TMS320C6452
DSP Subsystem

Reference Guide

Literature Number: SPRUFB1B
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About This Manual

This document describes the DSP subsystem in the TMS320C6452 device.

Notational Conventions

This document uses the following conventions.

- Hexadecimal numbers are shown with the suffix h. For example, the following number is 40 hexadecimal (decimal 64): 40h.
- Registers in this document are shown in figures and described in tables.
  - Each register figure shows a rectangle divided into fields that represent the fields of the register. Each field is labeled with its bit name, its beginning and ending bit numbers above, and its read/write properties below. A legend explains the notation used for the properties.
  - Reserved bits in a register figure designate a bit that is used for future device expansion.

Related Documents From Texas Instruments

The following documents describe the TMS320C6452 Digital Signal Processor (DSP). Copies of these documents are available on the Internet at www.ti.com. *Tip:* Enter the literature number in the search box provided at www.ti.com.

Data Manual—

SPRS371 —***TMS320C6452 Digital Signal Processor Data Manual*** describes the signals, specifications and electrical characteristics of the device.

CPU—

SPRU732 — ***TMS320C64x/C64x+ DSP CPU and Instruction Set Reference Guide*** describes the CPU architecture, pipeline, instruction set, and interrupts for the TMS320C64x and TMS320C64x+ digital signal processors (DSPs) of the TMS320C6000 DSP family. The C64x/C64x+ DSP generation comprises fixed-point devices in the C6000 DSP platform. The C64x+ DSP is an enhancement of the C64x DSP with added functionality and an expanded instruction set.

Reference Guides—

SPRUF85 —***C6452 DSP DDR2 Memory Controller User's Guide*** describes the DDR2 memory controller in the TMS320C6452 Digital Signal Processor (DSP). The DDR2/mDDR memory controller is used to interface with JESD79D-2A standard compliant DDR2 SDRAM devices and standard Mobile DDR SDRAM devices.

SPRUF86 —***C6452 Peripheral Component Interconnect (PCI) User's Guide*** describes the peripheral component interconnect (PCI) port in the TMS320C6452 Digital Signal Processor (DSP). The PCI port supports connection of the C642x DSP to a PCI host via the integrated PCI master/slave bus interface. The PCI port interfaces to the DSP via the enhanced DMA (EDMA) controller. This architecture allows for both PCI master and slave transactions, while keeping the EDMA channel resources available for other applications.

SPRUF87 —***C6452 DSP Host Port Interface (UHPI) User's Guide*** describes the host port interface (HPI) in the TMS320C6452 Digital Signal Processor (DSP). 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 direct memory access (EDMA) controller.

SPRUF89 —***C6452 DSP VLYNQ Port User's Guide*** describes the VLYNQ port in the TMS320C6452 Digital Signal Processor (DSP). The VLYNQ port is a high-speed point-to-point serial interface for connecting to host processors and other VLYNQ compatible devices. It is a full-duplex serial bus where transmit and receive operations occur separately and simultaneously without interference.

SPRUF90 —***C6452 DSP 64-Bit Timer User's Guide*** describes the operation of the 64-bit timer in the C6452 Digital Signal Processor (DSP). The timer can be configured as a general-purpose 64-bit timer or dual general-purpose 32-bit timers.

SPRUF91 —***C6452 DSP Multichannel Audio Serial Port (McASP) User's Guide*** describes the multichannel audio serial port (McASP) in the C6452 Digital Signal Processor (DSP). 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).

SPRUF92 —***C6452 DSP Serial Port Interface (SPI) User's Guide*** discusses the Serial Port Interface (SPI) in the C6452 Digital Signal Processor (DSP). This reference guide provides the specifications for a 16-bit configurable, synchronous serial peripheral interface. The SPI is a programmable-length shift register, used for high speed communication between external peripherals or other DSPs.

SPRUF93 —***C6452 DSP Universal Asynchronous Receiver/Transmitter (UART) User's Guide*** describes the universal asynchronous receiver/transmitter (UART) peripheral in the C6452 Digital Signal Processor (DSP). The UART peripheral performs serial-to-parallel conversion on data received from a peripheral device, and parallel-to-serial conversion on data received from the CPU.

SPRUF94 —***C6452 DSP Inter-Integrated Circuit (I2C) Module User's Guide*** describes the inter-integrated circuit (I2C) peripheral in the C6452 Digital Signal Processor (DSP). The I2C peripheral provides an interface between the DSP and other devices compliant with the I2C-bus specification and connected by way of an I2C-bus. External components attached to this 2-wire serial bus can transmit and receive up to 8-bit wide data to and from the DSP through the I2C peripheral. This document assumes the reader is familiar with the I2C-bus specification.

SPRUF95 —***C6452 DSP General-Purpose Input/Output (GPIO) User's Guide*** describes the general-purpose input/output (GPIO) peripheral in the C6452 Digital Signal Processor (DSP). The GPIO peripheral provides dedicated general-purpose pins that can be configured as either inputs or outputs. When configured as an input, you can detect the state of the input by reading the state of an internal register. When configured as an output, you can write to an internal register to control the state driven on the output pin.

SPRUF96 —***C6452 DSP Telecom Serial Interface Port (TSIP) User's Guide*** is a multi-link serial interface consisting of a maximum of two transmit data signals (or links), two receive data signals (or links), two frame sync input signals, and two serial clock inputs. Internally the TSIP offers single channel of timeslot data management and single DMA capability that allow individual timeslots to be selectively processed.

SPRUF97 —***TMS320C6452 DSP 3 Port Switch (3PSW) Ethernet Subsystem User's Guide*** describes the operation of the 3 port switch (3PSW) ethernet subsystem in the TMS320C6452 Digital Signal Processor (DSP). The 3 port switch gigabit ethernet subsystem provides ethernet packet communication and can be configured as an ethernet switch. It provides the serial gigabit media independent interface (SGMII), the management data input output (MDIO) for physical layer device (PHY) management.

Introduction

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1.1 Introduction

The TMS320C6452 contains a powerful DSP to handle telecom, infrastructure, imaging/medical, and communications tasks efficiently. The device consists of the following primary components and sub-systems:

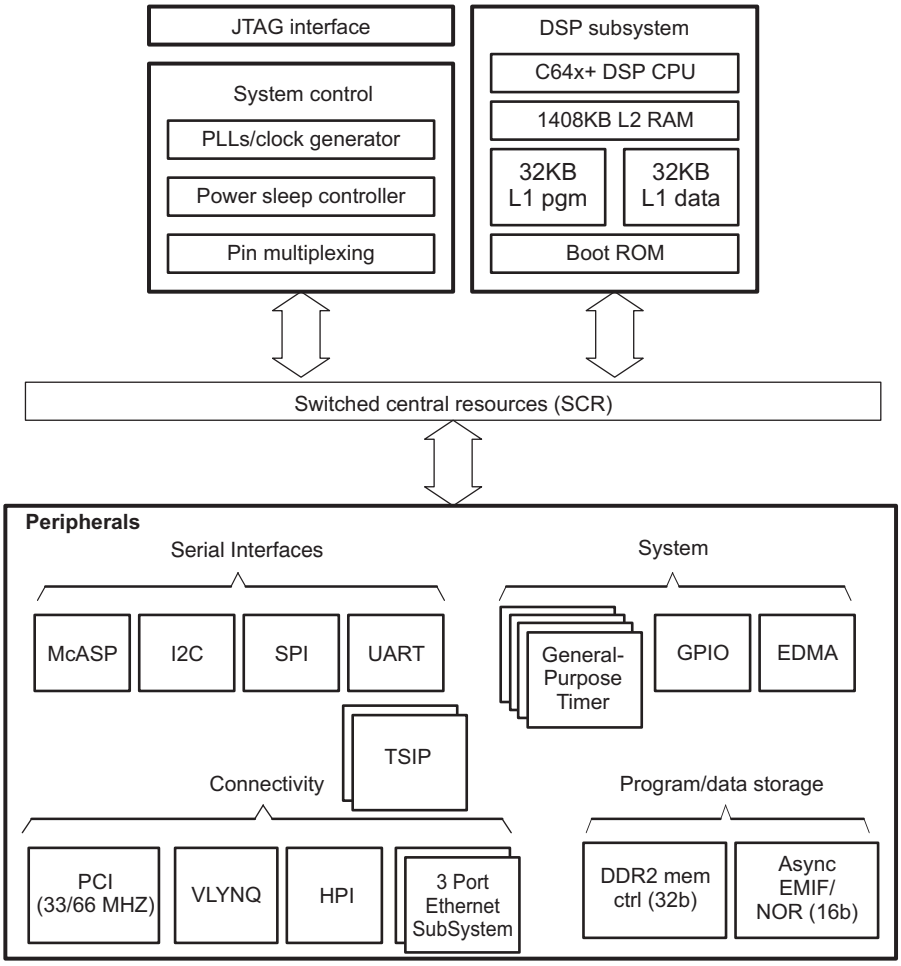
- DSP Subsystem (DSPSS), including the C64x+ Megamodule and associated memory
- Ethernet Subsystem
- Set of I/O peripherals
- Powerful DMA subsystem and DDR2 memory controller interface

The DSP subsystem includes TI's standard TMS320C64x+ Megamodule and several blocks of internal memory (L1P, L1D, and L2). For more information, see the *TMS320C64x+ DSP Megamodule Peripherals Reference Guide* (SPRU871), the *TMS320C64x/C64x+ DSP CPU and Instruction Set Reference Guide* (SPRU732), and the *TMS320C64x+ DSP Cache User's Guide* (SPRU862).

1.2 Block Diagram

An example block diagram for the TMS320C6452 is shown in Figure 1-1.

Figure 1-1. C6452 Block Diagram



1.3 DSP Subsystem in TMS320C6452

In the C6452, the DSP subsystem is responsible for performing digital signal processing for telecom infrastructure, imaging/medical, and communications applications. In addition, the DSP subsystem acts as the overall system controller, responsible for handling many system functions such as system-level initialization, configuration, user interface, user command execution, connectivity functions, and overall system control.

1.3.1 Components of the DSP Subsystem

The DSP subsystem in the C6452 consists of the following components:

- C64x+ Megamodule
- DSP Internal Memories
  - Level-1 program memory (L1P)
  - Level-1 data memory (L1D)
  - Level-2 unified memory (L2)

The DSP also manages/controls all peripherals on the device. See the device-specific data manual for the full list of peripherals.

shows the functional block diagram of the C6452 and how the DSP subsystem is connected to the rest of the device. The C6452 architecture uses the System Infrastructure (Switched Central Resource) to transfer data within the system.

Chapter 2 discusses the C64x+ Megamodule in more details, including its detailed block diagram.

TMS320C64x+ Megamodule

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2.1 Introduction

The C64x+ Megamodule (Figure 2-1) consists of the following components:

- TMS320C64x+ CPU
- Internal memory controllers:
  - Level-1 program memory controller (L1P controller)
  - Level-1 data memory controller (L1D controller)
  - Level-2 unified memory controller (L2 controller)
  - External memory controller (EMC)
  - Internal direct memory access (IDMA) controller
- Internal peripherals
  - Interrupt controller (INTC)
  - Power-down controller (PDC)
- Advanced Event Triggering (AET)

2.2 TMS320C64x+ CPU

The C64x+ Megamodule includes the C64x+ CPU. The C64x+ CPU is a member of the TMS320C6000™ generation of devices. The C6000™ devices execute up to eight 32-bit instructions per cycle. The CPU consists of 64 general-purpose 32-bit registers and eight functional units. The eight functional units contain two multipliers and six ALUs. For more information on the CPU, see the *TMS320C64x/C64x+ DSP CPU and Instruction Set Reference Guide* (SPRU732).

Features of the C6000 devices include:

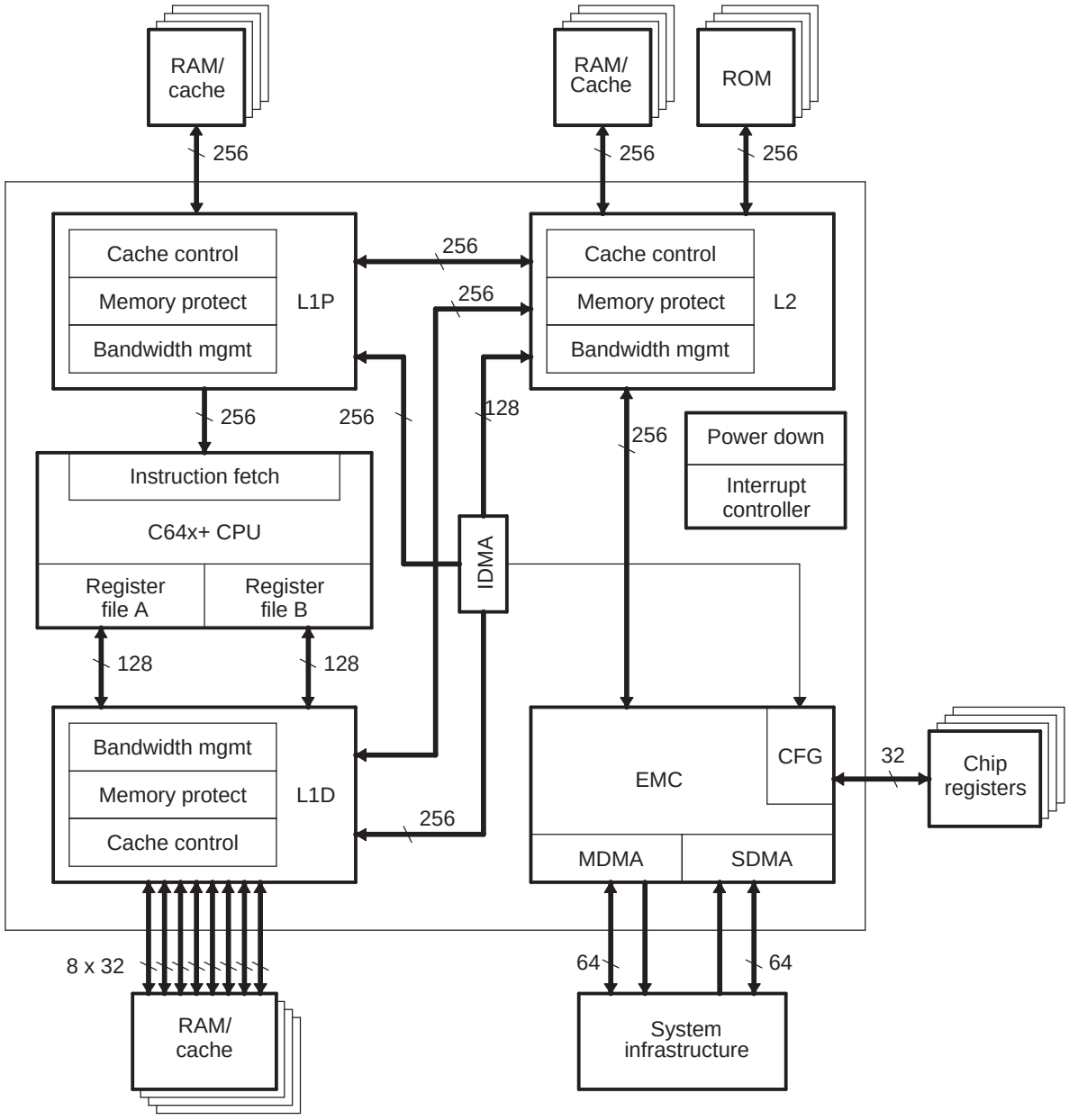
- Advanced VLIW CPU with eight functional units, including two multipliers and six arithmetic units
  - Executes up to eight instructions per cycle for up to ten times the performance of typical DSPs
  - Allows designers to develop highly effective RISC-like code for rapid development time
- Instruction packing
  - Gives code-size equivalence for eight instructions that execute serially or in parallel
  - Reduces code size, program fetches, and power consumption
- Conditional execution of most instructions
  - Reduces costly branching
  - Increases parallelism for higher sustained performance
- Efficient code execution on independent functional units
  - Industry's most efficient C compiler on DSP benchmark suite
  - Industry's first assembly optimizer for rapid development and improved parallelization
- 8/16/32-bit data support, providing efficient memory support for a variety of applications
- 40-bit arithmetic options add extra precision for vocoders and other computationally intensive applications
- Saturation and normalization provide support for key arithmetic operations
- Field manipulation and instruction extract, set, clear, and bit counting support a common operation found in control and data manipulation applications

The C64x+ devices include the following additional features:

- Each multiplier can perform two 16 × 16-bit or four 8 × 8-bit multiplies every clock cycle
- Quad 8-bit and dual 16-bit instruction set extensions with data flow support
- Support for nonaligned 32-bit (word) and 64-bit (double word) memory accesses
- Special communication-specific instructions to address common operations in error-correcting codes
- Bit count and rotate hardware extends support for bit-level algorithms

- Compact instructions: common instructions (AND, ADD, LD, MPY) have 16-bit versions to reduce code size
- Protected mode operation: a two-level system of privileged program execution to support higher capability operating systems and system features, such as memory protection
- Exceptions support for error detection and program redirection to provide robust code execution
- Hardware support for modulo loop operation to reduce code size
- Industry's first assembly optimizer for rapid development and improved parallelization

Figure 2-1. TMS320C64x+ Megamodule Block Diagram



2.3 Memory Controllers

The C64x+ Megamodule implements a two-level internal cache-based memory architecture with external memory support. Level 1 memory is split into separate program memory (L1P memory) and data memory (L1D memory). Figure 2-2 shows a diagram of the memory architecture. L1P and L1D are configurable as part L1 RAM (normal addressable on-chip memory) and part L1 cache. L1 memory is accessible to the CPU without stalls. Level 2 memory (L2) can also be split into L2 RAM (normal addressable on-chip memory) and L2 cache for caching external memory locations.

