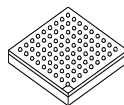
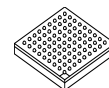




## MCF5329



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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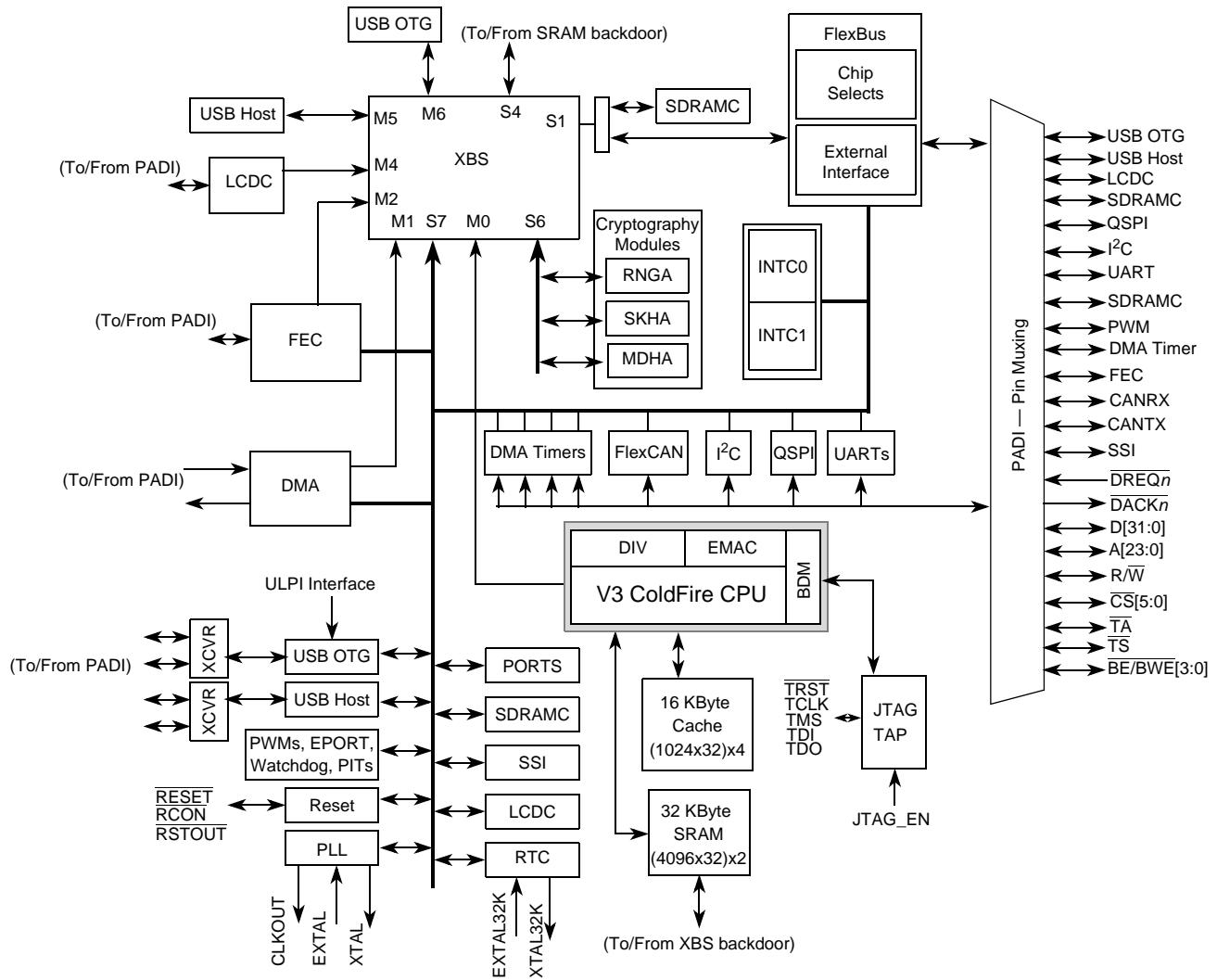


Figure 1. MCF5329 Block Diagram

# 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 <sup>®</sup> 1149.1 Test Access Port	•	•	•	•
Package	196 MAPBGA	256 MAPBGA	256 MAPBGA	256 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.

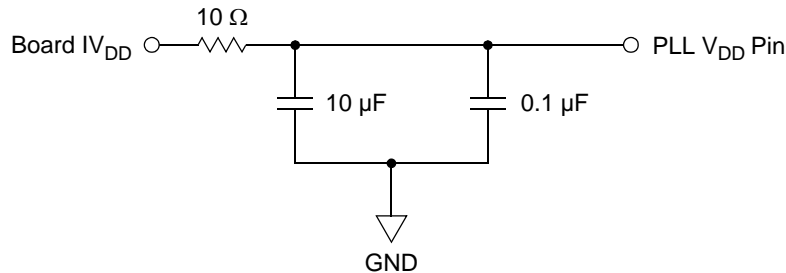


Figure 2. System PLL  $V_{DD}$  Power Filter

### 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  $EV_{DD}$  or  $IV_{DD}$  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.

