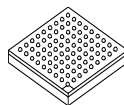
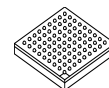


## MCF5329



MAPBGA-256  
17mm x 17mm



MAPBGA-196  
15mm x 15mm

# MCF532x ColdFire® Microprocessor Data Sheet

### Features

- Version 3 ColdFire variable-length RISC processor core
- System debug support
- JTAG support for system level board testing
- On-chip memories
  - 16-Kbyte unified write-back cache
  - 32-Kbyte dual-ported SRAM on CPU internal bus, accessible by core and non-core bus masters (e.g., DMA, FEC, LCD controller, and USB host and OTG)
- Power management
- Liquid Crystal Display Controller (LCDC)
- Embedded Voice-over-IP (VoIP) system solution
- SDR/DDR SDRAM Controller
- Universal Serial Bus (USB) Host Controller
- Universal Serial Bus (USB) On-the-Go (OTG) controller
- Synchronous Serial Interface (SSI)
- Fast Ethernet Controller (FEC)
- Cryptography Hardware Accelerators
- FlexCAN Module
- Three Universal Asynchronous Receiver Transmitters (UARTs)
- I<sup>2</sup>C Module
- Queued Serial Peripheral Interface (QSPI)
- Pulse Width Modulation (PWM) module
- Real Time Clock
- Four 32-bit DMA Timers
- Software Watchdog Timer
- Four Periodic Interrupt Timers (PITs)
- Phase Locked Loop (PLL)
- Interrupt Controllers (x2)
- DMA Controller
- FlexBus (External Interface)
- Chip Configuration Module (CCM)
- Reset Controller
- General Purpose I/O interface

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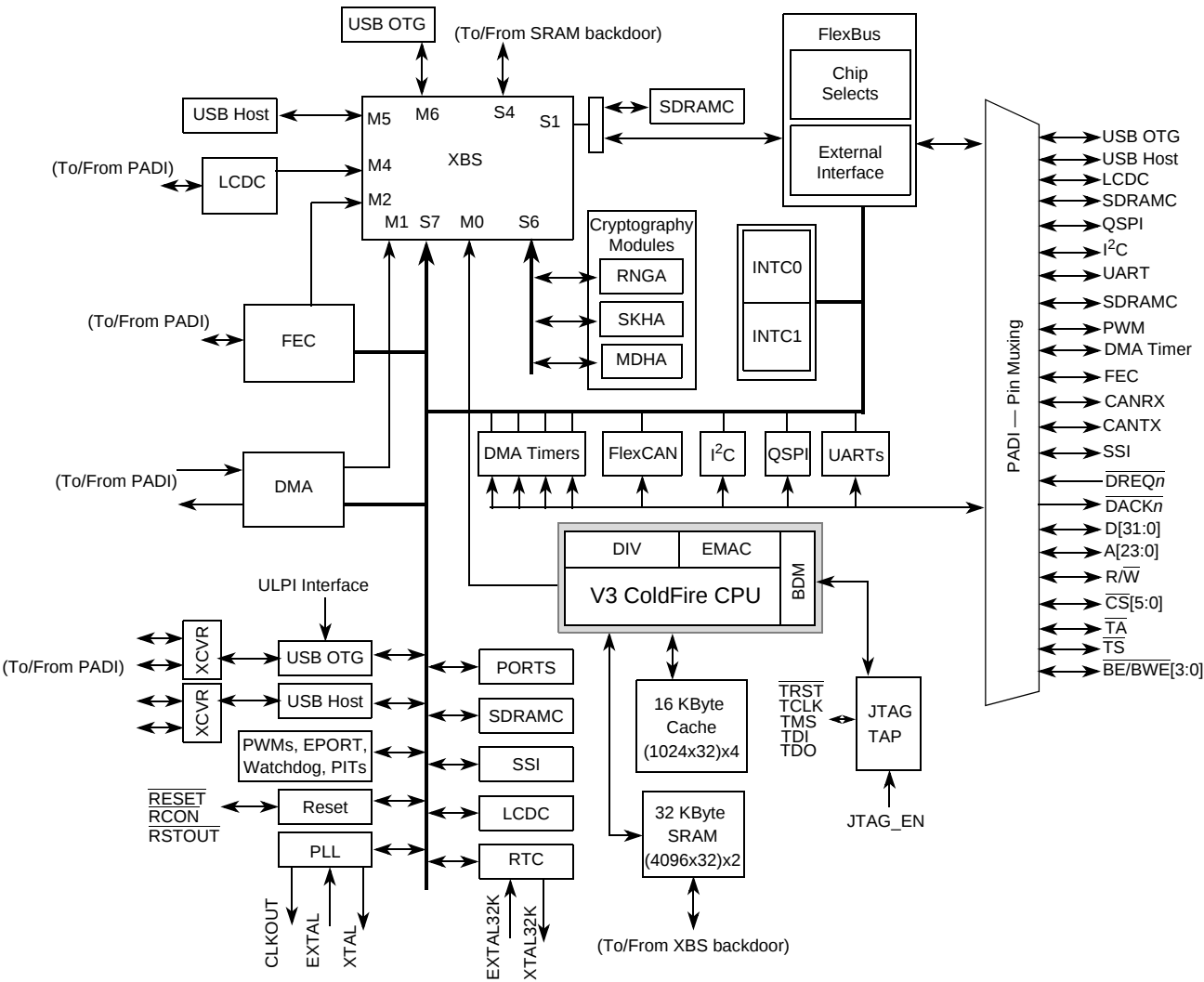


Figure 1. MCF5329 Block Diagram

# 1 MCF532x Family Comparison

The following table compares the various device derivatives available within the MCF532x family.

Table 1. MCF532x Family Configurations

| Module                                                                | MCF5327       | MCF5328 | MCF53281 | MCF5329 |
|-----------------------------------------------------------------------|---------------|---------|----------|---------|
| ColdFire Version 3 Core with EMAC (Enhanced Multiply-Accumulate Unit) | .             | .       | .        | .       |
| Core (System) Clock                                                   | up to 240 MHz |         |          |         |
| Peripheral and External Bus Clock (Core clock ÷ 3)                    | up to 80 MHz  |         |          |         |
| Performance (Dhrystone/2.1 MIPS)                                      | up to 211     |         |          |         |
| Unified Cache                                                         | 16 Kbytes     |         |          |         |
| Static RAM (SRAM)                                                     | 32 Kbytes     |         |          |         |

**Table 1. MCF532x Family Configurations (continued)**

| Module                                 | MCF5327       | MCF5328       | MCF53281      | MCF5329       |
|----------------------------------------|---------------|---------------|---------------|---------------|
| LCD Controller                         | •             | •             | •             | •             |
| SDR/DDR SDRAM Controller               | •             | •             | •             | •             |
| USB 2.0 Host                           | •             | •             | •             | •             |
| USB 2.0 On-the-Go                      | •             | •             | •             | •             |
| UTMI+ Low Pin Interface (ULPI)         | —             | •             | •             | •             |
| Synchronous Serial Interface (SSI)     | •             | •             | •             | •             |
| Fast Ethernet Controller (FEC)         | —             | •             | •             | •             |
| Cryptography Hardware Accelerators     | —             | —             | —             | •             |
| Embedded Voice-over-IP System Solution | —             | —             | •             | —             |
| FlexCAN 2.0B communication module      | —             | —             | •             | •             |
| UARTs                                  | 3             | 3             | 3             | 3             |
| I <sup>2</sup> C                       | •             | •             | •             | •             |
| QSPI                                   | •             | •             | •             | •             |
| PWM Module                             | •             | •             | •             | •             |
| Real Time Clock                        | •             | •             | •             | •             |
| 32-bit DMA Timers                      | 4             | 4             | 4             | 4             |
| Watchdog Timer (WDT)                   | •             | •             | •             | •             |
| Periodic Interrupt Timers (PIT)        | 4             | 4             | 4             | 4             |
| Edge Port Module (EPORT)               | •             | •             | •             | •             |
| Interrupt Controllers (INTC)           | 2             | 2             | 2             | 2             |
| 16-channel Direct Memory Access (DMA)  | •             | •             | •             | •             |
| FlexBus External Interface             | •             | •             | •             | •             |
| General Purpose I/O Module (GPIO)      | •             | •             | •             | •             |
| JTAG - IEEE® 1149.1 Test Access Port   | •             | •             | •             | •             |
| Package                                | 196<br>MAPBGA | 256<br>MAPBGA | 256<br>MAPBGA | 256<br>MAPBGA |

## 2 Ordering Information

**Table 2. Orderable Part Numbers**

| Freescall Part Number | Description                  | Package    | Speed   | Temperature    |
|-----------------------|------------------------------|------------|---------|----------------|
| MCF5327CVM240         | MCF5327 RISC Microprocessor  | 196 MAPBGA | 240 MHz | –40° to +85° C |
| MCF5328CVM240         | MCF5328 RISC Microprocessor  | 256 MAPBGA | 240 MHz | –40° to +85° C |
| MCF53281CVM240        | MCF53281 RISC Microprocessor | 256 MAPBGA | 240 MHz | –40° to +85° C |
| MCF5329CVM240         | MCF5329 RISC Microprocessor  | 256 MAPBGA | 240 MHz | –40° to +85° C |

## 3 Hardware Design Considerations

### 3.1 PLL Power Filtering

To further enhance noise isolation, an external filter is strongly recommended for PLL analog  $V_{DD}$  pins. The filter shown in Figure 2 should be connected between the board  $V_{DD}$  and the PLL $V_{DD}$  pins. The resistor and capacitors should be placed as close to the dedicated PLL $V_{DD}$  pin as possible.

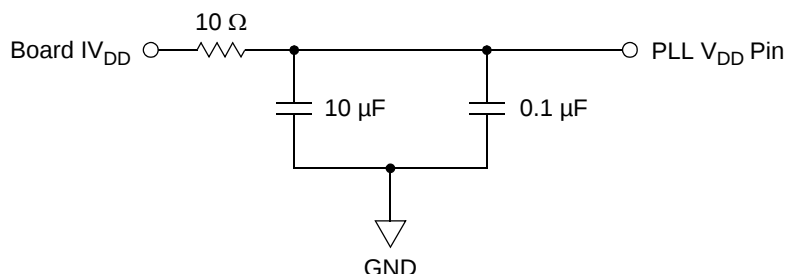


Figure 2. System PLL  $V_{DD}$  Power Filter

### 3.2 USB Power Filtering

To minimize noise, external filters are required for each of the USB power pins. The filter shown in Figure 3 should be connected between the board  $E_{VDD}$  or  $I_{VDD}$  and each of the USB $V_{DD}$  pins. The resistor and capacitors should be placed as close to the dedicated USB $V_{DD}$  pin as possible.

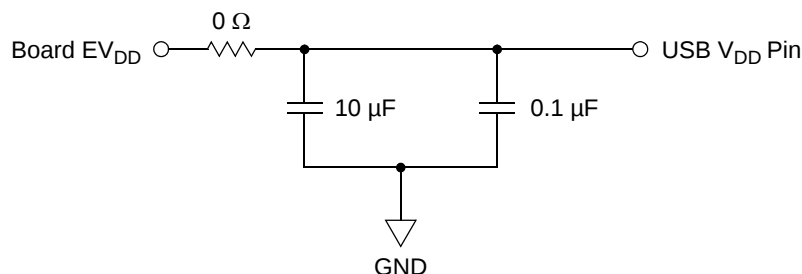


Figure 3. USB  $V_{DD}$  Power Filter

#### NOTE

In addition to the above filter circuitry, a 0.01 F capacitor is also recommended in parallel with those shown.

### 3.3 Supply Voltage Sequencing and Separation Cautions

The relationship between  $SDV_{DD}$  and  $EV_{DD}$  is non-critical during power-up and power-down sequences.  $SDV_{DD}$  (2.5V or 3.3V) and  $EV_{DD}$  are specified relative to  $IV_{DD}$ .

#### 3.3.1 Power Up Sequence

If  $EV_{DD}/SDV_{DD}$  are powered up with  $IV_{DD}$  at 0 V, the sense circuits in the I/O pads cause all pad output drivers connected to the  $EV_{DD}/SDV_{DD}$  to be in a high impedance state. There is no limit on how long after  $EV_{DD}/SDV_{DD}$  powers up before  $IV_{DD}$  must powered up.  $IV_{DD}$  should not lead the  $EV_{DD}$ ,  $SDV_{DD}$ , or PLL $V_{DD}$  by more than 0.4 V during power ramp-up or there is

high current in the internal ESD protection diodes. The rise times on the power supplies should be slower than 500 us to avoid turning on the internal ESD protection clamp diodes.

## 3.3.2 Power Down Sequence

If  $IV_{DD}/PLL_{V_{DD}}$  are powered down first, 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  $IV_{DD}$  and  $PLL_{V_{DD}}$  power down before  $EV_{DD}$  or  $SDV_{DD}$  must power down.  $IV_{DD}$  should not lag  $EV_{DD}$ ,  $SDV_{DD}$ , or  $PLL_{V_{DD}}$  going low by more than 0.4 V during power down or there is 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  $IV_{DD}/PLL_{V_{DD}}$  to 0 V.
2. Drop  $EV_{DD}/SDV_{DD}$  supplies.

## 4 Pin Assignments and Reset States

### 4.1 Signal Multiplexing

The following table lists all the MCF532x pins grouped by function. The Dir column is the direction for the primary function of the pin only. Refer to [Section 7, “Package Information,”](#) for package diagrams. For a more detailed discussion of the MCF532x signals, consult the *MCF5329 Reference Manual* (MCF5329RM).

#### NOTE

In this table and throughout this document, a single signal within a group is designated without square brackets (i.e., A23), 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 default to their GPIO functionality.

