



The MPC8245 combines a PowerPC™ MPC603e core with a PCI bridge. The PCI support on the MPC8245 will allow system designers to rapidly design systems using peripherals already designed for PCI and the other standard interfaces. The MPC8245 also integrates a high-performance memory controller which supports various types of ROM and SDRAM. The MPC8245 is the second of a family of products that provides system-level support for industry standard interfaces with a MPC603e processor core.

This document describes pertinent electrical and physical characteristics of the MPC8245. For functional characteristics of the processor, refer to the *MPC8245 Integrated Processor User's Manual* (MPC8245UM/D).

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1.1 Overview

The MPC8245 integrated processor is comprised of a peripheral logic block and a 32-bit superscalar MPC603e core, as shown in Figure 1.

Overview

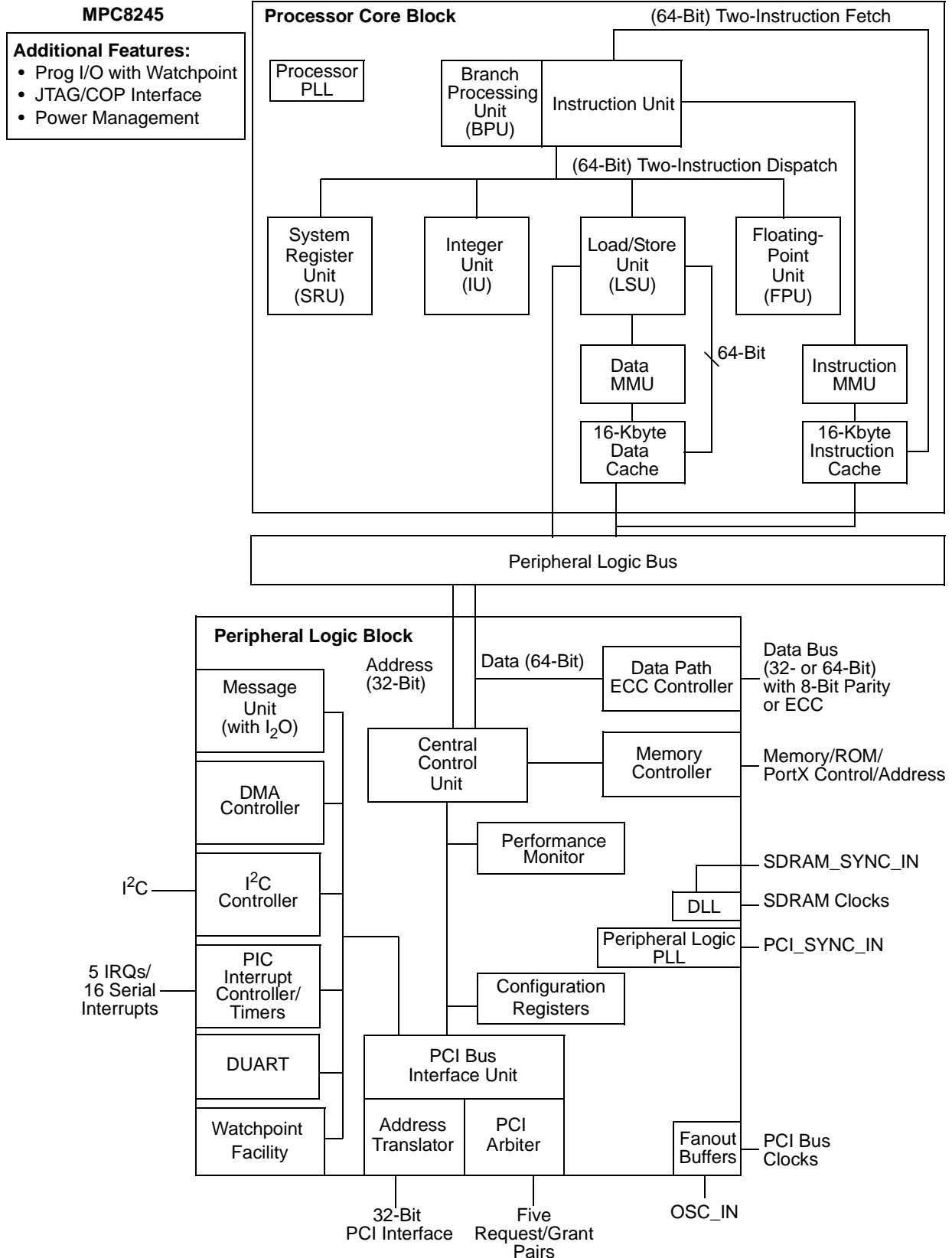


Figure 1. MPC8245 Block Diagram

The peripheral logic integrates a PCI bridge, dual universal asynchronous receiver/transmitter (DUART), memory controller, DMA controller, PIC interrupt controller, a message unit (and I₂O interface), and an I²C controller. The processor core is a full-featured, high-performance processor with floating-point support, memory management, 16-Kbyte instruction cache, 16-Kbyte data cache, and power management features. The integration reduces the overall packaging requirements and the number of discrete devices required for an embedded system.

The MPC8245 contains an internal peripheral logic bus that interfaces the processor core to the peripheral logic. The core can operate at a variety of frequencies, allowing the designer to trade-off performance for power consumption. The processor core is clocked from a separate PLL, which is referenced to the peripheral logic PLL. This allows the microprocessor and the peripheral logic block to operate at different frequencies, while maintaining a synchronous bus interface. The interface uses a 64- or 32-bit data bus (depending on memory data bus width) and a 32-bit address bus along with control signals that enable the interface between the processor and peripheral logic to be optimized for performance. PCI accesses to the MPC8245 memory space are passed to the processor bus for snooping when snoop mode is enabled.

The processor core and peripheral logic are general-purpose in order to serve a variety of embedded applications. The MPC8245 can be used as either a PCI host or PCI agent controller.

1.2 Features

Major features of the MPC8245 are as follows:

- Processor core
 - High-performance, superscalar processor core
 - Integer unit (IU), floating-point unit (FPU) (software enabled or disabled), load/store unit (LSU), system register unit (SRU), and a branch processing unit (BPU)
 - 16-Kbyte instruction cache
 - 16-Kbyte data cache
 - Lockable L1 caches—entire cache or on a per-way basis up to three of four ways
 - Dynamic power management—supports 60x nap, doze, and sleep modes
- Peripheral logic
 - Peripheral logic bus
 - Supports various operating frequencies and bus divider ratios
 - 32-bit address bus, 64-bit data bus
 - Supports full memory coherency
 - Decoupled address and data buses for pipelining of peripheral logic bus accesses
 - Store gathering on peripheral logic bus-to-PCI writes
 - Memory interface
 - Supports up to 2 Gbytes of SDRAM memory
 - High-bandwidth data bus (32- or 64-bit) to SDRAM
 - Programmable timing supporting SDRAM
 - Supports 1 to 8 banks of 16-, 64-, 128-, 256-, or 512-Mbit memory devices
 - Write buffering for PCI and processor accesses
 - Supports normal parity, read-modify-write (RMW), or ECC
 - Data-path buffering between memory interface and processor

Features

- Low-voltage TTL logic (LVTTL) interfaces
- 272 Mbytes of base and extended ROM/Flash/PortX space
- Base ROM space supports 8-bit data path or same size as the SDRAM data path (32- or 64-bit)
- Extended ROM space supports 8-, 16-, 32-bit gathering data path, 32- or 64-bit (wide) data path
- PortX: 8-, 16-, 32-, or 64-bit general-purpose I/O port using ROM controller interface with programmable address strobe timing, data ready input signal ($\overline{\text{DRDY}}$), and 4 chip selects
- 32-bit PCI interface
 - Operates up to 66 MHz
 - PCI 2.2-compatible
 - PCI 5.0-V tolerance
 - Support for dual address cycle (DAC) for 64-bit PCI addressing (master only)
 - Support for PCI locked accesses to memory
 - Support for accesses to PCI memory, I/O, and configuration spaces
 - Selectable big- or little-endian operation
 - Store gathering of processor-to-PCI write and PCI-to-memory write accesses
 - Memory prefetching of PCI read accesses
 - Selectable hardware-enforced coherency
 - PCI bus arbitration unit (five request/grant pairs)
 - PCI agent mode capability
 - Address translation with two inbound and outbound units (ATU)
 - Some internal configuration registers accessible from PCI
- Two-channel integrated DMA controller (writes to ROM/PortX not supported)
 - Supports direct mode or chaining mode (automatic linking of DMA transfers)
 - Supports scatter gathering—read or write discontinuous memory
 - 64-byte transfer queue per channel
 - Interrupt on completed segment, chain, and error
 - Local-to-local memory
 - PCI-to-PCI memory
 - Local-to-PCI memory
 - PCI memory-to-local memory
- Message unit
 - Two doorbell registers
 - Two inbound and two outbound messaging registers
 - I₂O message interface
- I²C controller with full master/slave support that accepts broadcast messages
- Programmable interrupt controller (PIC)
 - Five hardware interrupts (IRQs) or 16 serial interrupts
 - Four programmable timers with cascade
- Two (dual) universal asynchronous receiver/transmitters (UARTs)

- Integrated PCI bus and SDRAM clock generation
- Programmable PCI bus and memory interface output drivers
- System level performance monitor facility
- Debug features
 - Memory attribute and PCI attribute signals
 - Debug address signals
 - \overline{MIV} signal: marks valid address and data bus cycles on the memory bus
 - Programmable input and output signals with watchpoint capability
 - Error injection/capture on data path
 - IEEE 1149.1 (JTAG)/test interface

1.3 General Parameters

The following list provides a summary of the general parameters of the MPC8245:

| | |
|-------------------|---|
| Technology | 0.25 μm CMOS, five-layer metal |
| Die size | 49.2 mm ² |
| Transistor count | 4.5 million |
| Logic design | Fully static |
| Packages | Surface-mount 352 tape ball grid array (TBGA) |
| Core power supply | 1.8 V \pm 100 mV DC (only for 266 and 300 MHz parts) 2.0 V \pm 100 mV DC (for 266, 300, 333, and 350 MHz parts) (nominal; see Table 2 for details and recommended operating conditions) |
| I/O power supply | 3.0 to 3.6 V DC |

1.4 Electrical and Thermal Characteristics

This section provides the AC and DC electrical specifications and thermal characteristics for the MPC8245.

1.4.1 DC Electrical Characteristics

This section covers ratings, conditions, and other characteristics.

1.4.1.1 Absolute Maximum Ratings

The tables in this section describe the MPC8245 DC electrical characteristics. Table 1 provides the absolute maximum ratings.

Table 1. Absolute Maximum Ratings

| Characteristic ¹ | Symbol | Range | Unit |
|--|-------------------------------------|-------------|------|
| Supply voltage—CPU core and peripheral logic | V _{DD} | −0.3 to 2.1 | V |
| Supply voltage—memory bus drivers | GV _{DD} | −0.3 to 3.6 | V |
| Supply voltage—PCI and standard I/O buffers | OV _{DD} | −0.3 to 3.6 | V |
| Supply voltage—PLLs | AV _{DD} /AV _{DD2} | −0.3 to 2.1 | V |

Electrical and Thermal Characteristics

Table 1. Absolute Maximum Ratings (continued)

| Characteristic ¹ | Symbol | Range | Unit |
|--|-----------|-------------|------|
| Supply voltage—PCI reference | LV_{DD} | −0.3 to 5.4 | V |
| Input voltage ² | V_{in} | −0.3 to 3.6 | V |
| Operational die-junction temperature range | T_j | 0 to 105 | °C |
| Storage temperature range | T_{stg} | −55 to 150 | °C |

Notes:

1. Functional and tested operating conditions are given in Table 2. Absolute maximum ratings are stress ratings only, and functional operation at the maximums is not guaranteed. Stresses beyond those listed may affect device reliability or cause permanent damage to the device.
2. PCI inputs with $LV_{DD} = 5\text{ V} \pm 5\%$ V DC may be correspondingly stressed at voltages exceeding $LV_{DD} + 0.5\text{ V}$ DC.

1.4.1.2 Recommended Operating Conditions

Table 2 provides the recommended operating conditions for the MPC8245.

Table 2. Recommended Operating Conditions

| Characteristic | Symbol | Recommended Value | Unit | Notes |
|--|------------------|-------------------------|------|----------|
| Supply voltage | V_{DD} | $1.8 \pm 100\text{ mV}$ | V | 4, 6 |
| | | $2.0 \pm 100\text{ mV}$ | V | 6 |
| I/O buffer supply for PCI and standard | OV_{DD} | 3.3 ± 0.3 | V | 6 |
| Supply voltages for memory bus drivers | GV_{DD} | $3.3 \pm 5\%$ | V | 8 |
| CPU PLL supply voltage | AV_{DD} | $1.8 \pm 100\text{ mV}$ | V | 4, 6 |
| | | $2.0 \pm 100\text{ mV}$ | V | 6 |
| PLL supply voltage—peripheral logic | AV_{DD2} | $1.8 \pm 100\text{ mV}$ | V | 4, 6 |
| | | $2.0 \pm 100\text{ mV}$ | V | 6 |
| PCI reference | LV_{DD} | $5.0 \pm 5\%$ | V | 2, 9, 10 |
| | | 3.3 ± 0.3 | V | 3, 9, 10 |
| Input voltage | PCI inputs | V_{in} | V | 2, 3 |
| | All other inputs | | | |

Table 2. Recommended Operating Conditions (continued)

| Characteristic | Symbol | Recommended Value | Unit | Notes |
|--------------------------|--------|-------------------|------|-------|
| Die-junction temperature | T_j | 0 to 105 | °C | |

Notes:

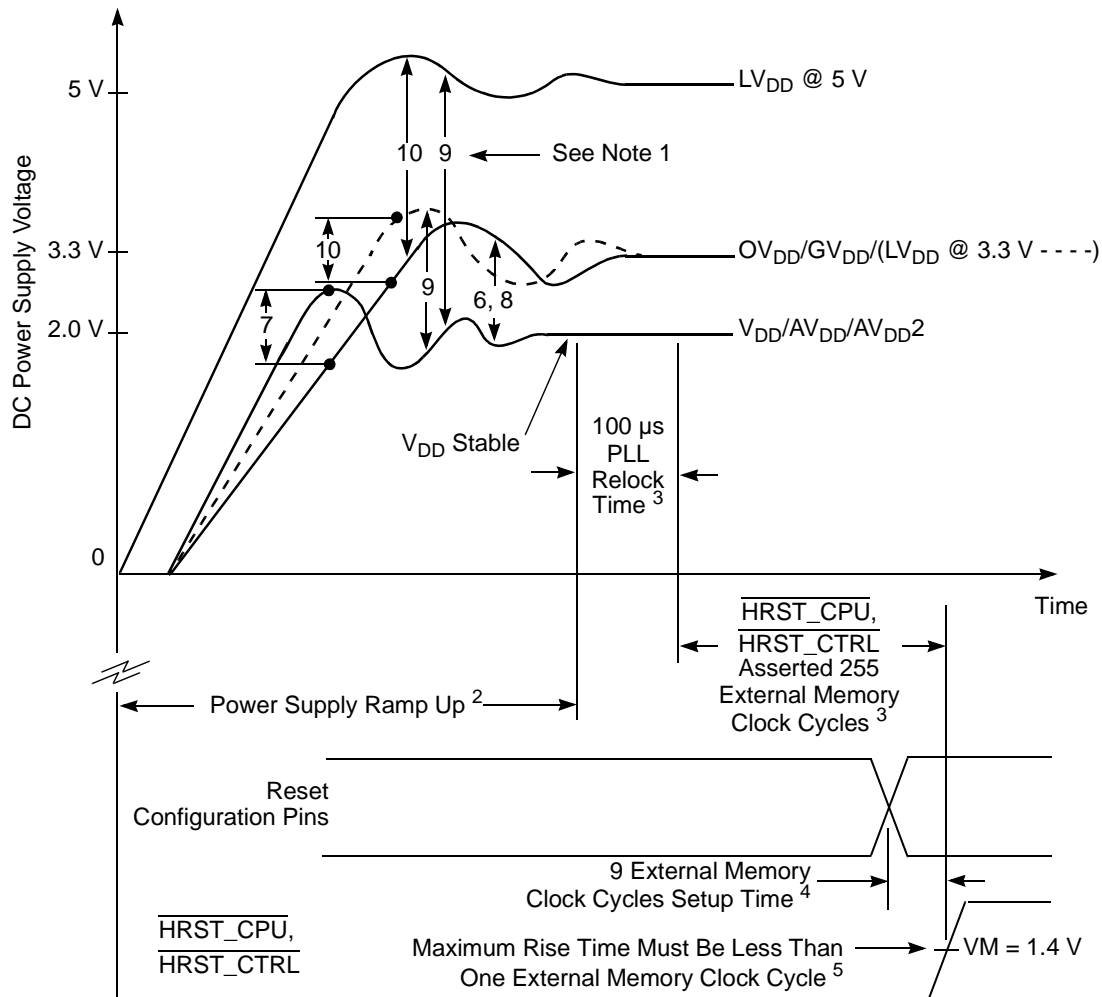
1. These are the recommended and tested operating conditions. Proper device operation outside of these conditions is not guaranteed.
2. PCI pins are designed to withstand $LV_{DD} + 0.5$ V DC when LV_{DD} is connected to a 5.0 V DC power supply.
3. PCI pins are designed to withstand $LV_{DD} + 0.5$ V DC when LV_{DD} is connected to a 3.3 V DC power supply.
4. CPU speed limited to 266 and 300 MHz operation at this voltage. See Table 7.

Cautions:

5. Input voltage (V_{in}) must not be greater than the supply voltage ($V_{DD}/AV_{DD}/AV_{DD2}$) by more than 2.5 V at all times including during power-on reset. Input voltage (V_{in}) must not be greater than GV_{DD}/OV_{DD} by more than 0.6 V at all times including during power-on reset.
6. OV_{DD} must not exceed $V_{DD}/AV_{DD}/AV_{DD2}$ by more than 1.8 V at any time including during power-on reset. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
7. $V_{DD}/AV_{DD}/AV_{DD2}$ must not exceed OV_{DD} by more than 0.6 V at any time including during power-on reset. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
8. GV_{DD} must not exceed $V_{DD}/AV_{DD}/AV_{DD2}$ by more than 1.8 V at any time including during power-on reset. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
9. LV_{DD} must not exceed $V_{DD}/AV_{DD}/AV_{DD2}$ by more than 5.4 V at any time including during power-on reset. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
10. LV_{DD} must not exceed OV_{DD} by more than 3.0 V at any time including during power-on reset. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.

Electrical and Thermal Characteristics

Figure 2 shows supply voltage sequencing and separation cautions.



Notes:

1. Numbers associated with waveform separations correspond to caution numbers listed in Table 2.
2. See Cautions section of Table 2 for additional information on this topic.
3. Refer to Table 8 for additional information on PLL relock and reset signal assertion timing requirements.
4. Refer to Table 10 for additional information on reset configuration pin setup timing requirements.
5. $\overline{\text{HRST_CPU}}/\overline{\text{HRST_CTRL}}$ must transition from a logic 0 to a logic 1 in less than one SDRAM_SYNC_IN clock cycle for the device to be in the nonreset state.

Figure 2. Supply Voltage Sequencing and Separation Cautions

Figure 3 shows the undershoot and overshoot voltage of the memory interface of the MPC8245.

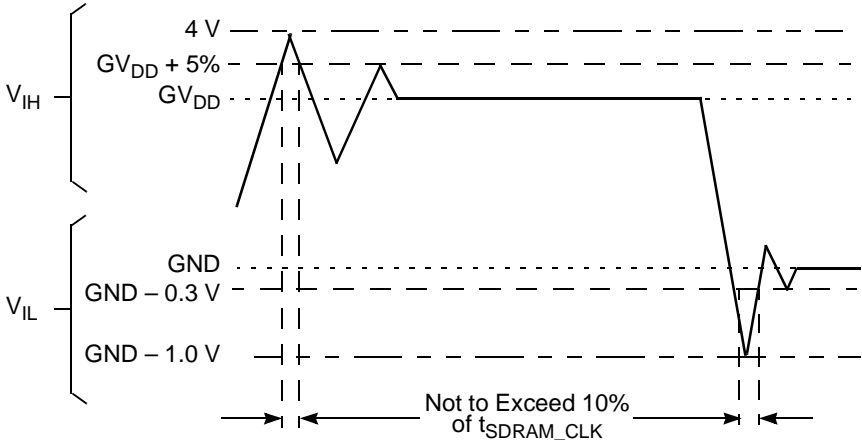


Figure 3. Overshoot/Undershoot Voltage

Figure 4 and Figure 5 show the undershoot and overshoot voltage of the PCI interface of the MPC8245 for the 3.3- and 5-V signals, respectively.

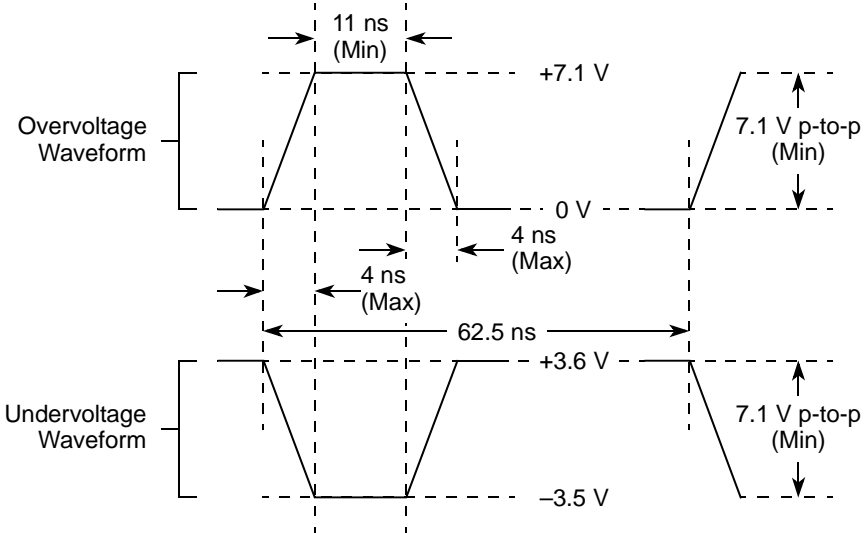


Figure 4. Maximum AC Waveforms for 3.3-V Signaling

Electrical and Thermal Characteristics

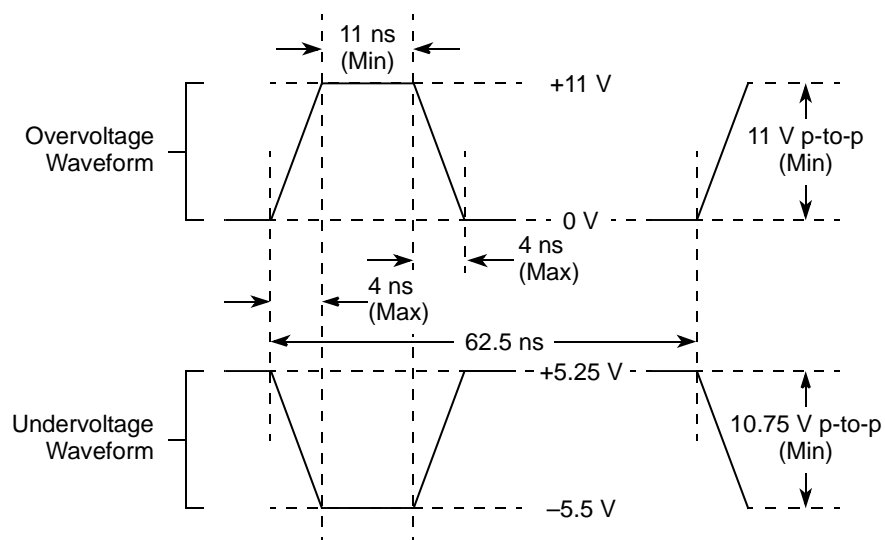


Figure 5. Maximum AC Waveforms for 5-V Signaling

1.4.1.3 DC Electrical Characteristics

Table 3 provides the DC electrical characteristics for the MPC8245 at recommended operating conditions.

