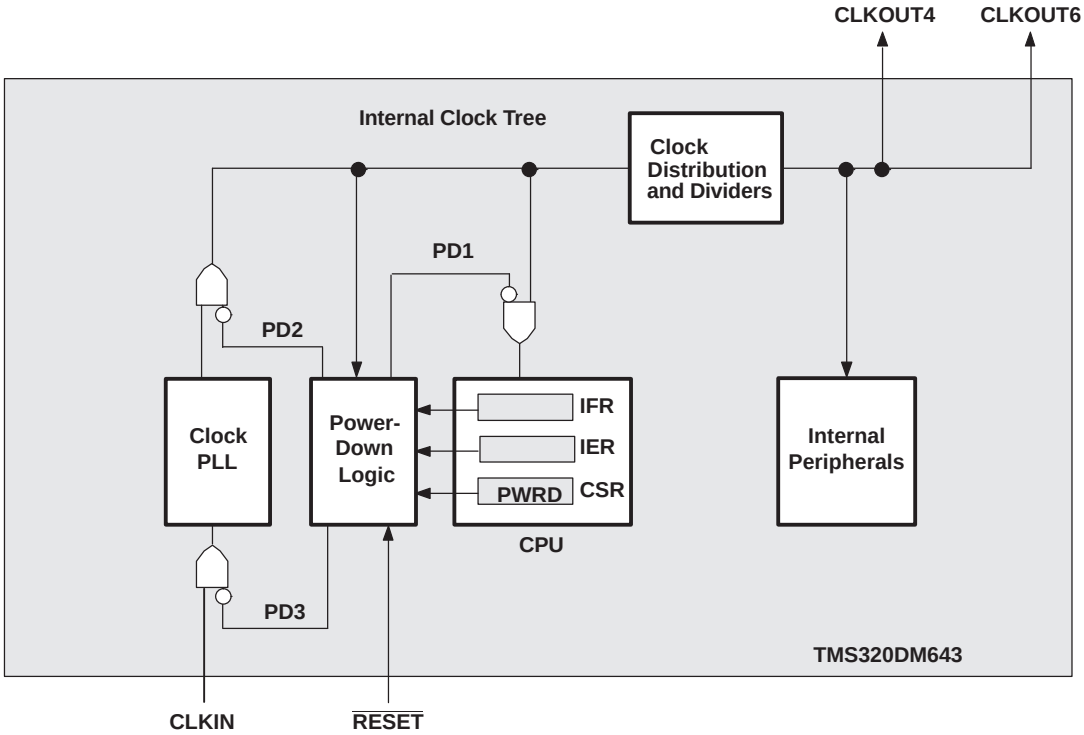
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The McASP0, McBSP0, VP1, VP2, and I2C0 peripheral functions are selected via the peripheral configuration (PERCFG) register bits.

For more detailed information on the peripheral configuration pins and the PERCFG register bits, see the Device Configurations section of this document.

### 5.3.5 Power-Down Modes Logic

Figure 5-8 shows the power-down mode logic on the DM643.




A. External input clocks, with the exception of CLKIN, are *not* gated by the power-down mode logic.

**Figure 5-8. Power-Down Mode Logic(A)**


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### 5.3.6 Triggering, Wake-up, and Effects

The power-down modes and their wake-up methods are programmed by setting the PWRD field (bits 15–10) of the control status register (CSR). The PWRD field of the CSR is shown in Figure 5-9 and described in Table 5-2. When writing to the CSR, all bits of the PWRD field should be set at the same time. Logic 0 should be used when writing to the reserved bit (bit 15) of the PWRD field. The CSR is discussed in detail in the *TMS320C6000 CPU and Instruction Set Reference Guide* (literature number SPRU189).

| 31 | | | | | | | 16 |
|---|---|---|---|---|---|---|---|
| (See NOTE) | | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| Reserved | Enable or Non-Enabled Interrupt Wake | Enabled Interrupt Wake | PD3 | PD2 | PD1 | (See NOTE) | |
| R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | | |
| 7 | | | | | | | 0 |
| (See NOTE) | | | | | | | |

**Legend**: R/W = Readable/Writable, -*n* = value after reset, -x = undefined value after reset

NOTE: The shaded bits are not part of the power-down logic discussion and therefore are not covered here. For information on these other bit fields in the CSR register, see the *TMS320C6000 CPU and Instruction Set Reference Guide* (literature number SPRU189).

**Figure 5-9. PWRD Field of the CSR Register**

A delay of up to nine clock cycles may occur after the instruction that sets the PWRD bits in the CSR before the PD mode takes effect. As best practice, NOPs should be padded after the PWRD bits are set in the CSR to account for this delay.

If PD1 mode is terminated by a non-enabled interrupt, the program execution returns to the instruction where PD1 took effect. If PD1 mode is terminated by an enabled interrupt, the interrupt service routine will be executed first, then the program execution returns to the instruction where PD1 took effect. In the case with an enabled interrupt, the GIE bit in the CSR and the NMIE bit in the interrupt enable register (IER) must also be set in order for the interrupt service routine to execute; otherwise, execution returns to the instruction where PD1 took effect upon PD1 mode termination by an enabled interrupt.

PD2 and PD3 modes can only be aborted by device reset. Table 5-2 summarizes all the power-down modes.

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**Table 5-2. Characteristics of the Power-Down Modes**

| PRWD Field (BITS 15–10) | POWER-DOWN MODE | WAKE-UP METHOD | EFFECT ON CHIP'S OPERATION |
|---|---|---|---|
| 000000 | No power-down | — | — |
| 001001 | PD1 | Wake by an enabled interrupt | CPU halted (except for the interrupt logic)<br>Power-down mode blocks the internal clock inputs at the boundary of the CPU, preventing most of the CPU's logic from switching. During PD1, EDMA transactions can proceed between peripherals and internal memory. |
| 010001 | PD1 | Wake by an enabled or non-enabled interrupt | |
| 011010 | PD2(1) | Wake by a device reset | Output clock from PLL is halted, stopping the internal clock structure from switching and resulting in the entire chip being halted. All register and internal RAM contents are preserved. All functional I/O "freeze" in the last state when the PLL clock is turned off. |
| 011100 | PD3(1) | Wake by a device reset | Input clock to the PLL stops generating clocks. All register and internal RAM contents are preserved. All functional I/O "freeze" in the last state when the PLL clock is turned off. Following reset, the PLL needs time to re-lock, just as it does following power-up.<br>Wake-up from PD3 takes longer than wake-up from PD2 because the PLL needs to be re-locked, just as it does following power-up. |
| All others | Reserved | — | — |

(1) When entering PD2 and PD3, all functional I/O remains in the previous state. However, for peripherals which are asynchronous in nature or peripherals with an external clock source, output signals may transition in response to stimulus on the inputs. Under these conditions, peripherals will not operate according to specifications.

### *5.3.7 C64x Power-Down Mode with an Emulator*

If user power-down modes are programmed, and an emulator is attached, the modes will be masked to allow the emulator access to the system. This condition prevails until the emulator is reset or the cable is removed from the header. If power measurements are to be performed when in a power-down mode, the emulator cable should be removed.

When the DSP is in power-down mode PD2 or PD3, emulation logic will force any emulation execution command (such as Step or Run) to spin in IDLE. For this reason, PC writes (such as loading code) will fail. A DSP reset will be required to get the DSP out of PD2/PD3.


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## 5.4 Enhanced Direct Memory Access (EDMA) Controller

The EDMA controller handles all data transfers between the level-two (L2) cache/memory controller and the device peripherals on the DM643 DSP. These data transfers include cache servicing, non-cacheable memory accesses, user-programmed data transfers, and host accesses.

### *5.4.1 EDMA Device-Specific Information*

#### 5.4.1.1 EDMA Channel Synchronization Events

The C64x EDMA supports up to 64 EDMA channels which service peripheral devices and external memory. Table 5-3 lists the source of C64x EDMA synchronization events associated with each of the programmable EDMA channels. For the DM643 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 (ERL, ERH) even if the events are disabled by the EDMA event enable registers (EERL, EERH). The priority of each event can be specified independently in the transfer parameters stored in the EDMA parameter RAM. For more detailed information on the EDMA module and how EDMA events are enabled, captured, processed, linked, chained, and cleared, etc., see the *TMS320C6000 DSP Enhanced Direct Memory Access (EDMA) Controller Reference Guide* (literature number SPRU234).

**Table 5-3. TMS320DM643 EDMA Channel Synchronization Events(1)**

| EDMA CHANNEL(1) | EVENT NAME | EVENT DESCRIPTION |
|---|---|---|
| 0 | DSP_INT | HPI-to-DSP interrupt |
| 1 | TINT0 | Timer 0 interrupt |
| 2 | TINT1 | Timer 1 interrupt |
| 3 | SD_INTA | EMIFA SDRAM timer interrupt |
| 4 | GPINT4/EXT_INT4 | GP0 event 4/External interrupt pin 4 |
| 5 | GPINT5/EXT_INT5 | GP0 event 5/External interrupt pin 5 |
| 6 | GPINT6/EXT_INT6 | GP0 event 6/External interrupt pin 6 |
| 7 | GPINT7/EXT_INT7 | GP0 event 7/External interrupt pin 7 |
| 8 | GPINT0 | GP0 event 0 |
| 9 | GPINT1 | GP0 event 1 |
| 10 | GPINT2 | GP0 event 2 |
| 11 | GPINT3 | GP0 event 3 |
| 12 | XEVT0 | McBSP0 transmit event |
| 13 | REVT0 | McBSP0 receive event |
| 14–18 | – | None |
| 19 | TINT2 | Timer 2 interrupt |
| 20–31 | – | None |
| 32 | AXEVTE0 | McASP0 transmit even event |
| 33 | AXEVTO0 | McASP0 transmit odd event |
| 34 | AXEVT0 | McASP0 transmit event |
| 35 | AREVTE0 | McASP0 receive even event |
| 36 | AREVTO0 | McASP0 receive odd event |
| 37 | AREVT0 | McASP0 receive event |
| 38 | VP1EVTYB | VP1 Channel B Y event DMA request |
| 39 | VP1EVTUB | VP1 Channel B Cb event DMA request |
| 40 | VP1EVTVB | VP1 Channel B Cr event DMA request |

(1) In addition to the events shown in this table, each of the 64 channels can also be synchronized with the transfer completion or alternate transfer completion events. For more detailed information on EDMA event-transfer chaining, see the *TMS320C6000 DSP Enhanced Direct Memory Access (EDMA) Controller Reference Guide* (literature number SPRU234).

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**Table 5-3. TMS320DM643 EDMA Channel Synchronization Events(1) (continued)**

| EDMA CHANNEL(1) | EVENT NAME | EVENT DESCRIPTION |
|---|---|---|
| 41 | VP2EVTYB | VP2 Channel B Y event DMA request |
| 42 | VP2EVTUB | VP2 Channel B Cb event DMA request |
| 43 | VP2EVTVB | VP2 Channel B Cr event DMA request |
| 44 | ICREVT0 | I2C0 receive event |
| 45 | ICXEVT0 | I2C0 transmit event |
| 46–47 | – | None |
| 48 | GPINT8 | GP0 event 8 |
| 49 | GPINT9 | GP0 event 9 |
| 50 | GPINT10 | GP0 event 10 |
| 51 | GPINT11 | GP0 event 11 |
| 52 | GPINT12 | GP0 event 12 |
| 53 | GPINT13 | GP0 event 13 |
| 54 | GPINT14 | GP0 event 14 |
| 55 | GPINT15 | GP0 event 15 |
| 56 | VP1EVTYA | VP1 Channel A Y event DMA request |
| 57 | VP1EVTUA | VP1 Channel A Cb event DMA request |
| 58 | VP1EVTVA | VP1 Channel A Cr event DMA request |
| 59 | VP2EVTYA | VP2 Channel A Y event DMA request |
| 60 | VP2EVTUA | VP2 Channel A Cb event DMA request |
| 61 | VP2EVTVA | VP2 Channel A Cr event DMA request |
| 62–63 | – | None |


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### 5.4.2 EDMA Peripheral Register Description(s)

**Table 5-4. EDMA Registers (C64x)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01A0 0800 – 01A0 FF98 | – | Reserved |
| 01A0 FF9C | EPRH | Event polarity high register |
| 01A0 FFA4 | CIPRH | Channel interrupt pending high register |
| 01A0 FFA8 | CIERH | Channel interrupt enable high register |
| 01A0 FFAC | CCERH | Channel chain enable high register |
| 01A0 FFB0 | ERH | Event high register |
| 01A0 FFB4 | EERH | Event enable high register |
| 01A0 FFB8 | ECRH | Event clear high register |
| 01A0 FFBC | ESRH | Event set high register |
| 01A0 FFC0 | PQAR0 | Priority queue allocation register 0 |
| 01A0 FFC4 | PQAR1 | Priority queue allocation register 1 |
| 01A0 FFC8 | PQAR2 | Priority queue allocation register 2 |
| 01A0 FFCC | PQAR3 | Priority queue allocation register 3 |
| 01A0 FFDC | EPRL | Event polarity low register |
| 01A0 FFE0 | PQSR | Priority queue status register |
| 01A0 FFE4 | CIPRL | Channel interrupt pending low register |
| 01A0 FFE8 | CIERL | Channel interrupt enable low register |
| 01A0 FFEC | CCERL | Channel chain enable low register |
| 01A0 FFF0 | ERL | Event low register |
| 01A0 FFF4 | EERL | Event enable low register |
| 01A0 FFF8 | ECRL | Event clear low register |
| 01A0 FFFC | ESRL | Event set low register |
| 01A1 0000 – 01A3 FFFF | – | Reserved |

**Table 5-5. Quick DMA (QDMA) and Pseudo Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 0200 0000 | QOPT | QDMA options parameter register |
| 0200 0004 | QSRC | QDMA source address register |
| 0200 0008 | QCNT | QDMA frame count register |
| 0200 000C | QDST | QDMA destination address register |
| 0200 0010 | QIDX | QDMA index register |
| 0200 0014 – 0200 001C | | Reserved |
| 0200 0020 | QSOPT | QDMA pseudo options register |
| 0200 0024 | QSSRC | QDMA psuedo source address register |
| 0200 0028 | QSCNT | QDMA psuedo frame count register |
| 0200 002C | QSDST | QDMA destination address register |
| 0200 0030 | QSIDX | QDMA psuedo index register |

**Table 5-6. EDMA Parameter RAM (C64x)(1)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 01A0 0000 – 01A0 0017 | – | Parameters for Event 0 (6 words) | Parameters for Event 0 (6 words) or Reload/Link Parameters for other Event |
| 01A0 0018 – 01A0 002F | – | Parameters for Event 1 (6 words) | |

(1) The DM643 device has 213 EDMA parameters total: 64-Event/Reload channels and 149-Reload only parameter sets [six (6) words each] that can be used to reload/link EDMA transfers.

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**Table 5-6. EDMA Parameter RAM (C64x) (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 01A0 0030 – 01A0 0047 | – | Parameters for Event 2 (6 words) | |
| 01A0 0048 – 01A0 005F | – | Parameters for Event 3 (6 words) | |
| 01A0 0060 – 01A0 0077 | – | Parameters for Event 4 (6 words) | |
| 01A0 0078 – 01A0 008F | – | Parameters for Event 5 (6 words) | |
| 01A0 0090 – 01A0 00A7 | – | Parameters for Event 6 (6 words) | |
| 01A0 00A8 – 01A0 00BF | – | Parameters for Event 7 (6 words) | |
| 01A0 00C0 – 01A0 00D7 | – | Parameters for Event 8 (6 words) | |
| 01A0 00D8 – 01A0 00EF | – | Parameters for Event 9 (6 words) | |
| 01A0 00F0 – 01A0 00107 | – | Parameters for Event 10 (6 words) | |
| 01A0 0108 – 01A0 011F | – | Parameters for Event 11 (6 words) | |
| 01A0 0120 – 01A0 0137 | – | Parameters for Event 12 (6 words) | |
| 01A0 0138 – 01A0 014F | – | Parameters for Event 13 (6 words) | |
| 01A0 0150 – 01A0 0167 | – | Parameters for Event 14 (6 words) | |
| 01A0 0168 – 01A0 017F | – | Parameters for Event 15 (6 words) | |
| 01A0 0180 – 01A0 0197 | – | Parameters for Event 16 (6 words) | |
| 01A0 0198 – 01A0 01AF | – | Parameters for Event 17 (6 words) | |
| ... | | ... | |
| 01A0 05D0 – 01A0 05E7 | – | Parameters for Event 62 (6 words) | |
| 01A0 05E8 – 01A0 05FF | – | Parameters for Event 63 (6 words) | |
| 01A0 0600 – 01A0 0617 | – | Reload/link parameters for Event 0 (6 words) | Reload/Link Parameters for other Event 0–15 |
| 01A0 0618 – 01A0 062F | – | Reload/link parameters for Event 1 (6 words) | |
| ... | | ... | |
| 01A0 07E0 – 01A0 07F7 | – | Reload/link parameters for Event 20 (6 words) | |
| 01A0 07F8 – 01A0 080F | – | Reload/link parameters for Event 21 (6 words) | |
| 01A0 0810 – 01A0 0827 | – | Reload/link parameters for Event 22 (6 words) | |
| ... | | ... | |
| 01A0 13C8 – 01A0 13DF | – | Reload/link parameters for Event 147 (6 words) | |
| 01A0 13E0 – 01A0 13F7 | – | Reload/link parameters for Event 148 (6 words) | |
| 01A0 13F8 – 01A0 13FF | – | Scratch pad area (2 words) | |
| 01A0 1400 – 01A3 FFFF | – | Reserved | |


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## 5.5 Interrupts

### 5.5.1 Interrupt Sources and Interrupt Selector

The C64x DSP core supports 16 prioritized interrupts, which are listed in Table 5-7. The highest-priority interrupt is INT_00 (dedicated to RESET) while the lowest-priority interrupt is INT_15. The first four interrupts (INT_00–INT_03) are non-maskable and fixed. The remaining interrupts (INT_04–INT_15) are maskable and default to the interrupt source specified in Table 5-7. The interrupt source for interrupts 4–15 can be programmed by modifying the selector value (binary value) in the corresponding fields of the Interrupt Selector Control registers: MUXH (address 0x019C0000) and MUXL (address 0x019C0004).

**Table 5-7. DM643 DSP Interrupts**

| CPU INTERRUPT NUMBER | INTERRUPT SELECTOR CONTROL REGISTER | SELECTOR VALUE (BINARY) | INTERRUPT EVENT | INTERRUPT SOURCE |
|---|---|---|---|---|
| INT_00(1) | – | – | RESET | |
| INT_01(1) | – | – | NMI | |
| INT_02(1) | – | – | Reserved | Reserved. Do not use. |
| INT_03(1) | – | – | Reserved | Reserved. Do not use. |
| INT_04(2) | MUXL[4:0] | 00100 | GPINT4/EXT_INT4 | GP0 interrupt 4/External interrupt pin 4 |
| INT_05(2) | MUXL[9:5] | 00101 | GPINT5/EXT_INT5 | GP0 interrupt 5/External interrupt pin 5 |
| INT_06(2) | MUXL[14:10] | 00110 | GPINT6/EXT_INT6 | GP0 interrupt 6/External interrupt pin 6 |
| INT_07(2) | MUXL[20:16] | 00111 | GPINT7/EXT_INT7 | GP0 interrupt 7/External interrupt pin 7 |
| INT_08(2) | MUXL[25:21] | 01000 | EDMA_INT | EDMA channel (0 through 63) interrupt |
| INT_09(2) | MUXL[30:26] | 01001 | EMU_DTDMA | EMU DTDMA |
| INT_10(2) | MUXH[4:0] | 00011 | SD_INTA | EMIFA SDRAM timer interrupt |
| INT_11(2) | MUXH[9:5] | 01010 | EMU_RTDXRX | EMU real-time data exchange (RTDX) receive |
| INT_12(2) | MUXH[14:10] | 01011 | EMU_RTDXTX | EMU RTDX transmit |
| INT_13(2) | MUXH[20:16] | 00000 | DSP_INT | HPI-to-DSP interrupt |
| INT_14(2) | MUXH[25:21] | 00001 | TINT0 | Timer 0 interrupt |
| INT_15(2) | MUXH[30:26] | 00010 | TINT1 | Timer 1 interrupt |
| – | – | 01100 | XINT0 | McBSP0 transmit interrupt |
| – | – | 01101 | RINT0 | McBSP0 receive interrupt |
| – | – | 01110 | Reserved | Reserved. Do not use. |
| – | – | 01111 | Reserved | Reserved. Do not use. |
| – | – | 10000 | GPINT0 | GP0 interrupt 0 |
| – | – | 10001 | Reserved | Reserved. Do not use. |
| – | – | 10010 | Reserved | Reserved. Do not use. |
| – | – | 10011 | TINT2 | Timer 2 interrupt |
| – | – | 10100 | Reserved | Reserved. Do not use. |
| – | – | 10101 | Reserved | Reserved. Do not use. |
| – | – | 10110 | ICINT0 | I2C0 interrupt |
| – | – | 10111 | Reserved | Reserved. Do not use. |
| – | – | 11000 | EMAC_MDIO_INT | EMAC/MDIO interrupt |
| – | – | 11001 | Reserved | Reserved. Do not use. |
| – | – | 11010 | VPINT1 | VP1 interrupt |
| – | – | 11011 | VPINT2 | VP2 interrupt |
| – | – | 11100 | AXINT0 | McASP0 transmit interrupt |

(1) Interrupts INT_00 through INT_03 are non-maskable and fixed.Interrupts
(2) INT_04 through INT_15 are programmable by modifying the binary selector values in the Interrupt Selector Control registers fields. Table 5-7 shows the default interrupt sources for Interrupts INT_04 through INT_15. For more detailed information on interrupt sources and selection, see the *TMS320C6000 DSP Interrupt Selector Reference Guide* (literature number SPRU646).

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**Table 5-7. DM643 DSP Interrupts (continued)**

| CPU INTERRUPT NUMBER | INTERRUPT SELECTOR CONTROL REGISTER | SELECTOR VALUE (BINARY) | INTERRUPT EVENT | INTERRUPT SOURCE |
|---|---|---|---|---|
| – | – | 11101 | ARINT0 | McASP0 receive interrupt |
| – | – | 11110 – 11111 | Reserved | Reserved. Do not use. |

### 5.5.2 Interrupts Peripheral Register Description(s)

**Table 5-8. Interrupt Selector Registers (C64x)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 019C 0000 | MUXH | Interrupt multiplexer high | Selects which interrupts drive CPU interrupts 10–15 (INT10–INT15) |
| 019C 0004 | MUXL | Interrupt multiplexer low | Selects which interrupts drive CPU interrupts 4–9 (INT04–INT09) |
| 019C 0008 | EXTPOL | External interrupt polarity | Sets the polarity of the external interrupts (EXT_INT4–EXT_INT7) |
| 019C 000C – 019F FFFF | – | Reserved | |

### 5.5.3 External Interrupts Electrical Data/Timing

**Table 5-9. Timing Requirements for External Interrupts(1) (see Figure 5-10)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(ILOW)}$ | Width of the NMI interrupt pulse low | 4P | | ns |
| | | Width of the EXT_INT interrupt pulse low | 8P | | ns |
| 2 | $t_{w(IHIGH)}$ | Width of the NMI interrupt pulse high | 4P | | ns |
| | | Width of the EXT_INT interrupt pulse high | 8P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.

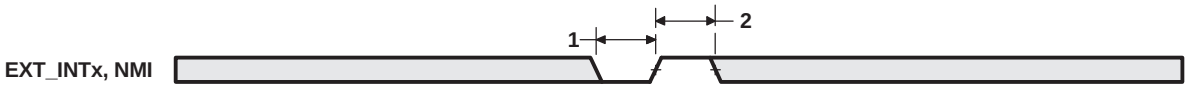



**Figure 5-10. External/NMI Interrupt Timing**


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## 5.6 Reset

A hardware reset ($\overline{\text{RESET}}$) is required to place the DSP into a known good state out of power-up. The $\overline{\text{RESET}}$ signal can be asserted (pulled low) prior to ramping the core and I/O voltages or after the core and I/O voltages have reached their proper operating conditions. As a best practice, reset should be held low during power-up. Prior to deasserting $\overline{\text{RESET}}$ (low-to-high transition), the core and I/O voltages should be at their proper operating conditions and CLKIN should also be running at the correct frequency.

For information on peripheral selection at the rising edge of $\overline{\text{RESET}}$, see the Device Configuration section of this data manual.

### 5.6.1 Reset Electrical Data/Timing

**Table 5-10. Timing Requirements for Reset (see Figure 5-11)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(RST)}$ | Width of the $\overline{\text{RESET}}$ pulse | 250 | | µs |
| 16 | $t_{su(boot)}$ | Setup time, boot configuration bits valid before $\overline{\text{RESET}}$ high (1) | 4E or 4C (2) | | ns |
| 17 | $t_{h(boot)}$ | Hold time, boot configuration bits valid after $\overline{\text{RESET}}$ high (1) | 4P (3) | | ns |

(1) AEA[22:19], LENDIAN, and HD5 are the boot configuration pins during device reset.
(2) E = 1/AECLKIN clock frequency in ns. C = 1/CLKIN clock frequency in ns.
Select the MIN parameter value, whichever value is larger.
(3) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.

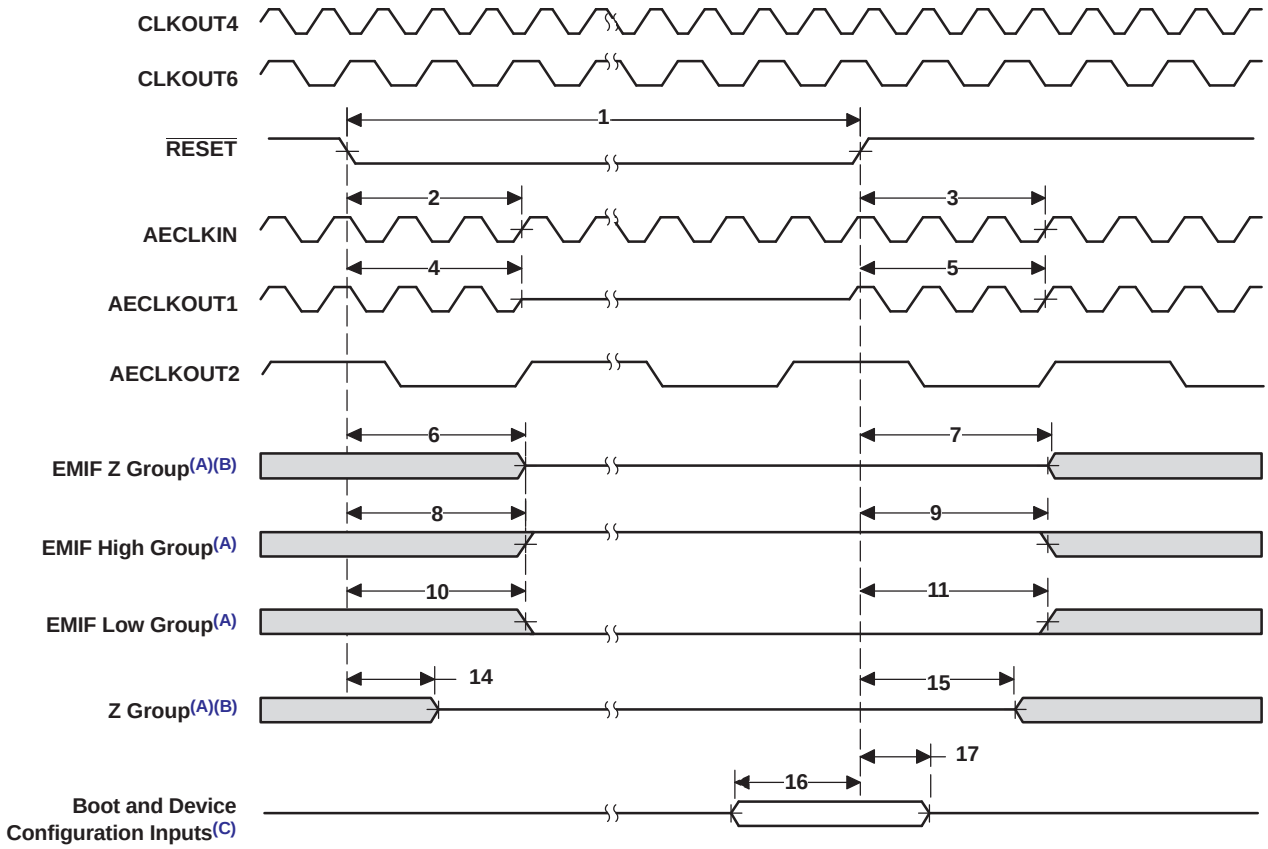
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**Table 5-11. Switching Characteristics Over Recommended Operating Conditions During Reset(1) (2) (3) (see Figure 5-11)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 2 | $t_{d(RSTL-ECKI)}$ | Delay time, RESET low to AECLKIN synchronized internally | 2E | 3P + 20E | ns |
| 3 | $t_{d(RSTH-ECKI)}$ | Delay time, RESET high to AECLKIN synchronized internally | 2E | 8P + 20E | ns |
| 4 | $t_{d(RSTL-ECKO1HZ)}$ | Delay time, RESET low to AECLKOUT1 high impedance | 2E | | ns |
| 5 | $t_{d(RSTH-ECKO1V)}$ | Delay time, RESET high to AECLKOUT1 valid | | 8P + 20E | ns |
| 6 | $t_{d(RSTL-EMIFZHZ)}$ | Delay time, RESET low to EMIF Z high impedance | 2E | 3P + 4E | ns |
| 7 | $t_{d(RSTH-EMIFZV)}$ | Delay time, RESET high to EMIF Z valid | 16E | 8P + 20E | ns |
| 8 | $t_{d(RSTL-EMIFHIV)}$ | Delay time, RESET low to EMIF high group invalid | 2E | | ns |
| 9 | $t_{d(RSTH-EMIFHV)}$ | Delay time, RESET high to EMIF high group valid | | 8P + 20E | ns |
| 10 | $t_{d(RSTL-EMIFLIV)}$ | Delay time, RESET low to EMIF low group invalid | 2E | | ns |
| 11 | $t_{d(RSTH-EMIFLV)}$ | Delay time, RESET high to EMIF low group valid | | 8P + 20E | ns |
| 14 | $t_{d(RSTL-ZHZ)}$ | Delay time, RESET low to Z group high impedance | 0 | | ns |
| 15 | $t_{d(RSTH-ZV)}$ | Delay time, RESET high to Z group valid | 2P | 8P | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) E = the EMIF input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA.
(3) **EMIF Z group consists of:** AEA[22:3], AED[63:0], ACE[3:0], ABE[7:0], AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, AAOE/ASDRAS/ASOE, ASOE3, ASDCKE, and APDT
**EMIF high group consists of:** AHOLDA (when the corresponding HOLD input is high)
**EMIF low group consists of:** ABUSREQ; AHOLDA (when the corresponding HOLD input is low)
**Z group consists of:** HD[31:0] and the muxed EMAC output pins, MDCLK, MDIO, CLKX0, FSX0, DX0, CLKR0, FSR0, TOUT0, TOUT1, VDAC/GP0[8], GP0[13, 11, 10, 7:0], HR/W, HDS2, HDS1, HCS, HCNTL1, HAS, HCNTL0, HHWIL (16-bit HPI mode only), HRDY, HINT, VP1D[19:0], and VP2D[19:0].


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A. EMIF Z group consists of: AEA[22:3], AED[63:0], $\overline{\text{ACE}}$[3:0], $\overline{\text{ABE}}$[7:0], $\overline{\text{AARE}}$/$\overline{\text{ASDCAS}}$/$\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$, $\overline{\text{AAWE}}$/$\overline{\text{ASDWE}}$/$\overline{\text{ASWE}}$, and $\overline{\text{AAOE}}$/$\overline{\text{ASDRAS}}$/$\overline{\text{ASOE}}$, $\overline{\text{ASOE3}}$, ASDCKE, and $\overline{\text{APDT}}$.
EMIF high group consists of: $\overline{\text{AHOLDA}}$ (when the corresponding $\overline{\text{HOLD}}$ input is high)
EMIF low group consists of: ABUSREQ; $\overline{\text{AHOLDA}}$ (when the corresponding $\overline{\text{HOLD}}$ input is low)
Z group consists of: HD[31:0] and the muxed EMAC output pins, MDCLK, MDIO, CLKX0, FSX0, DX0, CLKR0, FSR0, TOUT0, TOUT1, VDAC/GP0[8], GP0[13, 11, 10, 7:0], HR/$\overline{\text{W}}$, $\overline{\text{HDS2}}$, $\overline{\text{HDS1}}$, $\overline{\text{HCS}}$, HCNTL1, $\overline{\text{HAS}}$, HCNTL0, HHWIL (16-bit HPI mode only), $\overline{\text{HRDY}}$, $\overline{\text{HINT}}$, VP1D[19:0], and VP2D[19:0].

B. If AEA[22:19], LENDIAN, and HD5 pins are actively driven, care must be taken to ensure no timing contention between parameters 6, 7, 14, 15, 16, and 17.

C. Boot and Device Configurations Inputs (during reset) include: AEA[22:19], LENDIAN, and HD5.

**Figure 5-11. Reset Timing**

## 5.7 Clock PLL

The PLL controller features hardware-configurable PLL multiplier controller, dividers (/2, /4, /6, and /8), and reset controller. The PLL controller accepts an input clock, as determined by the logic state on the CLKMODE[1:0] pins, from the CLKIN pin. The resulting clock outputs are passed to the DSP core, peripherals, and other modules inside the C6000™ DSP.

### *5.7.1 Clock PLL Device-Specific Information*

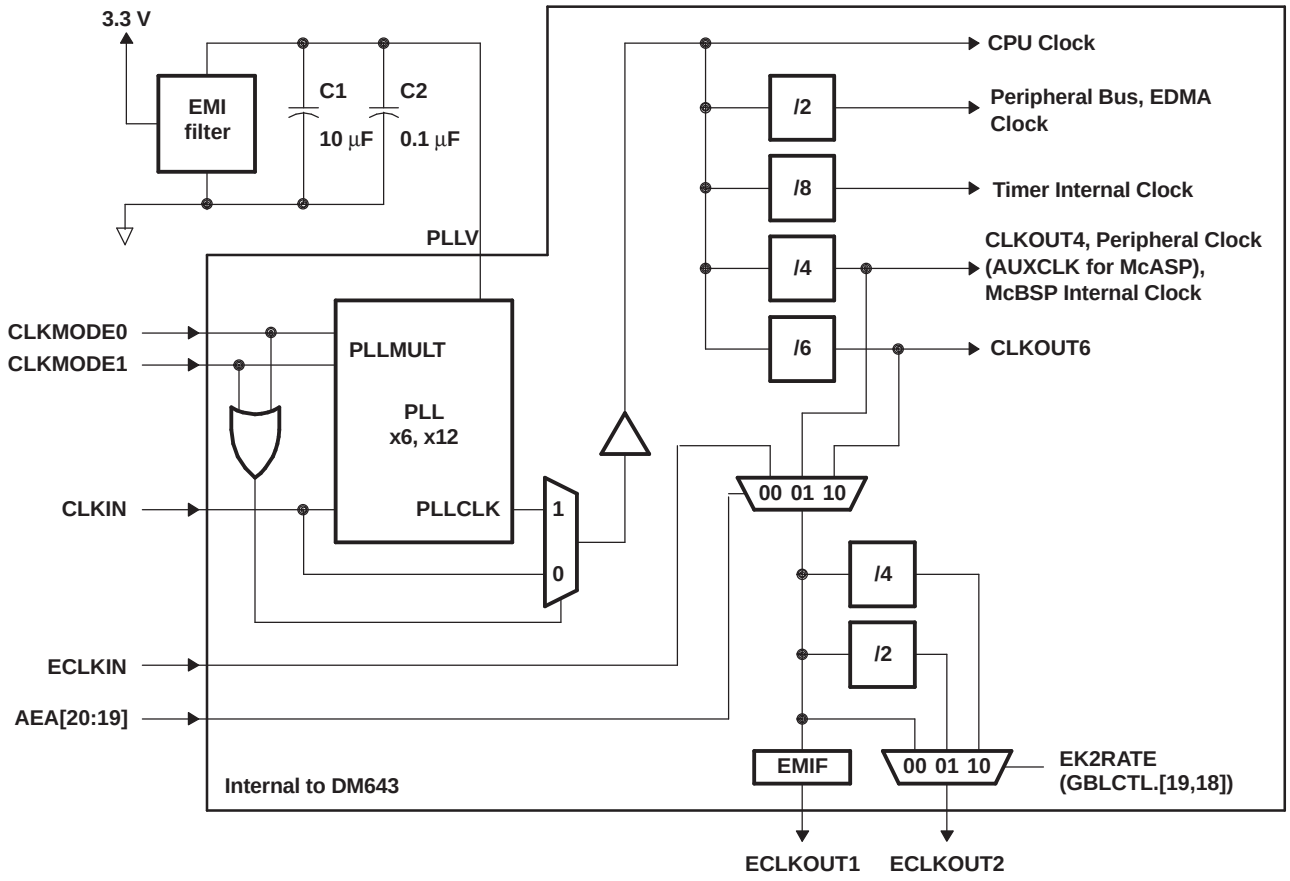
Most of the internal C64x™ DSP clocks are generated from a single source through the CLKIN pin. This source clock either drives the PLL, which multiplies the source clock frequency to generate the internal CPU clock, or bypasses the PLL to become the internal CPU clock.