**Table 3. MCF5327/8/9 Signal Information and Muxing**

| Signal Name                 | GPIO | Alternate 1 | Alternate 2 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA | MCF5328<br>256<br>MAPBGA | MCF53281<br>MCF5329<br>256<br>MAPBGA |
|-----------------------------|------|-------------|-------------|-------------------|----------------|--------------------------|--------------------------|--------------------------------------|
| <b>Reset</b>                |      |             |             |                   |                |                          |                          |                                      |
| $\overline{\text{RESET}}^2$ | —    | —           | —           | I                 | EVDD           | J11                      | N15                      | N15                                  |
| $\overline{\text{RSTOUT}}$  | —    | —           | —           | O                 | EVDD           | P14                      | P14                      | P14                                  |
| <b>Clock</b>                |      |             |             |                   |                |                          |                          |                                      |
| EXTAL                       | —    | —           | —           | I                 | EVDD           | L14                      | P16                      | P16                                  |
| XTAL <sup>2</sup>           | —    | —           | —           | O                 | EVDD           | K14                      | N16                      | N16                                  |
| EXTAL32K                    | —    | —           | —           | I                 | EVDD           | M11                      | P13                      | P13                                  |
| XTAL32K                     | —    | —           | —           | O                 | EVDD           | N11                      | R13                      | R13                                  |
| FB_CLK                      | —    | —           | —           | O                 | SDVDD          | L1                       | T2                       | T2                                   |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name       | GPIO     | Alternate 1              | Alternate 2 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA                                     | MCF5328<br>256<br>MAPBGA                                 | MCF53281<br>MCF5329<br>256<br>MAPBGA                     |
|-------------------|----------|--------------------------|-------------|-------------------|----------------|--------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| Mode Selection    |          |                          |             |                   |                |                                                              |                                                          |                                                          |
| RCON <sup>2</sup> | —        | —                        | —           | I                 | EVDD           | M7                                                           | M8                                                       | M8                                                       |
| DRAMSEL           | —        | —                        | —           | I                 | EVDD           | G11                                                          | H12                                                      | H12                                                      |
| FlexBus           |          |                          |             |                   |                |                                                              |                                                          |                                                          |
| A[23:22]          | —        | FB_CS[5:4]               | —           | O                 | SDVDD          | B11, C11                                                     | C13, D13                                                 | C13, D13                                                 |
| A[21:16]          | —        | —                        | —           | O                 | SDVDD          | B12, A12,<br>D11, C12,<br>B13, A13                           | E13, A14,<br>B14, C14,<br>A15, B15                       | E13, A14,<br>B14, C14,<br>A15, B15                       |
| A[15:14]          | —        | SD_BA[1:0] <sup>3</sup>  | —           | O                 | SDVDD          | A14, B14                                                     | D14, B16                                                 | D14, B16                                                 |
| A[13:11]          | —        | SD_A[13:11] <sup>3</sup> | —           | O                 | SDVDD          | C13, C14,<br>D12                                             | C15, C16,<br>D15                                         | C15, C16,<br>D15                                         |
| A10               | —        | —                        | —           | O                 | SDVDD          | D13                                                          | D16                                                      | D16                                                      |
| A[9:0]            | —        | SD_A[9:0] <sup>3</sup>   | —           | O                 | SDVDD          | D14,<br>E11–14,<br>F11–F14,<br>G14                           | E14–E16,<br>F13–F16,<br>G16– G14                         | E14–E16,<br>F13–F16,<br>G16– G14                         |
| D[31:16]          | —        | SD_D[31:16] <sup>4</sup> | —           | I/O               | SDVDD          | H3–H1,<br>J4–J1, K1,<br>L4, M2, M3,<br>N1, N2, P1,<br>P2, N3 | M1–M4,<br>N1–N4, T3,<br>P4, R4, T4,<br>N5, P5, R5,<br>T5 | M1–M4,<br>N1–N4, T3,<br>P4, R4, T4,<br>N5, P5, R5,<br>T5 |
| D[15:1]           | —        | FB_D[31:17] <sup>4</sup> | —           | I/O               | SDVDD          | F4–F1,<br>G5–G2, L5,<br>N4, P4, M5,<br>N5, P5, L6            | J3–J1,<br>K4–K1, L2,<br>R6, N7, P7,<br>R7, T7, P8,<br>R8 | J3–J1,<br>K4–K1, L2,<br>R6, N7, P7,<br>R7, T7, P8,<br>R8 |
| D0 <sup>2</sup>   | —        | FB_D[16] <sup>4</sup>    | —           | I/O               | SDVDD          | M6                                                           | T8                                                       | T8                                                       |
| BE/BWE[3:0]       | PBE[3:0] | SD_DQM[3:0] <sup>3</sup> | —           | O                 | SDVDD          | H4, P3, G1,<br>M4                                            | L4, P6, L3,<br>N6                                        | L4, P6, L3,<br>N6                                        |
| OE                | PBUSCTL3 | —                        | —           | O                 | SDVDD          | P6                                                           | R9                                                       | R9                                                       |
| TA <sup>2</sup>   | PBUSCTL2 | —                        | —           | I                 | SDVDD          | G13                                                          | G13                                                      | G13                                                      |
| R/W               | PBUSCTL1 | —                        | —           | O                 | SDVDD          | N6                                                           | N8                                                       | N8                                                       |
| TS                | PBUSCTL0 | DACK0                    | —           | O                 | SDVDD          | D2                                                           | H4                                                       | H4                                                       |
| Chip Selects      |          |                          |             |                   |                |                                                              |                                                          |                                                          |
| FB_CS[5:4]        | PCS[5:4] | —                        | —           | O                 | SDVDD          | —                                                            | B13, A13                                                 | B13, A13                                                 |
| FB_CS[3:1]        | PCS[3:1] | —                        | —           | O                 | SDVDD          | A11, D10,<br>C10                                             | A12, B12,<br>C12                                         | A12, B12,<br>C12                                         |
| FB_CS0            | —        | —                        | —           | O                 | SDVDD          | B10                                                          | D12                                                      | D12                                                      |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name                           | GPIO               | Alternate 1                 | Alternate 2 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA | MCF5328<br>256<br>MAPBGA | MCF53281<br>MCF5329<br>256<br>MAPBGA |
|---------------------------------------|--------------------|-----------------------------|-------------|-------------------|----------------|--------------------------|--------------------------|--------------------------------------|
| SDRAM Controller                      |                    |                             |             |                   |                |                          |                          |                                      |
| SD_A10                                | —                  | —                           | —           | O                 | SDVDD          | L2                       | P2                       | P2                                   |
| SD_CKE                                | —                  | —                           | —           | O                 | SDVDD          | E1                       | H2                       | H2                                   |
| SD_CLK                                | —                  | —                           | —           | O                 | SDVDD          | K3                       | R1                       | R1                                   |
| $\overline{\text{SD\_CLK}}$           | —                  | —                           | —           | O                 | SDVDD          | K2                       | R2                       | R2                                   |
| $\overline{\text{SD\_CS1}}$           | —                  | —                           | —           | O                 | SDVDD          | —                        | J4                       | J4                                   |
| $\overline{\text{SD\_CS0}}$           | —                  | —                           | —           | O                 | SDVDD          | E2                       | H1                       | H1                                   |
| SD_DQS3                               | —                  | —                           | —           | O                 | SDVDD          | H5                       | L1                       | L1                                   |
| SD_DQS2                               | —                  | —                           | —           | O                 | SDVDD          | K6                       | T6                       | T6                                   |
| $\overline{\text{SD\_SCAS}}$          | —                  | —                           | —           | O                 | SDVDD          | L3                       | P3                       | P3                                   |
| $\overline{\text{SD\_SRAS}}$          | —                  | —                           | —           | O                 | SDVDD          | M1                       | R3                       | R3                                   |
| SD_SDR_DQS                            | —                  | —                           | —           | O                 | SDVDD          | K4                       | P1                       | P1                                   |
| $\overline{\text{SD\_WE}}$            | —                  | —                           | —           | O                 | SDVDD          | D1                       | H3                       | H3                                   |
| External Interrupts Port <sup>5</sup> |                    |                             |             |                   |                |                          |                          |                                      |
| $\overline{\text{IRQ7}}^2$            | PIRQ7 <sup>2</sup> | —                           | —           | I                 | EVDD           | J13                      | J13                      | J13                                  |
| $\overline{\text{IRQ6}}^2$            | PIRQ6 <sup>2</sup> | USBHOST_<br>VBUS_EN         | —           | I                 | EVDD           | —                        | J14                      | J14                                  |
| $\overline{\text{IRQ5}}^2$            | PIRQ5 <sup>2</sup> | USBHOST_<br>VBUS_OC         | —           | I                 | EVDD           | —                        | J15                      | J15                                  |
| $\overline{\text{IRQ4}}^2$            | PIRQ4 <sup>2</sup> | SSI_MCLK                    | —           | I                 | EVDD           | L13                      | J16                      | J16                                  |
| $\overline{\text{IRQ3}}^2$            | PIRQ3 <sup>2</sup> | —                           | —           | I                 | EVDD           | M14                      | K14                      | K14                                  |
| $\overline{\text{IRQ2}}^2$            | PIRQ2 <sup>2</sup> | USB_CLKIN                   | —           | I                 | EVDD           | M13                      | K15                      | K15                                  |
| $\overline{\text{IRQ1}}^2$            | PIRQ1 <sup>2</sup> | $\overline{\text{DREQ1}}^2$ | SSI_CLKIN   | I                 | EVDD           | N13                      | K16                      | K16                                  |
| FEC                                   |                    |                             |             |                   |                |                          |                          |                                      |
| FEC_MDC                               | PFECI2C3           | I2C_SCL <sup>2</sup>        | —           | O                 | EVDD           | —                        | C1                       | C1                                   |
| FEC_MDIO                              | PFECI2C2           | I2C_SDA <sup>2</sup>        | —           | I/O               | EVDD           | —                        | C2                       | C2                                   |
| FEC_TXCLK                             | PFECH7             | —                           | —           | I                 | EVDD           | —                        | A2                       | A2                                   |
| FEC_TXEN                              | PFECH6             | —                           | —           | O                 | EVDD           | —                        | B2                       | B2                                   |
| FEC_TXD0                              | PFECH5             | ULPI_DATA0                  | —           | O                 | EVDD           | —                        | E4                       | E4                                   |
| FEC_COL                               | PFECH4             | ULPI_CLK                    | —           | I                 | EVDD           | —                        | A8                       | A8                                   |
| FEC_RXCLK                             | PFECH3             | ULPI_NXT                    | —           | I                 | EVDD           | —                        | C8                       | C8                                   |
| FEC_RXDV                              | PFECH2             | ULPI_STP                    | —           | I                 | EVDD           | —                        | D8                       | D8                                   |
| FEC_RXD0                              | PFECH1             | ULPI_DATA4                  | —           | I                 | EVDD           | —                        | C6                       | C6                                   |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name           | GPIO        | Alternate 1    | Alternate 2 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA | MCF5328<br>256<br>MAPBGA | MCF53281<br>MCF5329<br>256<br>MAPBGA |
|-----------------------|-------------|----------------|-------------|-------------------|----------------|--------------------------|--------------------------|--------------------------------------|
| FEC_CRS               | PFECH0      | ULPI_DIR       | —           | I                 | EVDD           | —                        | B8                       | B8                                   |
| FEC_TXD[3:1]          | PFECL[7:5]  | ULPI_DATA[3:1] | —           | O                 | EVDD           | —                        | D3–D1                    | D3–D1                                |
| FEC_TXER              | PFECL4      | —              | —           | O                 | EVDD           | —                        | B1                       | B1                                   |
| FEC_RXD[3:1]          | PFECL[3:1]  | ULPI_DATA[7:5] | —           | I                 | EVDD           | —                        | E7, A6, B6               | E7, A6, B6                           |
| FEC_RXER              | PFECL0      | —              | —           | I                 | EVDD           | —                        | D4                       | D4                                   |
| <b>LCD Controller</b> |             |                |             |                   |                |                          |                          |                                      |
| LCD_D17               | PLCDDH1     | CANTX          | —           | O                 | EVDD           | —                        | —                        | C9                                   |
| LCD_D16               | PLCDDH0     | CANRX          | —           | O                 | EVDD           | —                        | —                        | D9                                   |
| LCD_D17               | PLCDDH1     | —              | —           | O                 | EVDD           | A6                       | C9                       | —                                    |
| LCD_D16               | PLCDDH0     | —              | —           | O                 | EVDD           | B6                       | D9                       | —                                    |
| LCD_D15               | PLCDDM7     | —              | —           | O                 | EVDD           | C6                       | A7                       | A7                                   |
| LCD_D14               | PLCDDM6     | —              | —           | O                 | EVDD           | D6                       | B7                       | B7                                   |
| LCD_D13               | PLCDDM5     | —              | —           | O                 | EVDD           | A5                       | C7                       | C7                                   |
| LCD_D12               | PLCDDM4     | —              | —           | O                 | EVDD           | B5                       | D7                       | D7                                   |
| LCD_D[11:8]           | PLCDDM[3:0] | —              | —           | O                 | EVDD           | C5, D5, A4,<br>B4        | D6, E6, A5,<br>B5        | D6, E6, A5,<br>B5                    |
| LCD_D7                | PLCDDL7     | —              | —           | O                 | EVDD           | C4                       | C5                       | C5                                   |
| LCD_D6                | PLCDDL6     | —              | —           | O                 | EVDD           | B3                       | D5                       | D5                                   |
| LCD_D5                | PLCDDL5     | —              | —           | O                 | EVDD           | A3                       | A4                       | A4                                   |
| LCD_D4                | PLCDDL4     | —              | —           | O                 | EVDD           | A2                       | A3                       | A3                                   |
| LCD_D[3:0]            | PLCDDL[3:0] | —              | —           | O                 | EVDD           | D4, C3, D3,<br>B2        | B4, C4, B3,<br>C3        | B4, C4, B3,<br>C3                    |
| LCD_ACD/<br>LCD_OE    | PLCDCTLH0   | —              | —           | O                 | EVDD           | D7                       | B9                       | B9                                   |
| LCD_CLS               | PLCDCTL7    | —              | —           | O                 | EVDD           | C7                       | A9                       | A9                                   |
| LCD_CONTRAST          | PLCDCTL6    | —              | —           | O                 | EVDD           | B7                       | D10                      | D10                                  |
| LCD_FLM/<br>LCD_VSYNC | PLCDCTL5    | —              | —           | O                 | EVDD           | A7                       | C10                      | C10                                  |
| LCD_LP/<br>LCD_HSYNC  | PLCDCTL4    | —              | —           | O                 | EVDD           | A8                       | B10                      | B10                                  |
| LCD_LSCLK             | PLCDCTL3    | —              | —           | O                 | EVDD           | B8                       | A10                      | A10                                  |
| LCD_PS                | PLCDCTL2    | —              | —           | O                 | EVDD           | C8                       | A11                      | A11                                  |
| LCD_REV               | PLCDCTL1    | —              | —           | O                 | EVDD           | D8                       | B11                      | B11                                  |
| LCD_SPL_SPR           | PLCDCTL0    | —              | —           | O                 | EVDD           | B9                       | C11                      | C11                                  |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name                                                                                                                                                                                                                                                                                | GPIO     | Alternate 1        | Alternate 2 | Di <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA | MCF5328<br>256<br>MAPBGA | MCF53281<br>MCF5329<br>256<br>MAPBGA |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------|-------------|-----------------|----------------|--------------------------|--------------------------|--------------------------------------|
| <b>USB Host &amp; USB On-the-Go</b>                                                                                                                                                                                                                                                        |          |                    |             |                 |                |                          |                          |                                      |
| USBOTG_M                                                                                                                                                                                                                                                                                   | —        | —                  | —           | I/O             | USB VDD        | G12                      | L15                      | L15                                  |
| USBOTG_P                                                                                                                                                                                                                                                                                   | —        | —                  | —           | I/O             | USB VDD        | H13                      | L16                      | L16                                  |
| USBHOST_M                                                                                                                                                                                                                                                                                  | —        | —                  | —           | I/O             | USB VDD        | K13                      | M15                      | M15                                  |
| USBHOST_P                                                                                                                                                                                                                                                                                  | —        | —                  | —           | I/O             | USB VDD        | J12                      | M16                      | M16                                  |
| <b>FlexCAN (MCF53281 &amp; MCF5329 only)</b>                                                                                                                                                                                                                                               |          |                    |             |                 |                |                          |                          |                                      |
| CANRX and CANTX do not have dedicated bond pads. Please refer to the following pins for muxing:<br>I2C_SDA, SSI_RXD, or LCD_D16 for CANRX and I2C_SCL, SSI_TXD, or LCD_D17 for CANTX.                                                                                                      |          |                    |             |                 |                |                          |                          |                                      |
| <b>PWM</b>                                                                                                                                                                                                                                                                                 |          |                    |             |                 |                |                          |                          |                                      |
| PWM7                                                                                                                                                                                                                                                                                       | PPWM7    | —                  | —           | I/O             | EVDD           | —                        | H13                      | H13                                  |
| PWM5                                                                                                                                                                                                                                                                                       | PPWM5    | —                  | —           | I/O             | EVDD           | —                        | H14                      | H14                                  |
| PWM3                                                                                                                                                                                                                                                                                       | PPWM3    | DT3OUT             | DT3IN       | I/O             | EVDD           | H14                      | H15                      | H15                                  |
| PWM1                                                                                                                                                                                                                                                                                       | PPWM1    | DT2OUT             | DT2IN       | I/O             | EVDD           | J14                      | H16                      | H16                                  |
| <b>SSI</b>                                                                                                                                                                                                                                                                                 |          |                    |             |                 |                |                          |                          |                                      |
| SSI_MCLK                                                                                                                                                                                                                                                                                   | PSSI4    | —                  | —           | I/O             | EVDD           | —                        | G4                       | G4                                   |
| SSI_BCLK                                                                                                                                                                                                                                                                                   | PSSI3    | $\overline{U2CTS}$ | PWM7        | I/O             | EVDD           | —                        | F4                       | F4                                   |
| SSI_FS                                                                                                                                                                                                                                                                                     | PSSI2    | $\overline{U2RTS}$ | PWM5        | I/O             | EVDD           | —                        | G3                       | G3                                   |
| SSI_RXD <sup>2</sup>                                                                                                                                                                                                                                                                       | PSSI1    | U2RXD              | CANRX       | I               | EVDD           | —                        | —                        | G2                                   |
| SSI_TXD <sup>2</sup>                                                                                                                                                                                                                                                                       | PSSI0    | U2TXD              | CANTX       | O               | EVDD           | —                        | —                        | G1                                   |
| SSI_RXD <sup>2</sup>                                                                                                                                                                                                                                                                       | PSSI1    | U2RXD              | —           | I               | EVDD           | —                        | G2                       | —                                    |
| SSI_TXD <sup>2</sup>                                                                                                                                                                                                                                                                       | PSSI0    | U2TXD              | —           | O               | EVDD           | —                        | G1                       | —                                    |
| <b>I<sup>2</sup>C</b>                                                                                                                                                                                                                                                                      |          |                    |             |                 |                |                          |                          |                                      |
| I2C_SCL <sup>2</sup>                                                                                                                                                                                                                                                                       | PFECI2C1 | CANTX              | U2TXD       | I/O             | EVDD           | —                        | —                        | F3                                   |
| I2C_SDA <sup>2</sup>                                                                                                                                                                                                                                                                       | PFECI2C0 | CANRX              | U2RXD       | I/O             | EVDD           | —                        | —                        | F2                                   |
| I2C_SCL <sup>2</sup>                                                                                                                                                                                                                                                                       | PFECI2C1 | —                  | U2TXD       | I/O             | EVDD           | E3                       | F3                       | —                                    |
| I2C_SDA <sup>2</sup>                                                                                                                                                                                                                                                                       | PFECI2C0 | —                  | U2RXD       | I/O             | EVDD           | E4                       | F2                       | —                                    |
| <b>DMA</b>                                                                                                                                                                                                                                                                                 |          |                    |             |                 |                |                          |                          |                                      |
| $\overline{DACK}[1:0]$ and $\overline{DREQ}[1:0]$ do not have dedicated bond pads. Please refer to the following pins for muxing:<br>$\overline{TS}$ for $\overline{DACK0}$ , DT0IN for $\overline{DREQ0}$ , DT1IN for $\overline{DACK1}$ , and $\overline{IRQ1}$ for $\overline{DREQ1}$ . |          |                    |             |                 |                |                          |                          |                                      |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name                                                                                | GPIO    | Alternate 1                | Alternate 2                 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA | MCF5328<br>256<br>MAPBGA | MCF53281<br>MCF5329<br>256<br>MAPBGA |
|--------------------------------------------------------------------------------------------|---------|----------------------------|-----------------------------|-------------------|----------------|--------------------------|--------------------------|--------------------------------------|
| <b>QSPI</b>                                                                                |         |                            |                             |                   |                |                          |                          |                                      |
| QSPI_CS2                                                                                   | PQSPI5  | $\overline{\text{U2RTS}}$  | —                           | O                 | EVDD           | P10                      | T12                      | T12                                  |
| QSPI_CS1                                                                                   | PQSPI4  | PWM7                       | USBOTG_<br>PU_EN            | O                 | EVDD           | L11                      | T13                      | T13                                  |
| QSPI_CS0                                                                                   | PQSPI3  | PWM5                       | —                           | O                 | EVDD           | —                        | P11                      | P11                                  |
| QSPI_CLK                                                                                   | PQSPI2  | I2C_SCL <sup>2</sup>       | —                           | O                 | EVDD           | N10                      | R12                      | R12                                  |
| QSPI_DIN                                                                                   | PQSPI1  | $\overline{\text{U2CTS}}$  | —                           | I                 | EVDD           | L10                      | N12                      | N12                                  |
| QSPI_DOUT                                                                                  | PQSPI0  | I2C_SDA                    | —                           | O                 | EVDD           | M10                      | P12                      | P12                                  |
| <b>UARTs</b>                                                                               |         |                            |                             |                   |                |                          |                          |                                      |
| $\overline{\text{U1CTS}}$                                                                  | PUARTL7 | SSI_BCLK                   | —                           | I                 | EVDD           | C9                       | D11                      | D11                                  |
| $\overline{\text{U1RTS}}$                                                                  | PUARTL6 | SSI_FS                     | —                           | O                 | EVDD           | D9                       | E10                      | E10                                  |
| U1TXD                                                                                      | PUARTL5 | SSI_TXD <sup>2</sup>       | —                           | O                 | EVDD           | A9                       | E11                      | E11                                  |
| U1RXD                                                                                      | PUARTL4 | SSI_RXD <sup>2</sup>       | —                           | I                 | EVDD           | A10                      | E12                      | E12                                  |
| $\overline{\text{U0CTS}}$                                                                  | PUARTL3 | —                          | —                           | I                 | EVDD           | P13                      | R15                      | R15                                  |
| $\overline{\text{U0RTS}}$                                                                  | PUARTL2 | —                          | —                           | O                 | EVDD           | N12                      | T15                      | T15                                  |
| U0TXD                                                                                      | PUARTL1 | —                          | —                           | O                 | EVDD           | P12                      | T14                      | T14                                  |
| U0RXD                                                                                      | PUARTL0 | —                          | —                           | I                 | EVDD           | P11                      | R14                      | R14                                  |
| <b>Note:</b> The UART2 signals are multiplexed on the QSPI, SSI, DMA Timers, and I2C pins. |         |                            |                             |                   |                |                          |                          |                                      |
| <b>DMA Timers</b>                                                                          |         |                            |                             |                   |                |                          |                          |                                      |
| DT3IN                                                                                      | PTIMER3 | DT3OUT                     | U2RXD                       | I                 | EVDD           | C1                       | F1                       | F1                                   |
| DT2IN                                                                                      | PTIMER2 | DT2OUT                     | U2TXD                       | I                 | EVDD           | B1                       | E1                       | E1                                   |
| DT1IN                                                                                      | PTIMER1 | DT1OUT                     | $\overline{\text{DACK1}}$   | I                 | EVDD           | A1                       | E2                       | E2                                   |
| DT0IN                                                                                      | PTIMER0 | DT0OUT                     | $\overline{\text{DREQ0}}^2$ | I                 | EVDD           | C2                       | E3                       | E3                                   |
| <b>BDM/JTAG<sup>6</sup></b>                                                                |         |                            |                             |                   |                |                          |                          |                                      |
| JTAG_EN <sup>7</sup>                                                                       | —       | —                          | —                           | I                 | EVDD           | L12                      | M13                      | M13                                  |
| DSCLK                                                                                      | —       | $\overline{\text{TRST}}^2$ | —                           | I                 | EVDD           | N14                      | P15                      | P15                                  |
| PSTCLK                                                                                     | —       | TCLK <sup>2</sup>          | —                           | O                 | EVDD           | L7                       | T9                       | T9                                   |
| $\overline{\text{BKPT}}$                                                                   | —       | TMS <sup>2</sup>           | —                           | I                 | EVDD           | M12                      | R16                      | R16                                  |
| DSI                                                                                        | —       | TDI <sup>2</sup>           | —                           | I                 | EVDD           | K12                      | N14                      | N14                                  |
| DSO                                                                                        | —       | TDO                        | —                           | O                 | EVDD           | N9                       | N11                      | N11                                  |
| DDATA[3:0]                                                                                 | —       | —                          | —                           | O                 | EVDD           | N7, P7, L8,<br>M8        | N9, P9, N10,<br>P10      | N9, P9, N10,<br>P10                  |

Table 3. MCF5327/8/9 Signal Information and Muxing (continued)

| Signal Name           | GPIO | Alternate 1 | Alternate 2 | Dir. <sup>1</sup> | Voltage Domain | MCF5327<br>196<br>MAPBGA                        | MCF5328<br>256<br>MAPBGA                                                 | MCF53281<br>MCF5329<br>256<br>MAPBGA                                     |
|-----------------------|------|-------------|-------------|-------------------|----------------|-------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| PST[3:0]              | —    | —           | —           | O                 | EVDD           | N8, P8, L9,<br>M9                               | R10, T10,<br>R11, T11                                                    | R10, T10,<br>R11, T11                                                    |
| <b>Test</b>           |      |             |             |                   |                |                                                 |                                                                          |                                                                          |
| TEST <sup>7</sup>     | —    | —           | —           | I                 | EVDD           | E10                                             | A16                                                                      | A16                                                                      |
| PLL_TEST <sup>8</sup> | —    | —           | —           | I                 | EVDD           | —                                               | N13                                                                      | N13                                                                      |
| <b>Power Supplies</b> |      |             |             |                   |                |                                                 |                                                                          |                                                                          |
| EVDD                  | —    | —           | —           | —                 | —              | E6, E7,<br>F5–F7, H9,<br>J8, J9, K8,<br>K9, K11 | E8, F5–F8,<br>G5, G6, H5,<br>H6, J11,<br>K11, K12,<br>L9–L11, M9,<br>M10 | E8, F5–F8,<br>G5, G6, H5,<br>H6, J11,<br>K11, K12,<br>L9–L11, M9,<br>M10 |
| IVDD                  | —    | —           | —           | —                 | —              | E5, K5, K10,<br>J10                             | E5, G12, M5,<br>M11, M12                                                 | E5, G12, M5,<br>M11, M12                                                 |
| PLL_VDD               | —    | —           | —           | —                 | —              | H10                                             | J12                                                                      | J12                                                                      |
| SD_VDD                | —    | —           | —           | —                 | —              | E8, E9,<br>F8–F10,<br>J5–J7, K7                 | E9, F9–F11,<br>G11, H11,<br>J5, J6, K5,<br>K6, L5–L8,<br>M6, M7          | E9, F9–F11,<br>G11, H11,<br>J5, J6, K5,<br>K6, L5–L8,<br>M6, M7          |
| USB_VDD               | —    | —           | —           | —                 | —              | G10                                             | L14                                                                      | L14                                                                      |
| VSS                   | —    | —           | —           | —                 | —              | G6–G9,<br>H6–H8, P9                             | G7–G10,<br>H7–H10,<br>J7–10,<br>K7–K10,<br>L12, L13                      | G7–G10,<br>H7–H10,<br>J7–10,<br>K7–K10,<br>L12, L13                      |
| PLL_VSS               | —    | —           | —           | —                 | —              | H11                                             | K13                                                                      | K13                                                                      |
| USB_VSS               | —    | —           | —           | —                 | —              | H12                                             | M14                                                                      | M14                                                                      |

<sup>1</sup> Refers to pin's primary function.

<sup>2</sup> Pull-up enabled internally on this signal for this mode.

<sup>3</sup> The SDRAM functions of these signals are not programmable by the user. They are dynamically switched by the processor when accessing SDRAM memory space and are included here for completeness.

<sup>4</sup> Primary functionality selected by asserting the DRAMSEL signal (SDR mode). Alternate functionality selected by negating the DRAMSEL signal (DDR mode). The GPIO module is not responsible for assigning these pins.

<sup>5</sup> GPIO functionality is determined by the edge port module. The GPIO module is only responsible for assigning the alternate functions.