Table 3. DC Electrical Specifications

At recommended operating conditions (see Table 2)

| Characteristic | Condition ³ | Symbol | Min | Max | Unit | Notes |
|---|--|-----------|-----------------------|----------------------|---------|-------|
| Input high voltage | PCI only | V_{IH} | $0.65 \times OV_{DD}$ | LV_{DD} | V | 1 |
| Input low voltage | PCI only | V_{IL} | — | $0.3 \times OV_{DD}$ | V | |
| Input high voltage | All other pins ($GV_{DD} = 3.3$ V) | V_{IH} | 2.0 | 3.3 | V | |
| Input low voltage | All inputs except PCI_SYNC_IN | V_{IL} | GND | 0.8 | V | |
| PCI_SYNC_IN input high voltage | | CV_{IH} | 2.4 | — | V | |
| PCI_SYNC_IN input low voltage | | CV_{IL} | GND | 0.4 | V | |
| Input leakage current for pins using DRV_PCI driver | 0.5 V $\leq V_{in} \leq 2.7$ V @ $LV_{DD} = 4.75$ V | I_L | — | ± 70 | μ A | 4 |
| Input leakage current all others | $LV_{DD} = 3.6$ V $GV_{DD} \leq 3.465$ V | I_L | — | ± 10 | μ A | 4 |
| Output high voltage | I_{OH} = driver dependent ($GV_{DD} = 3.3$ V) | V_{OH} | 2.4 | — | V | 2 |
| Output low voltage | I_{OL} = driver dependent ($GV_{DD} = 3.3$ V) | V_{OL} | — | 0.4 | V | 2 |

Table 3. DC Electrical Specifications (continued)

At recommended operating conditions (see Table 2)

| Characteristic | Condition ³ | Symbol | Min | Max | Unit | Notes |
|----------------|---|----------|-----|------|------|-------|
| Capacitance | $V_{in} = 0\text{ V}, f = 1\text{ MHz}$ | C_{in} | — | 16.0 | pF | |

Notes:

1. See Table 17 for pins with internal pull-up resistors.
2. See Table 4 for the typical drive capability of a specific signal pin based on the type of output driver associated with that pin as listed in Table 17.
3. These specifications are for the default driver strengths indicated in Table 4.
4. Leakage current is measured on input and output pins in the high-impedance state. The leakage current is measured for nominal OV_{DD}/LV_{DD} and V_{DD} or both OV_{DD}/LV_{DD} and V_{DD} must vary in the same direction.

1.4.1.4 Output Driver Characteristics

Table 4 provides information on the characteristics of the output drivers referenced in Table 17. The values are preliminary estimates from an IBIS model and are not tested.

Table 4. Drive Capability of MPC8245 Output Pins ⁵

| Driver Type | Programmable Output Impedance (Ω) | Supply Voltage | I_{OH} | I_{OL} | Unit | Notes |
|--------------|--|--------------------------|----------|----------|------|---------|
| DRV_STD_MEM | 20 | $OV_{DD} = 3.3\text{ V}$ | 36.6 | 18.0 | mA | 2, 4, 6 |
| | 40 (default) | | 18.6 | 9.2 | mA | 2, 4, 6 |
| DRV_PCI | 20 | | 12.0 | 12.4 | mA | 1, 3 |
| | 40 (default) | | 6.1 | 6.3 | mA | 1, 3 |
| DRV_MEM_CTRL | 6 (default) | $GV_{DD} = 3.3\text{ V}$ | 89.0 | 42.3 | mA | 2, 4 |
| DRV_PCI_CLK | 20 | | 36.6 | 18.0 | mA | 2, 4 |
| DRV_MEM_CLK | 40 | | 18.6 | 9.2 | mA | 2, 4 |

Notes:

1. For DRV_PCI, I_{OH} read from the IBIS listing in the pull-up mode, I(Min) column, at the 0.33 V label by interpolating between the 0.3- and 0.4-V table entries' current values which corresponds to the PCI $V_{OH} = 2.97 = 0.9 \times OV_{DD}$ ($OV_{DD} = 3.3\text{ V}$) where table entry voltage = $OV_{DD} - PCI\ V_{OH}$.
2. For all others with GV_{DD} or $OV_{DD} = 3.3\text{ V}$, I_{OH} read from the IBIS listing in the pull-up mode, I(Min) column, at the 0.9 V table entry which corresponds to the $V_{OH} = 2.4\text{ V}$ where table entry voltage = $GV_{DD}/OV_{DD} - V_{OH}$.
3. For DRV_PCI, I_{OL} read from the IBIS listing in the pull-down mode, I(Min) column, at 0.33 V = PCI $V_{OL} = 0 \times OV_{DD}$ ($OV_{DD} = 3.3\text{ V}$) by interpolating between the 0.3- and 0.4-V table entries.
4. For all others with GV_{DD} or $OV_{DD} = 3.3\text{ V}$, I_{OL} read from the IBIS listing in the pull-down mode, I(Min) column, at the 0.4-V table entry.
5. See driver bit details for output driver control register (0x73) in the *MPC8245 Integrated Processor User's Manual*.
6. See Chip Errata No. 19 in the *MPC8245/MPC8241 RISC Microprocessor Chip Errata*.

1.4.1.5 Power Characteristics

Table 5 provides power consumption data for the MPC8245.

Table 5. Power Consumption

| Mode | PCI Bus Clock/Memory Bus Clock CPU Clock Frequency (MHz) | | | | | | | Unit | Notes |
|---|---|----------------|---------------|----------------|---------------|----------------|----------------|-------|---------|
| | 66/66/ 266 | 66/133/ 266 | 66/66/ 300 | 66/100/ 300 | 33/83/ 333 | 66/133/ 333 | 66/100/ 350 | | |
| Typical | 1.7 (1.5) | 2.0 (1.8) | 1.8 (1.7) | 2.0 (1.8) | 2.0 | 2.3 | 2.2 | W | 1, 5 |
| Max—FP | 2.2 (1.9) | 2.4 (2.1) | 2.3 (2.0) | 2.5 (2.2) | 2.6 | 2.8 | 2.8 | W | 1, 2 |
| Max—INT | 1.8 (1.6) | 2.1 (1.8) | 2.0 (1.8) | 2.1 (1.8) | 2.2 | 2.4 | 2.4 | W | 1, 3 |
| Doze | 1.1 (1.0) | 1.4 (1.3) | 1.2 (1.1) | 1.4 (1.3) | 1.4 | 1.6 | 1.5 | W | 1, 4, 6 |
| Nap | 0.4 (0.4) | 0.7 (0.7) | 0.4 (0.4) | 0.6 (0.6) | 0.5 | 0.7 | 0.6 | W | 1, 4, 6 |
| Sleep | 0.2 (0.2) | 0.4 (0.4) | 0.2 (0.4) | 0.3 (0.3) | 0.3 | 0.4 | 0.3 | W | 1, 4, 6 |
| I/O Power Supplies ¹⁰ | | | | | | | | | |
| Mode | Min | | | Max | | | Unit | Notes | |
| Typ—OV _{DD} | 134 (121) | | | 334 (301) | | | mW | 7, 8 | |
| Typ—GV _{DD} | 324 (292) | | | 800 (720) | | | mW | 7, 9 | |

Notes:

1. The values include V_{DD}, AV_{DD}, and AV_{DD2} but do not include I/O supply power. Information on OV_{DD} and GV_{DD} supply power is captured in the I/O power supplies section of this table. Values shown in parenthesis () indicate power consumption at V_{DD}/AV_{DD}/AV_{DD2} = 1.8 V.
2. Maximum—FP power is measured at V_{DD} = 2.1 V with dynamic power management enabled while running an entirely cache-resident, looping, floating-point multiplication instruction.
3. Maximum—INT power is measured at V_{DD} = 2.1 V with dynamic power management enabled while running entirely cache-resident, looping, integer instructions.
4. Power saving mode maximums are measured at V_{DD} = 2.1 V while the device is in doze, nap, or sleep mode.
5. Typical power is measured at V_{DD} = AV_{DD} = 2.0 V, OV_{DD} = 3.3 V where a nominal FP value, a nominal INT value, and a value where there is a continuous flush of cache lines with alternating ones and zeros on 64-bit boundaries to local memory are averaged.
6. Power saving mode data measured with only two PCI_CLKs and two SDRAM_CLKs enabled.
7. The typical minimum I/O power values were results of the MPC8245 performing cache resident integer operations at the slowest frequency combination of 33:66:200 (PCI:Mem:CPU) MHz.
8. The typical maximum OV_{DD} value resulted from the MPC8245 operating at the fastest frequency combination of 66:100:350 (PCI:Mem:CPU) MHz and performing continuous flushes of cache lines with alternating ones and zeros to PCI memory.
9. The typical maximum GV_{DD} value resulted from the MPC8245 operating at the fastest frequency combination of 66:100:350 (PCI:Mem:CPU) MHz and performing continuous flushes of cache lines with alternating ones and zeros on 64-bit boundaries to local memory.
10. Power consumption of PLL supply pins (AV_{DD} and AV_{DD2}) < 15 mW. Guaranteed by design and is not tested.

1.4.2 Thermal Characteristics

Table 6 provides the package thermal characteristics for the MPC8245. For further information, see Section 1.7.8, “Thermal Management Information.”

Table 6. Thermal Characteristics

| Characteristic | Symbol | Value | Unit | Notes |
|---|------------------|-------|------|-------|
| Junction-to-ambient natural convection (Single-layer board—1s) | $R_{\theta JA}$ | 16.1 | °C/W | 1, 2 |
| Junction-to-ambient natural convection (Four-layer board—2s2p) | $R_{\theta JMA}$ | 12.0 | °C/W | 1, 3 |
| Junction-to-ambient (@200 ft/min) (Single-layer board—1s) | $R_{\theta JMA}$ | 11.6 | °C/W | 1, 3 |
| Junction-to-ambient (@200 ft/min) (Four layer board—2s2p) | $R_{\theta JMA}$ | 9.0 | °C/W | 1, 3 |
| Junction-to-board | $R_{\theta JB}$ | 4.8 | °C/W | 4 |
| Junction-to-case | $R_{\theta JC}$ | 1.8 | °C/W | 5 |
| Junction-to-package top (natural convection) | Ψ_{JT} | 1.0 | °C/W | 6 |

Notes:

1. Junction temperature is a function of die size, on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, airflow, power dissipation of other components on the board, and board thermal resistance.
2. Per SEMI G38-87 and JEDEC JESD51-2 with the single-layer board horizontal.
3. Per JEDEC JESD51-6 with the board horizontal.
4. Thermal resistance between the die and the printed-circuit board per JEDEC JESD51-8. Board temperature is measured on the top surface of the board near the package.
5. Thermal resistance between the die and the case top surface as measured by the cold plate method (MIL SPEC-883 Method 1012.1) with the cold plate used for case temperature.
6. Thermal characterization parameter indicating the temperature difference between package top and the junction temperature per JEDEC JESD51-2. When Greek letters are not available, the thermal characterization parameter is written as Psi-JT.

1.4.3 AC Electrical Characteristics

This section provides the AC electrical characteristics for the MPC8245. After fabrication, functional parts are sorted by maximum processor core frequency as shown in Table 7 and tested for conformance to the AC specifications for that frequency. The processor core frequency is determined by the bus (PCI_SYNC_IN) clock frequency and the settings of the PLL_CFG[0:4] signals. Parts are sold by maximum processor core frequency. See Section 1.9, “Ordering Information.”

Table 7 provides the operating frequency information for the MPC8245 at recommended operating conditions (see Table 2) with $LV_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$.

Table 7. Operating Frequency ¹

| Characteristic ^{2, 3} | 266 MHz | 300 MHz | 333 MHz | 350 MHz | Unit |
|--------------------------------|--|---------------------|--|---------------------|------|
| | $V_{DD}/AV_{DD}/AV_{DD2} = 1.8/2.0 \pm 100 \text{ mV}$ | | $V_{DD}/AV_{DD}/AV_{DD2} = 2.0 \pm 100 \text{ mV}$ | | |
| Processor frequency (CPU) | 100–266 | 100–300 | 100–333 | 100–350 | MHz |
| Memory bus frequency | 50–133 | 50–100 ⁴ | 50–133 | 50–100 ⁴ | MHz |
| PCI input frequency | 25–66 | | | | MHz |

Notes:

1. See part number specification document MPC8245RZUPNS/D for additional part offering information.
2. **Caution:** The PCI_SYNC_IN frequency and PLL_CFG[0:4] settings must be chosen such that the resulting peripheral logic/memory bus frequency and CPU (core) frequencies do not exceed their respective maximum or minimum operating frequencies. Refer to the PLL_CFG[0:4] signal description in Section 1.6, “PLL Configuration,” for valid PLL_CFG[0:4] settings and PCI_SYNC_IN frequencies.
3. See Table 18 and Table 19 for more details on VCO limitations for memory and CPU VCO frequencies of various PLL configurations.
4. There are no available PLL_CFG[0:4] settings which support 133 MHz memory interface operation at 300 MHz CPU and 350 MHz operation, since the multipliers do not allow a 300:133 and 350:133 ratio relation. However, running these parts at slower processor speeds may produce ratios that will run above 100 MHz. See Table 18 for the PLL settings.

1.4.3.1 Clock AC Specifications

Table 8 provides the clock AC timing specifications at recommended operating conditions, as defined in Section 1.4.3.2, “Input AC Timing Specifications.” These specifications are for the default driver strengths indicated in Table 4. Figure 6 shows the PCI_SYNC_IN input clock timing diagram with the labeled number items listed in Table 8.

Table 8. Clock AC Timing Specifications

At recommended operating conditions (see Table 2) with $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$

| Num | Characteristics and Conditions | Min | Max | Unit | Notes |
|------|---|---|-----|------|---------|
| 1a | Frequency of operation (PCI_SYNC_IN) | 25 | 66 | MHz | |
| 2, 3 | PCI_SYNC_IN rise and fall times | — | 2.0 | ns | 1 |
| 4 | PCI_SYNC_IN duty cycle measured at 1.4 V | 40 | 60 | % | |
| 5a | PCI_SYNC_IN pulse width high measured at 1.4 V | 6 | 9 | ns | 2 |
| 5b | PCI_SYNC_IN pulse width low measured at 1.4 V | 6 | 9 | ns | 2 |
| 7 | PCI_SYNC_IN jitter | — | 200 | ps | |
| 8a | PCI_CLK[0:4] skew (pin-to-pin) | — | 250 | ps | |
| 8b | SDRAM_CLK[0:3] skew (pin-to-pin) | — | 190 | ps | 3 |
| 10 | Internal PLL reload time | — | 100 | μs | 2, 4, 5 |
| 15 | DLL Lock Range with DLL_EXTEND = 0 disabled (default) | $(N \times T_{clk} - T_{dp(max)}) \leq T_{loop}$ $\leq (N \times T_{clk} - T_{dp(min)})$ | | ns | 6 |
| 16 | DLL lock range with DLL_EXTEND = 1 enabled | $((N - 0.5) \times T_{clk} - T_{dp(max)}) \leq T_{loop}$ $\leq ((N - 0.5) \times T_{clk} - T_{dp(min)})$ | | ns | 6 |

Table 8. Clock AC Timing Specifications (continued)

At recommended operating conditions (see Table 2) with $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$

| Num | Characteristics and Conditions | Min | Max | Unit | Notes |
|-----|-------------------------------------|-----|-----|------|-------|
| 17 | Frequency of operation (OSC_IN) | 25 | 66 | MHz | |
| 19 | OSC_IN rise and fall times | — | 5 | ns | 7 |
| 20 | OSC_IN duty cycle measured at 1.4 V | 40 | 60 | % | |
| 21 | OSC_IN frequency stability | — | 100 | ppm | |

Notes:

1. Rise and fall times for the PCI_SYNC_IN input are measured from 0.4 to 2.4 V.
2. Specification value at maximum frequency of operation.
3. Pin-to-pin skew includes quantifying the additional amount of clock skew (or jitter) from the DLL besides any intentional skew added to the clocking signals from the variable length DLL synchronization feedback loop, that is, the amount of variance between the internal *sys_logic_clk* and the SDRAM_SYNC_IN signal after the DLL is locked. While pin-to-pin skew between SDRAM_CLKs can be measured, the relationship between the internal *sys_logic_clk* and the external SDRAM_SYNC_IN cannot be measured and is guaranteed by design.
4. Relock time is guaranteed by design and characterization. Relock time is not tested.
5. Relock timing is guaranteed by design. PLL-relock time is the maximum amount of time required for PLL lock after a stable V_{DD} and PCI_SYNC_IN are reached during the reset sequence. This specification also applies when the PLL has been disabled and subsequently re-enabled during sleep mode. Also note that HRST_CPU/HRST_CTRL must be held asserted for a minimum of 255 bus clocks after the PLL-relock time during the reset sequence.
6. DLL_EXTEND is bit 7 of the PMC2 register <72>. N is a non-zero integer (see Figures 5 through 8). T_{clk} is the period of one SDRAM_SYNC_OUT clock cycle in ns. T_{loop} is the propagation delay of the DLL synchronization feedback loop (PC board runner) from SDRAM_SYNC_OUT to SDRAM_SYNC_IN in ns; 6.25 inches of loop length (unloaded PC board runner) corresponds to approximately 1 ns of delay. $T_{dp(max)}$ and $T_{dp(min)}$ are dependent on tap delay. See Table 9 for values of $T_{dp(max)}$ and $T_{dp(min)}$. See Figure 7 through Figure 10 for DLL locking ranges. Refer to Motorola Application Note AN2164, *MPC8245/MPC8241 Memory Clock Design Guidelines*, for more details on memory clock design and an explanation of how T_{dp} is defined.
7. Rise and fall times for the OSC_IN input is guaranteed by design and characterization. OSC_IN input rise and fall times are not tested.

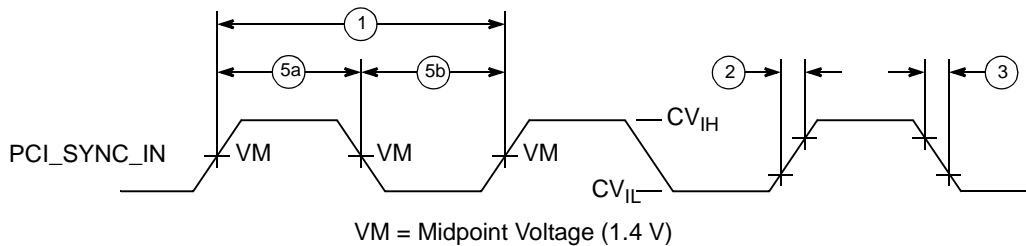


Figure 6. PCI_SYNC_IN Input Clock Timing Diagram

Table 9. $T_{dp(max)}$ and $T_{dp(min)}$

| Mode | $T_{dp(min)}$ | $T_{dp(max)}$ | Unit |
|---|---------------|---------------|------|
| Normal tap delay: Bit 2 (DLL_MAX_DELAY) at offset 0x76 is cleared | 7.58 | 12.97 | ns |
| Maximum tap delay: Bit 2 (DLL_MAX_DELAY) at offset 0x76 is set | 8.28 | 17.57 | ns |

Figure 7 through Figure 10 show the DLL locking range loop delay vs. frequency of operation. These graphs define the areas of DLL locking for various modes. The grey areas represent where the DLL will lock.

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Note also that the DLL_MAX_DELAY bit can lengthen the amount of time through the delay line. This is accomplished by increasing the time between each of the 128 tap points in the delay line. Although this increased time makes it easier to guarantee that the reference clock will be within the DLL lock range, it also means there may be slightly more jitter in the output clock of the DLL, should the phase comparator shift the clock between adjacent tap points. Refer to Motorola Application Note AN2164, *MPC8245/MPC8241 Memory Clock Design Guidelines*, for more details on memory design.

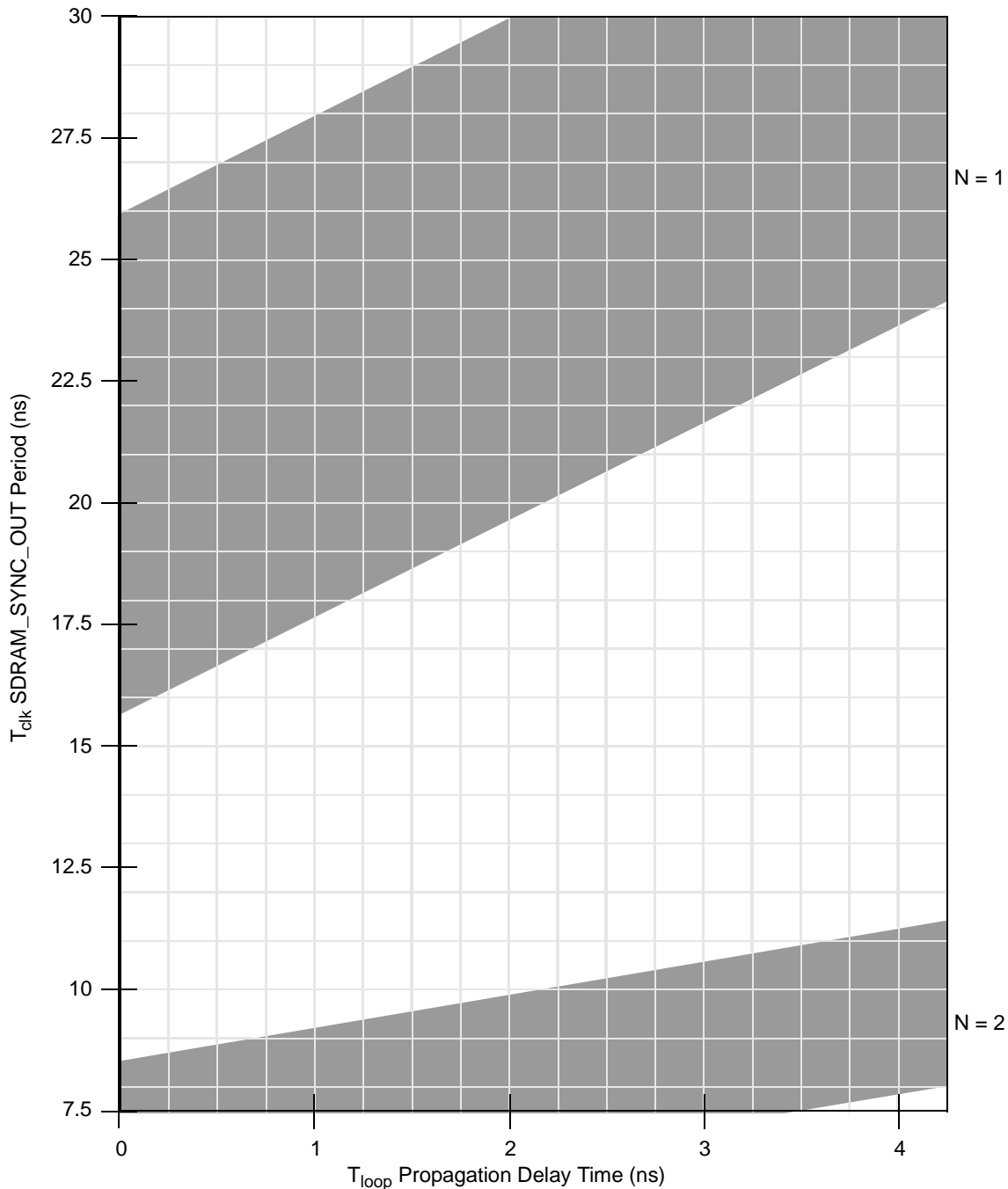


Figure 7. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend=1 and Normal Tap Delay

