



MCF523x Integrated Microprocessor Hardware Specification

by: Microcontroller Solutions Group

The MCF523x is a family of highly-integrated 32-bit microcontrollers based on the V2 ColdFire microarchitecture. Featuring a 16 or 32 channel eTPU, 64 Kbytes of internal SRAM, a 2-bank SDRAM controller, four 32-bit timers with dedicated DMA, a 4 channel DMA controller, up to 2 CAN modules, 3 UARTs and a queued SPI, the MCF523x family has been designed for general purpose industrial control applications. It is also a high-performance upgrade for users of the MC68332. This document provides an overview of the MCF523x microcontroller family, as well as detailed descriptions of the mechanical and electrical characteristics of the devices.

The MCF523x family is based on the Version 2 ColdFire reduced instruction set computing (RISC) microarchitecture operating at a core frequency of up to 150 MHz and bus frequency up to 75 MHz.

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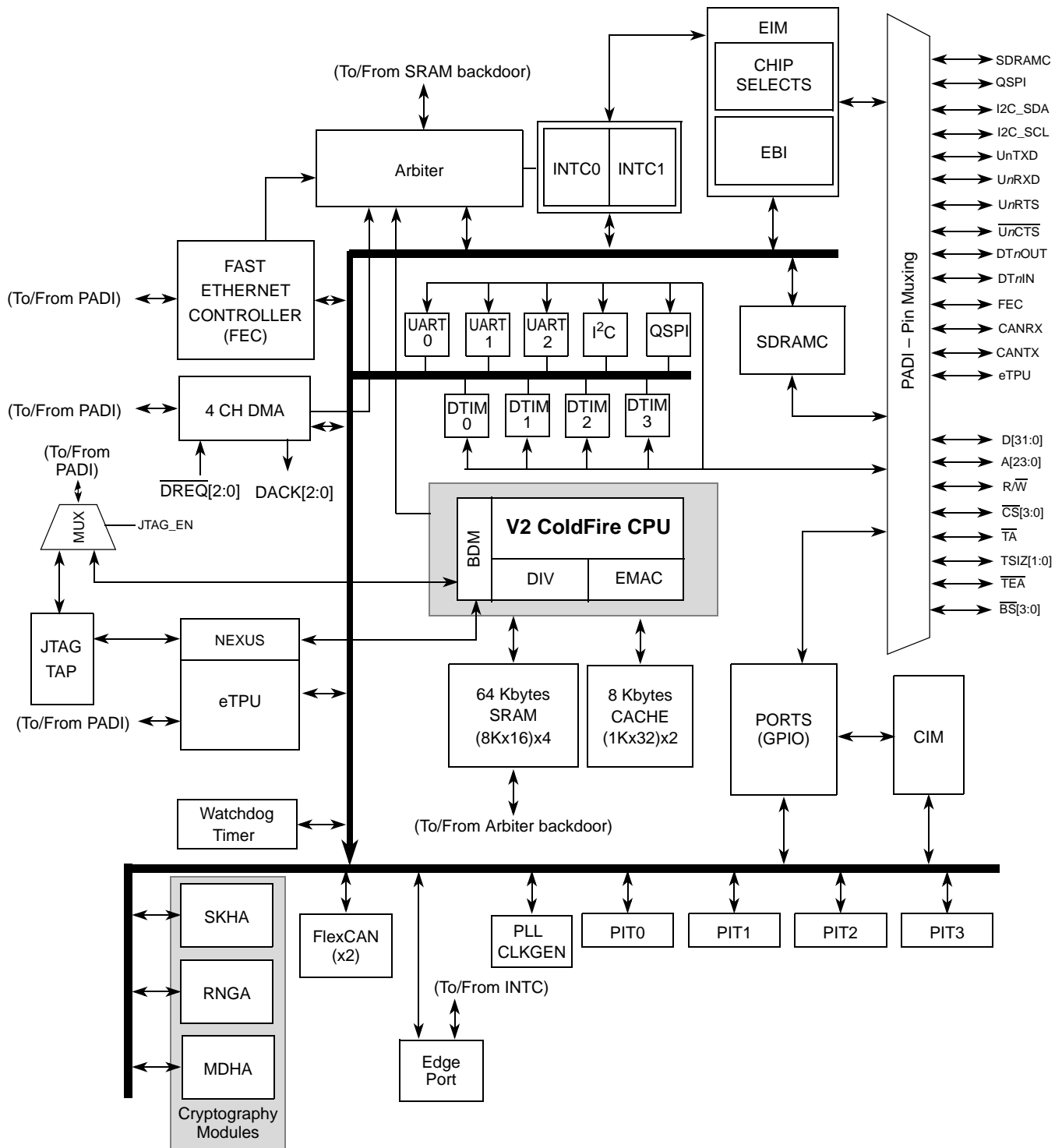
1 MCF523x Family Configurations

Table 1. MCF523x Family Configurations

| Module | MCF5232 | MCF5233 | MCF5234 | MCF5235 |
|--|--------------------------|---------------|---------------|---------------|
| ColdFire V2 Core with EMAC (Enhanced Multiply-Accumulate Unit) | x | x | x | x |
| Enhanced Time Processor Unit with memory (eTPU) | 16-ch 6K | 32-ch 6K | 16-ch 6K | 32-ch 6K |
| System Clock | up to 150 MHz | | | |
| Performance (Dhrystone/2.1 MIPS) | up to 144 | | | |
| Instruction/Data Cache | 8 Kbytes | | | |
| Static RAM (SRAM) | 64 Kbytes | | | |
| Interrupt Controllers (INTC) | 2 | 2 | 2 | 2 |
| Edge Port Module (EPORT) | x | x | x | x |
| External Interface Module (EIM) | x | x | x | x |
| 4-channel Direct-Memory Access (DMA) | x | x | x | x |
| SDRAM Controller | x | x | x | x |
| Fast Ethernet Controller (FEC) | — | — | x | x |
| Cryptography - Security module for data packets processing | — | — | — | x |
| Watchdog Timer (WDT) | x | x | x | x |
| Four Periodic Interrupt Timers (PIT) | x | x | x | x |
| 32-bit DMA Timers | 4 | 4 | 4 | 4 |
| QSPI | x | x | x | x |
| UART(s) | 3 | 3 | 3 | 3 |
| I ² C | x | x | x | x |
| FlexCAN 2.0B - Controller-Area Network communication module | 1 | 2 | 1 | 2 |
| General Purpose I/O Module (GPIO) | x | x | x | x |
| JTAG - IEEE 1149.1 Test Access Port | x | x | x | x |
| Package | 160 QFP 196 MAPBGA | 256 MAPBGA | 256 MAPBGA | 256 MAPBGA |

2 Block Diagram

The superset device in the MCF523x family comes in a 256 mold array process ball grid array (MAPBGA) package. [Figure](#) shows a top-level block diagram of the MCF5235, the superset device.



3 Features

For a detailed feature list see the MCF5235 Reference Manual (MCF5235RM).

4 Signal Descriptions

This section describes signals that connect off chip, including a table of signal properties. For a more detailed discussion of the MCF523x signals, consult the *MCF5235 Reference Manual* (MCF5235RM).

4.1 Signal Properties

Table 2 lists all of the signals grouped by function. The “Dir” column is the direction for the primary function of the pin. Refer to Section 6, “Mechanicals/Pinouts and Part Numbers,” for package diagrams.

NOTE

In this table and throughout this document a single signal within a group is designated without square brackets (i.e., A24), while designations for multiple signals within a group use brackets (i.e., A[23:21]) and is meant to include all signals within the two bracketed numbers when these numbers are separated by a colon.

NOTE

The primary functionality of a pin is not necessarily its default functionality. Pins that are muxed with GPIO will default to their GPIO functionality.

Table 2. MCF523x Signal Information and Muxing

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|--|------------|------------------------------|-------------|-------------------|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Reset | | | | | | | | | |
| $\overline{\text{RESET}}$ | — | — | — | I | 83 | N13 | T15 | T15 | T15 |
| $\overline{\text{RSTOUT}}$ | — | — | — | O | 82 | P13 | T14 | T14 | T14 |
| Clock | | | | | | | | | |
| EXTAL | — | — | — | I | 86 | M14 | P16 | P16 | P16 |
| XTAL | — | — | — | O | 85 | N14 | R16 | R16 | R16 |
| CLKOUT | — | — | — | O | 89 | K14 | M16 | M16 | M16 |
| Mode Selection | | | | | | | | | |
| CLKMOD[1:0] | — | — | — | I | 19,20 | G5, H5 | J3, J2 | J3, J2 | J3, J2 |
| $\overline{\text{RCON}}$ | — | — | — | I | 79 | K10 | P13 | P13 | P13 |
| External Memory Interface and Ports | | | | | | | | | |
| A[23:21] | PADDR[7:5] | $\overline{\text{CS}}$ [6:4] | — | O | 126, 125, 124 | B11, C11, D11 | B14, C14, A15 | B14, C14, A15 | B14, C14, A15 |

Table 2. MCF523x Signal Information and Muxing (continued)

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|-----------------------------|-------------|------------------------|-------------|-------------------|--------------------------------|---|---|---|---|
| A[20:0] | — | — | — | O | 123:115, 112:106, 102:98 | A12, B12, C12, A13, B13, B14, C13, C14, D12, D13, D14, E11, E12, E13, E14, F12, F13, F14, G11, G12, G13 | B15, B16, C15, C16, D16, D15, D14, E16, E15, E14, E13, F15, F14, F13, G15, G14, G13, H16, H15, H14, H13 | B15, B16, C15, C16, D16, D15, D14, E16, E15, E14, E13, F15, F14, F13, G15, G14, G13, H16, H15, H14, H13 | B15, B16, C15, C16, D16, D15, D14, E16, E15, E14, E13, F15, F14, F13, G15, G14, G13, H16, H15, H14, H13 |
| D[31:16] | — | — | — | O | 21:24, 26:30, 33:39 | G1, G2, H1, H2, H3, H4, J1, J2, J3, J4, K1, K2, K3, K4, L1, L2 | K4, K3, K2, K1, L4, L3, L2, L1, M3, M2, M1, N2, N1, P2, P1, R1 | K4, K3, K2, K1, L4, L3, L2, L1, M3, M2, M1, N2, N1, P2, P1, R1 | K4, K3, K2, K1, L4, L3, L2, L1, M3, M2, M1, N2, N1, P2, P1, R1 |
| D[15:8] | PDATAH[7:0] | — | — | O | 42:49, | M1, N1, M2, N2, P2, L3, M3, N3, | R2, T2, N3, P3, R3, T3, N4, P4, | R2, T2, N3, P3, R3, T3, N4, P4, | R2, T2, N3, P3, R3, T3, N4, P4, |
| D[7:0] | PDATAL[7:0] | — | — | O | 50:52, 56:60 | P3, M4, N4, P4, L5, M5, N5, P5 | R4, T4, P5, R5, N6, P6, R6, N7 | R4, T4, P5, R5, N6, P6, R6, N7 | R4, T4, P5, R5, N6, P6, R6, N7 |
| \overline{BS} [3:0] | PBS[7:4] | \overline{CAS} [3:0] | — | O | 143:140 | B6, C6, D7, C7 | C9, B9, A9, A10 | C9, B9, A9, A10 | C9, B9, A9, A10 |
| \overline{OE} | PBUSCTL7 | — | — | O | 63 | N6 | T7 | T7 | T7 |
| \overline{TA} | PBUSCTL6 | — | — | I | 97 | H11 | K14 | K14 | K14 |
| \overline{TEA} | PBUSCTL5 | $\overline{DREQ1}$ | — | I | — | J14 | K13 | K13 | K13 |
| $\overline{R/\overline{W}}$ | PBUSCTL4 | — | — | O | 96 | J13 | L16 | L16 | L16 |
| $\overline{TSIZ1}$ | PBUSCTL3 | DACK1 | — | O | — | P6 | N8 | N8 | N8 |
| $\overline{TSIZ0}$ | PBUSCTL2 | DACK0 | — | O | — | P7 | P8 | P8 | P8 |
| \overline{TS} | PBUSCTL1 | DACK2 | — | O | — | H13 | K16 | K16 | K16 |
| \overline{TIP} | PBUSCTL0 | $\overline{DREQ0}$ | — | O | — | H12 | K15 | K15 | K15 |
| Chip Selects | | | | | | | | | |
| \overline{CS} [7:4] | PCS[7:4] | — | — | O | — | B9, A10, C10, A11 | C12, A13, C13, A14 | C12, A13, C13, A14 | C12, A13, C13, A14 |
| \overline{CS} [3:2] | PCS[3:2] | SD_CS[1:0] | — | O | 134,133 | A9, C9 | B12, D12 | B12, D12 | B12, D12 |
| $\overline{CS1}$ | PCS1 | — | — | O | 130 | B10 | B13 | B13 | B13 |
| $\overline{CS0}$ | — | — | — | O | 129 | D10 | D13 | D13 | D13 |
| SDRAM Controller | | | | | | | | | |

Table 2. MCF523x Signal Information and Muxing (continued)

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|---------------------------------|-------------|---------------------------|-------------|-------------------|---------------------------------------|--|---|---|---|
| $\overline{\text{SD_WE}}$ | PSDRAM5 | — | — | O | 93 | K13 | L13 | L13 | L13 |
| $\overline{\text{SD_SCAS}}$ | PSDRAM4 | — | — | O | 92 | K12 | M15 | M15 | M15 |
| $\overline{\text{SD_SRAS}}$ | PSDRAM3 | — | — | O | 91 | K11 | M14 | M14 | M14 |
| $\overline{\text{SD_CKE}}$ | PSDRAM2 | — | — | O | — | E8 | C10 | C10 | C10 |
| $\overline{\text{SD_CS}}[1:0]$ | PSDRAM[1:0] | — | — | O | — | L12, L13 | N15, M13 | N15, M13 | N15, M13 |
| External Interrupts Port | | | | | | | | | |
| $\overline{\text{IRQ}}[7:3]$ | PIRQ[7:3] | — | — | I | IRQ7=64 IRQ4=65 | N7, M7, L7, P8, N8 | R8, T8, N9, P9, R9 | R8, T8, N9, P9, R9 | R8, T8, N9, P9, R9 |
| $\overline{\text{IRQ2}}$ | PIRQ2 | $\overline{\text{DREQ2}}$ | — | I | — | M8 | T9 | T9 | T9 |
| $\overline{\text{IRQ1}}$ | PIRQ1 | — | — | I | 66 | L8 | N10 | N10 | N10 |
| eTPU | | | | | | | | | |
| TPUCH31 | — | ECOL | — | | — | — | F3 | — | F3 |
| TPUCH30 | — | ECRS | — | | — | — | F4 | — | F4 |
| TPUCH29 | — | ERXCLK | — | | — | — | E3 | — | E3 |
| TPUCH28 | — | ERXDV | — | | — | — | E4 | — | E4 |
| TPUCH[27:24] | — | ERXD[3:0] | — | | — | — | D3, D4, C3, C4 | — | D3, D4, C3, C4 |
| TPUCH23 | — | ERXER | — | | — | — | D5 | — | D5 |
| TPUCH22 | — | ETXCLK | — | | — | — | C5 | — | C5 |
| TPUCH21 | — | ETXEN | — | | — | — | D6 | — | D6 |
| TPUCH20 | — | ETXER | — | | — | — | C6 | — | C6 |
| TPUCH[19:16] | — | ETXD[3:0] | — | | — | — | B6, B5, A5, B7 | — | B6, B5, A5, B7 |
| TPUCH[15:0] | — | — | — | | 11, 10, 7, 2, 159:154, 152, 151 | E2, E1, D1 D2, D3, C1, C2, B1, B2, A2, C3, B3, A3, A4, C4, BR | F2, E1, E2, D1, D2, C1, C2, B1, B2, A2, B3, A3, B4, A4, A6, A7 | F2, E1, E2, D1, D2, C1, C2, B1, B2, A2, B3, A3, B4, A4, A6, A7 | F2, E1, E2, D1, D2, C1, C2, B1, B2, A2, B3, A3, B4, A4, A6, A7 |
| TCRCLK | PETPU2 | — | — | | 12 | E3 | F1 | F1 | F1 |
| UTPUODIS | PETPU1 | — | — | | — | H10 | J13 | J13 | J13 |
| LTPUODIS | PETPU0 | — | — | | — | G10 | J14 | J14 | J14 |
| FEC | | | | | | | | | |
| EMDIO | PFECI2C2 | I2C_SDA | U2RXD | I/O | — | — | — | C7 | C7 |
| EMDC | PFECI2C3 | I2C_SCL | U2TXD | O | — | — | — | D7 | D7 |
| ECOL | — | — | — | I | — | — | — | F3 | F3 |

Table 2. MCF523x Signal Information and Muxing (continued)