The following controllers manage RAM/cache configuration and cache data paths:

- L1P controller
- L1D controller
- L2 controller
- External memory controller (EMC)

The internal direct memory access (IDMA) controller manages DMA among the L1P, L1D, and L2 memories.

This section briefly describes the cache and DMA controllers. For detailed information about each of these controllers, see the *TMS320C64x+ DSP Cache User's Guide* (SPRU862) and the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871).

Note: The C64x+ Megamodule includes the memory controllers; however, the physical L1P, L1D, and L2 memories are not part of the megamodule, even though they reside in the DSP subsystem. Thus, the physical memories are described separately because the C64x+ Megamodule supports a variety of memory configurations. See the Section 3.1 for more information on the L1P, L1D, and L2 memory configuration specific to the C6452.

2.3.1 L1P Controller

The L1P controller is the hardware interface between level 1 program memory (L1P memory) and the other components in the C64x+ Megamodule (for example, C64x+ CPU, L2 controller, and EMC). The L1P controller responds to instruction fetch requests from the C64x+ CPU and manages transfer operations between L1P memory and the L2 controller and between L1P memory and the EMC.

See the device-specific data manual for the amount of L1P memory on the device. The L1P controller has a register interface that allows you to configure part or all of the L1P RAM as normal RAM or as cache. You can configure cache sizes of 0 KB, 4 KB, 8 KB, 16 KB, or 32 KB of the RAM.

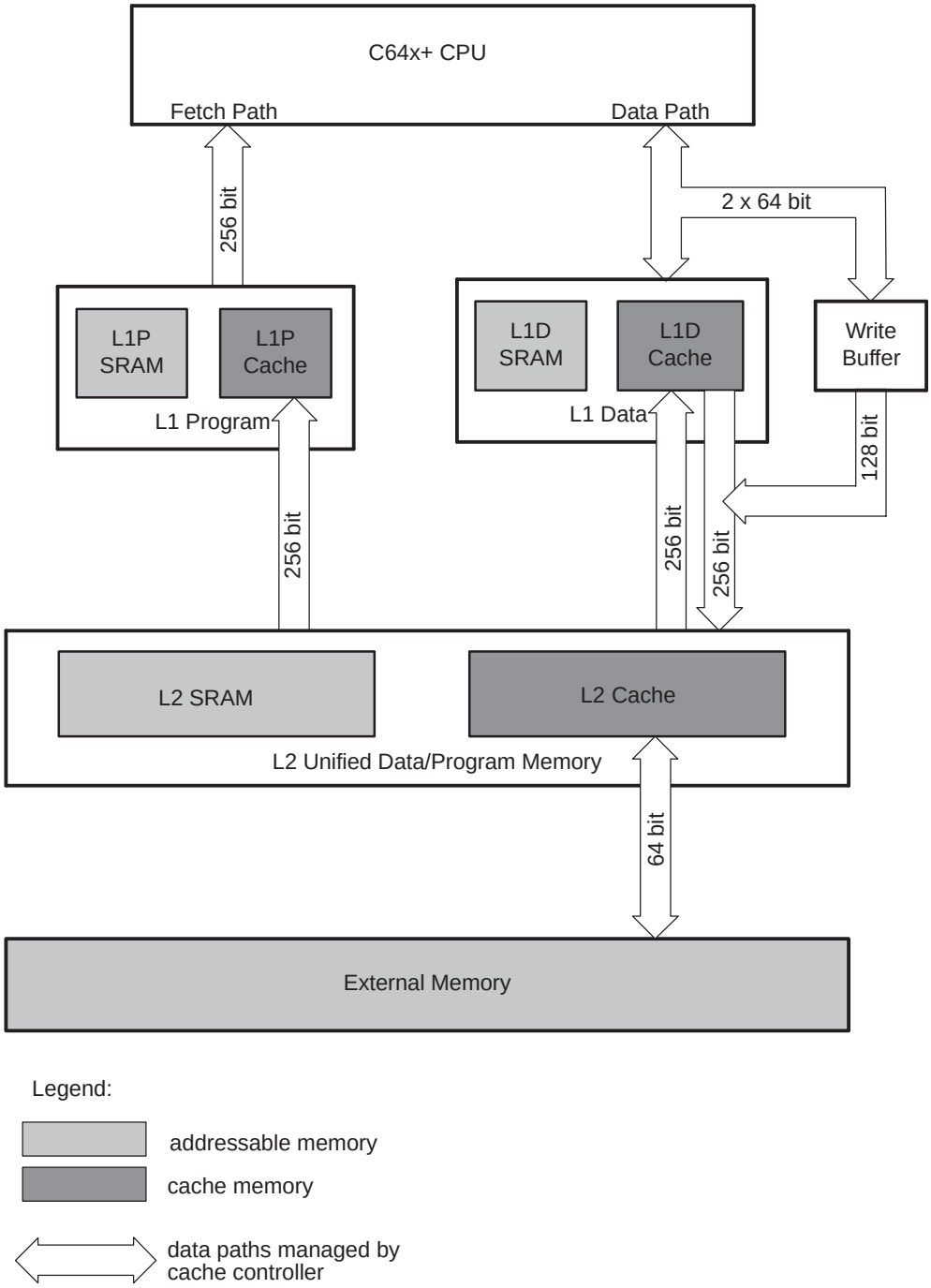
The L1P is divided into two regions—denoted L1P region 0 and L1P region 1. This is the L1P architecture on the C6452:

- L1P region 0: Not populated with memory.
- L1P region 1: Populated with memory that can be configured as mapped memory or cache. The L1P region 1 memory has 0 wait states. This region is shown as "L1P RAM/Cache" in the device-specific data manual.

The C6452 supports the L1P memory protection feature of the standard C64x+ Megamodule.

See the *TMS320C64x+ DSP Cache User's Guide* (SPRU862) and to the L1P controller section of the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the L1P controller, description of its control registers and memory protection features.

Figure 2-2. C64x+ Cache Memory Architecture



2.3.2 L1D Controller

The L1D controller is the hardware interface between level 1 data memory (L1D memory) and the other components in the C64x+ Megamodule (for example, C64x+ CPU, L2 controller, and EMC). The L1D controller responds to data requests from the C64x+ CPU and manages transfer operations between L1D memory and the L2 controller and between L1D memory and the EMC.

See the device-specific data manual for the amount of L1D memory on the device. The L1D controller has a register interface that allows you to configure part of the L1D RAM as normal data RAM or as cache. You can configure cache sizes of 0 KB, 4 KB, 8 KB, 16 KB, or 32 KB of the RAM.

The L1D is divided into two regions—denoted L1D region 0 and L1D region 1. This is the L1D architecture on the C6452:

- L1D region 0: Not populated with memory.
- L1D region 1: Populated with memory that can be configured as mapped memory or cache. This region is shown as “L1D RAM/Cache” in the device-specific data manual.

The C6452 supports the L1D memory protection features of the standard C64x+ Megamodule.

See the *TMS320C64x+ DSP Cache User’s Guide* (SPRU862) and to the L1D controller section of the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the L1D controller, description of its control registers and memory protection features.

2.3.3 L2 Controller

The L2 controller is the hardware interface between level 2 memory (L2 memory) and the other components in the C64x+ Megamodule (for example, L1P controller, L1D controller, and EMC). The L2 controller manages transfer operations between L2 memory and the other memory controllers (L1P controller, L1D controller, and EMC).

See device-specific data manual for the amount of L2 memory on the device. The L2 controller has a register interface that allows you to configure part or all of the L2 RAM as normal RAM or as cache. You can configure cache sizes of 0 KB, 32 KB, 64 KB, 128 KB, or 256 KB of the RAM.

The L2 memory implements one memory port with the following architecture:

- Port 0
  - L2 RAM/Boot ROM
  - Banking scheme:4 × 128-bit banks
  - Latency: 2 cycle

The C6452 supports the L2 memory protection feature of the standard C64x+ Megamodule.

See the *TMS320C64x+ DSP Cache User’s Guide* (SPRU862) and to the L2 controller section of the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the L2 controller, description of its control registers and memory protection features.

2.3.4 Memory Protection

Memory protection allows an operating system to define who or what is authorized to access L1D, L1P, and L2 memory. To accomplish this, the L1D, L1P, and L2 Controllers divide the memory they control into pages. Region 1 of the L1D Controller has 16 pages at 2KB each, Region 1 of the L1P Controller has 16 pages at 2KB each, and Port 0 of the L2 Controller has 32 pages at 128KB each. (Note: The L2 Port 0 pages are contiguous and span the 4MByte address range from 0x00800000-0x00BFFFFF, covering the ROM, RAM, and Reserved regions of the memory map.) The DMC, PMC, and UMC memory controllers in the C64x+ Megamodule are equipped with a set of registers that specify the permissions for each memory page: L1DMPPA[31:16] for L1D Region 1 , L1PMPPA[31:16] for L1P Region 1, and L2MPPA[31:0] for L2 Port 0. Registers L1DMPPA16, L1PMPPA16, and L2MPPA0 control the page at the smallest address in their respective memory map ranges; i.e. L1DMPPA16 controls the page at address 0x00F00000, L1DPMPPA16 controls the page at address 0x00E00000, and L2MPPA0 controls the page at address 0x00800000.

Each page can be assigned with fully orthogonal user and supervisor read, write, and execute permissions. Additionally, a page can be marked as either (or both) locally or globally accessible. A local access is a direct CPU access to L1D, L1P, and L2, while a global access is initiated by a DMA (either IDMA or the EDMA3) or by other system masters. EDMA or IDMA transfers programmed by the CPU count as global accesses. The CPU is assigned a privilege ID of 0 and all other system masters are all assigned a privilege ID of 1. Therefore, the AID0 field and AID1 field can be used to control accesses from the CPU and other system masters, respectively.

For more information on memory protection for L1D, L1P, and L2, see the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871).

2.3.5 External Memory Controller (EMC)

The external memory controller (EMC) is the hardware interface between the external memory map (external memory and external registers) and the other controllers in the C64x+ Megamodule (for example, L1P controller, L1D controller, and L2 controller). The EMC manages transfer operations between external memory and registers and the other memory controllers (L1P controller, L1D controller, and EMC).

EMC does not support the memory protection feature of the standard C64x+ Megamodule.

See the *TMS320C64x+ DSP Cache User's Guide* (SPRU862) and to the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the EMC and for a description of its control registers.

2.3.6 Internal DMA (IDMA)

The internal DMA (IDMA) controller facilitates DMA transfers between any two internal memory-mapped locations. Internal memory-mapped locations include L1P, L1D, L2, and internal peripheral configuration registers.

Note: The IDMA cannot facilitate DMA to or from external memory-mapped locations. The EDMA facilitates external DMA transfers. See Section 3.1 and the device-specific Enhanced Direct Memory Access (EDMA) Controller User's Guide for information on EDMA.

The IDMA controller enables the rapid paging of data sections to any local memory-mapped RAM. A key advantage of the IDMA is that it allows paging between slower L2 and faster L1D data memory. These transfers take place without CPU intervention and without cache stalls.

Another key advantage is that you can use the IDMA controller to program internal peripheral configuration registers without CPU intervention.

See the internal DMA (IDMA) controller section in the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the IDMA controller and for a description of its control registers.

2.4 Internal Peripherals

This C64x+ Megamodule includes the following internal peripherals:

- Interrupt controller (INTC)
- Power-down controller (PDC)

This section briefly describes the INTC and PDC.

2.4.1 Interrupt Controller (INTC)

The C64x+ Megamodule includes an interrupt controller (INTC) to manage CPU interrupts. The INTC maps the 0 to 127 DSP device events to 12 CPU interrupts. See device-specific data manual for a list of all the DSP device events. The interrupt controller section of the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) fully describes the INTC and how it maps the DSP device events to the 12 CPU interrupts.

2.4.2 Power-Down Controller (PDC)

The C64x+ Megamodule includes a power-down controller (PDC). The PDC can power-down all of the following components of the C64x+ Megamodule:

- C64x+ CPU
- L1P controller
- L1D controller
- L2 controller
- Extended memory controller (EMC)
- Internal direct memory access (IDMA) controller

The C6452 does not support power-down of the internal memories of the DSP subsystem.

The C64x+ Megamodule is capable of providing both dynamic and static power-down; however, only static power-down is supported on the C6452. The *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) describes the power-down control in more detail.

- Static power-down: The PDC initiates power down of the entire C64x+ Megamodule and all internal memories immediately upon command from software.

On the C6452, static power-down affects all components of the C64x+ Megamodule. The C6452 does not support power-down of the internal memories. Software can initiate static power-down via a register bit in the PDC register.

Note: The C6452 does not support dynamic power-down.

2.4.3 Bandwidth Manager

The bandwidth manager provides a programmable interface for optimizing bandwidth among the requesters for resources, which include the following:

- EDMA-initiated DMA transfers (and resulting coherency operations)
- IDMA-initiated transfers (and resulting coherency operations)
- Programmable cache coherency operations
  - Block based coherency operations
  - Global coherency operations
- CPU direct-initiated transfers
  - Data access (load/store)
  - Program access

The resources include the following:

- L1P memory
- L1D memory
- L2 memory
- Resources outside of C64x+ Megamodule: external memory, on-chip peripherals, registers

Since any given requestor could potentially block a resource for extended periods of time, the bandwidth manager is implemented to assure fairness for all requesters.

The bandwidth manager implements a weighted-priority-driven bandwidth allocation. Each requestor (EDMA, IDMA, CPU, etc.) is assigned a priority level on a per-transfer basis. The programmable priority level has a single meaning throughout the system. There are a total of nine priority levels, where priority zero is the highest priority and priority eight is the lowest priority. When requests for a single resource contend, access is granted to the highest-priority requestor. When the contention occurs for multiple successive cycles, a contention counter assures that the lower-priority requestor gets access to the resource every 1 out of *n* arbitration cycles, where *n* is programmable. A priority level of -1 represents a transfer whose priority has been increased due to expiration of the contention counter or a transfer that is fixed as the highest-priority transfer to a given resource.

2.5 Advanced Event Triggering (AET)

The C64x+ Megamodule supports Advanced Event Triggering (AET). This capability can be used to debug complex problems as well as understand performance characteristics of user applications. AET provides the following capabilities:

- **Hardware Program Breakpoints**: specify addresses or address ranges that can generate events such as halting the processor or triggering the trace capture.
- **Data Watchpoints**: specify data variable addresses, address ranges, or data values that can generate events such as halting the processor or triggering the trace capture.
- **Counters**: count the occurrence of an event or cycles for performance monitoring.
- **State Sequencing**: allows combinations of hardware program breakpoints and data watchpoints to precisely generate events for complex sequences.