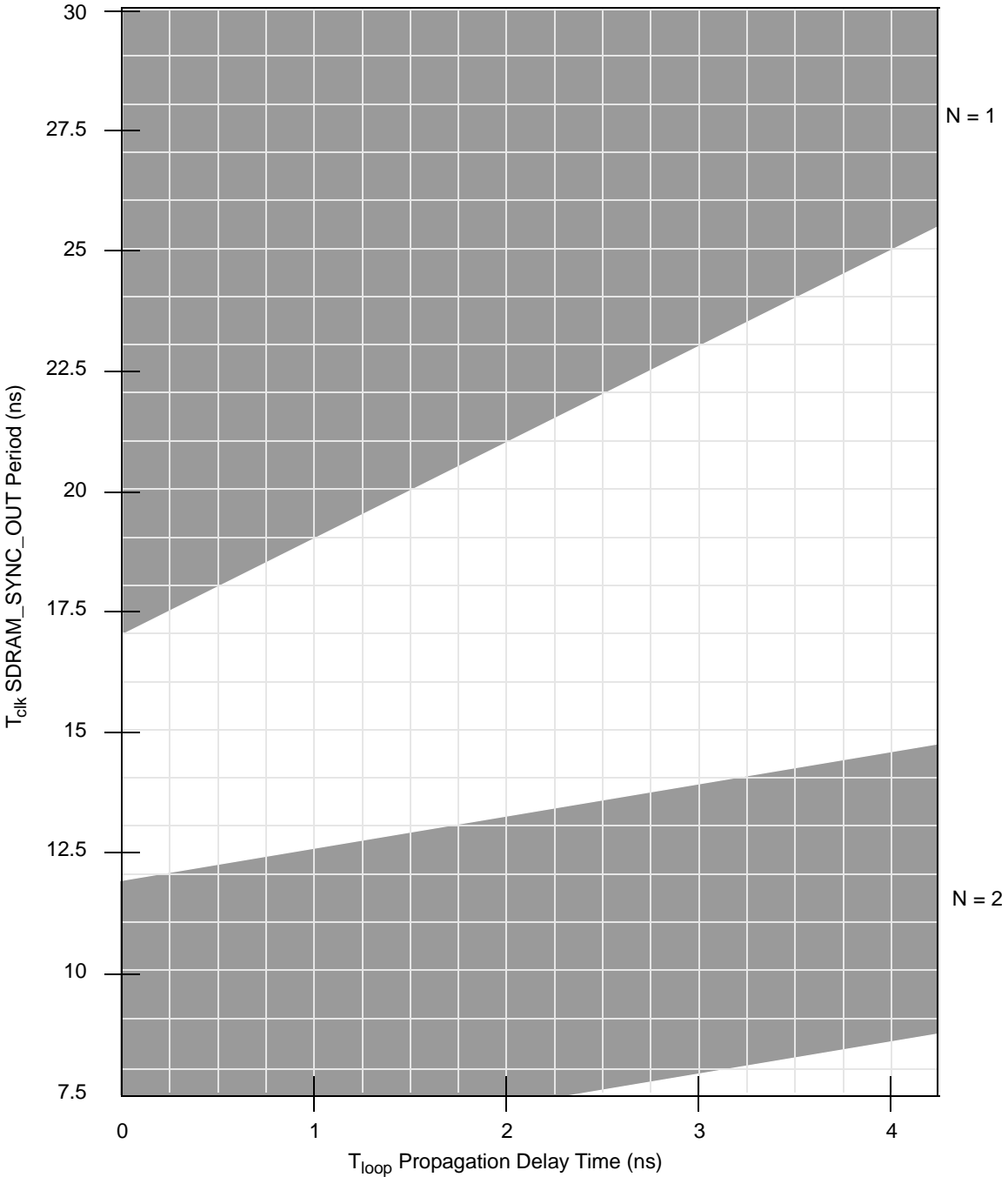


Figure 8. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend=1 and Tap Max Delay

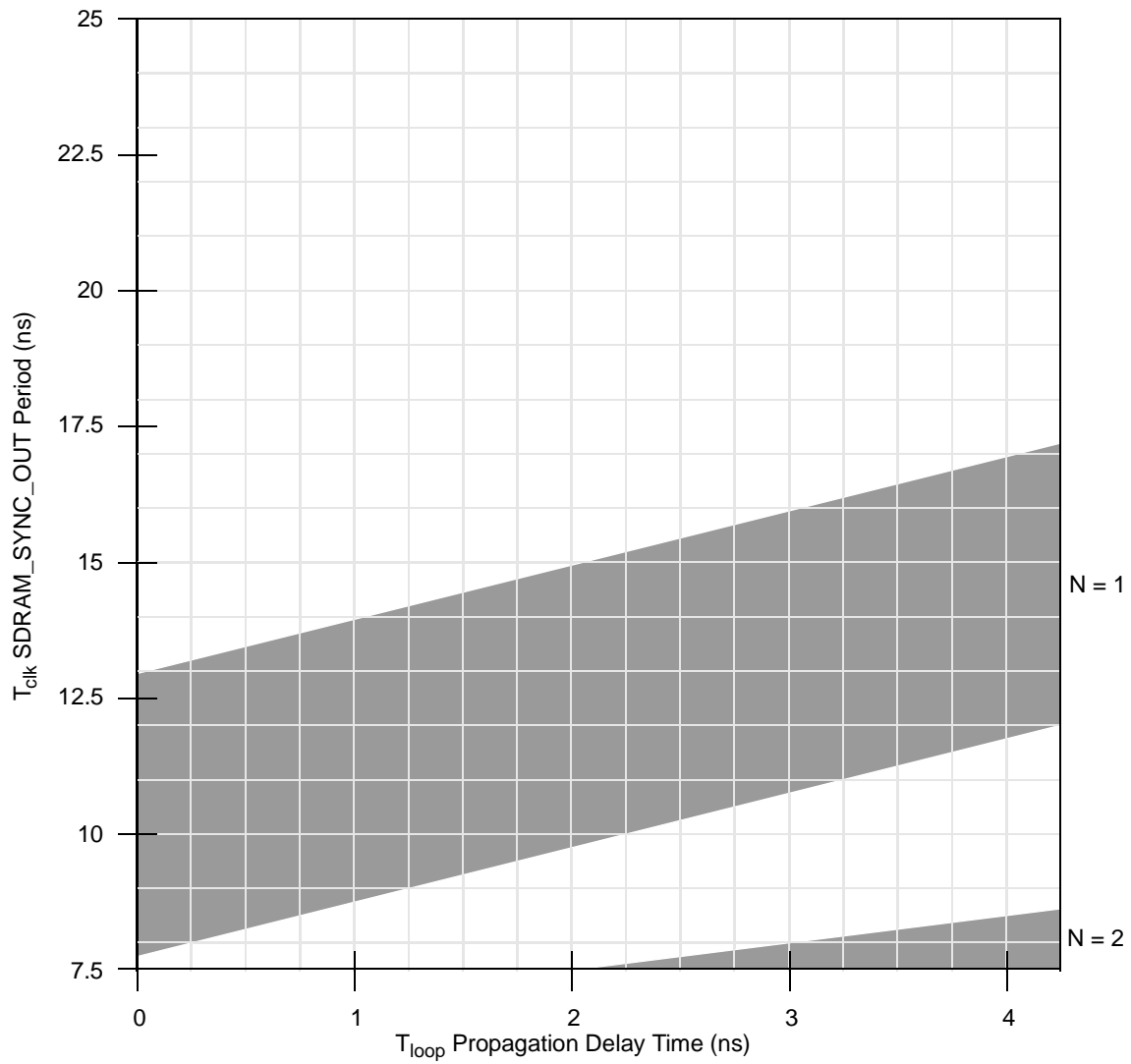


Figure 9. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend=0 and Normal Tap Delay

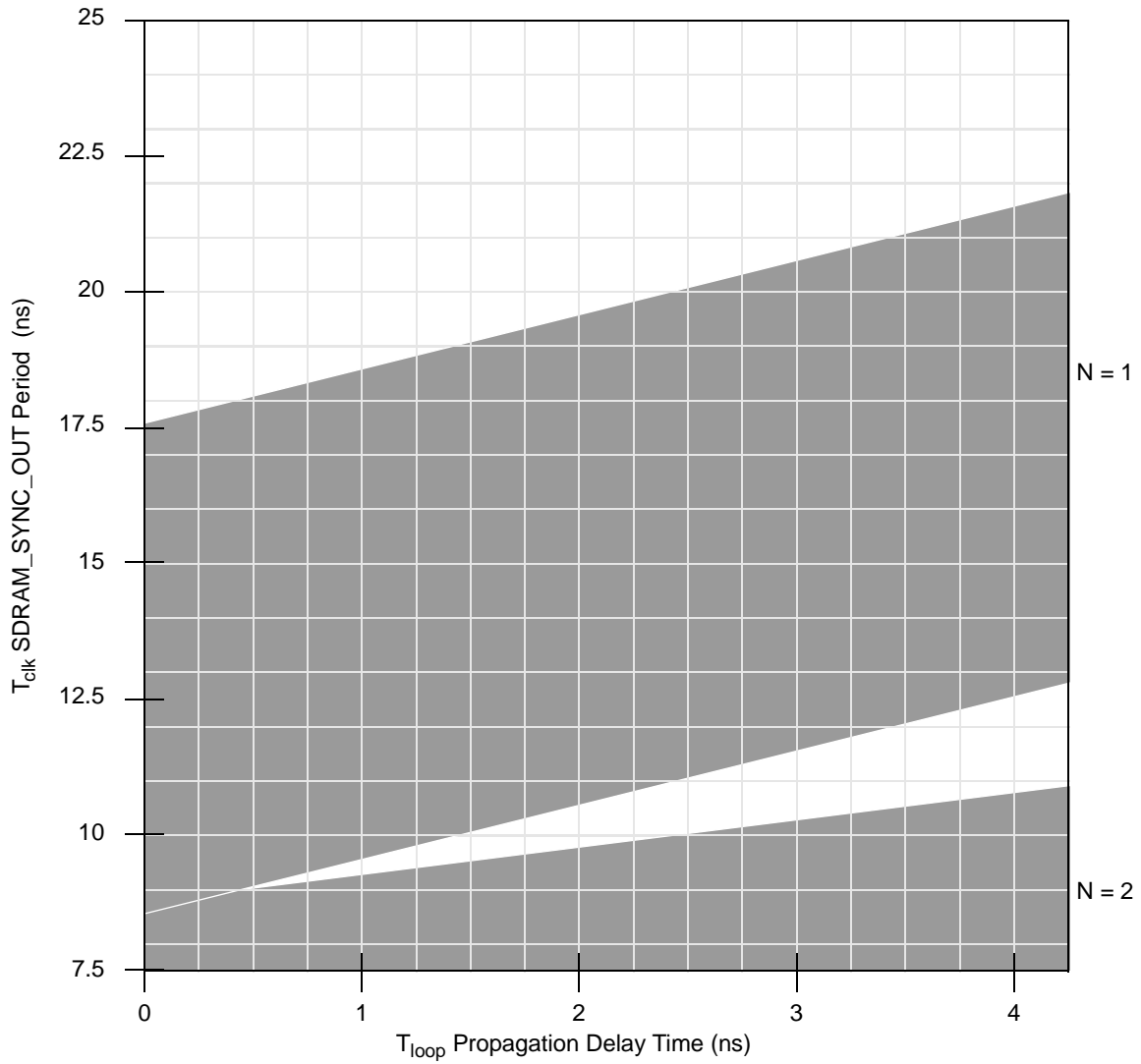


Figure 10. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend=0 and Max Tap Delay

1.4.3.2 Input AC Timing Specifications

Table 10 provides the input AC timing specifications at recommended operating conditions (see Table 2) with $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$. See Figure 11 and Figure 12.

Table 10. Input AC Timing Specifications

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|---|-----|-----|------|-------|
| 10a | PCI input signals valid to PCI_SYNC_IN (input setup) | 3.0 | — | ns | 1, 3 |
| 10b | Memory input signals valid to SDRAM_SYNC_IN (input setup) | | | | |

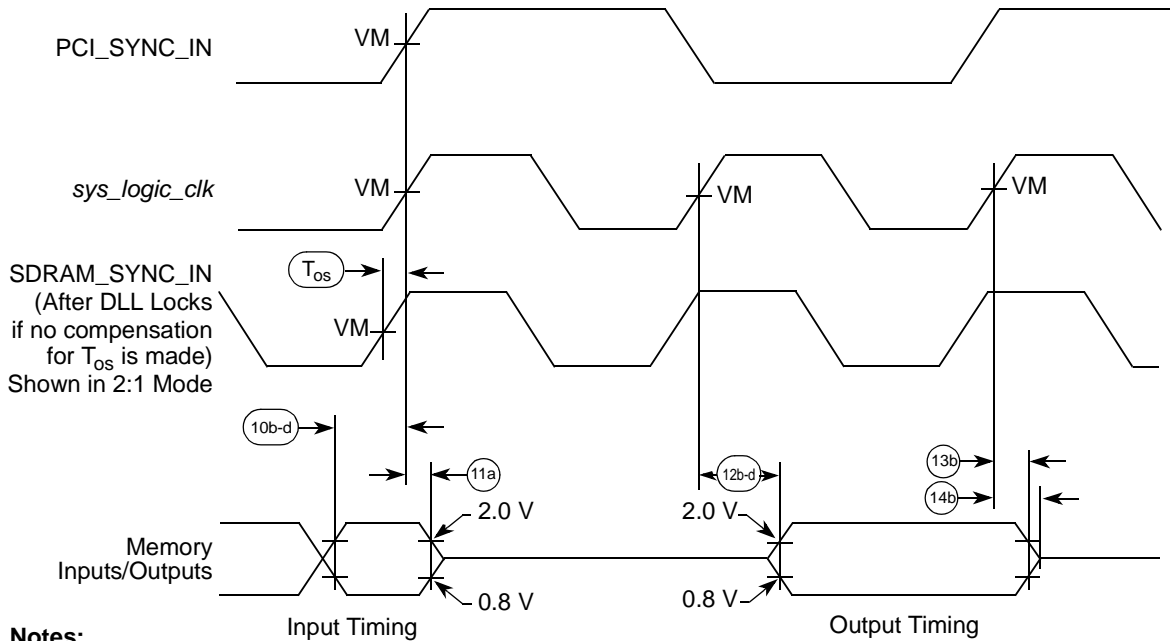
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Table 10. Input AC Timing Specifications (continued)

| Num | Characteristic | Min | Max | Unit | Notes |
|------|---|---------------------------|-----|------|---------|
| 10b0 | Tap 0, register offset <0x77>, bits 5:4 = 0b00 | 2.6 | — | ns | 2, 3, 6 |
| 10b1 | Tap 1, register offset <0x77>, bits 5:4 = 0b01 | 1.9 | — | | |
| 10b2 | Tap 2, register offset <0x77>, bits 5:4 = 0b10 (default) | 1.2 | — | | |
| 10b3 | Tap 3, register offset <0x77>, bits 5:4 = 0b11 | 0.5 | — | | |
| 10c | PIC, misc. debug input signals valid to SDRAM_SYNC_IN (input setup) | 3.0 | — | ns | 2, 3 |
| 10d | I ² C input signals valid to SDRAM_SYNC_IN (input setup) | 3.0 | — | ns | 2, 3 |
| 10e | Mode select inputs valid to $\overline{\text{HRST_CPU}}/\overline{\text{HRST_CTRL}}$ (input setup) | $9 \times t_{\text{CLK}}$ | — | ns | 2, 3–5 |
| 11 | T_{os} —SDRAM_SYNC_IN to <i>sys_logic_clk</i> offset time | 0.65 | 1.0 | ns | 7 |
| 11a | SDRAM_SYNC_IN to memory signal inputs invalid (input hold) | | | | |
| 11a0 | Tap 0, register offset <0x77>, bits 5:4 = 0b00 | 0 | — | ns | 2, 3, 6 |
| 11a1 | Tap 1, register offset <0x77>, bits 5:4 = 0b01 | 0.7 | — | | |
| 11a2 | Tap 2, register offset <0x77>, bits 5:4 = 0b10 (default) | 1.4 | — | | |
| 11a3 | Tap 3, register offset <0x77>, bits 5:4 = 0b11 | 2.1 | — | | |
| 11b | $\overline{\text{HRST_CPU}}/\overline{\text{HRST_CTRL}}$ to mode select inputs invalid (input hold) | 0 | — | ns | 2, 3, 5 |
| 11c | PCI_SYNC_IN to Inputs invalid (input hold) | 1.0 | — | ns | 1, 2, 3 |

Notes:

- All PCI signals are measured from $OV_{\text{DD}}/2$ of the rising edge of PCI_SYNC_IN to $0.4 \times OV_{\text{DD}}$ of the signal in question for 3.3-V PCI signaling levels. See Figure 12.
- All memory and related interface input signal specifications are measured from the TTL level (0.8 or 2.0 V) of the signal in question to the $V_{\text{M}} = 1.4$ V of the rising edge of the memory bus clock, SDRAM_SYNC_IN. SDRAM_SYNC_IN is the same as PCI_SYNC_IN in 1:1 mode, but is twice the frequency in 2:1 mode (processor/memory bus clock rising edges occur on every rising and falling edge of PCI_SYNC_IN). See Figure 11.
- Input timings are measured at the pin.
- t_{CLK} is the time of one SDRAM_SYNC_IN clock cycle.
- All mode select input signals specifications are measured from the TTL level (0.8 or 2.0 V) of the signal in question to the $V_{\text{M}} = 1.4$ V of the rising edge of the $\overline{\text{HRST_CPU}}/\overline{\text{HRST_CTRL}}$ signal. See Figure 13.
- The memory interface input setup and hold times are programmable to four possible combinations by programming bits 5:4 of register offset <0x77> to select the desired input setup and hold times.
- T_{os} represents a timing adjustment for SDRAM_SYNC_IN with respect to *sys_logic_clk*. Due to the internal delay present on the SDRAM_SYNC_IN signal with respect to the *sys_logic_clk* inputs to the DLL, the resulting SDRAM clocks become offset by the delay amount. The feedback trace length of SDRAM_SYNC_OUT to SDRAM_SYNC_IN must be shortened by this amount relative to the SDRAM clock output trace lengths to maintain phase-alignment of the memory clocks with respect to *sys_logic_clk*. Note that the DLL locking range graphs of Figure 7 through Figure 10 compensate for T_{os} and there is no additional requirement to shorten T_{loop} by the duration of T_{os} . Refer to Motorola Application Note AN2164, *MPC8245/MPC8241 Memory Clock Design Guidelines*, for more details on accommodating for the problem of T_{os} and trace measurements in general.



Notes:
 VM = midpoint voltage (1.4 V).
 10b-d = input signals valid timing.
 11a = input hold time of SDRAM_SYNC_IN to memory.
 12b-d = SDRAM_SYNC_IN to output valid timing.
 13b = output hold time for non-PCI signals.
 14b = SDRAM_SYNC_IN to output high-impedance timing for non-PCI signals.
 Tos = offset timing required to align sys_logic_clk with SDRAM_SYNC_IN. The SDRAM_SYNC_IN signal is adjusted by the DLL to accommodate for internal delay. This causes SDRAM_SYNC_IN to be seen before sys_logic_clk once the DLL locks, if no other accommodation is made for the delay.

Figure 11. Input/Output Timing Diagram Referenced to SDRAM_SYNC_IN

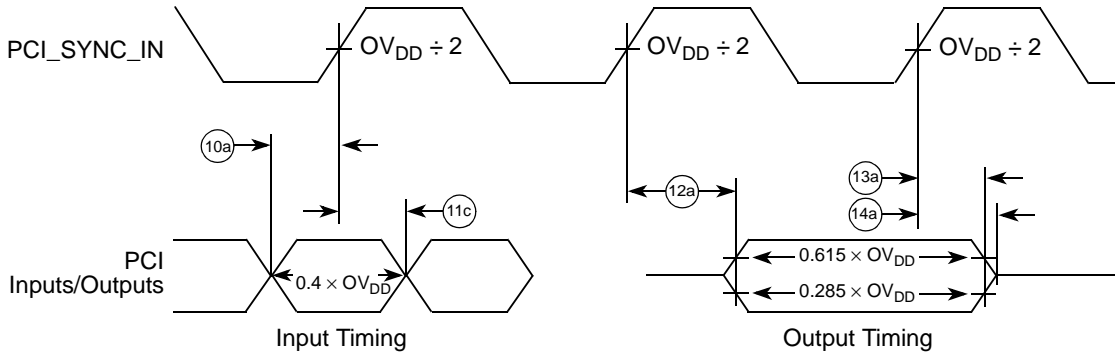


Figure 12. Input/Output Timing Diagram Referenced to PCI_SYNC_IN

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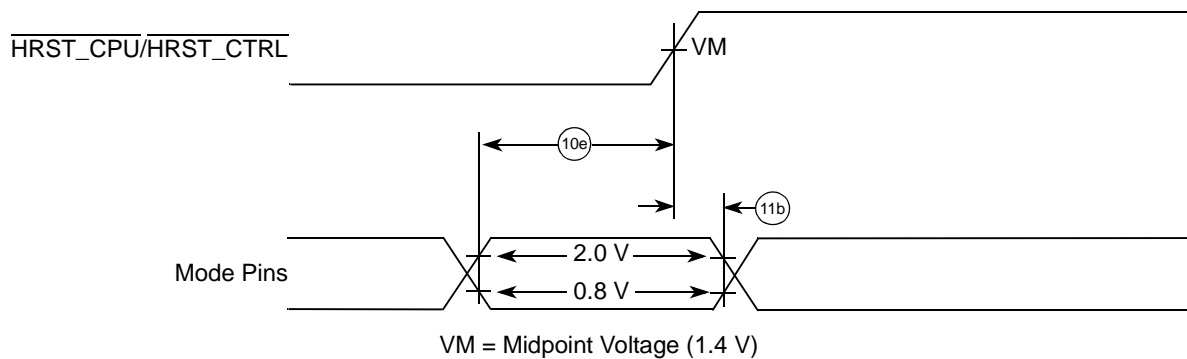


Figure 13. Input Timing Diagram for Mode Select Signals

1.4.3.3 Output AC Timing Specification

Table 11 provides the processor bus AC timing specifications for the MPC8245 at recommended operating conditions (see Table 2) with $LV_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$. See Figure 11. All output timings assume a purely resistive 50- Ω load (see Figure 14). Output timings are measured at the pin; time-of-flight delays must be added for trace lengths, vias, and connectors in the system. These specifications are for the default driver strengths indicated in Table 4.

Table 11. Output AC Timing Specifications

| Num | Characteristic | Min | Max | Unit | Notes |
|------|---|-----|------|------|---------|
| 12a | PCI_SYNC_IN to output valid, see Figure 15 | | | | |
| 12a0 | Tap 0, PCI_HOLD_DEL=00, $[\overline{\text{MCP,CKE}}] = 11$, 66 MHz PCI (default) | — | 6.0 | ns | 1, 3 |
| 12a1 | Tap 1, PCI_HOLD_DEL=01, $[\overline{\text{MCP,CKE}}] = 10$ | — | 6.5 | | |
| 12a2 | Tap 2, PCI_HOLD_DEL=10, $[\overline{\text{MCP,CKE}}] = 01$, 33 MHz PCI | — | 7.0 | | |
| 12a3 | Tap 3, PCI_HOLD_DEL=11, $[\overline{\text{MCP,CKE}}] = 00$ | — | 7.5 | | |
| 12b | SDRAM_SYNC_IN to output valid (memory control, address, and data signals) | — | 4.5 | ns | 2 |
| 12c | SDRAM_SYNC_IN to output valid (for all others) | — | 7.0 | ns | 2 |
| 12d | SDRAM_SYNC_IN to output valid (for I ² C) | — | 5.0 | ns | 2 |
| 12e | SDRAM_SYNC_IN to output valid (ROM/Flash/PortX) | — | 6.0 | ns | 2 |
| 13a | Output hold (PCI), see Figure 15 | | | | |
| 13a0 | Tap 0, PCI_HOLD_DEL=00, $[\overline{\text{MCP,CKE}}] = 11$, 66 MHz PCI (default) | 2.0 | — | ns | 1, 3, 4 |
| 13a1 | Tap 1, PCI_HOLD_DEL=01, $[\overline{\text{MCP,CKE}}] = 10$ | 2.5 | — | | |
| 13a2 | Tap 2, PCI_HOLD_DEL=10, $[\overline{\text{MCP,CKE}}] = 01$, 33 MHz PCI | 3.0 | — | | |
| 13a3 | Tap 3, PCI_HOLD_DEL=11, $[\overline{\text{MCP,CKE}}] = 00$ | 3.5 | — | | |
| 13b | Output hold (all others) | 1.0 | — | ns | 2 |
| 14a | PCI_SYNC_IN to output high impedance (for PCI) | — | 14.0 | ns | 1, 3 |

Table 11. Output AC Timing Specifications (continued)

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|---|-----|-----|------|-------|
| 14b | SDRAM_SYNC_IN to output high impedance (for all others) | — | 4.0 | ns | 2 |

Notes:

- All PCI signals are measured from $GV_{DD}/2$ of the rising edge of PCI_SYNC_IN to $0.285 \times OV_{DD}$ or $0.615 \times OV_{DD}$ of the signal in question for 3.3 V PCI signaling levels. See Figure 12.
- All memory and related interface output signal specifications are specified from the $VM = 1.4$ V of the rising edge of the memory bus clock, SDRAM_SYNC_IN to the TTL level (0.8 or 2.0 V) of the signal in question.
SDRAM_SYNC_IN is the same as PCI_SYNC_IN in 1:1 mode, but is twice the frequency in 2:1 mode (processor/memory bus clock rising edges occur on every rising and falling edge of PCI_SYNC_IN). See Figure 11.
- PCI bused signals are composed of the following signals: \overline{LOCK} , \overline{IRDY} , $\overline{C/BE[3:0]}$, \overline{PAR} , \overline{TRDY} , \overline{FRAME} , \overline{STOP} , \overline{DEVSEL} , \overline{PERR} , \overline{SERR} , $AD[31:0]$, $REQ[4:0]$, $GNT[4:0]$, \overline{IDSEL} , \overline{INTA} .
- In order to meet minimum output hold specifications relative to PCI_SYNC_IN for both 33- and 66-MHz PCI systems, the MPC8245 has a programmable output hold delay for PCI signals (the PCI_SYNC_IN to output valid timing is also affected). The initial value of the output hold delay is determined by the values on the \overline{MCP} and \overline{CKE} reset configuration signals; the values on these two signals are inverted then stored as the initial settings of $\overline{PCI_HOLD_DEL} = PMCR2[5:4]$ (power management configuration register 2 <0x72>), respectively. Since \overline{MCP} and \overline{CKE} have internal pull-up resistors, the default value of $\overline{PCI_HOLD_DEL}$ after reset is 0b00. Further output hold delay values are available by programming the $\overline{PCI_HOLD_DEL}$ value of the PMCR2 configuration register. See Figure 15.