To use the PLL to generate the CPU clock, the external PLL filter circuit must be properly designed. Figure 5-12 shows the external PLL circuitry for either x1 (PLL bypass) or other PLL multiply modes.

To minimize the clock jitter, a single clean power supply should power both the C64x™ DSP device and the external clock oscillator circuit. The minimum CLKIN rise and fall times should also be observed. For the input clock timing requirements, see the *input and output clocks* electricals section.

Rise/fall times, duty cycles (high/low pulse durations), and the load capacitance of the external clock source must meet the DSP requirements in this data sheet (see the *electrical characteristics over recommended ranges of supply voltage and operating case temperature* table and the *input and output clocks* electricals section).


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**(For the PLL Options, CLKMODE Pins Setup, and PLL Clock Frequency Ranges, see the "TMS320DM643 PLL Multiply Factor Options, Clock Frequency Ranges, and Typical Lock Time" table.)**

NOTES: Place all PLL external components (C1, C2, and the EMI Filter) as close to the C6000™ DSP device as possible. For the best performance, TI recommends that all the PLL external components be on a single side of the board without jumpers, switches, or components other than the ones shown.

For reduced PLL jitter, maximize the spacing between switching signals and the PLL external components (C1, C2, and the EMI Filter).

The 3.3-V supply for the EMI filter must be from the same 3.3-V power plane supplying the I/O voltage, $D_{VDD}$.

EMI filter manufacturer TDK part number ACF451832-333, -223, -153, -103. Panasonic part number EXCCET103U.

**Figure 5-12. External PLL Circuitry for Either PLL Multiply Modes or x1 (Bypass) Mode**

**Table 5-12. TMS320DM643 PLL Multiply Factor Options, Clock Frequency Ranges, and Typical Lock Time(1) (2)**

| GDK and ZDK PACKAGES – 23 x 23 mm BGA, GNZ and ZNZ PACKAGES – 27 x 27 mm BGA | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLKMODE1 | CLKMODE0 | CLKMODE (PLL MULTIPLY FACTORS) | CLKIN RANGE (MHz) | CPU CLOCK FREQUENCY RANGE (MHz) | CLKOUT4 RANGE (MHz) | CLKOUT6 RANGE (MHz) | TYPICAL LOCK TIME (µs)(3) |
| 0 | 0 | Bypass (x1) | 30–75 | 30–75 | 7.5–18.8 | 5–12.5 | N/A |
| 0 | 1 | x6 | 30–75 | 180–450 | 45–112.5 | 30–75 | 75 |
| 1 | 0 | x12 | 30–50 | 360–600 | 90–150 | 60–100 | |
| 1 | 1 | Reserved | – | – | – | – | – |

(1) These clock frequency range values are applicable to a DM643-600 speed device. For -500 device speed values, see the CLKIN timing requirements table for the specific device speed.
(2) Use external pullup resistors on the CLKMODE pins (CLKMODE1 and CLKMODE0) to set the DM643 device to one of the valid PLL multiply clock modes (x6 or x12). With internal pulldown resistors on the CLKMODE pins (CLKMODE1, CLKMODE0), the default clock mode is x1 (bypass).
(3) Under some operating conditions, the maximum PLL lock time may vary by as much as 150% from the specified typical value. For example, if the typical lock time is specified as 100 µs, the maximum value may be as long as 250 µs.

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

**Table 5-13. Timing Requirements for CLKIN for –500 Devices(1) (2) (3) (see Figure 5-13)**

| NO. | | | –500 | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | PLL MODE x12 | | PLL MODE x6 | | x1 (Bypass) | | |
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| 1 | $t_{c(CLKIN)}$ | Cycle time, CLKIN | 24 | 33.3 | 13.3 | 33.3 | 13.3 | 33.3 | ns |
| 2 | $t_{w(CLKINH)}$ | Pulse duration, CLKIN high | 0.45C | | 0.45C | | 0.45C | | ns |
| 3 | $t_{w(CLKINL)}$ | Pulse duration, CLKIN low | 0.45C | | 0.45C | | 0.45C | | ns |
| 4 | $t_{t(CLKIN)}$ | Transition time, CLKIN | | 5 | | 5 | | 1 | ns |
| 5 | $t_{J(CLKIN)}$ | Period jitter, CLKIN | | 0.02C | | 0.02C | | 0.02C | ns |

(1) The reference points for the rise and fall transitions are measured at $V_{IL}$ MAX and $V_{IH}$ MIN.
(2) For more details on the PLL multiplier factors (x6, x12), see the *Clock PLL* section of this data sheet.
(3) C = CLKIN cycle time in ns. For example, when CLKIN frequency is 50 MHz, use C = 20 ns.

**Table 5-14. Timing Requirements for CLKIN for –600 Devices(1) (2) (3) (see Figure 5-13)**

| NO. | | | –600 | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | PLL MODE x12 | | PLL MODE x6 | | x1 (Bypass) | | |
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| 1 | $t_{c(CLKIN)}$ | Cycle time, CLKIN | 20 | 33.3 | 13.3 | 33.3 | 13.3 | 33.3 | ns |
| 2 | $t_{w(CLKINH)}$ | Pulse duration, CLKIN high | 0.45C | | 0.45C | | 0.45C | | ns |
| 3 | $t_{w(CLKINL)}$ | Pulse duration, CLKIN low | 0.45C | | 0.45C | | 0.45C | | ns |
| 4 | $t_{t(CLKIN)}$ | Transition time, CLKIN | | 5 | | 5 | | 1 | ns |
| 5 | $t_{J(CLKIN)}$ | Period jitter, CLKIN | | 0.02C | | 0.02C | | 0.02C | ns |

(1) The reference points for the rise and fall transitions are measured at $V_{IL}$ MAX and $V_{IH}$ MIN.
(2) For more details on the PLL multiplier factors (x6, x12), see the *Clock PLL* section of this data sheet.
(3) C = CLKIN cycle time in ns. For example, when CLKIN frequency is 50 MHz, use C = 20 ns.

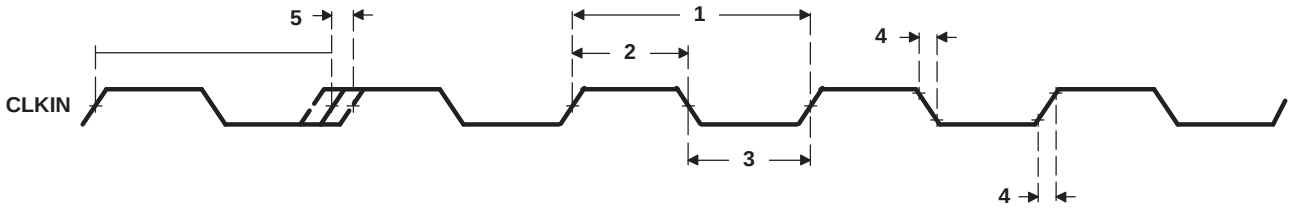



**Figure 5-13. CLKIN Timing**


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**Table 5-15. Switching Characteristics Over Recommended Operating Conditions for CLKOUT4 (1) (2) (3) (see Figure 5-14)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | CLKMODE = x1, x6, x12 | | |
| | | | MIN | MAX | |
| 1 | $t_{w(CKO4H)}$ | Pulse duration, CLKOUT4 high | 2P – 0.7 | 2P + 0.7 | ns |
| 2 | $t_{w(CKO4L)}$ | Pulse duration, CLKOUT4 low | 2P – 0.7 | 2P + 0.7 | ns |
| 3 | $t_{t(CKO4)}$ | Transition time, CLKOUT4 | | 1 | ns |

(1) The reference points for the rise and fall transitions are measured at $V_{OL}$ MAX and $V_{OH}$ MIN.
(2) PH is the high period of CLKIN in ns and PL is the low period of CLKIN in ns.
(3) P = 1/CPU clock frequency in nanoseconds (ns)

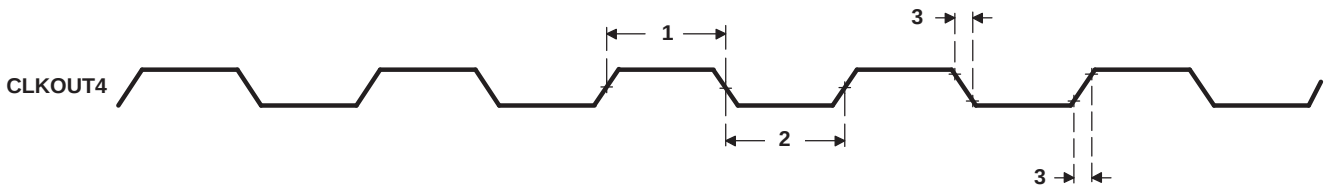



**Figure 5-14. CLKOUT4 Timing**

**Table 5-16. Switching Characteristics Over Recommended Operating Conditions for CLKOUT6[1] [2] [3] (see Figure 5-15)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | CLKMODE = x1, x6, x12 | | |
| | | | MIN | MAX | |
| 1 | $t_{w(CKO6H)}$ | Pulse duration, CLKOUT6 high | 3P – 0.7 | 3P + 0.7 | ns |
| 2 | $t_{w(CKO6L)}$ | Pulse duration, CLKOUT6 low | 3P – 0.7 | 3P + 0.7 | ns |
| 3 | $t_{t(CKO6)}$ | Transition time, CLKOUT6 | | 1 | ns |

(1) The reference points for the rise and fall transitions are measured at $V_{OL}$ MAX and $V_{OH}$ MIN.
(2) PH is the high period of CLKIN in ns and PL is the low period of CLKIN in ns.
(3) P = 1/CPU clock frequency in nanoseconds (ns)

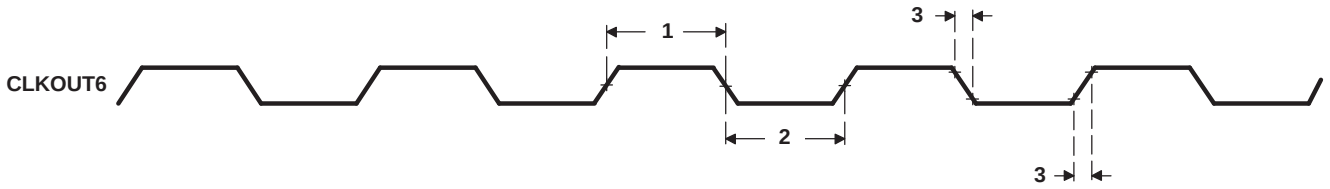



**Figure 5-15. CLKOUT6 Timing**

**Table 5-17. Timing Requirements for AECLKIN for EMIFA[1] [2] [3] (see Figure 5-16)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(EKI)}$ | Cycle time, AECLKIN | 6[4] | 16P | ns |
| 2 | $t_{w(EKIH)}$ | Pulse duration, AECLKIN high | 2.7 | | ns |
| 3 | $t_{w(EKIL)}$ | Pulse duration, AECLKIN low | 2.7 | | ns |
| 4 | $t_{t(EKI)}$ | Transition time, AECLKIN | | 3 | ns |
| 5 | $t_{J(EKI)}$ | Period jitter, AECLKIN | | 0.02E | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) The reference points for the rise and fall transitions are measured at $V_{IL}$ MAX and $V_{IH}$ MIN.
(3) E = the EMIF input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA.
(4) Minimum AECLKIN cycle times *must* be met, even when AECLKIN is generated by an internal clock source. Minimum AECLKIN times are based on internal logic speed; the maximum useable speed of the EMIF may be lower due to AC timing requirements. On the 600 devices, 133-MHz operation is achievable if the requirements of the EMIF Device Speed section are met. On the 500 devices, 100-MHz operation is achievable if the requirements of the EMIF Device Speed section are met.

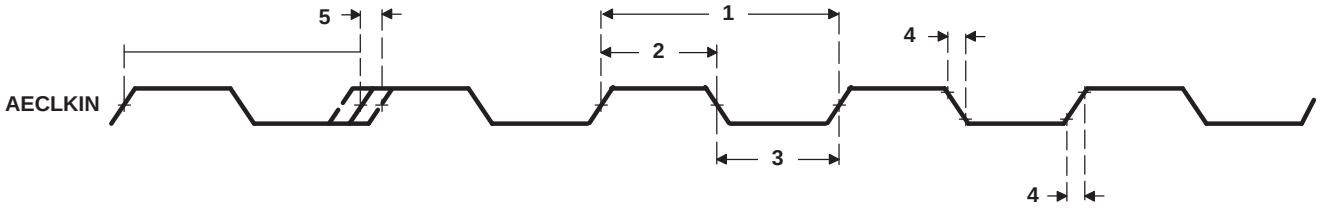



**Figure 5-16. AECLKIN Timing for EMIFA**


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**Table 5-18. Switching Characteristics Over Recommended Operating Conditions for AECLKOUT1 for the EMIFA Module(1) (2) (3) (see Figure 5-17)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(EKO1H)}$ | Pulse duration, AECLKOUT1 high | EH – 0.7 | EH + 0.7 | ns |
| 2 | $t_{w(EKO1L)}$ | Pulse duration, AECLKOUT1 low | EL – 0.7 | EL + 0.7 | ns |
| 3 | $t_{t(EKO1)}$ | Transition time, AECLKOUT1 | | 1 | ns |
| 4 | $t_{d(EKIH-EKO1H)}$ | Delay time, AECLKIN high to AECLKOUT1 high | 1 | 8 | ns |
| 5 | $t_{d(EKIL-EKO1L)}$ | Delay time, AECLKIN low to AECLKOUT1 low | 1 | 8 | ns |

(1) E = the EMIF input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA.
(2) The reference points for the rise and fall transitions are measured at $V_{OL}$ MAX and $V_{OH}$ MIN.
(3) EH is the high period of E (EMIF input clock period) in ns and EL is the low period of E (EMIF input clock period) in ns for EMIFA.

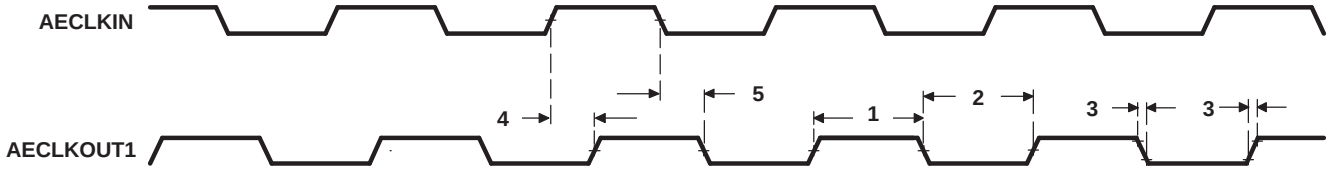



**Figure 5-17. AECLKOUT1 Timing for the EMIFA Module**

**Table 5-19. Switching Characteristics Over Recommended Operating Conditions for AECLKOUT2 for the EMIFA Module(1) (2) (see Figure 5-18)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(EKO2H)}$ | Pulse duration, AECLKOUT2 high | 0.5NE – 0.7 | 0.5NE + 0.7 | ns |
| 2 | $t_{w(EKO2L)}$ | Pulse duration, AECLKOUT2 low | 0.5NE – 0.7 | 0.5NE + 0.7 | ns |
| 3 | $t_{t(EKO2)}$ | Transition time, AECLKOUT2 | | 1 | ns |
| 4 | $t_{d(EKIH-EKO2H)}$ | Delay time, AECLKIN high to AECLKOUT2 high | 1 | 8 | ns |
| 5 | $t_{d(EKIL-EKO2L)}$ | Delay time, AECLKIN low to AECLKOUT2 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) E = the EMIF input clock (AECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA. N = the EMIF input clock divider; N = 1, 2, or 4.

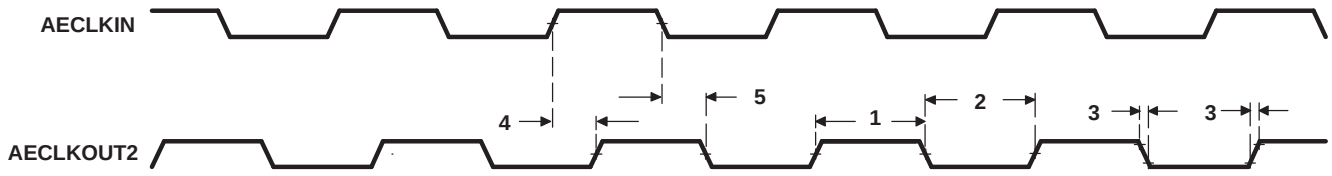



**Figure 5-18. AECLKOUT2 Timing for the EMIFA Module**

## 5.8 External Memory Interface (EMIIF)

EMIF supports a glueless interface to a variety of external devices, including:

- Pipelined synchronous-burst SRAM (SBSRAM)
- Synchronous DRAM (SDRAM)
- Asynchronous devices, including SRAM, ROM, and FIFOs
- An external shared-memory device

### *5.8.1 EMIF Device-Specific Information*

**EMIF Device Speed**

The rated EMIF speed of these devices only applies to the SDRAM interface when in a system that meets the following requirements:

- 1 chip-enable (CE) space (maximum of 2 chips) of SDRAM connected to EMIF
- up to 1 CE space of buffers connected to EMIF
- EMIF trace lengths between 1 and 3 inches
- 166-MHz SDRAM for 133-MHz operation
- 143-MHz SDRAM for 100-MHz operation

Other configurations may be possible, but timing analysis must be done to verify all AC timings are met. Verification of AC timings is mandatory when using configurations other than those specified above. TI recommends utilizing I/O buffer information specification (IBIS) to analyze all AC timings.

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).

To maintain signal integrity, serial termination resistors should be inserted into all EMIF output signal lines (see the Terminal Functions table for the EMIF output signals).

For more detailed information on the DM643 EMIF peripheral, see the *TMS320C6000 DSP External Memory Interface (EMIF) Reference Guide* (literature number SPRU266).


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### 5.8.2 EMIF Peripheral Register Description(s)

**Table 5-20. EMIFA Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0180 0000 | GBLCTL | EMIFA global control | |
| 0180 0004 | CECTL1 | EMIFA CE1 space control | |
| 0180 0008 | CECTL0 | EMIFA CE0 space control | |
| 0180 000C | – | Reserved | |
| 0180 0010 | CECTL2 | EMIFA CE2 space control | |
| 0180 0014 | CECTL3 | EMIFA CE3 space control | |
| 0180 0018 | SDCTL | EMIFA SDRAM control | |
| 0180 001C | SDTIM | EMIFA SDRAM refresh control | |
| 0180 0020 | SDEXT | EMIFA SDRAM extension | |
| 0180 0024 – 0180 003C | – | Reserved | |
| 0180 0040 | PDTCTL | Peripheral device transfer (PDT) control | |
| 0180 0044 | CESEC1 | EMIFA CE1 space secondary control | |
| 0180 0048 | CESEC0 | EMIFA CE0 space secondary control | |
| 0180 004C | – | Reserved | |
| 0180 0050 | CESEC2 | EMIFA CE2 space secondary control | |
| 0180 0054 | CESEC3 | EMIFA CE3 space secondary control | |
| 0180 0058 – 0183 FFFF | – | Reserved | |

### 5.8.3 EMIF Electrical Data/Timing

#### 5.8.3.1 Asynchronous Memory Timing

**Table 5-21. Timing Requirements for Asynchronous Memory Cycles for EMIFA Module(1) (2) (see Figure 5-19 and Figure 5-20)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 3 | $t_{su(EDV-AREH)}$ | Setup time, AEDx valid before $\overline{AARE}$ high | 6.5 | | ns |
| 4 | $t_{h(AREH-EDV)}$ | Hold time, AEDx valid after $\overline{AARE}$ high | 1 | | ns |
| 6 | $t_{su(ARDY-EKO1H)}$ | Setup time, AARDY valid before AECLKOUTx high | 3 | | ns |
| 7 | $t_{h(EKO1H-ARDY)}$ | Hold time, AARDY valid after AECLKOUTx high | 2.5 | | ns |

(1) To ensure data setup time, simply program the strobe width wide enough. AARDY is internally synchronized. The AARDY signal is *only* recognized two cycles before the end of the programmed strobe time and while AARDY is low, the strobe time is extended cycle-by-cycle. When AARDY is recognized low, the end of the strobe time is two cycles after AARDY is recognized high. To use AARDY as an asynchronous input, the pulse width of the AARDY signal should be wide enough (e.g., pulse width = 2E) to ensure setup and hold time is met.
(2) RS = Read setup, RST = Read strobe, RH = Read hold, WS = Write setup, WST = Write strobe, WH = Write hold. These parameters are programmed via the EMIF CE space control registers.

**Table 5-22. Switching Characteristics Over Recommended Operating Conditions for Asynchronous Memory Cycles for EMIFA Module(1) (2) (3) (see Figure 5-19 and Figure 5-20)**

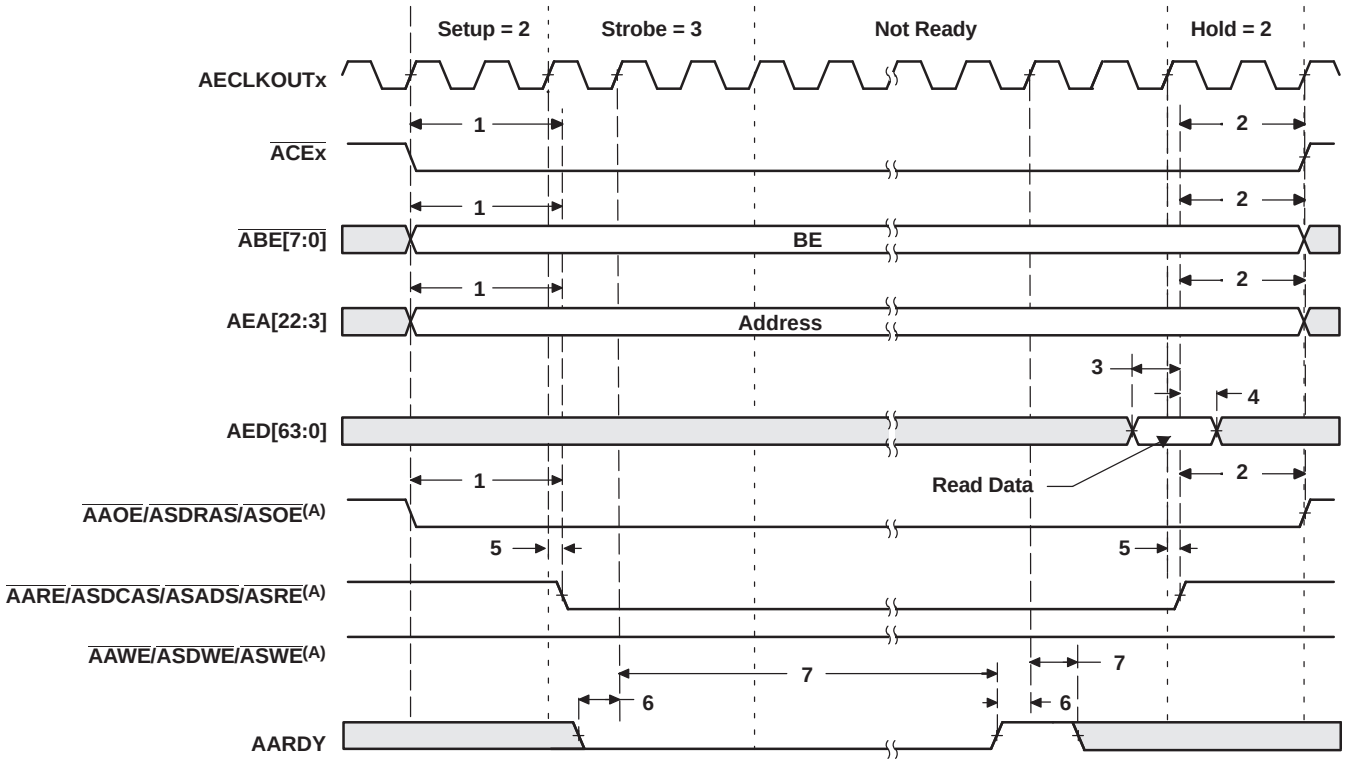
| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{osu(SELV-AREL)}$ | Output setup time, select signals valid to $\overline{AARE}$ low | RS * E – 1.8 | | ns |
| 2 | $t_{oh(AREH-SELIV)}$ | Output hold time, $\overline{AARE}$ high to select signals invalid | RH * E – 1.9 | | ns |

(1) RS = Read setup, RST = Read strobe, RH = Read hold, WS = Write setup, WST = Write strobe, WH = Write hold. These parameters are programmed via the EMIF CE space control registers.
(2) E = AECLKOUT1 period in ns for EMIFA
(3) Select signals for EMIFA include: $\overline{ACEx}$, $\overline{ABE[7:0]}$, AEA[22:3], $\overline{AAOE}$; and for EMIFA writes, include AED[63:0].

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**Table 5-22. Switching Characteristics Over Recommended Operating Conditions for Asynchronous Memory Cycles for EMIFA Module (see Figure 5-19 and Figure 5-20) (continued)**

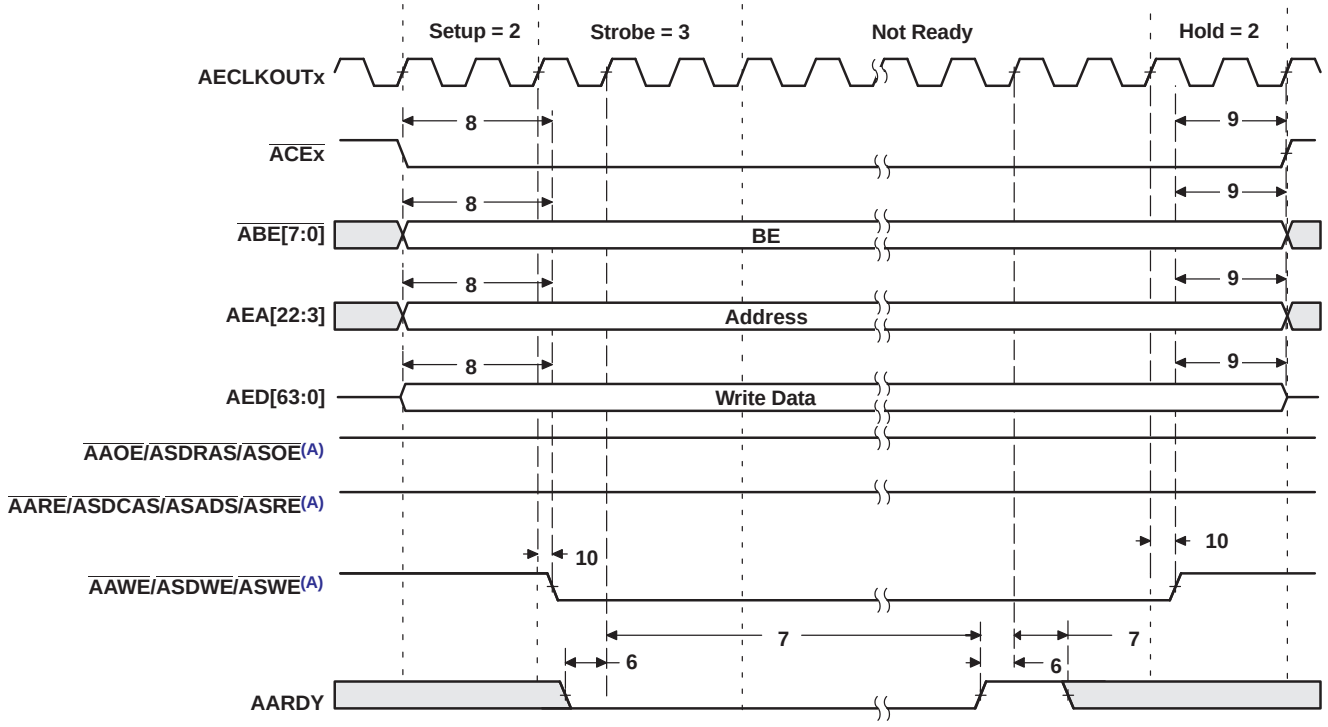
| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 5 | $t_{d(EKO1H-AREV)}$ | Delay time, AECLKOUTx high to $\overline{AARE}$ valid | 1 | 7 | ns |
| 8 | $t_{osu(SELV-AWEL)}$ | Output setup time, select signals valid to $\overline{AAWE}$ low | WS * E – 2.0 | | ns |
| 9 | $t_{oh(AWEH-SELIV)}$ | Output hold time, $\overline{AAWE}$ high to select signals invalid | WH * E – 2.5 | | ns |
| 10 | $t_{d(EKO1H-AWEV)}$ | Delay time, AECLKOUTx high to $\overline{AAWE}$ valid | 1.3 | 7.1 | ns |




A. $\overline{AAOE}$/ASDRAS/ASOE, $\overline{AARE}$/ASDCAS/ASADS/ASRE, and $\overline{AAWE}$/ASDWE/ASWE operate as $\overline{AAOE}$ (identified under select signals), $\overline{AARE}$, and $\overline{AAWE}$, respectively, during asynchronous memory accesses.

**Figure 5-19. Asynchronous Memory Read Timing for EMIFA**


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A. AAOE/ASDRAS/ASOE, AARE/ASDCAS/ASADS/ASRE, and AAWE/ASDWE/ASWE operate as AAOE (identified under select signals), AARE, and AAWE, respectively, during asynchronous memory accesses.

**Figure 5-20. Asynchronous Memory Write Timing for EMIFA**

### 5.8.3.2 Programmable Synchronous Interface Timing

**Table 5-23. Timing Requirements for Programmable Synchronous Interface Cycles for EMIFA Module (see Figure 5-21)**

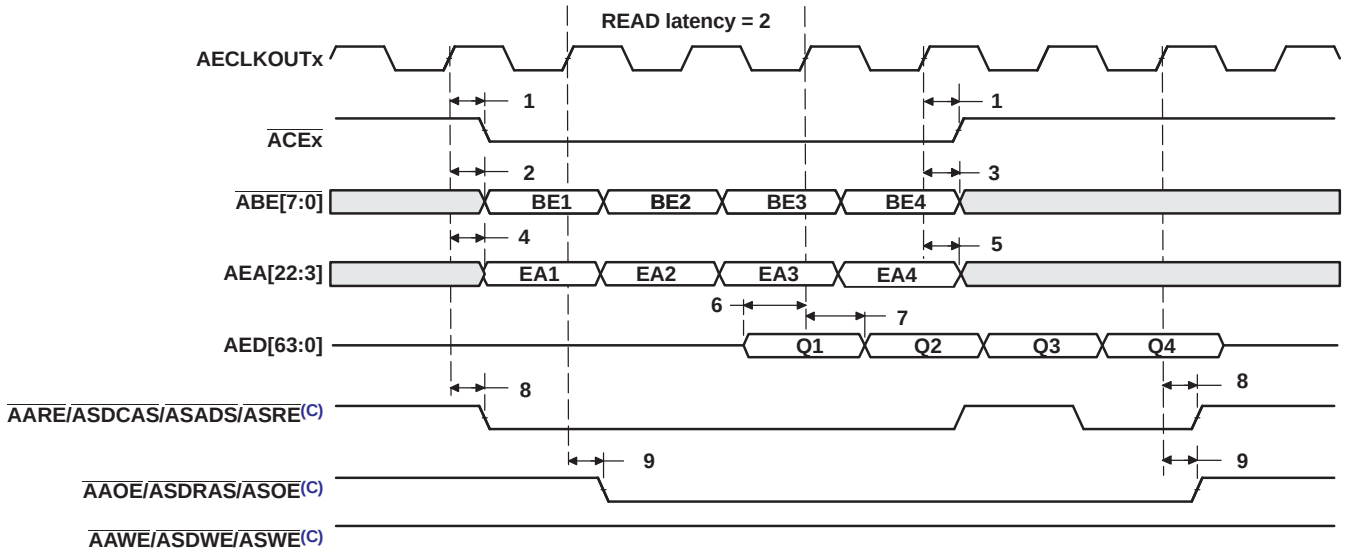
| NO. | | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 6 | $t_{su(EDV-EKOxH)}$ | Setup time, read AEDx valid before AECLKOUTx high | 3.1 | | 2 | | ns |
| 7 | $t_{h(EKOxH-EDV)}$ | Hold time, read AEDx valid after AECLKOUTx high | 1.8 | | 1.5 | | ns |

**Table 5-24. Switching Characteristics Over Recommended Operating Conditions for Programmable Synchronous Interface Cycles for EMIFA Module(1) (see Figure 5-21–Figure 5-23)**

| NO. | PARAMETER | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{d(EKOxH-CEV)}$ | Delay time, AECLKOUTx high to $\overline{ACEx}$ valid | 1.1 | 6.4 | 1.1 | 4.9 | ns |
| 2 | $t_{d(EKOxH-BEV)}$ | Delay time, AECLKOUTx high to $\overline{ABEx}$ valid | | 6.4 | | 4.9 | ns |
| 3 | $t_{d(EKOxH-BEIV)}$ | Delay time, AECLKOUTx high to $\overline{ABEx}$ invalid | 1.1 | | 1.1 | | ns |
| 4 | $t_{d(EKOxH-EAV)}$ | Delay time, AECLKOUTx high to AEAx valid | | 6.4 | | 4.9 | ns |
| 5 | $t_{d(EKOxH-EAIV)}$ | Delay time, AECLKOUTx high to AEAx invalid | 1.1 | | 1.1 | | ns |
| 8 | $t_{d(EKOxH-ADSV)}$ | Delay time, AECLKOUTx high to $\overline{ASADS}$/$\overline{ASRE}$ valid | 1.1 | 6.4 | 1.1 | 4.9 | ns |
| 9 | $t_{d(EKOxH-OEV)}$ | Delay time, AECLKOUTx high to $\overline{ASOE}$ valid | 1.1 | 6.4 | 1.1 | 4.9 | ns |
| 10 | $t_{d(EKOxH-EDV)}$ | Delay time, AECLKOUTx high to AEDx valid | | 6.4 | | 4.9 | ns |
| 11 | $t_{d(EKOxH-EDIV)}$ | Delay time, AECLKOUTx high to AEDx invalid | 1.1 | | 1.1 | | ns |
| 12 | $t_{d(EKOxH-WEV)}$ | Delay time, AECLKOUTx high to $\overline{ASWE}$ valid | 1.1 | 6.4 | 1.1 | 4.9 | ns |

(1) The following parameters are programmable via the EMIF CE Space Secondary Control register (CExSEC):
- Read latency (SYNCRL): 0-, 1-, 2-, or 3-cycle read latency
- Write latency (SYNCWL): 0-, 1-, 2-, or 3-cycle write latency
- $\overline{ACEx}$ assertion length (CEEXT): For standard SBSRAM or ZBT SRAM interface, $\overline{ACEx}$ goes inactive after the final command has been issued (CEEXT = 0). For synchronous FIFO interface with glue, $\overline{ACEx}$ is active when $\overline{ASOE}$ is active (CEEXT = 1).
- Function of $\overline{ASADS}$/$\overline{ASRE}$ (RENEN): For standard SBSRAM or ZBT SRAM interface, $\overline{ASADS}$/$\overline{ASRE}$ acts as $\overline{ASADS}$ with deselect cycles (RENEN = 0). For FIFO interface, $\overline{ASADS}$/$\overline{ASRE}$ acts as $\overline{ASRE}$ with NO deselect cycles (RENEN = 1).
- Synchronization clock (SNCCLK): Synchronized to AECLKOUT1 or AECLKOUT2


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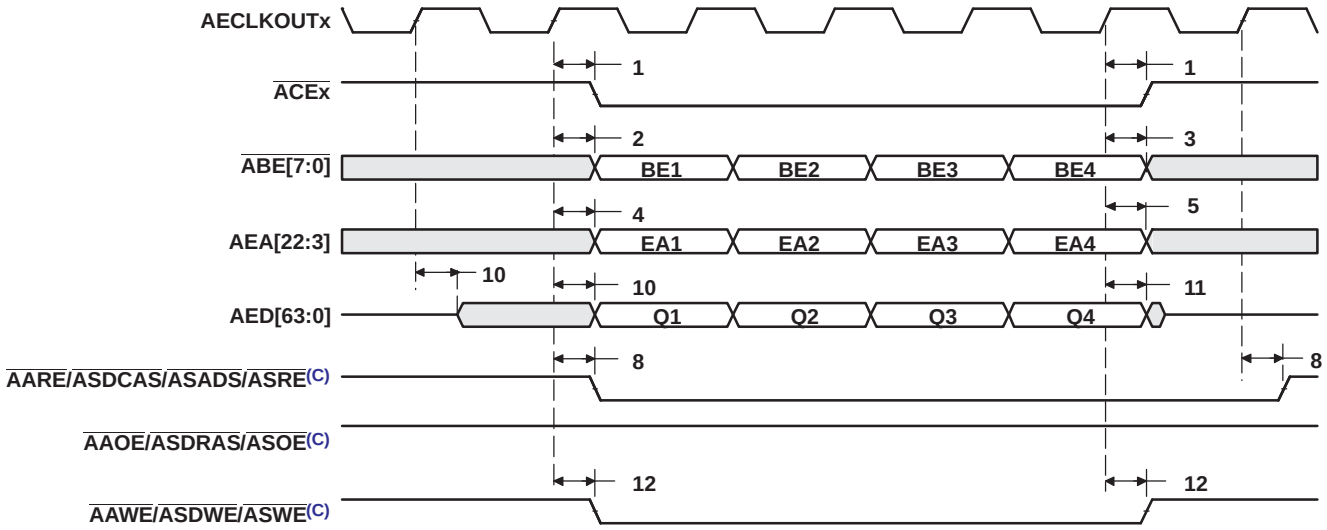



A. The read latency and the length of ACEx assertion are programmable via the SYNCRL and CEEXT fields, respectively, in the EMIFA CE Space Secondary Control register (CExSEC). In this figure, SYNCRL = 2 and CEEXT = 0.