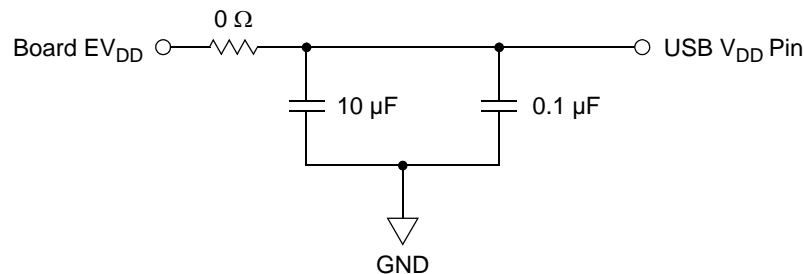


Figure 3. USB  $V_{DD}$  Power Filter

#### 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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 MAPBGA
<b>Mode Selection</b>								
$\overline{\text{RCON}}^2$	—	—	—	I	EVDD	M7	M8	M8
DRAMSEL	—	—	—	I	EVDD	G11	H12	H12
<b>FlexBus</b>								
A[23:22]	—	$\overline{\text{FB\_CS}}[5:4]$	—	O	SDVDD	B11, C11	C13, D13	C13, D13
A[21:16]	—	—	—	O	SDVDD	B12, A12, D11, C12, B13, A13	E13, A14, B14, C14, A15, B15	E13, A14, B14, C14, 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, D12	C15, C16, D15	C15, C16, D15
A10	—	—	—	O	SDVDD	D13	D16	D16
A[9:0]	—	SD_A[9:0] <sup>3</sup>	—	O	SDVDD	D14, E11–14, F11–F14, G14	E14–E16, F13–F16, G16–G14	E14–E16, F13–F16, G16–G14
D[31:16]	—	SD_D[31:16] <sup>4</sup>	—	I/O	SDVDD	H3–H1, J4–J1, K1, L4, M2, M3, N1, N2, P1, P2, N3	M1–M4, N1–N4, T3, P4, R4, T4, N5, P5, R5, T5	M1–M4, N1–N4, T3, P4, R4, T4, N5, P5, R5, T5
D[15:1]	—	FB_D[31:17] <sup>4</sup>	—	I/O	SDVDD	F4–F1, G5–G2, L5, N4, P4, M5, N5, P5, L6	J3–J1, K4–K1, L2, R6, N7, P7, R7, T7, P8, R8	J3–J1, K4–K1, L2, R6, N7, P7, R7, T7, P8, R8
D0 <sup>2</sup>	—	FB_D[16] <sup>4</sup>	—	I/O	SDVDD	M6	T8	T8
$\overline{\text{BE}}/\overline{\text{BWE}}[3:0]$	PBE[3:0]	$\overline{\text{SD\_DQM}}[3:0]^3$	—	O	SDVDD	H4, P3, G1, M4	L4, P6, L3, N6	L4, P6, L3, N6
$\overline{\text{OE}}$	PBUSCTL3	—	—	O	SDVDD	P6	R9	R9
$\overline{\text{TA}}^2$	PBUSCTL2	—	—	I	SDVDD	G13	G13	G13
R/ $\overline{\text{W}}$	PBUSCTL1	—	—	O	SDVDD	N6	N8	N8
$\overline{\text{TS}}$	PBUSCTL0	$\overline{\text{DACK0}}$	—	O	SDVDD	D2	H4	H4
<b>Chip Selects</b>								
$\overline{\text{FB\_CS}}[5:4]$	PCS[5:4]	—	—	O	SDVDD	—	B13, A13	B13, A13
$\overline{\text{FB\_CS}}[3:1]$	PCS[3:1]	—	—	O	SDVDD	A11, D10, C10	A12, B12, C12	A12, B12, C12
$\overline{\text{FB\_CS0}}$	—	—	—	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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 MAPBGA
<b>SDRAM Controller</b>								
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
<b>External Interrupts Port<sup>5</sup></b>								
$\overline{\text{IRQ7}}^2$	PIRQ7 <sup>2</sup>	—	—	I	EVDD	J13	J13	J13
$\overline{\text{IRQ6}}^2$	PIRQ6 <sup>2</sup>	USBHOST_ VBUS_EN	—	I	EVDD	—	J14	J14
$\overline{\text{IRQ5}}^2$	PIRQ5 <sup>2</sup>	USBHOST_ 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
<b>FEC</b>								
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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 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, B4	D6, E6, A5, B5	D6, E6, A5, 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, B2	B4, C4, B3, C3	B4, C4, B3, C3
LCD_ACD/ LCD_OE	PLCDCTLH0	—	—	O	EVDD	D7	B9	B9
LCD_CLS	PLCDCTLL7	—	—	O	EVDD	C7	A9	A9
LCD_CONTRAST	PLCDCTLL6	—	—	O	EVDD	B7	D10	D10
LCD_FLM/ LCD_VSYNC	PLCDCTLL5	—	—	O	EVDD	A7	C10	C10
LCD_LP/ LCD_HSYNC	PLCDCTLL4	—	—	O	EVDD	A8	B10	B10
LCD_LSCLK	PLCDCTLL3	—	—	O	EVDD	B8	A10	A10
LCD_PS	PLCDCTLL2	—	—	O	EVDD	C8	A11	A11
LCD_REV	PLCDCTLL1	—	—	O	EVDD	D8	B11	B11
LCD_SPL_SPR	PLCDCTLL0	—	—	O	EVDD	B9	C11	C11