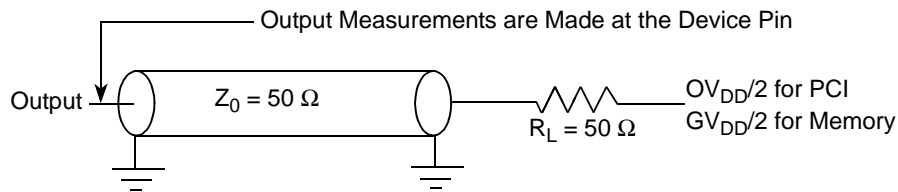
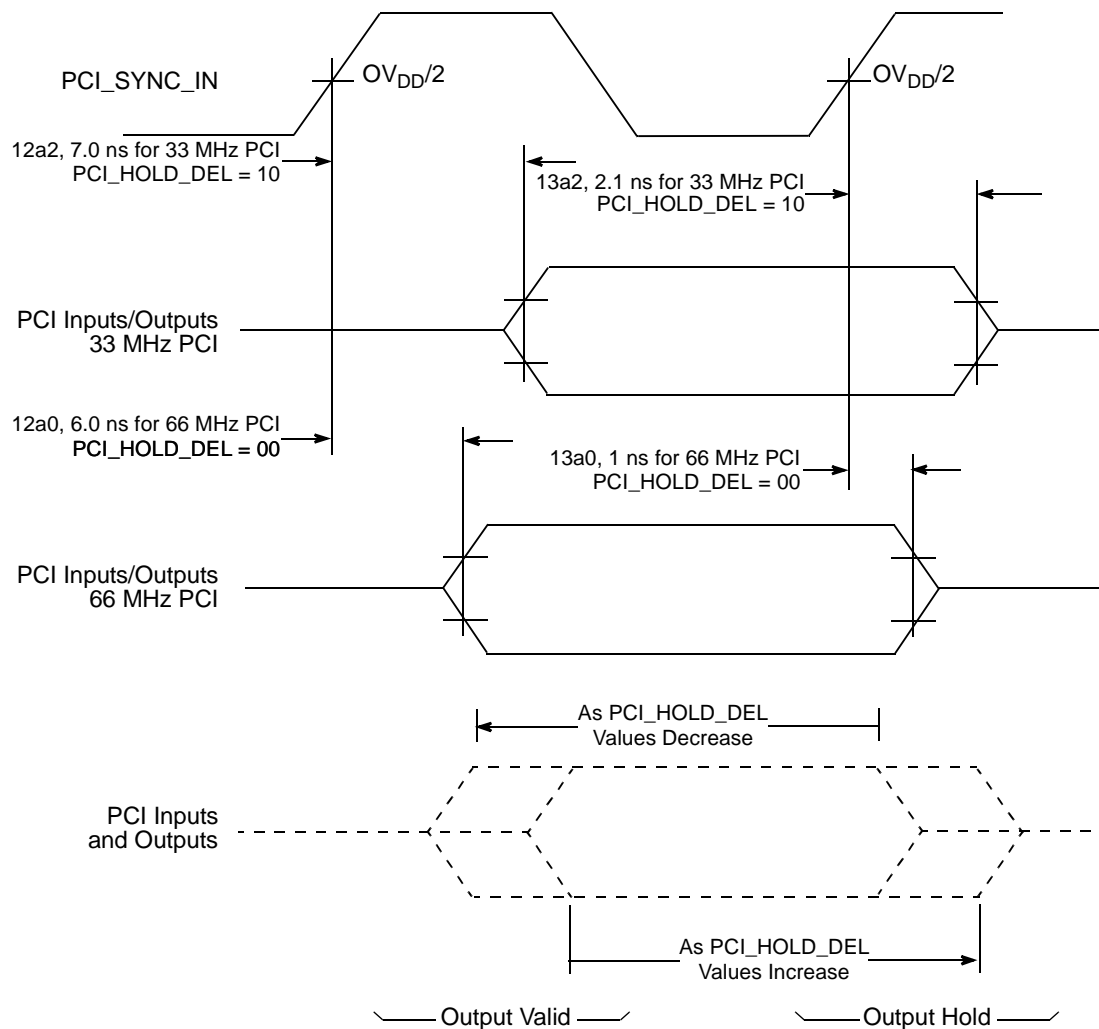


Figure 14. AC Test Load for the MPC8245

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Note: Diagram not to scale.

Figure 15. PCI_HOLD_DEL Effect on Output Valid and Hold Time

1.4.3.4 I²C AC Timing Specifications

Table 12 provides the I²C input AC timing specifications for the MPC8245 at recommended operating conditions (see Table 2) with $LV_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$.

Table 12. I²C Input AC Timing Specifications

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|--|--|-----|------|------------|
| 1 | Start condition hold time | 4.0 | — | CLKs | 1, 2 |
| 2 | Clock low period (time before the MPC8245 will drive SCL low as a transmitting slave after detecting SCL low as driven by an external master) | $8.0 + (16 \times 2^{\text{FDR}[4:2]}) \times (5 - 4(\{\text{FDR}[5], \text{FDR}[1]\} == \text{b}'10) - 3(\{\text{FDR}[5], \text{FDR}[1]\} == \text{b}'11) - 2(\{\text{FDR}[5], \text{FDR}[1]\} == \text{b}'00) - 1(\{\text{FDR}[5], \text{FDR}[1]\} == \text{b}'01))$ | — | CLKs | 1, 2, 4, 5 |
| 3 | SCL/SDA rise time (from 0.5 V to 2.4 V) | — | 1 | ms | |
| 4 | Data hold time | 0 | — | ns | 2 |
| 5 | SCL/SDA fall time (from 2.4 V to 0.5 V) | — | 1 | ms | |
| 6 | Clock high period (time needed to either receive a data bit or generate a START or STOP) | 5.0 | — | CLKs | 1, 2, 5 |
| 7 | Data setup time | 3.0 | — | ns | 3 |
| 8 | Start condition setup time (for repeated start condition only) | 4.0 | — | CLKs | 1,2 |
| 9 | Stop condition setup time | 4.0 | — | CLKs | 1, 2 |

Notes:

- Units for these specifications are in SDRAM_CLK units.
- The actual values depend on the setting of the digital filter frequency sampling rate (DFFSR) bits in the frequency divider register I2CFDR. Therefore, the noted timings in the above table are all relative to qualified signals. The qualified SCL and SDA are delayed signals from what is seen in real time on the I²C bus. The qualified SCL, SDA signals are delayed by the SDRAM_CLK clock times DFFSR times 2 plus 1 SDRAM_CLK clock. The resulting delay value is added to the value in the table (where this note is referenced). See Figure 17.
- Timing is relative to the sampling clock (not SCL).
- FDR[x] refers to the frequency divider register I2CFDR bit x.
- Input clock low and high periods in combination with the FDR value in the frequency divider register (I2CFDR) determine the maximum I²C input frequency. See Table 13.

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Table 13 provides the I²C frequency divider register (I2CFDR) information for the MPC8245.

Table 13. MPC8245 Maximum I²C Input Frequency

| FDR Hex ² | Divider ² (Dec) | Max I ² C Input Frequency ¹ | | | |
|---------------------------|---|---|-----------------------|------------------------|------------------------|
| | | SDRAM_CLK @ 33 MHz | SDRAM_CLK @ 50 MHz | SDRAM_CLK @ 100 MHz | SDRAM_CLK @ 133 MHz |
| 20, 21 | 160, 192 | 1.13 MHz | 1.72 MHz | 3.44 MHz | 4.58 MHz |
| 22, 23, 24, 25 | 224, 256, 320, 384 | 733 | 1.11 MHz | 2.22 MHz | 2.95 MHz |
| 0, 1 | 288, 320 | 540 | 819 | 1.63 MHz | 2.18 MHz |
| 2, 3, 26, 27, 28, 29 | 384, 448, 480, 512, 640, 768 | 428 | 649 | 1.29 MHz | 1.72 MHz |
| 4, 5 | 576, 640 | 302 | 458 | 917 | 1.22 MHz |
| 6, 7, 2A, 2B, 2C, 2D | 768, 896, 960, 1024, 1280, 1536 | 234 | 354 | 709 | 943 |
| 8, 9 | 1152, 1280 | 160 | 243 | 487 | 648 |
| A, B, 2E, 2F, 30, 31 | 1536, 1792, 1920, 2048, 2560, 3072 | 122 | 185 | 371 | 494 |
| C, D | 2304, 2560 | 83 | 125 | 251 | 335 |
| E, F, 32, 33, 34, 35 | 3072, 3584, 3840, 4096, 5120, 6144 | 62 | 95 | 190 | 253 |
| 10, 11 | 4608, 5120 | 42 | 64 | 128 | 170 |
| 12, 13, 36, 37, 38, 39 | 6144, 7168, 7680, 8192, 10240, 12288 | 31 | 48 | 96 | 128 |
| 14, 15 | 9216, 10240 | 21 | 32 | 64 | 85 |
| 16, 17, 3A, 3B, 3C, 3D | 12288, 14336, 15360, 16384, 20480, 24576 | 16 | 24 | 48 | 64 |
| 18, 19 | 18432, 20480 | 10 | 16 | 32 | 43 |
| 1A, 1B, 3E, 3F | 24576, 28672, 30720, 32768 | 8 | 12 | 24 | 32 |
| 1C, 1D | 36864, 40960 | 5 | 8 | 16 | 21 |
| 1E, 1F | 49152, 61440 | 4 | 6 | 12 | 16 |

Notes:

1. Values are in kHz unless otherwise specified.
2. FDR Hex and Divider (Dec) values are listed in corresponding order.
3. Multiple Divider (Dec) values will generate the same input frequency, but each Divider (Dec) value will generate a unique output frequency as shown in Table 14.

Table 14 provides the I²C output AC timing specifications for the MPC8245 at recommended operating conditions (see Table 2) with LV_{DD} = 3.3 V ± 0.3 V.

Table 14. I²C Output AC Timing Specifications

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|--|---|-----|------|---------|
| 1 | Start condition hold time | $(FDR[5] == 0) \times (D_{FDR}/16)/2N + (FDR[5] == 1) \times (D_{FDR}/16)/2M$ | — | CLKs | 1, 2, 3 |
| 2 | Clock low period | $D_{FDR}/2$ | — | CLKs | 1, 2, 3 |
| 3 | SCL/SDA rise time (from 0.5 V to 2.4 V) | — | — | ms | 4 |
| 4 | Data hold time | $8.0 + (16 \times 2^{FDR[4:2]}) \times (5 - 4(\{FDR[5], FDR[1]\} == b'10) - 3(\{FDR[5], FDR[1]\} == b'11) - 2(\{FDR[5], FDR[1]\} == b'00) - 1(\{FDR[5], FDR[1]\} == b'01))$ | — | CLKs | 1, 2, 3 |
| 5 | SCL/SDA fall time (from 2.4 V to 0.5 V) | — | < 5 | ns | 5 |
| 6 | Clock high time | $D_{FDR}/2$ | — | CLKs | 1, 2, 3 |
| 7 | Data setup time (MPC8245 as a master only) | $(D_{FDR}/2) - (\text{output data hold time})$ | — | CLKs | 1, 3 |
| 8 | Start condition setup time (for repeated start condition only) | $D_{FDR} + (\text{output start condition hold time})$ | — | CLKs | 1, 2, 3 |
| 9 | Stop condition setup time | 4.0 | — | CLKs | 1, 2 |

Notes:

1. Units for these specifications are in SDRAM_CLK units.
2. The actual values depend on the setting of the digital filter frequency sampling rate (DFFSR) bits in the frequency divider register I2CFDR. Therefore, the noted timings in the above table are all relative to qualified signals. The qualified SCL and SDA are delayed signals from what is seen in real time on the I²C bus. The qualified SCL, SDA signals are delayed by the SDRAM_CLK clock times DFFSR times 2 plus 1 SDRAM_CLK clock. The resulting delay value is added to the value in the table (where this note is referenced). See Figure 17.
3. D_{FDR} is the decimal divider number indexed by FDR[5:0] value. Refer to Table 10-5 in the *MPC8245 Integrated Processor User's Manual*. FDR[x] refers to bit x of the frequency divider register I2CFDR. N is equal to a variable number that would make the result of the divide (data hold time value) equal to a number less than 16. M is equal to a variable number that would make the result of the divide (data hold time value) equal to a number less than 9.
4. Since SCL and SDA are open-drain type outputs, which the MPC8245 can only drive low, the time required for SCL or SDA to reach a high level depends on external signal capacitance and pull-up resistor values.
5. Specified at a nominal 50 pF load.

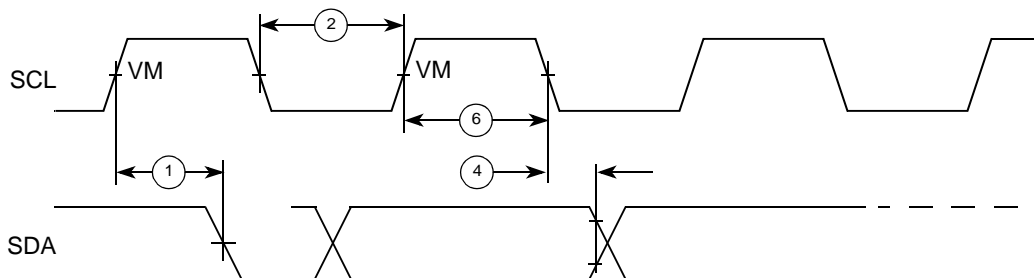


Figure 16. I²C Timing Diagram I

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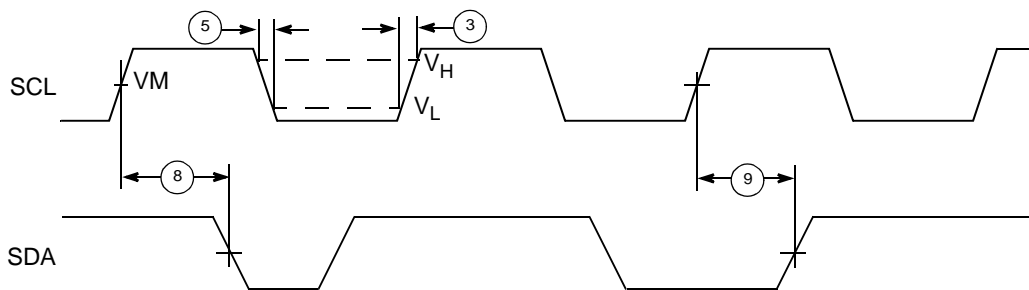
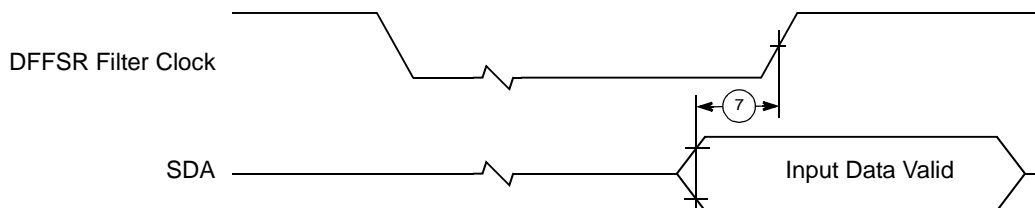
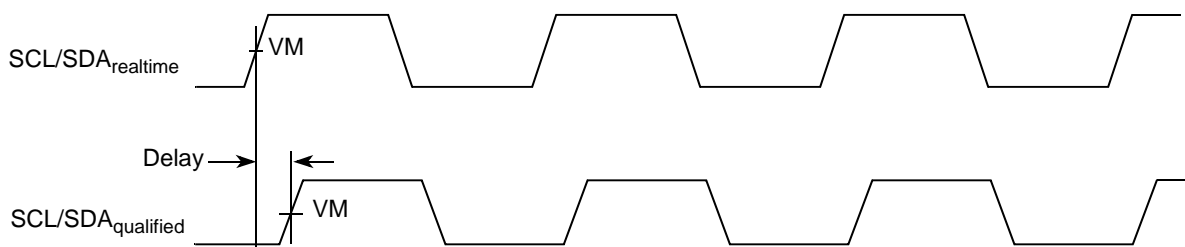


Figure 17. I²C Timing Diagram II



Note: DFFSR filter clock is the SDRAM_CLK clock times DFFSR value.

Figure 18. I²C Timing Diagram III



Note: The delay is the local memory clock times DFFSR times two plus one local memory clock.

Figure 19. I²C Timing Diagram IV (Qualified Signal)

1.4.3.5 PIC Serial Interrupt Mode AC Timing Specifications

Table 15 provides the PIC serial interrupt mode AC timing specifications for the MPC8245 at recommended operating conditions (see Table 2) with $GV_{DD} = 3.3\text{ V} \pm 5\%$ and $LV_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$.

Table 15. PIC Serial Interrupt Mode AC Timing Specifications

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|--|-----------------------------------|-----------------------------------|------|-------|
| 1 | S_CLK frequency | 1/14 SDRAM_SYNC_IN | 1/2 SDRAM_SYNC_IN | MHz | 1 |
| 2 | S_CLK duty cycle | 40 | 60 | % | — |
| 3 | S_CLK output valid time | — | 6 | ns | — |
| 4 | Output hold time | 0 | — | ns | — |
| 5 | $\overline{\text{S_FRAME}}$, S_RST output valid time | — | 1 <i>sys_logic_clk</i> period + 6 | ns | 2 |
| 6 | S_INT input setup time to S_CLK | 1 <i>sys_logic_clk</i> period + 2 | — | ns | 2 |
| 7 | S_INT inputs invalid (hold time) to S_CLK | — | 0 | ns | 2 |

Notes:

1. See the *MPC8245 Integrated Processor User's Manual* for a description of the PIC interrupt control register (ICR) describing S_CLK frequency programming.
2. S_RST, $\overline{\text{S_FRAME}}$, and S_INT shown in Figure 20 and Figure 21, depict timing relationships to *sys_logic_clk* and S_CLK and do not describe functional relationships between S_RST, $\overline{\text{S_FRAME}}$, and S_INT. See the *MPC8245 Integrated Processor User's Manual* for a complete description of the functional relationships between these signals.
3. The *sys_logic_clk* waveform is the clocking signal of the internal peripheral logic from the output of the peripheral logic PLL; *sys_logic_clk* is the same as SDRAM_SYNC_IN when the SDRAM_SYNC_OUT to SDRAM_SYNC_IN feedback loop is implemented and the DLL is locked. See the *MPC8245 Integrated Processor User's Manual* for a complete clocking description.

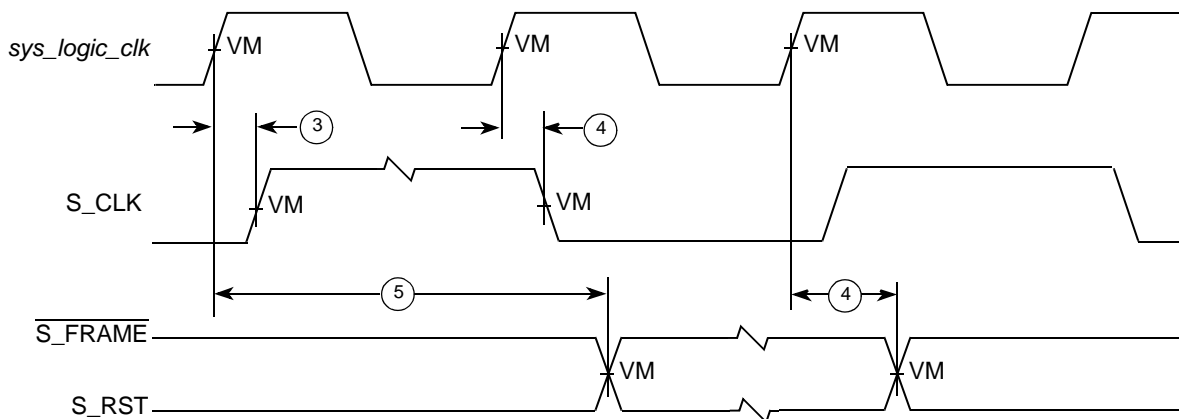


Figure 20. PIC Serial Interrupt Mode Output Timing Diagram

Electrical and Thermal Characteristics

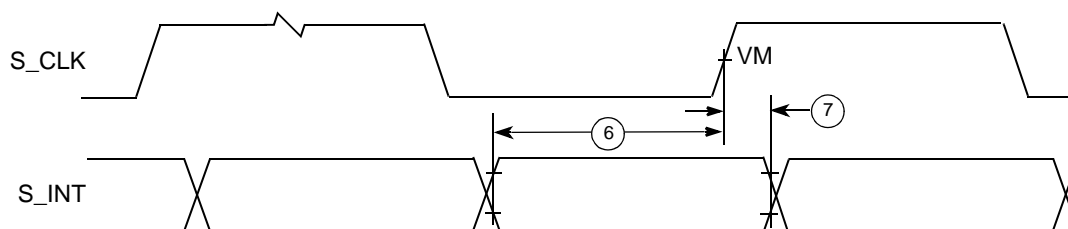


Figure 21. PIC Serial Interrupt Mode Input Timing Diagram

1.4.3.6 IEEE 1149.1 (JTAG) AC Timing Specifications

Table 16 provides the JTAG AC timing specifications for the MPC8245 while in the JTAG operating mode at recommended operating conditions (see Table 2) with $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$. Timings are independent of the system clock (PCI_SYNC_IN).

Table 16. JTAG AC Timing Specification (Independent of PCI_SYNC_IN)

| Num | Characteristic | Min | Max | Unit | Notes |
|-----|---|-----|-----|------|-------|
| | TCK frequency of operation | 0 | 25 | MHz | |
| 1 | TCK cycle time | 40 | — | ns | |
| 2 | TCK clock pulse width measured at 1.5 V | 20 | — | ns | |
| 3 | TCK rise and fall times | 0 | 3 | ns | |
| 4 | $\overline{\text{TRST}}$ setup time to TCK falling edge | 10 | — | ns | 1 |
| 5 | $\overline{\text{TRST}}$ assert time | 10 | — | ns | |
| 6 | Input data setup time | 5 | — | ns | 2 |
| 7 | Input data hold time | 15 | — | ns | 2 |
| 8 | TCK to output data valid | 0 | 30 | ns | 3 |
| 9 | TCK to output high impedance | 0 | 30 | ns | 3 |
| 10 | TMS, TDI Data setup time | 5 | — | ns | |
| 11 | TMS, TDI data hold time | 15 | — | ns | |
| 12 | TCK to TDO data valid | 0 | 15 | ns | |
| 13 | TCK to TDO high impedance | 0 | 15 | ns | |

Notes:

1. $\overline{\text{TRST}}$ is an asynchronous signal. The setup time is for test purposes only.
2. Nontest (other than TDI and TMS) signal input timing with respect to TCK.
3. Nontest (other than TDO) signal output timing with respect to TCK.