B. The following parameters are programmable via the EMIF CE Space Secondary Control register (CExSEC):
   - Read latency (SYNCRL): 0-, 1-, 2-, or 3-cycle read latency
   - Write latency (SYNCWL): 0-, 1-, 2-, or 3-cycle write latency
   - ACEx assertion length (CEEXT): For standard SBSRAM or ZBT SRAM interface, ACEx goes inactive after the final command has been issued (CEEXT = 0). For synchronous FIFO interface with glue, ACEx is active when ASOE is active (CEEXT = 1).
   - Function of ASADS/ASRE (RENEN): For standard SBSRAM or ZBT SRAM interface, ASADS/ASRE acts as ASADS with deselect cycles (RENEN = 0). For FIFO interface, ASADS/ASRE acts as ASRE with NO deselect cycles (RENEN = 1).
   - Synchronization clock (SNCCLK): Synchronized to AECLKOUT1 or AECLKOUT2

C. AARE/ASDCAS/ASADS/ASRE, AAOE/ASDRAS/ASOE, and AAWE/ASDWE/ASWE operate as ASADS/ASRE, ASOE, and ASWE, respectively, during programmable synchronous interface accesses.

**Figure 5-21. Programmable Synchronous Interface Read Timing for EMIFA (With Read Latency = 2) (A)(B)**



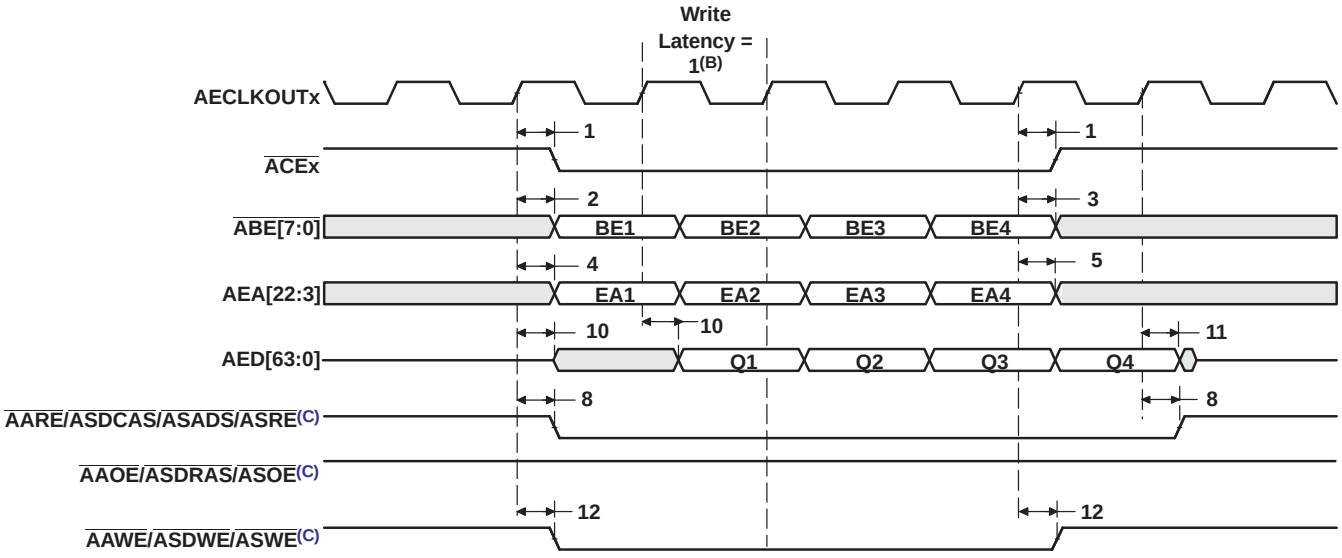

A. The write latency and the length of ACEx assertion are programmable via the SYNCWL and CEEXT fields, respectively, in the EMIFA CE Space Secondary Control register (CExSEC). In this figure, SYNCWL = 0 and CEEXT = 0.

B. The following parameters are programmable via the EMIF CE Space Secondary Control register (CExSEC):
   - Read latency (SYNCRL): 0-, 1-, 2-, or 3-cycle read latency
   - Write latency (SYNCWL): 0-, 1-, 2-, or 3-cycle write latency
   - ACEx assertion length (CEEXT): For standard SBSRAM or ZBT SRAM interface, ACEx goes inactive after the final command has been issued (CEEXT = 0). For synchronous FIFO interface with glue, ACEx is active when ASOE is active (CEEXT = 1).
   - Function of ASADS/ASRE (RENEN): For standard SBSRAM or ZBT SRAM interface, ASADS/ASRE acts as ASADS with deselect cycles(RENEN = 0). For FIFO interface, ASADS/ASRE acts as ASRE with NO deselect cycles (RENEN = 1).
   - Synchronization clock (SNCCLK): Synchronized to AECLKOUT1 or AECLKOUT2

C. AARE/ASDCAS/ASADS/ASRE, AAOE/ASDRAS/ASOE, and AAWE/ASDWE/ASWE operate as ASADS/ASRE, ASOE, and ASWE, respectively, during programmable synchronous interface accesses.

**Figure 5-22. Programmable Synchronous Interface Write Timing for EMIFA (With Write Latency = 0)(A)(B)**


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A. The write latency and the length of $\overline{\text{ACEx}}$ assertion are programmable via the SYNCWL and CEEXT fields, respectively, in the EMIFA CE Space Secondary Control register (CExSEC). In this figure, SYNCWL = 0 and CEEXT = 0.

B. The following parameters are programmable via the EMIF CE Space Secondary Control register (CExSEC):
   - Read latency (SYNCRL): 0-, 1-, 2-, or 3-cycle read latency
   - Write latency (SYNCWL): 0-, 1-, 2-, or 3-cycle write latency
   - $\overline{\text{ACEx}}$ assertion length (CEEXT): For standard SBSRAM or ZBT SRAM interface, $\overline{\text{ACEx}}$ goes inactive after the final command has been issued (CEEXT = 0). For synchronous FIFO interface with glue, $\overline{\text{ACEx}}$ is active when $\overline{\text{ASOE}}$ is active (CEEXT = 1).
   - Function of $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$ (RENEN): For standard SBSRAM or ZBT SRAM interface, $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$ acts as $\overline{\text{ASADS}}$ with deselect cycles (RENEN = 0). For FIFO interface, $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$ acts as $\overline{\text{ASRE}}$ with NO deselect cycles (RENEN = 1).
   - Synchronization clock (SNCCLK): Synchronized to AECLKOUT1 or AECLKOUT2

C. $\overline{\text{AARE}}$/$\overline{\text{ASDCAS}}$/$\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$, $\overline{\text{AAOE}}$/$\overline{\text{ASDRAS}}$/$\overline{\text{ASOE}}$, and $\overline{\text{AAWE}}$/$\overline{\text{ASDWE}}$/$\overline{\text{ASWE}}$ operate as $\overline{\text{ASADS}}$/$\overline{\text{ASRE}}$, $\overline{\text{ASOE}}$, and $\overline{\text{ASWE}}$, respectively, during programmable synchronous interface accesses.

**Figure 5-23. Programmable Synchronous Interface Write Timing for EMIFA (With Write Latency = 1) (A)(B)**

### 5.8.3.3 Synchronous DRAM Timing

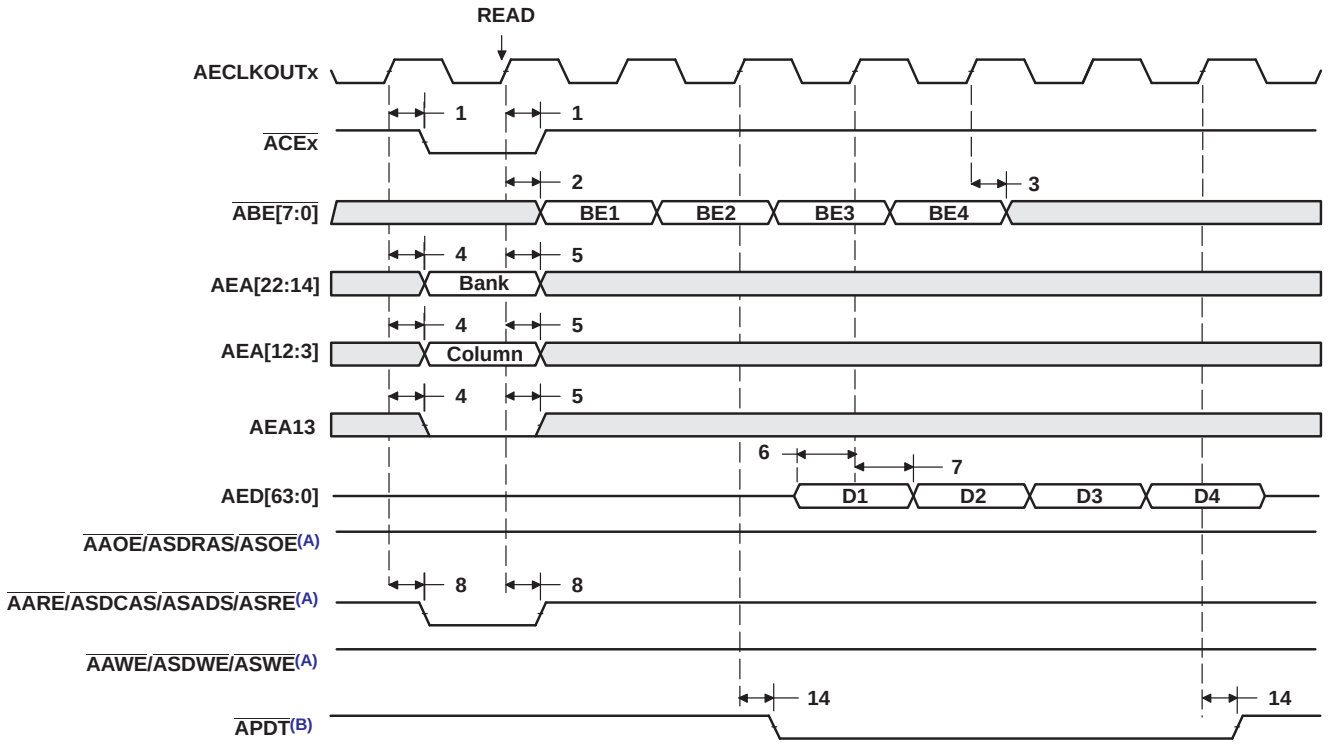
**Table 5-25. Timing Requirements for Synchronous DRAM Cycles for EMIFA Module (see Figure 5-24)**

| NO. | | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 6 | $t_{su(EDV-EKO1H)}$ | Setup time, read AEDx valid before AECLKOUTx high | 2.1 | | 0.6 | | ns |
| 7 | $t_{h(EKO1H-EDV)}$ | Hold time, read AEDx valid after AECLKOUTx high | 2.8 | | 2.1 | | ns |

**Table 5-26. Switching Characteristics Over Recommended Operating Conditions for Synchronous DRAM Cycles for EMIFA Module (see Figure 5-24–Figure 5-31)**

| NO. | PARAMETER | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{d(EKO1H-CEV)}$ | Delay time, AECLKOUTx high to $\overline{ACEx}$ valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |
| 2 | $t_{d(EKO1H-BEV)}$ | Delay time, AECLKOUTx high to $\overline{ABEx}$ valid | | 6.4 | | 4.9 | ns |
| 3 | $t_{d(EKO1H-BEIV)}$ | Delay time, AECLKOUTx high to $\overline{ABEx}$ invalid | 1.3 | | 1.3 | | ns |
| 4 | $t_{d(EKO1H-EAV)}$ | Delay time, AECLKOUTx high to AEAx valid | | 6.4 | | 4.9 | ns |
| 5 | $t_{d(EKO1H-EAIV)}$ | Delay time, AECLKOUTx high to AEAx invalid | 1.3 | | 1.3 | | ns |
| 8 | $t_{d(EKO1H-CASV)}$ | Delay time, AECLKOUTx high to $\overline{ASDCAS}$ valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |
| 9 | $t_{d(EKO1H-EDV)}$ | Delay time, AECLKOUTx high to AEDx valid | | 6.4 | | 4.9 | ns |
| 10 | $t_{d(EKO1H-EDIV)}$ | Delay time, AECLKOUTx high to AEDx invalid | 1.3 | | 1.3 | | ns |
| 11 | $t_{d(EKO1H-WEV)}$ | Delay time, AECLKOUTx high to $\overline{ASDWE}$ valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |
| 12 | $t_{d(EKO1H-RAS)}$ | Delay time, AECLKOUTx high to $\overline{ASDRAS}$ valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |
| 13 | $t_{d(EKO1H-ACKEV)}$ | Delay time, AECLKOUTx high to ASDCKE valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |
| 14 | $t_{d(EKO1H-PDTV)}$ | Delay time, AECLKOUTx high to $\overline{APDT}$ valid | 1.3 | 6.4 | 1.3 | 4.9 | ns |

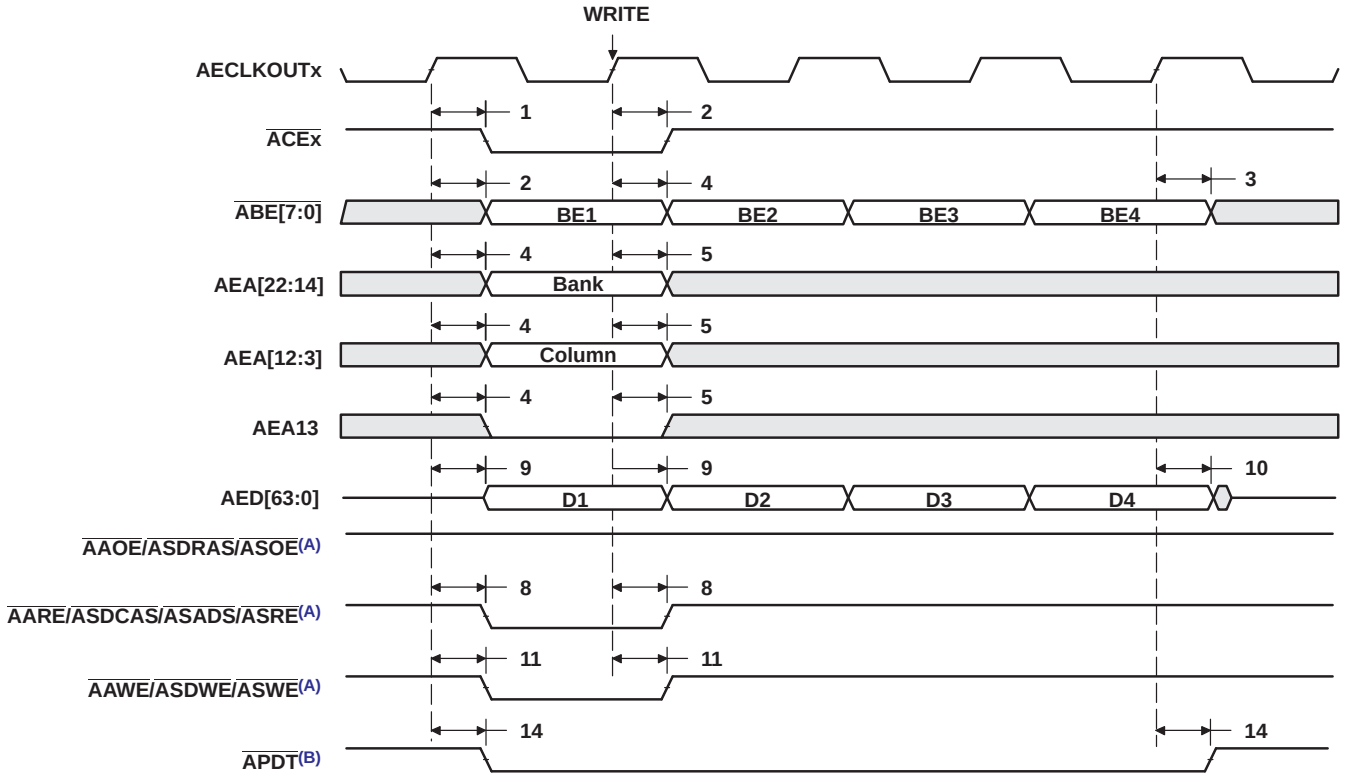

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A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

B. APDT signal is only asserted when the EDMA is in PDT mode (set the PDTS bit to 1 in the EDMA options parameter RAM). For APDT read, data is not latched into EMIF. The PDTRL field in the PDT control register (PDTCTL) configures the latency of the APDT signal with respect to the data phase of a read transaction. The latency of the APDT signal for a read can be programmed to 0, 1, 2, or 3 by setting PDTRL to 00, 01, 10, or 11, respectively. PDTRL equals 00 (zero latency) in this figure.

**Figure 5-24. SDRAM Read Command (CAS Latency 3) for EMIFA**

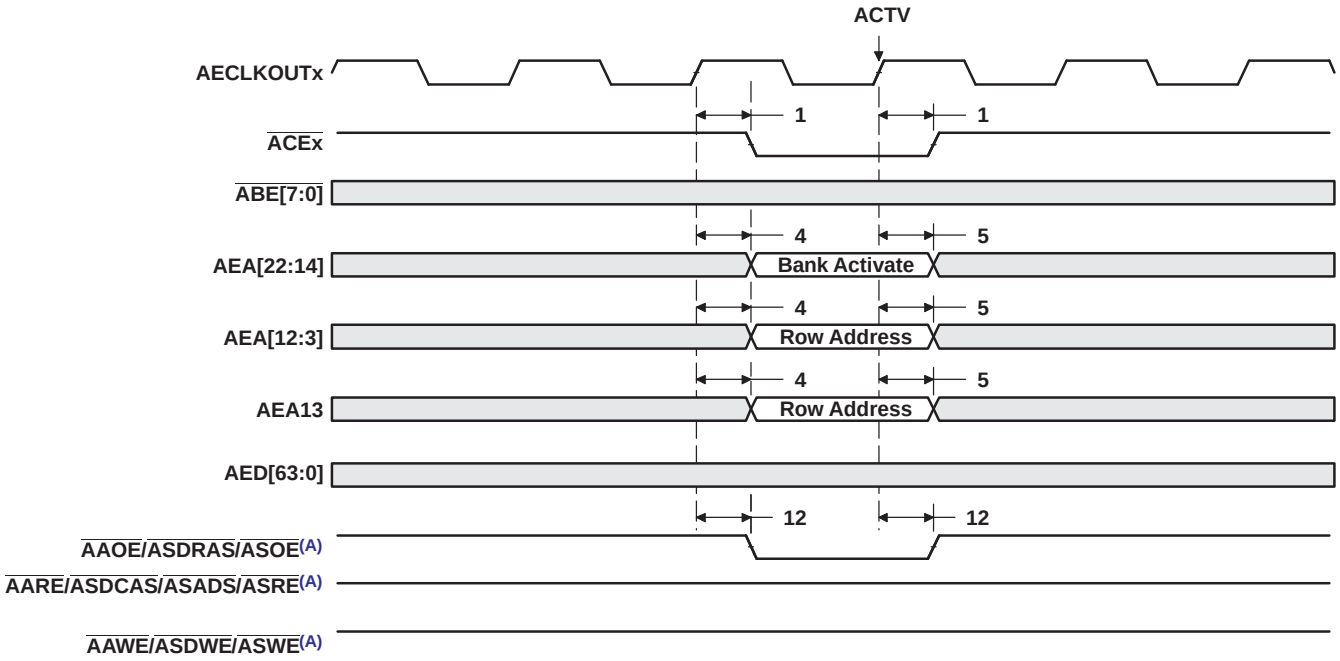



A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

B. APDT signal is only asserted when the EDMA is in PDT mode (set the PDTD bit to 1 in the EDMA options parameter RAM). For APDT write, data is not driven (in High-Z). The PDTWL field in the PDT control register (PDTCTL) configures the latency of the APDT signal with respect to the data phase of a write transaction. The latency of the APDT signal for a write transaction can be programmed to 0, 1, 2, or 3 by setting PDTWL to 00, 01, 10, or 11, respectively. PDTWL equals 00 (zero latency) in this figure.

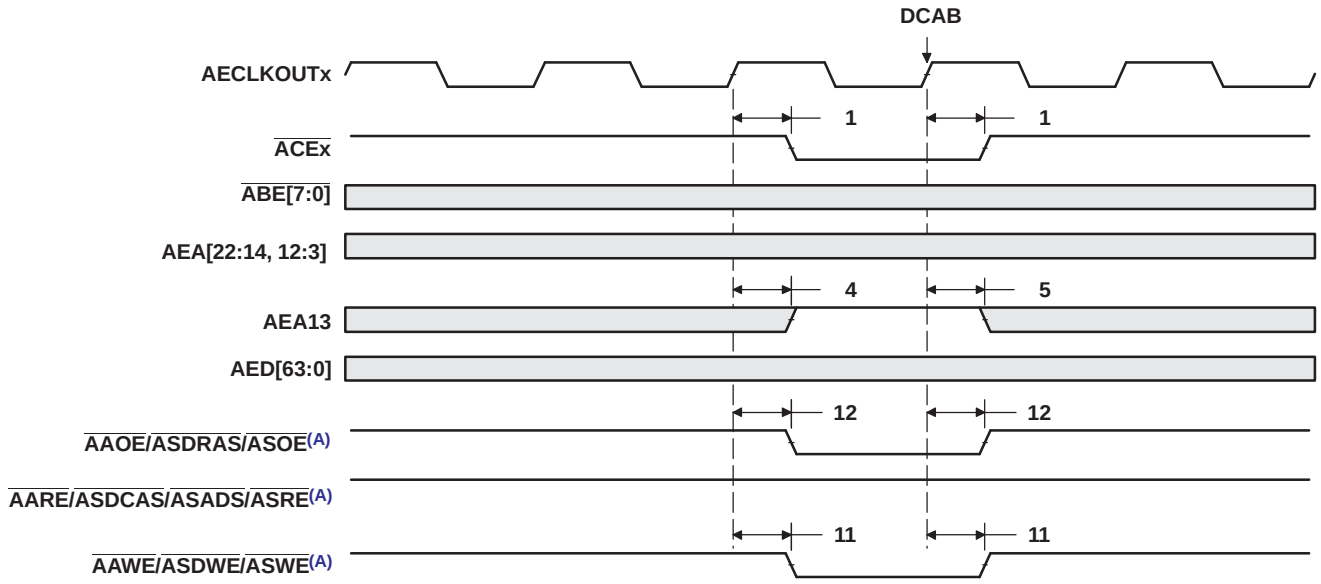
**Figure 5-25. SDRAM Write Command for EMIFA**


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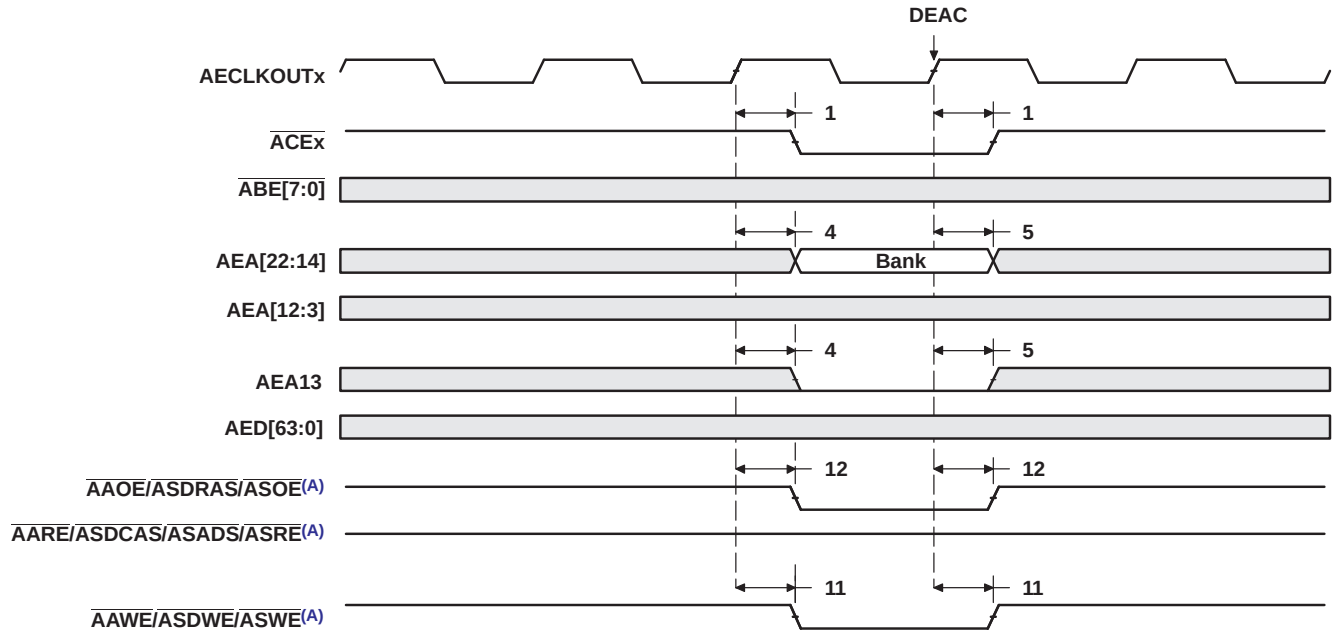

A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

**Figure 5-26. SDRAM ACTV Command for EMIFA**



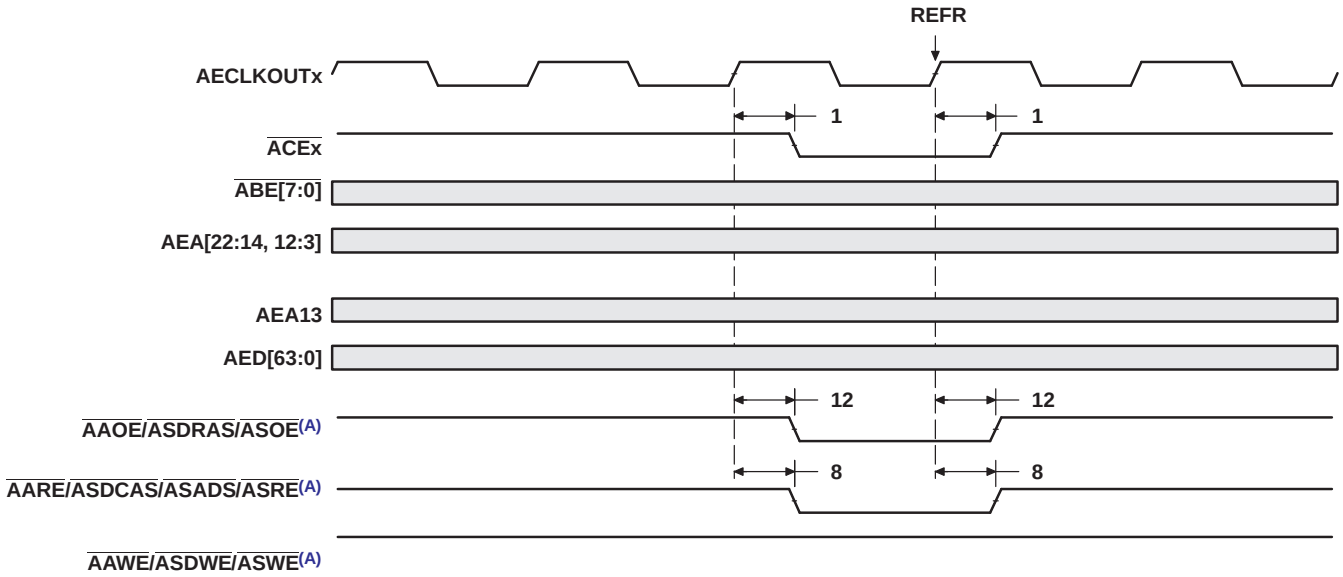

A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

**Figure 5-27. SDRAM DCAB Command for EMIFA**




A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

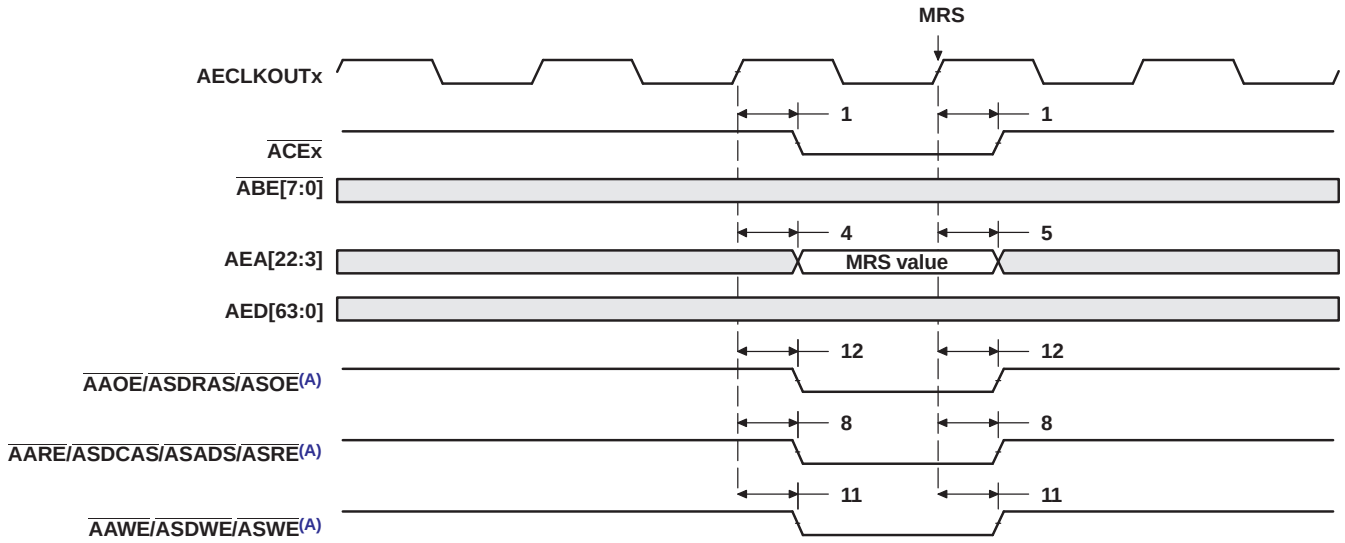
**Figure 5-28. SDRAM DEAC Command for EMIFA**




A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

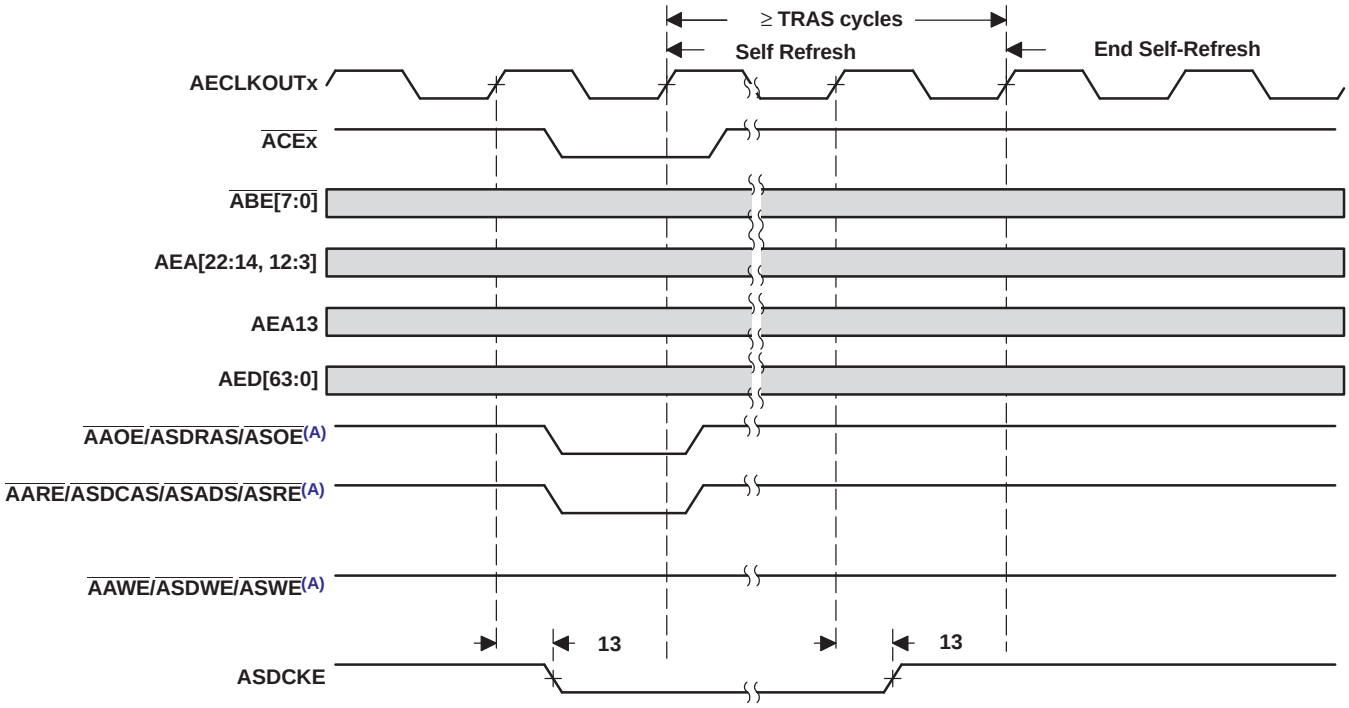
**Figure 5-29. SDRAM REFR Command for EMIFA**


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A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

**Figure 5-30. SDRAM MRS Command for EMIFA**




A. AARE/ASDCAS/ASADS/ASRE, AAWE/ASDWE/ASWE, and AAOE/ASDRAS/ASOE operate as ASDCAS, ASDWE, and ASDRAS, respectively, during SDRAM accesses.

**Figure 5-31. SDRAM Self-Refresh Timing for EMIFA**

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### 5.8.3.4 HOLD/HOLDA Timing

**Table 5-27. Timing Requirements for the HOLD/HOLDA Cycles for EMIFA Module(1) (see Figure 5-32)**

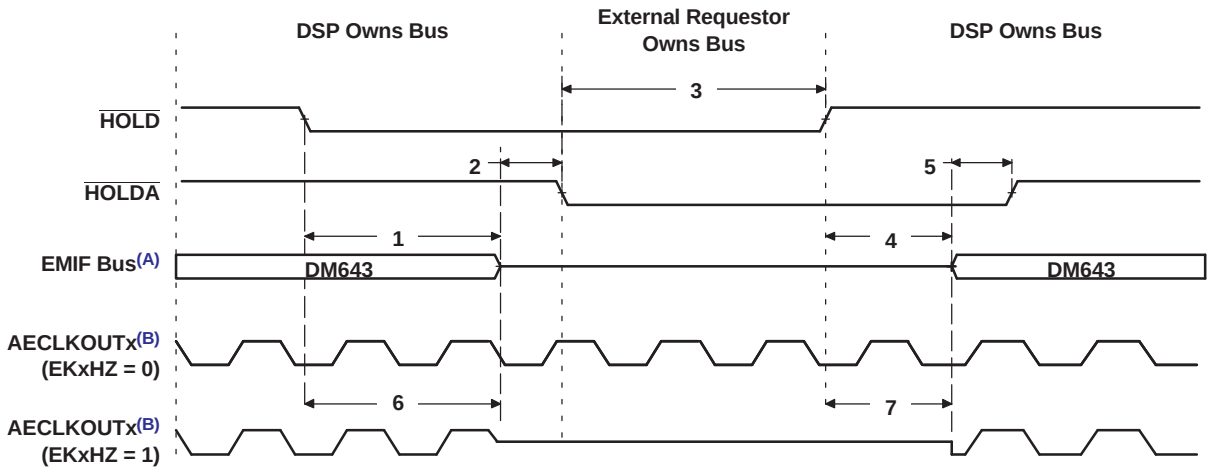
| NO. | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | |
| 3 | $t_{h(HOLDAL-HOLDL)}$ Hold time, HOLD low after HOLDA low | E | | E | | ns |

(1) E = the EMIF input clock (ECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA.