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

Signal Name	GPIO	Alternate 1	Alternate 2	Dir. <sup>1</sup>	Voltage Domain	MCF5327 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 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: 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: $\overline{TS}$ 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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 MAPBGA
<b>QSPI</b>								
QSPI_CS2	PQSPI5	$\overline{U2RTS}$	—	O	EVDD	P10	T12	T12
QSPI_CS1	PQSPI4	PWM7	USBOTG_ 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	$\overline{U2CTS}$	—	I	EVDD	L10	N12	N12
QSPI_DOUT	PQSPI0	I2C_SDA	—	O	EVDD	M10	P12	P12
<b>UARTs</b>								
$\overline{U1CTS}$	PUARTL7	SSI_BCLK	—	I	EVDD	C9	D11	D11
$\overline{U1RTS}$	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
$\overline{U0CTS}$	PUARTL3	—	—	I	EVDD	P13	R15	R15
$\overline{U0RTS}$	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	$\overline{DACK1}$	I	EVDD	A1	E2	E2
DT0IN	PTIMER0	DT0OUT	$\overline{DREQ0}$ <sup>2</sup>	I	EVDD	C2	E3	E3
<b>BDM/JTAG<sup>6</sup></b>								
JTAG_EN <sup>7</sup>	—	—	—	I	EVDD	L12	M13	M13
DSCLK	—	$\overline{TRST}$ <sup>2</sup>	—	I	EVDD	N14	P15	P15
PSTCLK	—	$\overline{TCLK}$ <sup>2</sup>	—	O	EVDD	L7	T9	T9
$\overline{BKPT}$	—	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, M8	N9, P9, N10, P10	N9, P9, N10, 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 196 MAPBGA	MCF5328 256 MAPBGA	MCF53281 MCF5329 256 MAPBGA
PST[3:0]	—	—	—	O	EVDD	N8, P8, L9, M9	R10, T10, R11, T11	R10, T10, 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, F5–F7, H9, J8, J9, K8, K9, K11	E8, F5–F8, G5, G6, H5, H6, J11, K11, K12, L9–L11, M9, M10	E8, F5–F8, G5, G6, H5, H6, J11, K11, K12, L9–L11, M9, M10
IVDD	—	—	—	—	—	E5, K5, K10, J10	E5, G12, M5, M11, M12	E5, G12, M5, M11, M12
PLL_VDD	—	—	—	—	—	H10	J12	J12
SD_VDD	—	—	—	—	—	E8, E9, F8–F10, J5–J7, K7	E9, F9–F11, G11, H11, J5, J6, K5, K6, L5–L8, M6, M7	E9, F9–F11, G11, H11, J5, J6, K5, K6, L5–L8, M6, M7
USB_VDD	—	—	—	—	—	G10	L14	L14
VSS	—	—	—	—	—	G6–G9, H6–H8, P9	G7–G10, H7–H10, J7–10, K7–K10, L12, L13	G7–G10, H7–H10, J7–10, K7–K10, 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	RW	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/ VSYNC	LCD_LP/ HSYNC	U1TXD	U1RXD	$\overline{\text{FB\_CS3}}$	A20	A16	A15	A
B	D2TIN	LCD_D0	LCD_D6	LCD_D8	LCD_D12	LCD_D16	LCD_CON TRAST	LCD_LSCLK	LCD_SPL_SPR	$\overline{\text{FB\_CS0}}$	A23	A21	A17	A14	B
C	DT3IN	DT0IN	LCD_D2	LCD_D7	LCD_D11	LCD_D15	LCD_CLS	LCD_PS	$\overline{\text{U1CTS}}$	$\overline{\text{FB\_CS1}}$	A22	A18	A13	A12	C
D	$\overline{\text{SD\_WE}}$	$\overline{\text{TS}}$	LCD_D1	LCD_D3	LCD_D10	LCD_D14	LCD_ACD/OE	LCD_REV	$\overline{\text{U1RTS}}$	$\overline{\text{FB\_CS2}}$	A19	A11	A10	A9	D
E	SD_CKE	$\overline{\text{SD\_CS0}}$	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	$\overline{\text{BE/}}/$ BWE1	D8	D9	D10	D11	VSS	VSS	VSS	VSS	USB OTG_VDD	DRAM SEL	USB OTG_M	$\overline{\text{TA}}$	A0	G
H	D29	D30	D31	$\overline{\text{BE/}}/$ 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	$\overline{\text{RESET}}$	USB HOST_P	$\overline{\text{IRQ7}}$	PWM1	J
K	D24	$\overline{\text{SD\_CLK}}$	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	$\overline{\text{SD\_CAS}}$	D23	D7	D1	TCLK/ PSTCLK	DDATA1	PST1	QSPI_DIN	QSPI_CS1	JTAG_EN	$\overline{\text{IRQ4}}$	EXTAL	L
M	$\overline{\text{SD\_RAS}}$	D22	D21	$\overline{\text{BE/}}/$ BWE0	D4	D0	$\overline{\text{RCON}}$	DDATA0	PST0	QSPI_DOUT	EXTAL 32K	TMS/ BKPT	$\overline{\text{IRQ2}}$	$\overline{\text{IRQ3}}$	M
N	D20	D19	D16	D6	D3	$\overline{\text{RW}}$	DDATA3	PST3	TDO/ DSO	QSPI_CLK	XTAL 32K	$\overline{\text{UORTS}}$	$\overline{\text{IRQ1}}$	$\overline{\text{TRST/}}/$ DSCLK	N
P	D18	D17	$\overline{\text{BE/}}/$ BWE2	D5	D2	$\overline{\text{OE}}$	DDATA2	PST2	VSS	QSPI_CS2	U0RXD	U0TXD	$\overline{\text{U0CTS}}$	$\overline{\text{RSTOUT}}$	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 Single pin limit (applies to all pins) <sup>3, 4, 5</sup>	$I_D$	25	mA
Operating Temperature Range (Packaged)	$T_A$ ( $T_L - T_H$ )	- 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  $I_D$ , 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
$P_D$	= $P_{INT} + P_{I/O}$
$P_{INT}$	= $I_{DD} \times IV_{DD}$ , 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:

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

Solving equations 1 and 2 for K gives:

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

## 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 Mobile DDR/Bus Pad Supply Voltage (nominal 1.8V) DDR/Bus Pad Supply Voltage (nominal 2.5V) SDR/Bus Pad Supply Voltage (nominal 3.3V)	$SDV_{DD}$	1.70 2.25 3.0	1.95 2.75 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 $I_{OH} = -5.0$ mA	$EV_{OH}$	$EV_{DD} - 0.4$	—	V
CMOS Output Low Voltage $I_{OL} = 5.0$ mA	$EV_{OL}$	—	0.4	V
SDRAM and FlexBus Input High Voltage Mobile DDR/Bus Input High Voltage (nominal 1.8V) DDR/Bus Pad Supply Voltage (nominal 2.5V) SDR/Bus Pad Supply Voltage (nominal 3.3V)	$SDV_{IH}$	1.35 1.7 2	$SDV_{DD} + 0.3$ $SDV_{DD} + 0.3$ $SDV_{DD} + 0.3$	V
SDRAM and FlexBus Input Low Voltage Mobile DDR/Bus Input High Voltage (nominal 1.8V) DDR/Bus Pad Supply Voltage (nominal 2.5V) SDR/Bus Pad Supply Voltage (nominal 3.3V)	$SDV_{IL}$	$V_{SS} - 0.3$ $V_{SS} - 0.3$ $V_{SS} - 0.3$	0.45 0.8 0.8	V

Table 7. DC Electrical Specifications (continued)

Characteristic	Symbol	Min	Max	Unit
SDRAM and FlexBus Output High Voltage Mobile DDR/Bus Input High Voltage (nominal 1.8V) DDR/Bus Pad Supply Voltage (nominal 2.5V) SDR/Bus Pad Supply Voltage (nominal 3.3V) $I_{OH} = -5.0$ mA for all modes	$SDV_{OH}$	$SDV_{DD} - 0.35$ 2.1 2.4	— — —	V
SDRAM and FlexBus Output Low Voltage Mobile DDR/Bus Input High Voltage (nominal 1.8V) DDR/Bus Pad Supply Voltage (nominal 2.5V) SDR/Bus Pad Supply Voltage (nominal 3.3V) $I_{OL} = 5.0$ mA for all modes	$SDV_{OL}$	— — —	0.3 0.3 0.5	V
Input Leakage Current $V_{in} = V_{DD}$ 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> All input-only pins All input/output (three-state) pins	$C_{in}$	— —	7 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 Crystal reference External reference	$f_{ref\_crystal}$	12	25 <sup>1</sup>	MHz
		$f_{ref\_ext}$	12	40 <sup>1</sup>	MHz
2	Core frequency CLKOUT Frequency <sup>2</sup>	$f_{sys}$	$488 \times 10^{-6}$	240	MHz
		$f_{sys/3}$	$163 \times 10^{-6}$	80	MHz
3	Crystal Start-up Time <sup>3, 4</sup>	$t_{cst}$	—	10	ms
4	EXTAL Input High Voltage Crystal Mode <sup>5</sup> All other modes (External, Limp)	$V_{IHEXT}$	$V_{XTAL} + 0.4$	—	V
		$V_{IHEXT}$	$E_{VDD}/2 + 0.4$	—	V
5	EXTAL Input Low Voltage Crystal Mode <sup>5</sup> All other modes (External, Limp)	$V_{ILEXT}$	—	$V_{XTAL} - 0.4$	V
		$V_{ILEXT}$	—	$E_{VDD}/2 - 0.4$	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 Peak-to-peak Jitter (Clock edge to clock edge) Long Term Jitter	$C_{jitter}$	— —	10 TBD	% $f_{sys}/3$ % $f_{sys}/3$
18	Frequency Modulation Range Limit <sup>3, 10, 11</sup> ( $f_{sys}$ 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.

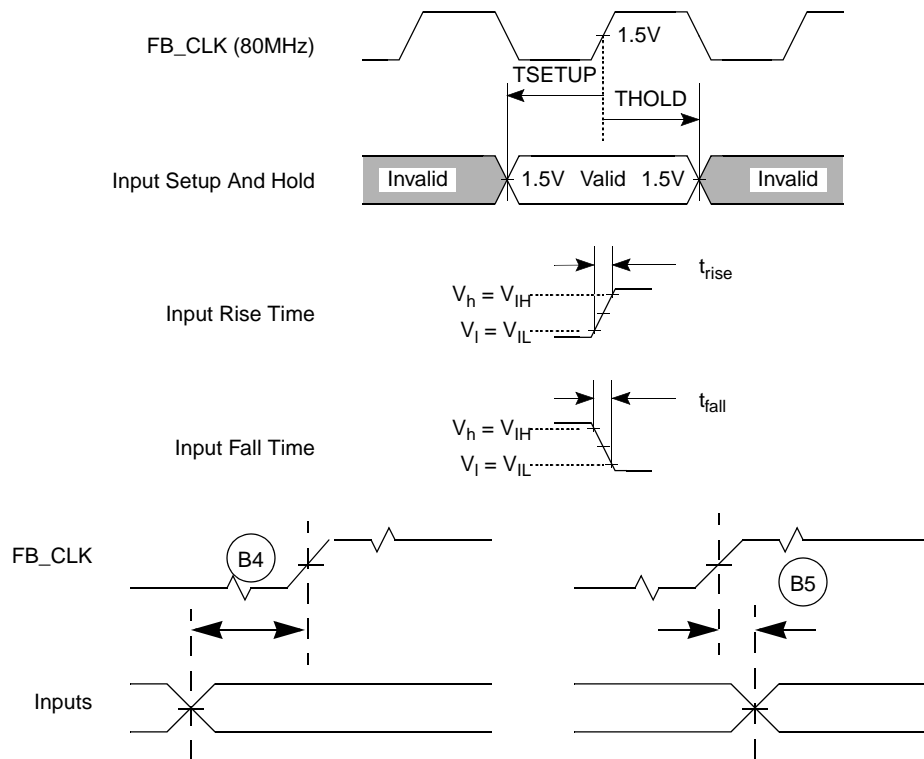


Figure 6. General Input Timing Requirements

## 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,  $\overline{\text{FB\_CS}}0$  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

- 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.
- 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.