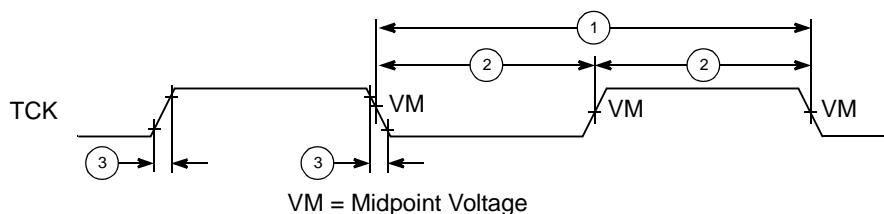


Figure 22. JTAG Clock Input Timing Diagram

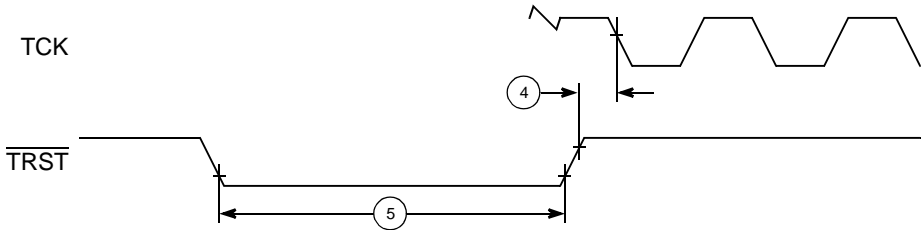


Figure 23. JTAG TRST Timing Diagram

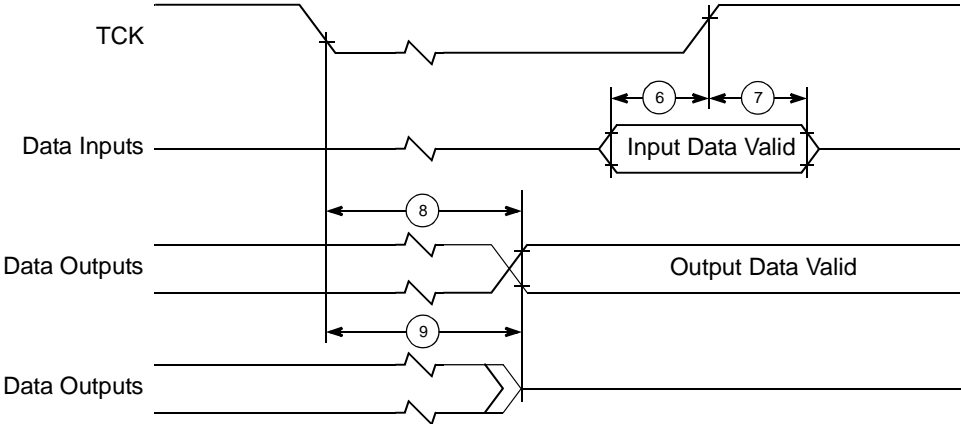


Figure 24. JTAG Boundary Scan Timing Diagram

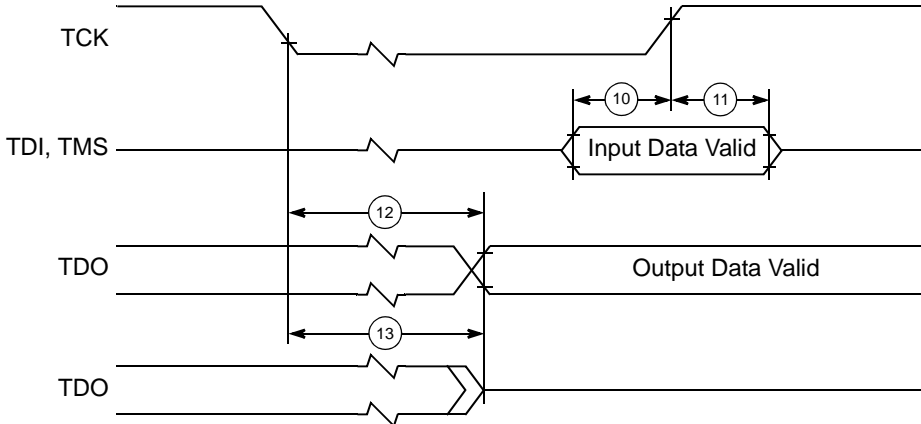


Figure 25. Test Access Port Timing Diagram

1.5 Package Description

This section details package parameters, pin assignments, and dimensions.

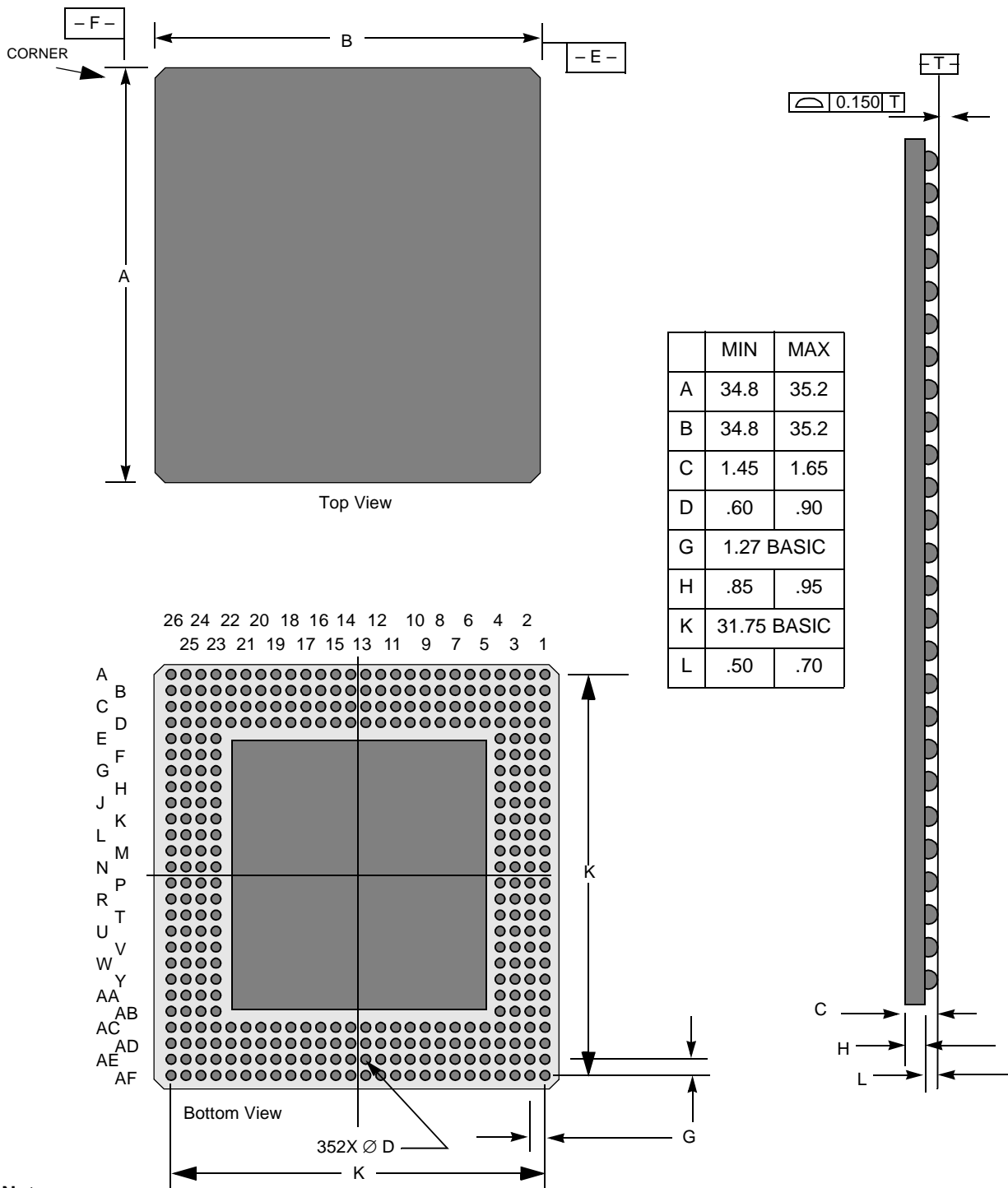
1.5.1 Package Parameters for the MPC8245

The MPC8245 uses a 35 mm × 35 mm, cavity up, 352-pin tape ball grid array (TBGA) package. The package parameters are as follows.

| | |
|----------------------------|---|
| Package Outline | 35 mm × 35 mm |
| Interconnects | 352 |
| Pitch | 1.27 mm |
| Solder Balls | 62 Sn/36 Pb/2 Ag |
| Solder Ball Diameter | 0.75 mm |
| Maximum Module Height | 1.65 mm |
| Co-Planarity Specification | 0.15 mm |
| Maximum Force | 6.0 lbs. total, uniformly distributed over package (8 grams/ball) |

1.5.2 Pin Assignments and Package Dimensions

Figure 26 shows the top surface, side profile, and pinout of the MPC8245, 352 TBGA package.



Notes:

1. Drawing not to scale.
2. All measurements are in millimeters (mm).

Figure 26. MPC8245 Package Dimensions and Pinout Assignments

1.5.3 Pinout Listings

Table 17 provides the pinout listing for the MPC8245, 352 TBGA package.

Table 17. MPC8245 Pinout Listing

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|---------------------------------|---|--------|------------------|--------------------|---------------|
| PCI Interface Signals | | | | | |
| $\overline{C/BE}[3:0]$ | P25 K23 F23 A25 | I/O | OV _{DD} | DRV_PCI | 6, 15 |
| \overline{DEVSEL} | H26 | I/O | OV _{DD} | DRV_PCI | 8, 15 |
| \overline{FRAME} | J24 | I/O | OV _{DD} | DRV_PCI | 8, 15 |
| \overline{IRDY} | K25 | I/O | OV _{DD} | DRV_PCI | 8, 15 |
| \overline{LOCK} | J26 | Input | OV _{DD} | — | 8 |
| AD[31:0] | V25 U25 U26 U24 U23 T25 T26 R25 R26 N26 N25 N23 M26 M25 L25 L26 F24 E26 E25 E23 D26 D25 C26 A26 B26 A24 B24 D19 B23 B22 D22 C22 | I/O | OV _{DD} | DRV_PCI | 6, 15 |
| PAR | G25 | I/O | OV _{DD} | DRV_PCI | 15 |
| $\overline{GNT}[3:0]$ | W25 W24 W23 V26 | Output | OV _{DD} | DRV_PCI | 6, 15 |
| $\overline{GNT4/DA5}$ | W26 | Output | OV _{DD} | DRV_PCI | 7, 15, 14 |
| $\overline{REQ}[3:0]$ | Y25 AA26 AA25 AB26 | Input | OV _{DD} | — | 6, 12 |
| $\overline{REQ4/DA4}$ | Y26 | I/O | OV _{DD} | — | 12, 14 |
| \overline{PERR} | G26 | I/O | OV _{DD} | DRV_PCI | 8, 15, 18 |
| \overline{SERR} | F26 | I/O | OV _{DD} | DRV_PCI | 8, 15, 16 |
| \overline{STOP} | H25 | I/O | OV _{DD} | DRV_PCI | 8, 15 |
| \overline{TRDY} | K26 | I/O | OV _{DD} | DRV_PCI | 8, 15 |
| \overline{INTA} | AC26 | Output | OV _{DD} | DRV_PCI | 10, 15, 16 |
| IDSEL | P26 | Input | OV _{DD} | — | |
| Memory Interface Signals | | | | | |
| MDL[0:31] | AD17 AE17 AE15 AF15 AC14 AE13 AF13 AF12 AF11 AF10 AF9 AD8 AF8 AF7 AF6 AE5 B1 A1 A3 A4 A5 A6 A7 D7 A8 B8 A10 D10 A12 B11 B12 A14 | I/O | GV _{DD} | DRV_STD_MEM | 5, 6 |

Table 17. MPC8245 Pinout Listing (continued)

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|--|--|--------|------------------|--------------------|---------|
| MDH[0:31] | AC17 AF16 AE16 AE14 AF14 AC13 AE12 AE11 AE10 AE9 AE8 AC7 AE7 AE6 AF5 AC5 E4 A2 B3 D4 B4 B5 D6 C6 B7 C9 A9 B10 A11 A13 B13 A15 | I/O | GV _{DD} | DRV_STD_MEM | 6 |
| DQM[0:7] | AB1 AB2 K3 K2 AC1 AC2 K1 J1 | Output | GV _{DD} | DRV_MEM_CTRL | 6 |
| $\overline{\text{CS}}[0:7]$ | Y4 AA3 AA4 AC4 M2 L2 M1 L1 | Output | GV _{DD} | DRV_MEM_CTRL | 6 |
| $\overline{\text{FOE}}$ | H1 | I/O | GV _{DD} | DRV_MEM_CTRL | 3, 4 |
| $\overline{\text{RCS0}}$ | N4 | Output | GV _{DD} | DRV_MEM_CTRL | 3, 4 |
| $\overline{\text{RCS1}}$ | N2 | Output | GV _{DD} | DRV_MEM_CTRL | |
| $\overline{\text{RCS2}}/\text{TRIG_IN}$ | AF20 | I/O | OV _{DD} | 6 ohms | 10, 14 |
| $\overline{\text{RCS3}}/\text{TRIG_OUT}$ | AC18 | Output | GV _{DD} | DRV_MEM_CTRL | 14 |
| SDMA[1:0] | W1 W2 | I/O | GV _{DD} | DRV_MEM_CTRL | 3, 4, 6 |
| SDMA[11:2] | N1 R1 R2 T1 T2 U4 U2 U1 V1 V3 | Output | GV _{DD} | DRV_MEM_CTRL | 6 |
| $\overline{\text{DRDY}}$ | B20 | Input | OV _{DD} | — | 9, 14 |
| SDMA12/ $\overline{\text{SRESET}}$ | B16 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| SDMA13/TBEN | B14 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| SDMA14/ $\overline{\text{CHKSTOP_IN}}$ | D14 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| SDBA1 | P1 | Output | GV _{DD} | DRV_MEM_CTRL | |
| SDBA0 | P2 | Output | GV _{DD} | DRV_MEM_CTRL | |
| PAR[0:7] | AF3 AE3 G4 E2 AE4 AF4 D2 C2 | I/O | GV _{DD} | DRV_STD_MEM | 6 |
| $\overline{\text{SDRAS}}$ | AD1 | Output | GV _{DD} | DRV_MEM_CTRL | 3 |
| $\overline{\text{SDCAS}}$ | AD2 | Output | GV _{DD} | DRV_MEM_CTRL | 3 |
| CKE | H2 | Output | GV _{DD} | DRV_MEM_CTRL | 3, 4 |
| $\overline{\text{WE}}$ | AA1 | Output | GV _{DD} | DRV_MEM_CTRL | |
| $\overline{\text{AS}}$ | Y1 | Output | GV _{DD} | DRV_MEM_CTRL | 3, 4 |
| PIC Control Signals | | | | | |
| IRQ0/S_INT | C19 | Input | OV _{DD} | — | |
| IRQ1/S_CLK | B21 | I/O | OV _{DD} | DRV_PCI | |
| IRQ2/S_RST | AC22 | I/O | OV _{DD} | DRV_PCI | |

Package Description

Table 17. MPC8245 Pinout Listing (continued)

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|---------------------------------------|-------------|--------|------------------|-----------------------------------|----------|
| IRQ3/S_FRAME | AE24 | I/O | OV _{DD} | DRV_PCI | |
| IRQ4/L_INT | A23 | I/O | OV _{DD} | DRV_PCI | |
| I²C Control Signals | | | | | |
| SDA | AE20 | I/O | OV _{DD} | DRV_STD_MEM | 10, 16 |
| SCL | AF21 | I/O | OV _{DD} | DRV_STD_MEM | 10, 16 |
| UART Control Signals | | | | | |
| SOUT1/PCI_CLK0 | AC25 | Output | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| SIN1/PCI_CLK1 | AB25 | I/O | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| SOUT2/R _T S1/ PCI_CLK2 | AE26 | Output | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| SIN2/C _T S1/ PCI_CLK3 | AF25 | I/O | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| Clock-Out Signals | | | | | |
| PCI_CLK0/SOUT1 | AC25 | Output | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| PCI_CLK1/SIN1 | AB25 | I/O | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| PCI_CLK2/R _T S1/ SOUT2 | AE26 | Output | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| PCI_CLK3/C _T S1/ SIN2 | AF25 | I/O | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| PCI_CLK4/DA3 | AF26 | Output | GV _{DD} | DRV_PCI_CLK | 13, 14 |
| PCI_SYNC_OUT | AD25 | Output | GV _{DD} | DRV_PCI_CLK | |
| PCI_SYNC_IN | AB23 | Input | GV _{DD} | — | |
| SDRAM_CLK [0:3] | D1 G1 G2 E1 | Output | GV _{DD} | DRV_MEM_CTRL or DRV_MEM_CLK | 6, 21 |
| SDRAM_SYNC_OUT | C1 | Output | GV _{DD} | DRV_MEM_CTRL or DRV_MEM_CLK | 21 |
| SDRAM_SYNC_IN | H3 | Input | GV _{DD} | — | |
| CKO/DA1 | B15 | Output | OV _{DD} | DRV_STD_MEM | 14 |
| OSC_IN | AD21 | Input | OV _{DD} | — | 19 |
| Miscellaneous Signals | | | | | |
| H _R ST_CTRL | A20 | Input | OV _{DD} | — | |
| H _R ST_CPU | A19 | Input | OV _{DD} | — | |
| MCP | A17 | Output | OV _{DD} | DRV_STD_MEM | 3, 4, 17 |

Table 17. MPC8245 Pinout Listing (continued)

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|---|--|--------|------------------|--------------------|-------------|
| NMI | D16 | Input | OV _{DD} | — | |
| $\overline{\text{SMI}}$ | A18 | Input | OV _{DD} | — | 10 |
| $\overline{\text{SRESET}}/\text{SDMA12}$ | B16 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| TBEN/SDMA13 | B14 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| $\overline{\text{QACK}}/\text{DA0}$ | F2 | Output | OV _{DD} | DRV_STD_MEM | 4, 10, 14 |
| $\overline{\text{CHKSTOP_IN}}/\text{SDMA14}$ | D14 | I/O | GV _{DD} | DRV_MEM_CTRL | 10, 14 |
| TRIG_IN/ $\overline{\text{RCS2}}$ | AF20 | I/O | OV _{DD} | — | 10, 14 |
| TRIG_OUT/ $\overline{\text{RCS3}}$ | AC18 | Output | GV _{DD} | DRV_MEM_CTRL | 14 |
| MAA[0:2] | AF2 AF1 AE1 | Output | GV _{DD} | DRV_STD_MEM | 3, 4, 6 |
| $\overline{\text{MIV}}$ | A16 | Output | OV _{DD} | — | 24 |
| PMAA[0:1] | AD18 AF18 | Output | OV _{DD} | DRV_STD_MEM | 3, 4, 6, 15 |
| PMAA[2] | AE19 | Output | OV _{DD} | DRV_STD_MEM | 4, 6, 15 |
| Test/Configuration Signals | | | | | |
| PLL_CFG[0:4]/DA[10:6] | A22 B19 A21 B18 B17 | I/O | OV _{DD} | DRV_STD_MEM | 6, 14, 20 |
| $\overline{\text{TEST0}}$ | AD22 | Input | OV _{DD} | — | 1, 9 |
| $\overline{\text{DRDY}}$ | B20 | Input | OV _{DD} | — | 9, 10 |
| RTC | Y2 | Input | GV _{DD} | — | 11 |
| TCK | AF22 | Input | OV _{DD} | — | 9, 12 |
| TDI | AF23 | Input | OV _{DD} | — | 9, 12 |
| TDO | AC21 | Output | OV _{DD} | — | 24 |
| TMS | AE22 | Input | OV _{DD} | — | 9, 12 |
| $\overline{\text{TRST}}$ | AE23 | Input | OV _{DD} | — | 9, 12 |
| Power and Ground Signals | | | | | |
| GND | AA2 AA23 AC12 AC15 AC24 AC3 AC6 AC9 AD11 AD14 AD16 AD19 AD23 AD4 AE18 AE2 AE21 AE25 B2 B25 B6 B9 C11 C13 C16 C23 C4 C8 D12 D15 D18 D21 D24 D3 F25 F4 H24 J25 J4 L24 L3 M23 M4 N24 P3 R23 R4 T24 T3 V2 V23 W3 | Ground | — | — | |

Package Description

Table 17. MPC8245 Pinout Listing (continued)

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|---------------------------------|---|---|-------------------|--------------------|-----------|
| LV _{DD} | AC20 AC23 D20 D23 G23 P23 Y23 | Reference voltage 3.3 V, 5.0 V | LV _{DD} | — | |
| GV _{DD} | AB3 AB4 AC10 AC11 AC8 AD10 AD13 AD15 AD3 AD5 AD7 C10 C12 C3 C5 C7 D13 D5 D9 E3 G3 H4 K4 L4 N3 P4 R3 U3 V4 Y3 | Power for memory drivers 3.3 V | GV _{DD} | — | |
| OV _{DD} | AB24 AD20 AD24 C14 C20 C24 E24 G24 J23 K24 M24 P24 T23 Y24 | PCI/Std 3.3 V | OV _{DD} | — | |
| V _{DD} | AA24 AC16 AC19 AD12 AD6 AD9 C15 C18 C21 D11 D8 F3 H23 J3 L23 M3 R24 T4 V24 W4 | Power for core 1.8/2.0 V | V _{DD} | — | 22 |
| No Connect | D17 | — | — | — | 23 |
| AV _{DD} | C17 | Power for PLL (CPU core logic) 1.8/2.0 V | AV _{DD} | — | 22 |
| AV _{DD2} | AF24 | Power for PLL (peripheral logic) 1.8/ 2.0 V | AV _{DD2} | — | 22 |
| Debug/Manufacturing Pins | | | | | |
| DA0/QACK | F2 | Output | OV _{DD} | DRV_STD_MEM | 3, 4, 14 |
| DA1/CKO | B15 | Output | OV _{DD} | DRV_STD_MEM | 14 |
| DA2 | C25 | Output | OV _{DD} | DRV_PCI | 2 |
| DA3/PCI_CLK4 | AF26 | Output | GV _{DD} | DRV_PCI_CLK | 14 |
| DA4/REQ4 | Y26 | I/O | OV _{DD} | — | 12, 14 |
| DA5/GNT4 | W26 | Output | OV _{DD} | DRV_PCI | 7, 15, 14 |
| DA[10:6]/ PLL_CFG[0:4] | A22 B19 A21 B18 B17 | I/O | OV _{DD} | DRV_STD_MEM | 6, 14, 20 |
| DA[11] | AD26 | Output | OV _{DD} | DRV_PCI | 2 |
| DA[12:13] | AF17 AF19 | Output | OV _{DD} | DRV_STD_MEM | 2, 6 |

Table 17. MPC8245 Pinout Listing (continued)

| Name | Pin Number | Type | Power Supply | Output Driver Type | Notes |
|-----------|------------|--------|------------------|--------------------|-------|
| DA[14:15] | F1 J2 | Output | GV _{DD} | DRV_MEM_CTRL | 2, 6 |

Notes:

- Place a pull-up resistor of 120 Ω or less on the $\overline{\text{TEST0}}$ pin.
- Treat these pins as no connects (NC) unless using debug address functionality.
- This pin has an internal pull-up resistor which is enabled only when the MPC8245 is in the reset state. The value of the internal pull-up resistor is not guaranteed, but is sufficient to ensure that a logic 1 is read into configuration bits during reset.
- This pin is a reset configuration pin.
- DL[0] is a reset configuration pin and has an internal pull-up resistor which is enabled only when the MPC8245 is in the reset state. The value of the internal pull-up resistor is not guaranteed, but is sufficient to ensure that a logic 1 is read into configuration bits during reset.
- Multi-pin signals such as AD[31:0] or MDL[0:31] have their physical package pin numbers listed in order, corresponding to the signal names. Example: AD0 is on pin C22, AD1 is on pin D22, ..., AD31 is on pin V25.
- $\overline{\text{GNT4}}$ is a reset configuration pin and has an internal pull-up resistor which is enabled only when the MPC8245 is in the reset state.
- Recommend a weak pull-up resistor (2–10 k Ω) be placed on this PCI control pin to LV_{DD}.
- V_{IH} and V_{IL} for these signals are the same as the PCI V_{IH} and V_{IL} entries in Table 3.
- Recommend a weak pull-up resistor (2–10 k Ω) be placed on this pin to OV_{DD}.
- Recommend a weak pull-up resistor (2–10 k Ω) be placed on this pin to GV_{DD}.
- This pin has an internal pull-up resistor which is enabled at all times. The value of the internal pull-up resistor is not guaranteed, but is sufficient to prevent unused inputs from floating.
- External PCI clocking source or fan-out buffer may be required for system if using the MPC8245 DUART functionality since PCI_CLK[0:3] are not available in DUART mode. Only PCI_CLK4 is available in DUART mode.
- This pin is a multiplexed signal and appears more than once in this table.
- This pin is affected by programmable PCI_HOLD_DEL parameter.
- This pin is an open drain signal.
- This pin can be programmed to be driven (default) or can be programmed (in PMCR2) to be open drain.
- This pin is a sustained three-state pin as defined by the *PCI Local Bus Specification*.
- OSC_IN utilizes the 3.3-V PCI interface driver which is 5-V tolerant, see Table 2 for details.
- PLL_CFG[0:4] signals are sampled a few clocks after the negation of $\overline{\text{HRST_CPU}}$ and $\overline{\text{HRST_CTRL}}$.
- SDRAM_CLK[0:3] and SDRAM_SYNC_OUT signals use DRV_MEM_CTRL for chip Rev 1.1 (A). These signals use DRV_MEM_CLK for chip Rev 1.2 (B).
- The 266- and 300-MHz part offerings can be run at a source voltage of 1.8 \pm 100 mV or 2.0 \pm 100 mV. Note that source voltage should be 2.0 \pm 100 mV for 333- and 350-MHz parts.
- This pin was formally LAVDD on the MPC8240. It is a no connect on the MPC8245. This should not pose a problem when replacing an MPC8240 with an MPC8245.
- The driver capability of this pin is hardwired to 40 Ω and cannot be changed.