System Memory

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3.1 Memory Map

See your device-specific data manual for memory-map information.

3.1.1 DSP Internal Memory (L1P, L1D, L2)

This section describes the configuration of the DSP internal memory in the C6452 that consists of L1P, L1D, and L2. In the C6452:

- L1P memory: The L1P controller allows you to configure part or all of the L1P RAM as normal program RAM or as direct mapped cache. You can configure cache sizes of 0 KB, 4 KB, 8 KB, 16 KB, or 32 KB of the RAM.
- L1D memory: The L1D controller allows you to configure part of the L1D RAM as normal data RAM or as cache. You can configure cache sizes of 0 KB, 4 KB, 8 KB, 16 KB, or 32 KB of the RAM.
- L2 memory: The L2 controller allows you to configure part or all of the L2 RAM as normal RAM or as cache. You can configure cache sizes of 0 KB, 32 KB, 64 KB, 128 KB, or 256 KB of the RAM.

See the device-specific data manual for the exact amount of RAM/cache. See the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for information on how to configure the cache.

3.1.2 External Memory

The DSP has access to the following external memories:

- DDR2 synchronous DRAM
- Asynchronous EMIF/NOR
- Synchronous EMIF

The external memory controller (EMC) facilitates DSP access to these memories in the C64x+ Megamodule. The following external memories are accessible to the DSP:

- DDR2 port
- Asynchronous EMIF
- Synchronous EMIF

For the memory-map locations of these external memories, See the memory-map section of the device-specific data manual.

3.1.3 Internal Peripherals

The following internal peripherals are accessible to the DSP:

- Power-down controller (PDC)
- Interrupt controller (INTC)

For more information on the internal peripherals, see the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871).

3.1.4 Device Peripherals

The DSP has access to all peripherals on the device. See the device-specific data manual for the full list of peripherals.

3.2 Memory Interfaces Overview

This section describes the different memory interfaces of C6452. The device supports several memory and external device interfaces, including the following:

- DDR2 synchronous DRAM
- Asynchronous EMIF/NOR Flash
- Synchronous EMIF SBSRAM and ZBTSRAM

3.2.1 DDR2 External Memory Interface

The DDR2 external memory interface (EMIF) port is a dedicated interface to DDR2 SDRAM. It supports JESD79D-2A standard compliant DDR2 SDRAM devices and can support either 16-bit or 32-bit interfaces.

DDR2 SDRAM plays a key role in a C6452-based system. Such a system is expected to require a significant amount of high-speed external memory for the following:

- Buffering for intermediate data while performing encode and decode functions
- Storage of executable firmware for DSP

3.2.2 External Memory Interface

The C6452 external memory interface (EMIF) provides a 16-bit data bus, an address bus width of up to 25-bits, and 2 dedicated chip selects, along with memory control signals.

The EMIFA signals are multiplexed with other peripheral signals on the device. See the device-specific data manual for details on pin multiplexing.

3.2.2.1 Asynchronous EMIF Interface

The asynchronous EMIF (EMIFA) interface provides asynchronous EMIF interfaces. Two chip selects are provided. Each is individually configurable to provide asynchronous EMIF.

- The asynchronous EMIF mode supports asynchronous devices (RAM, ROM, and NOR Flash)
- 128MB asynchronous address range over 2 chip selects (64MB each)
- Supports 16-bit data bus width
- Programmable asynchronous cycle timings
- Supports extended waits
- Supports Select Strobe mode
- Supports TI DSP HPI interface
- Supports booting C6452 from CS2 (SRAM/NOR Flash)

Device Clocking

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4.1 Overview

The C6452 requires two primary reference clocks. The primary reference clocks are driven by external oscillators. An external oscillator from 25 MHz to 66.6 MHz can be used as CLKIN1, which generates the clocks for the DSP, peripherals, DMA. But for some boot options to work, the device must boot up with 27-MHz CLKIN1. A 26.66-MHZ external oscillator at the CLKIN2 pin is recommended for the DDR PLL, which generates the clocks for DDR.

For detailed specifications on clock frequency and voltage requirements, see the *TMS320C6452 Digital Signal Processor Data Manual* (SPRS371).

There are two clocking modes:

- PLL Bypass Mode - power saving (device defaults to this mode)
- PLL Mode - PLL multiplies input clock up to the desired operating frequency

The clock of the major chip subsystems must be programmed to operate at fixed ratios of the primary system/DSP clock frequency within each mode, as shown in Table 4-1. The C6452 clocking architecture is shown in .

Table 4-1. System Clock Modes and Fixed Ratios for Core Clock Domains

Subsystem	Core Clock Domain	SYSCLKS	Fixed Ratio vs. DSP frequency
DSP	CLKDIV1		-
Peripherals (CLKDIV3 Domain)	CLKDIV3	SYSCLK1	1:3
Emulation/Trace	CLKDIV4 1	SYSCLK2	1:4
Peripherals (CLKDIV6 Domain)	CLKDIV6	SYSCLK3	1:6
Internal EMIFA Clock	CLKDIV4 0	SYSCLK4	1:4

4.2 Clock Domains

4.2.1 Core Domains

The core domains see the clock domains for all of the internal processing elements of the C6452, such as the DSP/EDMA/peripherals, etc. All internal communications between DSP and modules operate at core domain clock frequencies. All of the core clock domains are synchronous to each other, come from a single PLL (PLL1), have aligned clock edges, and have fixed divide by ratio requirements, as shown in Table 4-1 and Figure 4-1. It is user's responsibility to ensure the fixed divide ratios between these core clock domains are achieved.

The DSP is in the CLKDIV1 domain and receives the PLL1 frequency directly from PLLC1 output. The DSP has internal clock dividers that it uses to create the DSP ÷ 3 clock frequency to communicate with other components on-chip.

Modules in the CLKDIV3 domain (EDMA, TSIP, CLKDIV3 domain peripherals) must run at 1/3 the DSP frequency.

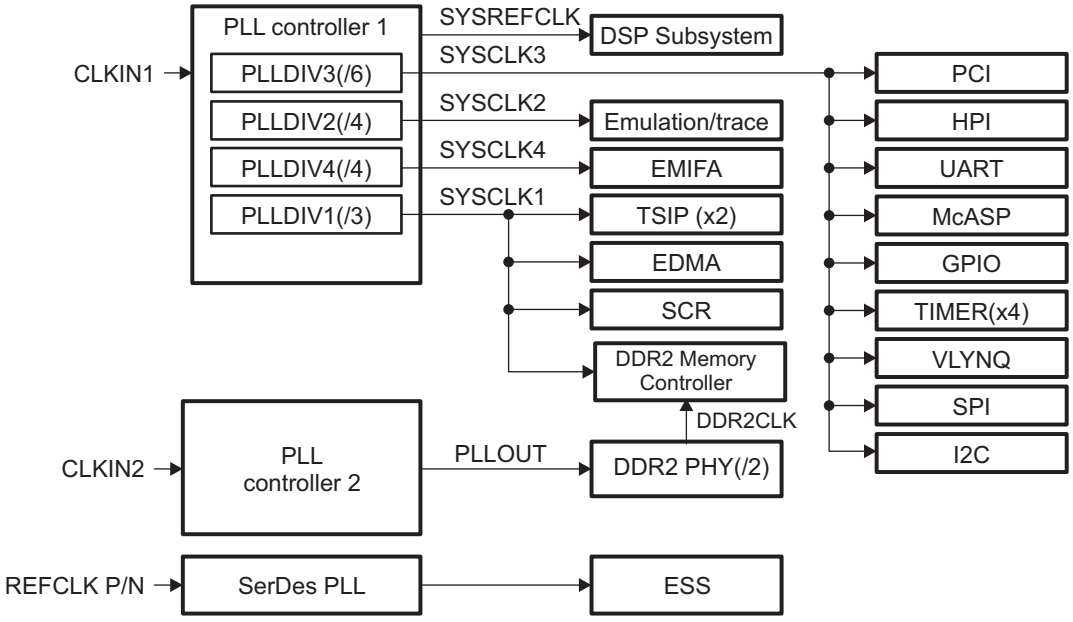
Modules in the CLKDIV6 domain (for example, CLKDIV6 domain peripherals) must run at 1/6 the DSP frequency.

Modules in the CLKDIV4 0 domain (for example, EMIFA) must run at 1/4 the DSP frequency.

Modules in the CLKDIV4 1 domain (for example, Emulation/Trace) must run at 1/4 the DSP frequency.

See the *TMS320C6452 Digital Signal Processor Data Manual* (SPRS371) for the core clock domain for each peripheral.

Figure 4-1. Clocking Diagram



4.2.2 Core Frequency Flexibility

The core frequency domain clocks are supplied by the PLL controller 1 (PLLC1). These domain clocks are flexible, to a degree, within the limitations specified in the device-specific data manual. All of the following frequency ranges and multiplier/divider ratios in the data manual must be adhered to:

- Input clock frequency range (CLKIN1, CLKIN2)
- PLL1 multiplier (PLLM) range
- PLL1 output (PLLOUT) frequency range
- Maximum device speed

As specified in the data manual, the PLLC1 can be driven by any input ranging from 25 to 66.6 MHZ and the PLLC2 can be driven by 26.6 MHZ.

Table 4-2 shows some example PLL1 multiplier and divider settings assuming CLKIN1 frequency of 36 MHZ. The Applicable to Device Core Voltage column indicates whether the setting is allowed for a given device core voltage. You must ensure the SYSREFCLK frequency does not exceed the speed grade of the device. For example, for a device rated at 720 MHZ speed grade, SYSREFCLK must not exceed 720 MHZ.

Table 4-2. Example PLL1 Frequencies and Dividers (36 MHZ Clock Input)

		CLKDIV3 Domain (SYSCLK1)		CLKDIV4 Domain (SYSCLK2)		CLKDIV6 Domain (SYSCLK3)		Applicable to Device Core Voltage
PLL1 Multiplier	PLL1 PLLOUT Freq (MHZ)	Divider[(1)]	Freq (MHZ)	Divider[(1)]	Freq (MHZ)	Divider[(1)]	Freq(MHZ)	1.2 V
20	720	3	240.0	4	180.0	6	120.0	YES
21	756	3	252.0	4	189.0	6	126.0	YES
22	792	3	264.0	4	198.0	6	132.0	YES
23	828	3	276.0	4	207.0	6	138.0	YES
24	864	3	288.0	4	216.0	6	144.0	YES
25	900	3	300.0	4	225.0	6	150.0	YES

(1) The RATIO bit in PLLDIV*n* is programmed as Divider - 1. For example, for a SYSCLK1 divider of 3, you should program PLLDIV1.RATIO = 2, PLLDIV2.RATIO = 3, PLLDIV3.RATIO = 5, PLLDIV4.RATIO = 3.

4.2.3 DDR2/EMIF Clock

The DDR2 interface has a dedicated clock driven from PLL2. This is a separate clock system from the PLL2. This dedicated clock allows the reduction of the core clock rates to save power while maintaining the required minimum clock rate (266.5 MHZ) for DDR2. PLL2 must be configured to output a 2 × clock to the DDR2 PHY interface.

You must adhere to all of the following frequency ranges and multiplier/divider ratios in the device-specific data manual when configuring PLL2:

- Input clock frequency range (CLKIN2)
- PLL2 multiplier (PLLM) is fixed
- PLL2 controller only operates in PLL mode.

Table 4-3 shows some PLL2/DDR2 clock rates assuming a CLKIN2 frequency of 26.66 MHZ.

Table 4-3. Example PLL2 Frequencies (Core Voltage = 1.2 V)

PLL2 Multiplier	PLL2 PLLOUT Freq (MHZ)	PHY [2× clock] (MHZ)	DDR2 Clock (MHZ)
20	533	533	266.5

4.2.4 I/O Domains

The I/O domains refer to the frequencies of the peripherals that communicate through device pins. In many cases, there are frequency requirements for a peripheral pin interface that are set by an outside standard and must be met. It is not necessarily possible to obtain these frequencies from the on-chip clock generation circuitry, so the frequencies must be obtained from external sources and are asynchronous to the core frequency domain by definition.

Table 4-4 lists peripherals with external I/O interface, and their I/O domain clock/frequency. It also shows the core clock domain as a reference to show the core clock used for internal communications. See Section 4.2.1 for more details on core clock domains. See the device-specific data manual for the exact I/O clock frequency supported on the device.

Table 4-4. Peripheral I/O Domain Clock

Peripheral	I/O Domain Clock Frequency	I/O (External) Domain Clock Source Options		Core Clock Domain
		Internal Clock Source	External Clock Source	
DDR2	266.5 MHZ	PLLC2 SYSCLK1	—	CLKDIV1
TSIP0-1	up to 32 MHz	—	TSIP0CLKA, TSIP0CLKB, TSIP1CLKA, TSIP1CLKB	CLKDIV3
PCI	33/66 MHZ	—	PCLK	CLKDIV6
Ethernet Subsystem	125 MHZ	—	REFCLKN, REFCLKP	TXBCLK
VLYNQ	up to 80 MHZ	PLLC1 SYSCLK3	VCLK	CLKDIV6
McASP	up to 40 MHZ	PLLC1 SYSCLK3	AHCLKX, AHCLKR, ACLKX, ACLKR	CLKDIV6
SPI	up to 12 MHZ	PLLC1 SYSCLK3	-	CLKDIV6
GPIO	NA (asynchronous interface)	—	—	CLKDIV6
EMIFA	NA (asynchronous interface)	SYSCLK4 /2	—	CLKDIV6
	up to 166 MHZ		AECLKIN	CLKDIV6
HPI	NA (asynchronous interface)	—	—	CLKDIV6
I2C	up to 400 kHz	PLLC1 SYSCLK3	SCL	CLKDIV6
Timer	output up to 1/2 CLKIN frequency	PLLC1 SYSCLK3	T0INP12 (Timer 0), T1INP12 (Timer 1)	CLKDIV6
UART	NA	—	—	CLKDIV6

PLL Controller

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5.1 PLL Module

The device has two PLLs (PLL1 and PLL2) that provide clocks to different parts of the system. PLL1 provides clocks (through various dividers) to most of the components of the device. PLL2 is dedicated to the DDR2 port. The typical reference clock is the 36 MHZ clock input, as mentioned in Chapter 4.

The PLL controller provides the following:

- Glitch-Free Transitions (on changing clock settings)
- Domain Clocks Alignment
- Clock Gating
- PLL power down

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

- Domain Clocks: SYSCLK[1:*n*]

Various dividers that can be used on the C6452 are as follows:

- PLL Controller Dividers (for SYSCLK[1:*n*]): PLLDIV1, ..., PLLDIV*n*

Various other controls supported are as follows:

- PLL Multiplier Control: PLLM
- Software-programmable PLL Bypass: PLLEN

5.2 PLL1 Control

PLL1 supplies the primary system clock. Software controls the PLL1 operation through the system PLL controller 1 (PLLC1) registers. The registers used in PLLC1 are listed in Section 5.4. Figure 5-1 shows the customization of PLL1 in the C6452. The domain clocks are distributed to the core clock domains (discussed in Section 4.2.1) and the rest of the device as follows:

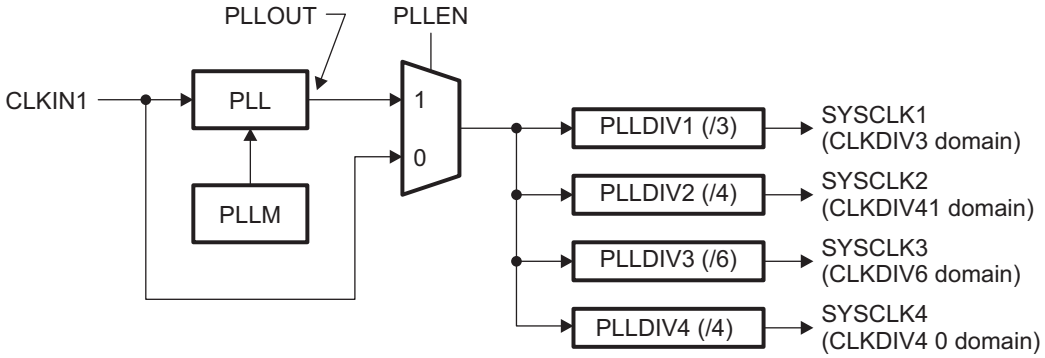
- SYSCLK1: CLKDIV3 Domain
- SYSCLK2: CLKDIV4 1 Domain
- SYSCLK3: CLKDIV6 Domain
- SYSCLK4: CLKDIV4 0 Domain

The PLL1 multiplier is controlled by the PLLM bit of the PLL multiplier control register (PLLM). The PLL1 output clock may be divided using the PLLC1 SYSCLK divider PLLDIV4.