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|---|----------|---------------------------|-------------|-------------------|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| ECRS | — | — | — | I | — | — | — | F4 | F4 |
| ERXCLK | — | — | — | I | — | — | — | E3 | E3 |
| ERXDV | — | — | — | I | — | — | — | E4 | E4 |
| ERXD[3:0] | — | — | — | I | — | — | — | D3, D4, C3, C4 | D3, D4, C3, C4 |
| ERXER | — | — | — | I | — | — | — | D5 | D5 |
| ETXCLK | — | — | — | I | — | — | — | C5 | C5 |
| ETXEN | — | — | — | O | — | — | — | D6 | D6 |
| ETXER | — | — | — | O | — | — | — | C6 | C6 |
| ETXD[3:0] | — | — | — | O | — | — | — | B6, B5, A5, B7 | B6, B5, A5, B7 |
| Feature Control | | | | | | | | | |
| eTPU/ $\overline{\text{EthENB}}$ | — | — | — | I | — | — | — | — | M4 |
| I²C | | | | | | | | | |
| I2C_SDA | PFECI2C1 | CAN0RX | — | I/O | — | J12 | L15 | L15 | L15 |
| I2C_SCL | PFECI2C0 | CAN0TX | — | I/O | — | J11 | L14 | L14 | L14 |
| DMA | | | | | | | | | |
| DACK[2:0] and $\overline{\text{DREQ}}[2:0]$ do not have a dedicated bond pads. Please refer to the following pins for muxing: $\overline{\text{TS}}$ and DT2OUT for DACK2, TSIZ1 and DT1OUT for DACK1, TSIZ0 and DT0OUT for DACK0, $\overline{\text{IRQ2}}$ and DT2IN for $\overline{\text{DREQ2}}$, $\overline{\text{TEA}}$ and DT1IN for $\overline{\text{DREQ1}}$, and $\overline{\text{TIP}}$ and DT0IN for $\overline{\text{DREQ0}}$. | | | | | — | — | — | — | — |
| QSPI | | | | | | | | | |
| QSPI_CS1 | PQSPI4 | SD_CKE | — | O | 139 | B7 | B10 | B10 | B10 |
| QSPI_CS0 | PQSPI3 | — | — | O | 147 | A6 | D9 | D9 | D9 |
| QSPI_CLK | PQSPI2 | I2C_SCL | — | O | 148 | C5 | B8 | B8 | B8 |
| QSPI_DIN | PQSPI1 | I2C_SDA | — | I | 149 | B5 | C8 | C8 | C8 |
| QSPI_DOUT | PQSPI0 | — | — | O | 150 | A5 | D8 | D8 | D8 |
| UARTs | | | | | | | | | |
| U2TXD | PUARTH1 | CAN1TX | — | O | — | A8 | D11 | D11 | D11 |
| U2RXD | PUARTH0 | CAN1RX | — | I | — | A7 | D10 | D10 | D10 |
| $\overline{\text{U1CTS}}$ | PUARTL7 | $\overline{\text{U2CTS}}$ | — | I | — | B8 | C11 | C11 | C11 |
| $\overline{\text{U1RTS}}$ | PUARTL6 | $\overline{\text{U2RTS}}$ | — | O | — | C8 | B11 | B11 | B11 |
| U1TXD | PUARTL5 | CAN0TX | — | O | 135 | D9 | A12 | A12 | A12 |

Table 2. MCF523x Signal Information and Muxing (continued)

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|-----------------------------|---------|--------------------|-------------|-------------------|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| U1RXD | PUARTL4 | CAN0RX | — | I | 136 | D8 | A11 | A11 | A11 |
| $\overline{U0CTS}$ | PUARTL3 | — | — | I | — | F3 | G1 | G1 | G1 |
| $\overline{U0RTS}$ | PUARTL2 | — | — | O | — | G3 | H3 | H3 | H3 |
| U0TXD | PUARTL1 | — | — | O | 14 | F1 | H2 | H2 | H2 |
| U0RXD | PUARTL0 | — | — | I | 13 | F2 | G2 | G2 | G2 |
| DMA Timers | | | | | | | | | |
| DT3IN | PTIMER7 | $\overline{U2CTS}$ | QSPI_CS2 | I | — | H14 | J15 | J15 | J15 |
| DT3OUT | PTIMER6 | $\overline{U2RTS}$ | QSPI_CS3 | O | — | G14 | J16 | J16 | J16 |
| DT2IN | PTIMER5 | $\overline{DREQ2}$ | DT2OUT | I | — | M9 | P10 | P10 | P10 |
| DT2OUT | PTIMER4 | DACK2 | — | O | — | L9 | R10 | R10 | R10 |
| DT1IN | PTIMER3 | $\overline{DREQ1}$ | DT1OUT | I | — | L6 | P7 | P7 | P7 |
| DT1OUT | PTIMER2 | DACK1 | — | O | — | M6 | R7 | R7 | R7 |
| DT0IN | PTIMER1 | $\overline{DREQ0}$ | — | I | — | E4 | G4 | G4 | G4 |
| DT0OUT | PTIMER0 | DACK0 | — | O | — | F4 | G3 | G3 | G3 |
| BDM/JTAG² | | | | | | | | | |
| DSCLK | — | TRST | — | I | 70 | N9 | N11 | N11 | N11 |
| PSTCLK | — | TCLK | — | O | 68 | P9 | T10 | T10 | T10 |
| \overline{BKPT} | — | TMS | — | I | 71 | P10 | P11 | P11 | P11 |
| DSI | — | TDI | — | I | 73 | M10 | T11 | T11 | T11 |
| DSO | — | TDO | — | O | 72 | N10 | R11 | R11 | R11 |
| JTAG_EN | — | — | — | I | 78 | K9 | N13 | N13 | N13 |
| DDATA[3:0] | — | — | — | O | — | M12, N12, P12, L11 | N14, P14, T13, R13 | N14, P14, T13, R13 | N14, P14, T13, R13 |
| PST[3:0] | — | — | — | O | 77:74 | M11, N11, P11, L10 | T12, R12, P12, N12 | T12, R12, P12, N12 | T12, R12, P12, N12 |

Table 2. MCF523x Signal Information and Muxing (continued)

| Signal Name | GPIO | Alternate 1 | Alternate 2 | Dir. ¹ | MCF5232 160 QFP | MCF5232 196 MAPBGA | MCF5233 256 MAPBGA | MCF5234 256 MAPBGA | MCF5235 256 MAPBGA |
|-----------------------|------|-------------|-------------|-------------------|---|--|--|--------------------------|--------------------------|
| Test | | | | | | | | | |
| TEST | — | — | — | I | 18 | F5 | J4 | J4 | J4 |
| PLL_TEST | — | — | — | I | — | | R14 | R14 | R14 |
| Power Supplies | | | | | | | | | |
| VDDPLL | — | — | — | I | 87 | M13 | P15 | | |
| VSSPLL | — | — | — | I | 84 | L14 | R15 | | |
| OVDD | — | — | — | I | 1, 9, 17, 32, 41, 55, 62, 69, 81, 90, 95, 105, 114, 128, 132, 138, 146 | E5, E7, E10, F7, F9, G6, G8, H7, H8, H9, J6, J8, J10, K5, K6, K8 | E6:11, F5, F7:10, F12, G5, G6, G11, G12, H5, H6, H11, H12, J5, J6, J11, J12, K5, K6, K11, K12, L5, L7:10, L12, M6:M11 | | |
| VSS | — | — | — | I | 8, 16, 25, 31, 40, 54, 61, 67, 80, 88, 94, 104, 113, 127, 131, 137, 145, 153, 160 | A1, A14, E6, E9, F6, F8, F10, G7, G9, H6, J5, J7, J9, K7, P1, P14 | A1, A16, E5, E12, F6, F11, F16, G7:10, H7: 10, J1, J7:10, K7:10, L6, L11, M5, M12, N16, T1, T6, T16 | | |
| VDD | — | — | — | I | 15, 53, 103, 144 | D6, F11, G4, L4 | A8, G16, H1, T5 | | |

¹ Refers to pin's primary function. All pins which are configurable for GPIO have a pullup enabled in GPIO mode with the exception of PBUSCTL[7], PBUSCTL[4:0], PADDR, PBS, PSDRAM.

² If JTAG_EN is asserted, these pins default to Alternate 1 (JTAG) functionality. The GPIO module is not responsible for assigning these pins.

5 Design Recommendations

5.1 Layout

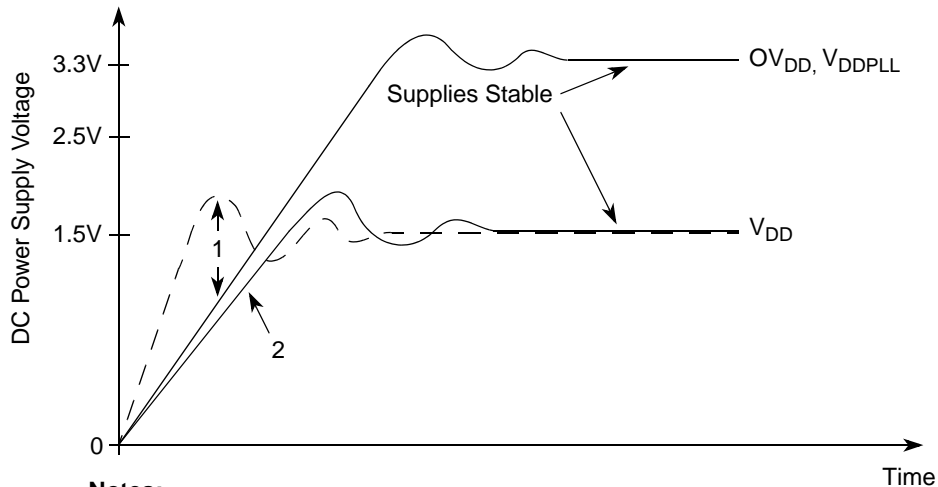
- Use a 4-layer printed circuit board with the VDD and GND pins connected directly to the power and ground planes for the MCF523x.
- See application note AN1259, *System Design and Layout Techniques for Noise Reduction in Processor-Based Systems*.
- Match the PC layout trace width and routing to match trace length to operating frequency and board impedance. Add termination (series or therein) to the traces to dampen reflections. Increase the PCB impedance (if possible) keeping the trace lengths balanced and short. Then do cross-talk analysis to separate traces with significant parallelism or are otherwise "noisy". Use 6 mils trace and separation. Clocks get extra separation and more precise balancing.

5.2 Power Supply

- 33 μF , 0.1 μF , and 0.01 μF across each power supply

5.2.1 Supply Voltage Sequencing and Separation Cautions

Figure 1 shows situations in sequencing the I/O V_{DD} (OV_{DD}), PLL V_{DD} (V_{DDPLL}), and Core V_{DD} (V_{DD}). OV_{DD} is specified relative to V_{DD} .



Notes:

1. V_{DD} should not exceed OV_{DD} or V_{DDPLL} by more than 0.4 V at any time, including power-up.
2. Recommended that V_{DD} should track $\text{OV}_{\text{DD}}/V_{\text{DDPLL}}$ up to 0.9 V, then separate for completion of ramps.
3. Input voltage must not be greater than the supply voltage (OV_{DD} , V_{DD} , or V_{DDPLL}) by more than 0.5 V at any time, including during power-up.
4. Use 1 ms or slower rise time for all supplies.

Figure 1. Supply Voltage Sequencing and Separation Cautions

5.2.1.1 Power Up Sequence

If OV_{DD} is powered up with V_{DD} at 0 V, then the sense circuits in the I/O pads cause all pad output drivers connected to the OV_{DD} to be in a high impedance state. There is no limit on how long after OV_{DD} powers up before V_{DD} must power up. V_{DD} should not lead the OV_{DD} or V_{DDPLL} by more than 0.4 V during power ramp-up, or there will be high current in the internal ESD protection diodes. The rise times on the power supplies should be slower than 1 μs to avoid turning on the internal ESD protection clamp diodes.

The recommended power up sequence is as follows:

1. Use 1 ms or slower rise time for all supplies.
2. V_{DD} and $\text{OV}_{\text{DD}}/V_{\text{DDPLL}}$ should track up to 0.9 V, then separate for the completion of ramps with OV_{DD} going to the higher external voltages. One way to accomplish this is to use a low drop-out voltage regulator.

5.2.1.2 Power Down Sequence

If V_{DD} is powered down first, then sense circuits in the I/O pads cause all output drivers to be in a high impedance state. There is no limit on how long after V_{DD} powers down before OV_{DD}/V_{DDPLL} must power down. V_{DD} should not lag OV_{DD} or V_{DDPLL} going low by more than 0.4 V during power down or there will be undesired high current in the ESD protection diodes. There are no requirements for the fall times of the power supplies.

The recommended power down sequence is as follows:

1. Drop V_{DD} to 0 V.
2. Drop OV_{DD}/V_{DDPLL} supplies.

5.3 Decoupling

- Place the decoupling caps as close to the pins as possible, but they can be outside the footprint of the package.
- 0.1 μ F and 0.01 μ F at each supply input

5.4 Buffering

- Use bus buffers on all data/address lines for all off-board accesses and for all on-board accesses when excessive loading is expected. See [Section 7, “Electrical Characteristics.”](#)

5.5 Pull-up Recommendations

- Use external pull-up resistors on unused inputs. See pin table.

5.6 Clocking Recommendations

- Use a multi-layer board with a separate ground plane.
- Place the crystal and all other associated components as close to the EXTAL and XTAL (oscillator pins) as possible.
- Do not run a high frequency trace around crystal circuit.
- Ensure that the ground for the bypass capacitors is connected to a solid ground trace.
- Tie the ground trace to the ground pin nearest EXTAL and XTAL. This prevents large loop currents in the vicinity of the crystal.
- Tie the ground pin to the most solid ground in the system.
- Do not connect the trace that connects the oscillator and the ground plane to any other circuit element. This tends to make the oscillator unstable.
- Tie XTAL to ground when an external oscillator is clocking the device.

5.7 Interface Recommendations

5.7.1 SDRAM Controller

5.7.1.1 SDRAM Controller Signals in Synchronous Mode

Table 3 shows the behavior of SDRAM signals in synchronous mode.

Table 3. Synchronous DRAM Signal Connections

| Signal | Description |
|---------------------------------|--|
| $\overline{\text{SD_SRAS}}$ | Synchronous row address strobe. Indicates a valid SDRAM row address is present and can be latched by the SDRAM. $\overline{\text{SD_SRAS}}$ should be connected to the corresponding SDRAM $\overline{\text{SD_SRAS}}$. Do not confuse $\overline{\text{SD_SRAS}}$ with the DRAM controller's $\overline{\text{SD_CS}}[1:0]$, which should not be interfaced to the SDRAM $\overline{\text{SD_SRAS}}$ signals. |
| $\overline{\text{SD_SCAS}}$ | Synchronous column address strobe. Indicates a valid column address is present and can be latched by the SDRAM. $\overline{\text{SD_SCAS}}$ should be connected to the corresponding signal labeled $\overline{\text{SD_SCAS}}$ on the SDRAM. |
| $\overline{\text{DRAMW}}$ | DRAM read/write. Asserted for write operations and negated for read operations. |
| $\overline{\text{SD_CS}}[1:0]$ | Row address strobe. Select each memory block of SDRAMs connected to the MCF523x. One $\overline{\text{SD_CS}}$ signal selects one SDRAM block and connects to the corresponding $\overline{\text{CS}}$ signals. |
| $\overline{\text{SD_CKE}}$ | Synchronous DRAM clock enable. Connected directly to the CKE (clock enable) signal of SDRAMs. Enables and disables the clock internal to SDRAM. When CKE is low, memory can enter a power-down mode where operations are suspended or they can enter self-refresh mode. $\overline{\text{SD_CKE}}$ functionality is controlled by DCR[COC]. For designs using external multiplexing, setting COC allows $\overline{\text{SD_CKE}}$ to provide command-bit functionality. |
| $\overline{\text{BS}}[3:0]$ | Column address strobe. For synchronous operation, $\overline{\text{BS}}[3:0]$ function as byte enables to the SDRAMs. They connect to the DQM signals (or mask qualifiers) of the SDRAMs. |
| CLKOUT | Bus clock output. Connects to the CLK input of SDRAMs. |

5.7.1.2 Address Multiplexing

See the SDRAM controller module chapter in the *MCF5235 Reference Manual* for details on address multiplexing.

5.7.2 Ethernet PHY Transceiver Connection

The FEC supports both an MII interface for 10/100 Mbps Ethernet and a seven-wire serial interface for 10 Mbps Ethernet. The interface mode is selected by R_CNTRL[MII_MODE]. In MII mode, the 802.3 standard defines and the FEC module supports 18 signals. These are shown in Table 4.

Table 4. MII Mode

| Signal Description | MCF523x Pin |
|--------------------|-------------|
| Transmit clock | ETXCLK |
| Transmit enable | ETXEN |
| Transmit data | ETXD[3:0] |

Table 4. MII Mode (continued)

| Signal Description | MCF523x Pin |
|--------------------------------|-------------|
| Transmit error | ETXER |
| Collision | ECOL |
| Carrier sense | ECRS |
| Receive clock | ERXCLK |
| Receive enable | ERXDV |
| Receive data | ERXD[3:0] |
| Receive error | ERXER |
| Management channel clock | EMDC |
| Management channel serial data | EMDIO |

The serial mode interface operates in what is generally referred to as AMD mode. The MCF523x configuration for seven-wire serial mode connections to the external transceiver are shown in [Table 5](#).

Table 5. Seven-Wire Mode Configuration

| Signal Description | MCF523x Pin |
|--------------------------------------|-------------|
| Transmit clock | ETXCLK |
| Transmit enable | ETXEN |
| Transmit data | ETXD[0] |
| Collision | ECOL |
| Receive clock | ERXCLK |
| Receive enable | ERXDV |
| Receive data | ERXD[0] |
| Unused, configure as PB14 | ERXER |
| Unused input, tie to ground | ECRS |
| Unused, configure as PB[13:11] | ERXD[3:1] |
| Unused output, ignore | ETXER |
| Unused, configure as PB[10:8] | ETXD[3:1] |
| Unused, configure as PB15 | EMDC |
| Input after reset, connect to ground | EMDIO |

Refer to the M523xEVB evaluation board user's manual for an example of how to connect an external PHY. Schematics for this board are accessible at the MCF5235 site by navigating to: <http://www.freescale.com/coldfire>.

5.7.3 FlexCAN

The FlexCAN module interface to the CAN bus is composed of 2 pins: CANTX and CANRX, which are the serial transmitted data and the serial received data. The use of an external CAN transceiver to interface to the CAN bus is generally required. The transceiver is capable of driving the large current needed for the CAN bus and has current protection, against a defective CAN bus or defective stations.

5.7.4 BDM

Use the BDM interface as shown in the M523xEVB evaluation board user's manual. The schematics for this board are accessible at the Freescale website at: <http://www.freescale.com/coldfire>.