**Table 5-28. Switching Characteristics Over Recommended Operating Conditions for the HOLD/HOLDA Cycles for EMIFA Module(1) (2) (3) (see Figure 5-32)**

| NO. | PARAMETER | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{d(HOLDL-EMHZ)}$ | Delay time, HOLD low to EMIFA Bus high impedance | 2E | (4) | 2E | (4) | ns |
| 2 | $t_{d(EMHZ-HOLDAL)}$ | Delay time, EMIF Bus high impedance to HOLDA low | 0 | 2E | 0 | 2E | ns |
| 4 | $t_{d(HOLDH-EMLZ)}$ | Delay time, HOLD high to EMIF Bus low impedance | 2E | 7E | 2E | 7E | ns |
| 5 | $t_{d(EMLZ-HOLDAH)}$ | Delay time, EMIFA Bus low impedance to HOLDA high | 0 | 2E | 0 | 2E | ns |
| 6 | $t_{d(HOLDL-EKOHZ)}$ | Delay time, HOLD low to AECLKOUTx high impedance | 2E | (4) | 2E | (4) | ns |
| 7 | $t_{d(HOLDH-EKOLZ)}$ | Delay time, HOLD high to AECLKOUTx low impedance | 2E | 7E | 2E | 7E | ns |

(1) E = the EMIF input clock (ECLKIN, CPU/4 clock, or CPU/6 clock) period in ns for EMIFA.
(2) EMIFA Bus consists of: ACE[3:0], ABE[7:0], AED[63:0], AEA[22:3], AARE/ASDCAS/ASADS/ASRE, AAOE/ASDRAS/ASOE, and AAWE/ASDWE/ASWE , ASDCKE, ASOE3, and APDT.
(3) The EKxHZ bits in the EMIF Global Control register (GBLCTL) determine the state of the ECLKOUTx signals during HOLDA. If EKxHZ = 0, ECLKOUTx continues clocking during Hold mode. If EKxHZ = 1, ECLKOUTx goes to high impedance during Hold mode, as shown in Figure 5-32.
(4) All pending EMIF transactions are allowed to complete before HOLDA is asserted. If no bus transactions are occurring, then the minimum delay time can be achieved. Also, bus hold can be indefinitely delayed by setting NOHOLD = 1.




A. EMIFA Bus consists of: ACE[3:0], ABE[7:0], AED[63:0], AEA[22:3], AARE/ASDCAS/ASADS/ASRE, AAOE/ASDRAS/ASOE, and AAWE/ASDWE/ASWE, ASDCKE, ASOE3, and APDT.
B. The EKxHZ bits in the EMIF Global Control register (GBLCTL) determine the state of the ECLKOUTx signals during HOLDA. If EKxHZ = 0, ECLKOUTx continues clocking during Hold mode. If EKxHZ = 1, ECLKOUTx goes to high impedance during Hold mode, as shown in this figure.

**Figure 5-32. HOLD/HOLDA Timing for EMIFA**


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### 5.8.3.5 BUSREQ Timing

**Table 5-29. Switching Characteristics Over Recommended Operating Conditions for the BUSREQ Cycles for EMIFA Module (see Figure 5-33)**

| NO. | PARAMETER | | –500 | | –600 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{d(AEKO1H-ABUSRV)}$ | Delay time, AECLKOUTx high to ABUSREQ valid | 0.6 | 7.1 | 1 | 5.5 | ns |

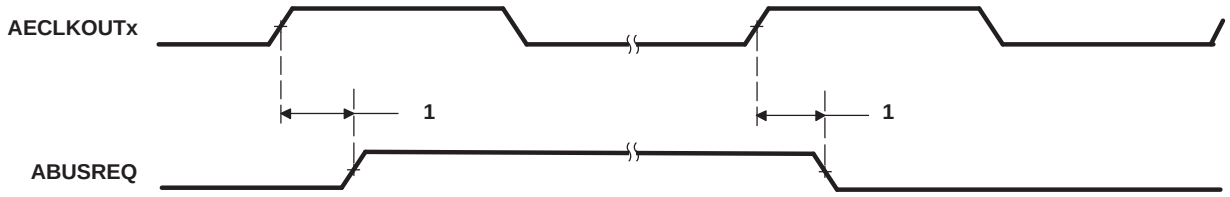



**Figure 5-33. BUSREQ Timing for EMIFA**

## 5.9 Multichannel Audio Serial Port (McASP0) Peripheral

The McASP functions as a general-purpose audio serial port optimized for the needs of multichannel audio applications. The McASP is useful for time-division multiplexed (TDM) stream, Inter-Integrated Sound (I2S) protocols, and intercomponent digital audio interface transmission (DIT).

### *5.9.1 McASP0 Device-Specific Information*

The TMS320DM643 device includes one multichannel audio serial port (McASP) interface peripheral (McASP0). The McASP is a serial port optimized for the needs of multichannel audio applications.

The McASP consists of a transmit and receive section. These sections can operate completely independently with different data formats, separate master clocks, bit clocks, and frame syncs or alternatively, the transmit and receive sections may be synchronized. The McASP module also includes a pool of 16 shift registers that may be configured to operate as either transmit data, receive data, or general-purpose I/O (GPIO).

The transmit section of the McASP can transmit data in either a time-division-multiplexed (TDM) synchronous serial format or in a digital audio interface (DIT) format where the bit stream is encoded for S/PDIF, AES-3, IEC-60958, CP-430 transmission. The receive section of the McASP supports the TDM synchronous serial format.

The McASP can support one transmit data format (either a TDM format or DIT format) and one receive format at a time. All transmit shift registers use the same format and all receive shift registers use the same format. However, the transmit and receive formats need not be the same.

Both the transmit and receive sections of the McASP also support burst mode which is useful for non-audio data (for example, passing control information between two DSPs).

The McASP peripheral has additional capability for flexible clock generation, and error detection/handling, as well as error management.

For more detailed information on and the functionality of the McASP peripheral, see the *TMS320C6000 DSP Multichannel Audio Serial Port (McASP) Reference Guide* (literature number SPRU041).

#### 5.9.1.1 McASP Block Diagram

Figure 5-34 illustrates the major blocks along with external signals of the TMS320DM643 McASP0 peripheral; and shows the 8 serial data [AXR] pins. The McASP also includes full general-purpose I/O (GPIO) control, so any pins not needed for serial transfers can be used for general-purpose I/O.


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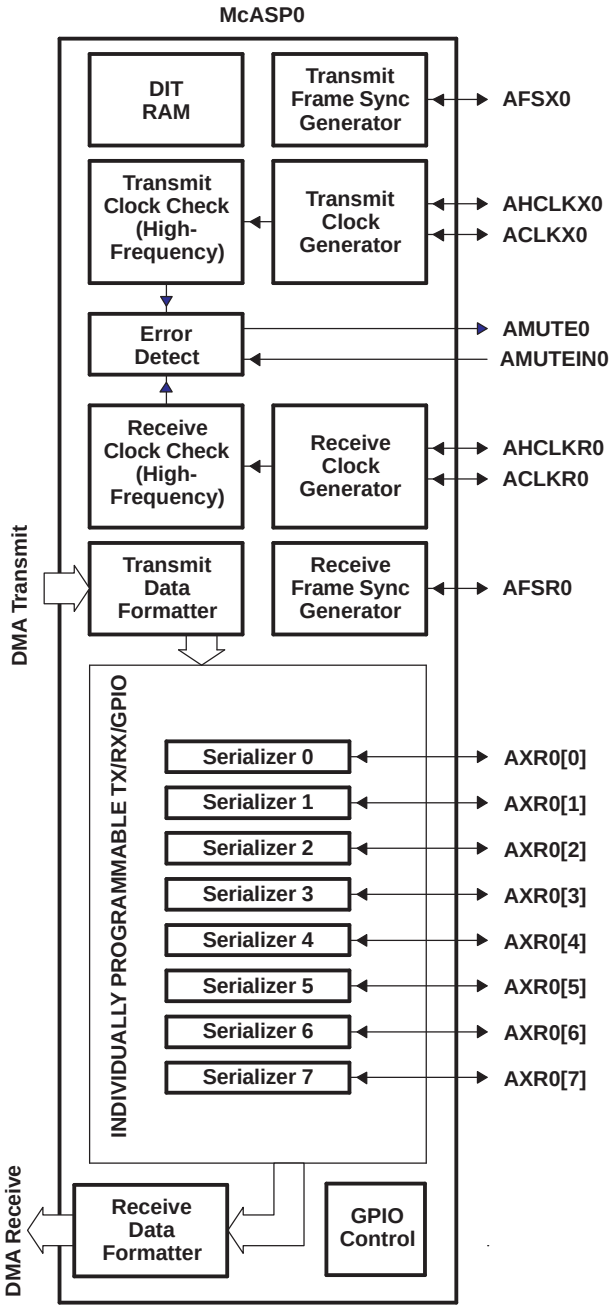



**Figure 5-34. McASP0 Configuration**

### 5.9.2 McASP0 Peripheral Register Description(s)

**Table 5-30. McASP0 Control Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01B4 C000 | PID | Peripheral Identification register [Register value: 0x0010 0101] |
| 01B4 C004 | PWRDEMU | Power down and emulation management register |
| 01B4 C008 | – | Reserved |
| 01B4 C00C | – | Reserved |
| 01B4 C010 | PFUNC | Pin function register |
| 01B4 C014 | PDIR | Pin direction register |
| 01B4 C018 | PDOUT | Pin data out register |
| 01B4 C01C | PDIN/PDSET | Pin data in / data set registerRead returns: PDINWrites affect: PDSET |
| 01B4 C020 | PDCLR | Pin data clear register |
| 01B4 C024 – 01B4 C040 | – | Reserved |
| 01B4 C044 | GBLCTL | Global control register |
| 01B4 C048 | AMUTE | Mute control register |
| 01B4 C04C | DLBCTL | Digital Loop-back control register |
| 01B4 C050 | DITCTL | DIT mode control register |
| 01B4 C054 – 01B4 C05C | – | Reserved |
| 01B4 C060 | RGBLCTL | Alias of GBLCTL containing only Receiver Reset bits, allows transmit to be reset independently from receive. |
| 01B4 C064 | RMASK | Receiver format UNIT bit mask register |
| 01B4 C068 | RFMT | Receive bit stream format register |
| 01B4 C06C | AFSRCTL | Receive frame sync control register |
| 01B4 C070 | ACLKRCTL | Receive clock control register |
| 01B4 C074 | AHCLKRCTL | High-frequency receive clock control register |
| 01B4 C078 | RTDM | Receive TDM slot 0–31 register |
| 01B4 C07C | RINTCTL | Receiver interrupt control register |
| 01B4 C080 | RSTAT | Status register – Receiver |
| 01B4 C084 | RSLOT | Current receive TDM slot register |
| 01B4 C088 | RCLKCHK | Receiver clock check control register |
| 01B4 C08C – 01B4 C09C | – | Reserved |
| 01B4 C0A0 | XGBLCTL | Alias of GBLCTL containing only Transmitter Reset bits, allows transmit to be reset independently from receive. |
| 01B4 C0A4 | XMASK | Transmit format UNIT bit mask register |
| 01B4 C0A8 | XFMT | Transmit bit stream format register |
| 01B4 C0AC | AFSXCTL | Transmit frame sync control register |
| 01B4 C0B0 | ACLKXCTL | Transmit clock control register |
| 01B4 C0B4 | AHCLKXCTL | High-frequency Transmit clock control register |
| 01B4 C0B8 | XTDM | Transmit TDM slot 0–31 register |
| 01B4 C0BC | XINTCTL | Transmit interrupt control register |
| 01B4 C0C0 | XSTAT | Status register – Transmitter |
| 01B4 C0C4 | XSLOT | Current transmit TDM slot |
| 01B4 C0C8 | XCLKCHK | Transmit clock check control register |


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**Table 5-30. McASP0 Control Registers (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01B4 C0CC – 01B4 C0FC | – | Reserved |
| 01B4 C100 | DITCSRA0 | Left (even TDM slot) channel status register file |
| 01B4 C104 | DITCSRA1 | Left (even TDM slot) channel status register file |
| 01B4 C108 | DITCSRA2 | Left (even TDM slot) channel status register file |
| 01B4 C10C | DITCSRA3 | Left (even TDM slot) channel status register file |
| 01B4 C110 | DITCSRA4 | Left (even TDM slot) channel status register file |
| 01B4 C114 | DITCSRA5 | Left (even TDM slot) channel status register file |
| 01B4 C118 | DITCSRB0 | Right (odd TDM slot) channel status register file |
| 01B4 C11C | DITCSRB1 | Right (odd TDM slot) channel status register file |
| 01B4 C120 | DITCSRB2 | Right (odd TDM slot) channel status register file |
| 01B4 C124 | DITCSRB3 | Right (odd TDM slot) channel status register file |
| 01B4 C128 | DITCSRB4 | Right (odd TDM slot) channel status register file |
| 01B4 C12C | DITCSRB5 | Right (odd TDM slot) channel status register file |
| 01B4 C130 | DITUDRA0 | Left (even TDM slot) user data register file |
| 01B4 C134 | DITUDRA1 | Left (even TDM slot) user data register file |
| 01B4 C138 | DITUDRA2 | Left (even TDM slot) user data register file |
| 01B4 C13C | DITUDRA3 | Left (even TDM slot) user data register file |
| 01B4 C140 | DITUDRA4 | Left (even TDM slot) user data register file |
| 01B4 C144 | DITUDRA5 | Left (even TDM slot) user data register file |
| 01B4 C148 | DITUDRB0 | Right (odd TDM slot) user data register file |
| 01B4 C14C | DITUDRB1 | Right (odd TDM slot) user data register file |
| 01B4 C150 | DITUDRB2 | Right (odd TDM slot) user data register file |
| 01B4 C154 | DITUDRB3 | Right (odd TDM slot) user data register file |
| 01B4 C158 | DITUDRB4 | Right (odd TDM slot) user data register file |
| 01B4 C15C | DITUDRB5 | Right (odd TDM slot) user data register file |
| 01B4 C160 – 01B4 C17C | – | Reserved |
| 01B4 C180 | SRCTL0 | Serializer 0 control register |
| 01B4 C184 | SRCTL1 | Serializer 1 control register |
| 01B4 C188 | SRCTL2 | Serializer 2 control register |
| 01B4 C18C | SRCTL3 | Serializer 3 control register |
| 01B4 C190 | SRCTL4 | Serializer 4 control register |
| 01B4 C194 | SRCTL5 | Serializer 5 control register |
| 01B4 C198 | SRCTL6 | Serializer 6 control register |
| 01B4 C19C | SRCTL7 | Serializer 7 control register |
| 01B4 C1A0 – 01B4 C1FC | – | Reserved |
| 01B4 C200 | XBUF0 | Transmit Buffer for Serializer 0 |
| 01B4 C204 | XBUF1 | Transmit Buffer for Serializer 1 |
| 01B4 C208 | XBUF2 | Transmit Buffer for Serializer 2 |
| 01B4 C20C | XBUF3 | Transmit Buffer for Serializer 3 |
| 01B4 C210 | XBUF4 | Transmit Buffer for Serializer 4 |
| 01B4 C214 | XBUF5 | Transmit Buffer for Serializer 5 |
| 01B4 C218 | XBUF6 | Transmit Buffer for Serializer 6 |
| 01B4 C21C | XBUF7 | Transmit Buffer for Serializer 7 |
| 01B4 C220 – 01B4 C27C | – | Reserved |
| 01B4 C280 | RBUF0 | Receive Buffer for Serializer 0 |
| 01B4 C284 | RBUF1 | Receive Buffer for Serializer 1 |
| 01B4 C288 | RBUF2 | Receive Buffer for Serializer 2 |

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**Table 5-30. McASP0 Control Registers (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01B4 C28C | RBUF3 | Receive Buffer for Serializer 3 |
| 01B4 C290 | RBUF4 | Receive Buffer for Serializer 4 |
| 01B4 C294 | RBUF5 | Receive Buffer for Serializer 5 |
| 01B4 C298 | RBUF6 | Receive Buffer for Serializer 6 |
| 01B4 C29C | RBUF7 | Receive Buffer for Serializer 7 |
| 01B4 C2A0 – 01B4 FFFF | – | Reserved |

**Table 5-31. McASP0 Data Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 3C00 0000 – 3C0F FFFF | RBUF/XBUFx | McASPx receive buffers or McASPx transmit buffers via the Peripheral Data Bus. | (Used when RSEL or XSEL bits = 0 [these bits are located in the RFMT or XFMT registers, respectively].) |

## *5.9.3 McASP0 Electrical Data/Timing*

### 5.9.3.1 Multichannel Audio Serial Port (McASP) Timing

**Table 5-32. Timing Requirements for McASP (see Figure 5-35 and Figure 5-36)**

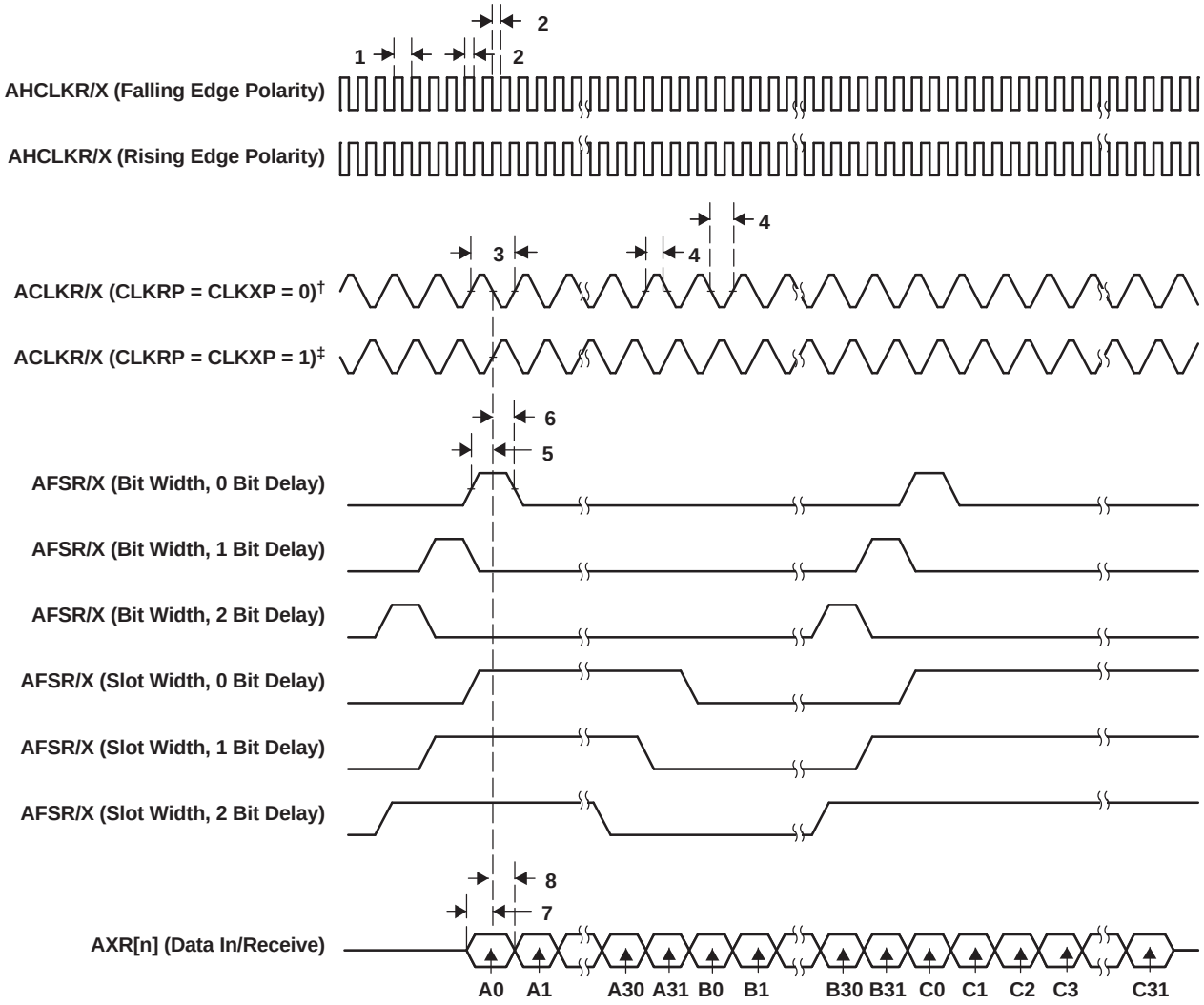
| NO. | | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|---|
| | | | | MIN | MAX | |
| 1 | $t_{c(AHCKRX)}$ | Cycle time, AHCLKR/X | | 20 | | ns |
| 2 | $t_{w(AHCKRX)}$ | Pulse duration, AHCLKR/X high or low | | 10 | | ns |
| 3 | $t_{c(CKRX)}$ | Cycle time, ACLKR/X | ACLKR/X ext | 33 | | ns |
| 4 | $t_{w(CKRX)}$ | Pulse duration, ACLKR/X high or low | ACLKR/X ext | 16.5 | | ns |
| 5 | $t_{su(FRX-CKRX)}$ | Setup time, AFSR/X input valid before ACLKR/X latches data | ACLKR/X int | 5 | | ns |
| | | | ACLKR/X ext | 5 | | ns |
| 6 | $t_{h(CKRX-FRX)}$ | Hold time, AFSR/X input valid after ACLKR/X latches data | ACLKR/X int | 5 | | ns |
| | | | ACLKR/X ext | 5 | | ns |
| 7 | $t_{su(AXR-CKRX)}$ | Setup time, AXR input valid before ACLKR/X latches data | ACLKR/X int | 5 | | ns |
| | | | ACLKR/X ext | 5 | | ns |
| 8 | $t_{h(CKRX-AXR)}$ | Hold time, AXR input valid after ACLKR/X latches data | ACLKR/X int | 5 | | ns |
| | | | ACLKR/X ext | 5 | | ns |


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**Table 5-33. Switching Characteristics Over Recommended Operating Conditions for McASP (see Figure 5-35 and Figure 5-36)**

| NO. | PARAMETER | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|---|
| | | | | MIN | MAX | |
| 9 | $t_{c(AHCKRX)}$ | Cycle time, AHCLKR/X | | 20 | | ns |
| 10 | $t_{w(AHCKRX)}$ | Pulse duration, AHCLKR/X high or low | | 10 | | ns |
| 11 | $t_{c(CKRX)}$ | Cycle time, ACLKR/X | ACLKR/X int | 33 | | ns |
| 12 | $t_{w(CKRX)}$ | Pulse duration, ACLKR/X high or low | ACLKR/X int | 16.5 | | ns |
| 13 | $t_{d(CKRX-FRX)}$ | Delay time, ACLKR/X transmit edge to AFSX/R output valid | ACLKR/X int | –1 | 5 | ns |
| | | | ACLKR/X ext | 0 | 10 | ns |
| 14 | $t_{d(CKX-AXRV)}$ | Delay time, ACLKX transmit edge to AXR output valid | ACLKX int | –1 | 5 | ns |
| | | | ACLKX ext | 0 | 10 | ns |
| 15 | $t_{dis(CKRX-AXRHZ)}$ | Disable time, AXR high impedance following last data bit from ACLKR/X transmit edge | ACLKR/X int | 0 | 10 | ns |
| | | | ACLKR/X ext | 0 | 10 | ns |

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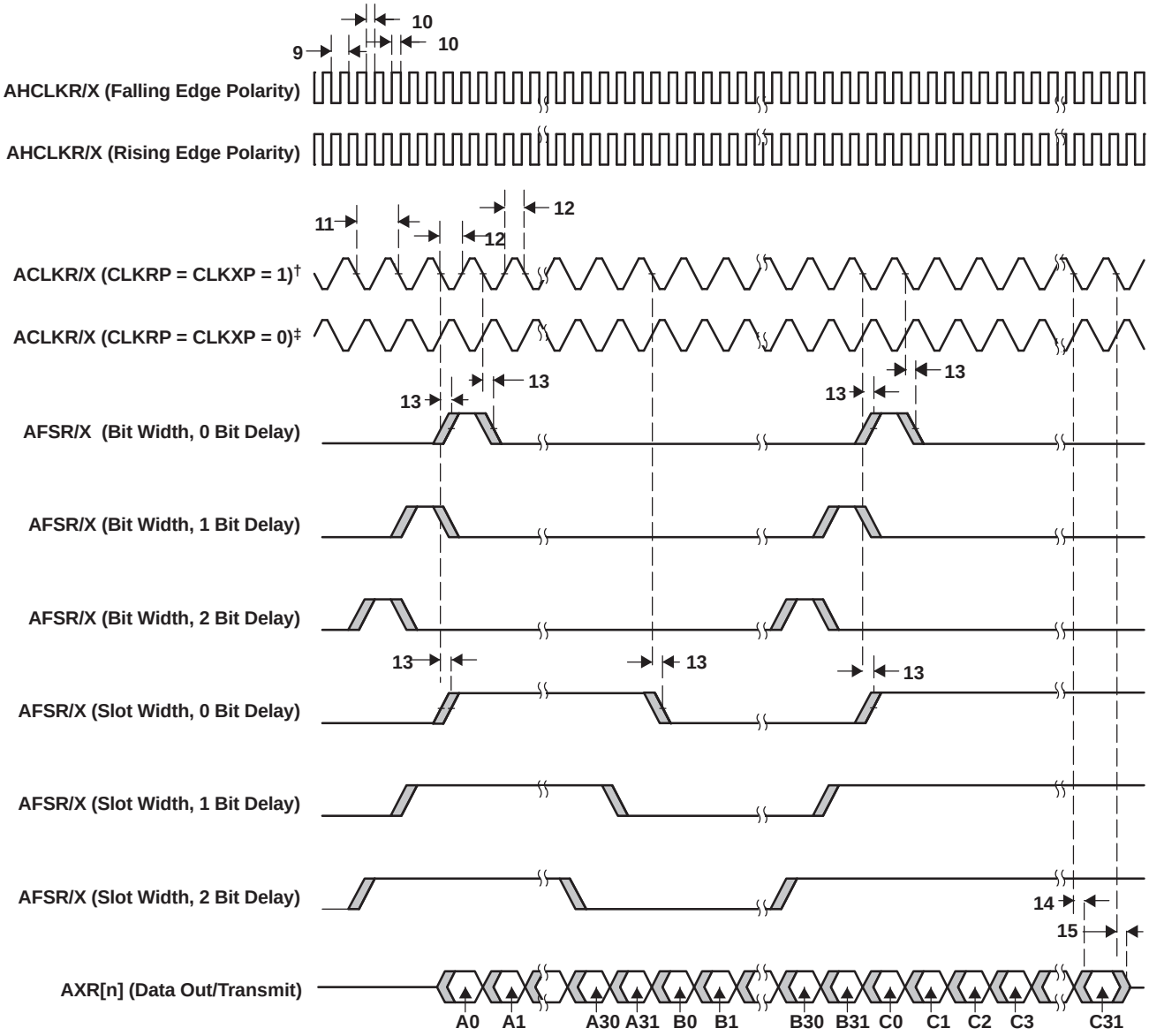



† For CLKRP = CLKXP = 0, the McASP transmitter is configured for rising edge (to shift data out) and the McASP receiver is configured for falling edge (to shift data in).

‡ For CLKRP = CLKXP = 1, the McASP transmitter is configured for falling edge (to shift data out) and the McASP receiver is configured for rising edge (to shift data in).

**Figure 5-35. McASP Input Timings**


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† For CLKRP = CLKXP = 1, the McASP transmitter is configured for falling edge (to shift data out) and the McASP receiver is configured for rising edge (to shift data in).
‡ For CLKRP = CLKXP = 0, the McASP transmitter is configured for rising edge (to shift data out) and the McASP receiver is configured for falling edge (to shift data in).

**Figure 5-36. McASP Output Timings**

## 5.10 Inter-Integrated Circuit (I2C)

The inter-integrated circuit (I2C) module provides an interface between a TMS320C6000™ DSP and other devices compliant with Philips Semiconductors Inter-IC bus ($I^2C$ bus) specification version 2.1 and connected by way of an $I^2C$-bus. External components attached to this 2-wire serial bus can transmit/receive up to 8-bit data to/from the DSP through the I2C module.

### *5.10.1 I2C Device-Specific Information*

The I2C module on the TMS320DM643 may be used by the DSP to control local peripherals ICs (DACs, ADCs, etc.) while the other may be used to communicate with other controllers in a system or to implement a user interface.

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

Figure 5-37 is a block diagram of the I2C0 module.


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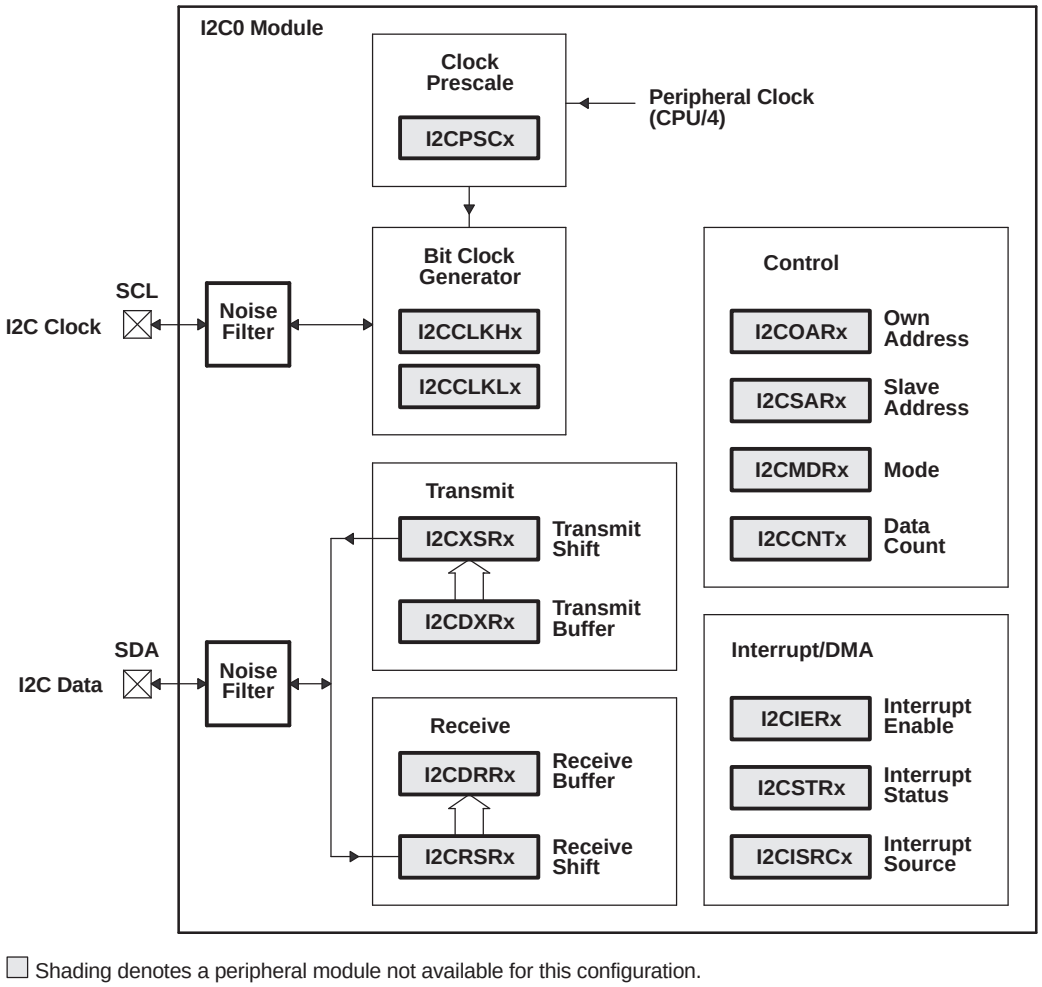



**Figure 5-37. I2C0 Module Block Diagram**

For more detailed information on the I2C peripheral, see the *TMS320C6000 DSP Inter-Integrated Circuit (I2C) Module Reference Guide* (literature number SPRU175).

### 5.10.2 I2C Peripheral Register Description(s)

**Table 5-34. I2C0 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01B4 0000 | I2COAR0 | I2C0 own address register |
| 01B4 0004 | I2CIER0 | I2C0 interrupt enable register |
| 01B4 0008 | I2CSTR0 | I2C0 interrupt status register |
| 01B4 000C | I2CCLKL0 | I2C0 clock low-time divider register |
| 01B4 0010 | I2CCLKH0 | I2C0 clock high-time divider register |
| 01B4 0014 | I2CCNT0 | I2C0 data count register |
| 01B4 0018 | I2CDRR0 | I2C0 data receive register |
| 01B4 001C | I2CSAR0 | I2C0 slave address register |
| 01B4 0020 | I2CDXR0 | I2C0 data transmit register |
| 01B4 0024 | I2CMDR0 | I2C0 mode register |
| 01B4 0028 | I2CISRC0 | I2C0 interrupt source register |
| 01B4 002C | – | Reserved |
| 01B4 0030 | I2CPSC0 | I2C0 prescaler register |
| 01B4 0034 | I2CPID10 | I2C0 Peripheral Identification register 1 [Value: 0x0000 0101] |
| 01B4 0038 | I2CPID20 | I2C0 Peripheral Identification register 2 [Value: 0x0000 0005] |
| 01B4 003C – 01B4 3FFF | – | Reserved |


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## 5.10.3 I2C Electrical Data/Timing

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

**Table 5-35. Timing Requirements for I2C Timings(1) (see Figure 5-38)**

| NO. | | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | STANDARD MODE | | FAST MODE | | |
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{c(SCL)}$ | Cycle time, SCL | 10 | | 2.5 | | µs |
| 2 | $t_{su(SCLH-SDAL)}$ | Setup time, SCL high before SDA low (for a repeated START condition) | 4.7 | | 0.6 | | µs |
| 3 | $t_{h(SCLL-SDAL)}$ | Hold time, SCL low after SDA low (for a START and a repeated START condition) | 4 | | 0.6 | | µs |
| 4 | $t_{w(SCLL)}$ | Pulse duration, SCL low | 4.7 | | 1.3 | | µs |
| 5 | $t_{w(SCLH)}$ | Pulse duration, SCL high | 4 | | 0.6 | | µs |
| 6 | $t_{su(SDAV-SDLH)}$ | Setup time, SDA valid before SCL high | 250 | | 100(2) | | ns |
| 7 | $t_{h(SDA-SDLL)}$ | Hold time, SDA valid after SCL low (For $I^2C$ bus™ devices) | 0(3) | | 0(3) | 0.9(4) | µs |
| 8 | $t_{w(SDAH)}$ | Pulse duration, SDA high between STOP and START conditions | 4.7 | | 1.3 | | µs |
| 9 | $t_{r(SDA)}$ | Rise time, SDA | | 1000 | $20 + 0.1C_b$(5) | 300 | ns |
| 10 | $t_{r(SCL)}$ | Rise time, SCL | | 1000 | $20 + 0.1C_b$(5) | 300 | ns |
| 11 | $t_{f(SDA)}$ | Fall time, SDA | | 300 | $20 + 0.1C_b$(5) | 300 | ns |
| 12 | $t_{f(SCL)}$ | Fall time, SCL | | 300 | $20 + 0.1C_b$(5) | 300 | ns |
| 13 | $t_{su(SCLH-SDAH)}$ | Setup time, SCL high before SDA high (for STOP condition) | 4 | | 0.6 | | µs |
| 14 | $t_{w(SP)}$ | 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 $I^2C$-bus™ device can be used in a Standard-mode $I^2C$-bus™ system, but the requirement $t_{su(SDA-SCLH)}$ ≥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 $I^2C$-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-mode devices, faster fall-times are allowed.