You are responsible for adhering to the PLLC1 frequency ranges and multiplier/divider ratios specified in the data manual. See also Section 4.2.1 and Section 4.2.2.

By default, the system operates in bypass mode and the system clock is provided directly from the input reference clock (CLKIN1 pin). Once the PLL is locked, you can switch the device to PLL mode operation in software by setting the PLLEN bit in PLLCTL to 1. If the boot mode of the device is set to fast boot (FASTBOOT = 1), the bootloader code in the Boot ROM follows the previous process to lock the PLL and switches the device to PLL mode to accelerate the boot process. Therefore, coming out of a fast boot, the device operates in PLL mode.

Figure 5-1. PLL1 Structure



5.2.1 Device Clock Generation

PLLC1 generates several clocks from the PLL1 output clock for use by processor and various modules. These are summarized in Table 5-1.

Table 5-1. System PLLC1 Output Clocks

PLLC1 Output Clock	Used by	Default Divider
REFSYSCLK	DSP Subsystem	-
SYSCLK1	SCR, EDMA, DDR2 peripherals	/3
SYSCLK2	Emulation/Trace peripherals	/4
SYSCLK3	CLKDIV6 Domain peripherals	/6
SYSCLK4	EMIFA Domain peripheral	/4

5.2.2 Steps for Changing PLL1/Core Domain Frequency

See the appropriate subsection on how to program the PLL1/Core Domain clocks:

- If the PLL is powered down (PLLPWRDN bit in PLLCTL is set to 1), follow the full PLL initialization procedure in Section 5.2.2.1 to initialize the PLL.
- If the PLL is not powered down (PLLPWRDN bit in PLLCTL is cleared to 0), follow the sequence in Section 5.2.2.2 to change the PLL multiplier.
- If the PLL is already running at a desired multiplier and you only want to change the SYSCLK dividers, follow the sequence in Section 5.2.2.3.

Note that the PLL is powered up after the following device-level global resets:

- Power-on Reset ($\overline{\text{POR}}$)
- Warm Reset ($\overline{\text{RESET}}$)
- Max Reset

5.2.2.1 Initialization to PLL Mode from PLL Power Down

If the PLL is powered down (PLLPWRDN bit in PLLCTL is set to 1), you must follow the procedure below to change PLL1 frequencies. The recommendation is to stop all peripheral operation before changing the PLL1 frequency, with the exception of the C64x+ DSP and DDR2. The C64x+ DSP must be operational to program the PLL controller. DDR2 operates off of the clock from PLLC2.

Step 1. Before changing the PLL frequency, switch to PLL bypass mode:

a. Clear the PLLENSRC bit in PLLCTL to 0 to allow PLLCTL.PLLEN to take effect.

b. Clear the PLLEN bit in PLLCTL to 0 (select PLL bypass mode).

c. Wait for 4 CLKIN1 cycles to ensure PLLC switches to bypass mode properly.

Step 2. Set the PLLRST bit in PLLCTL to 1 (reset PLL).

Step 3. Clear the PLLPWRDN bit in PLLCTL to 0 to bring the PLL out of power-down mode.

Step 4. Wait for PLL stabilization time. See the device-specific data manual for PLL stabilization time.

Step 5. Program the required multiplier value in PLLM.

Step 6. Program PLLDIV4.RATIO=0x1 register to change the SYSCLK4 divide value:

a. Check for the GOSTAT bit in PLLSTAT to clear to 0 to indicate that no GO operation is currently in progress.

b. Program the RATIO field in PLLDIV4.RATIO = 0x1. See the device-specific data manual for more details on Clock Domains. In addition, make sure in this step you leave the PLLDIV4.D4EN bit set (default).

c. Set the GOSET bit in PLLCMD to 1 to initiate a new divider transition. During this transition, SYSCLK4 is paused momentarily.

d. Wait for N number of PLLDIV*n* source clock cycles to ensure divider changes have completed. See Section 5.2.2.3 for the formula on calculating the number of cycles N.

e. Wait for the GOSTAT bit in PLLSTAT to clear to 0.

Step 7. Wait for PLL to reset properly. See the device-specific data manual for PLL reset time.

Step 8. Clear the PLLRST bit in PLLCTL to 0 to bring the PLL out of reset.

Step 9. Wait for PLL to lock. See the device-specific data manual for PLL lock time.

Step 10. Set the PLLEN bit in PLLCTL to 1 to remove the PLL from bypass mode.

5.2.2.2 Changing PLL Multiplier

If the PLL is not powered down (PLLPWRDN bit in PLLCTL is cleared to 0) and the PLL stabilization time is previously met (step 4 in Section 5.2.2.1), follow this procedure to change PLL1 multiplier. The recommendation is to stop all peripheral operation before changing the PLL multiplier, with the exception of the C64x+ DSP and DDR2. The C64x+ DSP must be operational to program the PLL controller. DDR2 operates off of the clock from PLLC2.

Step 1. Before changing the PLL frequency, switch to PLL bypass mode:

a. Clear the PLLENSRC bit in PLLCTL to 0 to allow PLLCTL.PLLEN to take effect.

b. Clear the PLLEN bit in PLLCTL to 0 (select PLL bypass mode).

c. Wait for 4 CLKIN1 cycles to ensure PLLC switches to bypass mode properly.

Step 2. Set the PLLRST bit in PLLCTL to 1 (reset PLL).

Step 3. Program the required multiplier value in PLLM.

Step 4. Program PLLDIV4.RATIO = 0x1 register to change the SYSCLK4 divide value:

a. Check for the GOSTAT bit in PLLSTAT to clear to 0 to indicate that no GO operation is currently in progress.

b. Program the RATIO field in PLLDIV4.RATIO = 0x1. See the device-specific data manual for more details on Clock Domains. In addition, make sure you leave the PLLDIV4.D4EN bit set (default) in this step.

c. Set the GOSET bit in PLLCMD to 1 to initiate a new divider transition. During this transition, SYSCLK4 is paused momentarily.

d. Wait for N number of PLLDIV*n* source clock cycles to ensure divider changes have completed. See Section 5.2.2.3 for the formula on calculating the number of cycles N.

e. Wait for the GOSTAT bit in PLLSTAT to clear to 0.

Step 5. Wait for PLL to reset properly. See the device-specific data manual for PLL reset time.

Step 6. Clear the PLLRST bit in PLLCTL to 0 to bring the PLL out of reset.

Step 7. Wait for PLL to lock. See the device-specific data manual for PLL lock time.

Step 8. Set the PLLEN bit in PLLCTL to 1 to remove the PLL from bypass mode.

5.2.2.3 Changing SYSCLK Dividers

This section discusses the software sequence to change the SYSCLK dividers. The SYSCLK divider change sequence is also referred to as GO operation, as it involves hitting the GO bit (GOSET bit in PLLCMD) to initiate the divider change. The recommendation is to stop all peripheral operation before changing the SYSCLK dividers, with the exception of the C64x+ DSP and DDR2. The C64x+ DSP must be operational to program the PLL controller. DDR2 operates off of the clock from PLLC2.

Step 1. Check for the GOSTAT bit in PLLSTAT to clear to 0 to indicate that no GO operation is currently in progress.

Step 2. Program the PLLDIV4.RATIO = 0x1. See the device-specific data manual for more details on Clock Domains. In addition, make sure in this step you leave the PLLDIV4.D4EN bit set (default).

Step 3. Set the GOSET bit in PLLCMD to 1 to initiate a new divider transition. During this transition, SYSCLK4 is paused momentarily.

Step 4. Wait for N number of PLLDIV*n* source clock cycles to ensure divider changes have completed. Use the following formula for calculating the number of cycles N.

Step 5. Wait for the GOSTAT bit in PLLSTAT to clear to 0.

The following formula should be used to calculate the number of PLLDIV*n* source clock cycles:

N = (2 × Least Common Multiple [LCM] of all the old SYSCLK divide values) + 50 cycles overhead

Example 5-1. Calculating Number of Clock Cycles N

This example calculates the number of clock cycles N.

- Settings before divider change:
  - PLLDIV4.RATIO = 3 (divide-by-4)
- New divider settings:
  - PLLDIV4.RATIO = 1 (divide-by-2)

The least common multiple between the old divider values of /4 is /4; therefore, the number of cycles N is:

N = (2 × 4) + 50 cycles overhead = 58 PLLDIV*n* source clock cycles

If PLLC1 is in PLL mode (PLLCTL.PLLEN = 1), the PLLDIV*n* source clock is the PLL1 output clock. If PLLC1 is in PLL bypass mode (PLLCTL.PLLEN = 0), the PLLDIV*n* source clock is the device clock source CLKIN1.

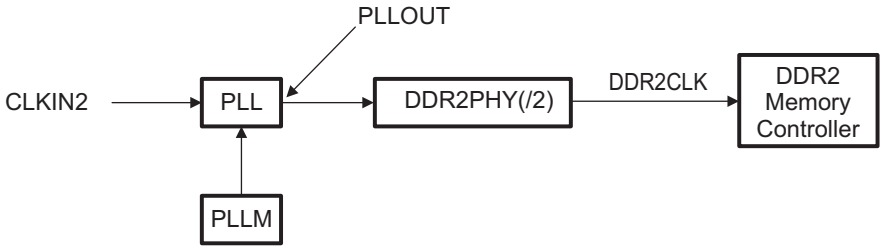
5.3 PLL2 Control

PLL2 provides the clock from which the DDR2 memory controller clocks are derived. The DDR PLL controller 2 (PLLC2) controls PLL2, which accepts the clock from CLKIN2. Figure 5-2 shows the customization of PLL2 in the C6452. The PLL2 clocks are distributed to the device as follows:

- PLLOUT: DDR2 PHY

PLL2 supplies the DDR2 memory controller clock. PLL2 Controller operates only in PLL mode. The registers used in PLLC2 are listed in Section 5.4.

Figure 5-2. PLL2 Structure in the TMS320C6452



5.3.1 Device Clock Generation

PLLC2 generates clocks from the PLL2 output clock for use by the DDR2 memory controller module. These are summarized in Table 5-2.

Table 5-2. DDR PLLC2 Output Clocks

Output Clock	Used by	Default Divider
PLLOUT	DDR Phy	-

The PLLOUT output clock fed to DDR2 PHY, PLLOUT (DDR2 PHY clock) is divided by 2 and generates DDR2 clock . Assuming a 26.6 MHZ CLKIN2 and the PLL2 multiplier of ×20, this results in a 533 MHZ DDR Phy clock (266 MHZ DDR2 Clock).

5.4 PLL Controller Registers

Table 5-3 lists the base address and end address for the PLL controllers. Table 5-4 lists the memory-mapped registers for the PLL and reset controller. See the device-specific data manual for the memory address of these registers.

Table 5-3. PLL and Reset Controller List

PLL and Reset Controller	Base Address	End Address	Size
PLLC1	020E 0000h	020E 0400h	400h
PLLC2	0212 0000h	0212 0400h	400h

Table 5-4. PLL and Reset Controller Registers

Offset	Acronym	Register Description	Section
00h	PID	Peripheral ID Register	Section 5.4.1
E4h	RSTYPE(1)	Reset Type Status Register	Section 5.4.2
100h	PLLCTL	PLL Control Register	Section 5.4.3
110h	PLLM	PLL Multiplier Control Register	Section 5.4.4
114h	PREDIV(1)	PLL Pre-Divider Control Register	Section 5.4.5
11Ch	PLLDIV2(1)	PLL Controller Divider 2 Register (SYSCLK2)	Section 5.4.6
138h	PLLCMD(1)	PLL Controller Command Register	Section 5.4.8
13Ch	PLLSTAT(1)	PLL Controller Status Register	Section 5.4.9
140h	ALNCTL(1)	PLL Controller Clock Align Control Register	Section 5.4.11
144h	DCHANGE(1)	PLLDIV Ratio Change Status Register	Section 5.4.12
150h	SYSTAT(1)	PLL Controller System Clock Status Register	Section 5.4.10
160h	PLLDIV4(1)	PLL Controller Divider 4 Register (SYSCLK4)	Section 5.4.7

(1) not supported for PLL2.

5.4.1 Peripheral ID Register (PID)

The peripheral ID register (PID) is shown in Figure 5-3 and described in Table 5-5.

Figure 5-3. Peripheral ID Register (PID)

31	24	23	16
Reserved		TYPE	
R-0		R-1h	

15	8	7	0
CLASS		REV	
R-8h		R-2h	

LEGEND: R = Read only; -*n* = value after reset

Table 5-5. Peripheral ID Register (PID) Field Descriptions

Bit	Field	Value	Description
31-24	Reserved	0	Reserved
23-16	TYPE		Peripheral type
		1h	PLLC
15-8	CLASS		Peripheral class
		8h	Current class
7-0	REV		Peripheral revision
		2h	Current revision

5.4.2 Reset Type Status Register (RSTYPE)

The reset type status register (RSTYPE) is shown in Figure 5-4 and described in Table 5-6. It latches cause of the last reset. Although the reset value of all bits is 0 after coming out of reset, one bit is set to 1 to indicate the cause of the reset.

Figure 5-4. Reset Type Status Register (RSTYPE)

31	16
Reserved	
R-0	

15	4	3	2	1	0
Reserved		SRST	MRST	XWRST	POR
R-0		R-0	R-0	R-0	R-0

LEGEND: R = Read only; -*n* = value after reset

Table 5-6. Reset Type Status Register (RSTYPE) Field Descriptions

Bit	Field	Value	Description
31-4	Reserved	0	Reserved
3	SRST	0-1	System reset. If 1, system reset was the reset to occur that is of highest priority.
2	MRST	0-1	Maximum reset. If 1, maximum reset was the reset to occur that is of highest priority.
1	XWRST	0-1	External warm reset. If 1, warm reset ($\overline{\text{RESET}}$) was the last reset to occur that is of highest priority.
0	POR	0-1	Power on reset. If 1, power on reset ($\overline{\text{POR}}$) was the last reset to occur that is of highest priority.

5.4.3 PLL Control Register (PLLCTL)

The PLL control register (PLLCTL) is shown in Figure 5-5 and described in Table 5-7.