6 Mechanicals/Pinouts and Part Numbers

This section contains drawings showing the pinout and the packaging and mechanical characteristics of the MCF523x devices. See [Table 2](#) for a list the signal names and pin locations for each device.

6.1 Pinout—196 MAPBGA

The following figure shows a pinout of the MCF5232CVMxxx package.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
|---|---------|---------|---------------------------|--------|-----------|--------------------------|---------------------------|---------------------------|--------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------|---|
| A | VSS | TPUCH6 | TPUCH3 | TPUCH2 | OSPI_DOUT | QSPI_CS0 | U2RXD | U2TXD | $\overline{\text{CS}}_3$ | $\overline{\text{CS}}_6$ | $\overline{\text{CS}}_4$ | A20 | A17 | VSS | A |
| B | TPUCH8 | TPUCH7 | TPUCH4 | TPUCH0 | OSPI_DIN | $\overline{\text{BS}}_3$ | QSPI_CS1 | $\overline{\text{U1CTS}}$ | $\overline{\text{CS}}_7$ | $\overline{\text{CS}}_1$ | A23 | A19 | A16 | A15 | B |
| C | TPUCH10 | TPUCH9 | TPUCH5 | TPUCH1 | OSPI_CLK | $\overline{\text{BS}}_2$ | $\overline{\text{BS}}_0$ | $\overline{\text{U1RTS}}$ | $\overline{\text{CS}}_2$ | $\overline{\text{CS}}_5$ | A22 | A18 | A14 | A13 | C |
| D | TPUCH13 | TPUCH12 | TPUCH11 | NC | NC | VDD | $\overline{\text{BS}}_1$ | U1RXD/ CAN0RX | U1TXD/ CAN0TX | $\overline{\text{CS}}_0$ | A21 | A12 | A11 | A10 | D |
| E | TPUCH14 | TPUCH15 | TCRCLK | DT0IN | OVDD | VSS | OVDD | SD_CKE | VSS | OVDD | A9 | A8 | A7 | A6 | E |
| F | U0TXD | U0RXD | $\overline{\text{U0CTS}}$ | DT0OUT | TEST | VSS | OVDD | VSS | OVDD | VSS | VDD | A5 | A4 | A3 | F |
| G | D31 | D30 | $\overline{\text{U0RTS}}$ | VDD | CLKMOD1 | OVDD | VSS | OVDD | VSS | LTPU ODIS | A2 | A1 | A0 | DT3OUT | G |
| H | D29 | D28 | D27 | D26 | CLKMOD0 | VSS | OVDD | OVDD | OVDD | UTPU ODIS | $\overline{\text{TA}}$ | $\overline{\text{TP}}$ | $\overline{\text{TS}}$ | DT3IN | H |
| J | D25 | D24 | D23 | D22 | VSS | OVDD | VSS | OVDD | VSS | OVDD | I2C_SCL | I2C_SDA | $\overline{\text{RW}}$ | $\overline{\text{TEA}}$ | J |
| K | D21 | D20 | D19 | D18 | OVDD | OVDD | VSS | OVDD | JTAG_EN | $\overline{\text{RCON}}$ | $\overline{\text{SD_SRAS}}$ | $\overline{\text{SD_SCAS}}$ | $\overline{\text{SD_WE}}$ | CLKOUT | K |
| L | D17 | D16 | D10 | VDD | D3 | DT1IN | $\overline{\text{IRO}}_5$ | $\overline{\text{IRO}}_1$ | DT2OUT | PST0 | DDATA0 | $\overline{\text{SD_CS}}_1$ | $\overline{\text{SD_CS}}_0$ | VSSPLL | L |
| M | D15 | D13 | D9 | D6 | D2 | DT1OUT | $\overline{\text{IRO}}_6$ | $\overline{\text{IRO}}_2$ | DT2IN | TDI/DSI | PST3 | DDATA3 | VDDPLL | EXTAL | M |
| N | D14 | D12 | D8 | D5 | D1 | $\overline{\text{OE}}$ | $\overline{\text{IRO}}_7$ | $\overline{\text{IRO}}_3$ | $\overline{\text{TRST}}/DSCLK$ | TDO/DSO | PST2 | DDATA2 | $\overline{\text{RESET}}$ | XTAL | N |
| P | VSS | D11 | D7 | D4 | D0 | TSIZ1 | TSIZ0 | $\overline{\text{IRO}}_4$ | TCLK/ PSTCLK | $\overline{\text{TMS}}/BKPT$ | PST1 | DDATA1 | $\overline{\text{RSTOUT}}$ | VSS | P |

Figure 2. MCF5232CVMxxx Pinout (196 MAPBGA)

6.2 Package Dimensions—196 MAPBGA

Figure 3 shows MCF5232CVMxxx package dimensions.

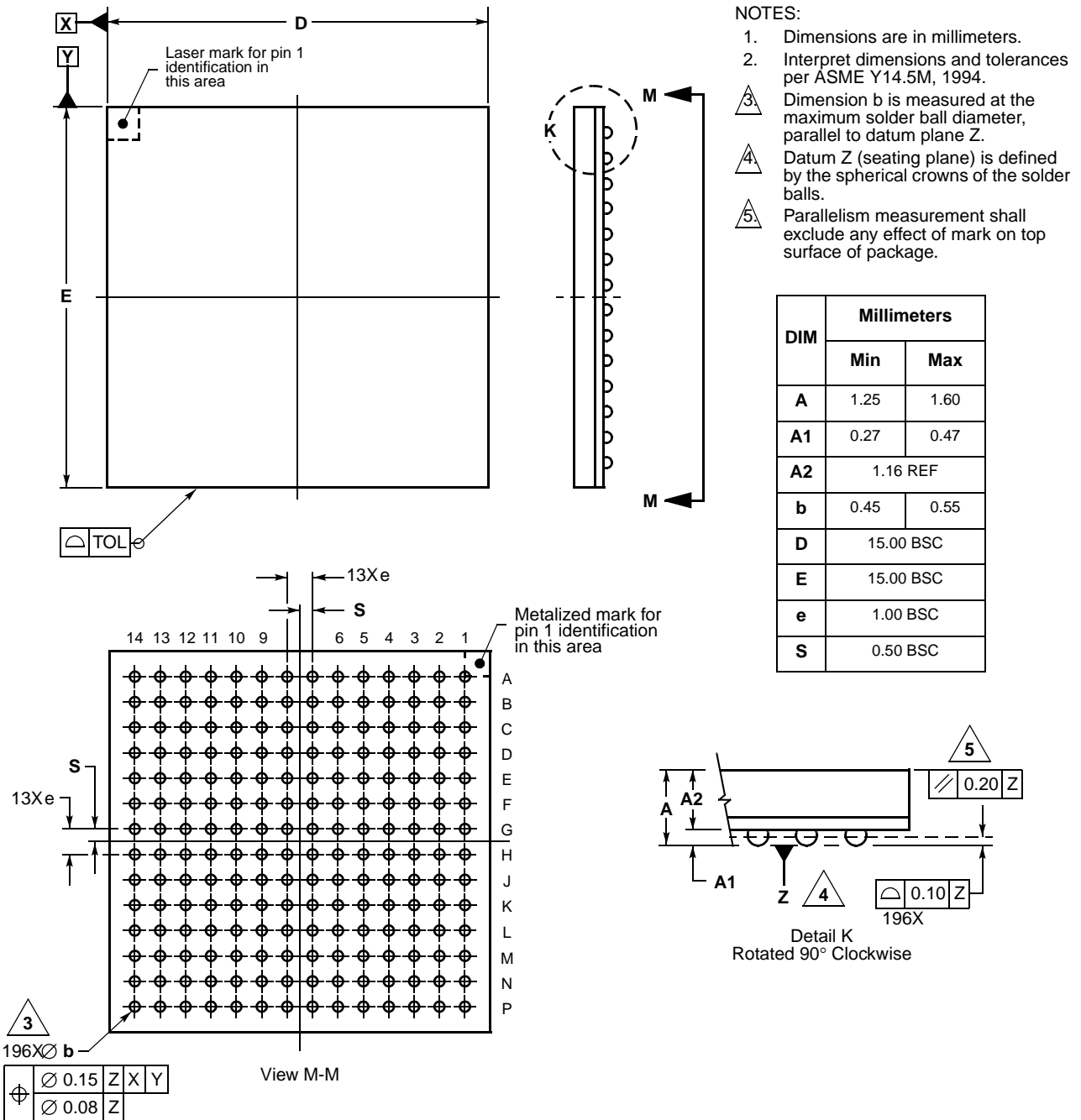


Figure 3. 196 MAPBGA Package Dimensions (Case No. 1128A-01)

6.2.1 Pinout—256 MAPBGA

Figure 4 through Figure 6 show pinouts of the MCF5233CVMxxx, MCF5234CVMxxx, and MCF5235CVMxxx packages.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
|---|--------------------|-------------|--------------------|---------|---------|---------|-------------------|-------------------|-------------------|-------------------|-----------------------------|------------------|----------------------|-----------------------|-----------------------|----------------------------|---|
| A | VSS | TPUCH6 | TPUCH4 | TPUCH2 | TPUCH17 | TPUCH1 | TPUCH0 | VDD | $\overline{BS1}$ | $\overline{BS0}$ | U1RXD/ CAN0RX | U1TXD/ CAN0TX | $\overline{CS6}$ | $\overline{CS4}$ | A21 | VSS | A |
| B | TPUCH8 | TPUCH7 | TPUCH5 | TPUCH3 | TPUCH18 | TPUCH19 | TPUCH16 | QSPL_ CLK | $\overline{BS2}$ | QSPL_ CS1 | $\overline{U1RTS}$ | $\overline{CS3}$ | $\overline{CS1}$ | A23 | A20 | A19 | B |
| C | TPUCH10 | TPUCH9 | TPUCH25 | TPUCH24 | TPUCH22 | TPUCH20 | I2C_SDA/ U2RXD | QSPL_ DIN | $\overline{BS3}$ | SD_CKE | $\overline{U1CTS}$ | $\overline{CS7}$ | $\overline{CS5}$ | A22 | A18 | A17 | C |
| D | TPUCH12 | TPUCH11 | TPUCH27 | TPUCH26 | TPUCH23 | TPUCH21 | I2C_SCL/ U2TXD | QSPL_ DOUT | QSPL_ CS0 | U2RXD/ CAN1RX | U2TXD/ CAN1TX | $\overline{CS2}$ | $\overline{CS0}$ | A14 | A15 | A16 | D |
| E | TPUCH14 | TPUCH13 | TPUCH29 | TPUCH28 | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | A10 | A11 | A12 | A13 | E |
| F | TCRCLK | TPUCH15 | TPUCH31 | TPUCH30 | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | A7 | A8 | A9 | VSS | F |
| G | $\overline{U0CTS}$ | U0RXD | DT0OUT | DT0IN | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A4 | A5 | A6 | VDD | G |
| H | VDD | U0TXD | $\overline{U0RTS}$ | NC | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A0 | A1 | A2 | A3 | H |
| J | VSS | CLK MOD0 | CLK MOD1 | TEST | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | UTPU ODIS | LTPU ODIS | DT3IN | DT3OUT | J |
| K | D28 | D29 | D30 | D31 | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | \overline{TEA} | \overline{TA} | \overline{TIP} | \overline{TS} | K |
| L | D24 | D25 | D26 | D27 | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | $\overline{SD_WE}$ | I2C_SCL/ CAN0TX | I2C_SDA/ CAN0RX | $\overline{R\overline{W}}$ | L |
| M | D21 | D22 | D23 | NC | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | $\overline{SD_CS0}$ | $\overline{SD_SRAS}$ | $\overline{SD_SCAS}$ | CLKOUT | M |
| N | D19 | D20 | D13 | D9 | NC | D3 | D0 | TSIZ1 | $\overline{IRQ5}$ | $\overline{IRQ1}$ | $\overline{TRST}/$ DSCLK | PST0 | JTAG_ EN | DDATA3 | $\overline{SD_CS1}$ | VSS | N |
| P | D17 | D18 | D12 | D8 | D5 | D2 | DT1IN | TSIZ0 | $\overline{IRO4}$ | DT2IN | $\overline{TMS}/$ BKPT | PST1 | \overline{RCON} | DDATA2 | VDDPLL | EXTAL | P |
| R | D16 | D15 | D11 | D7 | D4 | D1 | DT1OUT | $\overline{IRO7}$ | $\overline{IRO3}$ | DT2OUT | TDO/ DSO | PST2 | DDATA0 | PLL_ TEST | VSSPLL | XTAL | R |
| T | VSS | D14 | D10 | D6 | VDD | VSS | \overline{OE} | $\overline{IRO6}$ | $\overline{IRO2}$ | TCLK/ PSTCLK | TDI/DSI | PST3 | DDATA1 | \overline{RSTOUT} | \overline{RESET} | VSS | T |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |

Figure 4. MCF5233CVMxxx Pinout (256 MAPBGA)

Mechanicals/Pinouts and Part Numbers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
|---|--------------------|-------------|-------------|--------|--------|--------|-----------------|-------------------|-------------------|-------------------|-----------------------------|------------------|----------------------|-------------------------|-----------------------|------------------|---|
| A | VSS | TPUCH6 | TPUCH4 | TPUCH2 | ETXD1 | TPUCH1 | TPUCH0 | VDD | $\overline{BS1}$ | $\overline{BS0}$ | U1RXD/ CAN0RX | U1TXD/ CAN0TX | $\overline{CS6}$ | $\overline{CS4}$ | A21 | VSS | A |
| B | TPUCH8 | TPUCH7 | TPUCH5 | TPUCH3 | ETXD2 | ETXD3 | ETXD0 | QSPL_ CLK | $\overline{BS2}$ | QSPL_ CS1 | $\overline{U1RTS}$ | $\overline{CS3}$ | $\overline{CS1}$ | A23 | A20 | A19 | B |
| C | TPUCH10 | TPUCH9 | ERXD1 | ERXD0 | ETXCLK | ETXER | EMDIO | QSPL_ DIN | $\overline{BS3}$ | SD_CKE | $\overline{U1CTS}$ | $\overline{CS7}$ | $\overline{CS5}$ | A22 | A18 | A17 | C |
| D | TPUCH12 | TPUCH11 | ERXD3 | ERXD2 | ERXER | ETXEN | EMDC | QSPL_ DOUT | QSPL_ CS0 | U2RXD | U2TXD | $\overline{CS2}$ | $\overline{CS0}$ | A14 | A15 | A16 | D |
| E | TPUCH14 | TPUCH13 | ERXCLK | ERXDV | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | A10 | A11 | A12 | A13 | E |
| F | TCRCLK | TPUCH15 | ECOL | ECRS | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | A7 | A8 | A9 | VSS | F |
| G | $\overline{U0CTS}$ | U0RXD | DT0OUT | DT0IN | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A4 | A5 | A6 | VDD | G |
| H | VDD | U0TXD | U0RTS | NC | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A0 | A1 | A2 | A3 | H |
| J | VSS | CLK MOD0 | CLK MOD1 | TEST | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | UTPU ODIS | LTPU ODIS | DT3IN | DT3OUT | J |
| K | D28 | D29 | D30 | D31 | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | \overline{TEA} | \overline{TA} | \overline{TIP} | \overline{TS} | K |
| L | D24 | D25 | D26 | D27 | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | $\overline{SD_WE}$ | I2C_SCL/ CAN0TX | I2C_SDA/ CAN0RX | R \overline{W} | L |
| M | D21 | D22 | D23 | NC | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | $\overline{SD_CS0}$ | $\overline{SD_SRAS}$ | $\overline{SD_SCAS}$ | CLKOUT | M |
| N | D19 | D20 | D13 | D9 | NC | D3 | D0 | TSIZ1 | $\overline{IRQ5}$ | $\overline{IRQ1}$ | $\overline{TRST/}$ DSCLK | PST0 | JTAG_ EN | DDATA3 | $\overline{SD_CS1}$ | VSS | N |
| P | D17 | D18 | D12 | D8 | D5 | D2 | DT1IN | TSIZ0 | $\overline{IRQ4}$ | DT2IN | TMS/ BKPT | PST1 | \overline{RCON} | DDATA2 | VDDPLL | EXTAL | P |
| R | D16 | D15 | D11 | D7 | D4 | D1 | DT1OUT | $\overline{IRQ7}$ | $\overline{IRQ3}$ | DT2OUT | TDO/ DSO | PST2 | DDATA0 | PLL_ TEST | VSSPLL | XTAL | R |
| T | VSS | D14 | D10 | D6 | VDD | VSS | \overline{OE} | $\overline{IRQ6}$ | $\overline{IRQ2}$ | TCLK/ PSTCLK | TDI/DSI | PST3 | DDATA1 | \overline{RST} OUT | \overline{RESET} | VSS | T |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |

Figure 5. MCF5234CVMxxx Pinout (256 MAPBGA)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
|---|--------------------|-------------|--------------------|-------------------|--------------------|-------------------|-----------------------------|-------------------|-------------------|-------------------|-----------------------------|------------------|----------------------|-----------------------|-----------------------|------------------|---|
| A | VSS | TPUCH6 | TPUCH4 | TPUCH2 | TPUCH17/ ETXD1 | TPUCH1 | TPUCH0 | VDD | $\overline{BS1}$ | $\overline{BS0}$ | U1RXD/ CAN0RX | U1TXD/ CAN0TX | $\overline{CS6}$ | $\overline{CS4}$ | A21 | VSS | A |
| B | TPUCH8 | TPUCH7 | TPUCH5 | TPUCH3 | TPUCH18/ ETXD2 | TPUCH19/ ETXD3 | TPUCH16/ ETXD0 | QSPI_ CLK | $\overline{BS2}$ | QSPI_ CS1 | $\overline{U1RTS}$ | $\overline{CS3}$ | $\overline{CS1}$ | A23 | A20 | A19 | B |
| C | TPUCH10 | TPUCH9 | TPUCH25/ ERXD1 | TPUCH24/ ERXD0 | TPUCH22/ ETXCLK | TPUCH20/ ETXER | I2C_SDA/ U2RXD/ EMDIO | QSPI_ DIN | $\overline{BS3}$ | SD_CKE | $\overline{U1CTS}$ | $\overline{CS7}$ | $\overline{CS5}$ | A22 | A18 | A17 | C |
| D | TPUCH12 | TPUCH11 | TPUCH27/ ERXD3 | TPUCH26/ ERXD2 | TPUCH23/ ETXER | TPUCH21/ ETXEN | I2C_SCL/ U2TXD/ EMDC | QSPI_ DOUT | QSPI_ CS0 | U2RXD/ CAN1RX | U2TXD/ CAN1TX | $\overline{CS2}$ | $\overline{CS0}$ | A14 | A15 | A16 | D |
| E | TPUCH14 | TPUCH13 | TPUCH29/ ERXCLK | TPUCH2/ ERXDV | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | A10 | A11 | A12 | A13 | E |
| F | TCRCLK | TPUCH15 | TPUCH31/ ECOL | TPUCH30/ ECSR | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | A7 | A8 | A9 | VSS | F |
| G | $\overline{U0CTS}$ | U0RXD | DT0OUT | DT0IN | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A4 | A5 | A6 | VDD | G |
| H | VDD | U0TXD | $\overline{U0RTS}$ | NC | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | A0 | A1 | A2 | A3 | H |
| J | VSS | CLK MOD0 | CLK MOD1 | TEST | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | UTPU ODIS | LTPU ODIS | DT3IN | DT3OUT | J |
| K | D28 | D29 | D30 | D31 | OVDD | OVDD | VSS | VSS | VSS | VSS | OVDD | OVDD | \overline{TEA} | \overline{TA} | \overline{TIP} | \overline{TS} | K |
| L | D24 | D25 | D26 | D27 | OVDD | VSS | OVDD | OVDD | OVDD | OVDD | VSS | OVDD | $\overline{SD_WE}$ | I2C_SCL/ CAN0TX | I2C_SDA/ CAN0RX | $\overline{R/W}$ | L |
| M | D21 | D22 | D23 | eTPU/ EthENB | VSS | OVDD | OVDD | OVDD | OVDD | OVDD | OVDD | VSS | $\overline{SD_CS0}$ | $\overline{SD_SRAS}$ | $\overline{SD_SCAS}$ | CLKOUT | M |
| N | D19 | D20 | D13 | D9 | NC | D3 | D0 | TSIZ1 | $\overline{IRQ5}$ | $\overline{IRQ1}$ | $\overline{TRST}/$ DSCLK | PST0 | JTAG_ EN | DDATA3 | $\overline{SD_CS1}$ | VSS | N |
| P | D17 | D18 | D12 | D8 | D5 | D2 | DT1IN | TSIZ0 | $\overline{IRQ4}$ | DT2IN | $\overline{TMS}/$ BKPT | PST1 | \overline{RCON} | DDATA2 | VDDPLL | EXTAL | P |
| R | D16 | D15 | D11 | D7 | D4 | D1 | DT1OUT | $\overline{IRQ7}$ | $\overline{IRQ3}$ | DT2OUT | TDO/ DSO | PST2 | DDATA0 | PLL_ TEST | VSSPLL | XTAL | R |
| T | VSS | D14 | D10 | D6 | VDD | VSS | \overline{OE} | $\overline{IRQ6}$ | $\overline{IRQ2}$ | TCLK/ PSTCLK | TDI/DSI | PST3 | DDATA1 | \overline{RSTOUT} | \overline{RESET} | VSS | T |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |

Figure 6. MCF5235CVMxxx Pinout (256 MAPBGA)

6.2.2 Package Dimensions—256 MAPBGA

Figure 7 shows MCF5235CVMxxx, MCF5234CVMxxx, and MCF5233CVMxx package dimensions.

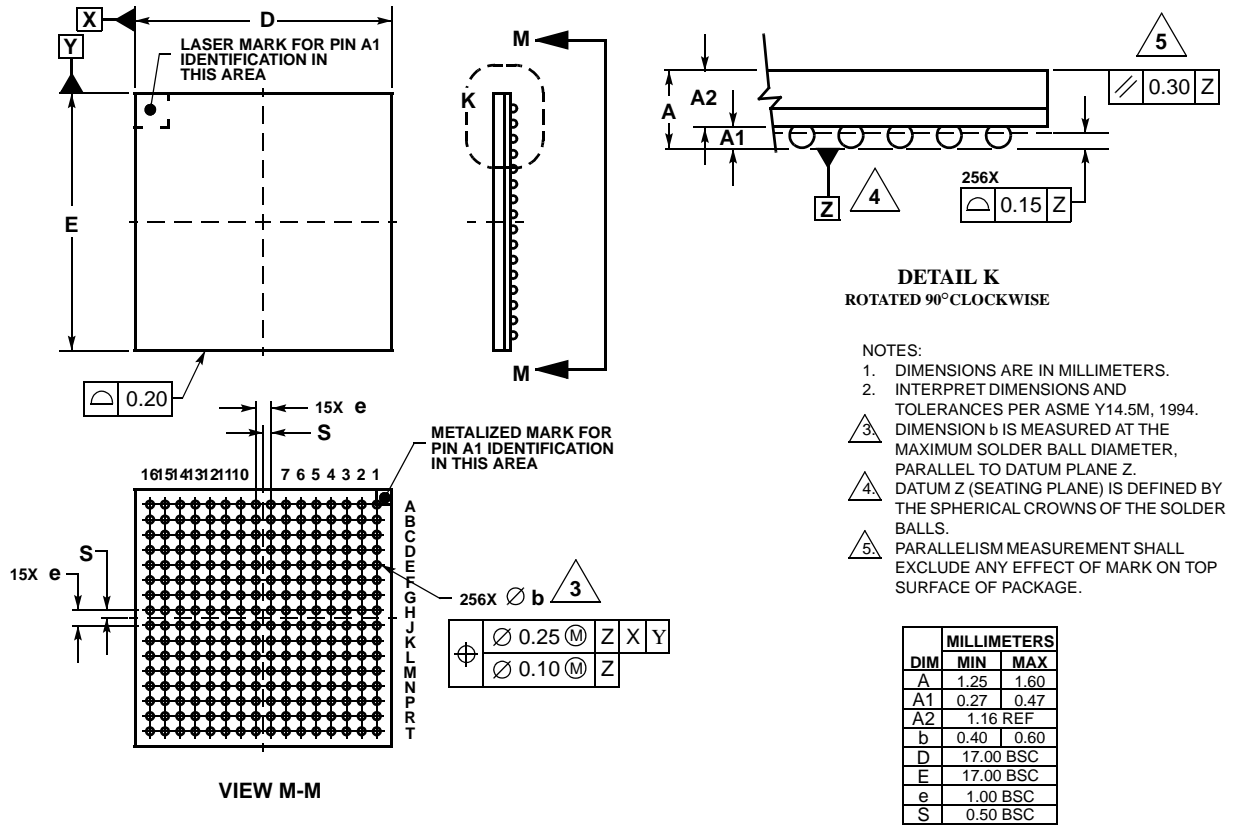
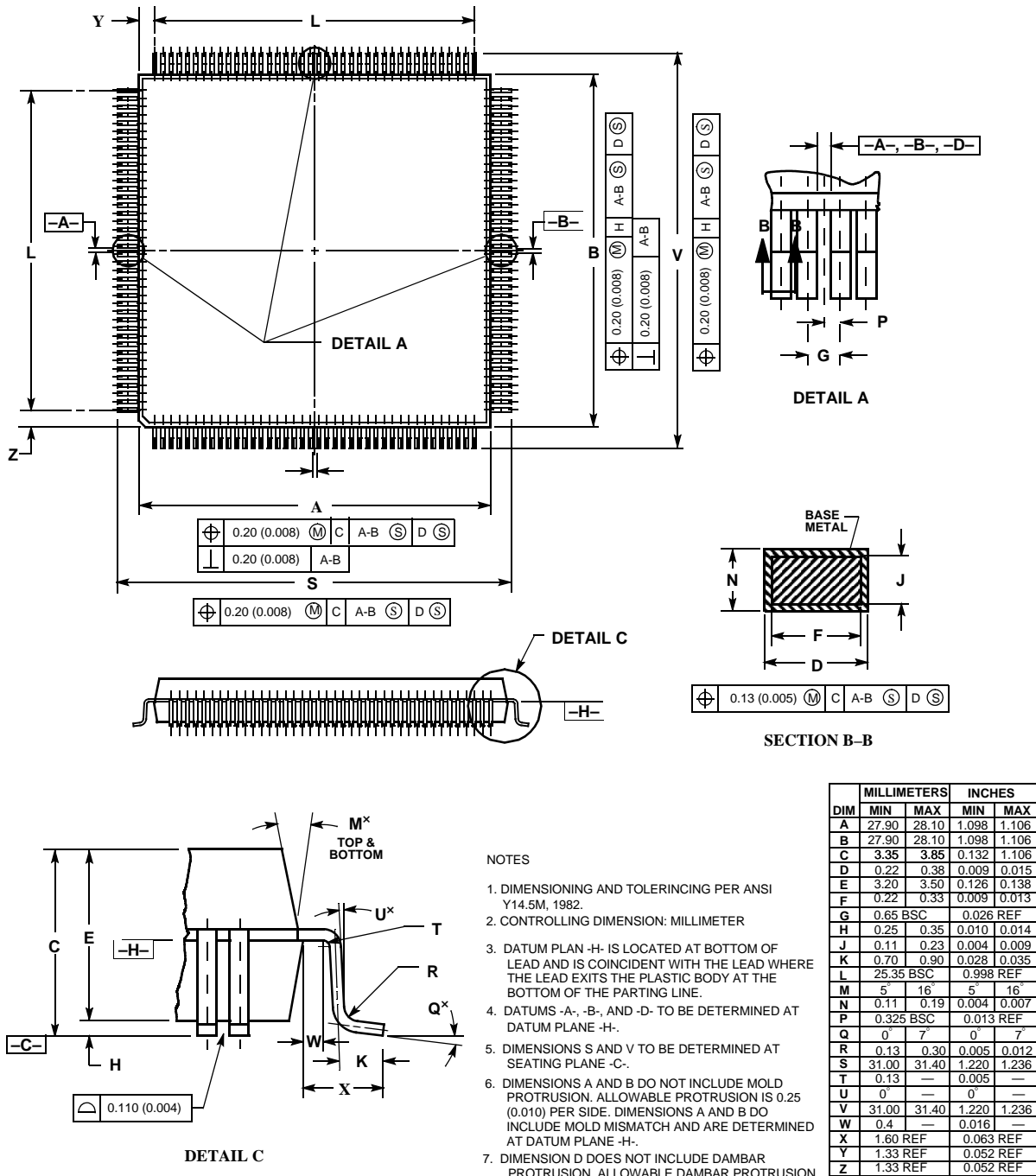


Figure 7. 256 MAPBGA Package Outline

6.4 Package Dimensions—160 QFP

Figure 9 shows MCF5232CAB80 package dimensions.



Case 864A-03

Figure 9. 160 QFP Package Dimensions

6.5 Ordering Information

Table 6. Orderable Part Numbers

| Freescale Part Number | Description | Package | Speed | Lead-Free? | Temperature |
|-----------------------|------------------------------|------------|--------|------------|----------------|
| MCF5232CAB80 | MCF5232 RISC Microprocessor | 160 QFP | 80MHz | Yes | -40° to +85° C |
| MCF5232CVM100 | MCF5232 RISC Microprocessor | 196 MAPBGA | 100MHz | Yes | -40° to +85° C |
| MCF5232CVM150 | MCF5232 RISC Microprocessor | 196 MAPBGA | 150MHz | Yes | -40° to +85° C |
| MCF5233CVM100 | MCF5233 RISC Microprocessor | 256 MAPBGA | 100MHz | Yes | -40° to +85° C |
| MCF5233CVM150 | MCF5233 RISC Microprocessor | 256 MAPBGA | 150MHz | Yes | -40° to +85° C |
| MCF5234CVM100 | MCF5234 RISC Microprocessor | 256 MAPBGA | 100MHz | Yes | -40° to +85° C |
| MCF5234CVM150 | MCF5234 RISC Microprocessor | 256 MAPBGA | 150MHz | Yes | -40° to +85° C |
| MCF5235CVM100 | MCF5235 RISC Microprocessor | 256 MAPBGA | 100MHz | Yes | -40° to +85° C |
| MCF5235CVM150 | MCF5235 RISC Microprocessor | 256 MAPBGA | 150MHz | Yes | -40° to +85° C |
| MCF5235CVF150 | MCF5235 RISC Microprocessor, | 256 MAPBGA | 150MHz | No | -40° to +85° C |

7 Electrical Characteristics

This chapter contains electrical specification tables and reference timing diagrams for the MCF5235 microcontroller unit. This section contains detailed information on power considerations, DC/AC electrical characteristics, and AC timing specifications of MCF5235.

NOTE

The parameters specified in this processor document supersede any values found in the module specifications.

7.1 Maximum Ratings

Table 7. Absolute Maximum Ratings^{1, 2}

| Rating | Symbol | Value | Unit |
|--|--------------------------|----------------|------|
| Core Supply Voltage | V_{DD} | - 0.5 to +2.0 | V |
| Pad Supply Voltage | OV_{DD} | - 0.3 to +4.0 | V |
| PLL Supply Voltage | V_{DDPLL} | - 0.3 to +4.0 | V |
| Digital Input Voltage ³ | V_{IN} | - 0.3 to + 4.0 | V |
| Instantaneous Maximum Current Single pin limit (applies to all pins) ^{3,4,5} | I_D | 25 | mA |
| Operating Temperature Range (Packaged) | T_A ($T_L - T_H$) | - 40 to 85 | °C |
| Storage Temperature Range | T_{stg} | - 65 to 150 | °C |

Electrical Characteristics

- ¹ Functional operating conditions are given in DC Electrical Specifications. Absolute Maximum Ratings are stress ratings only, and functional operation at the maxima is not guaranteed. Continued operation at these levels may affect device reliability or cause permanent damage to the device.
- ² This device contains circuitry protecting against damage due to high static voltage or electrical fields; however, it is advised that normal precautions be taken to avoid application of any voltages higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either V_{SS} or OV_{DD}).
- ³ Input must be current limited to the value specified. To determine the value of the required current-limiting resistor, calculate resistance values for positive and negative clamp voltages, then use the larger of the two values.
- ⁴ All functional non-supply pins are internally clamped to V_{SS} and OV_{DD} .
- ⁵ Power supply must maintain regulation within operating OV_{DD} range during instantaneous and operating maximum current conditions. If positive injection current ($V_{in} > OV_{DD}$) is greater than I_{DD} , the injection current may flow out of OV_{DD} and could result in external power supply going out of regulation. Insure external OV_{DD} load will shunt current greater than maximum injection current. This will be the greatest risk when the processor is not consuming power (ex; no clock). Power supply must maintain regulation within operating OV_{DD} range during instantaneous and operating maximum current conditions.

7.2 Thermal Characteristics

The below table lists thermal resistance values.

Table 8. Thermal Characteristics

| Characteristic | | Symbol | 256 MAPBGA | 196 MAPBGA | 160 QFP | Unit |
|---|-------------------------|----------------|-------------------|-------------------|-------------------|------|
| Junction to ambient, natural convection | Four layer board (2s2p) | θ_{JMA} | 26 ^{1,2} | 32 ^{1,2} | 40 ^{1,2} | °C/W |
| Junction to ambient (@200 ft/min) | Four layer board (2s2p) | θ_{JMA} | 23 ^{1,2} | 29 ^{1,2} | 36 ^{1,2} | °C/W |
| Junction to board | | θ_{JB} | 15 ³ | 20 ³ | 25 ³ | °C/W |
| Junction to case | | θ_{JC} | 10 ⁴ | 10 ⁴ | 10 ⁴ | °C/W |
| Junction to top of package | | Ψ_{jt} | 2 ^{1,5} | 2 ^{1,5} | 2 ^{1,5} | °C/W |
| Maximum operating junction temperature | | T_j | 102 | 104 | 105 ⁶ | °C |

¹ θ_{JMA} and Ψ_{jt} parameters are simulated in conformance with EIA/JESD Standard 51-2 for natural convection. Freescale recommends the use of θ_{JMA} and power dissipation specifications in the system design to prevent device junction temperatures from exceeding the rated specification. System designers should be aware that device junction temperatures can be significantly influenced by board layout and surrounding devices. Conformance to the device junction temperature specification can be verified by physical measurement in the customer's system using the Ψ_{jt} parameter, the device power dissipation, and the method described in EIA/JESD Standard 51-2.

² Per JEDEC JESD51-6 with the board horizontal.

³ Thermal resistance between the die and the printed circuit board in conformance with JEDEC JESD51-8. Board temperature is measured on the top surface of the board near the package.

⁴ Thermal resistance between the die and the case top surface as measured by the cold plate method (MIL SPEC-883 Method 1012.1).

⁵ 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 in conformance with Psi-JT.

⁶ At 100MHz.

The average chip-junction temperature (T_J) in °C can be obtained from:

$$T_J = T_A + (P_D \times \Theta_{JMA}) \quad (1)$$

Where:

T_A = Ambient Temperature, °C

Θ_{JMA} = Package Thermal Resistance, Junction-to-Ambient, °C/W

$P_D = P_{INT} + P_{I/O}$

$P_{INT} = I_{DD} \times V_{DD}$, Watts - Chip Internal Power

$P_{I/O}$ = Power Dissipation on Input and Output Pins — User Determined

For most applications $P_{I/O} < P_{INT}$ and can be ignored. An approximate relationship between P_D and T_J (if $P_{I/O}$ is neglected) is:

$$P_D = K \div (T_J + 273^\circ\text{C}) \quad (2)$$

Solving equations 1 and 2 for K gives:

$$K = P_D \times (T_A + 273^\circ\text{C}) + \Theta_{JMA} \times P_D^2 \quad (3)$$

where K is a constant pertaining to the particular part. K can be determined from equation (3) by measuring P_D (at equilibrium) for a known T_A . Using this value of K, the values of P_D and T_J can be obtained by solving equations (1) and (2) iteratively for any value of T_A .