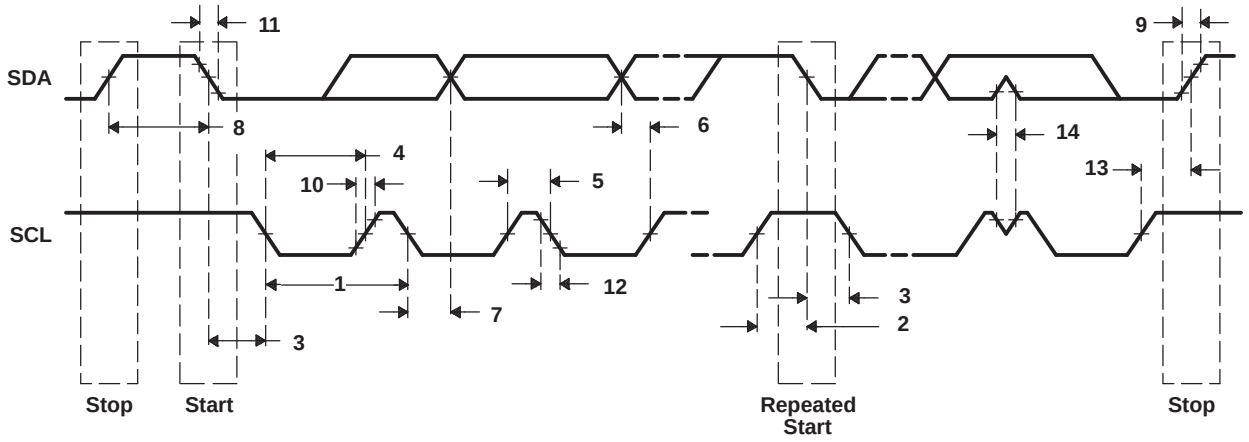



**Figure 5-38. I2C Receive Timings**

**Table 5-36. Switching Characteristics for I2C Timings(1) (see Figure 5-39)**

| NO. | PARAMETER | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | STANDARD MODE | | FAST MODE | | |
| | | | MIN | MAX | MIN | MAX | |
| 16 | $t_{c(SCL)}$ | Cycle time, SCL | 10 | | 2.5 | | µs |
| 17 | $t_{d(SCLH-SDAL)}$ | Delay time, SCL high to SDA low (for a repeated START condition) | 4.7 | | 0.6 | | µs |
| 18 | $t_{d(SDAL-SCLL)}$ | Delay time, SDA low to SCL low (for a START and a repeated START condition) | 4 | | 0.6 | | µs |
| 19 | $t_{w(SCLL)}$ | Pulse duration, SCL low | 4.7 | | 1.3 | | µs |
| 20 | $t_{w(SCLH)}$ | Pulse duration, SCL high | 4 | | 0.6 | | µs |
| 21 | $t_{d(SDAV-SDLH)}$ | Delay time, SDA valid to SCL high | 250 | | 100 | | ns |
| 22 | $t_{v(SDLL-SDAV)}$ | Valid time, SDA valid after SCL low (For $I^2C$ bus™ devices) | 0 | | 0 | 0.9 | µs |
| 23 | $t_{w(SDAH)}$ | Pulse duration, SDA high between STOP and START conditions | 4.7 | | 1.3 | | µs |
| 24 | $t_{r(SDA)}$ | Rise time, SDA | | 1000 | $20 + 0.1C_b$ (2) | 300 | ns |
| 25 | $t_{r(SCL)}$ | Rise time, SCL | | 1000 | $20 + 0.1C_b$ (2) | 300 | ns |
| 26 | $t_{f(SDA)}$ | Fall time, SDA | | 300 | $20 + 0.1C_b$ (2) | 300 | ns |
| 27 | $t_{f(SCL)}$ | Fall time, SCL | | 300 | $20 + 0.1C_b$ (2) | 300 | ns |
| 28 | $t_{d(SCLH-SDAH)}$ | Delay time, SCL high to SDA high (for STOP condition) | 4 | | 0.6 | | µs |
| 29 | $C_p$ | 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.
(2) $C_b$ = total capacitance of one bus line in pF. If mixed with HS-mode devices, faster fall-times are allowed.


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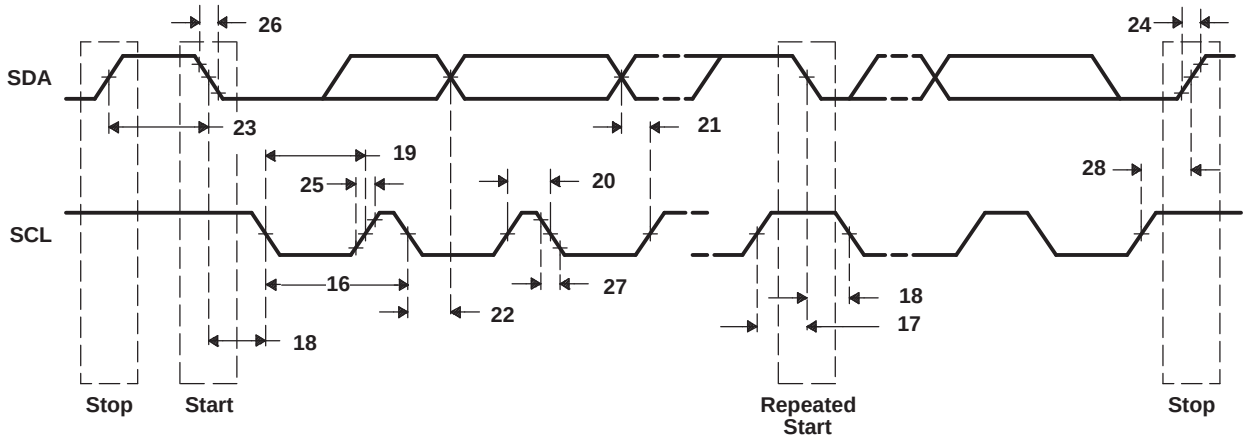



**Figure 5-39. I2C Transmit Timings**

## 5.11 Host-Port Interface (HPI)

The HPI is a parallel port through which a host processor can directly access the CPU memory space. The host device functions as a master to the interface, which increases ease of access. The host and CPU can exchange information via internal or external memory. The host also has direct access to memory-mapped peripherals. Connectivity to the CPU memory space is provided through the enhanced DMA (EDMA) controller. Both the host and the CPU can access the HPI control register (HPIC) and the HPI address register (HPIA). The host can access the HPI data register (HPID) and the HPIC by using the external data and interface control signals.

For more detailed information on the HPI peripheral, see the *TMS320C6000 DSP Host Port Interface (HPI) Reference Guide* (literature number SPRU578).

### *5.11.1 HPI Peripheral Register Description(s)*

**Table 5-37. HPI Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| – | HPID | HPI data register | Host read/write access only |
| 0188 0000 | HPIC | HPI control register | HPIC has both Host/CPU read/write access |
| 0188 0004 | HPIA (HPIAW)(1) | HPI address register (Write) | HPIA has both Host/CPU read/write access |
| 0188 0008 | HPIA (HPIAR)(1) | HPI address register (Read) | |
| 0188 000C – 0189 FFFF | – | Reserved | |
| 018A 0000 | HPI_TRCTL | HPI transfer request control register | |
| 018A 0004 – 018B FFFF | – | Reserved | |

(1) Host access to the HPIA register updates both the HPIAW and HPIAR registers. The CPU can access HPIAW and HPIAR independently.


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### 5.11.2 Host-Port Interface (HPI) Electrical Data/Timing

**Table 5-38. Timing Requirements for Host-Port Interface Cycles(1) (2) (see Figure 5-40 through Figure 5-47)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{su(SELV-HSTBL)}$ | Setup time, select signals(3) valid before $\overline{HSTROBE}$ low | 5 | | ns |
| 2 | $t_{h(HSTBL-SELV)}$ | Hold time, select signals(3) valid after $\overline{HSTROBE}$ low | 2.4 | | ns |
| 3 | $t_{w(HSTBL)}$ | Pulse duration, $\overline{HSTROBE}$ low | 4P(4) | | ns |
| 4 | $t_{w(HSTBH)}$ | Pulse duration, $\overline{HSTROBE}$ high between consecutive accesses | 4P | | ns |
| 10 | $t_{su(SELV-HASL)}$ | Setup time, select signals(3) valid before $\overline{HAS}$ low | 5 | | ns |
| 11 | $t_{h(HASL-SELV)}$ | Hold time, select signals(3) valid after $\overline{HAS}$ low | 2 | | ns |
| 12 | $t_{su(HDV-HSTBH)}$ | Setup time, host data valid before $\overline{HSTROBE}$ high | 5 | | ns |
| 13 | $t_{h(HSTBH-HDV)}$ | Hold time, host data valid after $\overline{HSTROBE}$ high | 2.8 | | ns |
| 14 | $t_{h(HRDYL-HSTBL)}$ | Hold time, $\overline{HSTROBE}$ low after $\overline{HRDY}$ low. $\overline{HSTROBE}$ should not be inactivated until $\overline{HRDY}$ is active (low); otherwise, HPI writes will not complete properly. | 2 | | ns |
| 18 | $t_{su(HASL-HSTBL)}$ | Setup time, $\overline{HAS}$ low before $\overline{HSTROBE}$ low | 2 | | ns |
| 19 | $t_{h(HSTBL-HASL)}$ | Hold time, $\overline{HAS}$ low after $\overline{HSTROBE}$ low | 2.1 | | ns |

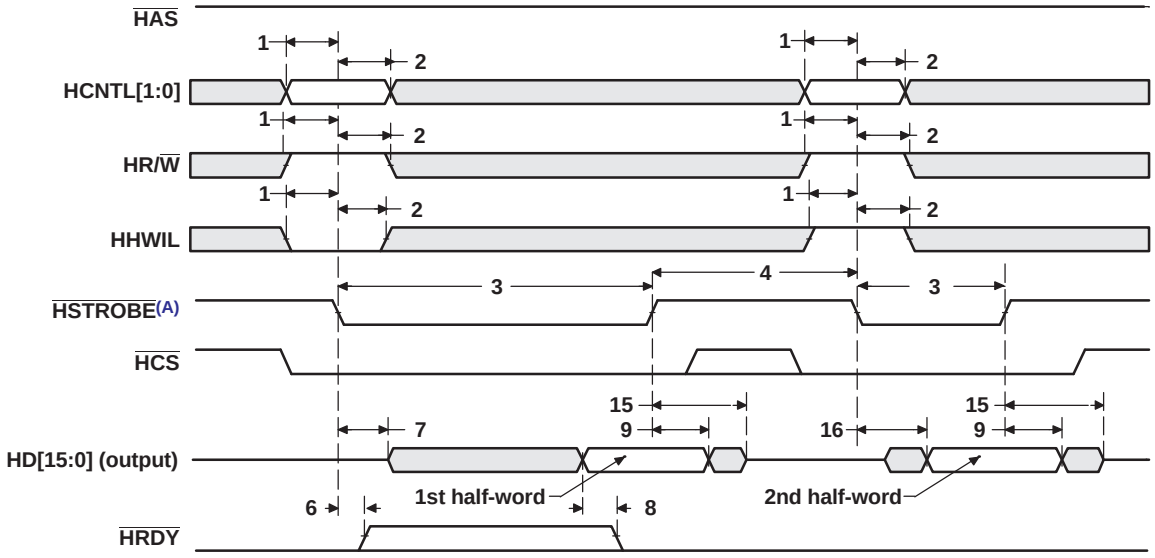
(1) $\overline{HSTROBE}$ refers to the following logical operation on $\overline{HCS}$, $\overline{HDS1}$, and $\overline{HDS2}$: [NOT($\overline{HDS1}$ XOR $\overline{HDS2}$)] OR $\overline{HCS}$.
(2) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(3) Select signals include: HCNTL[1:0] and HR/$\overline{W}$. For HPI16 mode only, select signals also include HHWIL.
(4) Select the parameter value of 4P or 12.5 ns, whichever is larger.

**Table 5-39. Switching Characteristics Over Recommended Operating Conditions During Host-Port Interface Cycles(1) (2) (see Figure 5-40 through Figure 5-47)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 6 | $t_{d(HSTBL-HRDYH)}$ | Delay time, $\overline{HSTROBE}$ low to $\overline{HRDY}$ high(3) | 1.3 | 4P + 8 | ns |
| 7 | $t_{d(HSTBL-HDLZ)}$ | Delay time, $\overline{HSTROBE}$ low to HD low impedance for an HPI read | 2 | | ns |
| 8 | $t_{d(HDV-HRDYL)}$ | Delay time, HD valid to $\overline{HRDY}$ low | –3 | | ns |
| 9 | $t_{oh(HSTBH-HDV)}$ | Output hold time, HD valid after $\overline{HSTROBE}$ high | 1.5 | | ns |
| 15 | $t_{d(HSTBH-HDHZ)}$ | Delay time, $\overline{HSTROBE}$ high to HD high impedance | | 12 | ns |
| 16 | $t_{d(HSTBL-HDV)}$ | Delay time, $\overline{HSTROBE}$ low to HD valid (HPI16 mode, 2nd half-word only) | | 4P + 8 | ns |

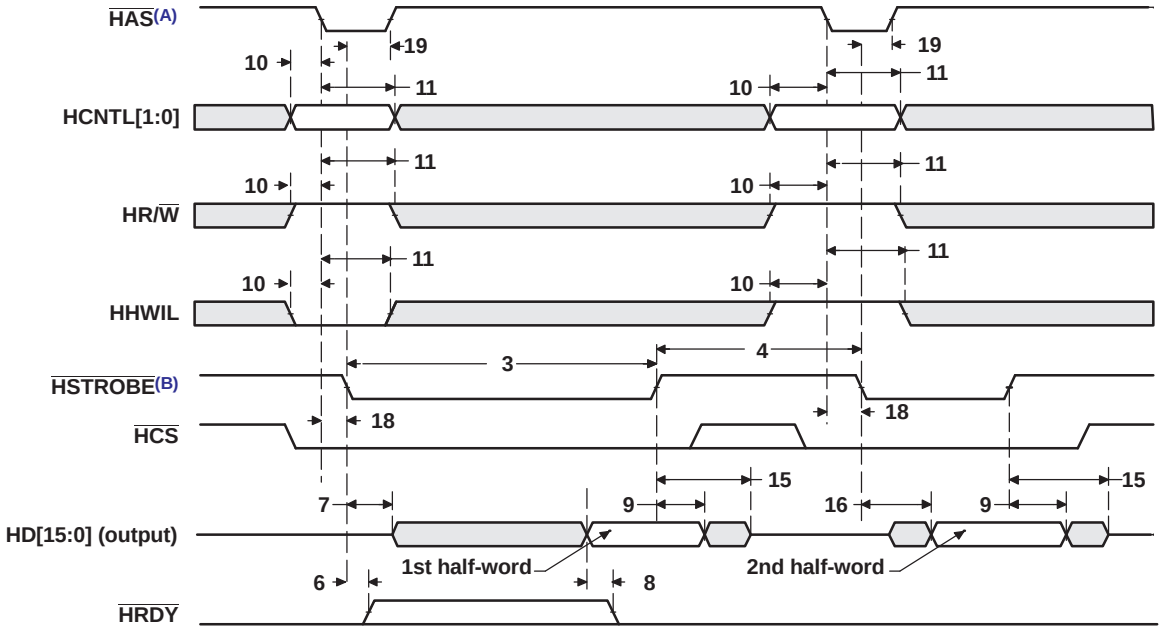
(1) $\overline{HSTROBE}$ refers to the following logical operation on $\overline{HCS}$, $\overline{HDS1}$, and $\overline{HDS2}$: [NOT($\overline{HDS1}$ XOR $\overline{HDS2}$)] OR $\overline{HCS}$.
(2) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(3) This parameter is used during HPID reads and writes. For reads, at the beginning of a word transfer (HPI32) or the first half-word transfer (HPI16) on the falling edge of $\overline{HSTROBE}$, the HPI sends the request to the EDMA internal address generation hardware, and $\overline{HRDY}$ remains high until the EDMA internal address generation hardware loads the requested data into HPID. For writes, $\overline{HRDY}$ goes high if the internal write buffer is full.

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A. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

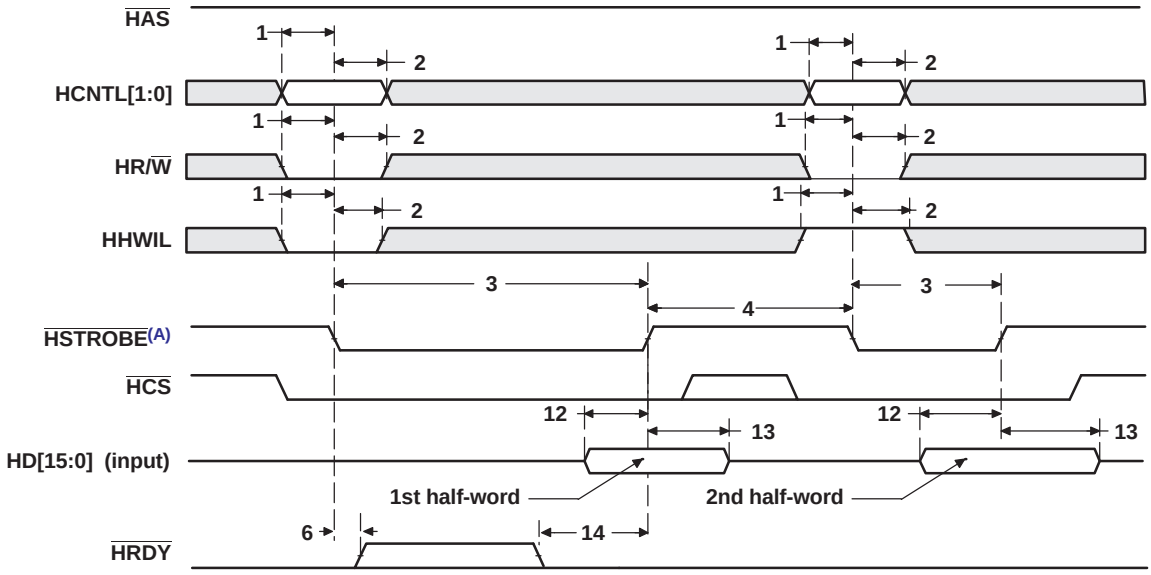
**Figure 5-40. HPI16 Read Timing (HAS Not Used, Tied High)**




A. For correct operation, strobe the HAS signal only once per HSTROBE active cycle.
B. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

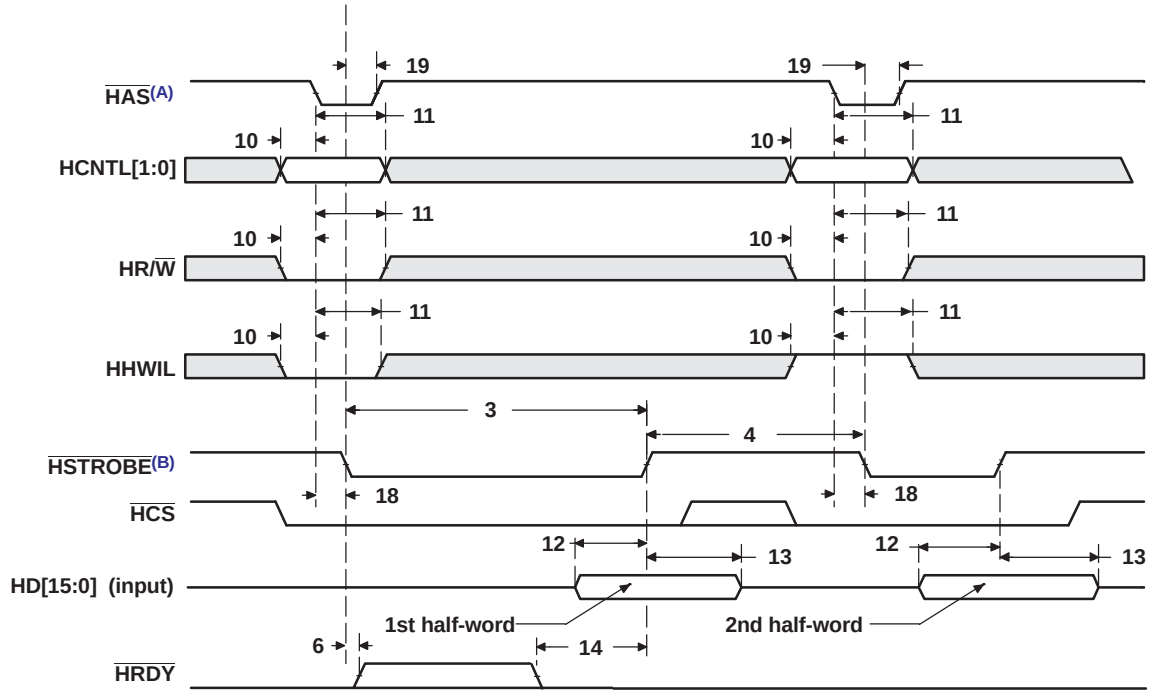
**Figure 5-41. HPI16 Read Timing (HAS Used)**


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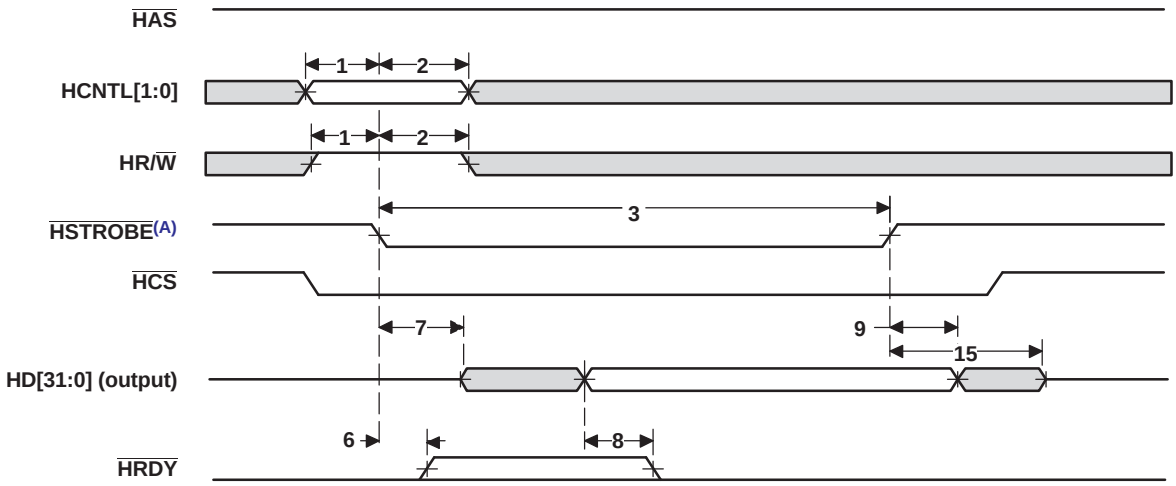

A. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

**Figure 5-42. HPI16 Write Timing (HAS Not Used, Tied High)**



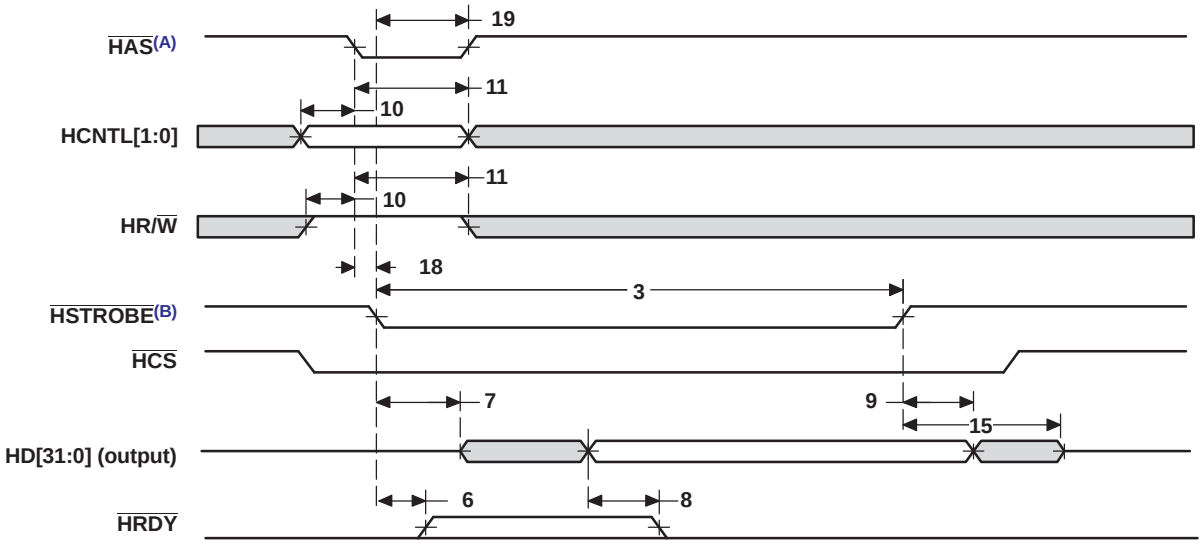

A. For correct operation, strobe the HAS signal only once per HSTROBE active cycle.
B. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

**Figure 5-43. HPI16 Write Timing (HAS Used)**




A. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

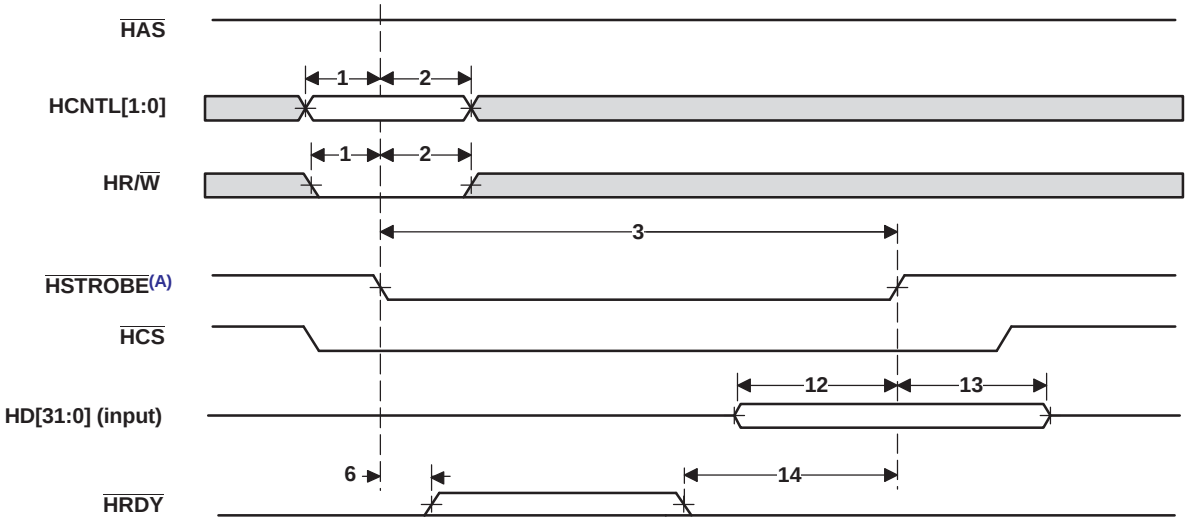
**Figure 5-44. HPI32 Read Timing (HAS Not Used, Tied High)**




A. For correct operation, strobe the HAS signal only once per HSTROBE active cycle.
B. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

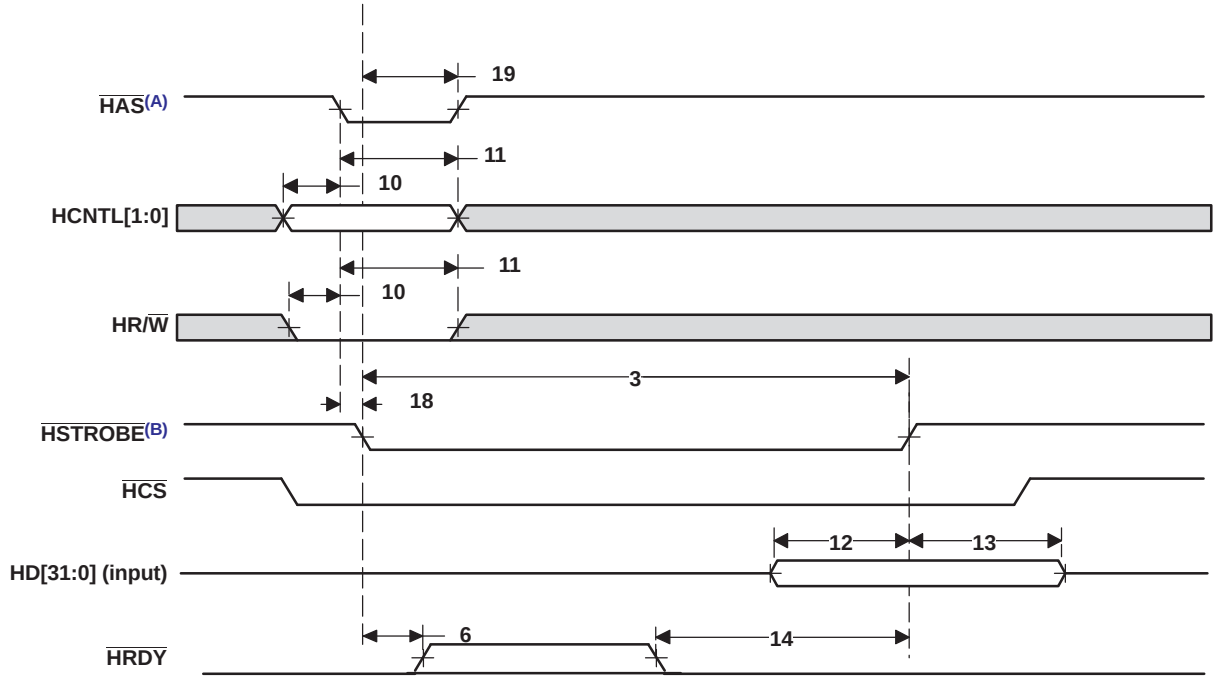
**Figure 5-45. HPI32 Read Timing (HAS Used)**


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A. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

**Figure 5-46. HPI32 Write Timing (HAS Not Used, Tied High)**




A. For correct operation, strobe the HAS signal only once per HSTROBE active cycle.
B. HSTROBE refers to the following logical operation on HCS, HDS1, and HDS2: [NOT(HDS1 XOR HDS2)] OR HCS.

**Figure 5-47. HPI32 Write Timing (HAS Used)**

## 5.12 Multichannel Buffered Serial Port (McBSP)

The McBSP provides these functions:

- Full-duplex communication
- 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

On the DM643 device, the McBSP peripheral does not support external clocking to the sample rate generator (no CLKS input).

For more detailed information on the McBSP peripheral, see the *TMS320C6000 DSP Multichannel Buffered Serial Port (McBSP) Reference Guide* (literature number SPRU580).

### *5.12.1 McBSP Peripheral Register Description(s)*

**Table 5-40. McBSP 0 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 018C 0000 | DRR0 | McBSP0 data receive register via Configuration Bus | The CPU and EDMA controller can only read this register; they cannot write to it. |
| 0x3000 0000 – 0x33FF FFFF | DRR0 | McBSP0 data receive register via Peripheral Bus | |
| 018C 0004 | DXR0 | McBSP0 data transmit register via Configuration Bus | |
| 0x3000 0000 – 0x33FF FFFF | DXR0 | McBSP0 data transmit register via Peripheral Bus | |
| 018C 0008 | SPCR0 | McBSP0 serial port control register | |
| 018C 000C | RCR0 | McBSP0 receive control register | |
| 018C 0010 | XCR0 | McBSP0 transmit control register | |
| 018C 0014 | SRGR0 | McBSP0 sample rate generator register | CLKSP (Bit 30) and CLKSM (Bit 29) are RSV on DM643 |
| 018C 0018 | MCR0 | McBSP0 multichannel control register | |
| 018C 001C | RCERE00 | McBSP0 enhanced receive channel enable register 0 | |
| 018C 0020 | XCERE00 | McBSP0 enhanced transmit channel enable register 0 | |
| 018C 0024 | PCR0 | McBSP0 pin control register | |
| 018C 0028 | RCERE10 | McBSP0 enhanced receive channel enable register 1 | |
| 018C 002C | XCERE10 | McBSP0 enhanced transmit channel enable register 1 | |
| 018C 0030 | RCERE20 | McBSP0 enhanced receive channel enable register 2 | |
| 018C 0034 | XCERE20 | McBSP0 enhanced transmit channel enable register 2 | |
| 018C 0038 | RCERE30 | McBSP0 enhanced receive channel enable register 3 | |
| 018C 003C | XCERE30 | McBSP0 enhanced transmit channel enable register 3 | |
| 018C 0040 – 018F FFFF | – | Reserved | |


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## 5.12.2 McBSP Electrical Data/Timing

### 5.12.2.1 Multichannel Buffered Serial Port (McBSP) Timing

**Table 5-41. Timing Requirements for McBSP(1) (see Figure 5-48)**

| NO. | | | | –500<br>–600 | | UNIT |
|---|---|---|---|---|---|---|
| | | | | MIN | MAX | |
| 2 | $t_{c(CKRX)}$ | Cycle time, CLKR/X | CLKR/X ext | 4P or 6.67(2) (3) | | ns |
| 3 | $t_{w(CKRX)}$ | Pulse duration, CLKR/X high or CLKR/X low | CLKR/X ext | $0.5t_{c(CKRX)}$ –1(4) | | ns |
| 5 | $t_{su(FRH-CKRL)}$ | Setup time, external FSR high before CLKR low | CLKR int | 9 | | ns |
| | | | CLKR ext | 1.3 | | |
| 6 | $t_{h(CKRL-FRH)}$ | Hold time, external FSR high after CLKR low | CLKR int | 6 | | ns |
| | | | CLKR ext | 3 | | |
| 7 | $t_{su(DRV-CKRL)}$ | Setup time, DR valid before CLKR low | CLKR int | 8 | | ns |
| | | | CLKR ext | 0.9 | | |
| 8 | $t_{h(CKRL-DRV)}$ | Hold time, DR valid after CLKR low | CLKR int | 3 | | ns |
| | | | CLKR ext | 3.1 | | |
| 10 | $t_{su(FXH-CKXL)}$ | Setup time, external FSX high before CLKX low | CLKX int | 9 | | ns |
| | | | CLKX ext | 1.3 | | |
| 11 | $t_{h(CKXL-FXH)}$ | Hold time, external FSX high after CLKX low | CLKX int | 6 | | ns |
| | | | CLKX ext | 3 | | |

(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/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(3) Use whichever value is greater. Minimum CLKR/X cycle times *must* be met, even when CLKR/X is generated by an internal clock source. The 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) This parameter applies to the maximum McBSP frequency. Operate serial clocks (CLKR/X) in the reasonable range of 40/60 duty cycle.