Figure 5-5. PLL Control Register (PLLCTL)

31	16
Reserved	
R-0	

15	8	7	6	5	4	3	2	1	0
Reserved		Reserved		PLLENSRC	PLLDIS	PLLRST	Rsvd	PLLPWRDN	PLLEN
R-0		R-1h		R/W-1	R/W-0	R/W-1	R-0	R/W-0	R/W-0

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

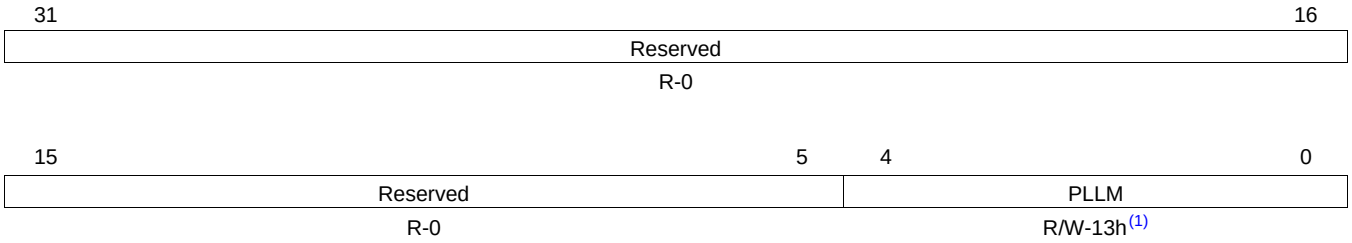
Table 5-7. PLL Control Register (PLLCTL) Field Descriptions

Bit	Field	Value	Description
31-8	Reserved	0	Reserved
7-6	Reserved	1	Reserved
5	PLLENSRC	0	This bit must be cleared to 0 before PLLEN will have any effect.
4	PLLDIS		Asserts DISABLE to PLL
		0	PLL disable is de-asserted.
		1	PLL disable is asserted. PLL output is disabled and not toggling.
3	PLLRST		Asserts RESET to PLL if supported.
		0	PLL reset is not asserted.
		1	PLL reset is asserted. See the device-specific data manual for the PLL reset time required.
2	Reserved	0	Reserved
1	PLLPWRDN		PLL power-down. After powering up the PLL (PLLPWRDN 1 to 0 transition), you must wait for the PLL to stabilize. See the device-specific data manual for the PLL stabilization time.
		0	PLL operational
		1	PLL power-down
0	PLLEN		PLL mode enable
		0	Bypass mode
		1	PLL mode, not bypassed

5.4.4 PLL Multiplier Control Register (PLLM)

The PLL multiplier control register (PLLM) is shown in Figure 5-6 and described in Table 5-8.

Figure 5-6. PLL Multiplier Control Register (PLLM)



LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

(1) For PLLC1, PLLM defaults to 13h (PLL1 multiply by 20); for PLLC2, PLLM defaults to 13h (PLL2 multiply by 20), PLLM field of PLLC2 is read-only.

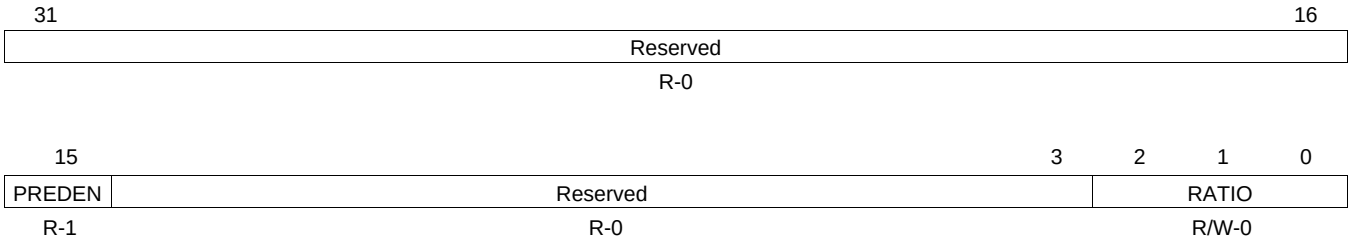
Table 5-8. PLL Multiplier Control Register (PLLM) Field Descriptions

Bit	Field	Value	Description
31-5	Reserved	0	Reserved
4-0	PLLM	0-1Fh	PLL multiplier select. Multiplier value = PLLM + 1. For example, PLLM = 19 (13h) means multiply by 20. See the device-specific data manual for valid multiplier values for each PLL.

5.4.5 PLL Pre-Divider Control Register (PREDIV)

The PLL Pre-Divider control register (PREDIV) is shown in Figure 5-7 and described in Table 5-9.

Figure 5-7. PLL Pre-Divider Control Register (PREDIV)



LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

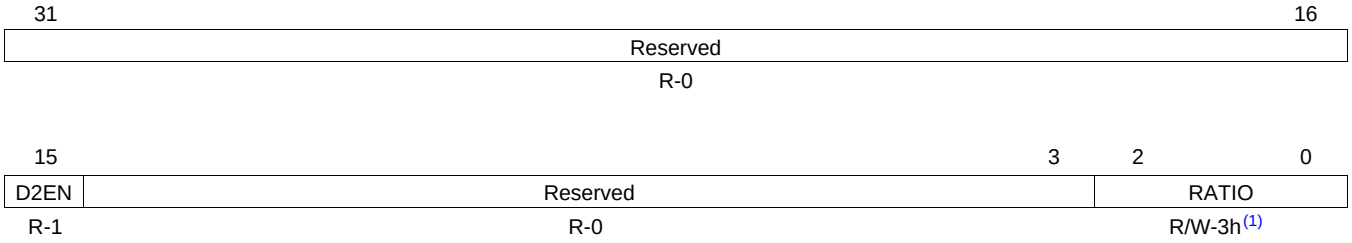
Table 5-9. PLL Controller Pre-Divider Control Register (PREDIV) Field Descriptions

Bit	Field	Value	Description
31-16	Reserved	0	Reserved
15	PREDEN		Pre Divider enable.
		0	Pre Divider is disabled.
		1	Pre Divider is enabled.
14-3	Reserved	0	Reserved
2-0	RATIO	0-7h	Divider ratio. Divider value = RATIO + 1. For example, RATIO = 2 means divide by 3.

5.4.6 PLL Controller Divider 2 Register (PLLDIV2)

The PLL controller divider 2 register (PLLDIV2) is shown in Figure 5-8 and described in Table 5-10. Divider 2 controls divider for SYSCLK2.

Figure 5-8. PLL Controller Divider 2 Register (PLLDIV2)



LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

(1) For PLLC1, RATIO defaults to 3h (PLL1 divide by 4); Not used by PLLC2.

Table 5-10. PLL Controller Divider 2 Register (PLLDIV2) Field Descriptions

Bit	Field	Value	Description
31-16	Reserved	0	Reserved
15	D2EN		Divider 2 enable.
		0	Divider 2 is disabled.
		1	Divider 2 is enabled.
14-3	Reserved	0	Reserved
2-0	RATIO	0-7h	Divider ratio. Divider value = RATIO + 1. For example, RATIO = 3 means divide by 4.

5.4.7 PLL Controller Divider 4 Register (PLLDIV4)

The PLL controller divider 4 register (PLLDIV4) is shown in Figure 5-9 and described in Table 5-11. Divider 4 controls divider for SYSCLK4. PLLDIV4 is not used on PLLC2.

Figure 5-9. PLL Controller Divider 4 Register (PLLDIV4)

31	16
Reserved	
R-0	

15	3	2	0
D4EN	Reserved	RATIO	
R-1	R-0	R/W-3h(1)	

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

(1) For PLLC1, RATIO defaults to 3h (PLL1 divide by 4);

Table 5-11. PLL Controller Divider 4 Register (PLLDIV4) Field Descriptions

Bit	Field	Value	Description
31-16	Reserved	0	Reserved
15	D4EN		Divider 4 enable.
		0	Divider 4 is disabled.
		1	Divider 4 is enabled.
14-3	Reserved	0	Reserved
2-0	RATIO	0-7h	Divider ratio. Divider value = RATIO + 1. For example, RATIO = 0 means divide by 1.

5.4.8 PLL Controller Command Register (PLLCMD)

The PLL controller command register (PLLCMD) is shown in Figure 5-10 and described in Table 5-12. PLLCMD contains the command bit for the GO operation. Writes of 1 initiate command. Writes of 0 clear the bit, but have no effect.

Figure 5-10. PLL Controller Command Register (PLLCMD)

31	16
Reserved	
R-0	

15	1	0
Reserved		GOSET
R-0		R/W-0

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

Table 5-12. PLL Controller Command Register (PLLCMD) Field Descriptions

Bit	Field	Value	Description
31-1	Reserved	0	Reserved
0	GOSET		GO bit for SYSCLKx loading new dividers and phase alignment.
		0	Clear bit (no effect).
		1	Initiate SYSCLKx phase alignment.

5.4.9 PLL Controller Status Register (PLLSTAT)

The PLL controller status register (PLLSTAT) is shown in Figure 5-11 and described in Table 5-13.

Figure 5-11. PLL Controller Status Register (PLLSTAT)

31	16
Reserved	
R-0	

15	3	2	1	0
Reserved		STABLE	Reserved	GOSTAT
R-0		R-1	R-0	R-0

LEGEND: R = Read only; -*n* = value after reset

Table 5-13. PLL Controller Status Register (PLLSTAT) Field Descriptions

Bit	Field	Value	Description
31-3	Reserved	0	Reserved
2	STABLE		OSC counter done, oscillator assumed to be stable. By the time the device comes out of reset, this bit should become 1.
		0	No
		1	Yes
1	Reserved	0	Reserved
0	GOSTAT		Status of GO operation.
		0	GO operation is not in progress.
		1	GO operation is in progress.

5.4.10 PLL Controller SYSCLK Status Register (SYSTAT)

The PLL controller SYSCLK status register (SYSTAT) is shown in Figure 5-12 and described in Table 5-14. SYSTAT shows the enable/disable status of SYSCLKs.

Figure 5-12. PLL Controller SYSCLK Status Register (SYSTAT)

31	16
Reserved	
R-0	

15	4	3	2	1	0
Reserved		SYS4ON	SYS3ON	SYS2ON	SYS1ON
R-0		R-1[(1)]	R-1[(1)]	R-1[(1)]	R-1[(1)]

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

(1) For PLLC1, this bit defaults to 1.

Table 5-14. PLL Controller SYSCLK Status Register (SYSTAT) Field Descriptions

Bit	Field	Value	Description
31-4	Reserved		Reserved
3	SYS4ON		SYS4ON on
		0	Clock is gated.
		1	Clock is on.
2	SYS3ON		SYS3ON on
		0	Clock is gated.
		1	Clock is on.
1	SYS2ON		SYS2ON on
		0	Clock is gated.
		1	Clock is on.
0	SYS1ON		SYS1ON on
		0	Clock is gated.
		1	Clock is on.

5.4.11 PLL Controller Clock Align Control Register (ALNCTL)

The PLL controller clock align control register (ALNCTL) is shown in Figure 5-13and described in Table 5-15. ALNCTL indicates which SYSCLKs need to be aligned for proper device operation.

Figure 5-13. PLL Controller Clock Align Control Register (ALNCTL)

31	16
Reserved	

15	4	3	2	1	0
Reserved		ALN4	ALN3	ALN2	ALN1
R-0		R-1[1]	R-1[1]	R-1[1]	R-1[1]

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

[1] For PLLC1, this bit defaults to 1.

Table 5-15. PLL Controller Clock Align Control Register (ALNCTL) Field Descriptions

Bit	Field	Value	Description
31-3	Reserved	0	Reserved
3	ALN4		SYSCLK4 needs to be aligned to others selected in this register.
		0	SYSCLK4 does not need to be aligned.
		1	SYSCLK4 does need to be aligned.
2	ALN3		SYSCLK3 needs to be aligned to others selected in this register.
		0	SYSCLK3 does not need to be aligned.
		1	SYSCLK3 does need to be aligned.
1	ALN2		SYSCLK2 needs to be aligned to others selected in this register.
		0	SYSCLK2 does not need to be aligned.
		1	SYSCLK2 does need to be aligned.
0	ALN1		SYSCLK1 needs to be aligned to others selected in this register.
		0	SYSCLK1 does not need to be aligned.
		1	SYSCLK1 does need to be aligned

5.4.12 PLLDIV Ratio Change Status Register (DCHANGE)

The PLLDIV ratio change status register (DCHANGE) is shown in Figure 5-14 and described in Table 5-16. DCHANGE indicates if the SYSCLK divide ratio has been modified.

Figure 5-14. PLLDIV Ratio Change Status Register (DCHANGE)

31	16
Reserved	
R-0	

15	4	3	2	1	0
Reserved		SYS4	SYS3	SYS2	SYS1
R-0		R-0	R-0	R-0	R-0

LEGEND: R = Read only; -*n* = value after reset

Table 5-16. PLLDIV Ratio Change Status Register (DCHANGE) Field Descriptions

Bit	Field	Value	Description
31-3	Reserved	0	Reserved
3	SYS4		SYSCLK4 divide ratio is modified.
		0	SYSCLK4 divide ratio is not modified.
		1	SYSCLK4 divide ratio is modified.
2	SYS3		SYSCLK3 divide ratio is modified.
		0	SYSCLK3 divide ratio is not modified.
		1	SYSCLK3 divide ratio is modified.
1	SYS2		SYSCLK2 divide ratio is modified.
		0	SYSCLK2 divide ratio is not modified.
		1	SYSCLK2 divide ratio is modified.
0	SYS1		SYSCLK1 divide ratio is modified.
		0	SYSCLK1 divide ratio is not modified.
		1	SYSCLK1 divide ratio is modified.

Power and Sleep Controller

Topic Page

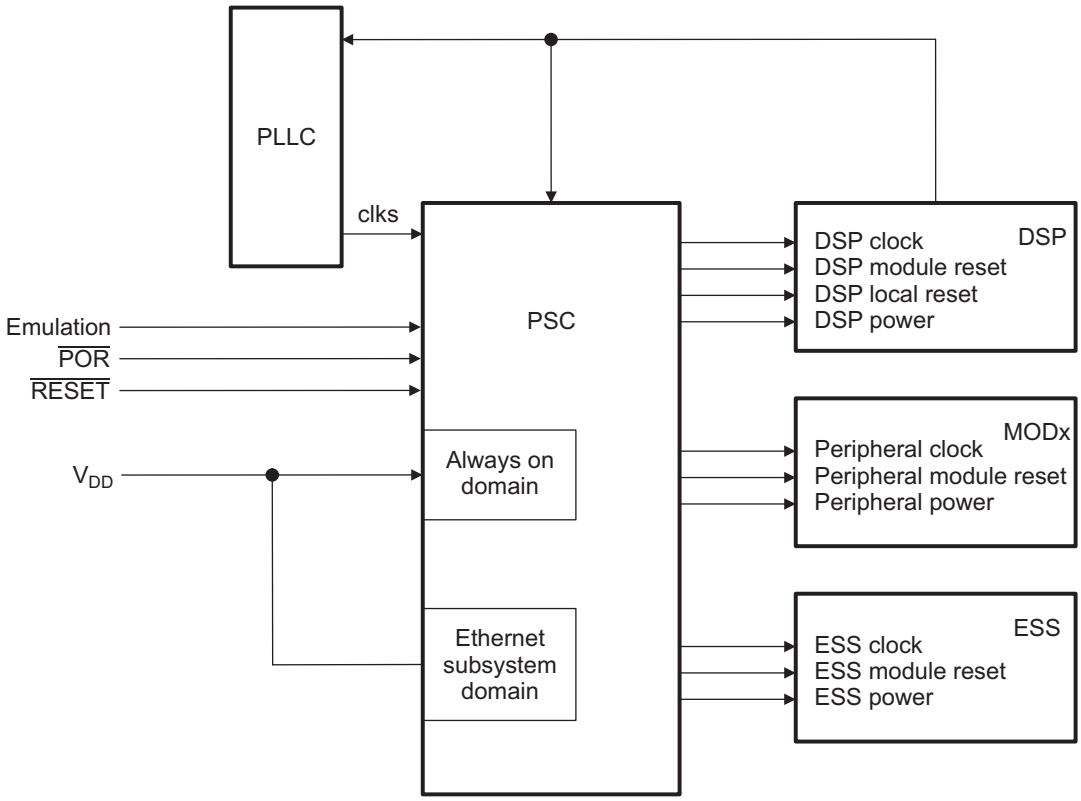
6.1 Introduction

The Power and Sleep Controller (PSC) is responsible for managing transitions of system power on/off, clock on/off, and reset. The C6452 only utilizes the clock gating feature of the PSC for power savings. The PSC consists of a Global PSC (GPSC) and a set of Local PSCs (LPSCs). The GPSC contains memory mapped registers, PSC interrupt control, and a state machine for each peripheral/module. An LPSC is associated with each peripheral/module and provides clock and reset control. Figure 6-1 shows how the PSC is integrated on the device. Many of the operations of the PSC are transparent to software, such as power-on and hard reset operations. However, the PSC provides you with an interface to control several important power, clock, and reset operations. The power, clock, and reset operations are the focus of this chapter.