1.6 PLL Configuration

The internal PLLs of the MPC8245 are configured by the PLL_CFG[0:4] signals. For a given PCI_SYNC_IN (PCI bus) frequency, the PLL configuration signals set both the peripheral logic/memory bus PLL (VCO) frequency of operation for the PCI-to-memory frequency multiplying and the MPC603e CPU PLL (VCO) frequency of operation for memory-to-CPU frequency multiplying. The PLL configurations for the MPC8245 is shown in Table 18 and Table 19.

PLL Configuration

Table 18. PLL Configurations (266- and 300-MHz Parts)

| Ref | PLL_CFG [0:4] ^{10,13} | 266 MHz Part ⁹ | | | 300 MHz Part ⁹ | | | Multipliers | |
|---------|--------------------------------|--|--|-----------------------|--|--|-----------------------|----------------------|----------------------|
| | | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI-to-Mem (Mem VCO) | Mem-to-CPU (CPU VCO) |
| 0 | 00000 ¹² | 25–35 ⁵ | 75–105 | 188–263 | 25–40 ⁵ | 75–120 | 188–300 | 3 (2) | 2.5 (2) |
| 1 | 00001 ¹² | 25–29 ⁵ | 75–88 | 225–264 | 25–33 ⁵ | 75–99 | 225–297 | 3 (2) | 3 (2) |
| 2 | 00010 ¹¹ | 50 ¹⁸ –59 ⁵ | 50–59 | 225–266 | 50 ¹⁸ –66 ¹ | 50–66 | 225–297 | 1 (4) | 4.5 (2) |
| 3 | 00011 ^{11,14} | 50 ¹⁷ –66 ¹ | 50–66 | 100–133 | 50 ¹⁷ –66 ¹ | 50–66 | 100–133 | 1 (Bypass) | 2 (4) |
| 4 | 00100 ¹² | 25–46 ⁴ | 50–92 | 100–184 | 25–46 ⁴ | 50–92 | 100–184 | 2 (4) | 2 (4) |
| 5 | 00101 | Reserved | | | Reserved | | | Note 20 | |
| 6 | 00110 ¹⁵ | Bypass | | | Bypass | | | Bypass | |
| 7 Rev B | 00111 ¹⁴ | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 1 (Bypass) | 3 (2) |
| 7 Rev D | 00111 ¹⁴ | Not available | | | | | | | |
| 8 | 01000 ¹² | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 1 (4) | 3 (2) |
| 9 | 01001 ¹⁹ | 45 ⁶ –66 ¹ | 90–132 | 180–264 | 45 ⁶ –66 ¹ | 90–132 | 180–264 | 2 (2) | 2 (2) |
| A | 01010 ¹² | 25–29 ⁵ | 50–58 | 225–261 | 25–33 ⁵ | 50–66 | 225–297 | 2 (4) | 4.5 (2) |
| B | 01011 ¹⁹ | 45 ³ –59 ⁵ | 68–88 | 204–264 | 45 ³ –66 ¹ | 68–99 | 204–297 | 1.5 (2) | 3 (2) |
| C | 01100 ¹² | 36 ⁶ –46 ⁴ | 72–92 | 180–230 | 36 ⁶ –46 ⁴ | 72–92 | 180–230 | 2 (4) | 2.5 (2) |
| D | 01101 ¹⁹ | 45 ³ –50 ⁵ | 68–75 | 238–263 | 45 ³ –57 ⁵ | 68–85 | 238–298 | 1.5 (2) | 3.5 (2) |
| E | 01110 ¹² | 30 ⁶ –44 ⁵ | 60–88 | 180–264 | 30 ⁶ –46 ⁴ | 60–92 | 180–276 | 2 (4) | 3 (2) |
| F | 01111 ¹⁹ | 25 ⁵ | 75 | 263 | 25–28 ⁵ | 75–85 | 263–298 | 3 (2) | 3.5 (2) |
| 10 | 10000 ¹² | 30 ⁶ –44 ^{2,5} | 90–132 | 180–264 | 30 ⁶ –44 ² | 90–132 | 180–264 | 3 (2) | 2 (2) |
| 11 | 10001 ¹⁹ | 25–26 ⁵ | 100–106 | 250–266 | 25–29 ² | 100–116 | 250–290 | 4 (2) | 2.5 (2) |
| 12 | 10010 ¹² | 60 ⁶ –66 ¹ | 90–99 | 180–198 | 60 ⁶ –66 ¹ | 90–99 | 180–198 | 1.5 (2) | 2 (2) |
| 13 | 10011 ¹⁹ | Not available | | | 25 ² | 100 | 300 | 4 (2) | 3 (2) |
| 14 | 10100 ¹² | 26 ⁶ –38 ⁵ | 52–76 | 182–266 | 26 ⁶ –42 ⁵ | 52–84 | 182–294 | 2 (4) | 3.5 (2) |
| 15 | 10101 ¹⁹ | Not available | | | 27 ³ –30 ⁵ | 68–75 | 272–300 | 2.5 (2) | 4 (2) |
| 16 | 10110 ¹² | 25–33 ⁵ | 50–66 | 200–264 | 25–37 ⁵ | 50–74 | 200–296 | 2 (4) | 4 (2) |
| 17 | 10111 ¹⁹ | 25–33 ⁵ | 100–132 | 200–264 | 25–33 ² | 100–132 | 200–264 | 4 (2) | 2 (2) |
| 18 | 11000 ¹² | 27 ³ –35 ⁵ | 68–88 | 204–264 | 27 ³ –40 ⁵ | 68–100 | 204–300 | 2.5 (2) | 3 (2) |
| 19 | 11001 ¹⁹ | 36 ⁶ –53 ⁵ | 72–106 | 180–265 | 36 ⁶ –59 ² | 72–118 | 180–295 | 2 (2) | 2.5 (2) |

Table 18. PLL Configurations (266- and 300-MHz Parts) (continued)

| Ref | PLL_CFG [0:4] ^{10,13} | 266 MHz Part ⁹ | | | 300 MHz Part ⁹ | | | Multipliers | |
|----------|--------------------------------|--|--|-----------------------|--|--|-----------------------|----------------------|----------------------|
| | | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI-to-Mem (Mem VCO) | Mem-to-CPU (CPU VCO) |
| 1A | 11010 ¹² | 50 ¹⁸ –66 ¹ | 50–66 | 200–264 | 50 ¹⁸ –66 ¹ | 50–66 | 200–264 | 1 (4) | 4 (2) |
| 1B | 11011 ¹⁹ | 34 ³ –44 ⁵ | 68–88 | 204–264 | 34 ³ –50 ⁵ | 68–100 | 204–300 | 2 (2) | 3 (2) |
| 1C | 11100 ¹² | 44 ³ –59 ⁵ | 66–88 | 198–264 | 44 ³ –66 ¹ | 66–99 | 198–297 | 1.5 (2) | 3 (2) |
| 1D | 11101 ¹² | 48 ⁶ –66 ¹ | 72–99 | 180–248 | 48 ⁶ –66 ¹ | 72–99 | 180–248 | 1.5 (2) | 2.5 (2) |
| 1E Rev B | 11110 ⁸ | Not usable | | | Not usable | | | Off | Off |
| 1E Rev D | 11110 ⁸ | 33 ³ –38 ⁵ | 66–76 | 231–266 | 33 ³ –42 ⁵ | 66–84 | 231–294 | 2(2) | 3.5(2) |
| 1F | 11111 ⁸ | Not usable | | | Not usable | | | Off | Off |

Notes:

- Limited by maximum PCI input frequency (66 MHz).
- Limited by maximum system memory interface operating frequency (100 MHz @ 300 MHz CPU).
- Limited by minimum memory VCO frequency (133 MHz).
- Limited due to maximum memory VCO frequency (372 MHz).
- Limited by maximum CPU operating frequency.
- Limited by minimum CPU VCO frequency (360 MHz).
- Limited by maximum CPU VCO frequency (800 MHz).
- In clock off mode, no clocking occurs inside the MPC8245 regardless of the PCI_SYNC_IN input.
- Range values are shown rounded down to the nearest whole number (decimal place accuracy removed) for clarity.
- PLL_CFG[0:4] settings not listed are reserved.
- Multiplier ratios for this PLL_CFG[0:4] setting are different from the MPC8240 and are not backwards-compatible.
- PCI_SYNC_IN range for this PLL_CFG[0:4] setting is different from the MPC8240 and may not be fully backwards-compatible.
- Bits 7–4 of register offset <0xE2> contain the PLL_CFG[0:4] setting value.
- In PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal processor directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI:Mem) mode operation. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in PLL bypass mode.
- In dual PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal peripheral logic directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI_SYNC_IN:Mem) mode operation. In this mode, the OSC_IN input signal clocks the internal processor directly in 1:1 (OSC_IN:CPU) mode operation, and the processor PLL is disabled. The PCI_SYNC_IN and OSC_IN input clocks must be externally synchronized. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in dual PLL bypass mode.
- Limited by maximum system memory interface operating frequency (133 MHz @ 266 MHz CPU).
- Limited by minimum CPU operating frequency (100 MHz).
- Limited by minimum memory bus frequency (50 MHz).
- PCI_SYNC_IN range for this PLL_CFG[0:4] setting does not exist on the MPC8240 and may not be fully backwards-compatible.
- No longer supported.

PLL Configuration

Table 19. PLL Configurations (333- and 350-MHz Parts)

| Ref | PLL_CFG [0:4] ^{10,13} | 333 MHz Part ⁹ | | | 350 MHz Part ⁹ | | | Multipliers | |
|------------|-----------------------------------|--|---|--------------------------------|--|---|--------------------------------|--------------------------------|--------------------------------|
| | | PCI Clock Input (PCI_ SYNC_IN) Range ¹ (MHz) | Periph Logic/ Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI Clock Input (PCI_ SYNC_IN) Range ¹ (MHz) | Periph Logic/ Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI-to- Mem (Mem VCO) | Mem-to- CPU (CPU VCO) |
| 0 | 00000 ¹² | 25–44 ¹⁶ | 75–132 | 188–330 | 25–44 ¹⁶ | 75–132 | 188–330 | 3 (2) | 2.5 (2) |
| 1 | 00001 ¹² | 25–37 ⁵ | 75–111 | 225–333 | 25–38 ⁵ | 75–114 | 225–342 | 3 (2) | 3 (2) |
| 2 | 00010 ¹¹ | 50 ¹⁸ –66 ¹ | 50–66 | 225–297 | 50 ¹⁸ –66 ¹ | 50–66 | 225–297 | 1 (4) | 4.5 (2) |
| 3 | 00011 ^{11,14} | 50 ¹⁷ –66 ¹ | 50–66 | 100–133 | 50 ¹⁷ –66 ¹ | 50–66 | 100–133 | 1 (Bypass) | 2 (4) |
| 4 | 00100 ¹² | 25–46 ⁴ | 50–92 | 100–184 | 25–46 ⁴ | 50–92 | 100–184 | 2 (4) | 2 (4) |
| 5 | 00101 | Reserved | | | Reserved | | | Note 20 | |
| 6 | 00110 ¹⁵ | Bypass | | | Bypass | | | Bypass | |
| 7 Rev B | 00111 ¹⁴ | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 1 (Bypass) | 3 (2) |
| 7 Rev D | 00111 ¹⁴ | Not available | | | 25 | 100 | 350 | 4(2) | 3.5(2) |
| 8 | 01000 ¹² | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 60 ⁶ –66 ¹ | 60–66 | 180–198 | 1 (4) | 3 (2) |
| 9 | 01001 ¹⁹ | 45 ⁶ –66 ¹ | 90–132 | 180–264 | 45 ⁶ –66 ¹ | 90–132 | 180–264 | 2 (2) | 2 (2) |
| A | 01010 ¹² | 25–37 ⁵ | 50–74 | 225–333 | 25–38 ⁵ | 50–76 | 225–342 | 2 (4) | 4.5 (2) |
| B | 01011 ¹⁹ | 45 ³ –66 ¹ | 68–99 | 204–297 | 45 ³ –66 ¹ | 68–99 | 204–297 | 1.5 (2) | 3 (2) |
| C | 01100 ¹² | 36 ⁶ –46 ⁴ | 72–92 | 180–230 | 36 ⁶ –46 ⁴ | 72–92 | 180–230 | 2 (4) | 2.5 (2) |
| D | 01101 ¹⁹ | 45 ³ –63 ⁵ | 68–95 | 238–333 | 45 ³ –66 ¹ | 68–99 | 238–347 | 1.5 (2) | 3.5 (2) |
| E | 01110 ¹² | 30 ⁶ –46 ⁴ | 60–92 | 180–276 | 30 ⁶ –46 ⁴ | 60–92 | 180–276 | 2 (4) | 3 (2) |
| F | 01111 ¹⁹ | 25–31 ⁵ | 75–93 | 263–326 | 25–33 ⁵ | 75–99 | 263–347 | 3 (2) | 3.5 (2) |
| 10 | 10000 ¹² | 30 ⁶ –44 ² | 90–132 | 180–264 | 30 ⁶ –44 ² | 90–132 | 180–264 | 3 (2) | 2 (2) |
| 11 | 10001 ¹⁹ | 25–33 ² | 100–132 | 250–330 | 25–33 ² | 100–132 | 250–330 | 4 (2) | 2.5 (2) |
| 12 | 10010 ¹² | 60 ⁶ –66 ¹ | 90–99 | 180–198 | 60 ⁶ –66 ¹ | 90–99 | 180–198 | 1.5 (2) | 2 (2) |
| 13 | 10011 ¹⁹ | 25–27 ⁵ | 100–108 | 300–324 | 25–29 ⁵ | 100–116 | 300–348 | 4 (2) | 3 (2) |
| 14 | 10100 ¹² | 26 ⁶ –47 ⁴ | 52–94 | 182–329 | 26 ⁶ –47 ⁴ | 52–94 | 182–329 | 2 (4) | 3.5 (2) |
| 15 | 10101 ¹⁹ | 27 ³ –33 ⁵ | 68–83 | 272–332 | 27 ³ –34 ⁵ | 68–85 | 272–340 | 2.5 (2) | 4 (2) |
| 16 | 10110 ¹² | 25–41 ⁵ | 50–82 | 200–328 | 25–43 ⁵ | 50–86 | 200–344 | 2 (4) | 4 (2) |
| 17 | 10111 ¹⁹ | 25–33 ² | 100–132 | 200–264 | 25–33 ² | 100–132 | 200–264 | 4 (2) | 2 (2) |
| 18 | 11000 ¹² | 27 ³ –44 ⁵ | 68–110 | 204–330 | 27 ³ –46 ⁵ | 68–115 | 204–345 | 2.5 (2) | 3 (2) |
| 19 | 11001 ¹⁹ | 36 ⁶ –66 ¹ | 72–132 | 180–330 | 36 ⁶ –66 ¹ | 72–132 | 180–330 | 2 (2) | 2.5 (2) |
| 1A | 11010 ¹² | 50 ¹⁸ –66 ¹ | 50–66 | 200–264 | 50 ¹⁸ –66 ¹ | 50–66 | 200–264 | 1 (4) | 4 (2) |

Table 19. PLL Configurations (333- and 350-MHz Parts) (continued)

| Ref | PLL_CFG [0:4] ^{10,13} | 333 MHz Part ⁹ | | | 350 MHz Part ⁹ | | | Multipliers | |
|----------|--------------------------------|--|--|-----------------------|--|--|-----------------------|----------------------|----------------------|
| | | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI Clock Input (PCI_SYNC_IN) Range ¹ (MHz) | Periph Logic/Mem Bus Clock Range (MHz) | CPU Clock Range (MHz) | PCI-to-Mem (Mem VCO) | Mem-to-CPU (CPU VCO) |
| 1B | 11011 ¹⁹ | 34 ³ –55 ⁵ | 68–110 | 204–330 | 34 ³ –58 ⁵ | 68–116 | 204–348 | 2 (2) | 3 (2) |
| 1C | 11100 ¹² | 44 ³ –66 ¹ | 66–99 | 198–297 | 44 ³ –66 ¹ | 66–99 | 198–297 | 1.5 (2) | 3 (2) |
| 1D | 11101 ¹² | 48 ⁶ –66 ¹ | 72–99 | 180–248 | 48 ⁶ –66 ¹ | 72–99 | 180–248 | 1.5 (2) | 2.5(2) |
| 1E Rev B | 11110 ⁸ | Not usable | | | Not usable | | | Off | Off |
| 1E Rev D | 11110 ⁸ | 33 ³ –47 ⁵ | 66–94 | 231–329 | 33 ³ –50 ⁵ | 66–100 | 231–350 | 2(2) | 3.5(2) |
| 1F | 11111 ⁸ | Not usable | | | Not usable | | | Off | Off |

Notes:

- Limited by maximum PCI input frequency (66 MHz).
- Limited by maximum system memory interface operating frequency (100 MHz @ 350 MHz CPU).
- Limited by minimum memory VCO frequency (132 MHz).
- Limited due to maximum memory VCO frequency (372 MHz).
- Limited by maximum CPU operating frequency.
- Limited by minimum CPU VCO frequency (360 MHz).
- Limited by maximum CPU VCO frequency (800 MHz).
- In clock off mode, no clocking occurs inside the MPC8245 regardless of the PCI_SYNC_IN input.
- Range values are shown rounded down to the nearest whole number (decimal place accuracy removed) for clarity.
- PLL_CFG[0:4] settings not listed are reserved.
- Multiplier ratios for this PLL_CFG[0:4] setting are different from the MPC8240 and are not backwards-compatible.
- PCI_SYNC_IN range for this PLL_CFG[0:4] setting is different from the MPC8240 and may not be fully backwards-compatible.
- Bits 7–4 of register offset <0xE2> contain the PLL_CFG[0:4] setting value.
- In PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal processor directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI:Mem) mode operation. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in PLL bypass mode.
- In dual PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal peripheral logic directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI_SYNC_IN:Mem) mode operation. In this mode, the OSC_IN input signal clocks the internal processor directly in 1:1 (OSC_IN:CPU) mode operation, and the processor PLL is disabled. The PCI_SYNC_IN and OSC_IN input clocks must be externally synchronized. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in dual PLL bypass mode.
- Limited by maximum system memory interface operating frequency (133 MHz @ 333 MHz CPU).
- Limited by minimum CPU operating frequency (100 MHz).
- Limited by minimum memory bus frequency (50 MHz).
- PCI_SYNC_IN range for this PLL_CFG[0:4] setting does not exist on the MPC8240 and may not be fully backwards-compatible.
- No longer supported.

1.7 System Design Information

This section provides electrical and thermal design recommendations for successful application of the MPC8245.

1.7.1 PLL Power Supply Filtering

The AV_{DD} and AV_{DD2} power signals are provided on the MPC8245 to provide power to the peripheral logic/memory bus PLL and the MPC603e processor PLL. To ensure stability of the internal clocks, the power supplied to the AV_{DD} and AV_{DD2} input signals should be filtered of any noise in the 500 kHz to 10 MHz resonant frequency range of the PLLs. Two separate circuits similar to the one shown in Figure 27 using surface mount capacitors with minimum effective series inductance (ESL) is recommended for AV_{DD} and AV_{DD2} power signal pins. Consistent with the recommendations of Dr. Howard Johnson in *High Speed Digital Design: A Handbook of Black Magic* (Prentice Hall, 1993), multiple small capacitors of equal value are recommended over using multiple values.

The circuits should be placed as close as possible to the respective input signal pins to minimize noise coupled from nearby circuits. Routing directly as possible from the capacitors to the input signal pins with minimal inductance of vias is important.

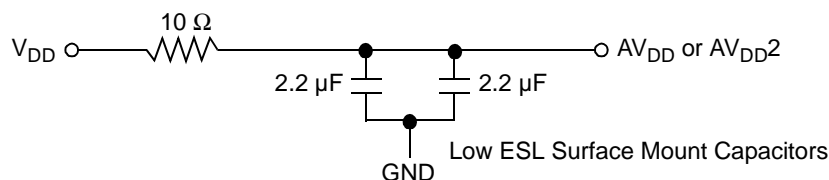


Figure 27. PLL Power Supply Filter Circuit

1.7.2 Decoupling Recommendations

Due to its dynamic power management feature, the large address and data buses, and its high operating frequencies, the MPC8245 can generate transient power surges and high frequency noise in its power supply, especially while driving large capacitive loads. This noise must be prevented from reaching other components in the MPC8245 system, and the MPC8245 itself requires a clean, tightly regulated source of power. Therefore, it is recommended that the system designer place at least one decoupling capacitor at each V_{DD} , OV_{DD} , GV_{DD} , and LV_{DD} pin of the MPC8245. It is also recommended that these decoupling capacitors receive their power from dedicated power planes in the PCB, utilizing short traces to minimize inductance. These capacitors should have a value of 0.1 μF . Only ceramic SMT (surface mount technology) capacitors should be used to minimize lead inductance, preferably 0508 or 0603, oriented such that connections are made along the length of the part.

In addition, it is recommended that there be several bulk storage capacitors distributed around the PCB, feeding the V_{DD} , OV_{DD} , GV_{DD} , and LV_{DD} planes, to enable quick recharging of the smaller chip capacitors. These bulk capacitors should have a low ESR (equivalent series resistance) rating to ensure the quick response time necessary. They should also be connected to the power and ground planes through two vias to minimize inductance. Suggested bulk capacitors: 100–330 μF (AVX TPS tantalum or Sanyo OSCON).

1.7.3 Connection Recommendations

To ensure reliable operation, it is highly recommended to connect unused inputs to an appropriate signal level. Unused active-low inputs should be tied to OV_{DD} . Unused active-high inputs should be connected to GND. All NC (no connect) signals must remain unconnected.

Power and ground connections must be made to all external V_{DD} , OV_{DD} , GV_{DD} , LV_{DD} , and GND pins of the MPC8245.

The PCI_SYNC_OUT signal is intended to be routed halfway out to the PCI devices and then returned to the PCI_SYNC_IN input of the MPC8245.

The SDRAM_SYNC_OUT signal is intended to be routed halfway out to the SDRAM devices and then returned to the SDRAM_SYNC_IN input of the MPC8245. The trace length may be used to skew or adjust the timing window as needed. See Motorola application notes AN1849/D, *MPC107 Design Guide*, and AN2164/D, *MPC8245/MPC8241 Memory Clock Design Guidelines*, for more information on this topic. Note that there is an SDRAM_SYNC_IN to PCI_SYNC_IN time requirement (see Table 10).

1.7.4 Pull-Up/Pull-Down Resistor Requirements

The data bus input receivers are normally turned off when no read operation is in progress; therefore, they do not require pull-up resistors on the bus. The data bus signals are: MDH[0:31], MDL[0:31], and PAR[0:7].

If the 32-bit data bus mode is selected, the input receivers of the unused data and parity bits (MDL[0:31] and PAR[4:7]) will be disabled, and their outputs will drive logic zeros when they would otherwise normally be driven. For this mode, these pins do not require pull-up resistors and should be left unconnected by the system to minimize possible output switching.

The $\overline{\text{TEST0}}$ pin requires a pull-up resistor of 120 Ω or less connected to OV_{DD} .

It is recommended that RTC have weak pull-up resistors (2–10 k Ω) connected to GV_{DD} .