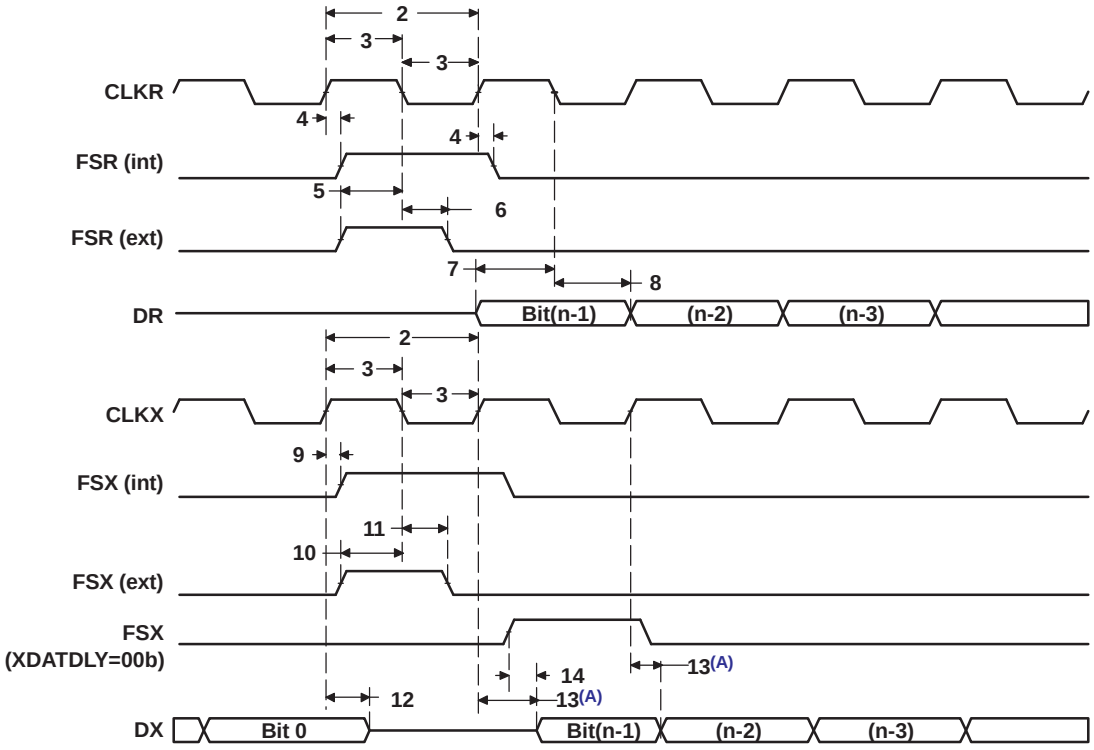
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**Table 5-42. Switching Characteristics Over Recommended Operating Conditions for McBSP[1] [2] (see Figure 5-48)**

| NO. | PARAMETER | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|---|
| | | | | MIN | MAX | |
| 2 | $t_{c(CKRX)}$ | Cycle time, CLKR/X | CLKR/X int | 4P or 6.67[3] [4] [5] | | ns |
| 3 | $t_{w(CKRX)}$ | Pulse duration, CLKR/X high or CLKR/X low | CLKR/X int | C – 1[6] | C + 1[6] | ns |
| 4 | $t_{d(CKRH-FRV)}$ | Delay time, CLKR high to internal FSR valid | CLKR int | –2.1 | 3 | ns |
| 9 | $t_{d(CKXH-FXV)}$ | Delay time, CLKX high to internal FSX valid | CLKX int | –1.7 | 3 | ns |
| | | | CLKX ext | 1.7 | 9 | |
| 12 | $t_{dis(CKXH-DXHZ)}$ | Disable time, DX high impedance following last data bit from CLKX high | CLKX int | –3.9 | 4 | ns |
| | | | CLKX ext | –2.1 | 9 | |
| 13 | $t_{d(CKXH-DXV)}$ | Delay time, CLKX high to DX valid | CLKX int | –3.9 + D1[7] | 4 + D2[7] | ns |
| | | | CLKX ext | –2.1 + D1[7] | 9 + D2[7] | |
| 14 | $t_{d(FXH-DXV)}$ | Delay time, FSX high to DX valid<br>ONLY applies when in data delay 0 (XDATDLY = 00b) mode | FSX int | –2.3 + D1[8] | 5.6 + D2[8] | ns |
| | | | FSX ext | 1.9 + D1[8] | 9 + D2[8] | |

(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/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(5) Use whichever value is greater.
(6) The CLKSM bit in the SRGR0 register ***must*** remain a 1, the DM643 device ***does not*** support a CLKS input.
C = H or L
H = CLKX high pulse width = (CLKGDV/2 + 1) * 4P if CLKGDV is even
H = CLKX high pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
L = CLKX low pulse width = (CLKGDV/2) * 4P if CLKGDV is even
L = CLKX low pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
CLKGDV should be set appropriately to ensure the McBSP bit rate does not exceed the maximum limit (see footnote (4) above).
(7) Extra delay from CLKX high to DX valid **applies *only* to the first data bit of a device**, if and only if DXENA = 1 in SPCR.
if DXENA = 0, then D1 = D2 = 0
if DXENA = 1, then D1 = 4P, D2 = 8P
(8) Extra delay from FSX high to DX valid **applies *only* to the first data bit of a device**, if and only if DXENA = 1 in SPCR.
if DXENA = 0, then D1 = D2 = 0
if DXENA = 1, then D1 = 4P, D2 = 8P


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A. Parameter No. 13 applies to the first data bit *only* when XDATDLY ≠ 0.

**Figure 5-48. McBSP Timing**

**Table 5-43. Timing Requirements for McBSP as SPI Master or Slave: CLKSTP = 10b, CLKXP = 0[1] [2] (see Figure 5-49)**

| NO. | | | –500<br>–600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 4 | $t_{su(DRV-CKXL)}$ | Setup time, DR valid before CLKX low | 12 | | 2 – 12P | | ns |
| 5 | $t_{h(CKXL-DRV)}$ | Hold time, DR valid after CLKX low | 4 | | 5 + 24P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.

**Table 5-44. Switching Characteristics Over Recommended Operating Conditions for McBSP as SPI Master or Slave: CLKSTP = 10b, CLKXP = 0[1] [2] (see Figure 5-49)**

| NO. | PARAMETER | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER[3] | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{h(CKXL-FXL)}$ | Hold time, FSX low after CLKX low[4] | T – 2 | T + 3 | | | ns |
| 2 | $t_{d(FXL-CKXH)}$ | Delay time, FSX low to CLKX high[5] | L – 2.5 | L + 3 | | | ns |
| 3 | $t_{d(CKXH-DXV)}$ | Delay time, CLKX high to DX valid | –2 | 4 | 12P + 2.8 | 20P + 17 | ns |
| 6 | $t_{dis(CKXL-DXHZ)}$ | Disable time, DX high impedance following last data bit from CLKX low | L – 2 | L + 3 | | | ns |
| 7 | $t_{dis(FXH-DXHZ)}$ | Disable time, DX high impedance following last data bit from FSX high | | | 4P + 3 | 12P + 17 | ns |
| 8 | $t_{d(FXL-DXV)}$ | Delay time, FSX low to DX valid | | | 8P + 1.8 | 16P + 17 | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.
(3) The CLKSM bit in the SRGR0 register ***must*** remain a 1, the DM643 device ***does not*** support a CLKS input.
T = CLKX period = (1 + CLKGDV) * 4P
H = CLKX high pulse width = (CLKGDV/2 + 1) * 4P if CLKGDV is even
H = CLKX high pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
L = CLKX low pulse width = (CLKGDV/2) * 4P if CLKGDV is even
L = CLKX low pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
(4) FSRP = FSXP = 1. As a SPI Master, FSX is inverted to provide active-low slave-enable output. As a Slave, the active-low signal input on FSX and FSR is inverted before being used internally.
CLKXM = FSXM = 1, CLKRM = FSRM = 0 for Master McBSP
CLKXM = CLKRM = FSXM = FSRM = 0 for Slave McBSP
(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).

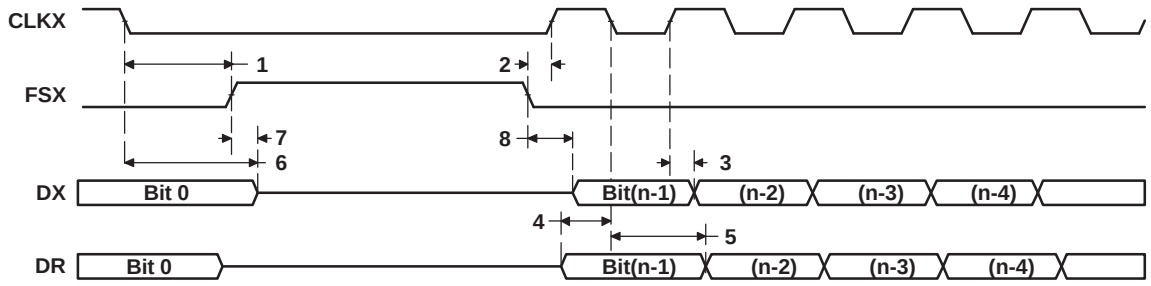



**Figure 5-49. McBSP Timing as SPI Master or Slave: CLKSTP = 10b, CLKXP = 0**

**Table 5-45. Timing Requirements for McBSP as SPI Master or Slave: CLKSTP = 11b, CLKXP = 0[1] [2] (see Figure 5-50)**

| NO. | | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 4 | $t_{su(DRV-CKXH)}$ | Setup time, DR valid before CLKX high | 12 | | 2 – 12P | | ns |
| 5 | $t_{h(CKXH-DRV)}$ | Hold time, DR valid after CLKX high | 4 | | 5 + 24P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.


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**Table 5-46. Switching Characteristics Over Recommended Operating Conditions for McBSP as SPI Master or Slave: CLKSTP = 11b, CLKXP = 0[1] [2] (see Figure 5-50)**

| NO. | PARAMETER | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER[3] | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{h(CKXL-FXL)}$ | Hold time, FSX low after CLKX low[4] | L – 2 | L + 3 | | | ns |
| 2 | $t_{d(FXL-CKXH)}$ | Delay time, FSX low to CLKX high[5] | T – 2.5 | T + 3 | | | ns |
| 3 | $t_{d(CKXL-DXV)}$ | Delay time, CLKX low to DX valid | –2 | 4 | 12P + 3 | 20P + 17 | ns |
| 6 | $t_{dis(CKXL-DXHZ)}$ | Disable time, DX high impedance following last data bit from CLKX low | –2 | 4 | 12P + 3 | 20P + 17 | ns |
| 7 | $t_{d(FXL-DXV)}$ | Delay time, FSX low to DX valid | H – 2 | H + 4 | 8P + 2 | 16P + 17 | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.
(3) The CLKSM bit in the SRGR0 register ***must*** remain a 1, the DM643 device ***does not*** support a CLKS input.
T = CLKX period = (1 + CLKGDV) * 4P
H = CLKX high pulse width = (CLKGDV/2 + 1) * 4P if CLKGDV is even
H = CLKX high pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
L = CLKX low pulse width = (CLKGDV/2) * 4P if CLKGDV is even
L = CLKX low pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
(4) FSRP = FSXP = 1. As a SPI Master, FSX is inverted to provide active-low slave-enable output. As a Slave, the active-low signal input on FSX and FSR is inverted before being used internally.
CLKXM = FSXM = 1, CLKRM = FSRM = 0 for Master McBSP
CLKXM = CLKRM = FSXM = FSRM = 0 for Slave McBSP
(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).

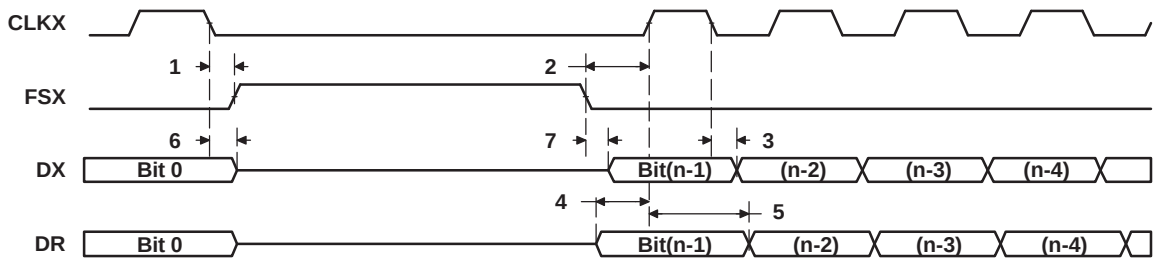



**Figure 5-50. McBSP Timing as SPI Master or Slave: CLKSTP = 11b, CLKXP = 0**

**Table 5-47. Timing Requirements for McBSP as SPI Master or Slave: CLKSTP = 10b, CLKXP = 1[1] [2] (see Figure 5-51)**

| NO. | | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 4 | $t_{su(DRV-CKXH)}$ | Setup time, DR valid before CLKX high | 12 | | 2 – 12P | | ns |
| 5 | $t_{h(CKXH-DRV)}$ | Hold time, DR valid after CLKX high | 4 | | 5 + 24P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.

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**Table 5-48. Switching Characteristics Over Recommended Operating Conditions for McBSP as SPI Master or Slave: CLKSTP = 10b, CLKXP = 1[1] [2] (see Figure 5-51)**

| NO. | PARAMETER | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER[3] | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{h(CKXH-FXL)}$ | Hold time, FSX low after CLKX high[4] | T – 2 | T + 3 | | | ns |
| 2 | $t_{d(FXL-CKXL)}$ | Delay time, FSX low to CLKX low[5] | H – 2.5 | H + 3 | | | ns |
| 3 | $t_{d(CKXL-DXV)}$ | Delay time, CLKX low to DX valid | –2 | 4 | 12P + 3 | 20P + 17 | ns |
| 6 | $t_{dis(CKXH-DXHZ)}$ | Disable time, DX high impedance following last data bit from CLKX high | H – 2 | H + 3 | | | ns |
| 7 | $t_{dis(FXH-DXHZ)}$ | Disable time, DX high impedance following last data bit from FSX high | | | 4P + 3 | 12P + 17 | ns |
| 8 | $t_{d(FXL-DXV)}$ | Delay time, FSX low to DX valid | | | 8P + 2 | 16P + 17 | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.
(3) The CLKSM bit in the SRGR0 register ***must*** remain a 1, the DM643 device ***does not*** support a CLKS input.
T = CLKX period = (1 + CLKGDV) * 4P
H = CLKX high pulse width = (CLKGDV/2 + 1) * 4P if CLKGDV is even
H = CLKX high pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
L = CLKX low pulse width = (CLKGDV/2) * 4P if CLKGDV is even
L = CLKX low pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
(4) FSRP = FSXP = 1. As a SPI Master, FSX is inverted to provide active-low slave-enable output. As a Slave, the active-low signal input on FSX and FSR is inverted before being used internally.
CLKXM = FSXM = 1, CLKRM = FSRM = 0 for Master McBSP
CLKXM = CLKRM = FSXM = FSRM = 0 for Slave McBSP
(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).

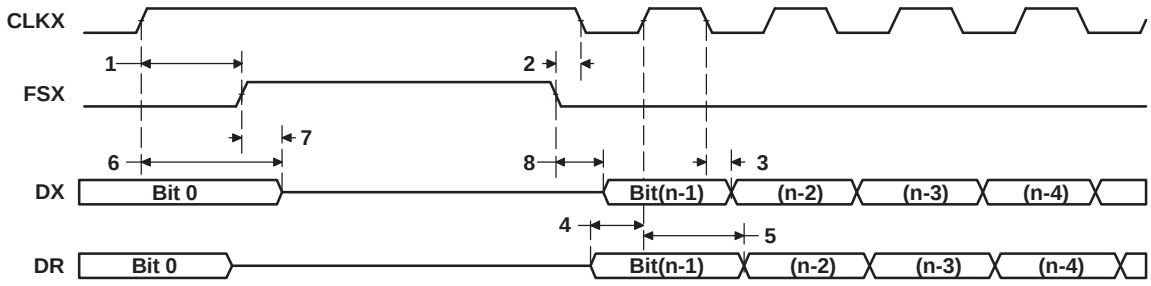



**Figure 5-51. McBSP Timing as SPI Master or Slave: CLKSTP = 10b, CLKXP = 1**

**Table 5-49. Timing Requirements for McBSP as SPI Master or Slave: CLKSTP = 11b, CLKXP = 1[1] [2] (see Figure 5-52)**

| NO. | | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 4 | $t_{su(DRV-CKXH)}$ | Setup time, DR valid before CLKX high | 12 | | 2 – 12P | | ns |
| 5 | $t_{h(CKXH-DRV)}$ | Hold time, DR valid after CLKX high | 4 | | 5 + 24P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.


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**Table 5-50. Switching Characteristics Over Recommended Operating Conditions for McBSP as SPI Master or Slave: CLKSTP = 11b, CLKXP = 1[1] [2] (see Figure 5-52)**

| NO. | PARAMETER | | –500 –600 | | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MASTER[3] | | SLAVE | | |
| | | | MIN | MAX | MIN | MAX | |
| 1 | $t_{h(CKXH-FXL)}$ | Hold time, FSX low after CLKX high[4] | H – 2 | H + 3 | | | ns |
| 2 | $t_{d(FXL-CKXL)}$ | Delay time, FSX low to CLKX low[5] | T – 2.5 | T + 1.5 | | | ns |
| 3 | $t_{d(CKXH-DXV)}$ | Delay time, CLKX high to DX valid | –2 | 4 | 12P + 3 | 20P + 17 | ns |
| 6 | $t_{dis(CKXH-DXHZ)}$ | Disable time, DX high impedance following last data bit from CLKX high | –2 | 4 | 12P + 3 | 20P + 17 | ns |
| 7 | $t_{d(FXL-DXV)}$ | Delay time, FSX low to DX valid | L – 2 | L + 4 | 8P + 2 | 16P + 17 | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) For all SPI Slave modes, CLKG is programmed as 1/4 of the CPU clock by setting CLKSM = CLKGDV = 1.
(3) The CLKSM bit in the SRGR0 register ***must*** remain a 1, the DM643 device ***does not*** support a CLKS input.
T = CLKX period = (1 + CLKGDV) * 4P
H = CLKX high pulse width = (CLKGDV/2 + 1) * 4P if CLKGDV is even
H = CLKX high pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
L = CLKX low pulse width = (CLKGDV/2) * 4P if CLKGDV is even
L = CLKX low pulse width = (CLKGDV + 1)/2 * 4P if CLKGDV is odd or zero
(4) FSRP = FSXP = 1. As a SPI Master, FSX is inverted to provide active-low slave-enable output. As a Slave, the active-low signal input on FSX and FSR is inverted before being used internally.
CLKXM = FSXM = 1, CLKRM = FSRM = 0 for Master McBSP
CLKXM = CLKRM = FSXM = FSRM = 0 for Slave McBSP
(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).

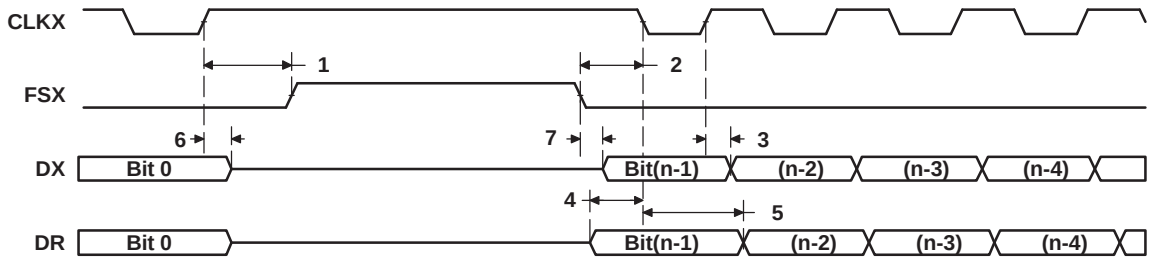



**Figure 5-52. McBSP Timing as SPI Master or Slave: CLKSTP = 11b, CLKXP = 1**

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## 5.13 Video Port

Each Video Port is capable of sending and receiving digital video data. The Video Ports are also capable of capturing/displaying RAW data. The Video Port peripherals follow video standards such as BT.656 and SMPTE296.

### *5.13.1 Video Port Device-Specific Information*

The TMS320DM643 device has two video port peripherals.

The video port peripheral can operate as a video capture port, video display port, or as a transport stream interface (TSI) capture port.

The port consists of two channels: A and B. A 5120-byte capture/display buffer is splittable between the two channels. The entire port (both channels) is always configured for either video capture or display only. Separate data pipelines control the parsing and formatting of video capture or display data for each of the BT.656, Y/C, raw video, and TSI modes.

For video capture operation, the video port may operate as two 8/10-bit channels of BT.656 or raw video capture; or as a single channel of 8/10-bit BT.656, 8/10-bit raw video, 16/20-bit Y/C video, 16/20-bit raw video, or 8-bit TSI.

For video display operation, the video port may operate as a single channel of 8/10-bit BT.656; or as a single channel of 8/10-bit BT.656, 8/10-bit raw video, 16/20 bit Y/C video, or 16/20-bit raw video. It may also operate in a two channel 8/10-bit raw mode in which the two channels are locked to the same timing. Channel B is not used during single channel operation.

For more detailed information on the DM643 Video Port peripherals, see the *TMS320C64x DSP Video Port/VCXO Interpolated Control (VIC) Port Reference Guide* (literature number SPRU629).

### *5.13.2 Video Port Peripheral Register Description(s)*

**Table 5-51. Video Port 1 and 2 (VP1 and VP2) Control Registers**

| HEX ADDRESS RANGE | | ACRONYM | DESCRIPTION |
|---|---|---|---|
| VP1 | VP2 | | |
| 01C4 4000 | 01C4 8000 | VP_PIDx | Video Port Peripheral Identification Register |
| 01C4 4004 | 01C4 8004 | VP_PCRx | Video Port Peripheral Control Register |
| 01C4 4008 | 01C4 8008 | – | Reserved |
| 01C4 400C | 01C4 800C | – | Reserved |
| 01C4 4020 | 01C4 8020 | VP_PFUNCx | Video Port Pin Function Register |
| 01C4 4024 | 01C4 8024 | VP_PDIRx | Video Port Pin Direction Register |
| 01C4 4028 | 01C4 8028 | VP_PDINx | Video Port Pin Data Input Register |
| 01C4 402C | 01C4 802C | VP_PDOUTx | Video Port Pin Data Output Register |
| 01C4 4030 | 01C4 8030 | VP_PDSETx | Video Port Pin Data Set Register |
| 01C4 4034 | 01C4 8034 | VP_PDCLRx | Video Port Pin Data Clear Register |
| 01C4 4038 | 01C4 8038 | VP_PIENx | Video Port Pin Interrupt Enable Register |
| 01C4 403C | 01C4 803C | VP_PIPOx | Video Port Pin Interrupt Polarity Register |
| 01C4 4040 | 01C4 8040 | VP_PISTATx | Video Port Pin Interrupt Status Register |
| 01C4 4044 | 01C4 8044 | VP_PICLRx | Video Port Pin Interrupt Clear Register |
| 01C4 40C0 | 01C4 80C0 | VP_CTLx | Video Port Control Register |
| 01C4 40C4 | 01C4 80C4 | VP_STATx | Video Port Status Register |
| 01C4 40C8 | 01C4 80C8 | VP_IEx | Video Port Interrupt Enable Register |
| 01C4 40CC | 01C4 80CC | VP_ISx | Video Port interrupt Status Register |
| 01C4 4100 | 01C4 8100 | VC_STATx | Video Capture Channel A Status Register |
| 01C4 4104 | 01C4 8104 | VC_CTLx | Video Capture Channel A Control Register |


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**Table 5-51. Video Port 1 and 2 (VP1 and VP2) Control Registers (continued)**

| HEX ADDRESS RANGE | | ACRONYM | DESCRIPTION |
|---|---|---|---|
| VP1 | VP2 | | |
| 01C4 4108 | 01C4 8108 | VC_ASTRTx | Video Capture Channel A Field 1 Start Register |
| 01C4 410C | 01C4 810C | VC_ASTOPx | Video Capture Channel A Field 1 Stop Register |
| 01C4 4110 | 01C4 8110 | VC_ASTRTx | Video Capture Channel A Field 2 Start Register |
| 01C4 4114 | 01C4 8114 | VC_ASTOPx | Video Capture Channel A Field 2 Stop Register |
| 01C4 4118 | 01C4 8118 | VC_AVINTx | Video Capture Channel A Vertical Interrupt Register |
| 01C4 411C | 01C4 811C | VC_ATHRLDx | Video Capture Channel A Threshold Register |
| 01C4 4120 | 01C4 8120 | VC_AEVTCTx | Video Capture Channel A Event Count Register |
| 01C4 4140 | 01C4 8140 | VC_BSTATx | Video Capture Channel B Status Register |
| 01C4 4144 | 01C4 8144 | VC_BCTLx | Video Capture Channel B Control Register |
| 01C4 4148 | 01C4 8148 | VC_BSTRTx | Video Capture Channel B Field 1 Start Register |
| 01C4 414C | 01C4 814C | VC_BSTOPx | Video Capture Channel B Field 1 Stop Register |
| 01C4 4150 | 01C4 8150 | VC_BSTRTx | Video Capture Channel B Field 2 Start Register |
| 01C4 4154 | 01C4 8154 | VC_BSTOPx | Video Capture Channel B Field 2 Stop Register |
| 01C4 4158 | 01C4 8158 | VC_BVINTx | Video Capture Channel B Vertical Interrupt Register |
| 01C4 415C | 01C4 815C | VC_BTHRLDx | Video Capture Channel B Threshold Register |
| 01C4 4160 | 01C4 8160 | VC_BEVTCTx | Video Capture Channel B Event Count Register |
| 01C4 4180 | 01C4 8180 | TSI_CTLx | TCI Capture Control Register |
| 01C4 4184 | 01C4 8184 | TSI_CLKINITLx | TCI Clock Initialization LSB Register |
| 01C4 4188 | 01C4 8188 | TSI_CLKINITMx | TCI Clock Initialization MSB Register |
| 01C4 418C | 01C4 818C | TSI_STCLKLx | TCI System Time Clock LSB Register |
| 01C4 4190 | 01C4 8190 | TSI_STCLKMx | TCI System Time Clock MSB Register |
| 01C4 4194 | 01C4 8194 | TSI_STCMPLx | TCI System Time Clock Compare LSB Register |
| 01C4 4198 | 01C4 8198 | TSI_STCMPMx | TCI System Time Clock Compare MSB Register |
| 01C4 419C | 01C4 819C | TSI_STMSKLx | TCI System Time Clock Compare Mask LSB Register |
| 01C4 41A0 | 01C4 81A0 | TSI_STMSKMx | TCI System Time Clock Compare Mask MSB Register |
| 01C4 41A4 | 01C4 81A4 | TSI_TICKSx | TCI System Time Clock Ticks Interrupt Register |
| 01C4 4200 | 01C4 8200 | VD_STATx | Video Display Status Register |
| 01C4 4204 | 01C4 8204 | VD_CTLx | Video Display Control Register |
| 01C4 4208 | 01C4 8208 | VD_FRMSZx | Video Display Frame Size Register |
| 01C4 420C | 01C4 820C | VD_HBLNKx | Video Display Horizontal Blanking Register |
| 01C4 4210 | 01C4 8210 | VD_VBLKS1x | Video Display Field 1 Vertical Blanking Start Register |
| 01C4 4214 | 01C4 8214 | VD_VBLKE1x | Video Display Field 1 Vertical Blanking End Register |
| 01C4 4218 | 01C4 8218 | VD_VBLKS2x | Video Display Field 2 Vertical Blanking Start Register |
| 01C4 421C | 01C4 821C | VD_VBLKE2x | Video Display Field 2 Vertical Blanking End Register |
| 01C4 4220 | 01C4 8220 | VD_IMGOFF1x | Video Display Field 1 Image Offset Register |
| 01C4 4224 | 01C4 8224 | VD_IMGSZ1x | Video Display Field 1 Image Size Register |
| 01C4 4228 | 01C4 8228 | VD_IMGOFF2x | Video Display Field 2 Image Offset Register |
| 01C4 422C | 01C4 822C | VD_IMGSZ2x | Video Display Field 2 Image Size Register |
| 01C4 4230 | 01C4 8230 | VD_FLDT1x | Video Display Field 1 Timing Register |
| 01C4 4234 | 01C4 8234 | VD_FLDT2x | Video Display Field 2 Timing Register |
| 01C4 4238 | 01C4 8238 | VD_THRLDx | Video Display Threshold Register |
| 01C4 423C | 01C4 823C | VD_HSYNCx | Video Display Horizontal Synchronization Register |
| 01C4 4240 | 01C4 8240 | VD_VSYNS1x | Video Display Field 1 Vertical Synchronization Start Register |
| 01C4 4244 | 01C4 8244 | VD_VSYNE1x | Video Display Field 1 Vertical Synchronization End Register |
| 01C4 4248 | 01C4 8248 | VD_VSYNS2x | Video Display Field 2 Vertical Synchronization Start Register |
| 01C4 424C | 01C4 824C | VD_VSYNE2x | Video Display Field 2 Vertical Synchronization End Register |

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**Table 5-51. Video Port 1 and 2 (VP1 and VP2) Control Registers (continued)**

| HEX ADDRESS RANGE | | ACRONYM | DESCRIPTION |
|---|---|---|---|
| VP1 | VP2 | | |
| 01C4 4250 | 01C4 8250 | VD_RELOADx | Video Display Counter Reload Register |
| 01C4 4254 | 01C4 8254 | VD_DISPEVTx | Video Display Display Event Register |
| 01C4 4258 | 01C4 8258 | VD_CLIPx | Video Display Clipping Register |
| 01C4 425C | 01C4 825C | VD_DEFVALx | Video Display Default Display Value Register |
| 01C4 4260 | 01C4 8260 | VD_VINTx | Video Display Vertical Interrupt Register |
| 01C4 4264 | 01C4 8264 | VD_FBITx | Video Display Field Bit Register |
| 01C4 4268 | 01C4 8268 | VD_VBIT1x | Video Display Field 1Vertical Blanking Bit Register |
| 01C4 426C | 01C4 826C | VD_VBIT2x | Video Display Field 2Vertical Blanking Bit Register |
| 7800 0000 | 7C00 0000 | Y_RSCA | Y FIFO Source Register A |
| 7800 0008 | 7C00 0008 | CB_SRCA | CB FIFO Source Register A |
| 7800 0010 | 7C00 0010 | CR_SRCA | CR FIFO Source Register A |
| 7800 0020 | 7C00 0020 | Y_DSTA | Y FIFO Destination Register A |
| 7800 0028 | 7C00 0028 | CB_DST | CB FIFO Destination Register |
| 7800 0030 | 7C00 0030 | CR_DST | CR FIFO Destination Register |
| 7A00 0000 | 7E00 0000 | Y_SRCB | Y FIFO Source Register B |
| 7A00 0008 | 7E00 0008 | CB_SRCB | CB FIFO Source Register b |
| 7A00 0010 | 7E00 0010 | CR_SRCB | CR FIFO Source Register B |
| 7A00 0020 | 7E00 0020 | Y_DSTB | Y FIFO Destination Register B |


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## 5.13.3 Video Port (VP1, VP2) Electrical Data/Timing

### 5.13.3.1 VCLKIN Timing (Video Capture Mode)

**Table 5-52. Timing Requirements for Video Capture Mode for VPxCLKINx(1) (see Figure 5-53)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(VKI)}$ | Cycle time, VPxCLKINx | 12.5 | | ns |
| 2 | $t_{w(VKIH)}$ | Pulse duration, VPxCLKINx high | 5.4 | | ns |
| 3 | $t_{w(VKIL)}$ | Pulse duration, VPxCLKINx low | 5.4 | | ns |
| 4 | $t_{t(VKI)}$ | Transition time, VPxCLKINx | | 3 | ns |

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

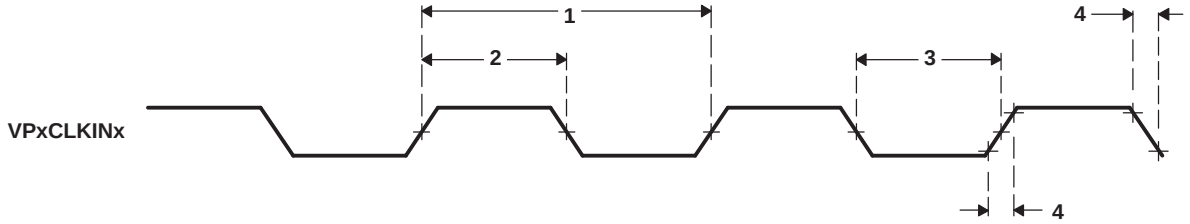



**Figure 5-53. Video Port Capture VPxCLKINx TIming**

### 5.13.3.2 Video Data and Control Timing (Video Capture Mode)

**Table 5-53. Timing Requirements in Video Capture Mode for Video Data and Control Inputs (see Figure 5-54)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{su(VDATV-VKIH)}$ | Setup time, VPxDx valid before VPxCLKINx high | 2.9 | | ns |
| 2 | $t_{h(VDATV-VKIH)}$ | Hold time, VPxDx valid after VPxCLKINx high | 0.5 | | ns |
| 3 | $t_{su(VCTLV-VKIH)}$ | Setup time, VPxCTLx valid before VPxCLKINx high | 2.9 | | ns |
| 4 | $t_{h(VCTLV-VKIH)}$ | Hold time, VPxCTLx valid after VPxCLKINx high | 0.5 | | ns |

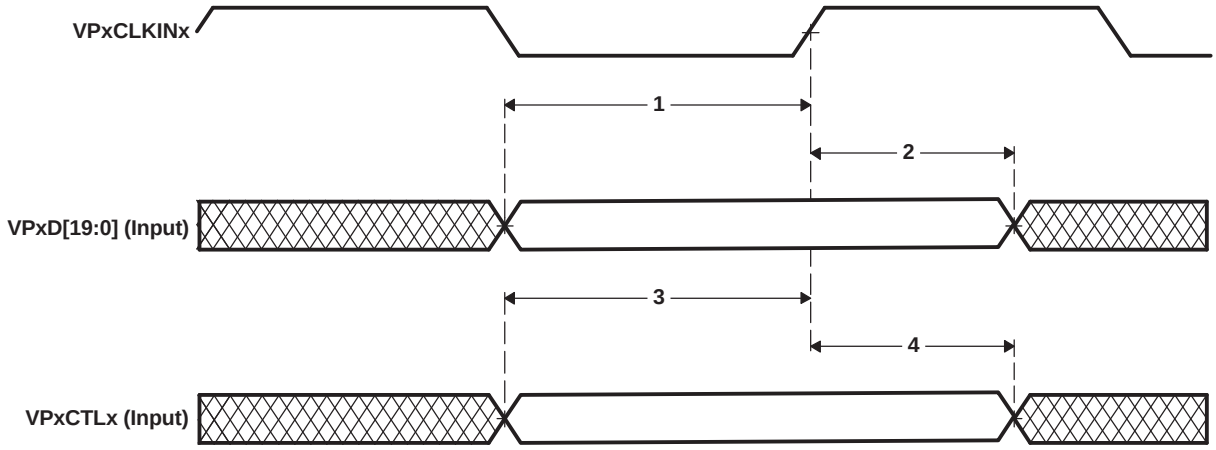



**Figure 5-54. Video Port Capture Data and Control Input Timing**


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### 5.13.3.3 VCLKIN Timing (Video Display Mode)

**Table 5-54. Timing Requirements for Video Display Mode for VPxCLKINx[1] (see Figure 5-55)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(VKI)}$ | Cycle time, VPxCLKINx | 9 | | ns |
| 2 | $t_{w(VKIH)}$ | Pulse duration, VPxCLKINx high | 4.1 | | ns |
| 3 | $t_{w(VKIL)}$ | Pulse duration, VPxCLKINx low | 4.1 | | ns |
| 4 | $t_{t(VKI)}$ | Transition time, VPxCLKINx | | 3 | ns |

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

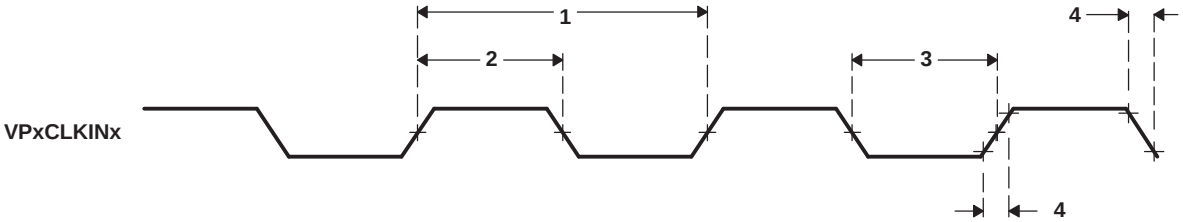



**Figure 5-55. Video Port Display VPxCLKINx Timing**

### 5.13.3.4 Video Control Input/Output and Video Display Data Output Timing With Respect to VPxCLKINx and VPxCLKOUTx (Video Display Mode)

**Table 5-55. Timing Requirements in Video Display Mode for Video Control Input Shown With Respect to VPxCLKINx and VPxCLKOUTx (see Figure 5-56)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 13 | $t_{su(VCTLV-VKIH)}$ | Setup time, VPxCTLx valid before VPxCLKINx high | 2.9 | | ns |
| 14 | $t_{h(VCTLV-VKIH)}$ | Hold time, VPxCTLx valid after VPxCLKINx high | 0.5 | | ns |
| 15 | $t_{su(VCTLV-VKOH)}$ | Setup time, VPxCTLx valid before VPxCLKOUTx high[1] | 7.4 | | ns |
| 16 | $t_{h(VCTLV-VKOH)}$ | Hold time, VPxCTLx valid after VPxCLKOUTx high[1] | –0.9 | | ns |

(1) Assuming non-inverted VPxCLKOUTx signal.