The PSC includes the following features:

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

Figure 6-1. Power and Sleep Controller (PSC) Integration



6.2 Power Domain and Module Topology

The C6452 includes two power domains--the AlwaysOn power domain(Power Domain 0) and Ethernet Subsystem power domain(Power Domain 1). The AlwaysOn power domain and Ethernet Subsystem power domain are always ON when the chip is on. The AlwaysOn domain and Ethernet Subsystem domain are powered by the V_{DD} pins of the C6452 (see the device-specific data manual). All of the modules reside within the AlwaysOn power domain except SGMII reside within the Ethernet Subsystem power domain. Table 6-1 lists all the possible peripherals on the C6452, their LPSC assignments, and default module states. See the device-specific data manual for the peripherals available on a given device. The module states are defined in Section 6.3.2.

Table 6-1. C6452 Default Module Configuration

LPSC Number	Module Name	Default Module State (MDSTAT.STATE)
0	EDMACC	Enable
1	Reserved	—
2	Reserved	—
3	Reserved	—
4	Reserved	—
5	TSIP0	SwRstDisable
6	TSIP1	SwRstDisable
7	DDR2 Memory Controller	Enable
8	UHPI	Enable, if pin UHPIEN =1b
		SwRstDisable, if pin UHPIEN = 0b
9	VLYNQ	SwRstDisable
10	GPIO	SwRstDisable
11	TIMER0	Enable
12	TIMER1	Enable
13	Reserved	—
14	Reserved	—
15	Reserved	—
16	Reserved	—
17	SPI	SwRstDisable
18	I2C	SwRstDisable
19	PCI	SwRstDisable, if pin UHPIEN = 1b
		Enable, if pin UHPIEN = 0b
20	—	SwRstDisable
21	—	SwRstDisable
22	—	SwRstDisable
23	—	SwRstDisable
24	—	SwRstDisable
25	EMIFA	SwRstDisable, if pins BOOTMODE[3:0] ≠ 0100b
		Enable, if pins BOOTMODE[3:0] = 0100b
26	TIMER2	Enable
27	TIMER3	Enable
28	—	SwRstDisable
29	McASP	SwRstDisable
30	UART	SwRstDisable
31	—	Reserved
32	CHIP REGISTERS	Enable

Table 6-1. C6452 Default Module Configuration (continued)

LPSC Number	Module Name	Default Module State (MDSTAT.STATE)
33	C64x+ CPU	Enable
34	Ethernet 3PSW	Enable

6.3 Power Domain and Module States

Table 6-1 shows the state of each module after chip Power-on Reset ($\overline{\text{POR}}$), Warm Reset ($\overline{\text{RESET}}$), or Max Reset. These states are defined in the following sections.

6.3.1 Power Domain States

A power domain can only be in one of two states: ON or OFF, defined as follows:

- ON: power to the power domain is on.
- OFF: power to the power domain is off.

In the C6452, the AlwaysOn Power Domain and Ethernet Subsystem Power Domain are always in the ON state when the chip is powered-on.

6.3.2 Module States

A module can be in one of four states: Disable, Enable, SyncReset, or SwRstDisable. These four states correspond to combinations of module reset asserted or de-asserted and module clock on or off, as shown in Table 6-2.

Table 6-2. Module States

Module State	Module Reset	Module Clock	Module State Definition
Enable	De-asserted	On	A module in the enable state has its module reset de-asserted and it has its clock on. This is the normal run-time state for a given module.
Disable	De-asserted	Off	A module in the disable state has its module reset de-asserted and it has its clock off. This state is typically used for disabling a module clock to save power. The C6452 is designed in full static CMOS, so when you stop a module clock, it retains the module's state. When the clock is restarted, the module resumes operating from the stopping point.
SyncReset	Asserted	On	A module in the SyncReset state has its module reset asserted and it has its clock on. Generally, software is not expected to initiate this state.
SwRstDisable	Asserted	Off	A module in the SwResetDisable state has its module reset asserted and it has its clock set to off. After initial power-on, most modules are in the SwRstDisable state by default (see Table 6-1). Generally, software is not expected to initiate this state.

Note: Module Reset is defined to completely reset a given module, so that all hardware returns to its default state. See Chapter 10 for more information on module reset.

For more information on power management, see Chapter 7.

6.3.3 Local Reset

In addition to module reset (described in Section 6.3.2), the DSP CPU can be reset using a special local reset. When DSP local reset is asserted, the DSPs internal memories (L1P, L1D, and L2) are still accessible. The local reset only resets the DSP CPU core, not the rest of the DSP subsystem, as the DSP module reset would.

Module reset takes precedence over Local Reset; therefore, Local Reset is not useful when the DSP is in SyncReset or SwRstDisable state.

See Chapter 10 for more information on local reset and scenarios where this can be used.

The procedures for asserting and de-asserting DSP local reset are as follows:

1. Clear the LRST bit in MDCTL33 to 0 (assert the DSP local reset).
2. Set the LRST bit in MDCTL33 to 1 (de-assert DSP local reset). If the DSP is in the enable state, it immediately executes program instructions after reset is de-asserted.

6.4 Executing State Transitions

This section describes how to execute state transitions for device modules.

6.4.1 Power Domain State Transitions

The C6452 consists of two power domains--the AlwaysOn power domain(Power Domain 0) and Ethernet Subsystem Power Domain(Power domain 1). AlwaysOn Power Domain and Ethernet Subsystem Power Domain are always in the ON state when the chip is powered-on. You are not allowed to change this power domain state to OFF.

6.4.2 Module State Transitions

This section describes the procedure for transitioning the module state. All C6452 modules are on the AlwaysOn domain (Power Domain 0) except SGMII reside in Ethernet Subsystem power domain(Power Domain 1).

Note that some peripherals have special programming requirements and steps you must take before you can invoke the PSC module state transition. See the individual peripheral reference guide for more details. For example, the DDR2 memory controller requires that you first place the DDR memory in self-refresh mode before you invoke the PSC module state transition, if you want to maintain the memory content.

Note: The following procedure is directly applicable for all modules, except for the DSP in the C6452. To transition the DSP module state, you must be aware of several system considerations.

The procedure for module state transitions is as follows (where *n* corresponds to the module):

1. Wait for the GOSTAT[0]/GOSTAT[1] bit in PTSTAT to clear to 0. You must wait for any previously initiated transitions to finish before initiating a new transition.
2. Set the NEXT bit in MDCTL*n* to SwRstDisable (0), SyncReset (1), Disable (2h), or Enable (3h).

Note: You may set transitions in multiple NEXT bits in MDCTL*n* in this step. Transitions do not actually take place until you set the GO[0]/GO[1] bit in PTCMD in a later step. GO[0] and GOSTAT[0] for AlwaysOn power domain peripherals and GO[1] and GOSTAT[1] for Ethernet Subsystem power domain peripheral.

3. Set the GO[0]/GO[1] bit in PTCMD to 1 to initiate the transition(s).
4. Wait for the GOSTAT[0]/GOSTAT[1] bit in PTSTAT to clear to 0. The modules are safely in the new states only after the GOSTAT[0]/GOSTAT[1] bit in PTSTAT is cleared to 0.

6.5 IcePick Emulation Support in the PSC

The PSC supports IcePick commands that allow IcePick aware emulation tools to have some control over the state of power domains and modules. On the C6452, this IcePick support only applies to the C64x+ CPU (Module number 33 in the AlwaysOn power domain 0).

In particular, Table 6-3 shows IcePick emulation commands recognized by the PSC. Except as noted these commands apply to the C64x+ CPU on the C6452.

Table 6-3. IcePick Emulation Commands

Power On and Enable Features	Power On and Enable Descriptions	Reset Features	Reset Descriptions
Inhibit Sleep	Allows emulation to prevent software from transitioning the module out of the enable state.	Assert Reset	Allows emulation to assert the module's local reset.
Force Power	Allows emulation to force the power domain into an on state. Not applicable on the C6452 as AlwaysOn power domain and Ethernet Subsystem power domain are always on.	Wait Reset	Allows emulation to keep local reset asserted for an extended period of time after software initiates local reset de-assert.
Force Active	Allows emulation to force the module into the enable state.	Block Reset	Allows emulation to block software initiated local and module resets.

Note: When emulation tools remove the above commands, the PSC immediately executes a state transition based on the current values in the NEXT bit in PDCTLn and the NEXT bit in MDCTL*n*, as set by software.

6.6 PSC Interrupts

The PSC has an interrupt that is tied to the C64x+ interrupt controller (INTC). This interrupt is named PSCINT in the interrupt map. The PSC interrupt is generated when certain IcePick emulation events occur.

6.6.1 Interrupt Events

The PSC interrupt is generated when any of the following events occur:

- Module State Emulation Event
- Module Local Reset Emulation Event

These interrupt events are summarized in Table 6-4 and described in more detail in this section.

Table 6-4. PSC Interrupt Events

Interrupt Enable Bits		
Control Register	Status Bit	Interrupt Condition
MDCTL*n*	EMUIHB	Interrupt occurs when the emulation alters the module state.
MDCTL*n*	EMURST	Interrupt occurs when the emulation alters the module's local reset.

The PSC interrupt events only apply when IcePick emulation alters the state of the module from the user-programmed state in the NEXT bit in MDCTL*n*. As discussed in Section 6.5, on the C6452, IcePick support only applies to the C64x+ CPU (module 33), therefore the PSC interrupt condition only applies to module 33.

The C6452 is a single-processor device. The C64x+ CPU must not program its own module state. The C64x+ CPU module state can only be programmed by an external host (for example, PCI, HPI). As a result, interrupt events listed in Table 6-4 can only occur in the scenario where an external host programs the C64x+ CPU module state but the emulator alters that desired state.

6.6.1.1 Module State Emulation Events

A module state emulation event occurs when emulation alters the state of a module. Status is reflected in the EMUIHB bit in MDSTAT*n*. In particular, a module state emulation event occurs under the following conditions:

- When inhibit sleep is asserted by emulation and software attempts to transition the module out of the enable state.
- When force active is asserted by emulation and module is not already in the enable state.

6.6.1.2 Local Reset Emulation Events

A local reset emulation event occurs when emulation alters the local reset of a module. Status is reflected in the EMURST bit in MDSTAT*n*. In particular, a module local reset emulation event occurs under the following conditions:

- When assert reset is asserted by emulation although software de-asserted the local reset.
- When wait reset is asserted by emulation.
- When block reset is asserted by emulation and software attempts to change the state of local reset.

6.6.2 Interrupt Registers

The PSC interrupt enable bits are the EMUIHBIE bit in MDCTL33 and the EMURSTIE bit in MDCTL33.

Note: To interrupt the DSP, the power and sleep controller interrupt (PSCINT) must also be enabled in the DSP interrupt controller. See Section 2.4.1 for more information on the interrupt controller.

The PSC interrupt status bits are the M[33] bit in MERRPR1, the EMUIHB bit in MDSTAT33, and the EMURST bit in MDSTAT33. The status bit in MERRPR1 is read by software to determine which module has generated an emulation interrupt, and then software can read the corresponding status bits in MDSTAT33 to determine which event caused the interrupt.

The PSC interrupt clear bit is the M[33] bit in MERRCR1.

The PSC interrupt evaluation bit is the ALLEV bit in INTEVAL. When set, this bit forces the PSC interrupt logic to re-evaluate event status. If any events are still active (if any status bits are set) when the ALLEV bit in INTEVAL is set to 1, the PSCINT is re-asserted to the DSP interrupt controller. Set the ALLEV bit in INTEVAL before exiting your PSCINT interrupt service routine to ensure that you do not miss any PSC interrupts.

See Section 6.7 for complete descriptions of all PSC registers.

6.6.3 Interrupt Handling

Handle the PSC interrupts as described in the following procedure:

First, enable the interrupt.

Step 1. Set the EMUIHBIE bit and the EMURSTIE bit in MDCTL33 to enable the interrupt events that you want.

Note: The PSC interrupt PSCINT is sent to the DSP interrupt controller when at least one enabled event becomes active.

Step 2. Enable the power and sleep controller interrupt (PSCINT) in the DSP interrupt controller. To interrupt the DSP, PSCINT must be enabled in the DSP interrupt controller. See Section 2.4.1 for more information.

The DSP enters the interrupt service routine (ISR) when it receives the interrupt.

1. Read the M*n* bit in MERRPR1 to determine the source of the interrupt(s). Note that on the C6452, only M[33] can cause an interrupt.
2. For each active event that you want to service:
   a. Read the event status bits in MDSTAT33, depending on the status bits read in the previous step to determine the event that caused the interrupt.
   b. Service the interrupt as required by your application.
   c. Write the M[33] bit in MERRCR1 to clear corresponding status.
   d. Set the ALLEV bit in INTEVAL to 1. Setting this bit reasserts the PSCINT to the DSP interrupt controller, if there are still any active interrupt events.

6.7 PSC Registers

Table 6-5 lists the memory-mapped registers for the PSC. See the device-specific data manual for the memory address of these registers.

Table 6-5. Power and Sleep Controller (PSC) Registers

Offset	Register	Description	Section
0h	PID	Peripheral Revision and Class Information Register	Section 6.7.1
18h	INTEVAL	Interrupt Evaluation Register	Section 6.7.2
44h	MERRPR1	Module Error Pending Register 1 (mod 32-34)	Section 6.7.3
54h	MERRCR1	Module Error Clear Register 1 (mod 32-34)	Section 6.7.4
120h	PTCMD	Power Domain Transition Command Register	Section 6.7.5
128h	PTSTAT	Power Domain Transition Status Register	Section 6.7.6
200h-204h	PDSTAT0-1	Power Domain Status n Register	Section 6.7.7
300h-304h	PDCTL0-1	Power Domain Control n Register	Section 6.7.8
800h-888h	MDSTAT0-34	Module Status *n* Register	Section 6.7.9
A00h-A88h	MDCTL0-34	Module Control *n* Register	Section 6.7.10

6.7.1 Peripheral Revision and Class Information Register (PID)

The peripheral revision and class information (PID) register is shown in Figure 6-2 and described in Table 6-6.

Figure 6-2. Peripheral Revision and Class Information Register (PID)

31 30	29 28	27 16
SCHEME	Reserved	FUNC
R-1	R-0	R-482h

15 11	10 8	7 6	5 0
RTL	MAJOR	CUSTOM	MINOR
R-4h	R-1	R-0	R-5h

LEGEND: R = Read only; -*n* = value after reset

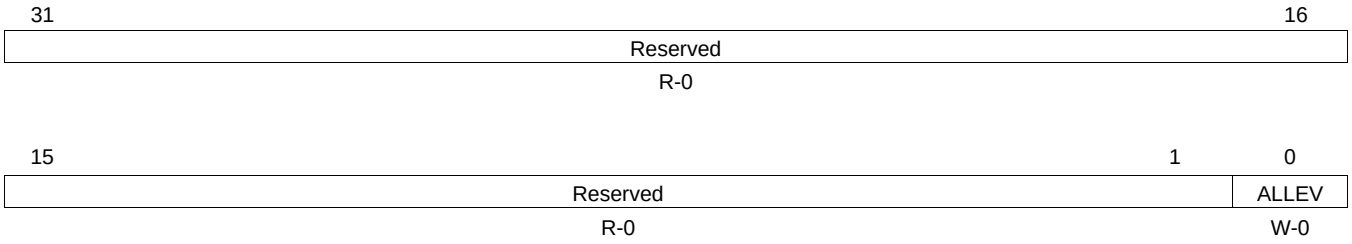
Table 6-6. Peripheral Revision and Class Information Register (PID) Field Descriptions

Bit	Field	Value	Description
31-30	SCHEME	0-3h	Distinguishes between the old scheme and the current scheme. There is a spare bit to encode future schemes.
29-28	Reserved	0	Reserved
27-16	FUNC	0-FFFh	Indicates a software compatible module family.
15-11	RTL		RTL version.
		4h	Current RTL version.
10-8	MAJOR		Major revision.
		1h	Current major revision.
7-6	CUSTOM	0-3h	Indicates a special version for a particular device.
5-0	MINOR		Minor revision.
		5h	Current minor revision.

6.7.2 Interrupt Evaluation Register (INTEVAL)

The interrupt evaluation register (INTEVAL) is shown in Figure 6-3 and described in Table 6-7.