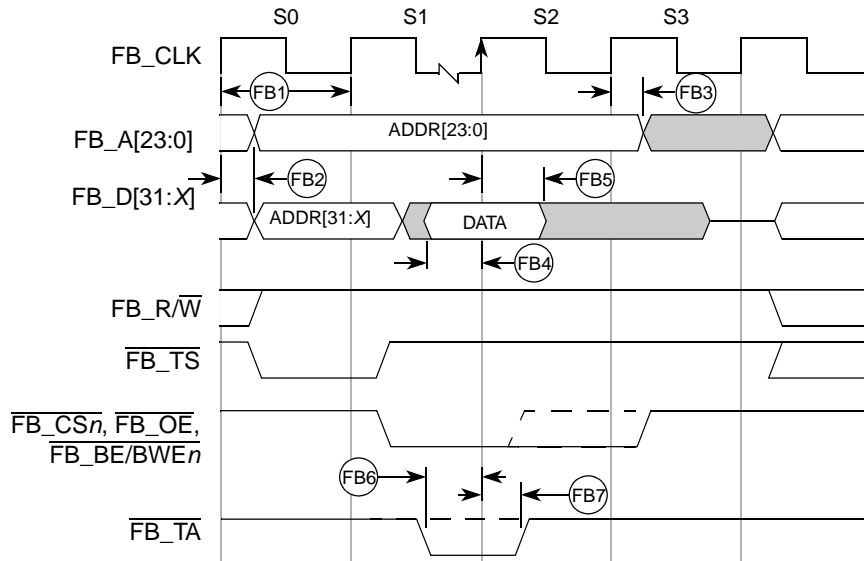


Figure 7. FlexBus Read Timing

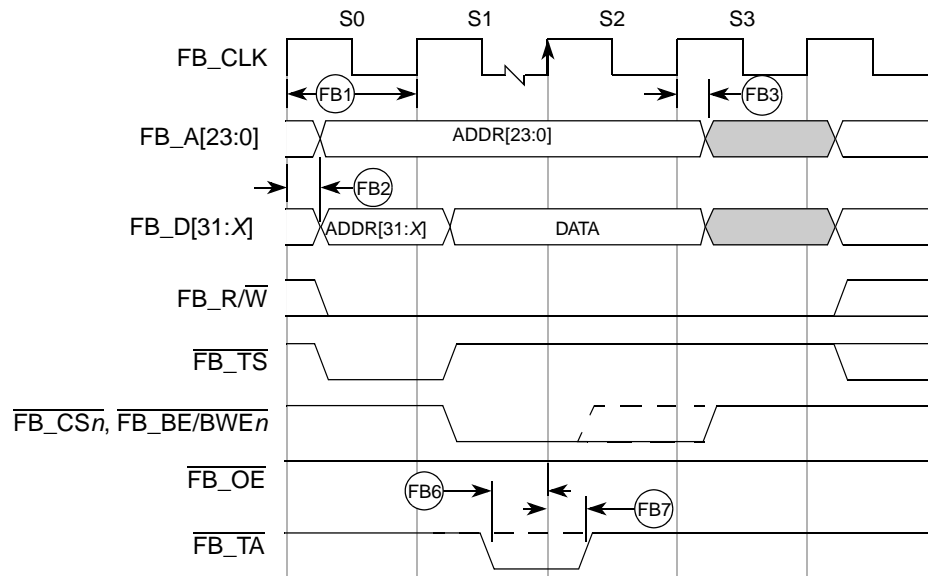


Figure 8. FlexBus Write Timing

## 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>	$t_{SDCK}$	12.5	16.67	ns
SD3	Pulse Width High <sup>3</sup>	$t_{SDCKH}$	0.45	0.55	SD_CLK
SD4	Pulse Width Low <sup>4</sup>	$t_{SDCKL}$	0.45	0.55	SD_CLK
SD5	Address, $\overline{SD\_CKE}$ , $\overline{SD\_CAS}$ , $\overline{SD\_RAS}$ , $\overline{SD\_WE}$ , $\overline{SD\_BA}$ , $\overline{SD\_CS}[1:0]$ - Output Valid	$t_{SDCHACV}$	—	$0.5 \times SD\_CLK + 1.0$	ns
SD6	Address, $\overline{SD\_CKE}$ , $\overline{SD\_CAS}$ , $\overline{SD\_RAS}$ , $\overline{SD\_WE}$ , $\overline{SD\_BA}$ , $\overline{SD\_CS}[1:0]$ - Output Hold	$t_{SDCHACI}$	2.0	—	ns
SD7	SD_SDR_DQS Output Valid <sup>5</sup>	$t_{DQSOV}$	—	Self timed	ns
SD8	SD_DQS[3:0] input setup relative to SD_CLK <sup>6</sup>	$t_{DQVSDCH}$	$0.25 \times SD\_CLK$	$0.40 \times SD\_CLK$	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 <sub>DQISDCH</sub>	Does not apply. 0.5×SD_CLK fixed width.		
SD10	Data (D[31:0]) Input Setup relative to SD_CLK (reference only) <sup>8</sup>	t <sub>DVSDCH</sub>	0.25 × SD_CLK	—	ns
SD11	Data Input Hold relative to SD_CLK (reference only)	t <sub>DISDCH</sub>	1.0	—	ns
SD12	Data (D[31:0]) and Data Mask(SD_DQM[3:0]) Output Valid	t <sub>SDCHDMV</sub>	—	0.75 × SD_CLK + 0.5	ns
SD13	Data (D[31:0]) and Data Mask (SD_DQM[3:0]) Output Hold	t <sub>SDCHDMI</sub>	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.