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**Table 5-56. Switching Characteristics Over Recommended Operating Conditions in Video Display Mode for Video Data and Control Output Shown With Respect to VPxCLKINx and VPxCLKOUTx(1) (2) (see Figure 5-56)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(VKO)}$ | Cycle time, VPxCLKOUTx | V – 0.7 | V + 0.7 | ns |
| 2 | $t_{w(VKOH)}$ | Pulse duration, VPxCLKOUTx high | VH – 0.7 | VH + 0.7 | ns |
| 3 | $t_{w(VKOL)}$ | Pulse duration, VPxCLKOUTx low | VL – 0.7 | VL + 0.7 | ns |
| 4 | $t_{t(VKO)}$ | Transition time, VPxCLKOUTx | | 1.8 | ns |
| 5 | $t_{d(VKIH-VKOH)}$ | Delay time, VPxCLKINx high to VPxCLKOUTx high(3) | 1.1 | 5.7 | ns |
| 6 | $t_{d(VKIL-VKOL)}$ | Delay time, VPxCLKINx low to VPxCLKOUTx low(3) | 1.1 | 5.7 | ns |
| 7 | $t_{d(VKIH-VKOL)}$ | Delay time, VPxCLKINx high to VPxCLKOUTx low | 1.1 | 5.7 | ns |
| 8 | $t_{d(VKIL-VKOH)}$ | Delay time, VPxCLKINx low to VPxCLKOUTx high | 1.1 | 5.7 | ns |
| 9 | $t_{d(VKIH-VPOUTV)}$ | Delay time, VPxCLKINx high to VPxOUT valid(4) | | 9 | ns |
| 10 | $t_{d(VKIH-VPOUTIV)}$ | Delay time, VPxCLKINx high to VPxOUT invalid(4) | 1.7 | | ns |
| 11 | $t_{d(VKOH-VPOUTV)}$ | Delay time, VPxCLKOUTx high to VPxOUT valid(1) (4) | | 4.3 | ns |
| 12 | $t_{d(VKOH-VPOUTIV)}$ | Delay time, VPxCLKOUTx high to VPxOUT invalid(1) (4) | –0.2 | | ns |

(1) V = the video input clock (VPxCLKINx) period in ns.
(2) VH is the high period of V (video input clock period) in ns and VL is the low period of V (video input clock period) in ns.
(3) Assuming non-inverted VPxCLKOUTx signal.
(4) VPxOUT consists of VPxCTLx and VPxD[19:0]

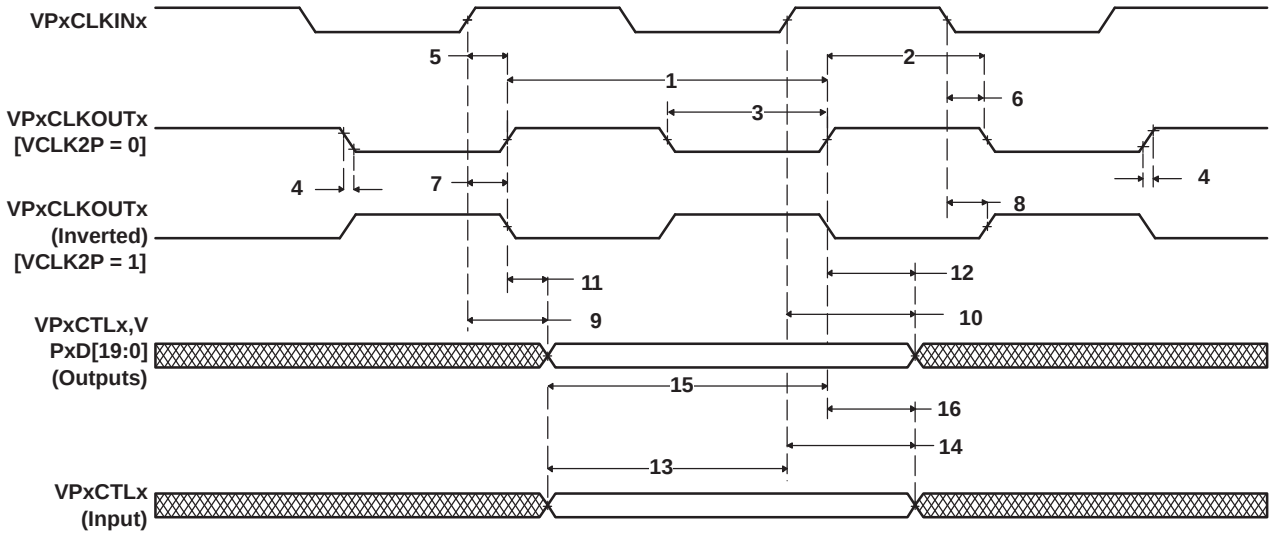



**Figure 5-56. Video Port Display Data Output Timing and Control Input/Output Timing With Respect to VPxCLKINx and VPxCLKOUTx**


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### 5.13.3.5 Video Dual-Display Sync Mode Timing (With Respect to VPxCLKINx)

**Table 5-57. Timing Requirements for Dual-Display Sync Mode for VPxCLKINx (see Figure 5-57)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{skr(VKI)}$ | Skew rate, VPxCLKINx before VPyCLKINy | | ±500 | ps |

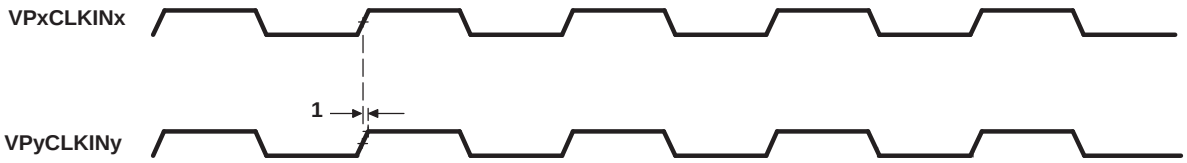



**Figure 5-57. Video Port Dual-Display Sync Timing**

## 5.14 VCXO Interpolated Control (VIC)

The VIC can be used in conjunction with the Video Ports (VPs) to maintain synchronization of a video stream. The VIC can also be used to control a VCXO to adjust the pixel clock rate to a video port.

### *5.14.1 VIC Device-Specific Information*

The VCXO interpolated control (VIC) port provides digital-to-analog conversation with resolution from 9-bits to up to 16-bits. The output of the VIC is a single bit interpolated D/A output (VDAC pin).

Typical D/A converters provide a discrete output level for every value of the digital word that is being converted. This is a problem for digital words that are long. This is avoided in a Sigma Delta type D/A converter by choosing a few widely spaced output levels and interpolating values between them. The interpolating mechanism causes the output to oscillate rapidly between the levels in such a manner that the average output represents the value of input code.

In the VIC, two output levels are chosen (0 and 1), and Sigma Delta interpolation scheme is implemented to interpolate between these levels with a rapidly changing signal. The frequency of interpolation is dependent on the resolution needed.

When the video port is used in transport stream interface (TSI) mode, the VIC port is used to control the system clock, VCXO, for MPEG transport stream.

The VIC supports the following features:

- Single interpolation for D/A conversion
- Programmable precision from 9-to-16 bits
- Interface for register accesses

For more detailed information on the DM643 VCXO interpolated control (VIC) peripheral, see the *TMS320C64x DSP Video Port/VCXO Interpolated Control (VIC) Port Reference Guide* (literature number SPRU629).

### *5.14.2 VIC Peripheral Register Description(s)*

**Table 5-58. VCXO Interpolated Control (VIC) Port Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C4 C000 | VICCTL | VIC control register |
| 01C4 C004 | VICIN | VIC input register |
| 01C4 C008 | VPDIV | VIC clock divider register |
| 01C4 C00C – 01C4 FFFF | – | Reserved |


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## 5.14.3 VIC Electrical Data/Timing

### 5.14.3.1 STCLK Timing

**Table 5-59. Timing Requirments for STCLK(1) (see Figure 5-58)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(STCLK)}$ | Cycle time, STCLK | 33.3 | | ns |
| 2 | $t_{w(STCLKH)}$ | Pulse duration, STCLK high | 16 | | ns |
| 3 | $t_{w(STCLKL)}$ | Pulse duration, STCLK low | 16 | | ns |
| 4 | $t_{t(STCLK)}$ | Transition time, STCLK | | 3 | ns |

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

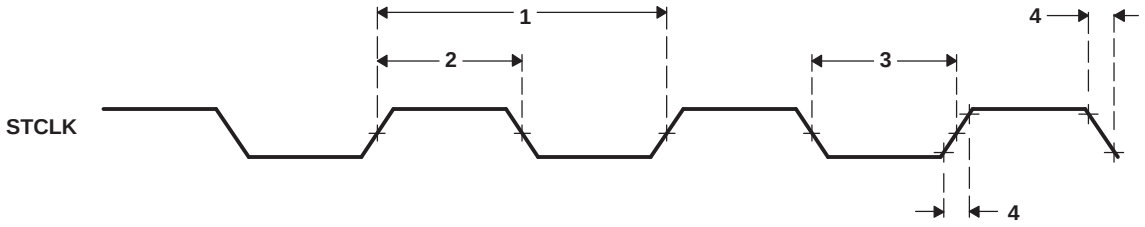



**Figure 5-58. STCLK Timing**

## 5.15 Ethernet Media Access Controller (EMAC)

The EMAC controls the flow of packet data from the DSP to the PHY.

### 5.15.1 EMAC Device-Specific Information

The ethernet media access controller (EMAC) provides an efficient interface between the DM643 DSP core processor and the network. The DM643 EMAC support both 10Base-T and 100Base-TX, or 10 Mbits/second (Mbps) and 100 Mbps in either half- or full-duplex, with hardware flow control and quality of service (QOS) support. The DM643 EMAC makes use of a custom interface to the DSP core that allows efficient data transmission and reception.

The EMAC controls the flow of packet data from the DSP to the PHY. The MDIO module controls PHY configuration and status monitoring.

Both the EMAC and the MDIO modules interface to the DSP through a custom interface that allows efficient data transmission and reception. This custom interface is referred to as the EMAC control module, and is considered integral to the EMAC/MDIO peripheral. The control module is also used to control device reset, interrupts, and system priority.

The *TMS320C6000 DSP Ethernet Media Access Controller (EMAC) / Management Data Input/Output (MDIO) Module Reference Guide* (literature number SPRU628) describes the DM643 EMAC peripheral in detail. Some of the features documented in this peripheral reference guide are not supported on the DM643 at this time. The DM643 supports one receive channel and does not support receive quality of service (QOS). For a list of supported registers and register fields, see Table 5-60 [Ethernet MAC (EMAC) Control Registers] and Table 5-61 [EMAC Statistics Registers] in this data manual.

### 5.15.2 EMAC Peripheral Register Description(s)

**Table 5-60. Ethernet MAC (EMAC) Control Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 0000 | TXIDVER | Transmit Identification and Version Register |
| 01C8 0004 | TXCONTROL | Transmit Control Register |
| 01C8 0008 | TXTEARDOWN | Transmit Teardown Register |
| 01C8 000C | – | Reserved |
| 01C8 0010 | RXIDVER | Receive Identification and Version Register |
| 01C8 0014 | RXCONTROL | Receive Control Register |
| 01C8 0018 | RXTEARDOWN | Receive Teardown Register<br>(RXTDNCH field only supports writes of 0.) |
| 01C8 001C – 01C8 00FF | – | Reserved |
| 01C8 0100 | RXMBPENABLE | Receive Multicast/Broadcast/Promiscuous Channel Enable Register<br>(The RXQOSEN field is reserved and only supports writes of 0. The PROMCH, BROADCH, and MUCTCH bit fields only support writes of 0.) |
| 01C8 0104 | RXUNICASTSET | Receive Unicast Set Register<br>(Bits 7–1 are reserved and only support writes of 0.) |
| 01C8 0108 | RXUNICASTCLEAR | Receive Unicast Clear Register<br>(Bits 7–1 are reserved and only support writes of 0.) |
| 01C8 010C | RXMAXLEN | Receive Maximum Length Register |
| 01C8 0110 | RXBUFFEROFFSET | Receive Buffer Offset Register |
| 01C8 0114 | RXFILTERLOWTHRESH | Receive Filter Low Priority Packets Threshold Register |
| 01C8 0118 – 01C8 011F | – | Reserved |
| 01C8 0120 | RX0FLOWTHRESH | Receive Channel 0 Flow Control Threshold Register |


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**Table 5-60. Ethernet MAC (EMAC) Control Registers (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 0124 | RX1FLOWTHRESH | Reserved. Do not write. |
| 01C8 0128 | RX2FLOWTHRESH | |
| 01C8 012C | RX3FLOWTHRESH | |
| 01C8 0130 | RX4FLOWTHRESH | |
| 01C8 0134 | RX5FLOWTHRESH | |
| 01C8 0138 | RX6FLOWTHRESH | |
| 01C8 013C | RX7FLOWTHRESH | |
| 01C8 0140 | RX0FREEBUFFER | Receive Channel 0 Free Buffer Count Register |
| 01C8 0144 | RX1FREEBUFFER | Reserved. Do not write. |
| 01C8 0148 | RX2FREEBUFFER | |
| 01C8 014C | RX3FREEBUFFER | |
| 01C8 0150 | RX4FREEBUFFER | |
| 01C8 0154 | RX5FREEBUFFER | |
| 01C8 0158 | RX6FREEBUFFER | |
| 01C8 015C | RX7FREEBUFFER | |
| 01C8 0160 | MACCONTROL | MAC Control Register |
| 01C8 0164 | MACSTATUS | MAC Status Register (RXQOSACT field is reserved.) |
| 01C8 0168 – 01C8 016C | – | Reserved |
| 01C8 0170 | TXINTSTATRAW | Transmit Interrupt Status (Unmasked) Register |
| 01C8 0174 | TXINTSTATMASKED | Transmit Interrupt Status (Masked) Register |
| 01C8 0178 | TXINTMASKSET | Transmit Interrupt Mask Set Register |
| 01C8 017C | TXINTMASKCLEAR | Transmit Interrupt Mask Clear Register |
| 01C8 0180 | MACINVECTOR | MAC Input Vector Register |
| 01C8 0184 – 01C8 018F | – | Reserved |
| 01C8 0190 | RXINTSTATRAW | Receive Interrupt Status (Unmasked) Register<br>(Bits 7–1 are reserved.) |
| 01C8 0194 | RXINTSTATMASKED | Receive Interrupt Status (Masked) Register<br>(Bits 7–1 are reserved.) |
| 01C8 0198 | RXINTMASKSET | Receive Interrupt Mask Set Register<br>(Bits 7–1 are reserved and only support writes of 0.) |
| 01C8 019C | RXINTMASKCLEAR | Receive Interrupt Mask Clear Register<br>(Bits 7–1 are reserved and only support writes of 0.) |
| 01C8 01A0 | MACINTSTATRAW | MAC Interrupt Status (Unmasked) Register |
| 01C8 01A4 | MACINTSTATMASKED | MAC Interrupt Status (Masked) Register |
| 01C8 01A8 | MACINTMASKSET | MAC Interrupt Mask Set Register |
| 01C8 01AC | MACINTMASKCLEAR | MAC Interrupt Mask Clear Register |
| 01C8 01B0 | MACADDRL0 | MAC Address Channel 0 Lower Byte Register |
| 01C8 01B4 | MACADDRL1 | Reserved. Do not write. |
| 01C8 01B8 | MACADDRL2 | |
| 01C8 01BC | MACADDRL3 | |
| 01C8 01C0 | MACADDRL4 | |
| 01C8 01C4 | MACADDRL5 | |
| 01C8 01C8 | MACADDRL6 | |
| 01C8 01CC | MACADDRL7 | |
| 01C8 01D0 | MACADDRM | MAC Address Middle Byte Register |
| 01C8 01D4 | MACADDRH | MAC Address High Bytes Register |
| 01C8 01D8 | MACHASH1 | MAC Address Hash 1 Register |
| 01C8 01DC | MACHASH2 | MAC Address Hash 2 Register |

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**Table 5-60. Ethernet MAC (EMAC) Control Registers (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 01E0 | BOFFTEST | Backoff Test Register |
| 01C8 01E4 | TPACETEST | Transmit Pacing Test Register |
| 01C8 01E8 | RXPAUSE | Receive Pause Timer Register |
| 01C8 01EC | TXPAUSE | Transmit Pause Timer Register |
| 01C8 01F0 – 01C8 01FF | – | Reserved |
| 01C8 0200 – 01C8 05FF | (see Table 5-61) | EMAC Statistics Registers |
| 01C8 0600 | TX0HDP | Transmit Channel 0 DMA Head Descriptor Pointer Register |
| 01C8 0604 | TX1HDP | Transmit Channel 1 DMA Head Descriptor Pointer Register |
| 01C8 0608 | TX2HDP | Transmit Channel 2 DMA Head Descriptor Pointer Register |
| 01C8 060C | TX3HDP | Transmit Channel 3 DMA Head Descriptor Pointer Register |
| 01C8 0610 | TX4HDP | Transmit Channel 4 DMA Head Descriptor Pointer Register |
| 01C8 0614 | TX5HDP | Transmit Channel 5 DMA Head Descriptor Pointer Register |
| 01C8 0618 | TX6HDP | Transmit Channel 6 DMA Head Descriptor Pointer Register |
| 01C8 061C | TX7HDP | Transmit Channel 7 DMA Head Descriptor Pointer Register |
| 01C8 0620 | RX0HDP | Receive Channel 0 DMA Head Descriptor Pointer Register |
| 01C8 0624 | RX1HDP | Reserved. Do not write. |
| 01C8 0628 | RX2HDP | |
| 01C8 062C | RX3HDP | |
| 01C8 0630 | RX4HDP | |
| 01C8 0634 | RX5HDP | |
| 01C8 0638 | RX6HDP | |
| 01C8 063C | RX7HDP | |
| 01C8 0640 | TX0INTACK | Transmit Channel 0 Interrupt Acknowledge Register |
| 01C8 0644 | TX1INTACK | Transmit Channel 1 Interrupt Acknowledge Register |
| 01C8 0648 | TX2INTACK | Transmit Channel 2 Interrupt Acknowledge Register |
| 01C8 064C | TX3INTACK | Transmit Channel 3 Interrupt Acknowledge Register |
| 01C8 0650 | TX4INTACK | Transmit Channel 4 Interrupt Acknowledge Register |
| 01C8 0654 | TX5INTACK | Transmit Channel 5 Interrupt Acknowledge Register |
| 01C8 0658 | TX6INTACK | Transmit Channel 6 Interrupt Acknowledge Register |
| 01C8 065C | TX7INTACK | Transmit Channel 7 Interrupt Acknowledge Register |
| 01C8 0660 | RX0INTACK | Receive Channel 0 Interrupt Acknowledge Register |
| 01C8 0664 | RX1INTACK | Reserved. Do not write. |
| 01C8 0668 | RX2INTACK | |
| 01C8 066C | RX3INTACK | |
| 01C8 0670 | RX4INTACK | |
| 01C8 0674 | RX5INTACK | |
| 01C8 0678 | RX6INTACK | |
| 01C8 067C | RX7INTACK | |
| 01C8 0680 – 01C8 0FFF | – | Reserved |


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**Table 5-61. EMAC Statistics Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 0200 | RXGOODFRAMES | Good Receive Frames Register |
| 01C8 0204 | RXBCASTFRAMES | Broadcast Receive Frames Register |
| 01C8 0208 | RXMCASTFRAMES | Multicast Receive Frames Register |
| 01C8 020C | RXPAUSEFRAMES | Pause Receive Frames Register |
| 01C8 0210 | RXCRCERRORS | Receive CRC Errors Register |
| 01C8 0214 | RXALIGNCODEERRORS | Receive Alignment/Code Errors Register |
| 01C8 0218 | RXOVERSIZED | Receive Oversized Frames Register |
| 01C8 021C | RXJABBER | Receive Jabber Frames Register |
| 01C8 0220 | RXUNDERSIZED | Receive Undersized Frames Register |
| 01C8 0224 | RXFRAGMENTS | Receive Frame Fragments Register |
| 01C8 0228 | RXFILTERED | Filtered Receive Frames Register |
| 01C8 022C | RXQOSFILTERED | Reserved |
| 01C8 0230 | RXOCTETS | Receive Octet Frames Register |
| 01C8 0234 | TXGOODFRAMES | Good Transmit Frames Register |
| 01C8 0238 | TXBCASTFRAMES | Broadcast Transmit Frames Register |
| 01C8 023C | TXMCASTFRAMES | Multicast Transmit Frames Register |
| 01C8 0240 | TXPAUSEFRAMES | Pause Transmit Frames Register |
| 01C8 0244 | TXDEFERRED | Deferred Transmit Frames Register |
| 01C8 0248 | TXCOLLISION | Collision Register |
| 01C8 024C | TXSINGLECOLL | Single Collision Transmit Frames Register |
| 01C8 0250 | TXMULTICOLL | Multiple Collision Transmit Frames Register |
| 01C8 0254 | TXEXCESSIVECOLL | Excessive Collisions Register |
| 01C8 0258 | TXLATECOLL | Late Collisions Register |
| 01C8 025C | TXUNDERRUN | Transmit Underrun Register |
| 01C8 0260 | TXCARRIERSLOSS | Transmit Carrier Sense Errors Register |
| 01C8 0264 | TXOCTETS | Transmit Octet Frames Register |
| 01C8 0268 | FRAME64 | Transmit and Receive 64 Octet Frames Register |
| 01C8 026C | FRAME65T127 | Transmit and Receive 65 to 127 Octet Frames Register |
| 01C8 0270 | FRAME128T255 | Transmit and Receive 128 to 255 Octet Frames Register |
| 01C8 0274 | FRAME256T511 | Transmit and Receive 256 to 511 Octet Frames Register |
| 01C8 0278 | FRAME512T1023 | Transmit and Receive 512 to 1023 Octet Frames Register |
| 01C8 027C | FRAME1024TUP | Transmit and Receive 1024 or Above Octet Frames Register |
| 01C8 0280 | NETOCTETS | Network Octet Frames Register |
| 01C8 0284 | RXSOFOVERRUNS | Receive Start of Frame Overruns Register |
| 01C8 0288 | RXMOFOVERRUNS | Receive Middle of Frame Overruns Register |
| 01C8 028C | RXDMAOVERRUNS | Receive DMA Overruns Register |
| 01C8 0290 – 01C8 05FF | – | Reserved |

**Table 5-62. EMAC Wrapper**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 1000 – 01C8 1FFF | | EMAC Control Module Descriptor Memory |
| 01C8 2000 – 01C8 2FFF | – | Reserved |

**Table 5-63. EWRAP Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 3000 | EWTRCTRL | TR control |
| 01C8 3004 | EWCTL | Interrupt control register |

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**Table 5-63. EWRAP Registers (continued)**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 3008 | EWINTTCNT | Interrupt timer count |
| 01C8 300C – 01C8 37FF | – | Reserved |

### 5.15.3 EMAC Electrical Data/Timing

**Table 5-64. Timing Requirements for MRCLK (see Figure 5-59)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(MRCLK)}$ | Cycle time, MRCLK | 40 | | ns |
| 2 | $t_{w(MRCLKH)}$ | Pulse duration, MRCLK high | 14 | | ns |
| 3 | $t_{w(MRCLKL)}$ | Pulse duration, MRCLK low | 14 | | ns |

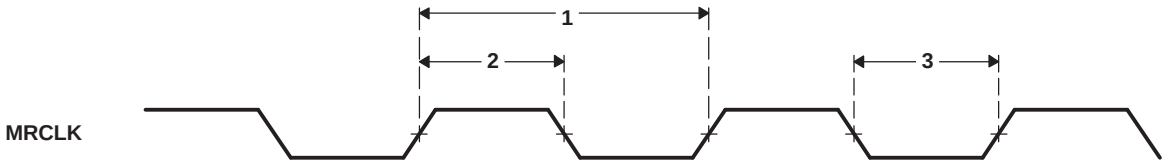



**Figure 5-59. MRCLK Timing (EMAC – Receive)**

**Table 5-65. Timing Requirements for MTCLK (see Figure 5-59)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(MTCLK)}$ | Cycle time, MTCLK | 40 | | ns |
| 2 | $t_{w(MTCLKH)}$ | Pulse duration, MTCLK high | 14 | | ns |
| 3 | $t_{w(MTCLKL)}$ | Pulse duration, MTCLK low | 14 | | ns |

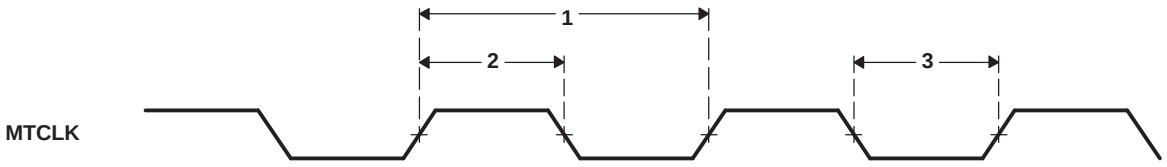



**Figure 5-60. MTCLK Timing (EMAC – Transmit)**

**Table 5-66. Timing Requirements for EMAC MII Receive 10/100 Mbit/s(1) (see Figure 5-61)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{su(MRXD-MRCLKH)}$ | Setup time, receive selected signals valid before MRCLK high | 8 | | ns |
| 2 | $t_{h(MRCLKH-MRXD)}$ | Hold time, receive selected signals valid after MRCLK high | 8 | | ns |

(1) Receive selected signals include: MRXD3-MRXD0, MRXDV, and MRXER.


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MRXD3–MRXD0 is driven by the PHY on the falling edge of MRCLK. MRXD3–MRXD0 timing must be met during clock periods when MRXDV is asserted. MRXDV is asserted and deasserted by the PHY on the falling edge of MRCLK. MRXER is driven by the PHY on the falling edge of MRCLK (xx = 00–01).

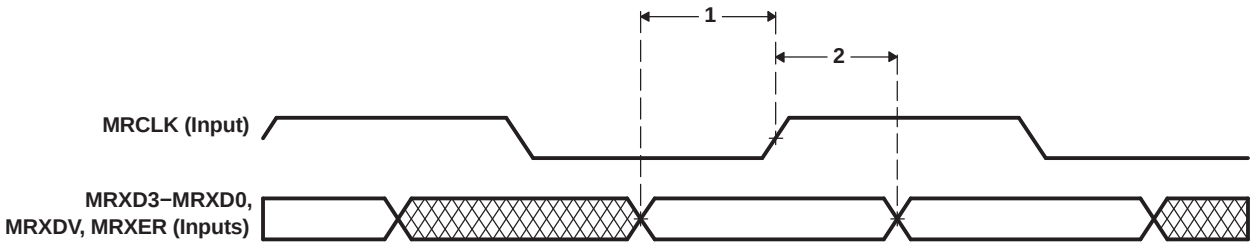



**Figure 5-61. EMAC Receive Interface Timing**

**Table 5-67. Switching Characteristics Over Recommended Operating Conditions for EMAC MII Transmit 10/100 Mbit/s(1) (see Figure 5-62)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{d(MTCLKH-MTXD)}$ | Delay time, MTCLK high to transmit selected signals valid | 5 | 25 | ns |

(1) Transmit selected signals include: MTXD3–MTXD0, and MTXEN.

MTXD3–MTXD0 is driven by the reconciliation sublayer synchronous to the MTCLK. MTXEN is asserted and deasserted by the reconciliation sublayer synchronous to the MTCLK rising edge.

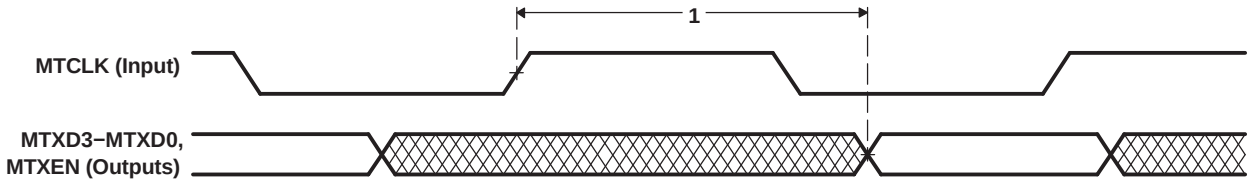



**Figure 5-62. EMAC Transmit Interface Timing**

## 5.16 Management Data Input/Output (MDIO)

The MDIO module controls PHY configuration and status monitoring.

### 5.16.1 Device-Specific Information

The management data input/output (MDIO) module continuously polls all 32 MDIO addresses in order to enumerate all PHY devices in the system.

The management data input/output (MDIO) module implements the 802.3 serial management interface to interrogate and control Ethernet PHY(s) using a shared two-wire bus. Host software uses the MDIO module to configure the auto-negotiation parameters of each PHY attached to the EMAC, retrieve the negotiation results, and configure required parameters in the EMAC module for correct operation. The module is designed to allow almost transparent operation of the MDIO interface, with very little maintenance from the core processor.

The *TMS320C6000 DSP Ethernet Media Access Controller (EMAC) / Management Data Input/Output (MDIO) Module Reference Guide* (literature number SPRU628) describes the DM643 MDIO peripheral in detail. Some of the features documented in this peripheral reference guide are not supported on the DM643 at this time. The DM643 only supports one EMAC module. For a list of supported registers and register fields, see Table 5-68 [MDIO Registers] in this data manual.

### 5.16.2 Peripheral Register Description(s)

**Table 5-68. MDIO Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01C8 3800 | VERSION | MDIO Version Register |
| 01C8 3804 | CONTROL | MDIO Control Register |
| 01C8 3808 | ALIVE | MDIO PHY Alive Indication Register |
| 01C8 380C | LINK | MDIO PHY Link Status Register |
| 01C8 3810 | LINKINTRAW | MDIO Link Status Change Interrupt Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 3814 | LINKINTMASKED | MDIO Link Status Change Interrupt (Masked) Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 3818 | USERINTRAW | MDIO User Command Complete Interrupt Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 381C | USERINTMASKED | MDIO User Command Complete Interrupt (Masked) Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 3820 | USERINTMASKSET | MDIO User Command Complete Interrupt Mask Set Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 3824 | USERINTMASKCLEAR | MDIO User Command Complete Interrupt Mask Clear Register<br>(MAC1 field is reserved and only supports writes of 0.) |
| 01C8 3828 | USERACCESS0 | MDIO User Access Register 0 |
| 01C8 382C | USERACCESS1 | Reserved. Do not write. |
| 01C8 3830 | USERPHYSEL0 | MDIO User PHY Select Register 0 |
| 01C8 3834 | USERPHYSEL1 | Reserved. Do not write. |
| 01C8 3838 – 01C8 3FFF | – | Reserved |


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### 5.16.3 Management Data Input/Output (MDIO) Electrical Data/Timing

**Table 5-69. Timing Requirements for MDIO Input (see Figure 5-63)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(MDCLK)}$ | Cycle time, MDCLK | 400 | | ns |
| 2 | $t_{w(MDCLK)}$ | Pulse duration, MDCLK high/low | 180 | | ns |
| 3 | $t_{su(MDIO-MDCLKH)}$ | Setup time, MDIO data input valid before MDCLK high | 10 | | ns |
| 4 | $t_{h(MDCLKH-MDIO)}$ | Hold time, MDIO data input valid after MDCLK high | 0 | | ns |

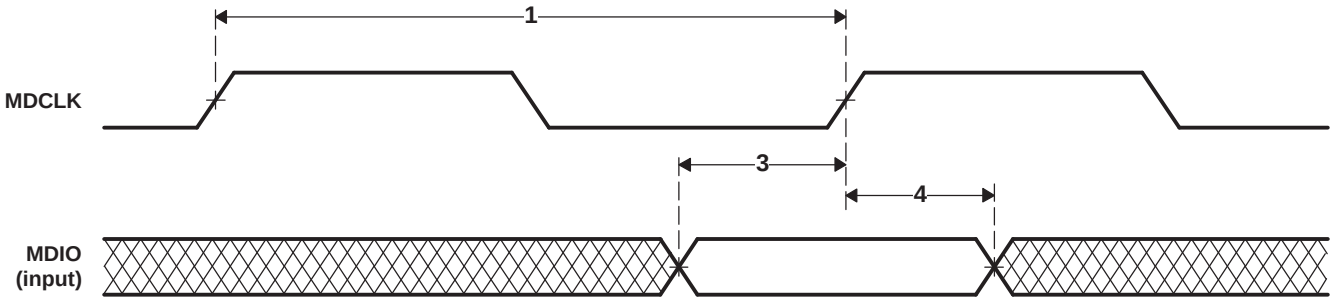



**Figure 5-63. MDIO Input Timing**

**Table 5-70. Switching Characteristics Over Recommended Operating Conditions for MDIO Output (see Figure 5-64)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 7 | $t_{d(MDCLKL-MDIO)}$ | Delay time, MDCLK low to MDIO data output valid | –10 | 100 | ns |

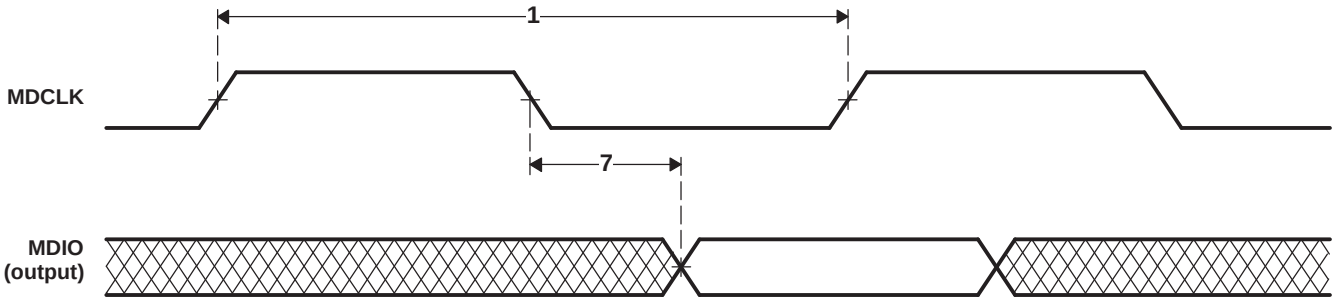



**Figure 5-64. MDIO Output Timing**

## 5.17 Timer

The C6000™ DSP device has 32-bit general-purpose timers that can be used to:

- Time events
- Count events
- Generate pulses
- Interrupt the CPU
- Send synchronization events to the DMA

The timers have two signaling modes and can be clocked by an internal or an external source. The timers have an input pin and an output pin. The input and output pins (TINP and TOUT) can function as timer clock input and clock output. They can also be respectively configured for general-purpose input and output.

With an internal clock, for example, the timer can signal an external A/D converter to start a conversion, or it can trigger the DMA controller to begin a data transfer. With an external clock, the timer can count external events and interrupt the CPU after a specified number of events.

### *5.17.1 Timer Device-Specific Information*

The DM643 device has a total of three 32-bit general-purpose timers (Timer0, Timer1, and Timer2). Timer2 is ***not*** externally pinned out.

For more detailed information, see the *TMS320C6000 DSP 32-Bit Timer Reference Guide* (literature number SPRU582).

### *5.17.2 Timer Peripheral Register Description(s)*

**Table 5-71. Timer 0 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0194 0000 | CTL0 | Timer 0 control register | Determines the operating mode of the timer, monitors the timer status, and controls the function of the TOUT pin. |
| 0194 0004 | PRD0 | Timer 0 period register | Contains the number of timer input clock cycles to count. This number controls the TSTAT signal frequency. |
| 0194 0008 | CNT0 | Timer 0 counter register | Contains the current value of the incrementing counter. |
| 0194 000C – 0197 FFFF | – | Reserved | |

**Table 5-72. Timer 1 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 0198 0000 | CTL1 | Timer 1 control register | Determines the operating mode of the timer, monitors the timer status, and controls the function of the TOUT pin. |
| 0198 0004 | PRD1 | Timer 1 period register | Contains the number of timer input clock cycles to count. This number controls the TSTAT signal frequency. |
| 0198 0008 | CNT1 | Timer 1 counter register | Contains the current value of the incrementing counter. |
| 0198 000C – 019B FFFF | – | Reserved | |

**Table 5-73. Timer 2 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 01AC 0000 | CTL2 | Timer 2 control register | Determines the operating mode of the timer, monitors the timer status. |
| 01AC 0004 | PRD2 | Timer 2 period register | Contains the number of timer input clock cycles to count. This number controls the TSTAT signal frequency. |
| 01AC 0008 | CNT2 | Timer 2 counter register | Contains the current value of the incrementing counter. |
| 01AC 000C – 01AF FFFF | – | Reserved | |


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### 5.17.3 Timer Electrical Data/Timing

**Table 5-74. Timing Requirements for Timer Inputs[1] (see Figure 5-65)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(TINPH)}$ | Pulse duration, TINP high | 8P | | ns |
| 2 | $t_{w(TINPL)}$ | Pulse duration, TINP low | 8P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.

**Table 5-75. Switching Characteristics Over Recommended Operating Conditions for Timer Outputs[1] (see Figure 5-65)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 3 | $t_{w(TOUTH)}$ | Pulse duration, TOUT high | 8P – 3 | | ns |
| 4 | $t_{w(TOUTL)}$ | Pulse duration, TOUT low | 8P – 3 | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.

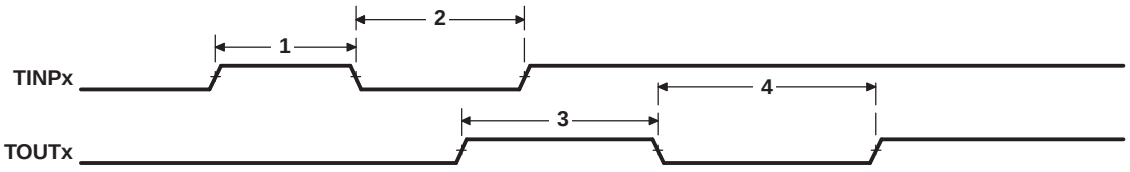



**Figure 5-65. Timer Timing**

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

The GPIO peripheral provides dedicated general-purpose pins that can be configured as either inputs or outputs. When configured as an output, you can write to an internal register to control the state driven on the output pin. When configured as an input, you can detect the state of the input 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.