Figure 6-3. Interrupt Evaluation Register (INTEVAL)



LEGEND: R = Read only; W= Write only; -*n* = value after reset

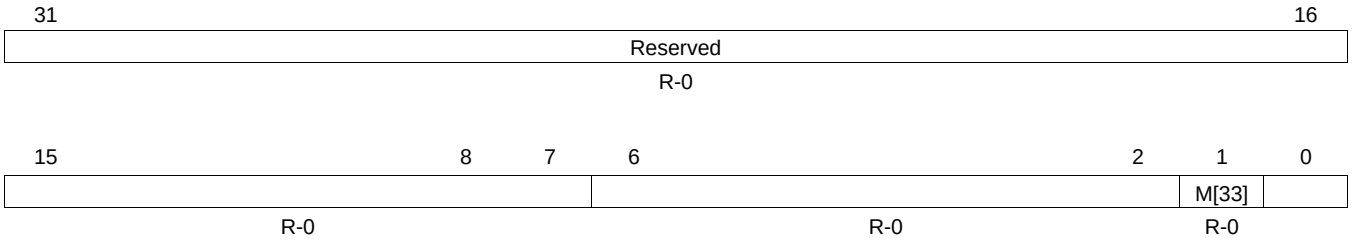
Table 6-7. Interrupt Evaluation Register (INTEVAL) Field Descriptions

Bit	Field	Value	Description
31-1	Reserved	0	Reserved
0	ALLEV		Evaluate PSC interrupt.
		0	A write of 0 has no effect.
		1	A write of 1 re-evaluates the interrupt condition.

6.7.3 Module Error Pending Register 1 (mod 33) (MERRPR1)

The module error pending register 1 (mod 33) (MERRPR1) is shown in Figure 6-4 and described in Table 6-8. Only the C64x+ DSP (module 33) can have an error condition, as it is the only module with IcePick support. See Section 6.5 for more information.

Figure 6-4. Module Error Pending Register 1 (mod 33) (MERRPR1)



LEGEND: R = Read only; -*n* = value after reset

Table 6-8. Module Error Pending Register 1 (mod 33) (MERRPR1) Field Descriptions

Bit	Field	Value	Description
31-8	Reserved	0	Reserved
7-2	Reserved	0	Reserved
1	M[33]		Module interrupt status bit for module 33 (C64x+ DSP).
		0	Module 33 does not have an error condition.
		1	Module 33 has an error condition. See the module status 33 register (MDSTAT33) for the exact error condition.
0	Reserved	0	Reserved

6.7.4 Module Error Clear Register 1 (mod 33) (MERRCR1)

The module error clear register 1 (mod 33) (MERRCR1) is shown in Figure 6-5 and described in Table 6-9.

Figure 6-5. Module Error Clear Register 1 (mod 33) (MERRCR1)

31	16
Reserved	
R-0	

15	8	7	6	2	1	0
Reserved			Reserved		M[33]	
R-0			R-0		W-0	

LEGEND: R = Read only; W = Write only; -*n* = value after reset

Table 6-9. Module Error Clear Register 1 (mod 33) (MERRCR1) Field Descriptions

Bit	Field	Value	Description
31-8	Reserved	0	Reserved
7-2	Reserved	0	Reserved
1	M[33]		Clears the interrupt status bits set in the corresponding module error pending register 1 (mod 33) (MERRPR1) and the module status 33 register (MDSTAT33). This pertains to module 33.
		0	A write of 0 has no effect.
		1	Clears module interrupt status bits: the M[33] bit in MERRPR1, the EMURST bit and the EMUIHB bit in MDSTAT33.
0	Reserved	0	Reserved

6.7.5 Power Domain Transition Command Register (PTCMD)

The power domain transition command register (PTCMD) is shown in Figure 6-6 and described in Table 6-10.

Figure 6-6. Power Domain Transition Command Register (PTCMD)

31	16
Reserved	
R-0	

15	2	1	0
Reserved		GO[1]	GO[0]
R-0		W-0	W-0

LEGEND: R = Read only; W = Write only; -*n* = value after reset

Table 6-10. Power Domain Transition Command Register (PTCMD) Field Descriptions

Bit	Field	Value	Description
31-2	Reserved	0	Reserved
1	GO[1]		Ethernet Subsystem Power domain GO transition command.
		0	A write of 0 has no effect.
		1	Writing 1 causes the PSC to evaluate all the NEXT fields relevant to this power domain (including the NEXT bit in MDCTL*n* for all the modules residing on this domain). If any of the NEXT fields are not matching the corresponding current state (STATE bit in MDSTAT*n*), the PSC will transition those respective domain/modules to the new NEXT state.
0	GO[0]		AlwaysOn Power domain GO transition command.
		0	A write of 0 has no effect.
		1	Writing 1 causes the PSC to evaluate all the NEXT fields relevant to this power domain (including the NEXT bit in MDCTL*n* for all the modules residing on this domain). If any of the NEXT fields are not matching the corresponding current state (STATE bit in MDSTAT*n*), the PSC will transition those respective domain/modules to the new NEXT state.

6.7.6 Power Domain Transition Status Register (PTSTAT)

The power domain transition status register (PTSTAT) is shown in Figure 6-7 and described in Table 6-11.

Figure 6-7. Power Domain Transition Status Register (PTSTAT)

31	16
Reserved	
R-0	

15	2	1	0
Reserved		GOSTAT[1]	GOSTAT[0]
R-0		R-0	R-0

LEGEND: R = Read only; -*n* = value after reset

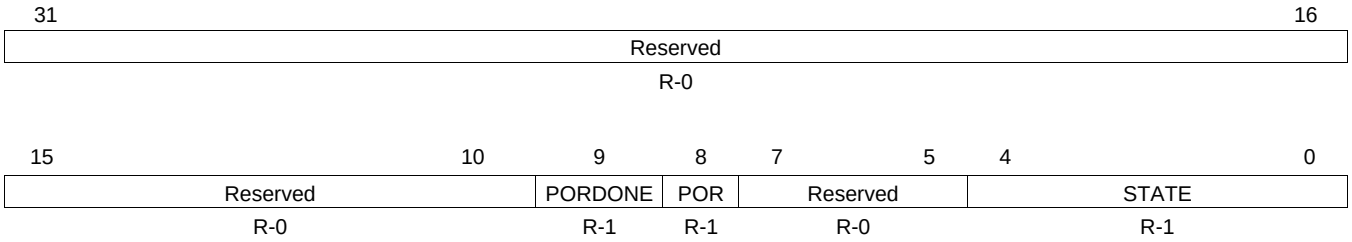
Table 6-11. Power Domain Transition Status Register (PTSTAT) Field Descriptions

Bit	Field	Value	Description
31-2	Reserved	0	Reserved
1	GOSTAT[1]		Ethernet Subsystem Power domain transition status.
		0	No transition is in progress.
		1	Modules in Ethernet Subsystem Power domain are transitioning.
0	GOSTAT[0]		AlwaysOn Power domain transition status.
		0	No transition is in progress.
		1	Modules in AlwaysOn power domain are transitioning.

6.7.7 Power Domain Status n Register (PDSTATn)

The power domain status n register (PDSTAT0-PDSTAT1) is shown in Figure 6-8 and described in Table 6-12. PDSTAT0 applies to the AlwaysOn power domain and PDSTAT1 applies to Ethernet Subsystem power domain.

Figure 6-8. Power Domain Status n Register (PDSTATn)



LEGEND: R = Read only; -*n* = value after reset

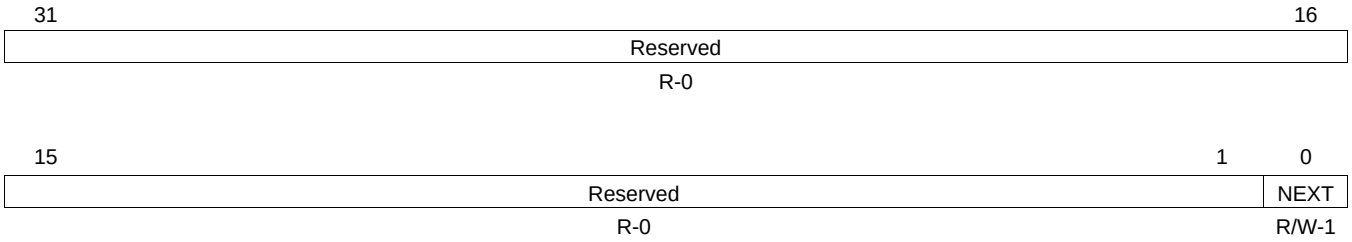
Table 6-12. Power Domain Status n Register (PDSTATn) Field Descriptions

Bit	Field	Value	Description
31-10	Reserved	0	Reserved
9	PORDONE		Power_On_Reset (POR) done status.
		0	Power domain POR is not done.
		1	Power domain POR is done.
8	POR		Power domain Power_On_Reset (POR) status. This bit reflects the POR status for this power domain including all modules in the domain.
		0	Power domain POR is asserted.
		1	Power domain POR is de-asserted.
7-5	Reserved	0	Reserved
4-0	STATE		Power domain status
		0	Power domain is in the off state.
		1	Power domain is in the on state.

6.7.8 Power Domain Control n Register (PDCTLn)

The power domain control n register (PDCTL0-PTDCTL1) is shown in Figure 6-9 and described in Table 6-13. PDCTL0 applies to the AlwaysOn power domain and PDCTL1 applies to Ethernet Subsystem power domain.

Figure 6-9. Power Domain Control n Register (PDCTLn)



LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

Table 6-13. Power Domain Control n Register (PDCTLn) Field Descriptions

Bit	Field	Value	Description
31-1	Reserved	0	Reserved
0	NEXT		Power domain next state.
		0	Power domain off.
		1	Power domain on. AlwaysOn domain and Ethernet Subsystem domain must always be programmed to this value.

6.7.9 Module Status n Register (MDSTATn)

The module status *n* register (MDSTAT0-MDSTAT34) is shown in Figure 6-10 and described in Table 6-14.

Figure 6-10. Module Status *n* Register (MDSTAT*n*)

31	18	17	16
Reserved		EMUIHB	EMURST
R-0		R-0	R-0

15	13	12	11	10	9	8	7	6	5	0
Reserved		MCKOUT	Reserved	MRST	LRSTDONE	LRST	Reserved		STATE	
R-0		R-0	R-1	R-0	R-1	R-1	R-0		R-0	

LEGEND: R = Read only; -*n* = value after reset

Table 6-14. Module Status *n* Register (MDSTAT*n*) Field Descriptions

Bit	Field	Value	Description
31-18	Reserved	0	Reserved
17	EMUIHB		Emulation Alters Module State. This bit applies to DSP module only (module 33). This field is 0 for all other modules.
		0	No emulation altering user-desired module state programmed in the NEXT bit in MDCTL33.
		1	Emulation altered user-desired state programmed in the NEXT bit in MDCTL33. If you desire to generate a PSCINT upon this event, you must set the EMUIHBIE bit in MDCTL33..
16	EMURST		Emulation Alters Module Reset. This bit applies to DSP module only (module 33). This field is 0 for all other modules.
		0	No emulation altering user-desired module reset state.
		1	Emulation altered user-desired module reset state. If you desire to generate a PSCINT upon this event, you must set the EMURSTIE bit in MDCTL33.
15-13	Reserved	0	Reserved
12	MCKOUT		Module clock output status. Shows actual status of module clock.
		0	Module clock is off.
		1	Module clock is on.
11	Reserved	1	Reserved
10	MRST		Module reset status. Reflects actual state of module reset.
		0	Module reset is asserted.
		1	Module reset is de-asserted.
9	LRSTDONE		Local reset done. Software is responsible for checking if local reset is done before accessing this module. This bit applies to the DSP module only (module 33). This field is 1 for all other modules.
		0	Local reset is not done.
		1	Local reset is done.
8	LRST		Module local reset status. This bit applies to the DSP module only (module 33).
		0	Local reset is asserted.
		1	Local reset is de-asserted.
7-6	Reserved	0	Reserved
5-0	STATE	0-3Fh	Module state status. Indicates current module status.
		0	SwRstDisable state
		1h	SyncReset state
		2h	Disable state
		3h	Enable state
		4h-3Fh	Indicates transition

6.7.10 Module Control n Register (MDCTLn)

The module control *n* register (MDCTL0-MDCTL34) is shown in Figure 6-11 and described in Table 6-15.

Figure 6-11. Module Control *n* Register (MDCTL*n*)

31	16
Reserved	
R-0	

15	11	10	9	8	7	3	2	0
Reserved		EMUIHBIE	EMURSTIE	LRST	Reserved		NEXT	
R-0		R/W-0	R/W-0	R/W-1	R-0		R/W-0	

LEGEND: R/W = Read/Write; R = Read only; -*n* = value after reset

Table 6-15. Module Control *n* Register (MDCTL*n*) Field Descriptions

Bit	Field	Value	Description
31-11	Reserved	0	Reserved
10	EMUIHBIE		Interrupt enable for emulation alters module state. This bit applies to the DSP module only (module 33). Program this field to 0 for all other modules.
		0	Disable interrupt.
		1	Enable interrupt.
9	EMURSTIE		Interrupt enable for emulation alters reset. This bit applies to the DSP module only (module 33). Program this field to 0 for all other modules.
		0	Disable interrupt.
		1	Enable interrupt.
8	LRST		Module local reset control. This bit applies to the DSP module only (module 33). Program this field to 1 for all other modules.
		0	Assert local reset.
		1	De-assert local reset.
7-3	Reserved	0	Reserved
2-0	NEXT	0-7h	Module next state.
		0	SwRstDisable state
		1h	SyncReset state
		2h	Disable state
		3h	Enable state
		4h-7h	Reserved

Power Management

Topic Page

7.1 Overview

In many applications, there may be specific requirements to minimize power consumption for both power supply (or battery) and thermal considerations. There are two components to power consumption: active power and leakage power. Active power is the power consumed to perform work and scales roughly with clock frequency and the amount of computations being performed. Active power can be reduced by controlling the clocks in such a way as to either operate at a clock setting just high enough to complete the required operation in the required timeline or to run at a clock setting until the work is complete and then drastically cut the clocks (that is, to PLL Bypass mode) until additional work must be performed. Leakage power is due to static current leakage and occurs regardless of the clock rate. Leakage, or standby power, is unavoidable while power is applied and scales roughly with the operating junction temperatures. Leakage power can only be avoided by removing power completely from a device or subsystem.

The TMS320C6452 has several means of managing the power consumption, as detailed in the following sections. There is extensive use of automatic clock gating in the design as well as software-controlled module clock gating to not only reduce the clock tree power, but to also reduce module power by basically freezing its state while not operating. Clock management enables you to slow the clocks down on the chip in order to reduce switching power. In particular, the C6452 includes all of the power management features described in Table 7-1.

Table 7-1. Power Management Features

Power Management Features	Description
	Clock Management
PLL power-down	The PLLs can be powered-down when not in use to reduce switching power
Module clock ON/OFF	Module clocks can be turned on/off to reduce switching power
Module clock frequency scaling	Module clock frequency can be scaled to reduce switching power
	DSP Sleep Management
DSP sleep modes	The DSP can be put into sleep mode to reduce switching power

7.2 PSC and PLLC Overview

The power and sleep controller (PSC) plays an important role in managing system power on/off, clock on/off, and reset. Similarly, the PLL controller (PLLC) plays an important role in device clock generation. The PSC and the PLLC are mentioned throughout this chapter. For detailed information on the PSC, see Chapter 6. For detailed information on the PLLC, see Chapter 4 and Chapter 5.

7.3 Clock Management

7.3.1 Module Clock ON/OFF

The module clock on/off feature allows software to disable clocks to module individually, in order to reduce the module's active power consumption to 0. The C6452 is designed in full static CMOS; thus, when a module clock stops, the module's state is preserved. When the clock is restarted, the module resumes operating from the stopping point.

Note: Stopping clocks to a module only affects active power consumption, it does not affect leakage power consumption.