<sup>6</sup> If JTAG\_EN is asserted, these pins default to Alternate 1 (JTAG) functionality. The GPIO module is not responsible for assigning these pins.

<sup>7</sup> Pull-down enabled internally on this signal for this mode.

<sup>8</sup> Must be left floating for proper operation of the PLL.



## NOTE

## 4.2 Pinout—256 MAPBGA

Figure 4 shows a pinout of the MCF5328CVM240, MCF53281CVM240, and MCF5329CVM240 devices.

## NOTE

The pin at location N13 (PLL\_TEST) must be left floating or improper operation of the PLL module occurs.

|   | 1         | 2         | 3        | 4        | 5      | 6        | 7        | 8         | 9           | 10            | 11          | 12        | 13        | 14          | 15         | 16         |   |
|---|-----------|-----------|----------|----------|--------|----------|----------|-----------|-------------|---------------|-------------|-----------|-----------|-------------|------------|------------|---|
| A | NC        | FEC_TXCLK | LCD_D4   | LCD_D5   | LCD_D9 | FEC_RXD2 | LCD_D15  | FEC_COL   | LCD_CLS     | LCD_LSCLK     | LCD_PS      | FB_CS3    | FB_CS4    | A20         | A17        | TEST       | A |
| B | FEC_TXER  | FEC_TXEN  | LCD_D1   | LCD_D3   | LCD_D8 | FEC_RXD1 | LCD_D14  | FEC_CRS   | LCD_ACD/OE  | LCD_LP/HSYNC  | LCD_REV     | FB_CS2    | FB_CS5    | A19         | A16        | A14        | B |
| C | FEC_MDC   | FEC_MDIO  | LCD_D0   | LCD_D2   | LCD_D7 | FEC_RXD0 | LCD_D13  | FEC_RXCLK | LCD_D17     | LCD_FLM/VSYNC | LCD_SPL_SPR | FB_CS1    | A23       | A18         | A13        | A12        | C |
| D | FEC_TXD1  | FEC_TXD2  | FEC_TXD3 | FEC_RXER | LCD_D6 | LCD_D11  | LCD_D12  | FEC_RXDV  | LCD_D16     | LCD_CON TRAST | U1CTS       | FB_CS0    | A22       | A15         | A11        | A10        | D |
| E | DT2IN     | DT1IN     | DT0IN    | FEC_TXD0 | IVDD   | LCD_D10  | FEC_RXD3 | EVDD      | SD_VDD      | U1RTS         | U1TXD       | U1RXD     | A21       | A9          | A8         | A7         | E |
| F | DT3IN     | I2C_SDA   | I2C_SCL  | SSI_BCLK | EVDD   | EVDD     | EVDD     | EVDD      | SD_VDD      | SD_VDD        | SD_VDD      | NC        | A6        | A5          | A4         | A3         | F |
| G | SSI_TXD   | SSI_RXD   | SSI_FS   | SSI_MCLK | EVDD   | EVDD     | VSS      | VSS       | VSS         | VSS           | SD_VDD      | IVDD      | TA        | A0          | A1         | A2         | G |
| H | SD_CS0    | SD_CKE    | SD_WE    | TS       | EVDD   | EVDD     | VSS      | VSS       | VSS         | VSS           | SD_VDD      | DRAM SEL  | PWM7      | PWM5        | PWM3       | PWM1       | H |
| J | D13       | D14       | D15      | SD_CS1   | SD_VDD | SD_VDD   | VSS      | VSS       | VSS         | VSS           | EVDD        | PLL_VDD   | IRQ7      | IRQ6        | IRQ5       | IRQ4       | J |
| K | D9        | D10       | D11      | D12      | SD_VDD | SD_VDD   | VSS      | VSS       | VSS         | VSS           | EVDD        | EVDD      | PLL_VSS   | IRQ3        | IRQ2       | IRQ1       | K |
| L | SD_DQS3   | D8        | BE/BWE1  | BE/BWE3  | SD_VDD | SD_VDD   | SD_VDD   | SD_VDD    | EVDD        | EVDD          | EVDD        | VSS       | USB_VSS   | USBOTG_VDD  | USB_OTG_M  | USB_OTG_P  | L |
| M | D31       | D30       | D29      | D28      | IVDD   | SD_VDD   | SD_VDD   | RCON      | EVDD        | EVDD          | IVDD        | IVDD      | JTAG_EN   | USBHOST_VSS | USB_HOST_M | USB_HOST_P | M |
| N | D27       | D26       | D25      | D24      | D19    | BE/BWE0  | D6       | R/W       | DDATA3      | DDATA1        | TDO/DSO     | QSPI_DIN  | PLL_TEST  | TDI/DSI     | RESET      | XTAL       | N |
| P | SD_DR_DQS | SD_A10    | SD_CAS   | D22      | D18    | BE/BWE2  | D5       | D2        | DDATA2      | DDATA0        | QSPI_CS0    | QSPI_DOUT | EXTAL_32K | RSTOUT      | TRST/DSCLK | EXTAL      | P |
| R | SD_CLK    | SD_CLK    | SD_RAS   | D21      | D17    | D7       | D4       | D1        | OE          | PST3          | PST1        | QSPI_CLK  | XTAL_32K  | U0RXD       | U0CTS      | TMS/BKPT   | R |
| T | NC        | FB_CLK    | D23      | D20      | D16    | SD_DQS2  | D3       | D0        | TCLK/PSTCLK | PST2          | PST0        | QSPI_CS2  | QSPI_CS1  | U0TXD       | U0RTS      | NC         | T |
|   | 1         | 2         | 3        | 4        | 5      | 6        | 7        | 8         | 9           | 10            | 11          | 12        | 13        | 14          | 15         | 16         |   |

Figure 4. MCF5328CVM240, MCF53281CVM240, and MCF5329CVM240 Pinout Top View (256 MAPBGA)

## 4.3 Pinout—196 MAPBGA

The pinout for the MCF5327CVM240 package is shown below.

|   | 1       | 2      | 3       | 4         | 5       | 6       | 7            | 8           | 9           | 10          | 11        | 12          | 13         | 14         |   |
|---|---------|--------|---------|-----------|---------|---------|--------------|-------------|-------------|-------------|-----------|-------------|------------|------------|---|
| A | DT1IN   | LCD_D4 | LCD_D5  | LCD_D9    | LCD_D13 | LCD_D17 | LCD_FLM/VSYN | LCD_LP/HSYN | U1TXD       | U1RXD       | FB_CS3    | A20         | A16        | A15        | A |
| B | D2TIN   | LCD_D0 | LCD_D6  | LCD_D8    | LCD_D12 | LCD_D16 | LCD_CONTRAST | LCD_LSCLK   | LCD_SPL_SPR | FB_CS0      | A23       | A21         | A17        | A14        | B |
| C | DT3IN   | DT0IN  | LCD_D2  | LCD_D7    | LCD_D11 | LCD_D15 | LCD_CLS      | LCD_PS      | U1CTS       | FB_CS1      | A22       | A18         | A13        | A12        | C |
| D | SD_WE   | TS     | LCD_D1  | LCD_D3    | LCD_D10 | LCD_D14 | LCD_ACD/OE   | LCD_REV     | U1RTS       | FB_CS2      | A19       | A11         | A10        | A9         | D |
| E | SD_CKE  | SD_CS0 | I2C_SCL | I2C_SDA   | IVDD    | EVDD    | EVDD         | SD_VDD      | SD_VDD      | TEST        | A8        | A7          | A6         | A5         | E |
| F | D12     | D13    | D14     | D15       | EVDD    | EVDD    | EVDD         | SD_VDD      | SD_VDD      | SD_VDD      | A4        | A3          | A2         | A1         | F |
| G | BE/BWE1 | D8     | D9      | D10       | D11     | VSS     | VSS          | VSS         | VSS         | USB_OTG_VDD | DRAM_SEL  | USB_OTG_M   | TA         | A0         | G |
| H | D29     | D30    | D31     | BE/BWE3   | SD_DQS3 | VSS     | VSS          | VSS         | EVDD        | PLL_VDD     | PLL_VSS   | USBHOST_VSS | USB_OTG_P  | PWM3       | H |
| J | D25     | D26    | D27     | D28       | SD_VDD  | SD_VDD  | SD_VDD       | EVDD        | EVDD        | IVDD        | RESET     | USB_HOST_P  | IRQ7       | PWM1       | J |
| K | D24     | SD_CLK | SD_CLK  | SD_DR_DQS | IVDD    | SD_DQS2 | SD_VDD       | EVDD        | EVDD        | IVDD        | EVDD      | TDI/DSI     | USB_HOST_M | XTAL       | K |
| L | FB_CLK  | SD_A10 | SD_CAS  | D23       | D7      | D1      | TCLK/PSTCLK  | DDATA1      | PST1        | QSPI_DIN    | QSPI_CS1  | JTAG_EN     | IRQ4       | EXTAL      | L |
| M | SD_RAS  | D22    | D21     | BE/BWE0   | D4      | D0      | RCON         | DDATA0      | PST0        | QSPI_DOUT   | EXTAL_32K | TMS/BKPT    | IRQ2       | IRQ3       | M |
| N | D20     | D19    | D16     | D6        | D3      | R/W     | DDATA3       | PST3        | TDO/DSO     | QSPI_CLK    | XTAL_32K  | U0RTS       | IRQ1       | TRST/DSCLK | N |
| P | D18     | D17    | BE/BWE2 | D5        | D2      | OE      | DDATA2       | PST2        | VSS         | QSPI_CS2    | U0RXD     | U0TXD       | U0CTS      | RSTOUT     | P |
|   | 1       | 2      | 3       | 4         | 5       | 6       | 7            | 8           | 9           | 10          | 11        | 12          | 13         | 14         |   |

Figure 5. MCF5327CVM240 Pinout Top View (196 MAPBGA)

## 5 Electrical Characteristics

This document contains electrical specification tables and reference timing diagrams for the MCF5329 microcontroller unit. This section contains detailed information on power considerations, DC/AC electrical characteristics, and AC timing specifications of MCF5329.

The electrical specifications are preliminary and are from previous designs or design simulations. These specifications may not be fully tested or guaranteed at this early stage of the product life cycle. However, for production silicon, these specifications will be met. Finalized specifications will be published after complete characterization and device qualifications have been completed.

## NOTE

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

## 5.1 Maximum Ratings

**Table 4. Absolute Maximum Ratings<sup>1, 2</sup>**

| Rating                                                                                     | Symbol                   | Value         | Unit |
|--------------------------------------------------------------------------------------------|--------------------------|---------------|------|
| Core Supply Voltage                                                                        | $IV_{DD}$                | – 0.5 to +2.0 | V    |
| CMOS Pad Supply Voltage                                                                    | $EV_{DD}$                | – 0.3 to +4.0 | V    |
| DDR/Memory Pad Supply Voltage                                                              | $SDV_{DD}$               | – 0.3 to +4.0 | V    |
| PLL Supply Voltage                                                                         | $PLLV_{DD}$              | – 0.3 to +2.0 | V    |
| Digital Input Voltage <sup>3</sup>                                                         | $V_{IN}$                 | – 0.3 to +3.6 | V    |
| Instantaneous Maximum Current<br>Single pin limit (applies to all pins) <sup>3, 4, 5</sup> | $I_D$                    | 25            | mA   |
| Operating Temperature Range (Packaged)                                                     | $T_A$<br>( $T_L - T_H$ ) | – 40 to +85   | °C   |
| Storage Temperature Range                                                                  | $T_{stg}$                | – 55 to +150  | °C   |

- <sup>1</sup> Functional operating conditions are given in [Section 5.4, “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.
- <sup>2</sup> 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 ( $V_{SS}$  or  $EV_{DD}$ ).
- <sup>3</sup> 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, and then use the larger of the two values.
- <sup>4</sup> All functional non-supply pins are internally clamped to  $V_{SS}$  and  $EV_{DD}$ .
- <sup>5</sup> Power supply must maintain regulation within operating  $EV_{DD}$  range during instantaneous and operating maximum current conditions. If positive injection current ( $V_{in} > EV_{DD}$ ) is greater than  $I_{DD}$ , the injection current may flow out of  $EV_{DD}$  and could result in external power supply going out of regulation. Ensure external  $EV_{DD}$  load shunts current greater than maximum injection current. This is the greatest risk when the MCU is not consuming power (ex; no clock). Power supply must maintain regulation within operating  $EV_{DD}$  range during instantaneous and operating maximum current conditions.

## 5.2 Thermal Characteristics

**Table 5. Thermal Characteristics**

| Characteristic                          |                         | Symbol         | 256MBGA           | 196MBGA           | Unit |
|-----------------------------------------|-------------------------|----------------|-------------------|-------------------|------|
| Junction to ambient, natural convection | Four layer board (2s2p) | $\theta_{JMA}$ | 37 <sup>1,2</sup> | 42 <sup>1,2</sup> | °C/W |
| Junction to ambient (@200 ft/min)       | Four layer board (2s2p) | $\theta_{JMA}$ | 34 <sup>1,2</sup> | 38 <sup>1,2</sup> | °C/W |
| Junction to board                       | —                       | $\theta_{JB}$  | 27 <sup>3</sup>   | 32 <sup>3</sup>   | °C/W |
| Junction to case                        | —                       | $\theta_{JC}$  | 16 <sup>4</sup>   | 19 <sup>4</sup>   | °C/W |
| Junction to top of package              | —                       | $\Psi_{jt}$    | 4 <sup>1,5</sup>  | 5 <sup>1,5</sup>  | °C/W |
| Maximum operating junction temperature  | —                       | $T_j$          | 105               | 105               | °C   |

<sup>1</sup>  $\theta_{JMA}$  and  $\Psi_{jt}$  parameters are simulated in conformance with EIA/JESD Standard 51-2 for natural convection. Freescale recommends the use of  $\theta_{JMA}$  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  $\Psi_{jt}$  parameter, the device power dissipation, and the method described in EIA/JESD Standard 51-2.

<sup>2</sup> Per JEDEC JESD51-6 with the board horizontal.

<sup>3</sup> 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.

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

<sup>5</sup> 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.

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

$$T_j = T_A + (P_D \times \theta_{JMA}) \quad \text{Eqn. 1}$$

Where:

|                |                                                                |
|----------------|----------------------------------------------------------------|
| $T_A$          | = Ambient Temperature, °C                                      |
| $\theta_{JMA}$ | = 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:

$$P_D = \frac{K}{(T_j + 273^\circ\text{C})} \quad \text{Eqn. 2}$$

Solving equations 1 and 2 for K gives:

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

## Electrical Characteristics

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 Equation 1 and Equation 2 iteratively for any value of  $T_A$ .

## 5.3 ESD Protection

**Table 6. ESD Protection Characteristics<sup>1, 2</sup>**

| Characteristics                 | Symbol | Value | Units |
|---------------------------------|--------|-------|-------|
| ESD Target for Human Body Model | HBM    | 2000  | V     |

<sup>1</sup> All ESD testing is in conformity with CDF-AEC-Q100 Stress Test Qualification for Automotive Grade Integrated Circuits.

<sup>2</sup> A device is defined as a failure if after exposure to ESD pulses the device no longer meets the device specification requirements. Complete DC parametric and functional testing is performed per applicable device specification at room temperature followed by hot temperature, unless specified otherwise in the device specification.

## 5.4 DC Electrical Specifications

**Table 7. DC Electrical Specifications**

| Characteristic                                                                                                                                                                     | Symbol       | Min                                                | Max                                                      | Unit |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------|----------------------------------------------------------|------|
| Core Supply Voltage                                                                                                                                                                | $IV_{DD}$    | 1.4                                                | 1.6                                                      | V    |
| PLL Supply Voltage                                                                                                                                                                 | $PLL V_{DD}$ | 1.4                                                | 1.6                                                      | V    |
| CMOS Pad Supply Voltage                                                                                                                                                            | $EV_{DD}$    | 3.0                                                | 3.6                                                      | V    |
| SDRAM and FlexBus Supply Voltage<br>Mobile DDR/Bus Pad Supply Voltage (nominal 1.8V)<br>DDR/Bus Pad Supply Voltage (nominal 2.5V)<br>SDR/Bus Pad Supply Voltage (nominal 3.3V)     | $SDV_{DD}$   | 1.70<br>2.25<br>3.0                                | 1.95<br>2.75<br>3.6                                      | V    |
| USB Supply Voltage                                                                                                                                                                 | $USB V_{DD}$ | 3.0                                                | 3.6                                                      | V    |
| CMOS Input High Voltage                                                                                                                                                            | $EV_{IH}$    | 2                                                  | $EV_{DD} + 0.3$                                          | V    |
| CMOS Input Low Voltage                                                                                                                                                             | $EV_{IL}$    | $V_{SS} - 0.3$                                     | 0.8                                                      | V    |
| CMOS Output High Voltage<br>$I_{OH} = -5.0$ mA                                                                                                                                     | $EV_{OH}$    | $EV_{DD} - 0.4$                                    | —                                                        | V    |
| CMOS Output Low Voltage<br>$I_{OL} = 5.0$ mA                                                                                                                                       | $EV_{OL}$    | —                                                  | 0.4                                                      | V    |
| SDRAM and FlexBus Input High Voltage<br>Mobile DDR/Bus Input High Voltage (nominal 1.8V)<br>DDR/Bus Pad Supply Voltage (nominal 2.5V)<br>SDR/Bus Pad Supply Voltage (nominal 3.3V) | $SDV_{IH}$   | 1.35<br>1.7<br>2                                   | $SDV_{DD} + 0.3$<br>$SDV_{DD} + 0.3$<br>$SDV_{DD} + 0.3$ | V    |
| SDRAM and FlexBus Input Low Voltage<br>Mobile DDR/Bus Input High Voltage (nominal 1.8V)<br>DDR/Bus Pad Supply Voltage (nominal 2.5V)<br>SDR/Bus Pad Supply Voltage (nominal 3.3V)  | $SDV_{IL}$   | $V_{SS} - 0.3$<br>$V_{SS} - 0.3$<br>$V_{SS} - 0.3$ | 0.45<br>0.8<br>0.8                                       | V    |

Table 7. DC Electrical Specifications (continued)

| Characteristic                                                                                                                                                                                                          | Symbol     | Min                             | Max               | Unit    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------------------|-------------------|---------|
| SDRAM and FlexBus Output High Voltage<br>Mobile DDR/Bus Input High Voltage (nominal 1.8V)<br>DDR/Bus Pad Supply Voltage (nominal 2.5V)<br>SDR/Bus Pad Supply Voltage (nominal 3.3V)<br>$I_{OH} = -5.0$ mA for all modes | $SDV_{OH}$ | $SDV_{DD} - 0.35$<br>2.1<br>2.4 | —<br>—<br>—       | V       |
| SDRAM and FlexBus Output Low Voltage<br>Mobile DDR/Bus Input High Voltage (nominal 1.8V)<br>DDR/Bus Pad Supply Voltage (nominal 2.5V)<br>SDR/Bus Pad Supply Voltage (nominal 3.3V)<br>$I_{OL} = 5.0$ mA for all modes   | $SDV_{OL}$ | —<br>—<br>—                     | 0.3<br>0.3<br>0.5 | V       |
| Input Leakage Current<br>$V_{in} = V_{DD}$ or $V_{SS}$ , Input-only pins                                                                                                                                                | $I_{in}$   | -1.0                            | 1.0               | $\mu$ A |
| Weak Internal Pull-Up Device Current, tested at $V_{IL}$ Max. <sup>1</sup>                                                                                                                                              | $I_{APU}$  | -10                             | -130              | $\mu$ A |
| Input Capacitance <sup>2</sup><br>All input-only pins<br>All input/output (three-state) pins                                                                                                                            | $C_{in}$   | —<br>—                          | 7<br>7            | pF      |

<sup>1</sup> Refer to the signals section for pins having weak internal pull-up devices.

<sup>2</sup> This parameter is characterized before qualification rather than 100% tested.