7.3 DC Electrical Specifications

Table 9. DC Electrical Specifications¹

| Characteristic | Symbol | Min | Typical | Max | Unit |
|--|-------------|-----------------------|---------|-----------------------|---------------|
| Core Supply Voltage | V_{DD} | 1.4 | — | 1.6 | V |
| Pad Supply Voltage | OV_{DD} | 3.0 | — | 3.6 | V |
| PLL Supply Voltage | V_{DDPLL} | 3.0 | — | 3.6 | V |
| Input High Voltage | V_{IH} | $0.7 \times OV_{DD}$ | — | 3.65 | V |
| Input Low Voltage | V_{IL} | $V_{SS} - 0.3$ | — | $0.35 \times OV_{DD}$ | V |
| Input Hysteresis | V_{HYS} | $0.06 \times OV_{DD}$ | — | — | mV |
| Input Leakage Current $V_{in} = V_{DD}$ or V_{SS} , Input-only pins | I_{in} | -1.0 | — | 1.0 | μA |
| High Impedance (Off-State) Leakage Current $V_{in} = V_{DD}$ or V_{SS} , All input/output and output pins | I_{OZ} | -1.0 | — | 1.0 | μA |
| Output High Voltage (All input/output and all output pins) $I_{OH} = -5.0$ mA | V_{OH} | $OV_{DD} - 0.5$ | — | — | V |
| Output Low Voltage (All input/output and all output pins) $I_{OL} = 5.0$ mA | V_{OL} | — | — | 0.5 | V |
| Weak Internal Pull Up Device Current, tested at V_{IL} Max. ² | I_{APU} | -10 | — | -130 | μA |

Electrical Characteristics

Table 9. DC Electrical Specifications¹ (continued)

| Characteristic | Symbol | Min | Typical | Max | Unit |
|--|--------------|-------------|------------|-----------|---------------|
| Input Capacitance ³ All input-only pins All input/output (three-state) pins | C_{in} | — — | — | 7 7 | pF |
| Load Capacitance ⁴ Low drive strength High drive strength | C_L | | — — | 25 50 | pF pF |
| Core Operating Supply Current ⁵ Master Mode | I_{DD} | — | 135 | 150 | mA |
| Pad Operating Supply Current Master Mode Low Power Modes | $O_{I_{DD}}$ | — — | 100 TBD | — — | mA μ A |
| DC Injection Current ^{3, 6, 7, 8} $V_{NEGCLAMP} = V_{SS} - 0.3$ V, $V_{POSCLAMP} = V_{DD} + 0.3$ Single Pin Limit Total processor Limit, Includes sum of all stressed pins | I_{IC} | | | | |
| | | -1.0 -10 | | 1.0 10 | mA mA |

¹ Refer to Table 10 for additional PLL specifications.

² Refer to the MCF5235 signals section for pins having weak internal pull-up devices.

³ This parameter is characterized before qualification rather than 100% tested.

⁴ pF load ratings are based on DC loading and are provided as an indication of driver strength. High speed interfaces require transmission line analysis to determine proper drive strength and termination. See [High Speed Signal Propagation: Advanced Black Magic](#) by Howard W. Johnson for design guidelines.

⁵ Current measured at maximum system clock frequency, all modules active, and default drive strength with matching load.

⁶ All functional non-supply pins are internally clamped to V_{SS} and their respective V_{DD} .

⁷ Input must be current limited to the value specified. To determine the value of the required current-limiting resistor, calculate resistance values for positive and negative clamp voltages, then use the larger of the two values.

⁸ Power supply must maintain regulation within operating V_{DD} range during instantaneous and operating maximum current conditions. If positive injection current ($V_{in} > V_{DD}$) is greater than I_{DD} , the injection current may flow out of V_{DD} and could result in external power supply going out of regulation. Insure external V_{DD} load will shunt current greater than maximum injection current. This will be the greatest risk when the processor is not consuming power. Examples are: if no system clock is present, or if clock rate is very low which would reduce overall power consumption. Also, at power-up, system clock is not present during the power-up sequence until the PLL has attained lock.

7.4 Oscillator and PLLRFM Electrical Characteristics

Table 10. HiP7 PLLRFM Electrical Specifications¹

| Num | Characteristic | Symbol | Min. Value | Max. Value | Unit |
|-----|--|--|-------------------------------|-----------------|----------------------|
| 1 | PLL Reference Frequency Range Crystal reference External reference 1:1 mode (NOTE: $f_{\text{sys}/2} = 2 \times f_{\text{ref}_1:1}$) | $f_{\text{ref_crystal}}$ $f_{\text{ref_ext}}$ $f_{\text{ref}_1:1}$ | 8 8 24 | 25 25 75 | MHz |
| 2 | Core frequency CLKOUT Frequency ² External reference On-Chip PLL Frequency | f_{sys} $f_{\text{sys}/2}$ | 0 $f_{\text{ref}} \div 32$ | 150 75 75 | MHz MHz MHz |
| 3 | Loss of Reference Frequency ^{3, 5} | f_{LOR} | 100 | 1000 | kHz |
| 4 | Self Clocked Mode Frequency ^{4, 5} | f_{SCM} | 10.25 | 15.25 | MHz |
| 5 | Crystal Start-up Time ^{5, 6} | t_{cst} | — | 10 | ms |
| 6 | XTAL Load Capacitance ⁵ | | 5 | 30 | pF |
| 7 | PLL Lock Time ^{5, 7, 13} | t_{pll} | — | 750 | μs |
| 8 | Power-up To Lock Time ^{5, 6, 8} With Crystal Reference (includes 5 time) Without Crystal Reference ⁹ | t_{plk} | — — | 11 750 | ms μs |
| 9 | 1:1 Mode Clock Skew (between CLKOUT and EXTAL) ¹⁰ | t_{skew} | -1 | 1 | ns |
| 10 | Duty Cycle of reference ⁵ | t_{dc} | 40 | 60 | % |
| 11 | Frequency un-LOCK Range | f_{UL} | -3.8 | 4.1 | % $f_{\text{sys}/2}$ |
| 12 | Frequency LOCK Range | f_{LCK} | -1.7 | 2.0 | % $f_{\text{sys}/2}$ |
| 13 | CLKOUT Period Jitter, ^{5, 6, 8, 11, 12} Measured at $f_{\text{sys}/2}$ Max Peak-to-peak Jitter (Clock edge to clock edge) Long Term Jitter (Averaged over 2 ms interval) | C_{jitter} | — — | 5.0 .01 | % $f_{\text{sys}/2}$ |
| 14 | Frequency Modulation Range Limit ^{13, 14} ($f_{\text{sys}/2}$ Max must not be exceeded) | C_{mod} | 0.8 | 2.2 | % $f_{\text{sys}/2}$ |
| 15 | ICO Frequency. $f_{\text{ico}} = f_{\text{ref}} \times 2 \times (\text{MFD}+2)$ ¹⁵ | f_{ico} | 48 | 150 | MHz |

¹ All values given are initial design targets and subject to change.

² All internal registers retain data at 0 Hz.

³ "Loss of Reference Frequency" is the reference frequency detected internally, which transitions the PLL into self clocked mode.

⁴ Self clocked mode frequency is the frequency that the PLL operates at when the reference frequency falls below f_{LOR} with default MFD/RFD settings.

⁵ This parameter is guaranteed by characterization before qualification rather than 100% tested.

⁶ Proper PC board layout procedures must be followed to achieve specifications.

Electrical Characteristics

- ⁷ This specification applies to the period required for the PLL to relock after changing the MFD frequency control bits in the synthesizer control register (SYNCR).
- ⁸ Assuming a reference is available at power up, lock time is measured from the time V_{DD} and V_{DDSYN} are valid to \overline{RSTOUT} negating. If the crystal oscillator is being used as the reference for the PLL, then the crystal start up time must be added to the PLL lock time to determine the total start-up time.
- ⁹ $t_{PLL} = (64 \cdot 4 \cdot 5 + 5 \times \tau) \times T_{ref}$, where $T_{ref} = 1/F_{ref_crystal} = 1/F_{ref_ext} = 1/F_{ref_1:1}$, and $\tau = 1.57 \times 10^{-6} \times 2(MFD + 2)$.
- ¹⁰ PLL is operating in 1:1 PLL mode.
- ¹¹ Jitter is the average deviation from the programmed frequency measured over the specified interval at maximum $f_{sys/2}$. Measurements are made with the device powered by filtered supplies and clocked by a stable external clock signal. Noise injected into the PLL circuitry via V_{DDSYN} and V_{SSSYN} and variation in crystal oscillator frequency increase the Cjitter percentage for a given interval.
- ¹² Values are with frequency modulation disabled. If frequency modulation is enabled, jitter is the sum of Cjitter+Cmod.
- ¹³ Modulation percentage applies over an interval of 10 μ s, or equivalently the modulation rate is 100KHz.
- ¹⁴ Modulation rate selected must not result in $f_{sys/2}$ value greater than the $f_{sys/2}$ maximum specified value. Modulation range determined by hardware design.
- ¹⁵ $f_{sys/2} = f_{ico} / (2 \cdot 2^{RFD})$

7.5 External Interface Timing Characteristics

Table 11 lists processor bus input timings.

NOTE

All processor bus timings are synchronous; that is, input setup/hold and output delay with respect to the rising edge of a reference clock. The reference clock is the CLKOUT output.

All other timing relationships can be derived from these values.

Table 11. Processor Bus Input Timing Specifications

| Name | Characteristic ¹ | Symbol | Min | Max | Unit |
|-----------------------|--|-------------|-----|------|------|
| freq | System bus frequency | $f_{sys/2}$ | 50 | 75 | MHz |
| B0 | CLKOUT period | t_{cyc} | — | 1/75 | ns |
| Control Inputs | | | | | |
| B1a | Control input valid to CLKOUT high ² | t_{CVCH} | 9 | — | ns |
| B1b | \overline{BKPT} valid to CLKOUT high ³ | t_{BKVCH} | 9 | — | ns |
| B2a | CLKOUT high to control inputs invalid ² | t_{CHCII} | 0 | — | ns |
| B2b | CLKOUT high to asynchronous control input \overline{BKPT} invalid ³ | t_{BKNCH} | 0 | — | ns |
| Data Inputs | | | | | |
| B4 | Data input (D[31:0]) valid to CLKOUT high | t_{DIVCH} | 4 | — | ns |
| B5 | CLKOUT high to data input (D[31:0]) invalid | t_{CHDII} | 0 | — | ns |

¹ Timing specifications are tested using full drive strength pad configurations in a 50ohm transmission line environment..

² TEA and TA pins are being referred to as control inputs.

³ Refer to figure A-19.

Timings listed in Table 11 are shown in Figure 10.

* The timings are also valid for inputs sampled on the negative clock edge.

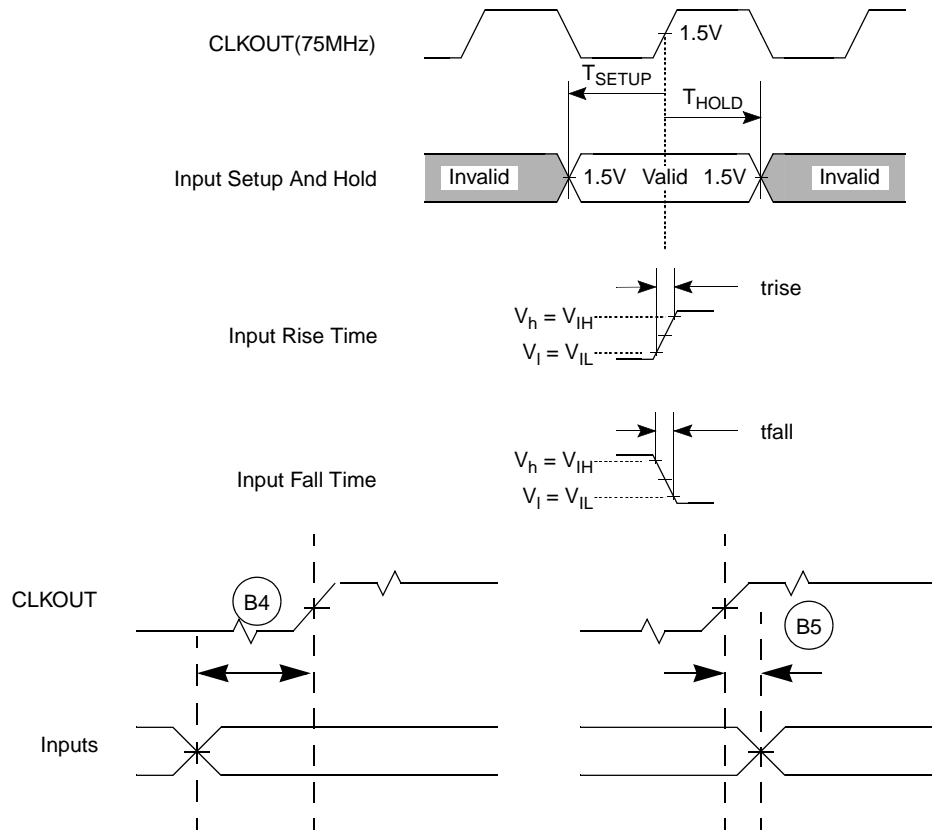


Figure 10. General Input Timing Requirements

7.6 Processor Bus Output Timing Specifications

Table 12 lists processor bus output timings.

Table 12. External Bus Output Timing Specifications

| Name | Characteristic | Symbol | Min | Max | Unit |
|------------------------|--|-------------|--------------------|------------------|------|
| Control Outputs | | | | | |
| B6a | CLKOUT high to chip selects valid ¹ | t_{CHCV} | — | $0.5t_{CYC} + 5$ | ns |
| B6b | CLKOUT high to byte enables ($\overline{BS}[3:0]$) valid ² | t_{CHBV} | — | $0.5t_{CYC} + 5$ | ns |
| B6c | CLKOUT high to output enable (\overline{OE}) valid ³ | t_{CHOV} | — | $0.5t_{CYC} + 5$ | ns |
| B7 | CLKOUT high to control output ($\overline{BS}[3:0]$, \overline{OE}) invalid | t_{CHCOI} | $0.5t_{CYC} + 1.5$ | — | ns |
| B7a | CLKOUT high to chip selects invalid | t_{CHCI} | $0.5t_{CYC} + 1.5$ | — | ns |

Table 12. External Bus Output Timing Specifications (continued)

| Name | Characteristic | Symbol | Min | Max | Unit |
|--------------------------------------|---|-------------|-----|-----|------|
| Address and Attribute Outputs | | | | | |
| B8 | CLKOUT high to address (A[23:0]) and control (\overline{TS} , $\overline{TSIZ}[1:0]$, \overline{TIP} , $\overline{R/W}$) valid | t_{CHAV} | — | 9 | ns |
| B9 | CLKOUT high to address (A[23:0]) and control (\overline{TS} , $\overline{TSIZ}[1:0]$, \overline{TIP} , $\overline{R/W}$) invalid | t_{CHAI} | 1.5 | — | ns |
| Data Outputs | | | | | |
| B11 | CLKOUT high to data output (D[31:0]) valid | t_{CHDOV} | — | 9 | ns |
| B12 | CLKOUT high to data output (D[31:0]) invalid | t_{CHDOI} | 1.5 | — | ns |
| B13 | CLKOUT high to data output (D[31:0]) high impedance | t_{CHDOZ} | — | 9 | ns |

¹ \overline{CS} transitions after the falling edge of CLKOUT.

² \overline{BS} transitions after the falling edge of CLKOUT.

³ \overline{OE} transitions after the falling edge of CLKOUT.

Read/write bus timings listed in Table 12 are shown in Figure 11, Figure 12, and Figure 13.