It is recommended that the following signals be pulled up to OV_{DD} with weak pull-up resistors (2–10 k Ω): SDA, SCL, SMI, SRESET/SDMA12, TBEN/SDMA13, CHKSTOP_IN/SDMA14, TRIG_IN/RCS2, INTA, QACK/DA0 and DRDY. Note that QACK/DA0 should be left without a pull resistor only if an external clock is used because when this signal is low on reset, it enables internal clock flipping logic, which is necessary when the PLL[0:4] signals select a half-clock frequency ratio and an external PLL is used to drive the SDRAM device.

It is recommended that the following PCI control signals be pulled up to LV_{DD} (the clamping voltage) with weak pull-up resistors (2–10 k Ω): DEVSEL, FRAME, IRDY, LOCK, PERR, SERR, STOP, and TRDY. The resistor values may need to be adjusted stronger to reduce induced noise on specific board designs.

The following pins have internal pull-up resistors enabled at all times: REQ[3:0], REQ4/DA4, TCK, TDI, TMS, and TRST. See Table 17 for more information.

The following pins have internal pull-up resistors enabled only while device is in the reset state: GNT4/DA5, MDL0, FOE, RCS0, SDRAS, SDCAS, CKE, AS, MCP, MAA[0:2], and PMAA[0:2]. See Table 17 for more information.

The following pins are reset configuration pins: GNT4/DA5, MDL[0], FOE, RCS0, CKE, AS, MCP, QACK/DA0, MAA[0:2], PMAA[0:2], SDMA[1:0], MDH[16:31], and PLL_CFG[0:4]/DA[10:15]. These pins are sampled during reset to configure the device. The PLL_CFG[0:4] signals are sampled a few clocks after the negation of HRST_CPU and HRST_CTRL.

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Reset configuration pins should be tied to GND via 1-k Ω pull-down resistors to ensure a logic zero level is read into the configuration bits during reset if the default logic-one level is not desired.

Any other unused active low input pins should be tied to a logic-one level via weak pull-up resistors (2–10 k Ω) to the appropriate power supply listed in Table 17. Unused active high input pins should be tied to GND via weak pull-down resistors (2–10 k Ω).

1.7.5 PCI Reference Voltage—LV_{DD}

The MPC8245 PCI reference voltage (LV_{DD}) pins should be connected to 3.3 \pm 0.3 V power supply if interfacing the MPC8245 into a 3.3-V PCI bus system. Similarly, the LV_{DD} pins should be connected to 5.0 V \pm 5% power supply if interfacing the MPC8245 into a 5-V PCI bus system. For either reference voltage, the MPC8245 always performs 3.3-V signaling as described in the *PCI Local Bus Specification* (Rev. 2.2). The MPC8245 tolerates 5-V signals when interfaced into a 5-V PCI bus system.

1.7.6 MPC8245 Compatibility with MPC8240

The MPC8245 AC timing specifications are backwards-compatible with those of the MPC8240, except for the requirements of item 11 in Table 10. Timing adjustments are needed as specified for T_{os} (SDRAM_SYNC_IN to *sys_logic_clk* offset) time requirements.

The MPC8245 does not support the SDRAM flow-through memory interface.

The nominal core V_{DD} power supply changes from 2.5 V on the MPC8240 to 1.8/2.0 V on the MPC8245. See Table 2 for details.

The MPC8245 PLL_CFG[0:4] setting 0x02 (0b00010) has a different ‘PCI-to-Mem’ and ‘Mem-to-CPU’ multiplier ratio than the same setting on the MPC8240, and thus, is not backwards-compatible. See Table 18 for details.

Most of the MPC8240 PLL_CFG[0:4] settings are subsets of the PCI_SYNC_IN input frequency range accepted by the MPC8245. However, the parts will not be fully backwards-compatible since the ranges of the two parts do not always match. Note that modes 0x8 and 0x18 of the MPC8245 are not compatible with settings 0x8 and 0x18 on the MPC8240. See Table 18 and Table 19 for details.

There are two additional reset configuration signals on the MPC8245 which are not used as reset configuration signals on the MPC8240: SDMA0 and SDMA1.

The SDMA0 reset configuration pin selects between the MPC8245 DUART or the MPC8240 backwards compatible mode PCI_CLK[0:4] functionality on these multiplexed signals. The default state (logic 1) of SDMA0 selects the MPC8240 backwards compatible mode of PCI_CLK[0:4] functionality while a logic 0 state on the SDMA0 signal selects DUART functionality. Note if using the DUART mode, four of the five PCI clocks, PCI_CLK[0:3], are not available.

The SDMA1 reset configuration pin selects between MPC8245 extended ROM functionality or MPC8240 backwards-compatible functionality on the multiplexed signals: TBEN, $\overline{\text{CHKSTOP_IN}}$, $\overline{\text{SRESET}}$, TRIG_IN, and TRIG_OUT. The default state (logic 1) of SDMA1 selects the MPC8240 backwards-compatible mode functionality, while a logic 0 state on the SDMA1 signal selects extended ROM functionality. Note if using the extended ROM mode, TBEN, $\overline{\text{CHKSTOP_IN}}$, $\overline{\text{SRESET}}$, TRIG_IN, and TRIG_OUT functionality are not available.

The driver names and capability of the pins for the MPC8245 and that of the MPC8240 vary slightly. Refer to the Drive Capability table (for the ODCR register at 0x73) in the *MPC8240 Integrated Processor Hardware Specifications* and Table 4 for more details.

The programmable PCI output valid and output hold feature controlled by bits in the power management configuration register 2 (PMCR2) <0x72> has changed slightly in the MPC8245. For the MPC8240, 3 bits, PMCR2[6:4] = PCI_HOLD_DEL, are used to select 1 of 8 possible PCI output timing configurations. PMCR2[6:5] are software controllable but initially are set by the reset configuration state of the \overline{MCP} and CKE signals, respectively; PMCR2[4] can be changed by software. The default configuration for PMCR2[6:4] = 0b110 since the \overline{MCP} and CKE signals have internal pull-up resistors, but this default configuration does not select 33 or 66 MHz PCI operation output timing parameters for the MPC8240; this choice is made by software. For the MPC8245, only 2 bits in the power management configuration register 2 (PMCR2), PMCR2[5:4] = PCI_HOLD_DEL, control the variable PCI output timing. PMCR2[5:4] are software controllable but initially are set by the inverted reset configuration state of the \overline{MCP} and CKE signals, respectively. The default configuration for PMCR2[5:4] = 0b00 since the \overline{MCP} and CKE signals have internal pull-up resistors and the values from these signals are inverted; this default configuration selects 66 MHz PCI operation output timing parameters. There are four programmable PCI output timing configurations on the MPC8245, see Table 11 for details.

Voltage sequencing requirements for the MPC8245 are similar to those for the MPC8240; however, there are two changes which are applicable for the MPC8245. First, there is an additional requirement for the MPC8245 that the non-PCI input voltages (V_{in}) must not be greater than GV_{DD} or OV_{DD} by more than 0.6 V at all times including during power-on reset (see caution 5 in Table 2). Second, for the MPC8245, LV_{DD} must not exceed OV_{DD} by more than 3.0 V at any time including during power-on reset (see caution 10 in Table 2); the allowable separation between LV_{DD} and OV_{DD} is 3.6 V for the MPC8240.

There is no LAV_{DD} input voltage supply signal on the MPC8245 since the SDRAM clock delay-locked loop (DLL) has power supplied internally. Signal D17 should be treated as a no connect for the MPC8245.

1.7.7 JTAG Configuration Signals

Boundary scan testing is enabled through the JTAG interface signals. The \overline{TRST} signal is optional in the IEEE 1149.1 specification, but is provided on all processors that implement the PowerPC architecture. While it is possible to force the TAP controller to the reset state using only the TCK and TMS signals, more reliable power-on reset performance will be obtained if the \overline{TRST} signal is asserted during power-on reset. Because the JTAG interface is also used for accessing the common on-chip processor (COP) function, simply tying \overline{TRST} to \overline{HRESET} is not practical.

The COP function of these processors allows a remote computer system (typically, a PC with dedicated hardware and debugging software) to access and control the internal operations of the processor. The COP interface connects primarily through the JTAG port of the processor, with some additional status monitoring signals. The COP port requires the ability to independently assert \overline{HRESET} or \overline{TRST} in order to fully control the processor. If the target system has independent reset sources, such as voltage monitors, watchdog timers, power supply failures, or push-button switches, then the COP reset signals must be merged into these signals with logic.

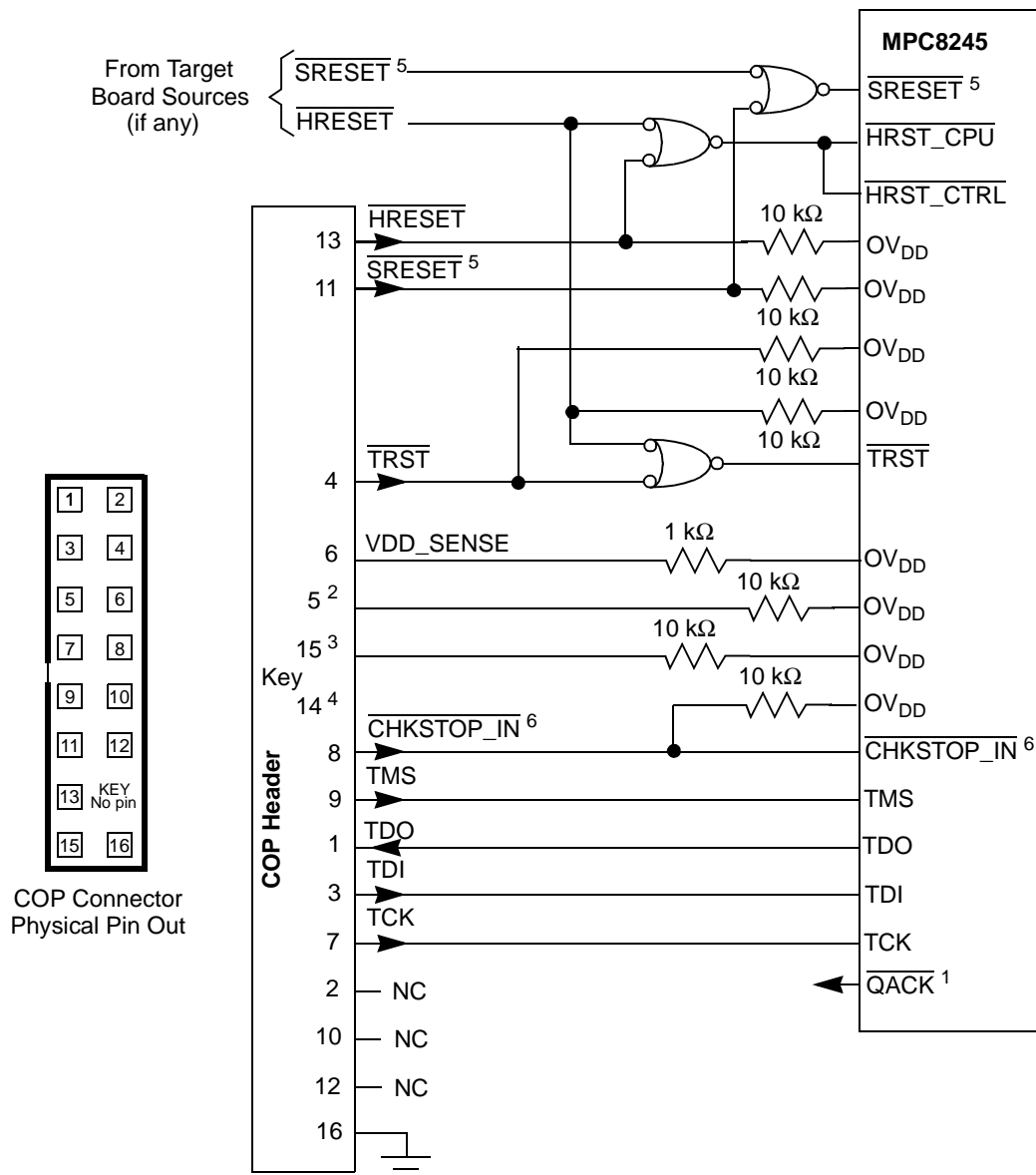
The arrangement shown in Figure 28 allows the COP to independently assert \overline{HRESET} or \overline{TRST} , while ensuring that the target can drive \overline{HRESET} as well. If the JTAG interface and COP header will not be used, \overline{TRST} should be tied to \overline{HRESET} so that it is asserted when the system reset signal (\overline{HRESET}) is asserted ensuring that the JTAG scan chain is initialized during power-on.

The COP header shown in Figure 28 adds many benefits—breakpoints, watchpoints, register and memory examination/modification, and other standard debugger features are possible through this interface—and can be as inexpensive as an unpopulated footprint for a header to be added when needed.

The COP interface has a standard header for connection to the target system, based on the 0.025" square-post, 0.100" centered header assembly (often called a Berg header).

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There is no standardized way to number the COP header shown in Figure 28; consequently, many different pin numbers have been observed from emulator vendors. Some are numbered top-to-bottom then left-to-right, while others use left-to-right then top-to-bottom, while still others number the pins counter clockwise from pin 1 (as with an IC). Regardless of the numbering, the signal placement recommended in Figure 28 is common to all known emulators.



Notes:

1. QACK is an output on the MPC8245 and is not required at the COP header for emulation.
2. RUN/STOP normally found on pin 5 of the COP header is not implemented on the MPC8245. Connect pin 5 of the COP header to OV_{DD} with a 1- kΩ pull-up resistor.
3. CKSTP_OUT normally found on pin 15 of the COP header is not implemented on the MPC8245. Connect pin 15 of the COP header to OV_{DD} with a 10-kΩ pull-up resistor.
4. Pin 14 is not physically present on the COP header.
5. SRESET functions as output SDMA12 in extended ROM mode.
6. CHKSTOP_IN functions as output SDMA14 in extended ROM mode.

Figure 28. COP Connector Diagram

1.7.8 Thermal Management Information

This section provides thermal management information for the tape ball grid array (TBGA) package for air-cooled applications. Depending on the application environment and the operating frequency, heat sinks may be required to maintain junction temperature within specifications. Proper thermal control design is primarily dependent upon the system-level design: the heat sink, airflow, and thermal interface material. To reduce the die-junction temperature, heat sinks may be attached to the package by several methods: adhesive, spring clip to holes in the printed-circuit board or package, or mounting clip and screw assembly; see Figure 29.

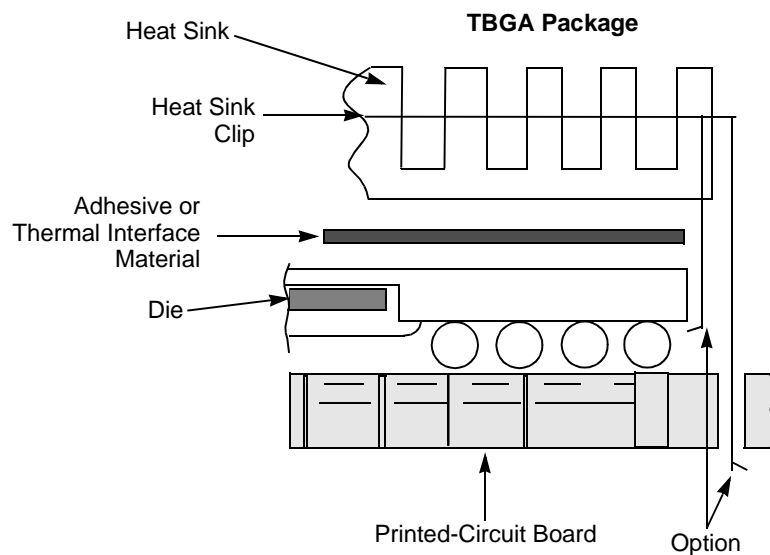


Figure 29. Package Exploded Cross-Sectional View with Several Heat Sink Options

Figure 30 depicts the die junction-to-ambient thermal resistance for four typical cases:

- A heat sink is not attached to the TBGA package and there exists a high board-level thermal loading from adjacent components.
- A heat sink is not attached to the TBGA package and there exists a low board-level thermal loading from adjacent components.
- A heat sink (for example, ChipCoolers) is attached to the TBGA package and there exists high board-level thermal loading from adjacent components.
- A heat sink (for example, ChipCoolers) is attached to the TBGA package and there exists low board-level thermal loading from adjacent components.

System Design Information

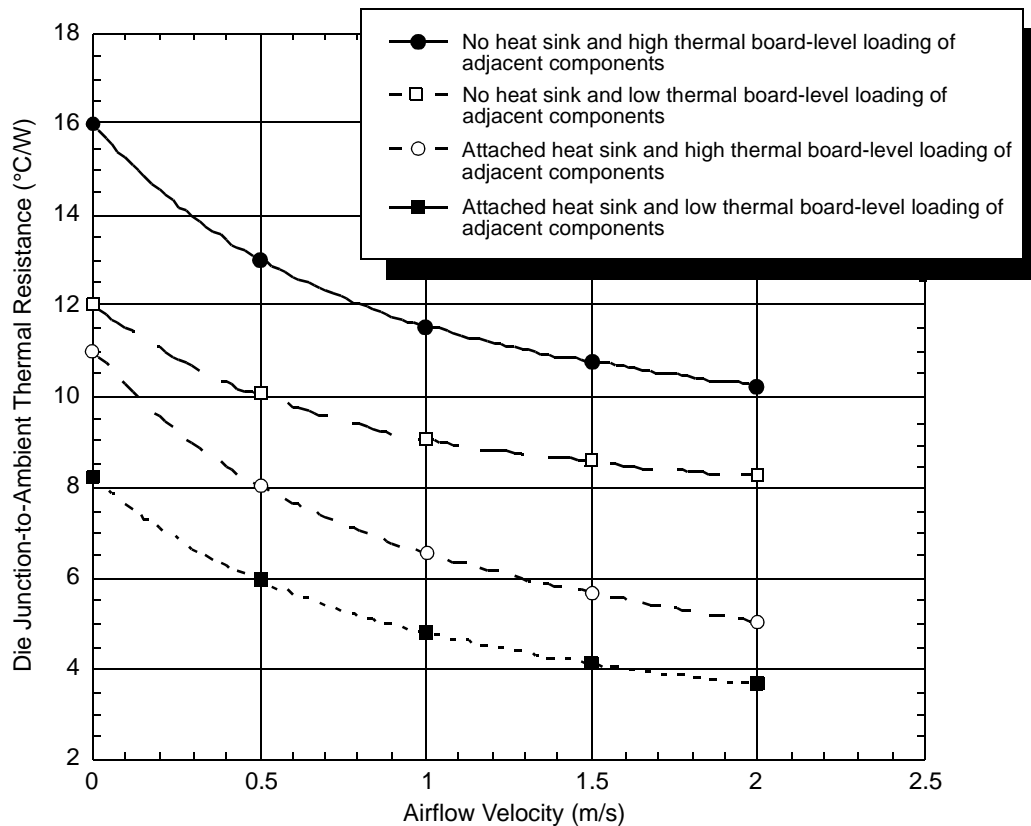


Figure 30. Die Junction-to-Ambient Resistance

The board designer can choose between several types of heat sinks to place on the MPC8245. There are several commercially available heat sinks for the MPC8245 provided by the following vendors:

Aavid Thermalloy 603-224-9988
 80 Commercial St.
 Concord, NH 03301
 Internet: www.aavidthermalloy.com

Alpha Novatech 408-749-7601
 473 Sapena Ct. #15
 Santa Clara, CA 95054
 Internet: www.alphanovatech.com

International Electronic Research Corporation (IERC) 818-842-7277
 413 North Moss St.
 Burbank, CA 91502
 Internet: www.ctscorp.com

Tyco Electronics 800-522-6752
 Chip Coolers™
 P.O. Box 3668
 Harrisburg, PA 17105-3668
 Internet: www.chipcoolers.com

Wakefield Engineering
 33 Bridge St.
 Pelham, NH 03076
 Internet: www.wakefield.com

603-635-5102

Ultimately, the final selection of an appropriate heat sink depends on many factors, such as thermal performance at a given air velocity, spatial volume, mass, attachment method, assembly, and cost. Other heat sinks offered by Aavid Thermalloy, Alpha Novatech, IERC, Chip Coolers, and Wakefield Engineering offer different heat sink-to-ambient thermal resistances, and may or may not need airflow.

1.7.8.1 Internal Package Conduction Resistance

For the TBGA, cavity down, packaging technology, shown in Figure 31, the intrinsic conduction thermal resistance paths are as follows:

- The die junction-to-case thermal resistance
- The die junction-to-ball thermal resistance

Figure 31 depicts the primary heat transfer path for a package with an attached heat sink mounted to a printed-circuit board.

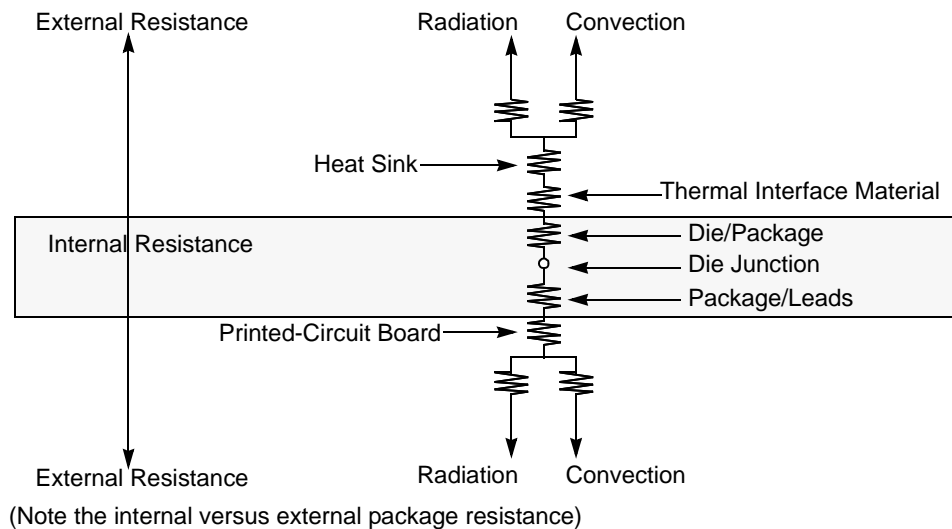


Figure 31. TBGA Package with Heat Sink Mounted to a Printed-Circuit Board

In TBGA package the active side of the die faces the printed-circuit board. Most of the heat travels through the die, across the die attach layer, into the copper spreader. Some of the heat is removed from the top surface of the spreader through convection and radiation. Another portion of the heat enters the printed-circuit board through the solder balls. The heat is then removed off the exposed surfaces of the board through convection and radiation. If a heat sink is used a larger percentage of heat leaves through the top side of the spreader.

1.7.8.2 Adhesives and Thermal Interface Materials

A thermal interface material is recommended between the top of the package and the bottom of the heat sink to minimize the thermal contact resistance. For those applications where the heat sink is attached by spring clip mechanism, Figure 32 shows the thermal performance of three thin-sheet thermal-interface materials

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(silicone, graphite/oil, fluoroether oil), a bare joint, and a joint with thermal grease as a function of contact pressure. As shown, the performance of these thermal interface materials improves with increasing contact pressure. The use of thermal grease significantly reduces the interface thermal resistance. That is, the bare joint results in a thermal resistance approximately seven times greater than the thermal grease joint.

Heat sinks are attached to the package by means of a spring clip to holes in the printed-circuit board (see Figure 32). Therefore, the synthetic grease offers the best thermal performance, considering the low interface pressure. Of course, the selection of any thermal interface material depends on many factors: thermal performance requirements, manufacturability, service temperature, dielectric properties, cost, etc.