## 5.5 Oscillator and PLL Electrical Characteristics

Table 8. PLL Electrical Characteristics

| Num | Characteristic                                                                            | Symbol                               | Min. Value                                   | Max. Value                            | Unit       |
|-----|-------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------|---------------------------------------|------------|
| 1   | PLL Reference Frequency Range<br>Crystal reference<br>External reference                  | $f_{ref\_crystal}$<br>$f_{ref\_ext}$ | 12<br>12                                     | 25 <sup>1</sup><br>40 <sup>1</sup>    | MHz<br>MHz |
| 2   | Core frequency<br>CLKOUT Frequency <sup>2</sup>                                           | $f_{sys}$<br>$f_{sys/3}$             | $488 \times 10^{-6}$<br>$163 \times 10^{-6}$ | 240<br>80                             | MHz<br>MHz |
| 3   | Crystal Start-up Time <sup>3, 4</sup>                                                     | $t_{cst}$                            | —                                            | 10                                    | ms         |
| 4   | EXTAL Input High Voltage<br>Crystal Mode <sup>5</sup><br>All other modes (External, Limp) | $V_{IHEXT}$<br>$V_{IHEXT}$           | $V_{XTAL} + 0.4$<br>$E_{VDD}/2 + 0.4$        | —<br>—                                | V<br>V     |
| 5   | EXTAL Input Low Voltage<br>Crystal Mode <sup>5</sup><br>All other modes (External, Limp)  | $V_{ILEXT}$<br>$V_{ILEXT}$           | —<br>—                                       | $V_{XTAL} - 0.4$<br>$E_{VDD}/2 - 0.4$ | V<br>V     |
| 7   | PLL Lock Time <sup>3, 6</sup>                                                             | $t_{pll}$                            | —                                            | 50000                                 | CLKIN      |
| 8   | Duty Cycle of reference <sup>3</sup>                                                      | $t_{dc}$                             | 40                                           | 60                                    | %          |
| 9   | XTAL Current                                                                              | $I_{XTAL}$                           | 1                                            | 3                                     | mA         |
| 10  | Total on-chip stray capacitance on XTAL                                                   | $C_{S\_XTAL}$                        |                                              | 1.5                                   | pF         |
| 11  | Total on-chip stray capacitance on EXTAL                                                  | $C_{S\_EXTAL}$                       |                                              | 1.5                                   | pF         |

Table 8. PLL Electrical Characteristics (continued)

| Num | Characteristic                                                                                                                                 | Symbol         | Min. Value | Max. Value                                             | Unit                           |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------|--------------------------------------------------------|--------------------------------|
| 12  | Crystal capacitive load                                                                                                                        | $C_L$          |            | See crystal spec                                       |                                |
| 13  | Discrete load capacitance for XTAL                                                                                                             | $C_{L\_XTAL}$  |            | $2 * C_L - C_{S\_XTAL} - C_{PCB\_XTAL}$ <sup>7</sup>   | pF                             |
| 14  | Discrete load capacitance for EXTAL                                                                                                            | $C_{L\_EXTAL}$ |            | $2 * C_L - C_{S\_EXTAL} - C_{PCB\_EXTAL}$ <sup>7</sup> | pF                             |
| 17  | CLKOUT Period Jitter, <sup>3, 4, 7, 8, 9</sup> Measured at $f_{SYS}$ Max<br>Peak-to-peak Jitter (Clock edge to clock edge)<br>Long Term Jitter | $C_{jitter}$   | —<br>—     | 10<br>TBD                                              | % $f_{sys/3}$<br>% $f_{sys/3}$ |
| 18  | Frequency Modulation Range Limit <sup>3, 10, 11</sup><br>( $f_{sys}$ Max must not be exceeded)                                                 | $C_{mod}$      | 0.8        | 2.2                                                    | % $f_{sys/3}$                  |
| 19  | VCO Frequency. $f_{VCO} = (f_{ref} * PFD)/4$                                                                                                   | $f_{VCO}$      | 350        | 540                                                    | MHz                            |

<sup>1</sup> The maximum allowable input clock frequency when booting with the PLL enabled is 24MHz. For higher input clock frequencies the processor must boot in LIMP mode to avoid violating the maximum allowable CPU frequency.

<sup>2</sup> All internal registers retain data at 0 Hz.

<sup>3</sup> This parameter is guaranteed by characterization before qualification rather than 100% tested.

<sup>4</sup> Proper PC board layout procedures must be followed to achieve specifications.

<sup>5</sup> This parameter is guaranteed by design rather than 100% tested.

<sup>6</sup> This specification is the PLL lock time only and does not include oscillator start-up time.

<sup>7</sup>  $C_{PCB\_EXTAL}$  and  $C_{PCB\_XTAL}$  are the measured PCB stray capacitances on EXTAL and XTAL, respectively.

<sup>8</sup> Jitter is the average deviation from the programmed frequency measured over the specified interval at maximum  $f_{sys}$ . 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 PLL  $V_{DD}$ ,  $EV_{DD}$ , and  $V_{SS}$  and variation in crystal oscillator frequency increase the  $C_{jitter}$  percentage for a given interval.

<sup>9</sup> Values are with frequency modulation disabled. If frequency modulation is enabled, jitter is the sum of  $C_{jitter} + C_{mod}$ .

<sup>10</sup> Modulation percentage applies over an interval of 10  $\mu s$ , or equivalently the modulation rate is 100 KHz.

<sup>11</sup> Modulation range determined by hardware design.

## 5.6 External Interface Timing Characteristics

Table 9 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 FB\_CLK output.

All other timing relationships can be derived from these values. Timings listed in Table 9 are shown in Figure 7 and Figure 8.

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

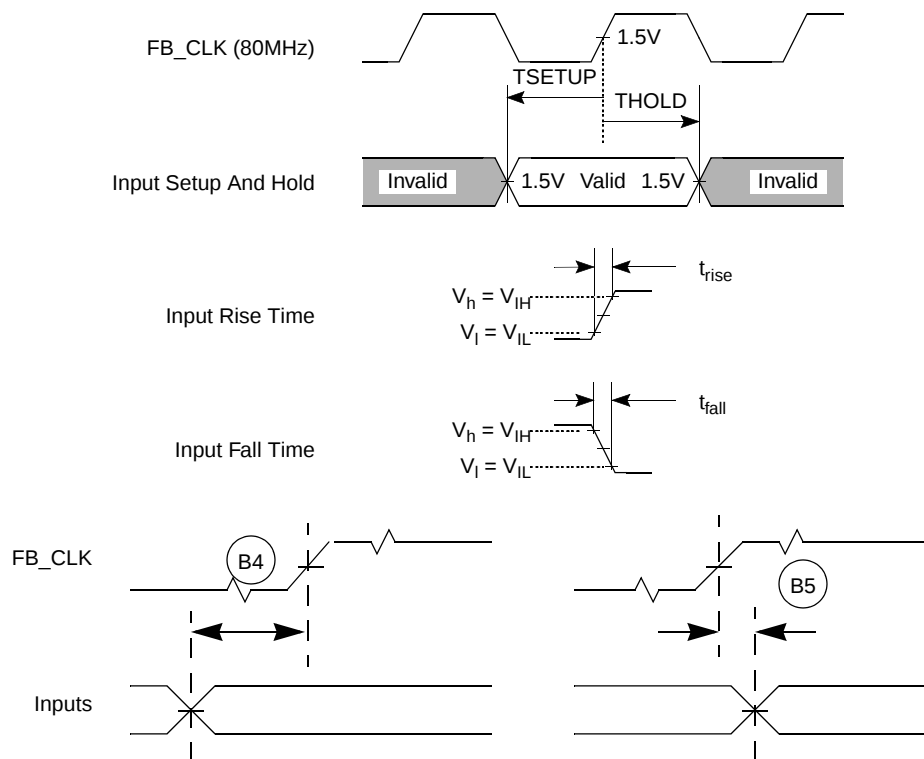


Figure 6. General Input Timing Requirements

## 5.6.1 FlexBus

A multi-function external bus interface called FlexBus is provided with basic functionality to interface to slave-only devices up to a maximum bus frequency of 80MHz. It can be directly connected to asynchronous or synchronous devices such as external boot ROMs, flash memories, gate-array logic, or other simple target (slave) devices with little or no additional circuitry. For asynchronous devices a simple chip-select based interface can be used. The FlexBus interface has six general purpose chip-selects ( $\overline{\text{FB\_CS}}[5:0]$ ) which can be configured to be distributed between the FlexBus or SDRAM memory interfaces. Chip-select,  $\overline{\text{FB\_CS0}}$  can be dedicated to boot ROM access and can be programmed to be byte (8 bits), word (16 bits), or longword (32 bits) wide. Control signal timing is compatible with common ROM/flash memories.

### 5.6.1.1 FlexBus AC Timing Characteristics

The following timing numbers indicate when data is latched or driven onto the external bus, relative to the system clock.

Table 9. FlexBus AC Timing Specifications

| Num | Characteristic                                                                                                                                                                                                                | Symbol                             | Min  | Max | Unit |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------|-----|------|
| —   | Frequency of Operation                                                                                                                                                                                                        | $f_{\text{sys}/3}$                 | —    | 80  | Mhz  |
| FB1 | Clock Period (FB_CLK)                                                                                                                                                                                                         | $t_{\text{FBCK}} (t_{\text{cyc}})$ | 12.5 | —   | ns   |
| FB2 | Address, Data, and Control Output Valid ( $A[23:0]$ , $D[31:0]$ , $\overline{\text{FB\_CS}}[5:0]$ , $R/\overline{W}$ , $\overline{\text{TS}}$ , $\overline{\text{BE/BWE}}[3:0]$ and $\overline{\text{OE}}$ ) <sup>1</sup>     | $t_{\text{FBCHDCV}}$               | —    | 7.0 | ns   |
| FB3 | Address, Data, and Control Output Hold ( $A[23:0]$ , $D[31:0]$ , $\overline{\text{FB\_CS}}[5:0]$ , $R/\overline{W}$ , $\overline{\text{TS}}$ , $\overline{\text{BE/BWE}}[3:0]$ , and $\overline{\text{OE}}$ ) <sup>1, 2</sup> | $t_{\text{FBCHDCI}}$               | 1    | —   | ns   |

Table 9. FlexBus AC Timing Specifications (continued)

| Num | Characteristic                                       | Symbol       | Min | Max | Unit |
|-----|------------------------------------------------------|--------------|-----|-----|------|
| FB4 | Data Input Setup                                     | $t_{DVFBCH}$ | 3.5 | —   | ns   |
| FB5 | Data Input Hold                                      | $t_{DIFBCH}$ | 0   | —   | ns   |
| FB6 | Transfer Acknowledge ( $\overline{TA}$ ) Input Setup | $t_{CVFBCH}$ | 4   | —   | ns   |
| FB7 | Transfer Acknowledge ( $\overline{TA}$ ) Input Hold  | $t_{CIFBCH}$ | 0   | —   | ns   |

<sup>1</sup> Timing for chip selects only applies to the  $\overline{FB\_CS}[5:0]$  signals. Please see [Section 5.7.2, “DDR SDRAM AC Timing Characteristics”](#) for  $\overline{SD\_CS}[3:0]$  timing.

<sup>2</sup> The FlexBus supports programming an extension of the address hold. Please consult the *Reference Manual* for more information.

### NOTE

The processor drives the data lines during the first clock cycle of the transfer with the full 32-bit address. This may be ignored by standard connected devices using non-multiplexed address and data buses. However, some applications may find this feature beneficial.

The address and data busses are muxed between the FlexBus and SDRAM controller. At the end of the read and write bus cycles the address signals are indeterminate.

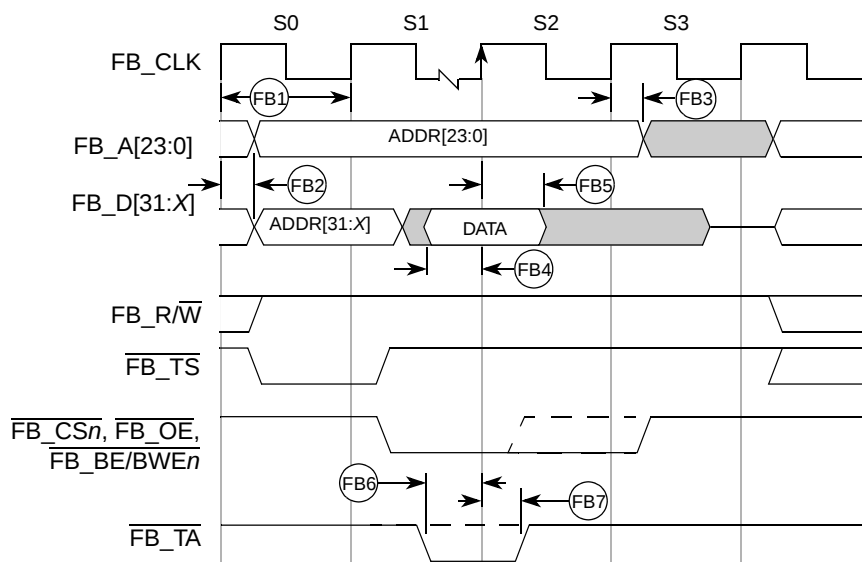


Figure 7. FlexBus Read Timing

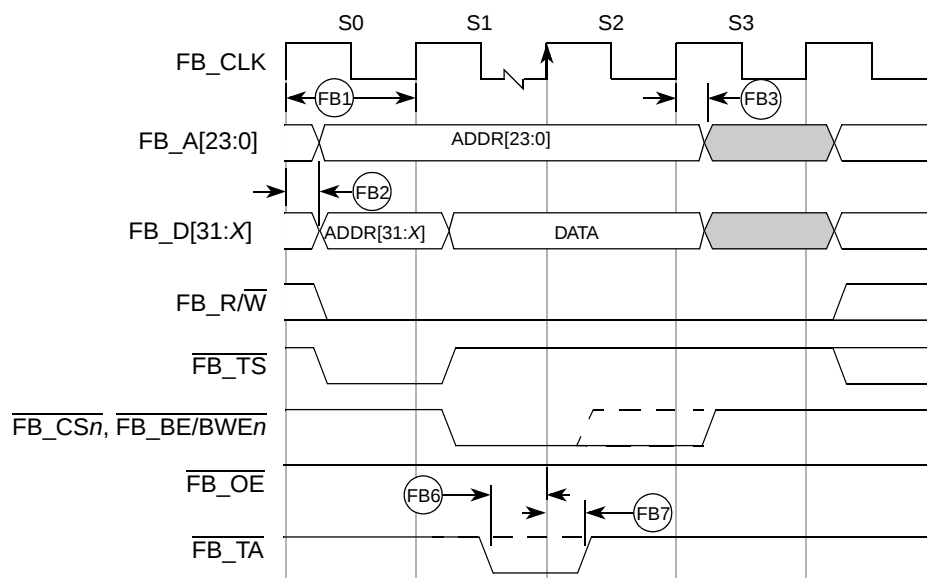


Figure 8. FlexBus Write Timing

## 5.7 SDRAM Bus

The SDRAM controller supports accesses to main SDRAM memory from any internal master. It supports standard SDRAM or double data rate (DDR) SDRAM, but it does not support both at the same time.

### 5.7.1 SDR SDRAM AC Timing Characteristics

The following timing numbers indicate when data is latched or driven onto the external bus, relative to the memory bus clock, when operating in SDR mode on write cycles and relative to SD\_DQS on read cycles. The device's SDRAM controller is a DDR controller that has an SDR mode. Because it is designed to support DDR, a DQS pulse must remain supplied to the device for each data beat of an SDR read. The processor accomplishes this by asserting a signal named SD\_SDR\_DQS during read cycles. Care must be taken during board design to adhere to the following guidelines and specs with regard to the SD\_SDR\_DQS signal and its usage.

Table 10. SDR Timing Specifications

| Symbol | Characteristic                                                           | Symbol               | Min           | Max                | Unit   |
|--------|--------------------------------------------------------------------------|----------------------|---------------|--------------------|--------|
| •      | Frequency of Operation <sup>1</sup>                                      | •                    | 60            | 80                 | MHz    |
| SD1    | Clock Period <sup>2</sup>                                                | t <sub>SDCK</sub>    | 12.5          | 16.67              | ns     |
| SD3    | Pulse Width High <sup>3</sup>                                            | t <sub>SDCKH</sub>   | 0.45          | 0.55               | SD_CLK |
| SD4    | Pulse Width Low <sup>4</sup>                                             | t <sub>SDCKL</sub>   | 0.45          | 0.55               | SD_CLK |
| SD5    | Address, SD_CKE, SD_CAS, SD_RAS, SD_WE, SD_BA, SD_CS[1:0] - Output Valid | t <sub>SDCHACV</sub> | —             | 0.5 × SD_CLK + 1.0 | ns     |
| SD6    | Address, SD_CKE, SD_CAS, SD_RAS, SD_WE, SD_BA, SD_CS[1:0] - Output Hold  | t <sub>SDCHACI</sub> | 2.0           | —                  | ns     |
| SD7    | SD_SDR_DQS Output Valid <sup>5</sup>                                     | t <sub>DQSOV</sub>   | —             | Self timed         | ns     |
| SD8    | SD_DQS[3:0] input setup relative to SD_CLK <sup>6</sup>                  | t <sub>DQVSDCH</sub> | 0.25 × SD_CLK | 0.40 × SD_CLK      | ns     |

**Table 10. SDR Timing Specifications (continued)**

| Symbol | Characteristic                                                              | Symbol        | Min                                               | Max                         | Unit |
|--------|-----------------------------------------------------------------------------|---------------|---------------------------------------------------|-----------------------------|------|
| SD9    | SD_DQS[3:2] input hold relative to SD_CLK <sup>7</sup>                      | $t_{DQISDCH}$ | Does not apply. $0.5 \times SD\_CLK$ fixed width. |                             |      |
| SD10   | Data (D[31:0]) Input Setup relative to SD_CLK (reference only) <sup>8</sup> | $t_{DVS DCH}$ | $0.25 \times SD\_CLK$                             | —                           | ns   |
| SD11   | Data Input Hold relative to SD_CLK (reference only)                         | $t_{DIS DCH}$ | 1.0                                               | —                           | ns   |
| SD12   | Data (D[31:0]) and Data Mask (SD_DQM[3:0]) Output Valid                     | $t_{SDCHDMV}$ | —                                                 | $0.75 \times SD\_CLK + 0.5$ | ns   |
| SD13   | Data (D[31:0]) and Data Mask (SD_DQM[3:0]) Output Hold                      | $t_{SDCHDMI}$ | 1.5                                               | —                           | ns   |

<sup>1</sup> The FlexBus and SDRAM clock operates at the same frequency of the internal bus clock. See the PLL chapter of the *MCF5329 Reference Manual* for more information on setting the SDRAM clock rate.

<sup>2</sup> SD\_CLK is one SDRAM clock in (ns).

<sup>3</sup> Pulse width high plus pulse width low cannot exceed min and max clock period.

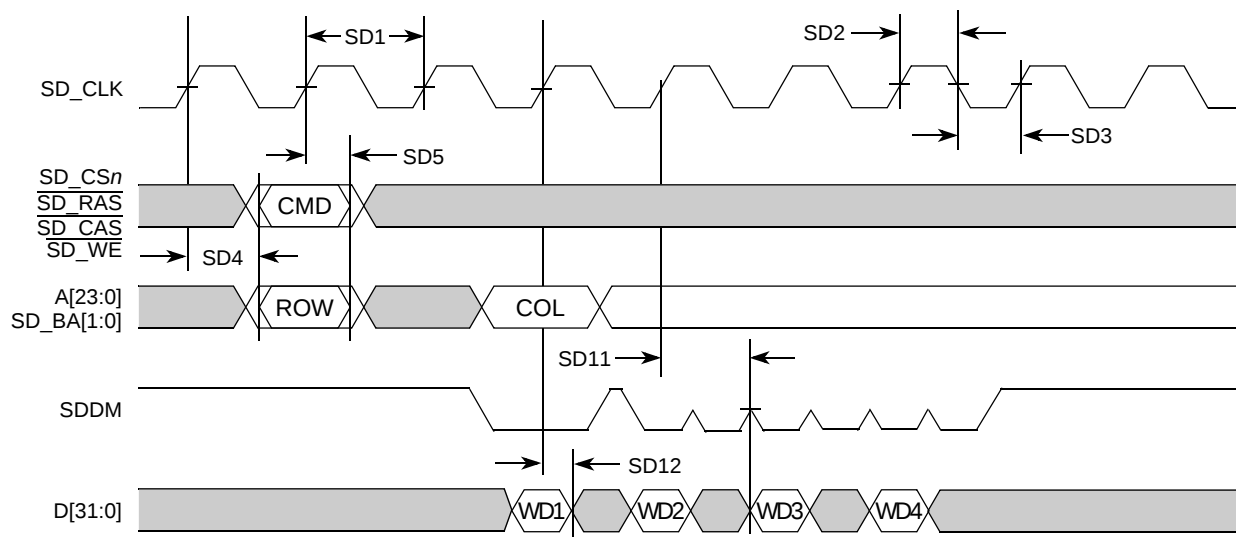
<sup>4</sup> Pulse width high plus pulse width low cannot exceed min and max clock period.

<sup>5</sup> SD\_DQS is designed to pulse 0.25 clock before the rising edge of the memory clock. This is a guideline only. Subtle variation from this guideline is expected. SD\_DQS only pulses during a read cycle and one pulse occurs for each data beat.

<sup>6</sup> SDR\_DQS is designed to pulse 0.25 clock before the rising edge of the memory clock. This spec is a guideline only. Subtle variation from this guideline is expected. SDR\_DQS only pulses during a read cycle and one pulse occurs for each data beat.

<sup>7</sup> The SDR\_DQS pulse is designed to be 0.5 clock in width. The timing of the rising edge is most important. The falling edge does not affect the memory controller.

<sup>8</sup> Because a read cycle in SDR mode uses the DQS circuit within the device, it is most critical that the data valid window be centered 1/4 clk after the rising edge of DQS. Ensuring that this happens results in successful SDR reads. The input setup spec is provided as guidance.