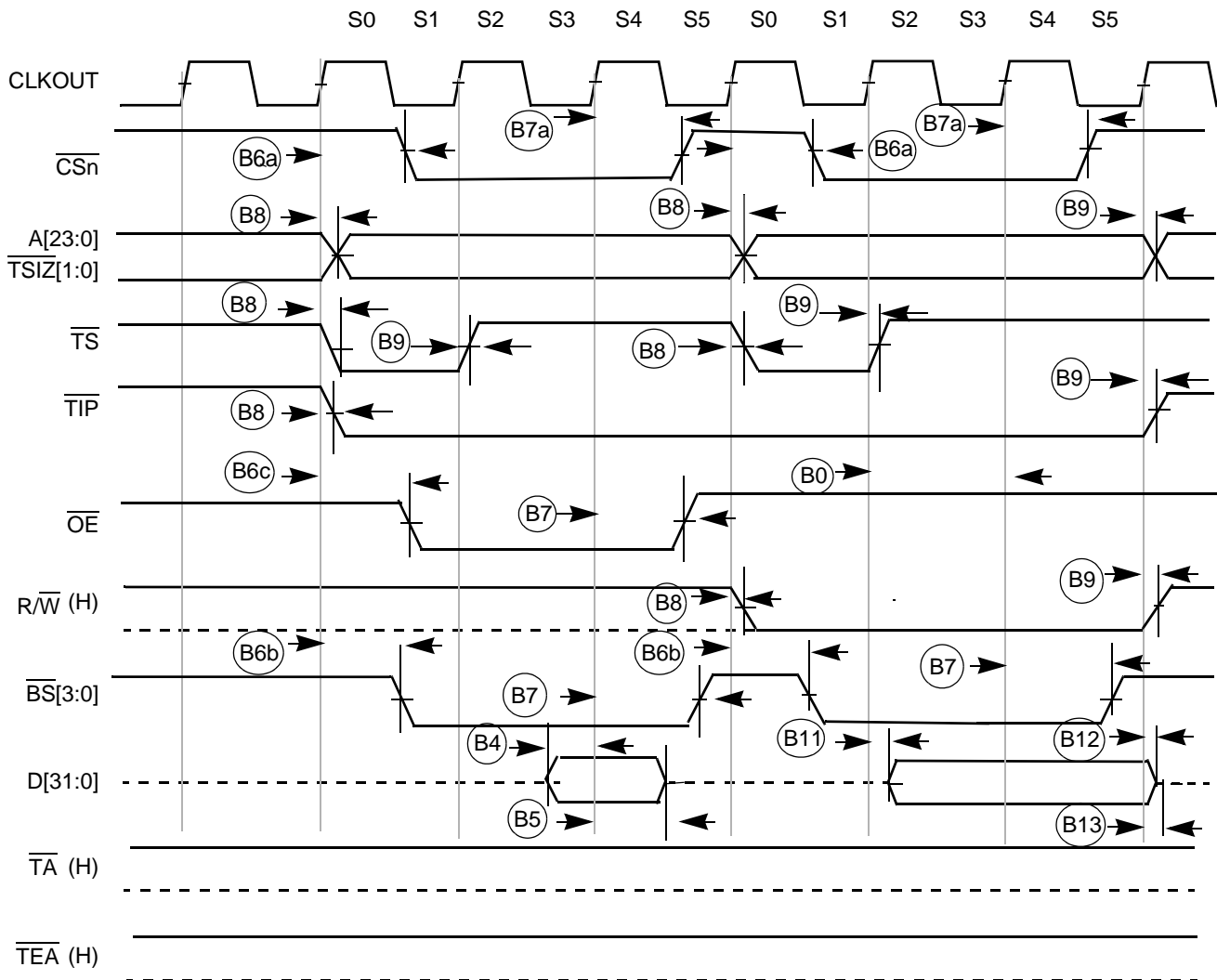


Figure 11. Read/Write (Internally Terminated) SRAM Bus Timing

Figure 12 shows a bus cycle terminated by \overline{TA} showing timings listed in Table 12.

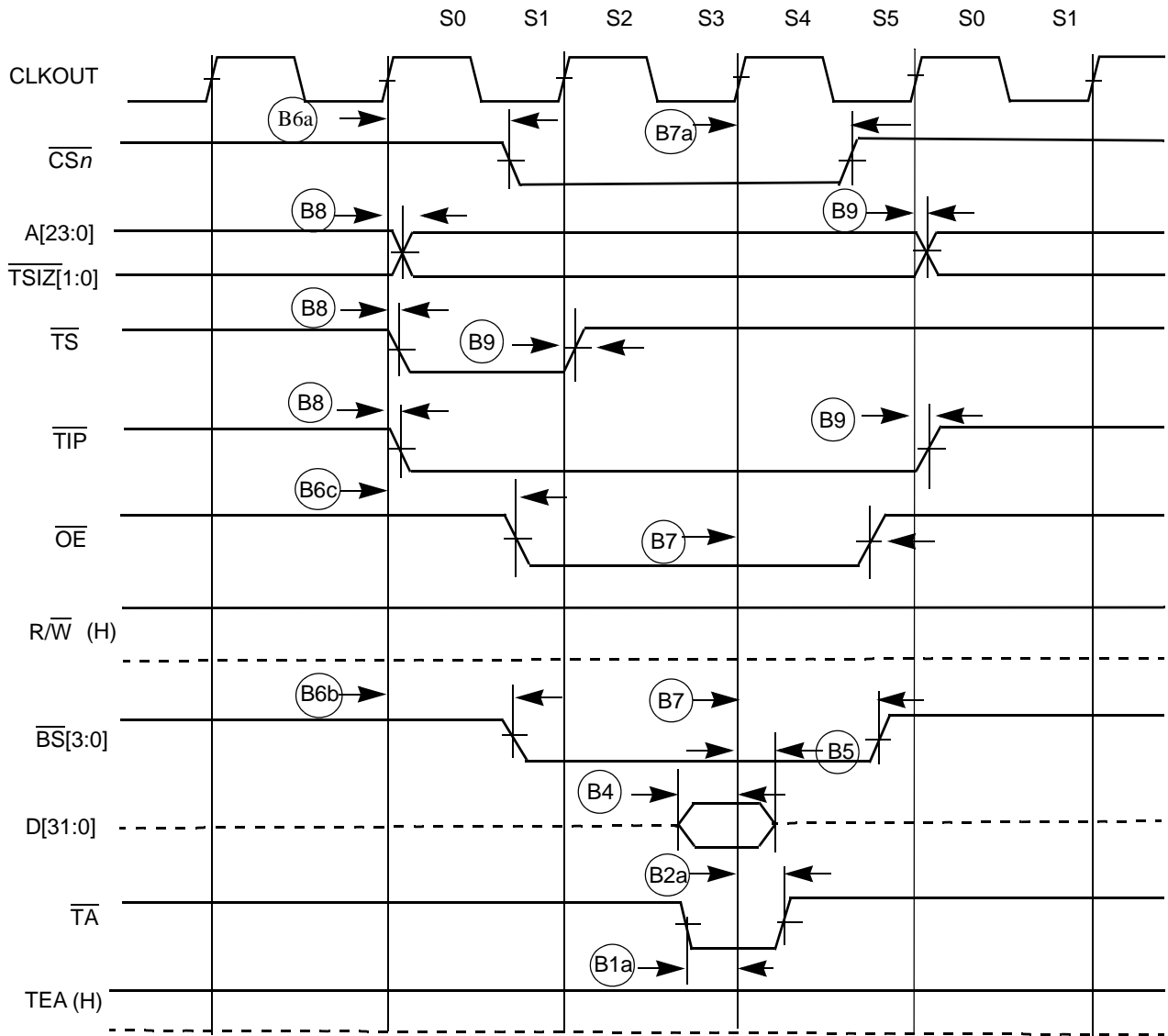


Figure 12. SRAM Read Bus Cycle Terminated by \overline{TA}

Figure 13 shows an SRAM bus cycle terminated by $\overline{\text{TEA}}$ showing timings listed in Table 12.

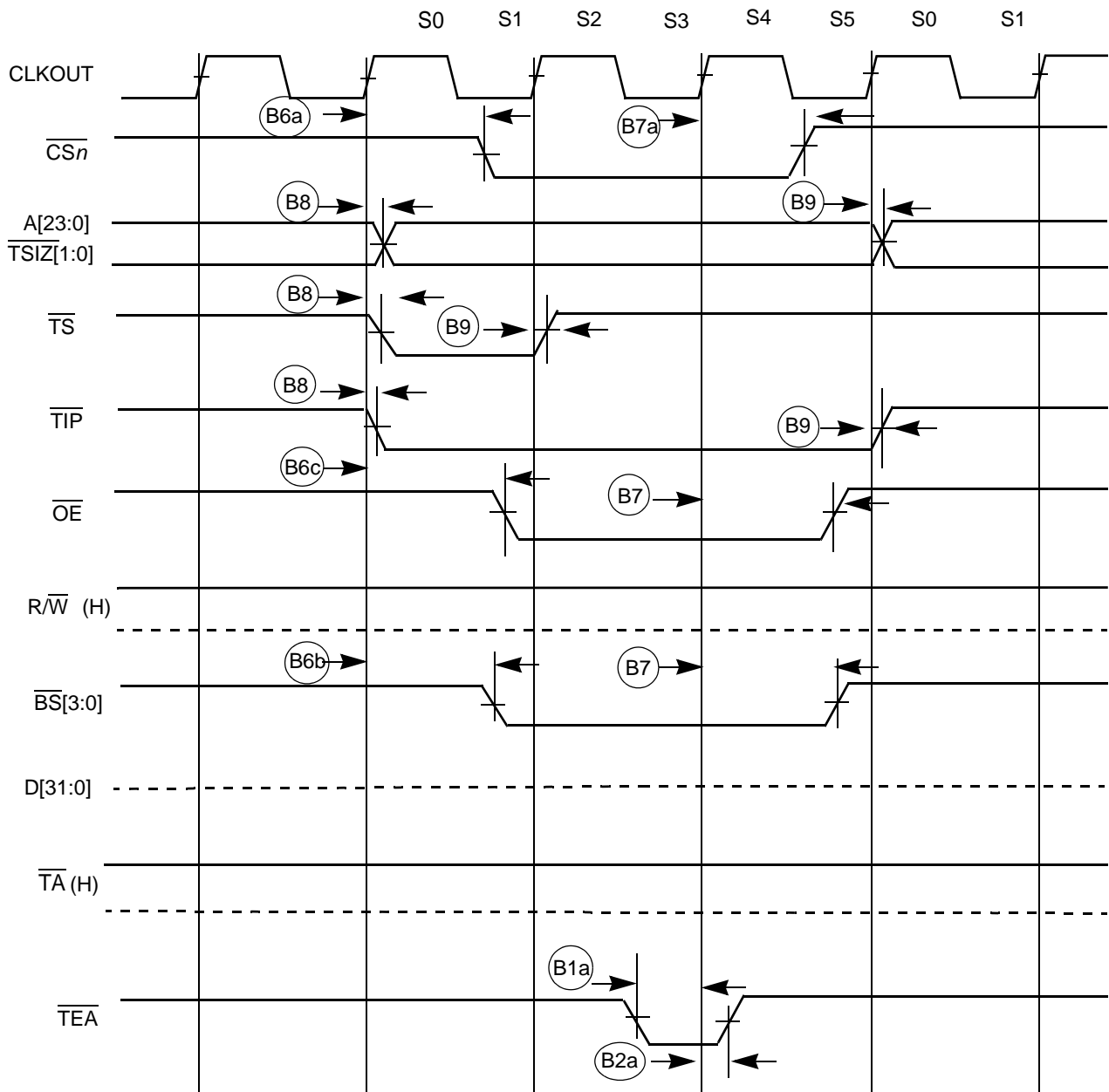


Figure 13. SRAM Read Bus Cycle Terminated by $\overline{\text{TEA}}$

Figure 14 shows an SDRAM read cycle.

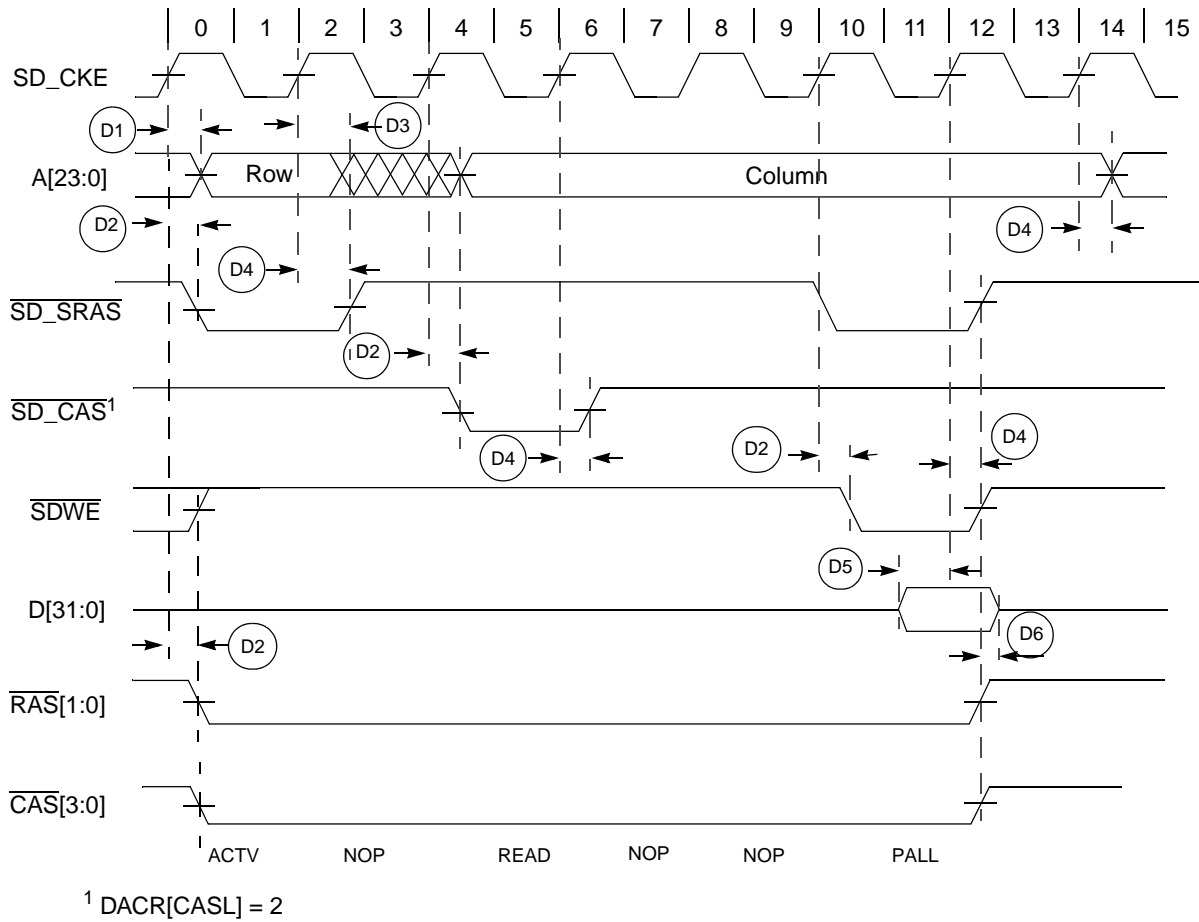


Figure 14. SDRAM Read Cycle

Table 13. SDRAM Timing

| NUM | Characteristic | Symbol | Min | Max | Unit |
|-----------------|--------------------------------------|--------------|-----|-----|------|
| D1 | CLKOUT high to SDRAM address valid | t_{CHDAV} | — | 9 | ns |
| D2 | CLKOUT high to SDRAM control valid | t_{CHDCV} | — | 9 | ns |
| D3 | CLKOUT high to SDRAM address invalid | t_{CHDAI} | 1.5 | — | ns |
| D4 | CLKOUT high to SDRAM control invalid | t_{CHDCI} | 1.5 | — | ns |
| D5 | SDRAM data valid to CLKOUT high | t_{DDVCH} | 4 | — | ns |
| D6 | CLKOUT high to SDRAM data invalid | t_{CHDDI} | 1.5 | — | ns |
| D7 ¹ | CLKOUT high to SDRAM data valid | t_{CHDDVW} | — | 9 | ns |
| D8 ¹ | CLKOUT high to SDRAM data invalid | t_{CHDDIW} | 1.5 | — | ns |

¹ D7 and D8 are for write cycles only.

Figure 15 shows an SDRAM write cycle.

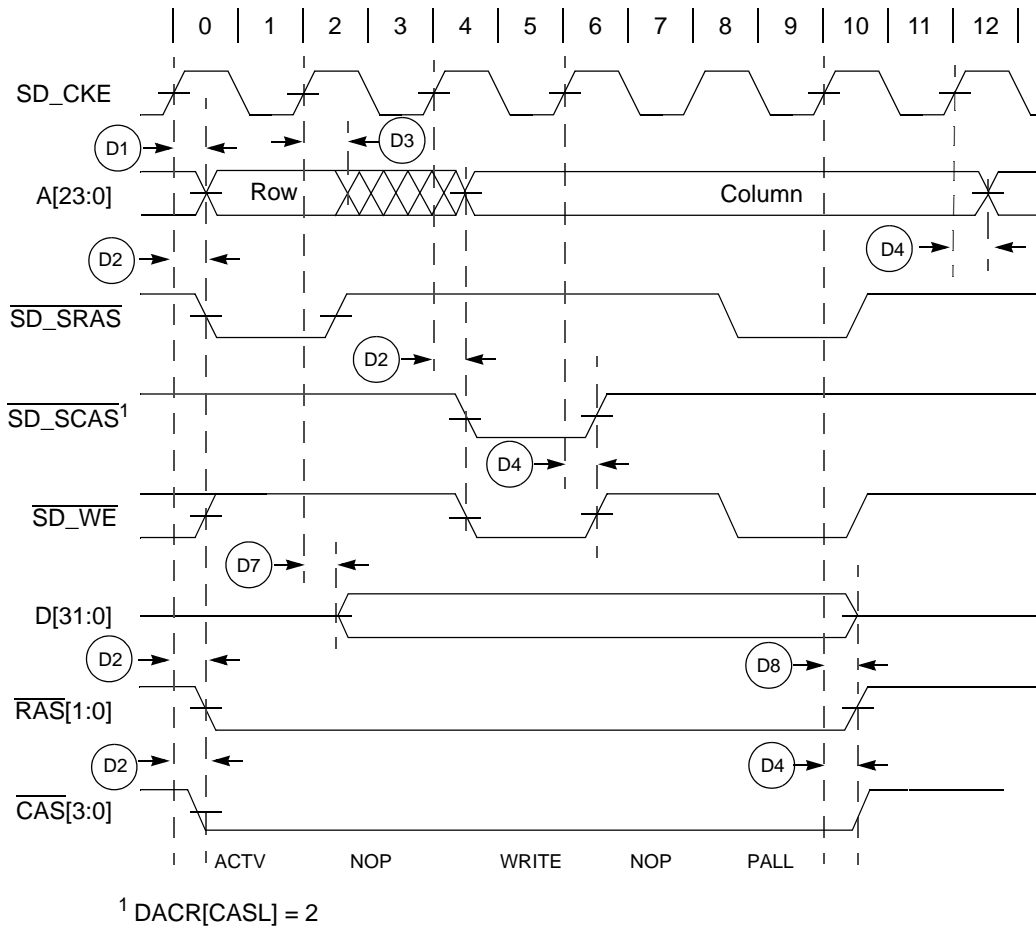


Figure 15. SDRAM Write Cycle

7.7 General Purpose I/O Timing

Table 14. GPIO Timing¹

| NUM | Characteristic | Symbol | Min | Max | Unit |
|-----|------------------------------------|-------------|-----|-----|------|
| G1 | CLKOUT High to GPIO Output Valid | t_{CHPOV} | — | 10 | ns |
| G2 | CLKOUT High to GPIO Output Invalid | t_{CHPOI} | 1.5 | — | ns |
| G3 | GPIO Input Valid to CLKOUT High | t_{PVCH} | 9 | — | ns |
| G4 | CLKOUT High to GPIO Input Invalid | t_{CHPI} | 1.5 | — | ns |

¹ GPIO pins include: INT, ETPU, UART, FlexCAN, Timer, \overline{DREQn} and \overline{DACKn} pins.