If a module's clock(s) is stopped while being accessed, the access may not occur, and could potentially lock-up the device. User must ensure that all of the transactions to the module are finished prior to stopping the clocks. The power and sleep controller (PSC) controls module clock gating. The PSC provides some protection against system hang by monitoring the internal bus activity—it only gates internal clock to the module after checking that there is no access to the module from the internal bus.

The procedure to turn module clocks on/off using the PSC is described in Chapter 6. Furthermore, special consideration must be given to DSP clock on/off. The procedure to turn the DSP clock on/off is further described in Section 7.4.2.

Some peripherals provide additional power saving features by clock gating components within its module boundary. See the peripheral-specific user's guide for more details on these additional power saving features.

7.3.2 Module Clock Frequency Scaling

Module clock frequency is scalable by programming the PLL's multiply and divide parameters. Reducing the clock frequency reduces the active switching power consumption linearly with frequency. It has no impact on leakage power consumption.

Chapter 4 and Chapter 5 describe the how to program the PLL frequency and the frequency constraints.

7.3.3 PLL Bypass and Power Down

You can bypass the PLLs in the C6452. Bypassing the PLLs sends the PLL reference clock (CLKIN1) instead of the PLL output (PLLOUT) to the SYSCLK dividers (PLLDIV*n*) of the PLLC. The PLL reference clock is typically at 36 MHZ; therefore, you can use this mode to reduce the core and module clock frequencies to very low maintenance levels without using the PLL during periods of very low system activity. Furthermore, you can power-down the PLL when bypassing it to save additional active power.

Chapter 4 and Chapter 5 describe PLL bypass and PLL power down.

7.4 DSP Sleep Mode Management

The C64x+ DSP supports sleep mode management to reduce power:

- DSP clock can be completely shut off
- C64x+ Megamodule can be put in sleep mode
  - C64x+ CPU can be put in sleep mode

On the C6452, sleep mode for the DSP internal memories (L1P, L1D, L2) is not supported.

7.4.1 DSP Sleep Modes

The C64x+ Megamodule of the DSP subsystem includes a power-down controller (PDC) that controls the power-down of the C64x+ Megamodule components. See Section 2.4.2 and the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more details on the PDC.

7.4.2 DSP Module Clock ON/OFF

As discussed in Section 7.4.1, the C64x+ Megamodule can clock gate its own components to save power. Additional power saving can be achieved by stopping the clock source to the C64x+ Megamodule by programming the power and sleep controller (PSC) to place the C64x+ Megamodule in Disable state. The C64x+ DSP cannot perform this programming task on its own, because the C64x+ DSP will not be able to complete the PSC programming sequence if the C64x+ DSP clock source is gated in the middle of the process. If stopping the clock source to the C64x+ DSP is desired for additional power saving, an external host is responsible for programming the PSC (for example, via HPI, PCI interfaces) to disable the C64x+ Megamodule. Similarly, in that case the external host is responsible for programming the PSC to enable the C64x+ Megamodule.

7.4.2.1 DSP Module Clock ON

In the clock Enable state, the DSP's module clock is enabled while DSP module reset is de-asserted. This is the state for normal DSP run-time. DSP defaults to Enable state, therefore this DSP Module Clock ON process is typically not needed. This process is only required to wake up the DSP after an external host puts the DSP in Disable state (Section 7.4.2.2).

- Host: Enable clocks to the DSP.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. You must wait for the power domain to finish any previously initiated transitions before initiating a new transition.
  - Set the NEXT bit in MDCTL33 to 3h to prepare the DSP module for an enable transition.
  - Set the GO[0] bit in PTCMD to 1 to initiate the state transition.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. The domain is only safely in the new state after the GOSTAT[0] bit is cleared to 0.
  - Wait for the STATE bit in MDSTAT33 to change to 3h. The module is only safely in the new state after the STATE bit in MDSTAT33 changes to reflect the new state.
- Host: Wake the DSP.
  - If transitioning from the disable state, trigger a DSP interrupt that has previously been configured as a wake-up interrupt.

Note: This step only applies if you are transitioning from the disable state. If previously in the disable state, a wake-up interrupt must be triggered in order to wake the DSP. This example assumes that the DSP enabled this interrupt before entering its IDLE state. If previously in the software reset disable or synchronous reset state, it is not necessary to wake the DSP because these states assert the DSP module reset. See Chapter 10 for information on the software reset disable and synchronous reset states. See the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on DSP interrupts.

7.4.2.2 DSP Module Clock Off

In the clock Disable state, the DSP's module clock is disabled, while DSP reset remains de-asserted. This state is typically used to disable the DSP clock to save power. As mentioned in Section 7.4.2, the DSP cannot put itself in Disable state. An external host is responsible for performing this task. For example, it can be an external host interfacing through the HPI or PCI peripheral.

- Host: Notify the DSP to prepare for power-down.
- DSP: Drain all existing operations and ensure there are no accesses to the C64x+ megamodule prior to DSP power-down.
  - Program the PSC to disable all master peripherals (except the Host) that are capable of initiating transfers to the C64x+ Megamodule.
  - Check EDMA transfer status to ensure there is no outstanding EDMA transfers that can access the C64x+ Megamodule.
- DSP: Prepare for power-down.
  - Set PDCCMD to 0001 5555h. PDCCMD is a control register in the DSP power-down controller module.

    Note: This register can only be written while the DSP is in supervisor mode.
  - Enable one of the interrupts that the host would like to use to wake the DSP in the DSP clock-on sequence.
  - Execute the IDLE instruction. IDLE is a program instruction in the C64x+ CPU instruction set. When the CPU executes IDLE, the PDC is notified and initiates DSP power-down according to the bits that you set in the PDCCMD (0181 0000h) register. See the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the PDC and the IDLE instruction.
- Host: Disable the DSP clock.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. You must wait for the power domain to finish any previously initiated transitions before initiating a new transition.
  - Set the NEXT bit in MDCTL33 to 2h to prepare the DSP module for a disable transition.
  - Set the GO[0] bit in PTCMD to 1 to initiate the state transition.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. The domain is only safely in the new state after the GOSTAT[0] bit is cleared to 0.
  - Wait for the STATE bit in MDSTAT33 to change to 2h. The module is only safely in the new state after the STATE bit in MDSTAT33 changes to reflect the new state.

Interrupt Controller

The C64x+ Megamodule includes an interrupt controller (INTC) to manage CPU interrupts. The interrupt controller interfaces the system events to the CPU's interrupt and exception inputs. The interrupt controller supports up to 128 system events, and it maps these system events to the 12 CPU interrupts. See the device-specific data manual for the list of system events. The interrupt controller section of the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) fully describes the INTC and how it maps the DSP device events to the 12 CPU interrupts.

System Module

Topic Page

9.1 Overview

The TMS320C6452 System Module is a system-level module containing status and top-level control logic required by the device. The System Module consists of a set of status and control registers, accessible by the DSP, supporting all of the following system features and operations:

- Device Identification
- Device Configuration
  - Pin multiplexing control
  - Device boot configuration status
- Ethernet Subsystem Control
- Bandwidth Management
  - Bus master DMA priority control
- Boot Control

This chapter describes the System Module.

9.2 Device Identification

The JTAGID register of the System Module contains a software readable version of the JTAG ID device. Software can use this register to determine the version of the device on which it is executing. The register format and description are shown in the device-specific data manual.

9.3 Device Configuration

The System Module contains registers for controlling pin multiplexing and registers that reflect the boot configuration status.

9.3.1 Pin Multiplexing Control

The C6452 makes extensive use of pin multiplexing to accommodate the large number of peripheral functions in the smallest possible package. A combination of hardware configuration (configuration pins latched at device reset) and register program control (PINMUX register) controls pin multiplexing to accomplish this. Hardware does not attempt to ensure that the proper pin multiplexing is selected for the peripherals or that interface mode is being used.

Detailed information about the pin multiplexing and control is covered in the device-specific data manual.

9.3.2 Device Boot Configuration Status

The device boot and configuration settings are latched at device reset ($\overline{\text{POR}}$ or $\overline{\text{RESET}}$), and captured in the BOOTCFG register. See the device-specific data manual for details on this register and the boot and configuration settings.

9.4 Ethernet Subsystem Control

The System Module contains the following Ethernet Subsystem control registers:

- SerDes PLL Configuration Register (CFGPLL)
- SerDes Transmitter Configuration Registers(CFGTX0, CFGTX1)
- SerDes Receiver Configuration Registers(CFGRX0, CFGRX1)

See the device-specific Ethernet Subsystem guide for descriptions of these registers.

9.5 Bandwidth Management

9.5.1 Bus Master DMA Priority Control

In order to determine allowed connections between masters and slaves, each master request source must have a unique master ID (mstid) associated with it. The master ID for each C6452 master is shown in Table 9-1.

Table 9-1. TMS320C6452 Master IDs

MSTID	Master
0	EDMA3TC0
0	EDMA3TC1
0	EDMA3TC2
0	EDMA3TC3
7	64X+_DMAP
1	64X+_CFGP
3	Ethernet Subsystem
4	VLYNQ
4	UHPI
4	PCI

Each switched central resource (SCR) performs prioritization based on the priority level of the master that sends the command. Each bus master's priority is programmed in the chip-level Bus Master Priority Allocation Registers (PRI_ALLOC). Application software is expected to modify these values to obtain the desired system performance.

9.6 Boot Control

The System Module contains the following boot control registers:

- Device Boot Configuration Register (BOOTCFG)
- Boot Complete Register (BOOTCMPLT)
- DSP Boot Address Register (DSPBOOTADDR)

See Chapter 11 and the device-specific data manual for descriptions of these registers.

Reset

Topic Page

10.1 Overview

There are different types of reset in the TMS320C6452. The types of reset differ by how they are initiated and/or by their effect on the chip. Each type is briefly described in Table 10-1. See the device-specific data manual for more details on each of the reset types.

Table 10-1. Reset Types

Type	Initiator	Effect
POR (Power-On-Reset)	$\overline{\text{POR}}$ pin low	Total reset of the chip (cold reset). Resets entire chip including test and emulation logic. The power-on reset ($\overline{\text{POR}}$) pin must be driven low during power ramp of the device. Device boot and configuration pins are latched.
Warm Reset	$\overline{\text{RESET}}$ pin low	Resets everything except for test and emulation logic and Ethernet Subsystem. Emulator stays alive during warm reset. Device boot and configuration pins are latched.
System Reset	PCI via the $\overline{\text{PRST}}$ pin	A soft reset, does not affect or reset clocks or power states. Does not reset test and emulator logic and Ethernet Subsystem. The Device boot and configuration pins are not re-latched.
Module/Peripheral Local Reset	DSP or external host software	Independently resets a specific module. Module reset is intended as a debug tool, not necessarily as a tool to use in production.
DSP Local Reset	External host software	Resets the DSP CPU. DSP internal memories (L1P, L1D, and L2) are not reset.

10.2 Reset Pins

There are two device-level global reset pins on the device: Power-On-Reset ($\overline{\text{POR}}$) and warm reset ($\overline{\text{RESET}}$). See the device-specific data manual for more details on these reset pins.

10.3 Device Configurations at Reset

Upon $\overline{\text{POR}}$ and warm reset, the device latches the values from the boot and configuration pins. See the device-specific data manual for the list of boot and configuration pins, and the device's default states.

10.4 DSP Reset

With access to the power and sleep controller (PSC) registers, the external host (for example, PCI, HPI) can assert and de-assert DSP local reset and DSP module reset. When DSP local reset is asserted, the DSP's internal memories (L1P, L1D, and L2) are still accessible. Local reset only resets the DSP CPU. Local reset is useful when the DSP module is in the enable or disable states, since module reset is asserted in the SyncReset and SwRstDisable states and module reset supersedes local reset. The intent of DSP module reset is for the external host to completely reset the DSP. The intent of DSP local reset is to allow the host to hold the CPU in reset while it is loading code into the DSP internal memory—this step can be useful after the host puts the DSP in module reset and then subsequently enables the DSP. For more information on the PSC, see Chapter 6. This section describes how to initiate DSP local reset and module reset.

10.4.1 DSP Local Reset

The following steps describe how an external host can assert/de-assert local reset to the DSP:

1. Clear the LRST bit in MDCTL33 to 0 to assert DSP reset.
2. Set the LRST bit in MDCTL33 to 1 to de-assert DSP reset.

10.4.2 DSP Module Reset

The external host may program the PSC to assert DSP module reset by placing the DSP in either Software Reset Disable (SwRstDisable) state or Synchronous Reset (SyncReset) state. See Chapter 6 for descriptions of these PSC states.

10.4.2.1 Software Reset Disable (SwRstDisable)

In the software reset disable (SwRstDisable) state, the DSP's module reset is asserted and its module clock is turned off. You can use this state to reset the DSP. The following steps describe how to put the DSP in the software reset disable state:

- Host: Notify the DSP to prepare for power-down.
- DSP: Put the DSP in the IDLE state.
  - Set PDCCMD to 0001 5555h. PDCCMD is a control register in the DSP power-down controller module.

    Note: This register can only be written while the DSP is in its supervisor mode.
  - Execute the IDLE instruction if the DSP is in the enable state. IDLE is a program instruction in the C64x+ CPU instruction set. When the CPU executes IDLE, the PDC is notified and will initiate the DSP power-down according to the bits that you set in the PDCCMD (0181 0000h) register. See the *TMS320C64x+ DSP Megamodule Reference Guide* (SPRU871) for more information on the PDC and the IDLE instruction.
- Host: Software reset disable DSP.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. You must wait for the power domain to finish any previously initiated transitions before initiating a new transition.
  - Clear the NEXT bit in MDCTL33 to 0 to prepare the DSP module for a SwRstDisable transition.
  - Set the GO[0] bit in PTCMD to 1 to initiate the state transition.
  - Wait for GOSTAT[0] bit in PTSTAT to clear to 0. The module is safely in the new state only after the GOSTAT[0] bit is cleared to 0.
- Host: Assert the DSP local reset (Optional)
  - Clear the LRST bit in MDCTL33 to 0. This step is optional. This step asserts the DSP local reset, and is included here so that the DSP does not start running immediately upon it is subsequently enable by the host. Typically, the host only de-asserts local reset to the DSP after it makes sure that code is properly loaded.

10.4.2.2 Synchronous Reset (SyncReset)

In the synchronous reset (SyncReset) state, the DSP's module reset is asserted and its module clock is enabled. You can use this state to reset the DSP. The following steps describe how to put the DSP in the synchronous reset state:

- Host: Notify the DSP to prepare for power-down.
- DSP: Put the DSP in the IDLE state.
  - Set PDCCMD to 0001 5555h. PDCCMD is a control register in the DSP power-down controller module.

    Note: This register can only be written while the DSP is in supervisor mode.
  - Execute the IDLE instruction.
- Host: Sync reset DSP
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. You must wait for the power domain to finish any previously initiated transitions before initiating a new transition.
  - Set the NEXT bit in MDCTL33 to 1 to prepare the DSP module for a SyncReset transition.
  - Set the GO[0] bit in PTCMD to 1 to initiate the state transition.
  - Wait for the GOSTAT[0] bit in PTSTAT to clear to 0. The module is safely in the new state only after the GOSTAT[0] bit is cleared to 0.
- Host: Assert DSP local reset (Optional)
  - Clear the LRST bit in MDCTL33 to 0. This step is optional. This step asserts the DSP local reset and is included here so that the DSP does not start running immediately upon it is subsequently enabled by the host. Typically, software de-asserts local reset to the DSP after it makes sure that code is properly loaded.

Boot Modes

The TMS320C6452 can boot from either asynchronous EMIF/NOR Flash/Synchronous EMIF directly or from internal boot ROM, as determined by the setting of the device boot and configuration pins. The input states of the boot and configuration pins are sampled and latched into the BOOTCFG register when device reset is deasserted. See the device-specific data manual for the list of boot and configuration pins and a list of boot modes supported on the C6452.

In all boot modes, the C64x+ CPU is immediately released from reset and begins executing from one of the two possible addresses:

- EMIFA Chip Select Space 2 (A000 0000h)
- Internal Boot ROM (0080 0000h)

For the boot modes that start at the internal boot ROM, the ROM Boot Loader (RBL) software is responsible for completing the boot sequence.

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