**Figure 9. SDR Write Timing**

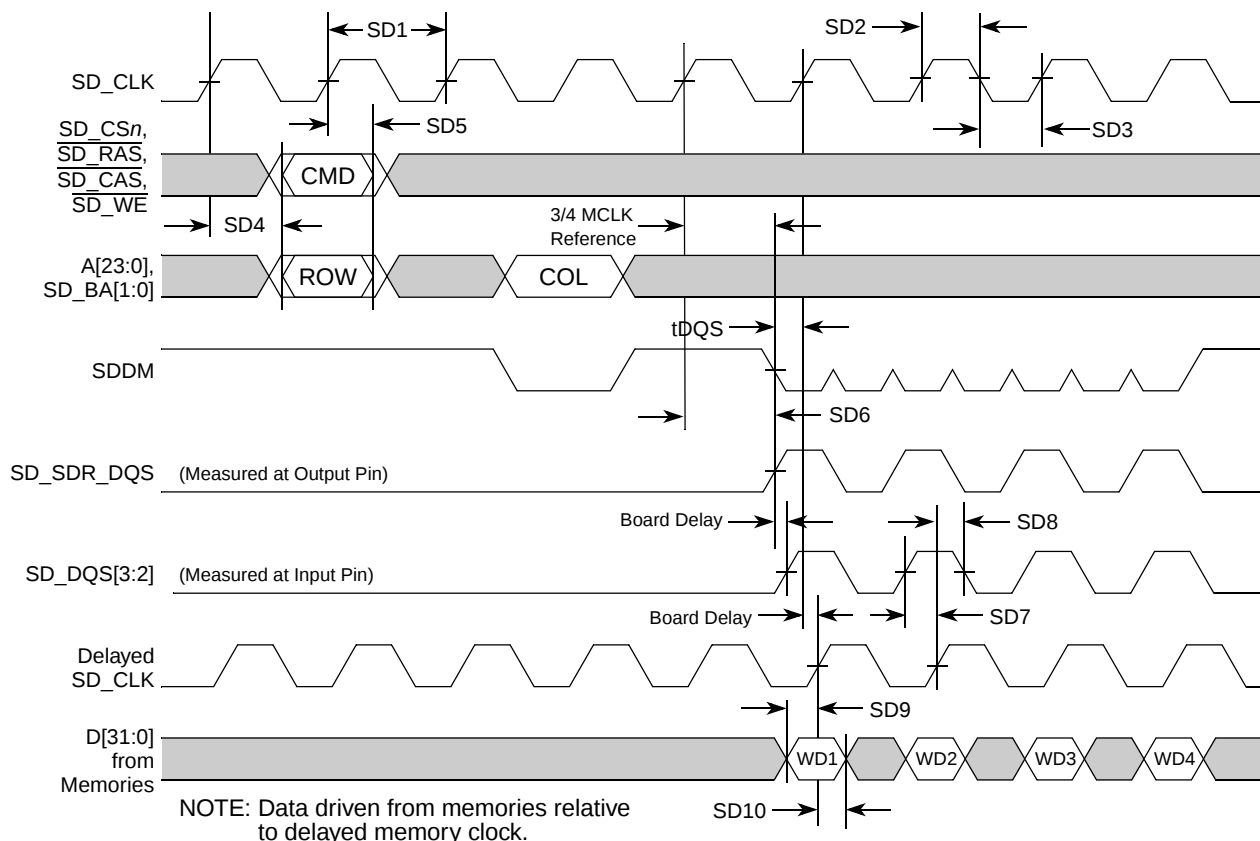


Figure 10. SDR Read Timing

## 5.7.2 DDR SDRAM AC Timing Characteristics

When using the SDRAM controller in DDR mode, the following timing numbers must be followed to properly latch or drive data onto the memory bus. All timing numbers are relative to the four DQS byte lanes.

Table 11. DDR Timing Specifications

| Num | Characteristic                                                                                                                                           | Symbol        | Min  | Max                        | Unit   |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|----------------------------|--------|
| •   | Frequency of Operation                                                                                                                                   | $t_{DDCK}$    | 60   | 80                         | Mhz    |
| DD1 | Clock Period <sup>1</sup>                                                                                                                                | $t_{DDSK}$    | 12.5 | 16.67                      | ns     |
| DD2 | Pulse Width High <sup>2</sup>                                                                                                                            | $t_{DDCKH}$   | 0.45 | 0.55                       | SD_CLK |
| DD3 | Pulse Width Low <sup>3</sup>                                                                                                                             | $t_{DDCKL}$   | 0.45 | 0.55                       | SD_CLK |
| DD4 | Address, $\overline{SD\_CKE}$ , $\overline{SD\_CAS}$ , $\overline{SD\_RAS}$ , $\overline{SD\_WE}$ , $\overline{SD\_CS}[1:0]$ - Output Valid <sup>3</sup> | $t_{SDCHACV}$ | —    | $0.5 \times SD\_CLK + 1.0$ | ns     |
| DD5 | Address, $\overline{SD\_CKE}$ , $\overline{SD\_CAS}$ , $\overline{SD\_RAS}$ , $\overline{SD\_WE}$ , $\overline{SD\_CS}[1:0]$ - Output Hold               | $t_{SDCHACI}$ | 2.0  | —                          | ns     |
| DD6 | Write Command to first DQS Latching Transition                                                                                                           | $t_{CMDVDQ}$  | —    | 1.25                       | SD_CLK |
| DD7 | Data and Data Mask Output Setup (DQ-->DQS) Relative to DQS (DDR Write Mode) <sup>4, 5</sup>                                                              | $t_{DQDMV}$   | 1.5  | —                          | ns     |

## Table 11. DDR Timing Specifications (continued)

| Num  | Characteristic                                                                          | Symbol        | Min                              | Max | Unit   |
|------|-----------------------------------------------------------------------------------------|---------------|----------------------------------|-----|--------|
| DD8  | Data and Data Mask Output Hold (DQS-->DQ) Relative to DQS (DDR Write Mode) <sup>6</sup> | $t_{DQDMI}$   | 1.0                              | —   | ns     |
| DD9  | Input Data Skew Relative to DQS (Input Setup) <sup>7</sup>                              | $t_{DQDQ}$    | —                                | 1   | ns     |
| DD10 | Input Data Hold Relative to DQS <sup>8</sup>                                            | $t_{DIDQ}$    | $0.25 \times SD\_CLK$<br>+ 0.5ns | —   | ns     |
| DD11 | DQS falling edge from SDCLK rising (output hold time)                                   | $t_{DQLSDCH}$ | 0.5                              | —   | ns     |
| DD12 | DQS input read preamble width                                                           | $t_{DQRPRE}$  | 0.9                              | 1.1 | SD_CLK |
| DD13 | DQS input read postamble width                                                          | $t_{DQRPST}$  | 0.4                              | 0.6 | SD_CLK |
| DD14 | DQS output write preamble width                                                         | $t_{DQWPRE}$  | 0.25                             |     | SD_CLK |
| DD15 | DQS output write postamble width                                                        | $t_{DQWPST}$  | 0.4                              | 0.6 | SD_CLK |

<sup>1</sup> SD\_CLK is one SDRAM clock in (ns).

<sup>2</sup> Pulse width high plus pulse width low cannot exceed min and max clock period.

<sup>3</sup> Command output valid should be 1/2 the memory bus clock (SD\_CLK) plus some minor adjustments for process, temperature, and voltage variations.

<sup>4</sup> This specification relates to the required input setup time of today's DDR memories. The processor's output setup should be larger than the input setup of the DDR memories. If it is not larger, the input setup on the memory is in violation. MEM\_DATA[31:24] is relative to MEM\_DQS[3], MEM\_DATA[23:16] is relative to MEM\_DQS[2], MEM\_DATA[15:8] is relative to MEM\_DQS[1], and MEM\_[7:0] is relative MEM\_DQS[0].

<sup>5</sup> The first data beat is valid before the first rising edge of DQS and after the DQS write preamble. The remaining data beats are valid for each subsequent DQS edge.

<sup>6</sup> This specification relates to the required hold time of today's DDR memories. MEM\_DATA[31:24] is relative to MEM\_DQS[3], MEM\_DATA[23:16] is relative to MEM\_DQS[2], MEM\_DATA[15:8] is relative to MEM\_DQS[1], and MEM\_[7:0] is relative MEM\_DQS[0].

<sup>7</sup> Data input skew is derived from each DQS clock edge. It begins with a DQS transition and ends when the last data line becomes valid. This input skew must include DDR memory output skew and system level board skew (due to routing or other factors).

<sup>8</sup> Data input hold is derived from each DQS clock edge. It begins with a DQS transition and ends when the first data line becomes invalid.

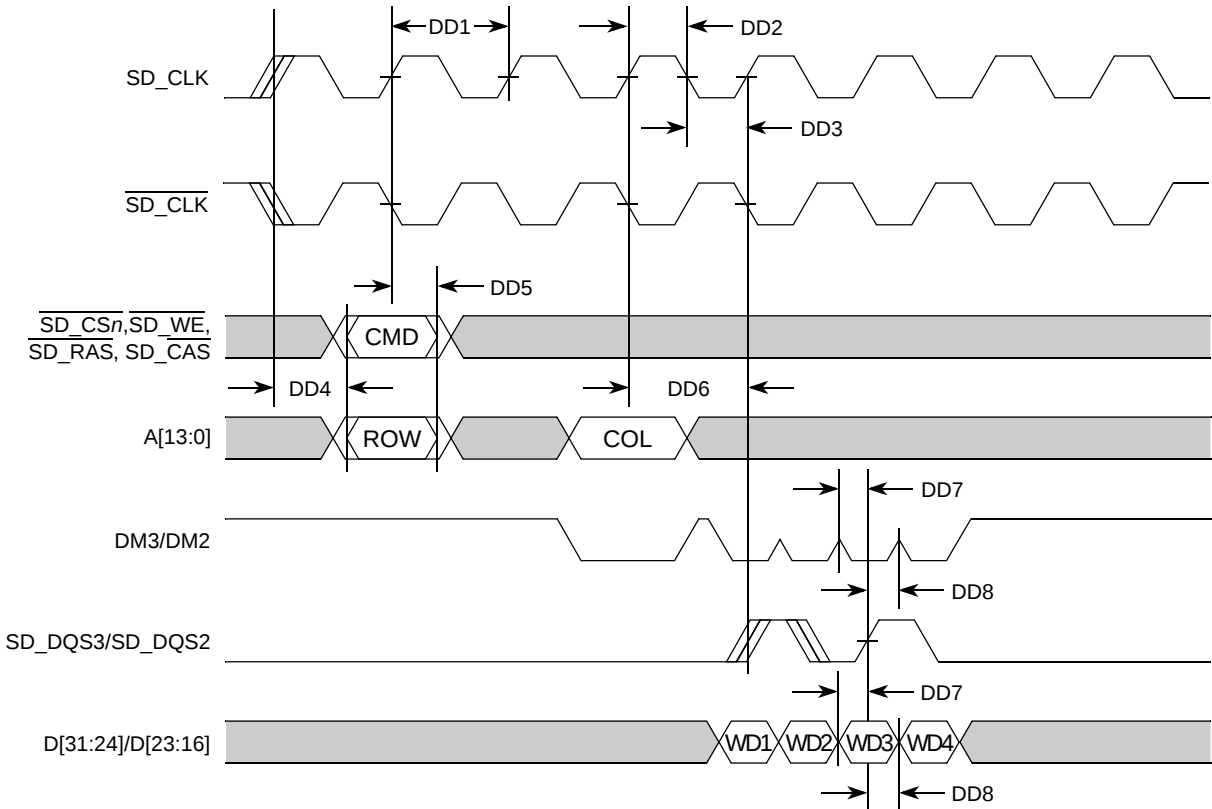


Figure 11. DDR Write Timing

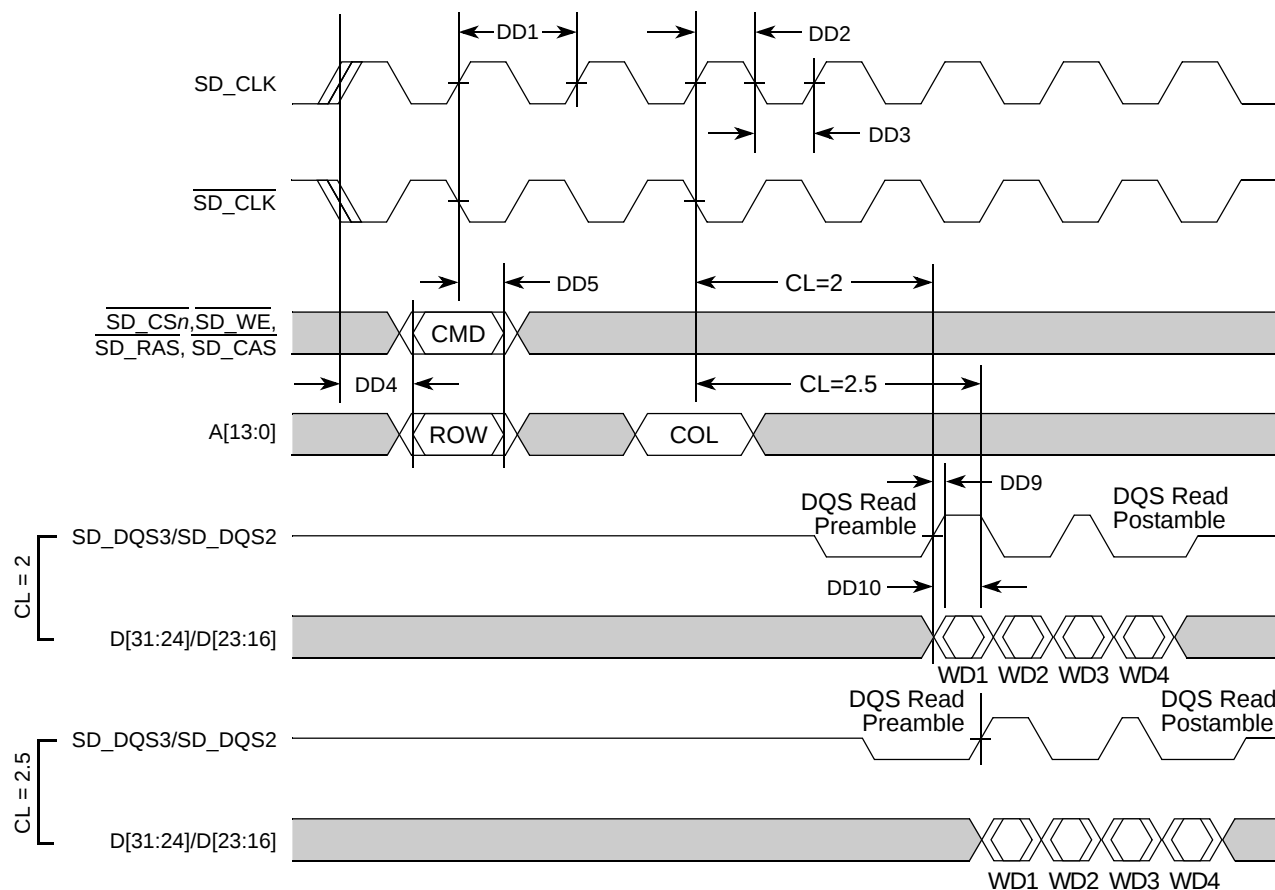


Figure 12. DDR Read Timing

## 5.8 General Purpose I/O Timing

Table 12. GPIO Timing<sup>1</sup>

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

<sup>1</sup> GPIO pins include:  $\overline{IRQ_n}$ , PWM, UART, FlexCAN, and Timer pins.

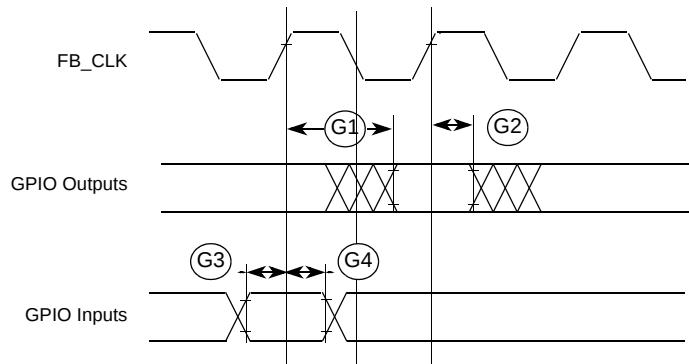


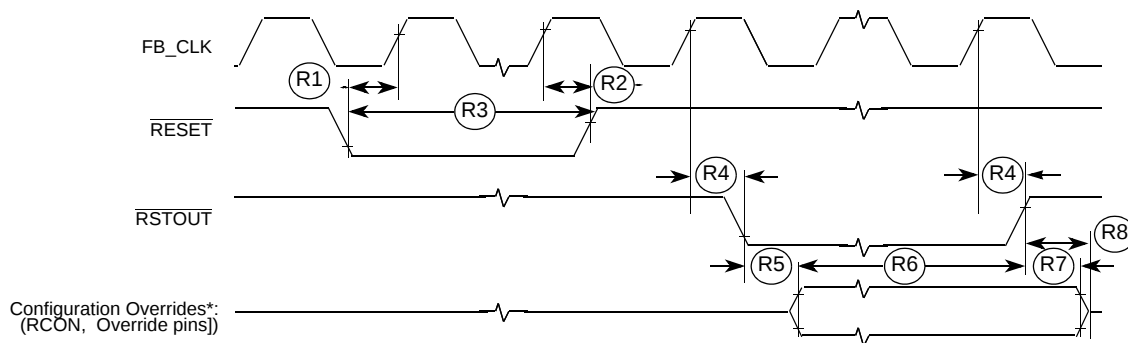
Figure 13. GPIO Timing

## 5.9 Reset and Configuration Override Timing

Table 13. Reset and Configuration Override Timing

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

<sup>1</sup> During low power STOP, the synchronizers for the  $\overline{\text{RESET}}$  input are bypassed and  $\overline{\text{RESET}}$  is asserted asynchronously to the system. Thus,  $\overline{\text{RESET}}$  must be held a minimum of 100 ns.


Figure 14.  $\overline{\text{RESET}}$  and Configuration Override Timing

### NOTE

Refer to the CCM chapter of the *MCF5329 Reference Manual* for more information.

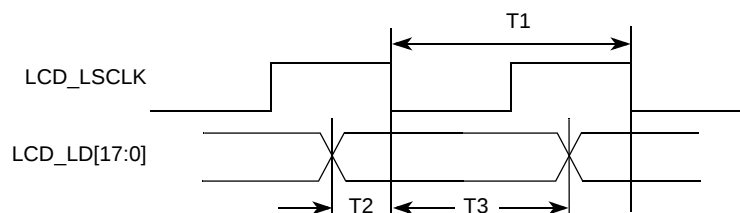
## 5.10 LCD Controller Timing Specifications

This sections lists the timing specifications for the LCD Controller.

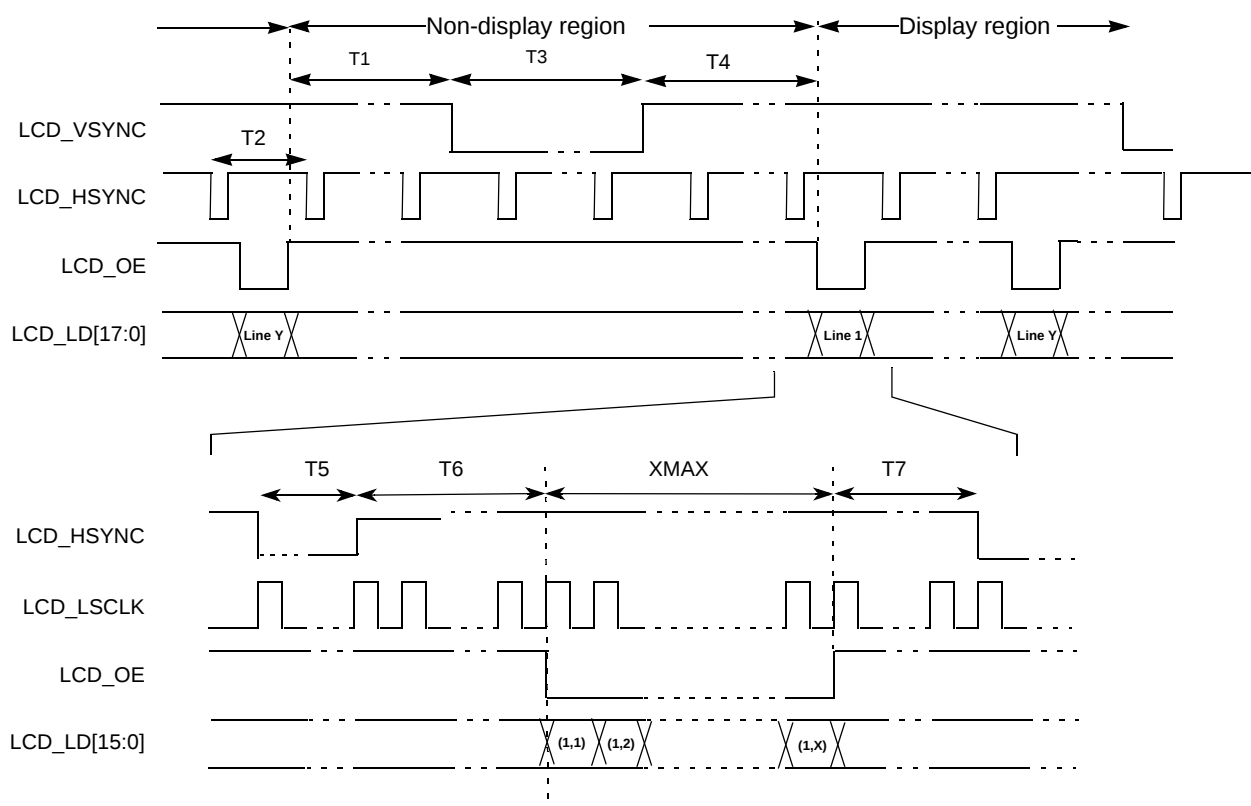
**Table 14. LCD\_LSCLK Timing**

| Num | Parameter             | Minimum | Maximum | Unit |
|-----|-----------------------|---------|---------|------|
| T1  | LCD_LSCLK Period      | 25      | 2000    | ns   |
| T2  | Pixel data setup time | 11      | —       | ns   |
| T3  | Pixel data up time    | 11      | —       | ns   |

**Note:** The pixel clock is equal to  $\text{LCD\_LSCLK} / (\text{PCD} + 1)$ . When it is in CSTN, TFT or monochrome mode with bus width is set and LCD\_LSCLK is equal to the pixel clock. When it is in monochrome with other bus width settings, LCD\_LSCLK is equal to the pixel clock divided by bus width. The polarity of LCD\_LSCLK and LCD\_LD signals can also be programmed.