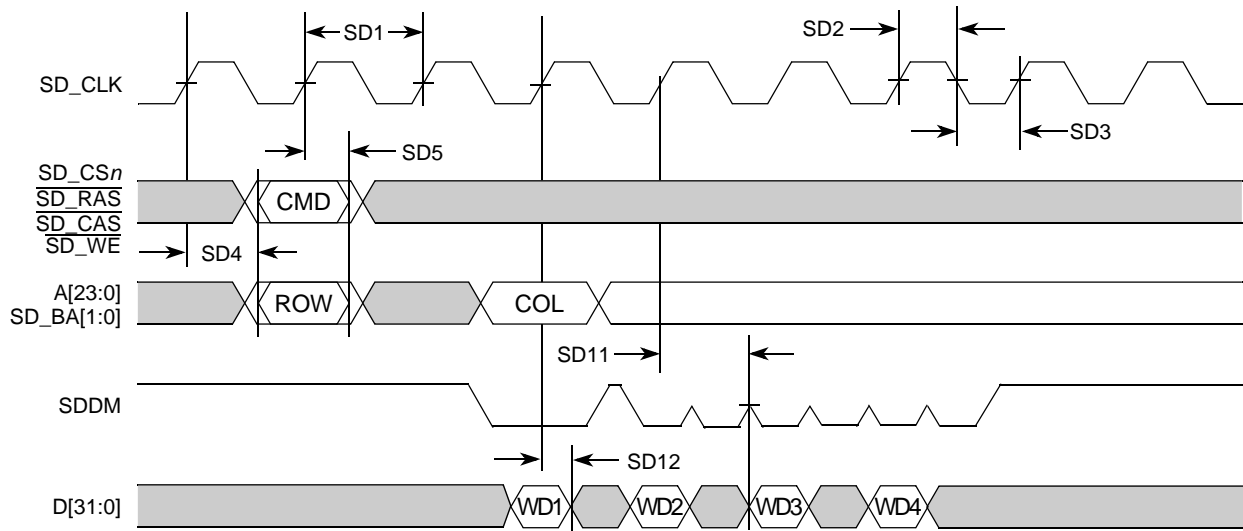


Figure 9. SDR Write Timing



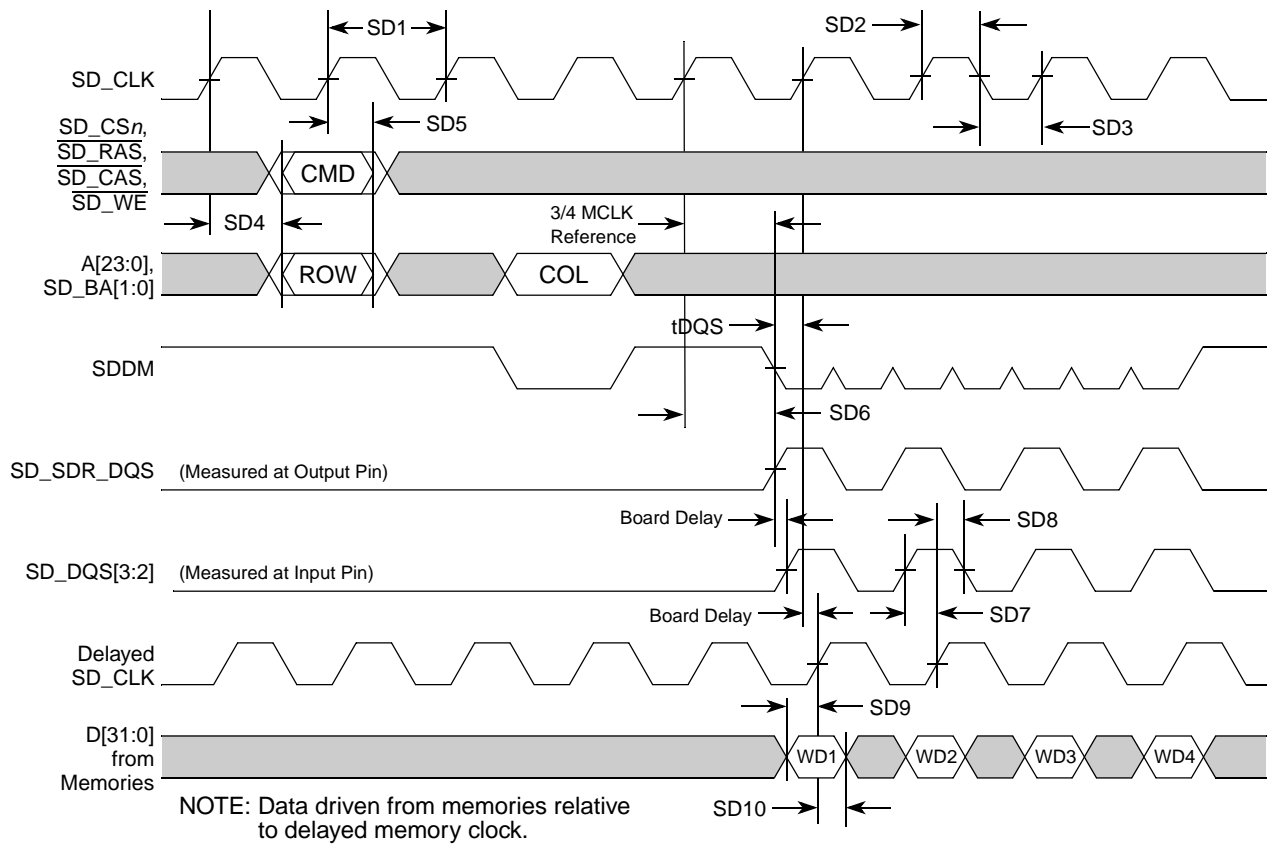


Figure 10. SDR Read Timing

### 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 <sub>DQDMI</sub>	1.0	—	ns
DD9	Input Data Skew Relative to DQS (Input Setup) <sup>7</sup>	t <sub>DVDQ</sub>	—	1	ns
DD10	Input Data Hold Relative to DQS <sup>8</sup>	t <sub>DIDQ</sub>	0.25 × SD_CLK + 0.5ns	—	ns
DD11	DQS falling edge from SDCLK rising (output hold time)	t <sub>DQLSDCH</sub>	0.5	—	ns
DD12	DQS input read preamble width	t <sub>DQRPRE</sub>	0.9	1.1	SD_CLK
DD13	DQS input read postamble width	t <sub>DQRPST</sub>	0.4	0.6	SD_CLK
DD14	DQS output write preamble width	t <sub>DQWPRE</sub>	0.25		SD_CLK
DD15	DQS output write postamble width	t <sub>DQWPST</sub>	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.