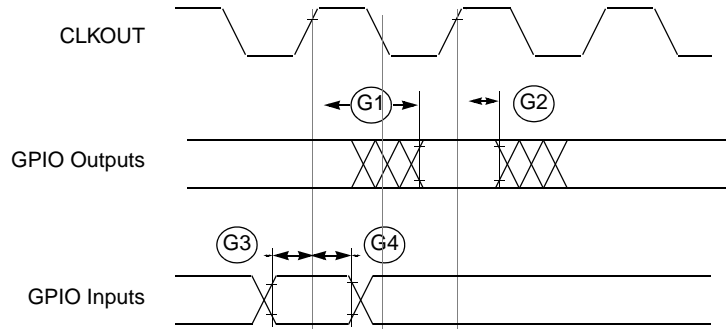


Figure 16. GPIO Timing

7.8 Reset and Configuration Override Timing

Table 15. Reset and Configuration Override Timing
($V_{DD} = 2.7$ to 3.6 V, $V_{SS} = 0$ V, $T_A = T_L$ to T_H)¹

| NUM | Characteristic | Symbol | Min | Max | Unit |
|-----|--|-------------|-----|-----|-----------|
| R1 | \overline{RESET} Input valid to CLKOUT High | t_{RVCH} | 9 | — | ns |
| R2 | CLKOUT High to \overline{RESET} Input invalid | t_{CHRI} | 1.5 | — | ns |
| R3 | \overline{RESET} Input valid Time ² | t_{RIVT} | 5 | — | t_{CYC} |
| R4 | CLKOUT High to \overline{RSTOUT} Valid | t_{CHROV} | — | 10 | ns |
| R5 | \overline{RSTOUT} valid to Config. Overrides valid | t_{ROVCV} | 0 | — | ns |
| R6 | Configuration Override Setup Time to \overline{RSTOUT} invalid | t_{COS} | 20 | — | t_{CYC} |
| R7 | Configuration Override Hold Time after \overline{RSTOUT} invalid | t_{COH} | 0 | — | ns |
| R8 | \overline{RSTOUT} invalid to Configuration Override High Impedance | t_{ROICZ} | — | 1 | t_{CYC} |

¹ All AC timing is shown with respect to 50% V_{DD} levels unless otherwise noted.

² During low power STOP, the synchronizers for the \overline{RESET} input are bypassed and \overline{RESET} is asserted asynchronously to the system. Thus, \overline{RESET} must be held a minimum of 100 ns.

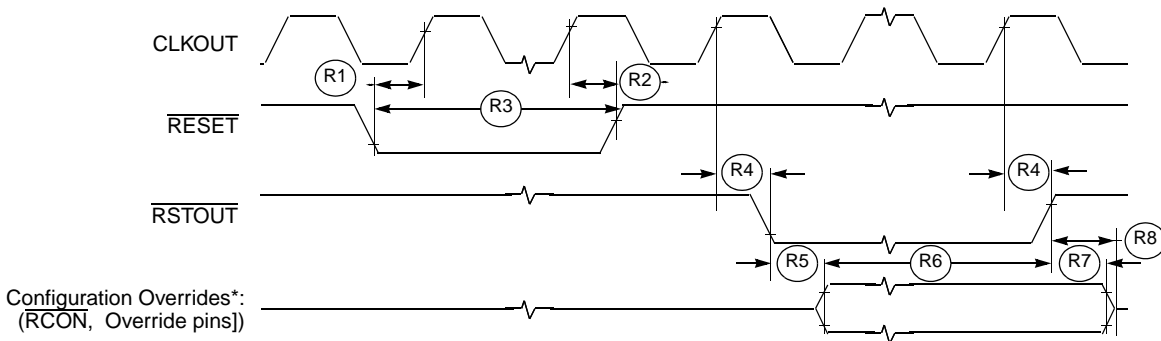


Figure 17. \overline{RESET} and Configuration Override Timing

Refer to the chip configuration module (CCM) chapter in the device’s reference manual for more information.

7.9 I²C Input/Output Timing Specifications

Table 16 lists specifications for the I²C input timing parameters shown in Figure 18.

Table 16. I²C Input Timing Specifications between I2C_SCL and I2C_SDA

| Num | Characteristic | Min | Max | Units |
|-----|--|-----|-----|------------------|
| I1 | Start condition hold time | 2 | — | t _{cyc} |
| I2 | Clock low period | 8 | — | t _{cyc} |
| I3 | I2C_SCL/I2C_SDA rise time (V _{IL} = 0.5 V to V _{IH} = 2.4 V) | — | 1 | ms |
| I4 | Data hold time | 0 | — | ns |
| I5 | I2C_SCL/I2C_SDA fall time (V _{IH} = 2.4 V to V _{IL} = 0.5 V) | — | 1 | ms |
| I6 | Clock high time | 4 | — | t _{cyc} |
| I7 | Data setup time | 0 | — | ns |
| I8 | Start condition setup time (for repeated start condition only) | 2 | — | t _{cyc} |
| I9 | Stop condition setup time | 2 | — | t _{cyc} |

Table 17 lists specifications for the I²C output timing parameters shown in Figure 18.

Table 17. I²C Output Timing Specifications between I2C_SCL and I2C_SDA

| Num | Characteristic | Min | Max | Units |
|-----------------|--|-----|-----|------------------|
| I1 ¹ | Start condition hold time | 6 | — | t _{cyc} |
| I2 ¹ | Clock low period | 10 | — | t _{cyc} |
| I3 ² | I2C_SCL/I2C_SDA rise time (V _{IL} = 0.5 V to V _{IH} = 2.4 V) | — | — | μs |
| I4 ¹ | Data hold time | 7 | — | t _{cyc} |
| I5 ³ | I2C_SCL/I2C_SDA fall time (V _{IH} = 2.4 V to V _{IL} = 0.5 V) | — | 3 | ns |
| I6 ¹ | Clock high time | 10 | — | t _{cyc} |
| I7 ¹ | Data setup time | 2 | — | t _{cyc} |
| I8 ¹ | Start condition setup time (for repeated start condition only) | 20 | — | t _{cyc} |
| I9 ¹ | Stop condition setup time | 10 | — | t _{cyc} |

¹ Note: Output numbers depend on the value programmed into the IFDR; an IFDR programmed with the maximum frequency (IFDR = 0x20) results in minimum output timings as shown in Table 17. The I²C interface is designed to scale the actual data transition time to move it to the middle of the I2C_SCL low period. The actual position is affected by the prescale and division values programmed into the IFDR; however, the numbers given in Table 17 are minimum values.

² Because I2C_SCL and I2C_SDA are open-collector-type outputs, which the processor can only actively drive low, the time I2C_SCL or I2C_SDA take to reach a high level depends on external signal capacitance and pull-up resistor values.

³ Specified at a nominal 50-pF load.

Figure 18 shows timing for the values in Table 16 and Table 17.

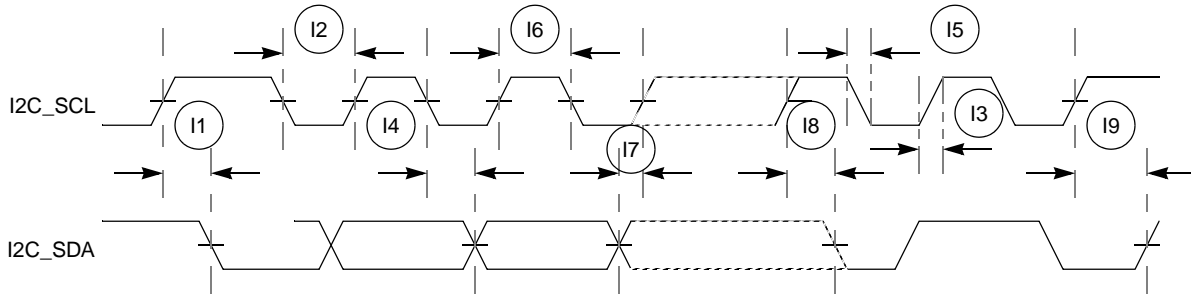


Figure 18. I²C Input/Output Timings

7.10 Fast Ethernet AC Timing Specifications

MII signals use TTL signal levels compatible with devices operating at either 5.0 V or 3.3 V.

7.10.1 MII Receive Signal Timing (ERXD[3:0], ERXDV, ERXER, and ERXCLK)

The receiver functions correctly up to a ERXCLK maximum frequency of 25 MHz +1%. The processor clock frequency must exceed twice the ERXCLK frequency.

Table 18 lists MII receive channel timings.

Table 18. MII Receive Signal Timing

| Num | Characteristic | Min | Max | Unit |
|-----|---|-----|-----|---------------|
| M1 | ERXD[3:0], ERXDV, ERXER to ERXCLK setup | 5 | — | ns |
| M2 | ERXCLK to ERXD[3:0], ERXDV, ERXER hold | 5 | — | ns |
| M3 | ERXCLK pulse width high | 35% | 65% | ERXCLK period |
| M4 | ERXCLK pulse width low | 35% | 65% | ERXCLK period |

Figure 19 shows MII receive signal timings listed in Table 18.

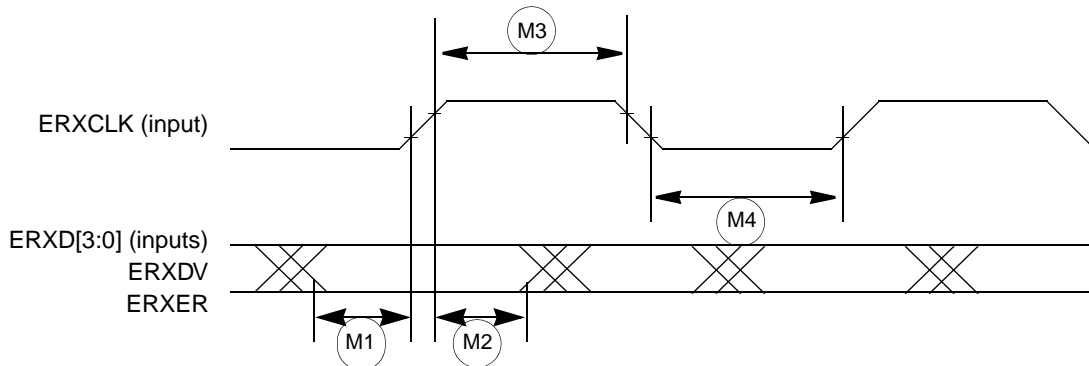


Figure 19. MII Receive Signal Timing Diagram

7.10.2 MII Transmit Signal Timing (ETXD[3:0], ETXEN, ETXER, ETXCLK)

Table 19 lists MII transmit channel timings.

The transmitter functions correctly up to a ETXCLK maximum frequency of 25 MHz +1%. The processor clock frequency must exceed twice the ETXCLK frequency.

Table 19. MII Transmit Signal Timing

| Num | Characteristic | Min | Max | Unit |
|-----|---|-----|-----|---------------|
| M5 | ETXCLK to ETXD[3:0], ETXEN, ETXER invalid | 5 | — | ns |
| M6 | ETXCLK to ETXD[3:0], ETXEN, ETXER valid | — | 25 | ns |
| M7 | ETXCLK pulse width high | 35% | 65% | ETXCLK period |
| M8 | ETXCLK pulse width low | 35% | 65% | ETXCLK period |

Figure 20 shows MII transmit signal timings listed in Table 19.

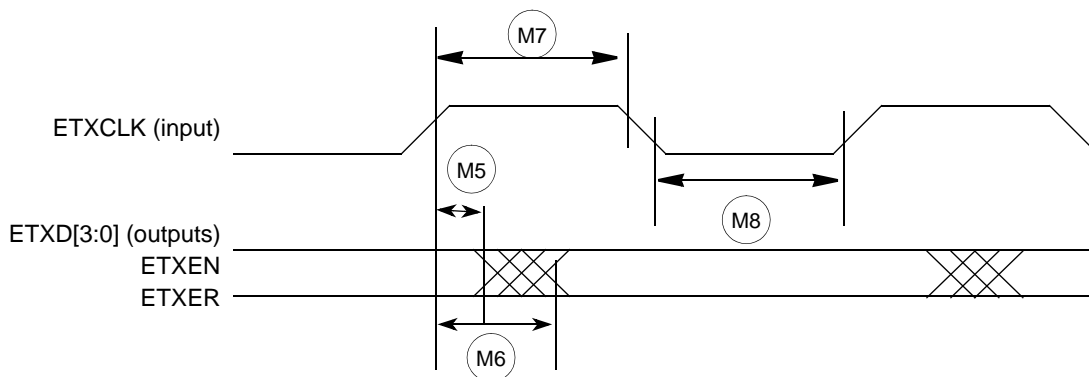


Figure 20. MII Transmit Signal Timing Diagram

7.10.3 MII Async Inputs Signal Timing (ECRS and ECOL)

Table 20 lists MII asynchronous inputs signal timing.

Table 20. MII Async Inputs Signal Timing

| Num | Characteristic | Min | Max | Unit |
|-----|--------------------------------|-----|-----|---------------|
| M9 | ECRS, ECOL minimum pulse width | 1.5 | — | ETXCLK period |

Figure 21 shows MII asynchronous input timings listed in Table 20.



Figure 21. MII Async Inputs Timing Diagram

7.10.4 MII Serial Management Channel Timing (EMDIO and EMDC)

Table 21 lists MII serial management channel timings. The FEC functions correctly with a maximum MDC frequency of 2.5 MHz.

Table 21. MII Serial Management Channel Timing

| Num | Characteristic | Min | Max | Unit |
|-----|---|-----|-----|------------|
| M10 | EMDC falling edge to EMDIO output invalid (minimum propagation delay) | 0 | — | ns |
| M11 | EMDC falling edge to EMDIO output valid (max prop delay) | — | 25 | ns |
| M12 | EMDIO (input) to EMDC rising edge setup | 10 | — | ns |
| M13 | EMDIO (input) to EMDC rising edge hold | 0 | — | ns |
| M14 | EMDC pulse width high | 40% | 60% | MDC period |
| M15 | EMDC pulse width low | 40% | 60% | MDC period |

Figure 22 shows MII serial management channel timings listed in Table 21.

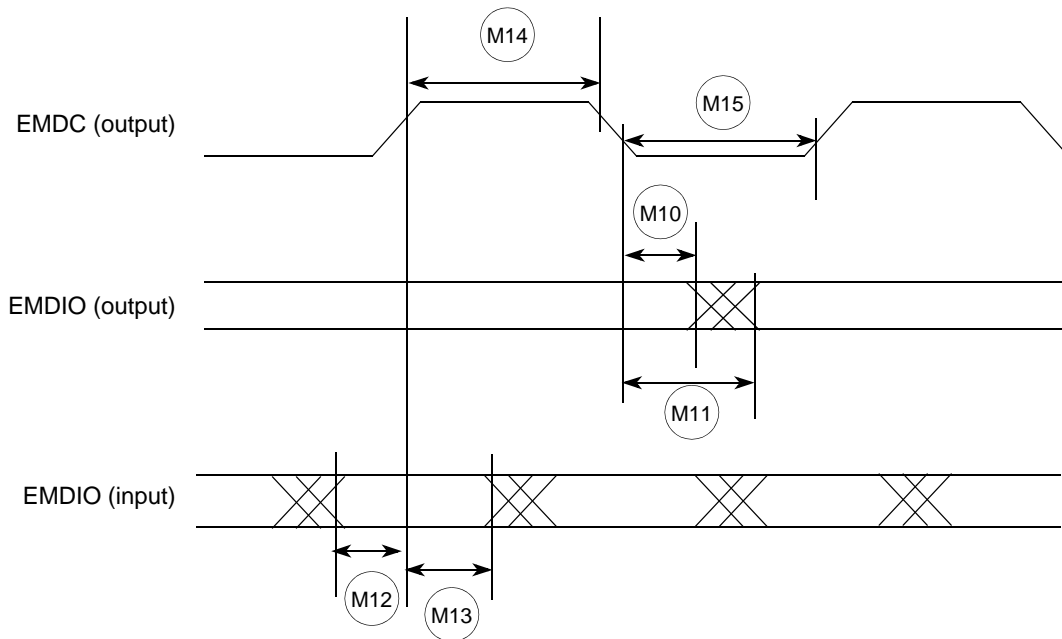


Figure 22. MII Serial Management Channel Timing Diagram

7.11 32-Bit Timer Module AC Timing Specifications

Table 22 lists timer module AC timings.

Table 22. Timer Module AC Timing Specifications

| Name | Characteristic | 0–66 MHz | | Unit |
|------|---|----------|-----|------------------|
| | | Min | Max | |
| T1 | DT0IN / DT1IN / DT2IN / DT3IN cycle time | 3 | — | t _{CYC} |
| T2 | DT0IN / DT1IN / DT2IN / DT3IN pulse width | 1 | — | t _{CYC} |

7.12 QSPI Electrical Specifications

Table 23 lists QSPI timings.