**Figure 15. LCD\_LSCLK to LCD\_LD[17:0] timing diagram**



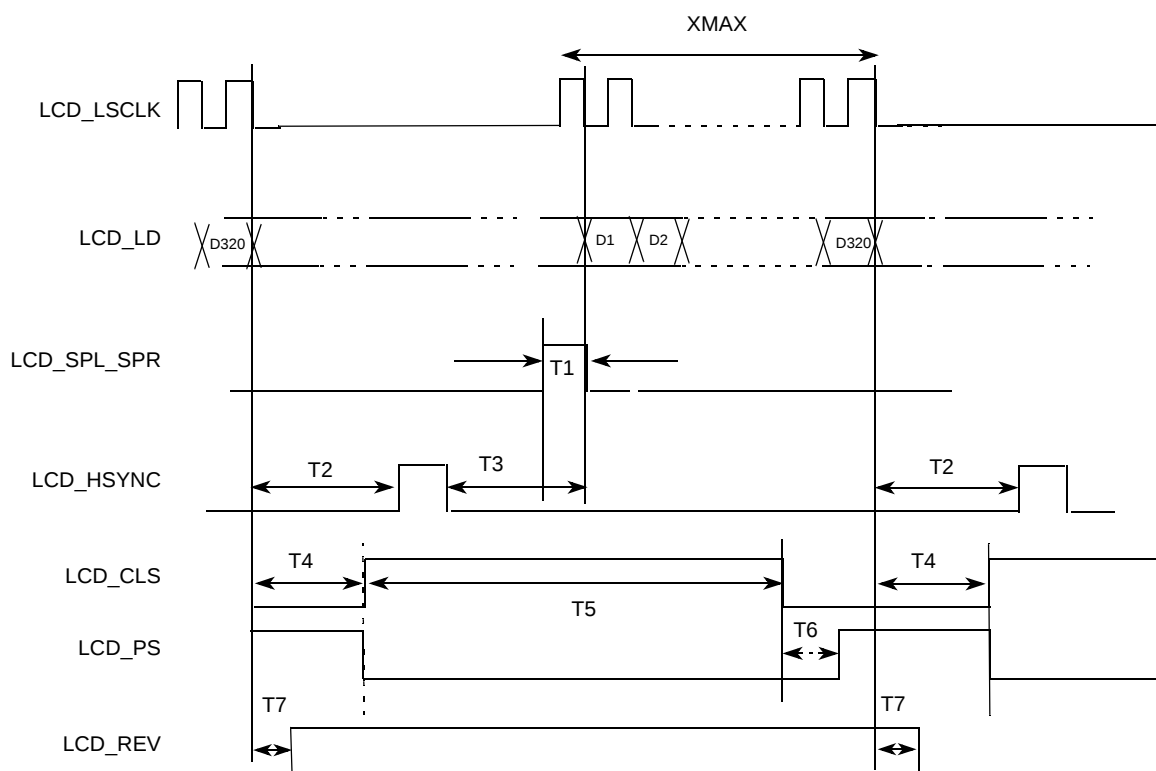
**Figure 16. 4/8/12/16/18 Bit/Pixel TFT Color Mode Panel Timing**

**Table 15. 4/8/12/16/18 Bit/Pixel TFT Color Mode Panel Timing**

| Number | Description                             | Minimum      | Value                          | Unit |
|--------|-----------------------------------------|--------------|--------------------------------|------|
| T1     | End of LCD_OE to beginning of LCD_VSYNC | $T5+T6+T7-1$ | $(VWAIT1 \cdot T2)+T5+T6+T7-1$ | Ts   |
| T2     | LCD_HSYNC period                        | —            | $XMAX+T5+T6+T7$                | Ts   |
| T3     | LCD_VSYNC pulse width                   | T2           | $VWIDTH \cdot T2$              | Ts   |
| T4     | End of LCD_VSYNC to beginning of LCD_OE | 1            | $(VWAIT2 \cdot T2)+1$          | Ts   |
| T5     | LCD_HSYNC pulse width                   | 1            | $HWIDTH+1$                     | Ts   |
| T6     | End of LCD_HSYNC to beginning to LCD_OE | 3            | $HWAIT2+3$                     | Ts   |
| T7     | End of LCD_OE to beginning of LCD_HSYNC | 1            | $HWAIT1+1$                     | Ts   |

**Note:** Ts is the LCD\_LSCLK period. LCD\_VSYNC, LCD\_HSYNC and LCD\_OE can be programmed as active high or active low. In Figure 16, all 3 signals are active low. LCD\_LSCLK can be programmed to be deactivated during the LCD\_VSYNC pulse or the LCD\_OE deasserted period. In Figure 16, LCD\_LSCLK is always active.

**Note:** XMAX is defined in number of pixels in one line.


**Figure 17. Sharp TFT Panel Timing**

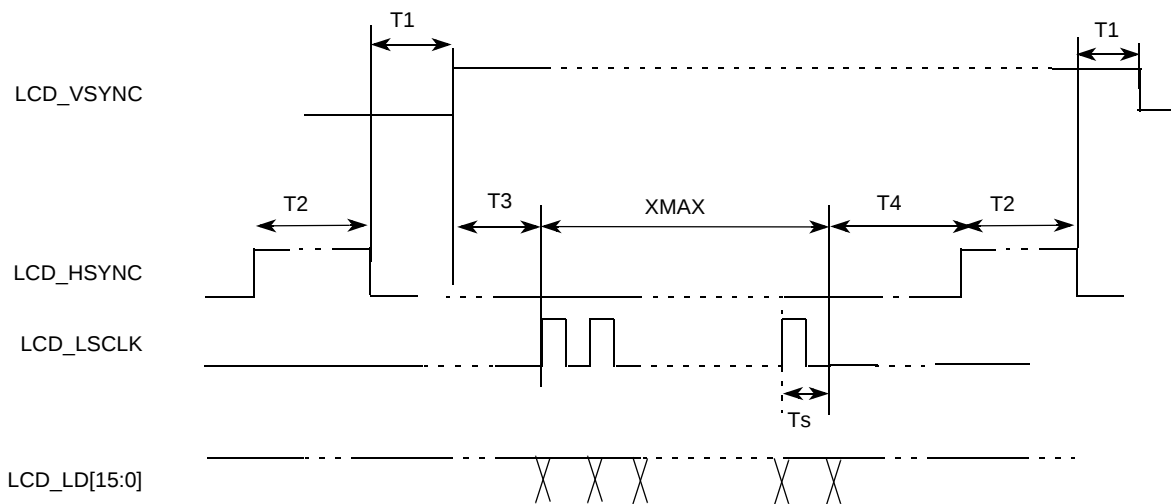
**Table 16. Sharp TFT Panel Timing**

| Num | Description                                     | Minimum | Value              | Unit |
|-----|-------------------------------------------------|---------|--------------------|------|
| T1  | LCD_SPL/LCD_SPR pulse width                     | —       | 1                  | Ts   |
| T2  | End of LCD_LD of line to beginning of LCD_HSYNC | 1       | HWAIT1+1           | Ts   |
| T3  | End of LCD_HSYNC to beginning of LCD_LD of line | 4       | HWAIT2 + 4         | Ts   |
| T4  | LCD_CLS rise delay from end of LCD_LD of line   | 3       | CLS_RISE_DELAY+1   | Ts   |
| T5  | LCD_CLS pulse width                             | 1       | CLS_HI_WIDTH+1     | Ts   |
| T6  | LCD_PS rise delay from LCD_CLS negation         | 0       | PS_RISE_DELAY      | Ts   |
| T7  | LCD_REV toggle delay from last LCD_LD of line   | 1       | REV_TOGGLE_DELAY+1 | Ts   |

**Note:** Falling of LCD\_SPL/LCD\_SPR aligns with first LCD\_LD of line.

**Note:** Falling of LCD\_PS aligns with rising edge of LCD\_CLS.

**Note:** LCD\_REV toggles in every LCD\_HSYN period.



**Figure 18. Non-TFT Mode Panel Timing**

**Table 17. Non-TFT Mode Panel Timing**

| Num | Description                  | Minimum | Value               | Unit |
|-----|------------------------------|---------|---------------------|------|
| T1  | LCD_HSYNC to LCD_VSYNC delay | 2       | HWAIT2 + 2          | Tpix |
| T2  | LCD_HSYNC pulse width        | 1       | HWIDTH + 1          | Tpix |
| T3  | LCD_VSYNC to LCD_LSCLK       | —       | $0 \leq T3 \leq Ts$ | —    |
| T4  | LCD_LSCLK to LCD_HSYNC       | 1       | HWAIT1 + 1          | Tpix |

**Note:** Ts is the LCD\_LSCLK period while Tpix is the pixel clock period. LCD\_VSYNC, LCD\_HSYNC and LCD\_LSCLK can be programmed as active high or active low. In Figure 18, all three signals are active high. When it is in CSTN mode or monochrome mode with bus width = 1, T3 = Tpix = Ts. When it is in monochrome mode with bus width = 2, 4 and 8, T3 = 1, 2 and 4 Tpix respectively.

## 5.11 USB On-The-Go

The MCF5329 device is compliant with industry standard USB 2.0 specification.

## 5.12 ULPI Timing Specification

Control and data timing requirements for the ULPI pins are given in Table 18. These timings apply in synchronous mode only. All timings are measured with either a 60 MHz input clock from the USB\_CLKIN pin. The USB\_CLKIN needs to maintain a 50% duty cycle. Control signals and 8-bit data are always clocked on the rising edge.

The ULPI interface on the MCF5329 processor is compliant with the industry standard definition.

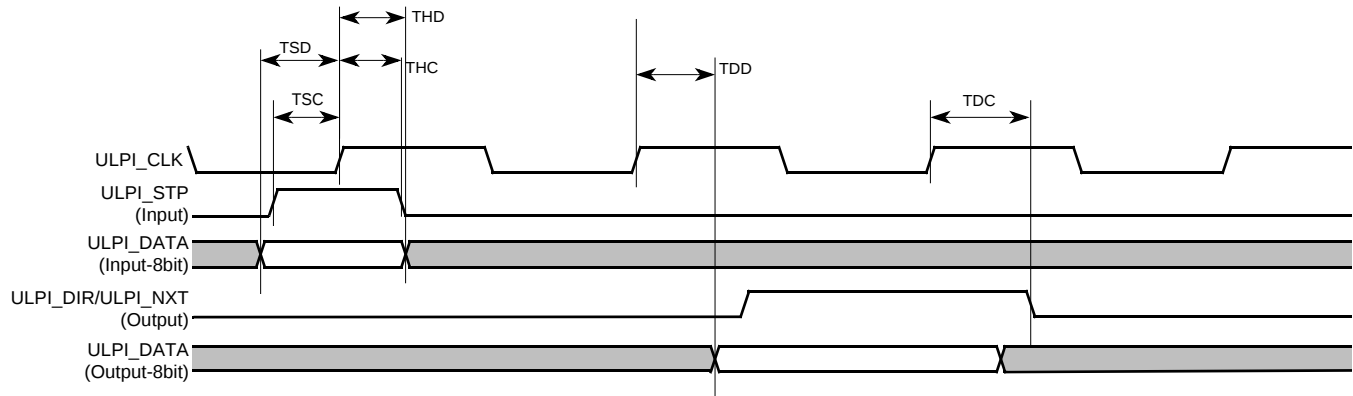


Figure 19. ULPI Timing Diagram

Table 18. ULPI Interface Timing

| Parameter                                  | Symbol   | Min  | Max | Units |
|--------------------------------------------|----------|------|-----|-------|
| Setup time (control in, 8-bit data in)     | TSC, TSD | —    | 3.0 | ns    |
| Hold time (control in, 8-bit data in)      | THC, THD | -1.5 | —   | ns    |
| Output delay (control out, 8-bit data out) | TDC, TDD | —    | 6.0 | ns    |

## 5.13 SSI Timing Specifications

This section provides the AC timings for the SSI in master (clocks driven) and slave modes (clocks input). All timings are given for non-inverted serial clock polarity (SSI\_TCR[TSCPK] = 0, SSI\_RCR[RSCKP] = 0) and a non-inverted frame sync (SSI\_TCR[TFSI] = 0, SSI\_RCR[RFSI] = 0). If the polarity of the clock and/or the frame sync have been inverted, all the timings remain valid by inverting the clock signal (SSI\_BCLK) and/or the frame sync (SSI\_FS) shown in the figures below.

Table 19. SSI Timing – Master Modes<sup>1</sup>

| Num | Description                      | Symbol     | Min                | Max | Units      |
|-----|----------------------------------|------------|--------------------|-----|------------|
| S1  | SSI_MCLK cycle time <sup>2</sup> | $t_{MCLK}$ | $8 \times t_{SYS}$ | —   | ns         |
| S2  | SSI_MCLK pulse width high / low  |            | 45%                | 55% | $t_{MCLK}$ |
| S3  | SSI_BCLK cycle time <sup>3</sup> | $t_{BCLK}$ | $8 \times t_{SYS}$ | —   | ns         |
| S4  | SSI_BCLK pulse width             |            | 45%                | 55% | $t_{BCLK}$ |
| S5  | SSI_BCLK to SSI_FS output valid  |            | —                  | 15  | ns         |

**Table 19. SSI Timing – Master Modes<sup>1</sup> (continued)**

| Num | Description                                  | Symbol | Min | Max | Units |
|-----|----------------------------------------------|--------|-----|-----|-------|
| S6  | SSI_BCLK to SSI_FS output invalid            |        | -2  | —   | ns    |
| S7  | SSI_BCLK to SSI_TXD valid                    |        | —   | 15  | ns    |
| S8  | SSI_BCLK to SSI_TXD invalid / high impedance |        | -4  | —   | ns    |
| S9  | SSI_RXD / SSI_FS input setup before SSI_BCLK |        | 15  | —   | ns    |
| S10 | SSI_RXD / SSI_FS input hold after SSI_BCLK   |        | 0   | —   | ns    |

<sup>1</sup> All timings specified with a capacitive load of 25pF.

<sup>2</sup> SSI\_MCLK can be generated from SSI\_CLKIN or a divided version of the internal system clock (SYSCLK).

<sup>3</sup> SSI\_BCLK can be derived from SSI\_CLKIN or a divided version of SYSCLK. If the SYSCLK is used, the minimum divider is 6. If the SSI\_CLKIN input is used, the programmable dividers must be set to ensure that SSI\_BCLK does not exceed  $4 \times f_{\text{SYS}}$ .

**Table 20. SSI Timing – Slave Modes<sup>1</sup>**

| Num | Description                                              | Symbol            | Min                       | Max | Units             |
|-----|----------------------------------------------------------|-------------------|---------------------------|-----|-------------------|
| S11 | SSI_BCLK cycle time                                      | $t_{\text{BCLK}}$ | $8 \times t_{\text{SYS}}$ | —   | ns                |
| S12 | SSI_BCLK pulse width high/low                            |                   | 45%                       | 55% | $t_{\text{BCLK}}$ |
| S13 | SSI_FS input setup before SSI_BCLK                       |                   | 10                        | —   | ns                |
| S14 | SSI_FS input hold after SSI_BCLK                         |                   | 3                         | —   | ns                |
| S15 | SSI_BCLK to SSI_TXD/SSI_FS output valid                  |                   | —                         | 15  | ns                |
| S16 | SSI_BCLK to SSI_TXD/SSI_FS output invalid/high impedance |                   | -2                        | —   | ns                |
| S17 | SSI_RXD setup before SSI_BCLK                            |                   | 10                        | —   | ns                |
| S18 | SSI_RXD hold after SSI_BCLK                              |                   | 3                         | —   | ns                |

<sup>1</sup> All timings specified with a capacitive load of 25pF.

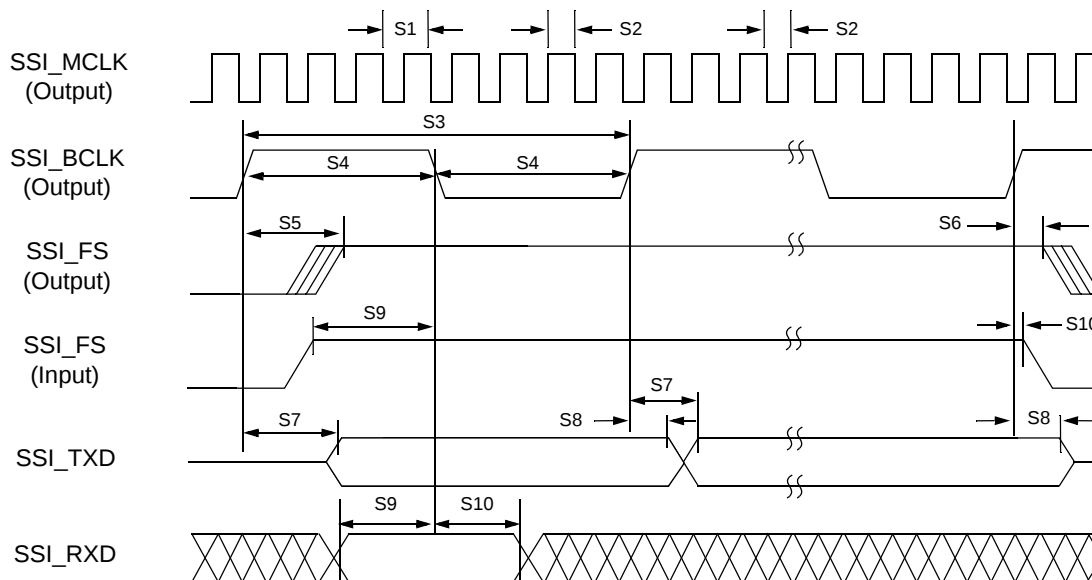


Figure 20. SSI Timing – Master Modes

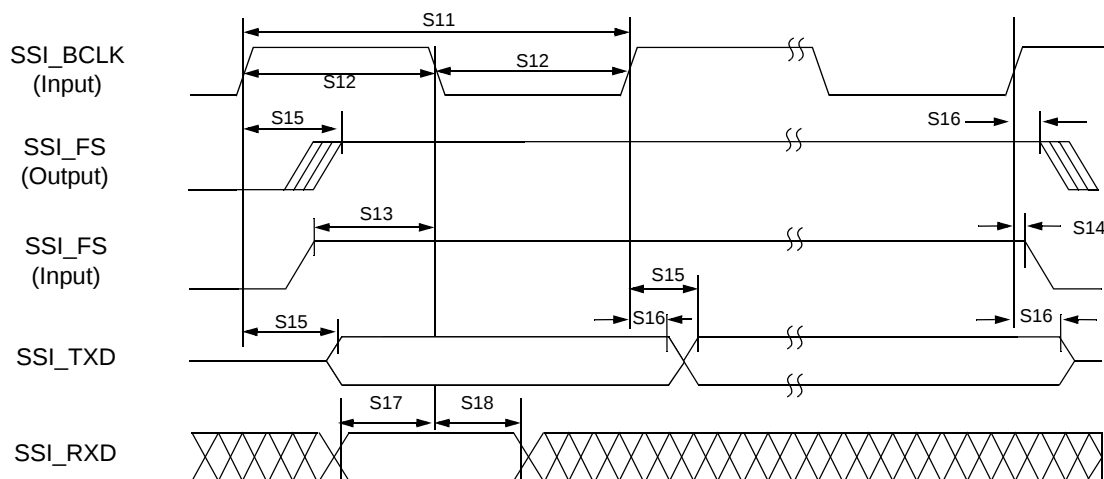


Figure 21. SSI Timing – Slave Modes

## 5.14 I<sup>2</sup>C Input/Output Timing Specifications

Table 21 lists specifications for the I<sup>2</sup>C input timing parameters shown in Figure 22.

**Table 21. I<sup>2</sup>C Input Timing Specifications between SCL and 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 ( $V_{IL} = 0.5\text{ V}$ to $V_{IH} = 2.4\text{ V}$ ) | —   | 1   | ms        |
| I4  | Data hold time                                                                   | 0   | —   | ns        |

**Table 21. I<sup>2</sup>C Input Timing Specifications between SCL and SDA (continued)**

| Num | Characteristic                                                                   | Min | Max | Units     |
|-----|----------------------------------------------------------------------------------|-----|-----|-----------|
| I5  | I2C_SCL/I2C_SDA fall time ( $V_{IH} = 2.4\text{ V}$ to $V_{IL} = 0.5\text{ V}$ ) | —   | 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 22 lists specifications for the I<sup>2</sup>C output timing parameters shown in Figure 22.