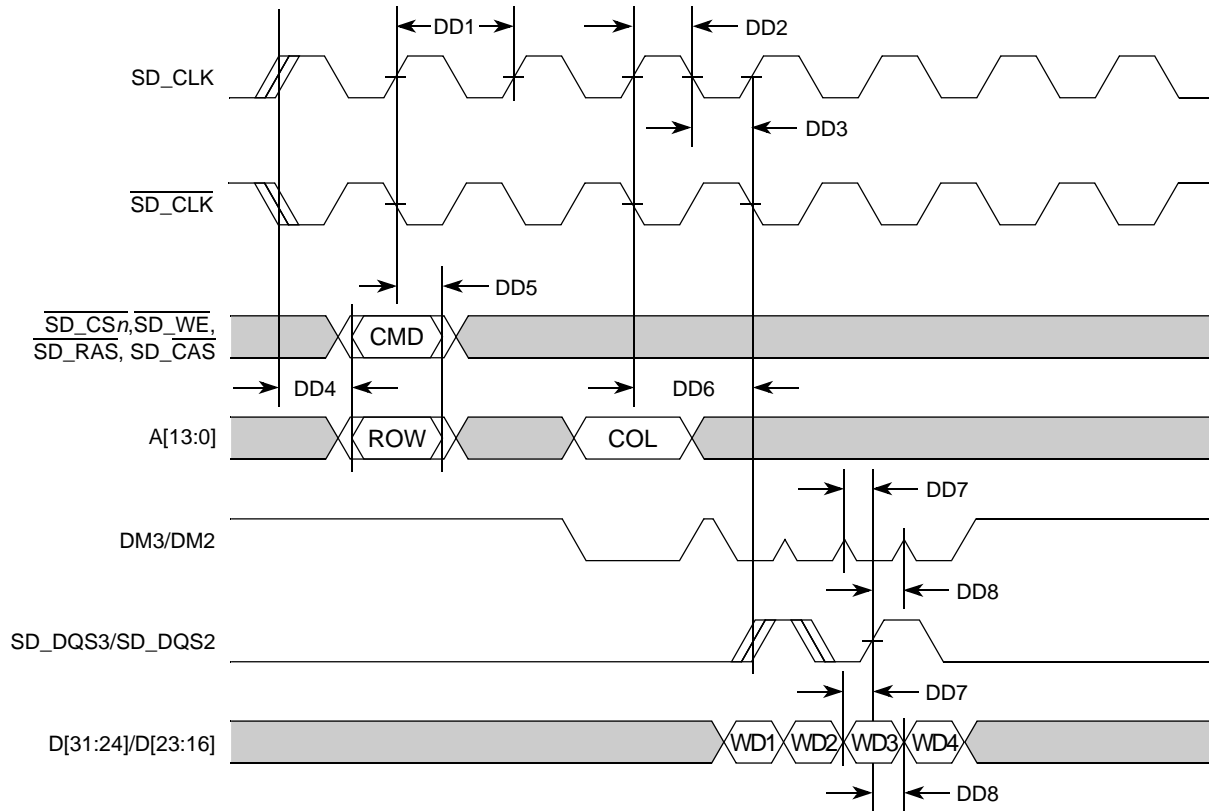


Figure 11. DDR Write Timing

## Electrical Characteristics

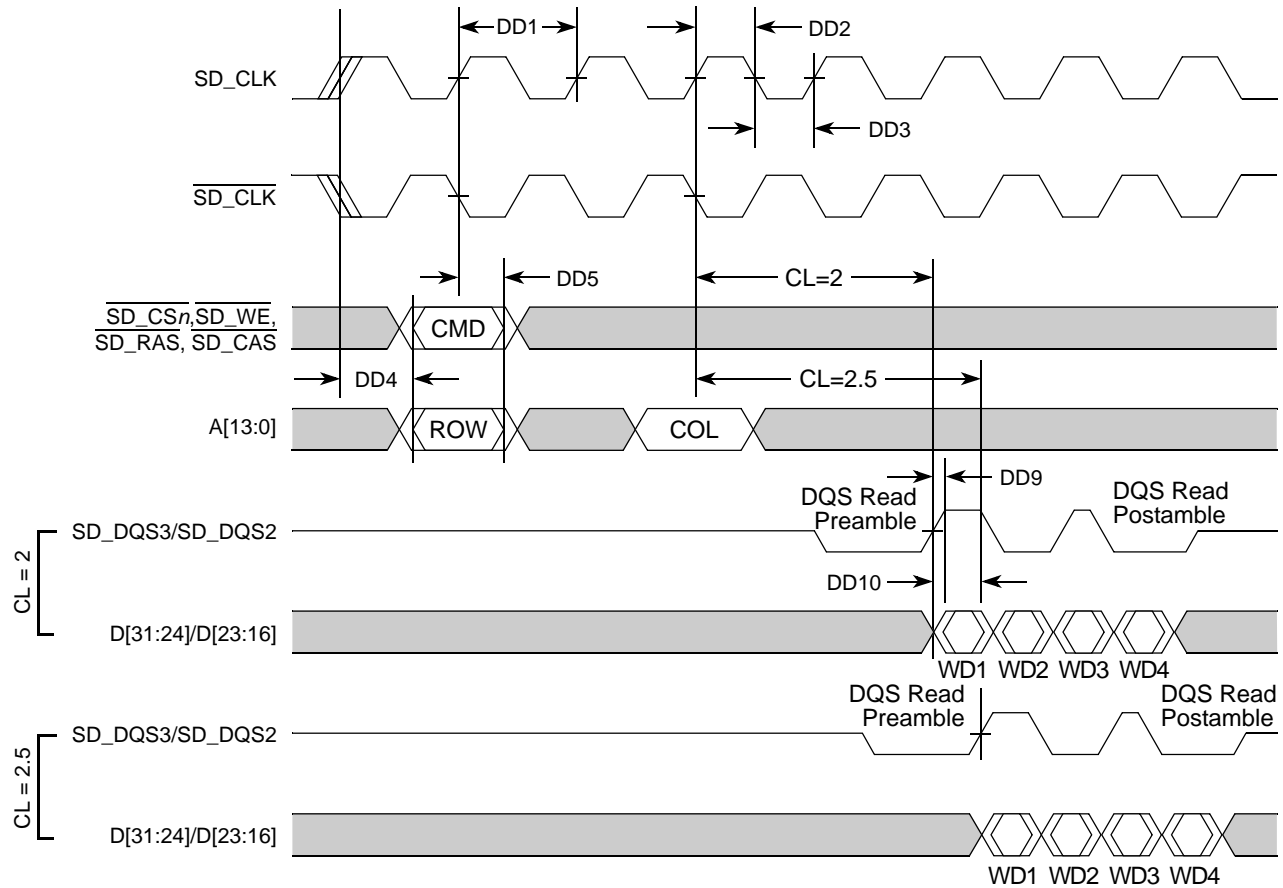


Figure 12. DDR Read Timing

## 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.

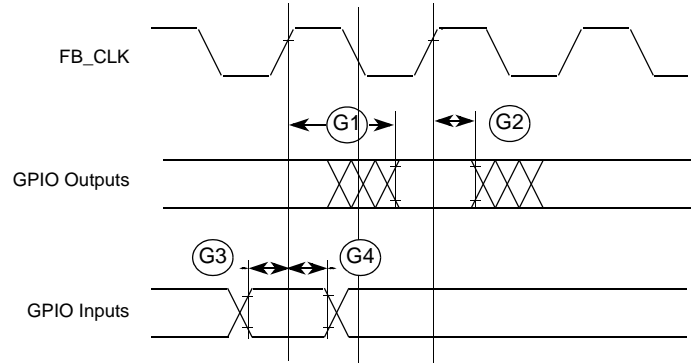


Figure 13. GPIO Timing