### *5.18.1 GPIO Device-Specific Information*

To use the GP[15:0] software-configurable GPIO pins, the GPxEN bits in the GP Enable (GPEN) Register and the GPxDIR bits in the GP Direction (GPDIR) Register must be properly configured.

GPxEN = 1 GP[x] pin is enabled

GPxDIR = 0 GP[x] pin is an input

GPxDIR = 1 GP[x] pin is an output

where "x" represents one of the 15 through 0 GPIO pins

Figure 5-66 shows the GPIO enable bits in the GPEN register for the DM643 device. To use any of the GPx pins as general-purpose input/output functions, the corresponding GPxEN bit must be set to "1" (enabled). Default values are device-specific, so refer to Figure 5-66 for the DM643 default configuration.

| 31 | | | | | | | | | | | | | | | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | |
| R-0 | | | | | | | | | | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GP15 EN | GP14 EN | GP13 EN | GP12 EN | GP11 EN | GP10 EN | GP9 EN | GP8 EN | GP7 EN | GP6 EN | GP5 EN | GP4 EN | GP3 EN | GP2 EN | GP1 EN | GP0 EN |
| R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-1 | R/W-1 | R/W-1 | R/W-1 | R/W-1 | R/W-0 | R/W-0 | R/W-1 |

**Legend**: R/W = Readable/Writable, -*n* = value after reset, -x = undefined value after reset

**Figure 5-66. GPIO Enable Register (GPEN) [Hex Address: 01B0 0000]**

Figure 5-67 shows the GPIO direction bits in the GPDIR register. This register determines if a given GPIO pin is an input or an output providing the corresponding GPxEN bit is enabled (set to "1") in the GPEN register. By default, all the GPIO pins are configured as input pins.


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| 31 | | | | | | | | | | | | | | | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | |
| R-0 | | | | | | | | | | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GP15 DIR | GP14 DIR | GP13 DIR | GP12 DIR | GP11 DIR | GP10 DIR | GP9 DIR | GP8 DIR | GP7 DIR | GP6 DIR | GP5 DIR | GP4 DIR | GP3 DIR | GP2 DIR | GP1 DIR | GP0 DIR |
| R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |

**Legend**: R/W = Readable/Writable, -*n* = value after reset, -x = undefined value after reset

**Figure 5-67. GPIO Direction Register (GPDIR) [Hex Address: 01B0 0004]**

For more detailed information on general-purpose inputs/outputs (GPIOs), see the *TMS320C6000 DSP General-Purpose Input/Output (GPIO) Reference Guide* (literature number SPRU584).

### *5.18.2 GPIO Peripheral Register Description(s)*

**Table 5-76. GP0 Registers**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME |
|---|---|---|
| 01B0 0000 | GPEN | GP0 enable register |
| 01B0 0004 | GPDIR | GP0 direction register |
| 01B0 0008 | GPVAL | GP0 value register |
| 01B0 000C | – | Reserved |
| 01B0 0010 | GPDH | GP0 delta high register |
| 01B0 0014 | GPHM | GP0 high mask register |
| 01B0 0018 | GPDL | GP0 delta low register |
| 01B0 001C | GPLM | GP0 low mask register |
| 01B0 0020 | GPGC | GP0 global control register |
| 01B0 0024 | GPPOL | GP0 interrupt polarity register |
| 01B0 0028 – 01B3 EFFF | – | Reserved |

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### 5.18.3 General-Purpose Input/Output (GPIO) Electrical Data/Timing

**Table 5-77. Timing Requirements for GPIO Inputs(1) (2) (see Figure 5-68)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{w(GPIH)}$ | Pulse duration, GPIx high | 8P | | ns |
| 2 | $t_{w(GPIL)}$ | Pulse duration, GPIx low | 8P | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) The pulse width given is sufficient to generate a CPU interrupt or an EDMA event. However, if a user wants to have the DSP recognize the GPIx changes through software polling of the GPIO register, the GPIx duration must be extended to at least 12P to allow the DSP enough time to access the GPIO register through the CFGBUS.

**Table 5-78. Switching Characteristics Over Recommended Operating Conditions for GPIO Outputs(1) (see Figure 5-68)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 3 | $t_{w(GPOH)}$ | Pulse duration, GPOx high | 24P – 8(2) | | ns |
| 4 | $t_{w(GPOL)}$ | Pulse duration, GPOx low | 24P – 8(2) | | ns |

(1) P = 1/CPU clock frequency in ns. For example, when running parts at 600 MHz, use P = 1.67 ns.
(2) 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.

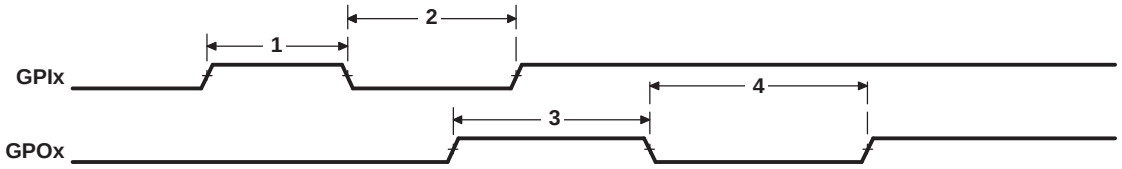



**Figure 5-68. GPIO Port Timing**


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## 5.19 JTAG

The JTAG interface is used for BSDL testing and emulation of the DM643 device.

**Note:** IEEE Standard 1149.1-1990 Standard-Test-Access Port and Boundary Scan Architecture.

### *5.19.1 JTAG Device-Specific Information*

#### 5.19.1.1 IEEE 1149.1 JTAG Compatibility Statement

The TMS320DM643 DSP 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 DSP core, $\overline{\text{TRST}}$ initializes the DSP's emulation logic. Both resets are required for proper operation.

**Note:** $\overline{\text{TRST}}$ is synchronous and ***must*** be clocked by TCLK; otherwise, BSCAN may not respond as expected after $\overline{\text{TRST}}$ is asserted.

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 DSP to boot properly. $\overline{\text{TRST}}$ may be asserted indefinitely for normal operation, keeping the JTAG port interface and DSP'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 DSP or exercise the DSP's boundary scan functionality. $\overline{\text{RESET}}$ 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 $\overline{\text{RESET}}$.

The TMS320DM643 DSP includes an internal pulldown (IPD) on the $\overline{\text{TRST}}$ pin to ensure that $\overline{\text{TRST}}$ will always be asserted upon power up and the DSP's internal emulation logic will always be properly initialized when this pin is not routed out. 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 intialize the DSP 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.

**Note:** The DESIGN_WARNING section of the TMS320DM643 BSDL file contains information and constraints regarding proper device operation while in Boundary Scan Mode.

#### 5.19.1.2 JTAG ID Register Description

The JTAG ID register is a read-only register that identifies to the customer the JTAG/Device ID. For the DM643 device, the JTAG ID register resides at address location 0x01B3 F008. The register hex value for the DM643 device is: 0x0007 902F. For the actual register bit names and their associated bit field descriptions, see Figure 5-69 and Table 5-79.

| 31-28 | 27-12 | 11-1 | 0 |
|---|---|---|---|
| VARIANT (4-Bit) | PART NUMBER (16-Bit) | MANUFACTURER (11-Bit) | LSB |
| R-0000 | R-0000 0000 0111 1001 | R-0000 0010 111 | R-1 |

**Legend**: R = Read only, *-n* = value after reset

**Figure 5-69. JTAG ID Register Description – TMS320DM643 Register Value – 0x0007 902F**

**Table 5-79. JTAG ID Register Selection Bit Descriptions**

| BIT | NAME | DESCRIPTION |
|---|---|---|
| 31:28 | VARIANT | Variant (4-Bit) value. DM643 value: 0000. |
| 27:12 | PART NUMBER | Part Number (16-Bit) value. DM643 value: 0000 0000 0111 1001. |
| 11–1 | MANUFACTURER | Manufacturer (11-Bit) value. DM643 value: 0000 0010 111. |
| 0 | LSB | LSB. This bit is read as a "1" for DM643. |

### 5.19.2 JTAG Peripheral Register Description(s)

**Table 5-80. JTAG ID Register**

| HEX ADDRESS RANGE | ACRONYM | REGISTER NAME | COMMENTS |
|---|---|---|---|
| 01B3 F008 | JTAGID | JTAG Identification Register | Read-only. Provides 32-bit JTAG ID of the device. |

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

**Table 5-81. Timing Requirements for JTAG Test Port (see Figure 5-70)**

| NO. | | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 1 | $t_{c(TCK)}$ | Cycle time, TCK | 35 | | ns |
| 3 | $t_{su(TDIV-TCKH)}$ | Setup time, TDI/TMS/$\overline{TRST}$ valid before TCK high | 10 | | ns |
| 4 | $t_{h(TCKH-TDIV)}$ | Hold time, TDI/TMS/$\overline{TRST}$ valid after TCK high | 9 | | ns |

**Table 5-82. Switching Characteristics Over Recommended Operating Conditions for JTAG Test Port (see Figure 5-70)**

| NO. | PARAMETER | | –500 –600 | | UNIT |
|---|---|---|---|---|---|
| | | | MIN | MAX | |
| 2 | $t_{d(TCKL-TDOV)}$ | Delay time, TCK low to TDO valid | 0 | 18 | ns |

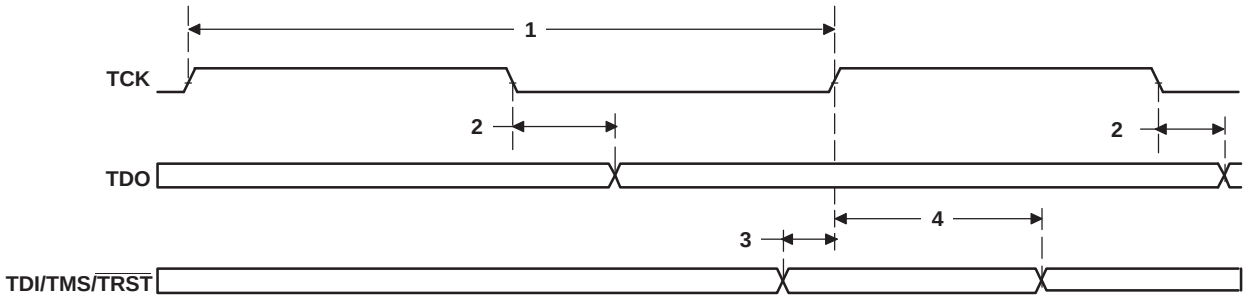



**Figure 5-70. JTAG Test-Port Timing**


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# 6 Revision History

This data sheet revision history highlights the technical changes made to the SPRS269C device-specific data sheet to make it a SPRS269D revision.

| SEE | ADDS/CHANGES/DELETES |
|---|---|
| Section 4.3 | Added note regarding $V_{OH}$ and $V_{OL}$. |

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# 7 Mechanical Data

The following table(s) show the thermal resistance characteristics for the PBGA − GDK, GNZ, ZDK, and ZNZ mechanical packages.

## 7.1 Thermal Data

**Table 7-1. Thermal Resistance Characteristics (S-PBGA Package) [GDK]**

| NO. | | | °C/W | AIR FLOW (m/s)(1) |
|---|---|---|---|---|
| 1 | $R\Theta_{JC}$ | Junction-to-case | 3.3 | N/A |
| 2 | $R\Theta_{JB}$ | Junction-to-board | 7.92 | N/A |
| 3 | $R\Theta_{JA}$ | Junction-to-free air | 18.2 | 0.00 |
| 4 | | | 15.3 | 0.5 |
| 5 | | | 13.7 | 1.0 |
| 6 | | | 12.2 | 2.00 |
| 7 | $Psi_{JT}$ | Junction-to-package top | 0.37 | 0.00 |
| 8 | | | 0.47 | 0.5 |
| 9 | | | 0.57 | 1.0 |
| 10 | | | 0.7 | 2.00 |
| 11 | $Psi_{JB}$ | Junction-to-board | 11.4 | 0.00 |
| 12 | | | 11 | 0.5 |
| 13 | | | 10.7 | 1.0 |
| 14 | | | 10.2 | 2.00 |

(1) m/s = meters per second

**Table 7-2. Thermal Resistance Characteristics (S-PBGA Package) [GNZ]**

| NO. | | | °C/W | AIR FLOW (m/s)(1) |
|---|---|---|---|---|
| 1 | $R\Theta_{JC}$ | Junction-to-case | 3.3 | N/A |
| 2 | $R\Theta_{JB}$ | Junction-to-board | 7.46 | N/A |
| 3 | $R\Theta_{JA}$ | Junction-to-free air | 17.4 | 0.00 |
| 4 | | | 14.0 | 0.5 |
| 5 | | | 12.3 | 1.0 |
| 6 | | | 10.8 | 2.00 |
| 7 | $Psi_{JT}$ | Junction-to-package top | 0.37 | 0.00 |
| 8 | | | 0.47 | 0.5 |
| 9 | | | 0.57 | 1.0 |
| 10 | | | 0.7 | 2.00 |
| 11 | $Psi_{JB}$ | Junction-to-board | 11.4 | 0.00 |
| 12 | | | 11 | 0.5 |
| 13 | | | 10.7 | 1.0 |
| 14 | | | 10.2 | 2.00 |

(1) m/s = meters per second

**Table 7-3. Thermal Resistance Characteristics (S-PBGA Package) [ZDK]**

| NO. | | | °C/W | AIR FLOW (m/s)(1) |
|---|---|---|---|---|
| 1 | $R\Theta_{JC}$ | Junction-to-case | 3.3 | N/A |
| 2 | $R\Theta_{JB}$ | Junction-to-board | 7.92 | N/A |

(1) m/s = meters per second


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**Table 7-3. Thermal Resistance Characteristics (S-PBGA Package) [ZDK] (continued)**

| NO. | | | °C/W | AIR FLOW (m/s)(1) |
|---|---|---|---|---|
| 3 | $R\Theta_{JA}$ | Junction-to-free air | 18.2 | 0.00 |
| 4 | | | 15.3 | 0.5 |
| 5 | | | 13.7 | 1.0 |
| 6 | | | 12.2 | 2.00 |
| 7 | $Psi_{JT}$ | Junction-to-package top | 0.37 | 0.00 |
| 8 | | | 0.47 | 0.5 |
| 9 | | | 0.57 | 1.0 |
| 10 | | | 0.7 | 2.00 |
| 11 | $Psi_{JB}$ | Junction-to-board | 11.4 | 0.00 |
| 12 | | | 11 | 0.5 |
| 13 | | | 10.7 | 1.0 |
| 14 | | | 10.2 | 2.00 |

**Table 7-4. Thermal Resistance Characteristics (S-PBGA Package) [ZNZ]**

| NO. | | | °C/W | AIR FLOW (m/s) (1) |
|---|---|---|---|---|
| 1 | $R\Theta_{JC}$ | Junction-to-case | 3.3 | N/A |
| 2 | $R\Theta_{JB}$ | Junction-to-board | 7.46 | N/A |
| 3 | $R\Theta_{JA}$ | Junction-to-free air | 17.4 | 0.00 |
| 4 | | | 14.0 | 0.5 |
| 5 | | | 12.3 | 1.0 |
| 6 | | | 10.8 | 2.00 |
| 7 | $Psi_{JT}$ | Junction-to-package top | 0.37 | 0.00 |
| 8 | | | 0.47 | 0.5 |
| 9 | | | 0.57 | 1.0 |
| 10 | | | 0.7 | 2.00 |
| 11 | $Psi_{JB}$ | Junction-to-board | 11.4 | 0.00 |
| 12 | | | 11 | 0.5 |
| 13 | | | 10.7 | 1.0 |
| 14 | | | 10.2 | 2.00 |

(1) m/s = meters per second

## 7.2 Packaging Information

The following packaging information and addendum reflect the most current released data available for the designated device(s). This data is subject to change without notice and without revision of this document.

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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TMS320DM643ACNZ6 | Active | Production | FCBGA (CNZ) \| 548 | 40 \| JEDEC TRAY (5+1) | Yes | Call TI | Level-4-260C-72HR | 0 to 90 | TMS320DM643ACNZ @ 2003 TI |
| TMS320DM643AGNZ5 | NRND | Production | FCBGA (GNZ) \| 548 | 40 \| JEDEC TRAY (5+1) | No | SNPB | Level-4-220C-72 HR | 0 to 90 | TMS320DM643A @ 2003 TI GNZ 500 |
| TMS320DM643AGNZ5.A | NRND | Production | FCBGA (GNZ) \| 548 | 40 \| JEDEC TRAY (5+1) | No | SNPB | Level-4-220C-72 HR | 0 to 90 | TMS320DM643A @ 2003 TI GNZ 500 |
| TMS320DM643AZDK6 | Last Time Buy | Production | FCBGA (ZDK) \| 548 | 60 \| JEDEC TRAY (5+1) | ROHS Exempt | SNAGCU | Level-4-260C-72HR | 0 to 90 | TMS320DM643A @ 2003 TI ZDK |
| TMS320DM643AZDK6.A | Last Time Buy | Production | FCBGA (ZDK) \| 548 | 60 \| JEDEC TRAY (5+1) | ROHS Exempt | SNAGCU | Level-4-260C-72HR | 0 to 90 | TMS320DM643A @ 2003 TI ZDK |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

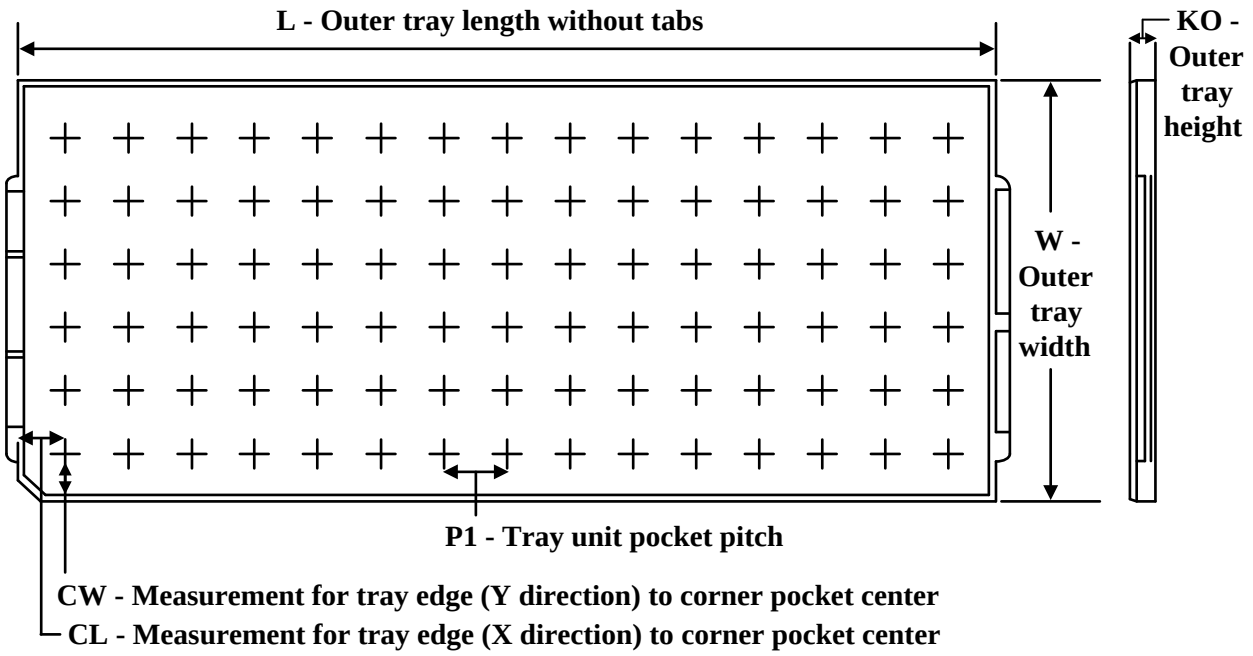
(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TRAY

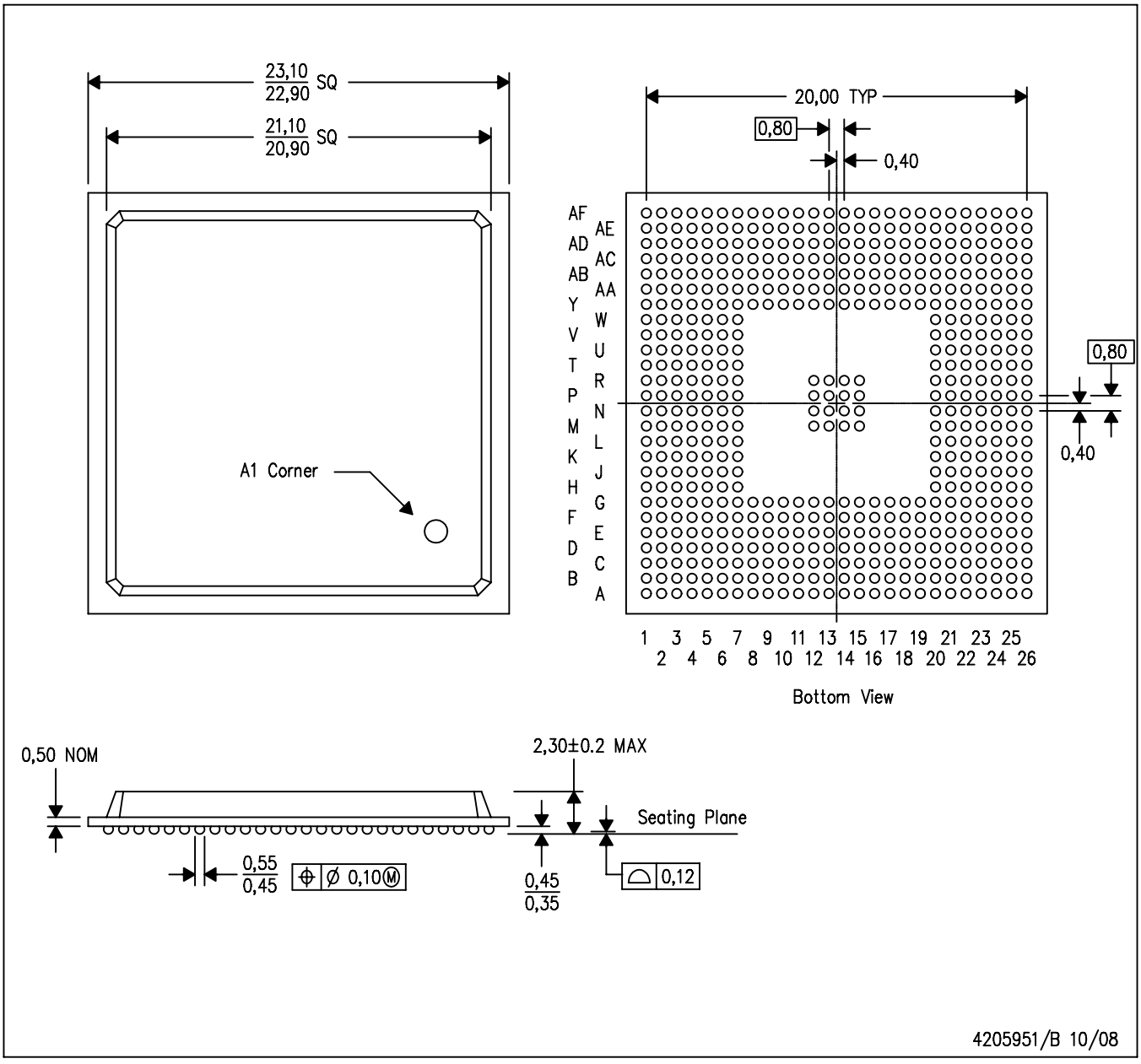



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

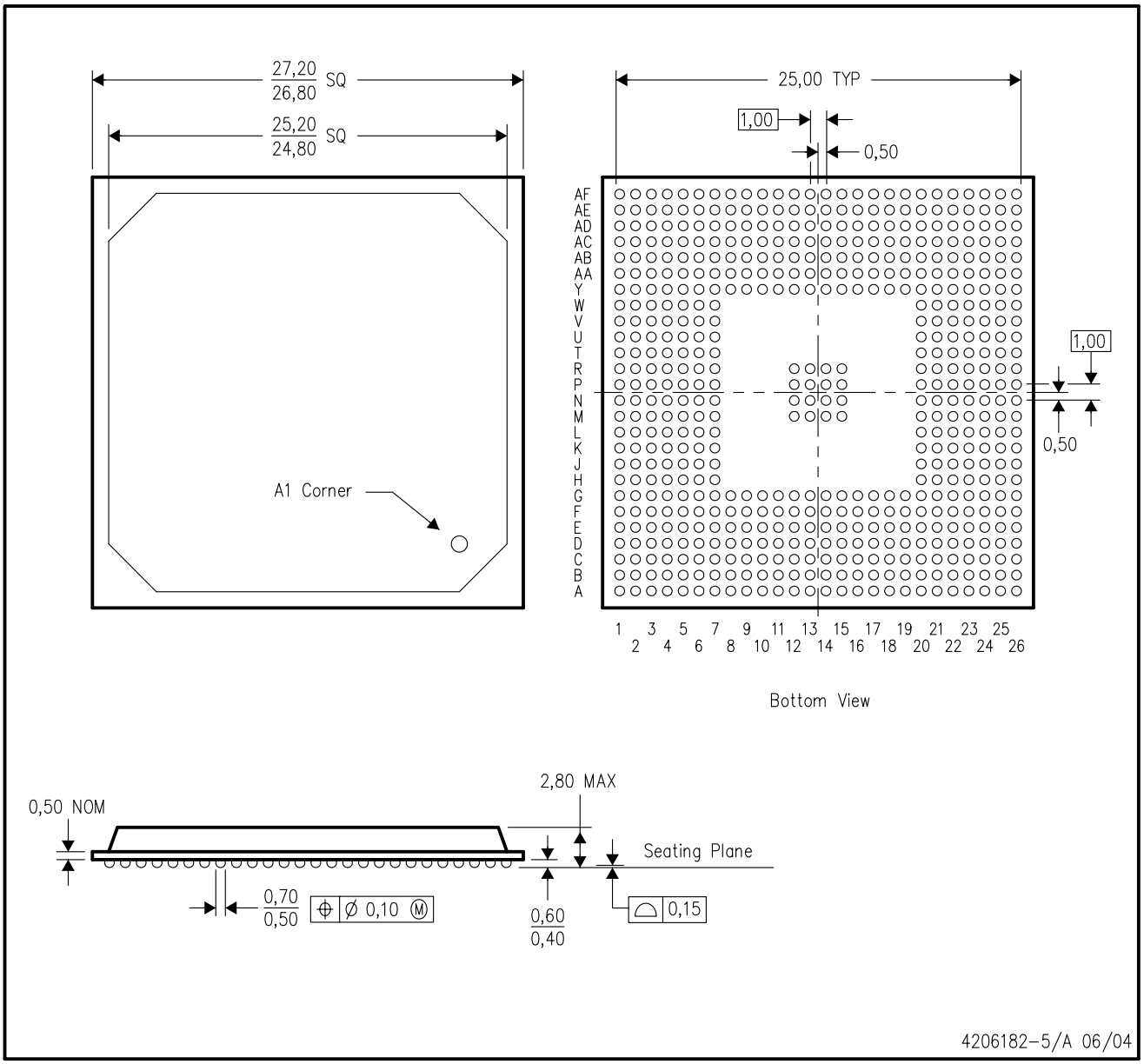
| Device | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (µm) | P1 (mm) | CL (mm) | CW (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TMS320DM643ACNZ6 | CNZ | FCBGA | 548 | 40 | 4x10 | 150 | 315 | 135.9 | 7620 | 29.2 | 26.1 | 24.15 |
| TMS320DM643AGNZ5 | GNZ | FCBGA | 548 | 40 | 4x10 | 150 | 315 | 135.9 | 7620 | 29.2 | 26.1 | 24.15 |
| TMS320DM643AGNZ5.A | GNZ | FCBGA | 548 | 40 | 4x10 | 150 | 315 | 135.9 | 7620 | 29.2 | 26.1 | 24.15 |
| TMS320DM643AZDK6 | ZDK | FCBGA | 548 | 60 | 5 X 12 | 150 | 315 | 135.9 | 7620 | 25.5 | 17.25 | 16.95 |
| TMS320DM643AZDK6.A | ZDK | FCBGA | 548 | 60 | 5 X 12 | 150 | 315 | 135.9 | 7620 | 25.5 | 17.25 | 16.95 |

ZDK (S–PBGA–N548) PLASTIC BALL GRID ARRAY



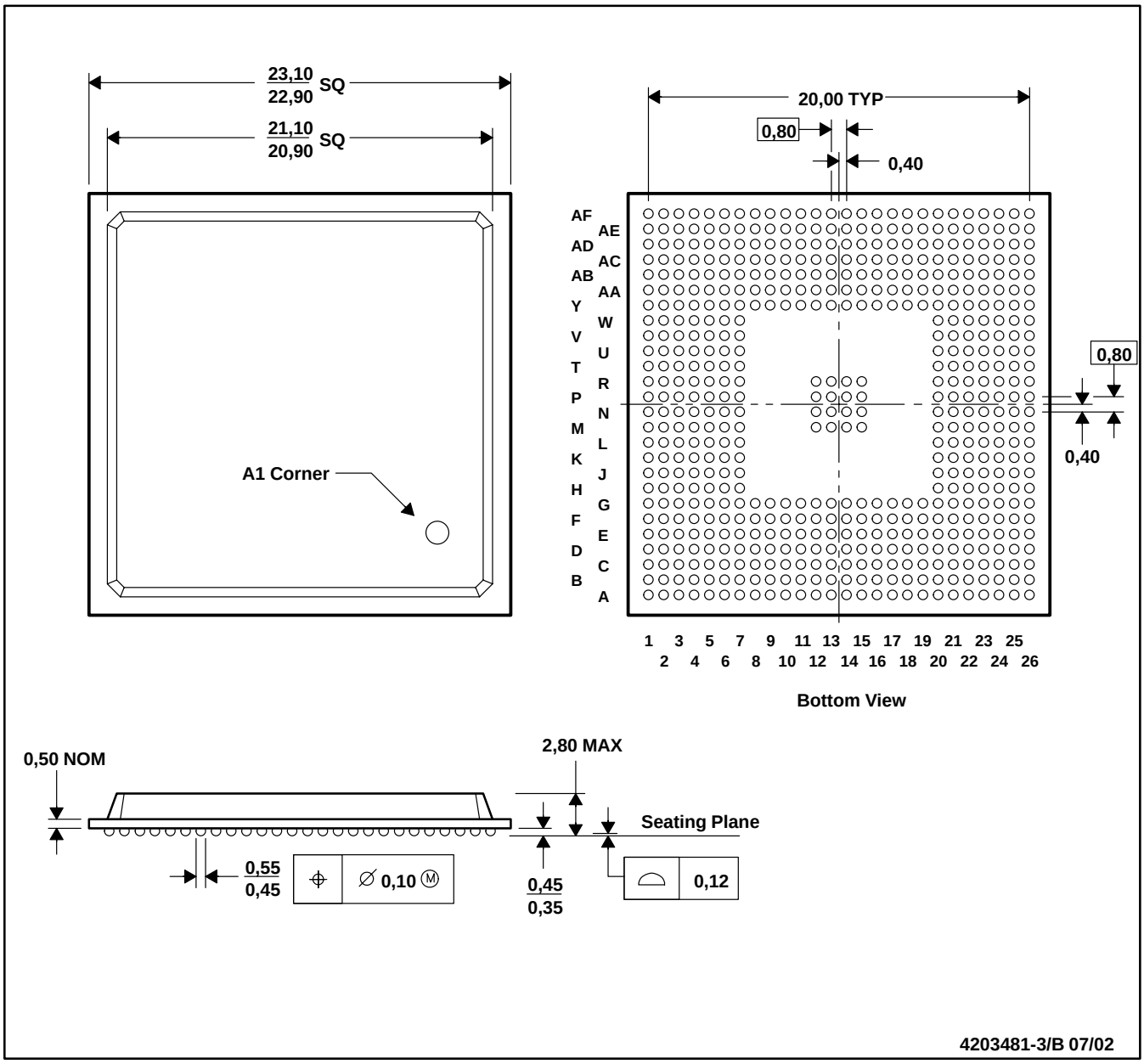

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Flip chip application only.
D. This package is lead–free.

## ZNZ (S–PBGA–N548) PLASTIC BALL GRID ARRAY




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Flip chip application only.
D. Substrate color may vary.
E. This package is lead–free.

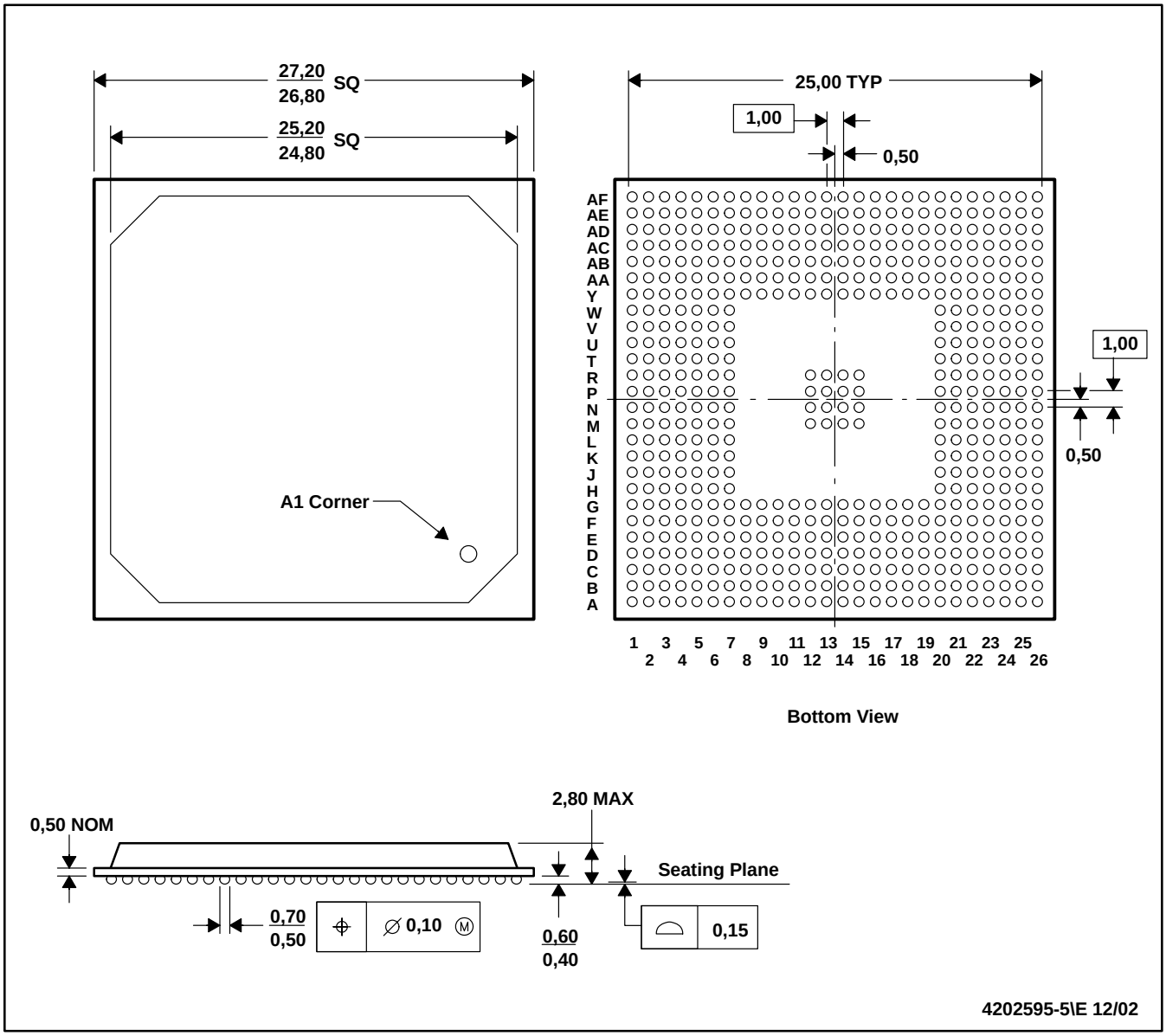
**GDK (S–PBGA–N548)** **PLASTIC BALL GRID ARRAY**




NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Flip chip application only.

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**GNZ (S–PBGA–N548)** **PLASTIC BALL GRID ARRAY**




NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Flip chip application only.
D. Substrate color may vary.

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Last updated 10/2025