**Table 22. I<sup>2</sup>C Output Timing Specifications between SCL and SDA**

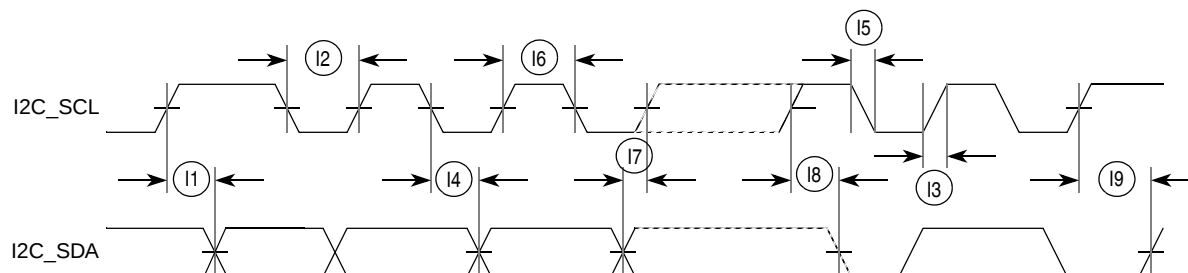
| Num             | Characteristic                                                                   | Min | Max | Units         |
|-----------------|----------------------------------------------------------------------------------|-----|-----|---------------|
| I1 <sup>1</sup> | Start condition hold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

<sup>1</sup> 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 22. The I<sup>2</sup>C interface is designed to scale the actual data transition time to move it to the middle of the SCL low period. The actual position is affected by the prescale and division values programmed into the IFDR; however, the numbers given in Table 22 are minimum values.

<sup>2</sup> 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.

<sup>3</sup> Specified at a nominal 50-pF load.

Figure 22 shows timing for the values in Table 22 and Table 21.


**Figure 22. I<sup>2</sup>C Input/Output Timings**

## 5.15 Fast Ethernet AC Timing Specifications

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

### 5.15.1 MII Receive Signal Timing

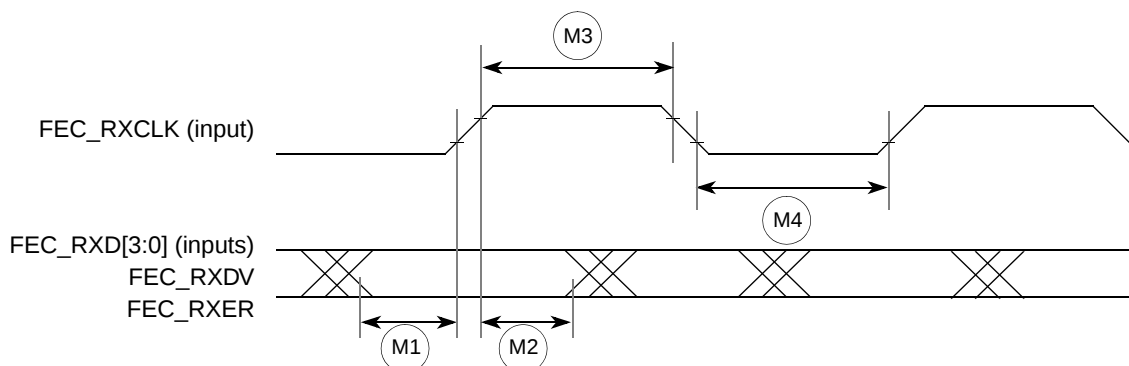
The receiver functions correctly up to a FEC\_RXCLK maximum frequency of 25 MHz +1%. The processor clock frequency must exceed twice the FEC\_RXCLK frequency.

Table 23 lists MII receive channel timings.

**Table 23. MII Receive Signal Timing**

| Num | Characteristic                                      | Min | Max | Unit             |
|-----|-----------------------------------------------------|-----|-----|------------------|
| M1  | FEC_RXD[3:0], FEC_RXDV, FEC_RXER to FEC_RXCLK setup | 5   | —   | ns               |
| M2  | FEC_RXCLK to FEC_RXD[3:0], FEC_RXDV, FEC_RXER hold  | 5   | —   | ns               |
| M3  | FEC_RXCLK pulse width high                          | 35% | 65% | FEC_RXCLK period |
| M4  | FEC_RXCLK pulse width low                           | 35% | 65% | FEC_RXCLK period |

Figure 23 shows MII receive signal timings listed in Table 23.



**Figure 23. MII Receive Signal Timing Diagram**

### 5.15.2 MII Transmit Signal Timing

Table 24 lists MII transmit channel timings.

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

**Table 24. MII Transmit Signal Timing**

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

Figure 24 shows MII transmit signal timings listed in Table 24.

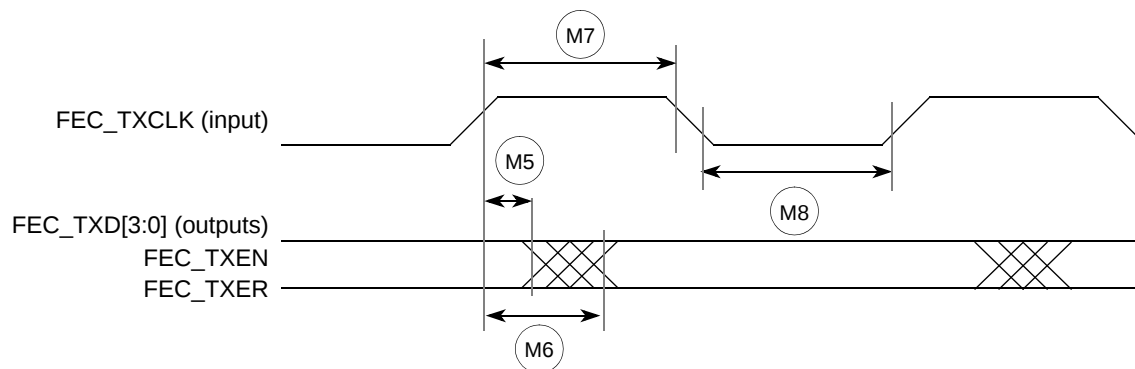


Figure 24. MII Transmit Signal Timing Diagram

## 5.15.3 MII Async Inputs Signal Timing

Table 25 lists MII asynchronous inputs signal timing.

Table 25. MII Async Inputs Signal Timing

| Num | Characteristic                       | Min | Max | Unit             |
|-----|--------------------------------------|-----|-----|------------------|
| M9  | FEC_CRS, FEC_COL minimum pulse width | 1.5 | —   | FEC_TXCLK period |

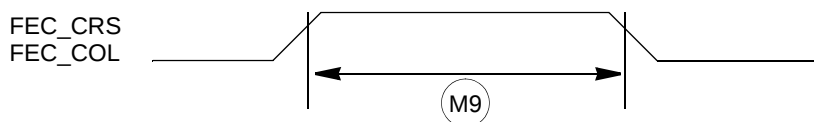


Figure 25. MII Async Inputs Timing Diagram

## 5.15.4 MII Serial Management Channel Timing

Table 26 lists MII serial management channel timings. The FEC functions correctly with a maximum MDC frequency of 2.5 MHz.

Table 26. MII Serial Management Channel Timing

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

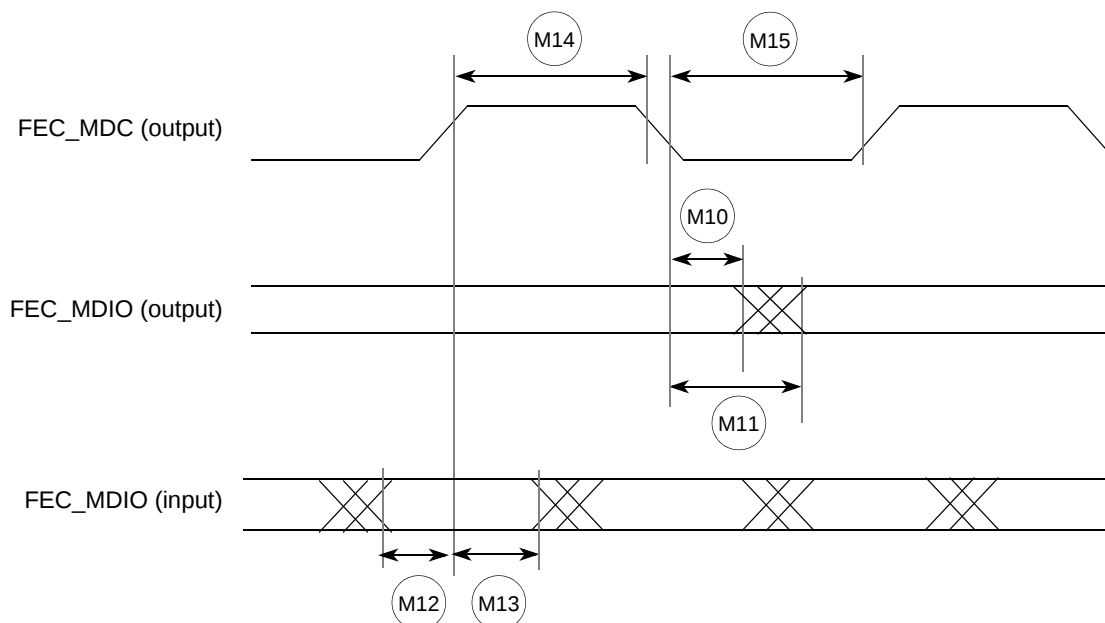


Figure 26. MII Serial Management Channel Timing Diagram

## 5.16 32-Bit Timer Module Timing Specifications

Table 27 lists timer module AC timings.

Table 27. Timer Module AC Timing Specifications

| Name | Characteristic                            | Min | Max | Unit      |
|------|-------------------------------------------|-----|-----|-----------|
| T1   | DT0IN / DT1IN / DT2IN / DT3IN cycle time  | 3   | —   | $t_{CYC}$ |
| T2   | DT0IN / DT1IN / DT2IN / DT3IN pulse width | 1   | —   | $t_{CYC}$ |

## 5.17 QSPI Electrical Specifications

Table 28 lists QSPI timings.

Table 28. QSPI Modules AC Timing Specifications

| Name | Characteristic                                    | Min | Max | Unit      |
|------|---------------------------------------------------|-----|-----|-----------|
| QS1  | QSPI_CS[3:0] to QSPI_CLK                          | 1   | 510 | $t_{CYC}$ |
| 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        |

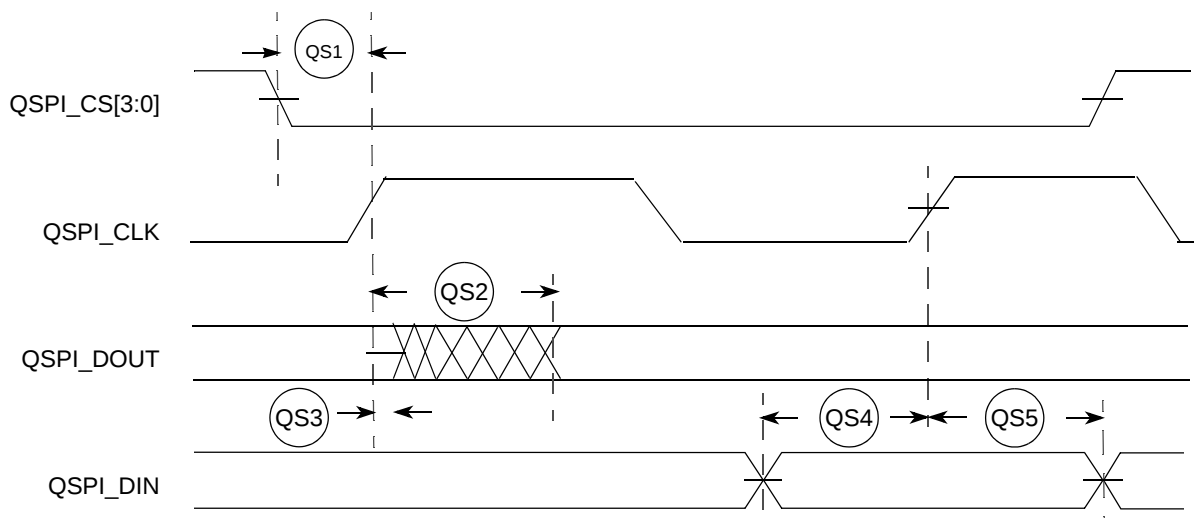


Figure 27. QSPI Timing

## 5.18 JTAG and Boundary Scan Timing

Table 29. JTAG and Boundary Scan Timing

| Num | Characteristics <sup>1</sup>                         | Symbol       | Min | Max | Unit        |
|-----|------------------------------------------------------|--------------|-----|-----|-------------|
| J1  | TCLK Frequency of Operation                          | $f_{JCYC}$   | DC  | 1/4 | $f_{sys}/3$ |
| 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          |

<sup>1</sup> JTAG\_EN is expected to be a static signal. Hence, specific timing is not associated with it.

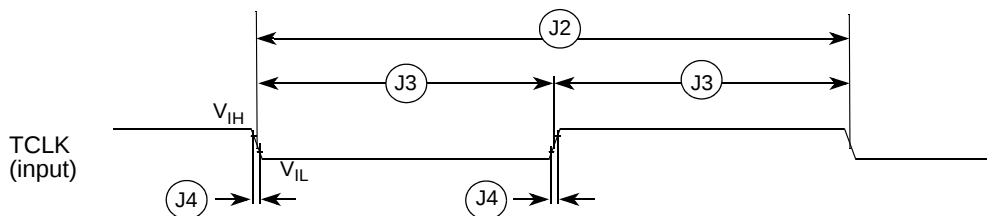


Figure 28. Test Clock Input Timing

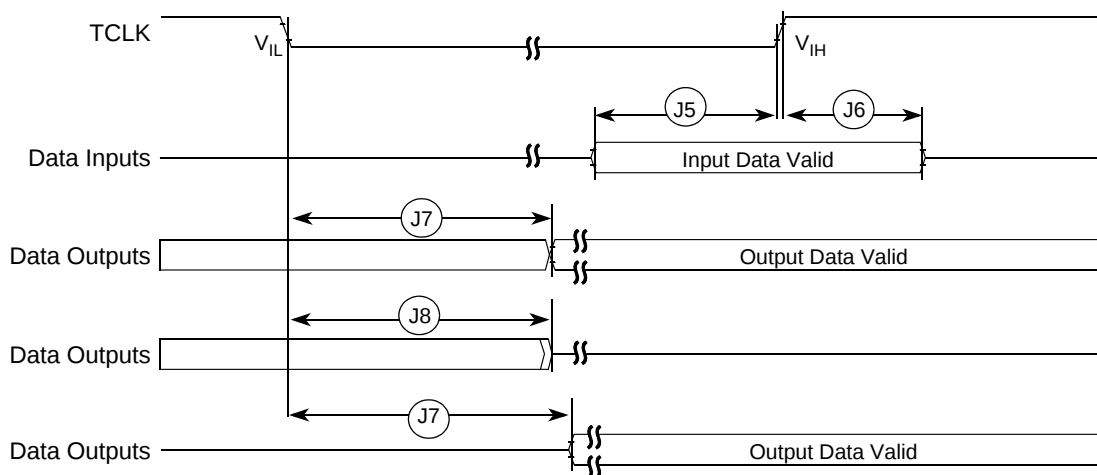


Figure 29. Boundary Scan (JTAG) Timing

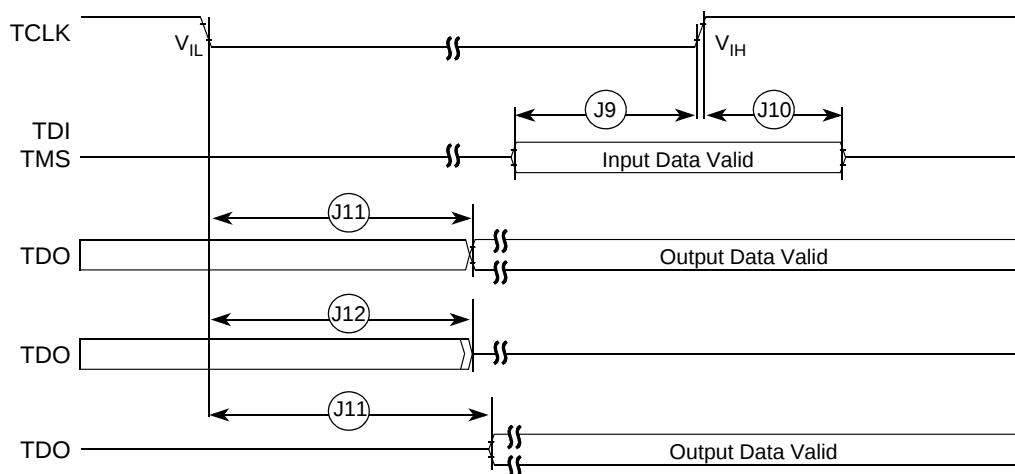
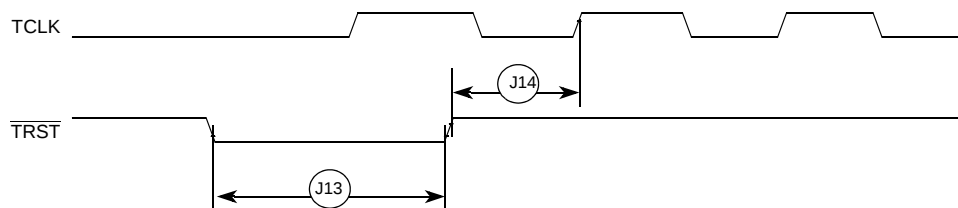


Figure 30. Test Access Port Timing


 Figure 31.  $\overline{\text{TRST}}$  Timing

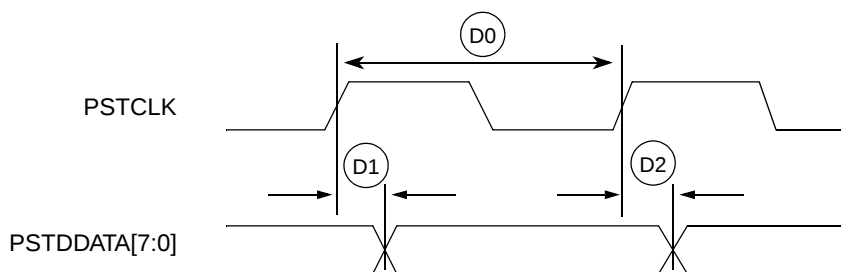
## 5.19 Debug AC Timing Specifications

Table 30 lists specifications for the debug AC timing parameters shown in Figure 32.

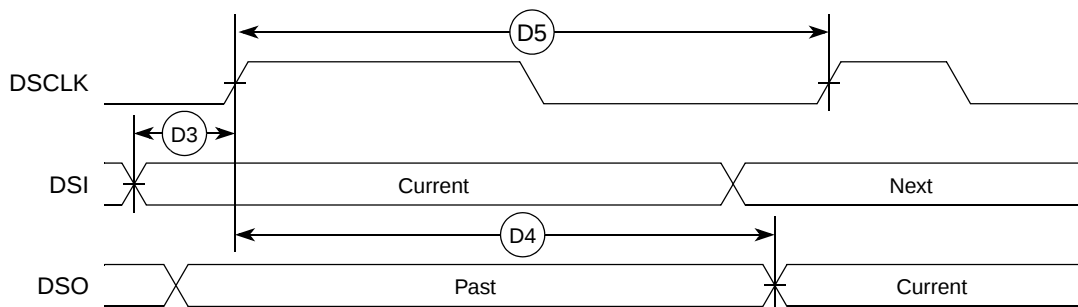
**Table 30. Debug AC Timing Specification**

| Num             | Characteristic                    | Min | Max | Units                 |
|-----------------|-----------------------------------|-----|-----|-----------------------|
| D0              | PSTCLK cycle time                 | 2   | 2   | $t_{SYS} = 1/f_{SYS}$ |
| D1              | PSTCLK rising to PSTDDATA valid   | —   | 3.0 | ns                    |
| D2              | PSTCLK rising to PSTDDATA invalid | 1.5 | —   | ns                    |
| D3              | DSI-to-DSCLK setup                | 1   | —   | PSTCLK                |
| D4 <sup>1</sup> | DSCLK-to-DSO hold                 | 4   | —   | PSTCLK                |
| D5              | DSCLK cycle time                  | 5   | —   | PSTCLK                |
| D6              | BKPT assertion time               | 1   | —   | PSTCLK                |

<sup>1</sup> DSCLK and DSI are synchronized internally. D4 is measured from the synchronized DSCLK input relative to the rising edge of PSTCLK.



**Figure 32. Real-Time Trace AC Timing**



**Figure 33. BDM Serial Port AC Timing**

## 6 Current Consumption

All current consumption data is lab data measured on a single device using an evaluation board. Table 31 shows the typical power consumption in low-power modes. These current measurements are taken after executing a STOP instruction.