Table 23. QSPI Modules AC Timing Specifications

| Name | Characteristic | Min | Max | Unit |
|------|---|-----|-----|------|
| QS1 | QSPI_CS[1:0] to QSPI_CLK | 1 | 510 | tcyc |
| QS2 | QSPI_CLK high to QSPI_DOUT valid. | — | 10 | ns |
| QS3 | QSPI_CLK high to QSPI_DOUT invalid. (Output hold) | 2 | — | ns |
| QS4 | QSPI_DIN to QSPI_CLK (Input setup) | 9 | — | ns |
| QS5 | QSPI_DIN to QSPI_CLK (Input hold) | 9 | — | ns |

The values in Table 23 correspond to Figure 23.

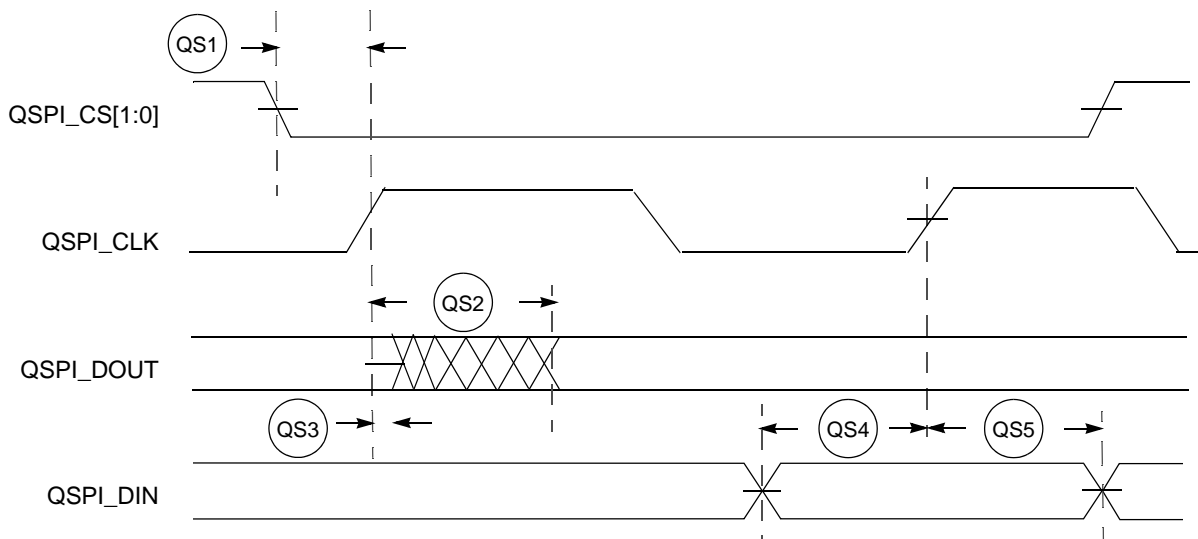


Figure 23. QSPI Timing

7.13 JTAG and Boundary Scan Timing

Table 24. JTAG and Boundary Scan Timing

| Num | Characteristics ¹ | Symbol | Min | Max | Unit |
|-----|--|--------------|-----|-----|-------------|
| J1 | TCLK Frequency of Operation | f_{JCYC} | DC | 1/4 | $f_{sys/2}$ |
| J2 | TCLK Cycle Period | t_{JCYC} | 4 | — | t_{CYC} |
| J3 | TCLK Clock Pulse Width | t_{JCW} | 26 | — | ns |
| J4 | TCLK Rise and Fall Times | t_{JCRF} | 0 | 3 | ns |
| J5 | Boundary Scan Input Data Setup Time to TCLK Rise | t_{BSDST} | 4 | — | ns |
| J6 | Boundary Scan Input Data Hold Time after TCLK Rise | t_{BSDHT} | 26 | — | ns |
| J7 | TCLK Low to Boundary Scan Output Data Valid | t_{BSDV} | 0 | 33 | ns |
| J8 | TCLK Low to Boundary Scan Output High Z | t_{BSDZ} | 0 | 33 | ns |
| J9 | TMS, TDI Input Data Setup Time to TCLK Rise | t_{TAPBST} | 4 | — | ns |
| J10 | TMS, TDI Input Data Hold Time after TCLK Rise | t_{TAPBHT} | 10 | — | ns |
| J11 | TCLK Low to TDO Data Valid | t_{TDODV} | 0 | 26 | ns |
| J12 | TCLK Low to TDO High Z | t_{TDODZ} | 0 | 8 | ns |
| J13 | \overline{TRST} Assert Time | t_{TRSTAT} | 100 | — | ns |
| J14 | \overline{TRST} Setup Time (Negation) to TCLK High | t_{TRSTST} | 10 | — | ns |

¹ JTAG_EN is expected to be a static signal. Hence, specific timing is not associated with it.

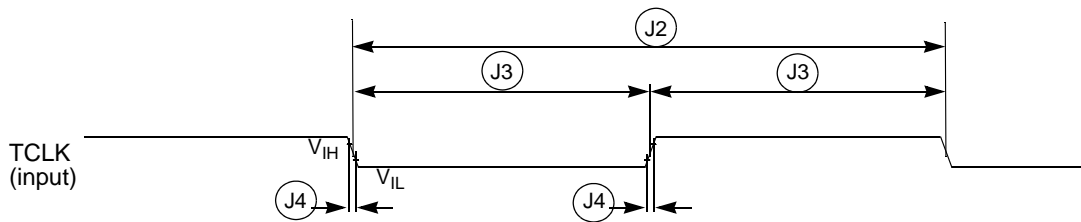


Figure 24. Test Clock Input Timing

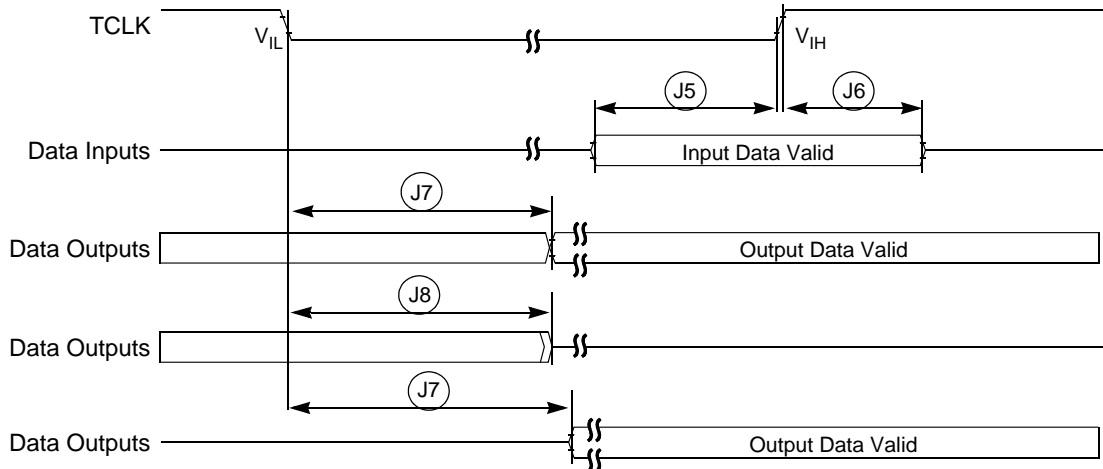


Figure 25. Boundary Scan (JTAG) Timing

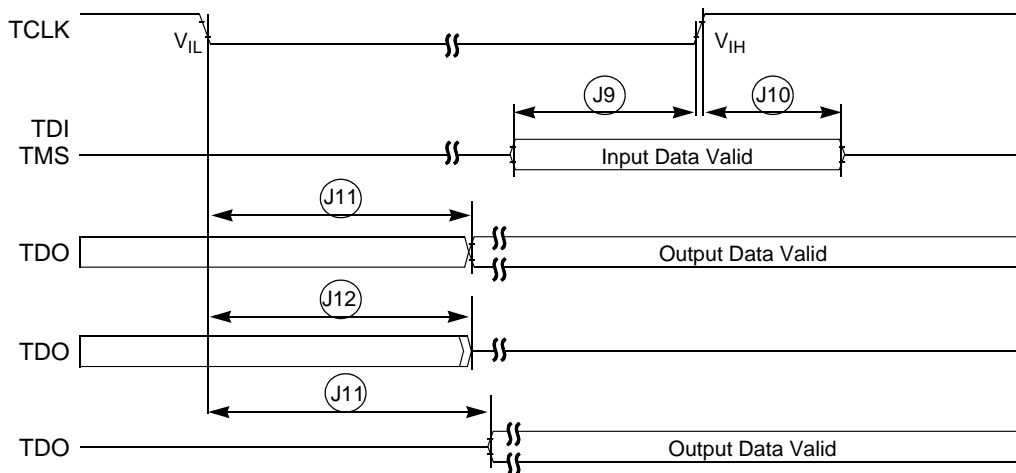


Figure 26. Test Access Port Timing

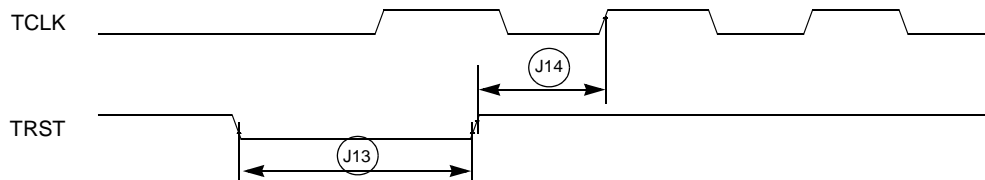


Figure 27. $\overline{\text{TRST}}$ Timing

7.14 Debug AC Timing Specifications

Table 25 lists specifications for the debug AC timing parameters shown in Figure 29.

Table 25. Debug AC Timing Specification

| Num | Characteristic | 150 MHz | | Units |
|------------------|--|---------|-----|-----------|
| | | Min | Max | |
| DE0 | PSTCLK cycle time | — | 0.5 | t_{cyc} |
| DE1 | PST valid to PSTCLK high | 4 | — | ns |
| DE2 | PSTCLK high to PST invalid | 1.5 | — | ns |
| DE3 | DSCLK cycle time | 5 | — | t_{cyc} |
| DE4 | DSI valid to DSCLK high | 1 | — | t_{cyc} |
| DE5 ¹ | DSCLK high to DSO invalid | 4 | — | t_{cyc} |
| DE6 | \overline{BKPT} input data setup time to CLKOUT rise | 4 | — | ns |
| DE7 | CLKOUT high to \overline{BKPT} high Z | 0 | 10 | ns |

¹ DSCLK and DSI are synchronized internally. D4 is measured from the synchronized DSCLK input relative to the rising edge of CLKOUT.

Figure 28 shows real-time trace timing for the values in Table 25.

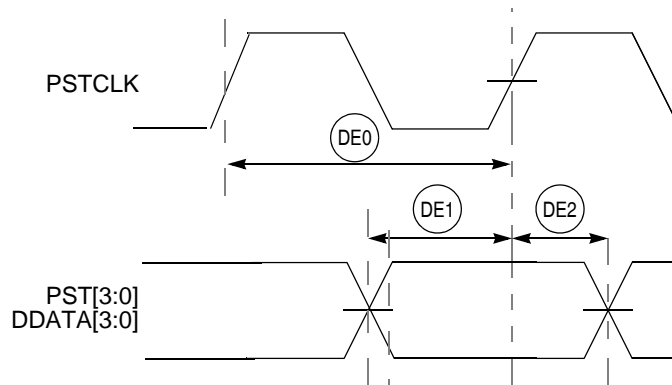


Figure 28. Real-Time Trace AC Timing

Figure 29 shows BDM serial port AC timing for the values in Table 25.

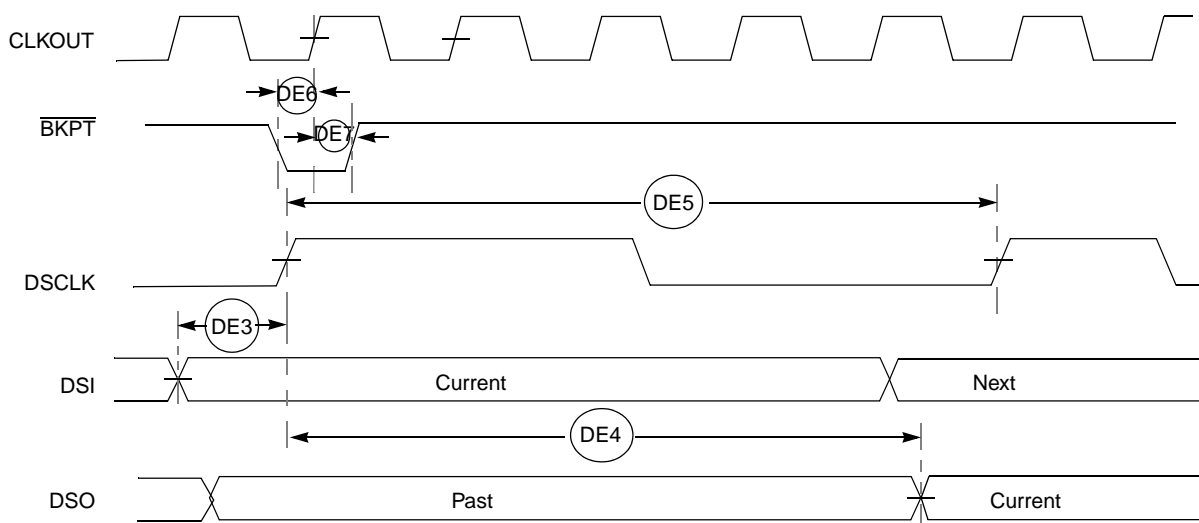


Figure 29. BDM Serial Port AC Timing

8 Documentation

Documentation regarding the MCF523x and their development support tools is available from a local Freescale distributor, a Freescale semiconductor sales office, the Freescale Literature Distribution Center, or through the Freescale web address at <http://www.freescale.com/coldfire>.

9 Document Revision History

The below table provides a revision history for this document.

Table 26. MCF5235EC Revision History

| Rev. No. | Substantive Change(s) |
|----------|--|
| 0 | Preliminary release. |
| 1 | <ul style="list-style-type: none"> Updated Signal List table |
| 1.1 | <ul style="list-style-type: none"> Removed duplicate information in the module description sections. The information is all in the Signals Description Table. |
| 1.2 | <ul style="list-style-type: none"> Corrected Figure 8 pin 81. VDD instead of VSS Changed instances of Motorola to Freescale |
| 1.3 | <ul style="list-style-type: none"> Removed detailed signal description section. This information can be found in the MCF5235RM Chapter 2. Removed detailed feature list. This information can be found in the MCF5235RM Chapter 1. Corrected Figure 2 pin F10. VSS instead of VDD. Change made in Table 2 as well. Corrected Figure 8 pin 81. OVDD instead of VDD. Change made in Table 2 as well. Cleaned up many inconsistencies within the pinout figure signal names Corrected document IDs in Documentation Table |
| 1.4 | <ul style="list-style-type: none"> Added values for 'Maximum operating junction temperature' in Table 8. Added typical values for 'Core operating supply current (master mode)' in Table 9. Added typical values for 'Pad operating supply current (master mode)' in Table 9. Removed unnecessary PLL specifications, #6-9, in Table 10. |

Table 26. MCF5235EC Revision History (continued)

| Rev. No. | Substantive Change(s) |
|----------|--|
| 1.5 | <ul style="list-style-type: none"> Removed Overview, Features, Modes of Operation, and Address Multiplexing sections. This information can be found in the MCF5235 Reference Manual. Removed list of documentation table in Section 8, "Documentation." An up-to-date list is always available on our web site. |
| 1.6 | <ul style="list-style-type: none"> Table 9: Changed core supply voltage (V_{DD}) from 1.35-1.65 to 1.4-1.6. |
| 1.7 | <ul style="list-style-type: none"> Table 10: Changed max f_{IC0} frequency from "75 MHz" to "150 MHz". |
| 1.8 | <ul style="list-style-type: none"> Added Section 5.2.1, "Supply Voltage Sequencing and Separation Cautions." Updated 196MAPBGA package dimensions, Figure 3. |
| 2 | <ul style="list-style-type: none"> Table 2: Changed SD_CKE pin location from 139 to "—" for the 160QFP device. Changed QSPI_CS1 pin location from "—" to 139 for the 160QFP device. Figure 8: Changed pin 139 label from "SD_CKE/QSPI_CS1" to "QSPI_CS1/SD_CKE". Removed second sentence from Section 7.10.1, "MII Receive Signal Timing (ERXD[3:0], ERXDV, ERXER, and ERXCLK)," and Section 7.10.2, "MII Transmit Signal Timing (ETXD[3:0], ETXEN, ETXER, ETXCLK)," regarding no minimum frequency requirement for TXCLK. Removed third and fourth paragraphs from Section 7.10.2, "MII Transmit Signal Timing (ETXD[3:0], ETXEN, ETXER, ETXCLK)," as this feature is not supported on this device. |
| 3 | <ul style="list-style-type: none"> Section 5.2.1, "Supply Voltage Sequencing and Separation Cautions" changed $PLL V_{DD}$ to V_{DDPLL} to match rest of document. Section 5.2.1, "Supply Voltage Sequencing and Separation Cautions" Changed V_{DDPLL} voltage level from 1.5V to 3.3V throughout section. Section 5.2.1.1, "Power Up Sequence" first bullet, changed "Use 1 μs" to "Use 1 ms". Corrected position of spec D5 in Figure 14. Table 14: Added \overline{DACKn} and \overline{DREQn} to footnote. Table 9, added PLL supply voltage row |
| 4 | <ul style="list-style-type: none"> Added part number MCF5235CVF150 in Table 6 |

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Europe, Middle East, and Africa:

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Technical Information Center
Schatzbogen 7
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+44 1296 380 456 (English)
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+33 1 69 35 48 48 (French)
support@freescale.com

Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
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Asia/Pacific:

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