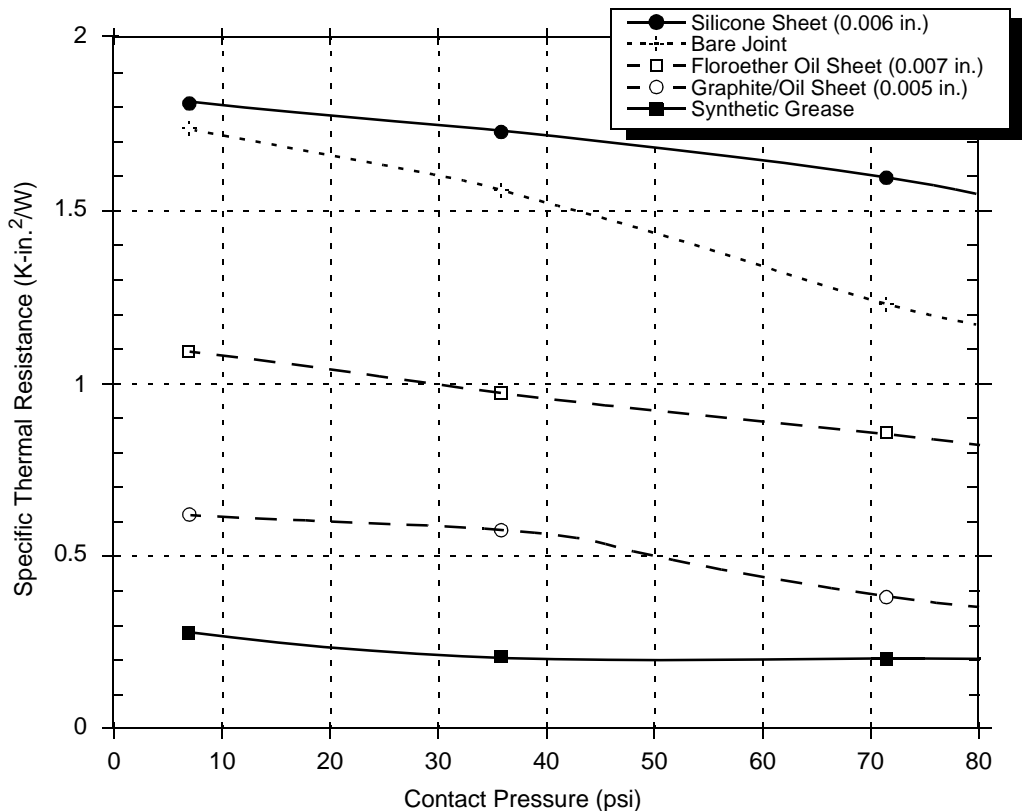


Figure 32. Thermal Performance of Select Thermal Interface Material

The board designer can choose between several types of thermal interface. Heat sink adhesive materials should be selected based upon high conductivity, yet adequate mechanical strength to meet equipment shock/vibration requirements. There are several commercially-available thermal interfaces and adhesive materials provided by the following vendors:

Chomerics, Inc. 781-935-4850
77 Dragon Ct.
Woburn, MA 01888-4014
Internet: www.chomerics.com

Dow-Corning Corporation 800-248-2481
Dow-Corning Electronic Materials
2200 W. Salzburg Rd.
Midland, MI 48686-0997
Internet: www.dow.com

| | |
|--|--------------|
| Shin-Etsu MicroSi, Inc. 10028 S. 51st St. Phoenix, AZ 85044 Internet: www.microsi.com | 888-642-7674 |
| The Bergquist Company 18930 West 78 th St. Chanhassen, MN 55317 Internet: www.bergquistcompany.com | 800-347-4572 |
| Thermagon Inc. 4707 Detroit Ave. Cleveland, OH 44102 Internet: www.thermagon.com | 888-246-9050 |

1.7.8.3 Heat Sink Usage

An estimation of the chip junction temperature, T_J , can be obtained from the equation:

$$T_J = T_A + (R_{\theta JA} \times P_D)$$

where

T_A = ambient temperature for the package ($^{\circ}\text{C}$)

$R_{\theta JA}$ = junction-to-ambient thermal resistance ($^{\circ}\text{C}/\text{W}$)

P_D = power dissipation in the package (W)

The junction-to-ambient thermal resistance is an industry-standard value that provides a quick and easy estimation of thermal performance. Unfortunately, two values are in common usage: the value determined on a single-layer board and the value obtained on a board with two planes. Which value is closer to the application depends on the power dissipated by other components on the board. The value obtained on a single-layer board is appropriate for the tightly packed printed-circuit board. The value obtained on the board with the internal planes is usually appropriate if the board has low power dissipation and the components are well separated.

When a heat sink is used, the thermal resistance is expressed as the sum of a junction-to-case thermal resistance and a case-to-ambient thermal resistance:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$$

where

$R_{\theta JA}$ = junction-to-ambient thermal resistance ($^{\circ}\text{C}/\text{W}$)

$R_{\theta JC}$ = junction-to-case thermal resistance ($^{\circ}\text{C}/\text{W}$)

$R_{\theta CA}$ = case-to-ambient thermal resistance ($^{\circ}\text{C}/\text{W}$)

$R_{\theta JC}$ is device-related and cannot be influenced by the user. The user controls the thermal environment to change the case-to-ambient thermal resistance, $R_{\theta CA}$. For instance, the user can change the size of the heat sink, the airflow around the device, the interface material, the mounting arrangement on the printed-circuit board, or the thermal dissipation on the printed-circuit board surrounding the device.

To determine the junction temperature of the device in the application without a heat sink, the thermal characterization parameter (Ψ_{JT}) can be used to determine the junction temperature with a measurement of the temperature at the top center of the package case using the following equation:

$$T_J = T_T + (\Psi_{JT} \times P_D)$$

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where:

T_T = thermocouple temperature atop the package ($^{\circ}\text{C}$)

Ψ_{JT} = thermal characterization parameter ($^{\circ}\text{C}/\text{W}$)

P_D = power dissipation in package (W)

The thermal characterization parameter is measured per JESD51-2 specification using a 40-gauge type T thermocouple epoxied to the top center of the package case. The thermocouple should be positioned so that the thermocouple junction rests on the package. A small amount of epoxy is placed over the thermocouple junction and over about 1 mm of wire extending from the junction. The thermocouple wire is placed flat against the package case to avoid measurement errors caused by cooling effects of the thermocouple wire.

When a heat sink is used, the junction temperature is determined from a thermocouple inserted at the interface between the case of the package and the interface material. A clearance slot or hole is normally required in the heat sink. Minimizing the size of the clearance is important to minimize the change in thermal performance caused by removing part of the thermal interface to the heat sink. Because of the experimental difficulties with this technique, many engineers measure the heat sink temperature and then back calculate the case temperature using a separate measurement of the thermal resistance of the interface. From this case temperature, the junction temperature is determined from the junction-to-case thermal resistance.

In many cases, it is appropriate to simulate the system environment using a computational fluid dynamics thermal simulation tool. In such a tool, the simplest thermal model of a package which has demonstrated reasonable accuracy (about 20%) is a two-resistor model consisting of a junction-to-board and a junction-to-case thermal resistance. The junction-to-case covers the situation where a heat sink will be used or where a substantial amount of heat is dissipated from the top of the package. The junction-to-board thermal resistance describes the thermal performance when most of the heat is conducted to the printed-circuit board.

1.7.9 References

Semiconductor Equipment and Materials International
805 East Middlefield Rd.
Mountain View, CA 94043
(415) 964-5111

MIL-SPEC and EIA/JESD (JEDEC) specifications are available from Global Engineering Documents at 800-854-7179 or 303-397-7956.

JEDEC specifications are available on the WEB at <http://www.jedec.org>.

1.8 Document Revision History

Table 20 provides a revision history for this hardware specification.

Table 20. Revision History Table

| Rev. No. | Substantive Change(s) |
|----------|--|
| 0.0 | Initial release. |
| 0.1 | <p>Made Vdd/AVdd/AVdd2 = 1.8 V ± 100 mV information for 133 MHz memory interface operation to Section 1.3, Table 2, Table 5, Table 9, Table 17, and Section 1.7.2.</p> <p>Pin D17, formerly LAVdd (supply voltage for DLL), is a No Connect on the MPC8245 since the DLL voltage is supplied internally. Eliminated all references to LAVdd; updated Section 1.7.1.</p> <p>Previous Note 4 of Table 2 did not apply to the MPC8245 (MPC8240 document legacy). New Note 4 added in reference to max CPU speed at reduced Vdd voltage.</p> <p>Updated the Programmable Output Impedance of DEV_MEM_ADDR in Table 4 to 6 Ω to reflect characterization data.</p> <p>Updated Table 5 to reflect reduced power consumption when operating Vdd/AVdd/AVdd2 = 1.8 V ± 100 mV. Changed Notes 2, 3, and 4 to reflect Vdd at 1.9 V. Changed Note 5 to represent Vdd = AVdd = 1.8 V.</p> <p>Updated Table 7 to reflect Vdd/AVdd/AVdd2 voltage level operating frequency dependencies; changed 250 MHz device column to 266 MHz; modified Note 1 eliminating VCO references; added Note 2. Changed 250 MHz processor frequency offering to 266 MHz.</p> <p>Changed Spec 12b for memory output valid time in Table 11 from 5.5 ns to 4.5 ns; this is a key specification change to enable 133 MHz memory interface designs.</p> <p>Updated Pinout Table 16 with the following changes:</p> <ul style="list-style-type: none"> • Pin Types for RCS0, RCS3/TRIG_OUT and DA[11:15] were erroneously listed as I/O, changed Pin Types to Output. • Pin Types for REQ4/DA4, RCS2/TRIG_IN, and PLL_CFG[0:4]/DA[10:6] were erroneously listed as Input, changed Pin Types to I/O. • Changed Pin D17 from LAVdd to No Connect; deleted Note 21 and references. • Notes 3, 5, and 7 contained references to the MPC8240 (MPC8240 document legacy); changed these references to MPC8245. • Previous Notes 13 and 14 did not apply to the MPC8245 (MPC8240 document legacy), these notes were deleted; moved Note 19 to become new Note 13; moved Note 20 to become new Note 14; updated associated references. • Added Note 3 to SDMA[1:0] signals about internal pull-up resistors during reset state. • Reversed vector ordering for the PCI Interface Signals: C/BE[0:3] changed to C/BE[3:0], AD[0:31] changed to AD[31:0], GNT[0:3] changed to GNT[3:0], and REQ[0:3] changed to REQ[3:0]. The package pin number orderings were also reversed meaning that pin functionality did NOT change. For example, ADO is still on signal C22, AD1 is still on signal D22, ..., AD31 is still on signal V25. This change was made to make the vectored PCI signals in this hardware specification consistent with the <i>PCI Local Bus Specification</i> and the <i>MPC8245 Integrated Processor User's Manual</i> vector ordering. • Changed TEST1/DRDY signal on pin B20 to DRDY. • Changed TEST2 signal on pin Y2 to RTC for performance monitor use. <p>Updated PLL Table 17 with the following changes for 133 MHz memory interface operation:</p> <ul style="list-style-type: none"> • Added Ref. 9 (01001) and Ref. 17 (10111) details; removed these settings from Note 10 (reserved settings list). • Enhanced range of Ref. 10 (10000). • Updated Note 13, changed bits 16–20 erroneous information to correct bits 23–19. • Added Notes 16 and 17. <p>Added information to Section 1.7.8, in reference to CHKSTOP_IN and SRESET not being available in extended ROM mode.</p> |

Table 20. Revision History Table (continued)

| Rev. No. | Substantive Change(s) |
|----------|---|
| 0.2 | <p>Changed core supply voltage to 2.0 ± 100 mV in Section 1.3. (Supply voltage of 1.8 ± 100 mV is no longer recommended.)</p> <p>Changed rows 2, 5, and 6 of Table 2 to 2.0 ± 100 mV in the “Recommended Value” column.</p> <p>Changed the power consumption numbers in Table 5 to reflect the power values for Vdd = 2.0 V. (Notes 2, 3, 4, and 5 of the table were also updated to reflect the new value of Vdd.)</p> <p>Updated Table 9 for Vdd/AVdd/AVdd2 to 2.0 ± 100 mV.</p> <p>Table 8: Vdd/AVdd/AVdd2 was changed to 2.0 V for both CPU frequency offerings. Note 2 was updated by removing the “at reduced voltage...” statement.</p> <p>Table 10: Update maximum time of the rows 12a0 through 12a3.</p> <p>Table 16: Fixed overbars for the active-low signals. Changed pin type information for Vdd, AVdd, and AVdd2 to 2.0 V.</p> <p>Changed note 16 of Table 17 to a value of 2.0 V for Vdd/AVdd/AVdd2.</p> <p>Removed second sentence of the second paragraph in Section 1.7.2, because it referenced information about a 1.8-V design.</p> <p>Removed reference to 1.8 V in third sentence of Section 1.7.7.</p> |
| 0.3 | <p>Section 1.4.1.5: Changed Max-FP value for 33/133/266 of Table 5, from 2.3 to 2.1 watts, to represent characterization data. Changed Note 4 to say Vdd = 2.1 for power measurements (for 2-V part). Changed numbers for maximum I/O power supplies for OVdd and GVdd to represent characterization data.</p> <p>Section 1.4.3.1: Added four graphs (Figures 5–8) and description for DLL Locking Range vs. Frequency of Operation to replace Figure 5 of Rev 0.2 document.</p> <p>Section 1.4.3.2: Added row (item 11: T_{su}—SDRAM_SYNC_IN to PCI_SYNC_IN timing) to Table 9, to include offset change requirement.</p> <p>Section 1.5.3: Changed Note 4 of PLL_CFG pins in Table 16 to Note 20.</p> <p>Section 1.7.2: Added diode (MUR420) to Figure 27, Voltage Sequencing Circuit. This is to compensate for voltage extremes in design.</p> <p>Section 1.7.5: Added sentence with regards to SDRAM_SYNC_IN to PCI_SYNC_IN timing requirement (T_{su}) as a connection recommendation.</p> <p>Section 1.7.8: Mention of T_{su} offset timing, and driver capability differences between the MPC8240 and the MPC8245.</p> |
| 0.4 | <p>Section 1.2: Changed Features list (format) to match with the features list of the <i>MPC8245 Integrated Processor User’s Manual</i>.</p> <p>Section 1.4.1.2: Updated Table 2 to include 1.8 ± 100mV numbers.</p> <p>Section 1.4.3: Changed Table 7 to include new part offerings of 333 and 350 MHz. Added rows to include VCO frequency ranges for all parts for both memory VCO and CPU VCO.</p> <p>Section 1.4.1.5: Updated power consumption table to include 1.8 V (Vdd) and higher frequency numbers.</p> <p>Section 1.4.3: Updated Table 7 to include higher frequency offerings and CPU VCO frequency range.</p> <p>Section 1.4.3.1: Changed lettering to caps for DLL_EXTEND and DLL_MAX_DELAY in graph description section.</p> <p>Section 1.4.3.2: Changed name of item 11 from T_{su}—SDRAM_SYNC_IN to PCI_SYNC_IN Time to T_{os}—SDRAM_SYNC_IN to <i>sys_logic_clk</i> Offset Time. Changed name to T_{os} in Note 7 as well.</p> <p>Section 1.6: Updated notes in Table 17. Included minimum and maximum VCO numbers for memory VCO. Changed Note 13 for location of PLL_CFG[0:4] to correct bits location. Bits 7–4 of register offset <0xE2>.</p> <p>Added Table 18 to cover PLL configuration of higher frequency part offerings.</p> <p>Section: 1.7: Changed frequency ranges for reference numbers 0, 9, 10, and 17, for the 300 MHz part, to include the higher memory bus frequencies when operating at lower CPU bus frequencies. Added Table 18 to include PLL configurations for the 333 MHz and the 350 MHz CPU part offerings. Added VCO multipliers in Tables 17 and 18.</p> <p>Section 1.7.8: Changed T_{su}—SDRAM_SYNC_IN to PCI_SYNC_IN Time to T_{os}—SDRAM_SYNC_IN to <i>sys_logic_clk</i> Offset Time.”</p> <p>Section 1.7.10: Added vendor (Cool Innovations, Inc.) to list of Heat Sink vendors.</p> |
| 0.5 | <p>Corrected labels for Figures 5 through 8.</p> |

Table 20. Revision History Table (continued)

| Rev. No. | Substantive Change(s) |
|----------|--|
| 1 | <p>Updated document template.</p> <p>Section 1.4.1.4—Changed the driver type names in Table 6 to match with the names used in the MPC8245 User's Manual.</p> <p>Section 1.5.3—Updated driver type names for signals in Table 16 to match with names used in the <i>MPC8245 Integrated Processor User's Manual</i>.</p> <p>Section 1.4.1.2—Updated Table 7 to refer to new PLL Tables for VCO limits.</p> <p>Section 1.4.3.3—Added item 12e to Table 10 for SDRAM_SYNC_IN to Output Valid timing.</p> <p>Section 1.5.1—Updated Solder Balls information to 62Sn/36PB/2Ag.</p> <p>Section 1.6—Updated PLL Tables 17 and 18 and appropriate notes to reflect changes of VCO ranges for memory and CPU frequencies.</p> <p>Section 1.7—Updated voltage sequencing requirements in Table 2 and removed Section 1.7.2.</p> <p>Section 1.7.8—Updated TRST information and Figure 26.</p> <p>New Section 1.7.2—Updated the range of I/O power consumption numbers for OVDD and GVDD to correct values as in Table 5. Updated fastest frequency combination to 66:100:350 MHz.</p> <p>Section 1.7.9—Updated list for Heat Sink and Thermal Interface vendors.</p> <p>Section 1.9—Changed format of Ordering Information section. Added tables to reflect part number specifications also available.</p> <p>Added Sections 1.9.2 and 1.9.3.</p> |
| 2 | <p>Globally changed EPIC to PIC.</p> <p>Section 1.4.1.4—Note 5: Changed register reference from 0x72 to 0x73.</p> <p>Section 1.4.1.5—Table 5: Updated power dissipation numbers based on latest characterization data.</p> <p>Section 1.4.2—Table 6: Updated table to show more thermal specifications.</p> <p>Section 1.4.3—Table 7: Updated minimum memory bus value to 50 MHz.</p> <p>Section 1.4.3.1—Changed equations for DLL locking range based on characterization data. Added updates and reference to AN2164 for note 6. Added table defining T_{dp} parameters. Labeled N value in Figures 5 through 8.</p> <p>Section 1.4.3.2—Table 10: Changed bit definitions for tap points. Updated note on T_{os} and added reference to AN2164 for note 7. Updated Figure 9 to show significance of T_{os}.</p> <p>Section 1.4.3.4—Added column for SDRAM_CLK @ 133 MHz</p> <p>Sections 1.5.1 and 1.5.2—Corrected packaging information to state TBGA packaging.</p> <p>Section 1.5.3—Corrected some signals in Table 16 which were missing overbars in the Rev 1.0 release of the document.</p> <p>Section 1.6—Updated note 10 of Tables 18 and 19.</p> <p>Section 1.7.3—Changed sentence recommendation regarding decoupling capacitors.</p> <p>Section 1.9—Updated format of tables in Ordering Information section.</p> |

Ordering Information

Table 20. Revision History Table (continued)

| Rev. No. | Substantive Change(s) |
|----------|--|
| 3 | <p>Section 1.4.1.2—Figure 2: Updated note 2 and removed ‘voltage regulator delay’ label since Section 1.7.2 is being deleted this revision. Added Figures 4 and 5 to show voltage overshoot and undershoot of the PCI interface on the MPC8245.</p> <p>Section 1.4.1.3—Table 3: Updated the maximum input capacitance from 7 to 16 pF based on characterization data.</p> <p>Section 1.4.3.1—Updated PCI_SYNC_IN jitter specifications to 200 ps.</p> <p>Section 1.4.3.3—Table 11: Added the word address to the signal description of item 12b.</p> <p>Section 1.6—Corrected note numbers for reference numbers 3, 10, 1B, and 1C of the PLL tables.</p> <p>Section 1.4.3.3—Table 11, item 12b: added the word ‘address’ to help clarify which signals the spec applies to. Figure 15: edited timing for items 12a0 and 12a2 to correspond with Table 11.</p> <p>Section 1.5.3—Updated notes for the QACK/DA0 signal because this signal has been found to have no internal pull resistor.</p> <p>Section 1.6—Tables 18 and 19: Updated PLL specifications for modes 7 and 1E. Corrected values for mode 10.</p> <p>Section 1.7.2—Removed this section since the information already exists in Section 1.4.1.5.</p> <p>Section 1.7.4—Added the words ‘the clamping voltage’ to describe LV_{DD} in the sixth paragraph. Changed the QACK/DA0 signal from the list of signals having an internal pull-up resistor to the list of signals needing a weak pull-up resistor to OV_{DD}.</p> <p>Section 1.9.1—Tables 21 thru 23: Added processor version register value.</p> |

1.9 Ordering Information

Ordering information for the parts fully covered by this specification document is provided in Section 1.9.1, “Part Numbers Fully Addressed by This Document.” Section 1.9.2, “Part Numbers Not Fully Addressed by This Document,” lists the part numbers which do not fully conform to the specifications of this document. These special part numbers require an additional document called a part number specification.

1.9.1 Part Numbers Fully Addressed by This Document

Table 21 provides the Motorola part numbering nomenclature for the MPC8245. Note that the individual part numbers correspond to a maximum processor core frequency. For available frequencies, contact your local Motorola sales office. In addition to the processor frequency, the part numbering scheme also includes an application modifier which may specify special application conditions. Each part number also contains a revision code which refers to the die mask revision number. The revision level can be determined by reading the Revision ID register at address offset 0x08.

Table 21. Part Numbering Nomenclature

| MPC | nnnn | L | xx | nnn | x | |
|--------------|-----------------|--------------------------------------|----------------------|----------------------------------|---|----------------------------------|
| Product Code | Part Identifier | Process Descriptor | Package ¹ | Processor Frequency ² | Revision Level | Processor Version Register Value |
| MPC | 8245 | L: 1.8/2.0 V ± 100 mV 0° to 105°C | ZU = TBGA | 266 300 | B:1.2 Rev. ID:0x12 D:1.4 Rev ID:0x14 | 0x80811014 |
| | | L: 2.0 V ± 100 mV 0° to 105°C | ZU = TBGA | 333 350 | B:1.2 Rev. ID:0x12 D:1.4 Rev ID:0x14 | |

Notes:

1. See Section 1.5, "Package Description," for more information on available package types.
2. Processor core frequencies supported by parts addressed by this specification only. Not all parts described in this specification support all core frequencies. Additionally, parts addressed by part number specifications may support other maximum core frequencies.

1.9.2 Part Numbers Not Fully Addressed by This Document

Parts with application modifiers or revision levels not fully addressed in this specification document are described in separate part number specifications which supplement and supersede this document; see Table 22 and Table 23. The revision level can be determined by reading the Revision ID register at address offset 0x08.

**Table 22. Part Numbers Addressed by MPC8245TZUnnnx Series
Part Number Specification Markings
(Document Order No. MPC8245TZUPNS/D)**

| MPC | nnnn | X | xx | nnn | x | |
|--------------|-----------------|------------------------------------|----------------------|----------------------------------|--|----------------------------------|
| Product Code | Part Identifier | Process Descriptor | Package ¹ | Processor Frequency ² | Revision Level | Processor Version Register Value |
| MPC | 8245 | T :2.0 V ± 100 mV -40° to 105°C | ZU = TBGA | 266 300 333 350 | B:1.2 Rev ID:0x12 D:1.4 Rev ID:0x14 | 0x80811014 |

Notes:

1. See Section 1.5, "Package Description," for more information on available package types.
2. Processor core frequencies supported by parts addressed by this specification only. Not all parts described in this specification support all core frequencies. Additionally, parts addressed by part number specifications may support other maximum core frequencies.

Ordering Information

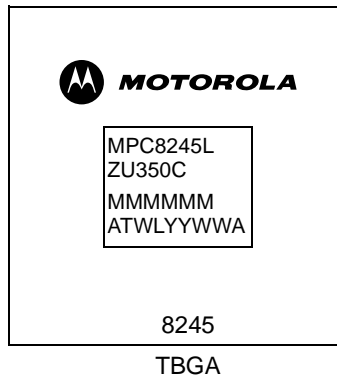
**Table 23. Part Numbers Addressed by MPC8245RZUnnnx Series
Part Number Specification Markings
(Document Order No. MPC8245RZUPNS/D)**

| MPC | nnnn | X | xx | nnn | x | |
|---------------------|------------------------|--------------------------------|-----------------------------|---|---|---|
| Product Code | Part Identifier | Process Descriptor | Package ¹ | Processor Frequency ² | Revision Level | Processor Version Register Value |
| MPC | 8245 | R:2.1 V ± 100 mV 0° to 85°C | ZU = TBGA | 400 | B:1.2 Rev. ID:0x12 D:1.4 Rev ID:0x14 | 0x80811014 |

Notes:

1. See Section 1.5, "Package Description," for more information on available package types.
2. Processor core frequencies supported by parts addressed by this specification only. Not all parts described in this specification support all core frequencies. Additionally, parts addressed by part number specifications may support other maximum core frequencies.

Parts are marked as the example shown in Figure 33.



Notes:

MMMMMM is the 6-digit mask number.

ATWLYYWWA is the traceability code.

CCCCC is the country of assembly. This space is left blank if parts are assembled in the United States.

Figure 33. Part Marking for TBGA Device

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