**Table 31. Current Consumption in Low-Power Modes<sup>1,2</sup>**

| Mode                               | Voltage | 58 MHz (Typ) <sup>3</sup> | 64 MHz (Typ) <sup>3</sup> | 72 MHz (Typ) <sup>3</sup> | 80 MHz (Typ) <sup>3</sup> | 80 MHz (Peak) <sup>4</sup> | Units |
|------------------------------------|---------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------------|-------|
| Stop Mode 3 (Stop 11) <sup>5</sup> | 3.3 V   | 3.9                       | 3.92                      | 4.0                       | 4.0                       | 4.0                        | mA    |
|                                    | 1.5 V   | 1.04                      | 1.04                      | 1.04                      | 1.04                      | 1.08                       |       |
| Stop Mode 2 (Stop 10) <sup>4</sup> | 3.3 V   | 4.69                      | 4.72                      | 4.8                       | 4.8                       | 4.8                        |       |
|                                    | 1.5 V   | 2.69                      | 2.69                      | 2.70                      | 2.70                      | 2.75                       |       |
| Stop Mode 1 (Stop 01) <sup>4</sup> | 3.3 V   | 4.72                      | 4.73                      | 4.81                      | 4.81                      | 4.81                       |       |
|                                    | 1.5 V   | 15.28                     | 16.44                     | 17.85                     | 19.91                     | 20.42                      |       |
| Stop Mode 0 (Stop 00) <sup>4</sup> | 3.3 V   | 21.65                     | 21.68                     | 24.33                     | 26.13                     | 26.16                      |       |
|                                    | 1.5 V   | 15.47                     | 16.63                     | 18.06                     | 20.12                     | 20.67                      |       |
| Wait/Doze                          | 3.3 V   | 22.49                     | 22.52                     | 25.21                     | 27.03                     | 39.8                       |       |
|                                    | 1.5 V   | 26.79                     | 28.85                     | 30.81                     | 34.47                     | 97.4                       |       |
| Run                                | 3.3 V   | 33.61                     | 33.61                     | 42.3                      | 50.5                      | 62.6                       |       |
|                                    | 1.5 V   | 56.3                      | 60.7                      | 65.4                      | 73.4                      | 132.3                      |       |

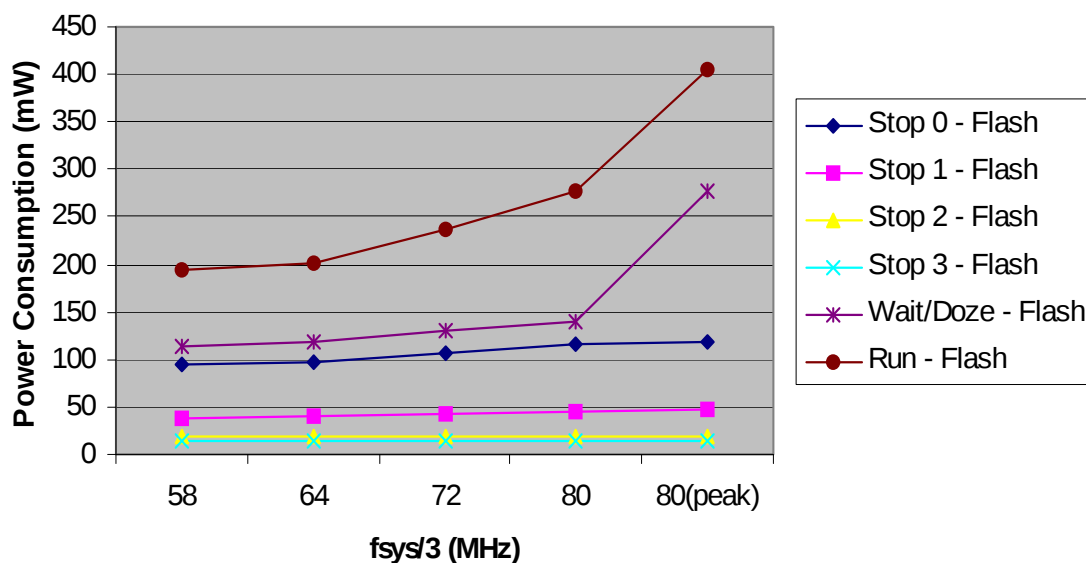
<sup>1</sup> All values are measured with a 3.30V EV<sub>DD</sub>, 3.30V SDV<sub>DD</sub> and 1.5V IV<sub>DD</sub> power supplies. Tests performed at room temperature with pins configured for high drive strength.

<sup>2</sup> Refer to the Power Management chapter in the *MCF532x Reference Manual* for more information on low-power modes.

<sup>3</sup> All peripheral clocks except UART0, FlexBus, INTC0, reset controller, PLL, and edge port off before entering low power mode. All code executed from flash.

<sup>4</sup> All peripheral clocks on before entering low power mode. All code is executed from flash.

<sup>5</sup> See the description of the low-power control register (LCPR) in the *MCF532x Reference Manual* for more information on stop modes 0–3.


**Figure 34. Current Consumption in Low-Power Modes**

**Table 32. Typical Active Current Consumption Specifications<sup>1</sup>**

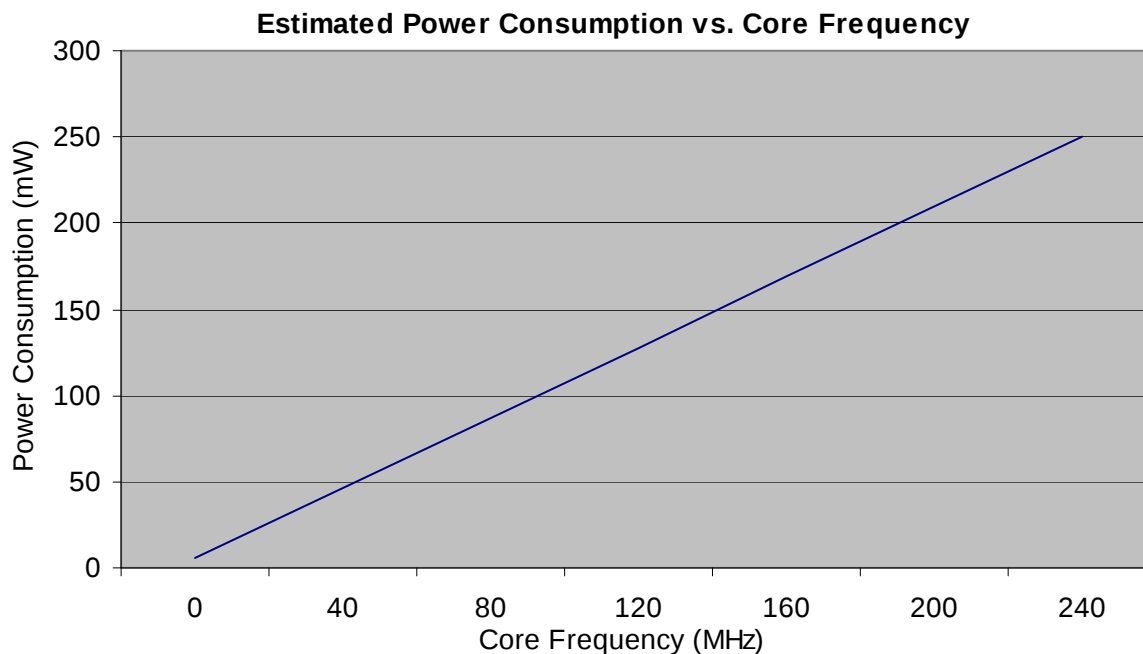
| f <sub>sys/3</sub> Frequency | Voltage | Typical <sup>2</sup> Active (Flash) | Peak <sup>3</sup> | Unit |
|------------------------------|---------|-------------------------------------|-------------------|------|
| 1.333 MHz                    | 3.3V    | 7.73                                | 7.74              | mA   |
|                              | 1.5V    | 2.87                                | 3.56              |      |
| 2.666 MHz                    | 3.3V    | 8.57                                | 8.60              |      |
|                              | 1.5V    | 4.37                                | 5.52              |      |
| 58 MHz                       | 3.3V    | 40.10                               | 49.3              |      |
|                              | 1.5V    | 65.90                               | 91.70             |      |
| 64 MHz                       | 3.3V    | 44.40                               | 54.0              |      |
|                              | 1.5V    | 69.50                               | 97.0              |      |
| 72 MHz                       | 3.3V    | 53.6                                | 63.7              |      |
|                              | 1.5V    | 74.6                                | 104.7             |      |
| 80 MHz                       | 3.3V    | 63.0                                | 73.7              |      |
|                              | 1.5V    | 79.6                                | 112.9             |      |

<sup>1</sup> All values are measured with a 3.30 V EV<sub>DD</sub>, 3.30 V SDV<sub>DD</sub> and 1.5 V IV<sub>DD</sub> power supplies. Tests performed at room temperature with pins configured for high drive strength.

<sup>2</sup> CPU polling a status register. All peripheral clocks except UART0, FlexBus, INTC0, reset controller, PLL, and edge port disabled.

<sup>3</sup> Peak current measured while running a while(1) loop with all modules active.

Figure 35 shows the estimated maximum power consumption.



**Figure 35. Estimated Maximum Power Consumption**

## 7 Package Information

This section contains drawings showing the pinout and the packaging and mechanical characteristics of the MCF532x devices.

### NOTE

The mechanical drawings are the latest revisions at the time of publication of this document. The most up-to-date mechanical drawings can be found at the product summary page located at <http://www.freescale.com/coldfire>.

### 7.1 Package Dimensions—256 MAPBGA

Figure 36 shows MCF5328CVM240, MCF53281CVM240, and MCF5329CVM240 package dimensions.

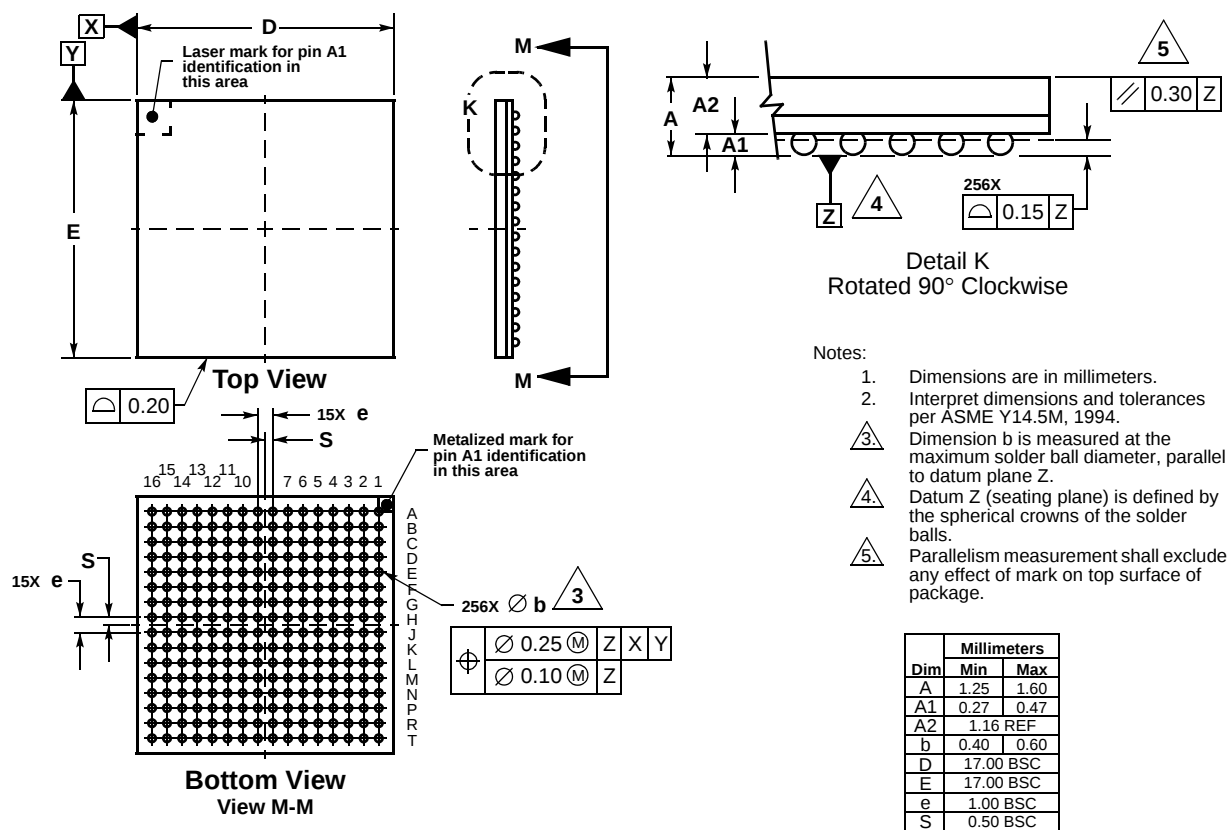


Figure 36. 256 MAPBGA Package Outline

## 7.2 Package Dimensions—196 MAPBGA

Figure 37 shows the MCF5327CVM240 package dimensions.

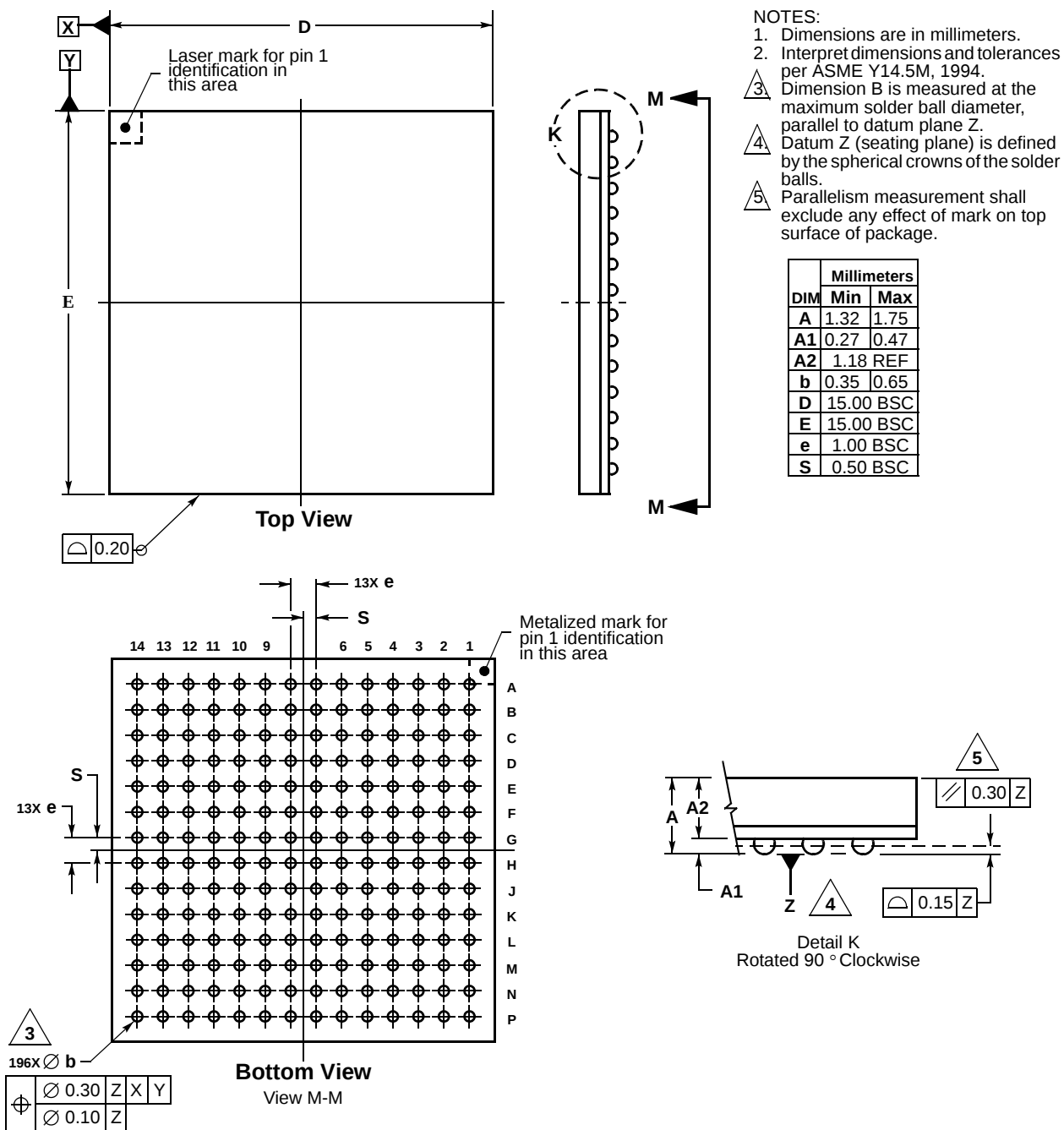


Figure 37. 196 MAPBGA Package Dimensions (Case No. 1128A-01)

# 8 Revision History

**Table 33. MCF5329DS Document Revision History**

| Rev. No. | Substantive Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Date of Release |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 0        | <ul style="list-style-type: none"> <li>Initial release.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 11/2005         |
| 0.1      | <ul style="list-style-type: none"> <li>Added not to <a href="#">Section 7, "Package Information."</a></li> <li>Added top view and bottom view where appropriate in mechanical drawings and pinout figures.</li> <li><a href="#">Figure 6</a>: Corrected "FB_CLK (75MHz)" label to "FB_CLK (80MHz)"</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3/2006          |
| 1        | <ul style="list-style-type: none"> <li>Corrected MCF5327 196MAPBGA ball map locations in <a href="#">Table 5</a> for the following signals: RCON, D1, D0, OE, R/W, SD_DQS2, PSTCLK, DDATA[3:0], PST[3:0], EVDD, IVDD, and SD_VDD. <a href="#">Figure 5</a> was correct.</li> <li>Updated thermal characteristic values in <a href="#">Table 5</a>.</li> <li>Updated DC electricals values in <a href="#">Table 7</a>.</li> <li>Updated <a href="#">Section 3.3, "Supply Voltage Sequencing and Separation Cautions"</a> and subsections.</li> <li>Updated and added Oscillator/PLL characteristics in <a href="#">Table 8</a>.</li> <li><a href="#">Table 9</a>: Swapped min/max for FB1; Removed FB8 &amp; FB9.</li> <li>Updated SDRAM write timing diagram, <a href="#">Figure 9</a>.</li> <li><a href="#">Table 11</a>: Added values for frequency of operation and DD1.</li> <li>Reworded first paragraph in <a href="#">Section 5.12, "ULPI Timing Specification."</a></li> <li>Updated <a href="#">Figure 19</a>.</li> <li>Replaced figure &amp; table <a href="#">Section 5.13, "SSI Timing Specifications,"</a> with slave &amp; master mode versions.</li> <li>Removed second sentence from <a href="#">Section 5.15.2, "MII Transmit Signal Timing,"</a> regarding no minimum frequency requirement for TXCLK.</li> <li>Removed third and fourth paragraphs from <a href="#">Section 5.15.2, "MII Transmit Signal Timing,"</a> as this feature is not supported on this device.</li> <li>Updated figure &amp; table <a href="#">Section 5.19, "Debug AC Timing Specifications."</a></li> <li>Renamed &amp; moved previous version's <a href="#">Section 5.5 "Power Consumption"</a> to <a href="#">Section 6, "Current Consumption."</a> Added additional real-world data to this section as well.</li> </ul> | 7/2007          |
| 2        | <ul style="list-style-type: none"> <li>Added MCF53281 device information throughout: features list, family configuration table, ordering information table, signals description table, and relevant package diagram titles</li> <li>Remove Footnote 1 from <a href="#">Table 11</a>.</li> <li>Changed document type from Advance Information to Technical Data.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 8/2007          |
| 3        | <ul style="list-style-type: none"> <li>Corrected MCF53281 in features list table. This device contains CAN, but does not feature the cryptography accelerators.</li> <li>In pin-multiplexing table, moved MCF53281 label from the MCF5328 column to the MCF5329 column, because this device contains CAN output signals.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10/2007         |

Table 33. MCF5329DS Document Revision History (continued)

| Rev. No. | Substantive Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Date of Release |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 4        | <ul style="list-style-type: none"> <li>Corrected pinouts in Signal Information and Pin-Muxing table for 196 MAPBGA device:<br/>Changed D[15:1] entry from "F4–F1, G4–G2..." to "F4–F1, G5–G2..."<br/>Changed DSO/TDO entry from "P9" to "N9"</li> <li>Corrected D0 spec in <a href="#">Table 30</a> from <math>1.5 \times t_{sys}</math> to <math>2 \times t_{sys}</math> for min and max values.</li> <li>Updated FlexBus read and write timing diagrams in <a href="#">Figure 7</a> and <a href="#">Figure 8</a>.</li> <li>Removed footnote 2 from the IRQ[7:1] alternate functions USBHOST VBUS_EN, USBHOST VBUS_OC, SSI_MCLK, USB_CLKIN, and SSI_CLKIN signals in Signal Information and Pin-Muxing table.</li> <li>Updated pinouts for 196 MAPBGA device, MCF5327CVM240 in both <a href="#">Figure 5</a> and <a href="#">Table 2</a>.<br/>The following locations are affected: G10–12, H12–14, J11–14, K12–13, L12–13, M12–14, N13.<br/>The following signals are affected: USBOTG_VDD, USBHOST_VSS, USBOTG_M, USBOTG_P, USBHOST_M, USBHOST_P, DRAMSEL, PWM3, PWM1, <math>\overline{IRQ}[7,4,3,2,1]</math>, <math>\overline{RESET}</math>, TDI/DSI, JTAG_EN, TMS/BKPT.</li> </ul> | 4/2008          |
| 5        | <p>Changed the following specs in <a href="#">Table 10</a> and <a href="#">Table 11</a>:</p> <ul style="list-style-type: none"> <li>Minimum frequency of operation from TBD to 60MHz</li> <li>Maximum clock period from TBD to 16.67 ns</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 11/2008         |



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