## 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.

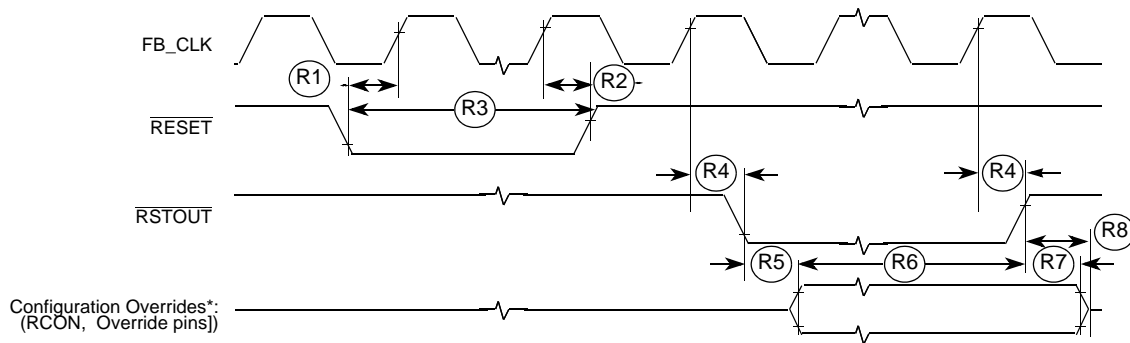


Figure 14.  $\overline{\text{RESET}}$  and Configuration Override Timing

### NOTE

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

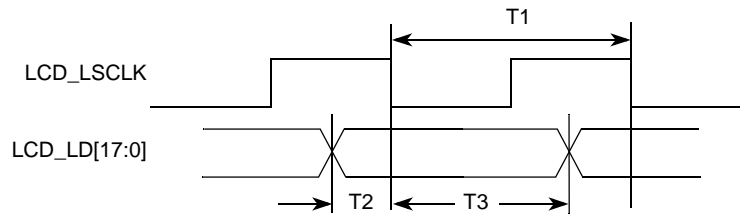
## 5.10 LCD Controller Timing Specifications

This sections lists the timing specifications for the LCD Controller.

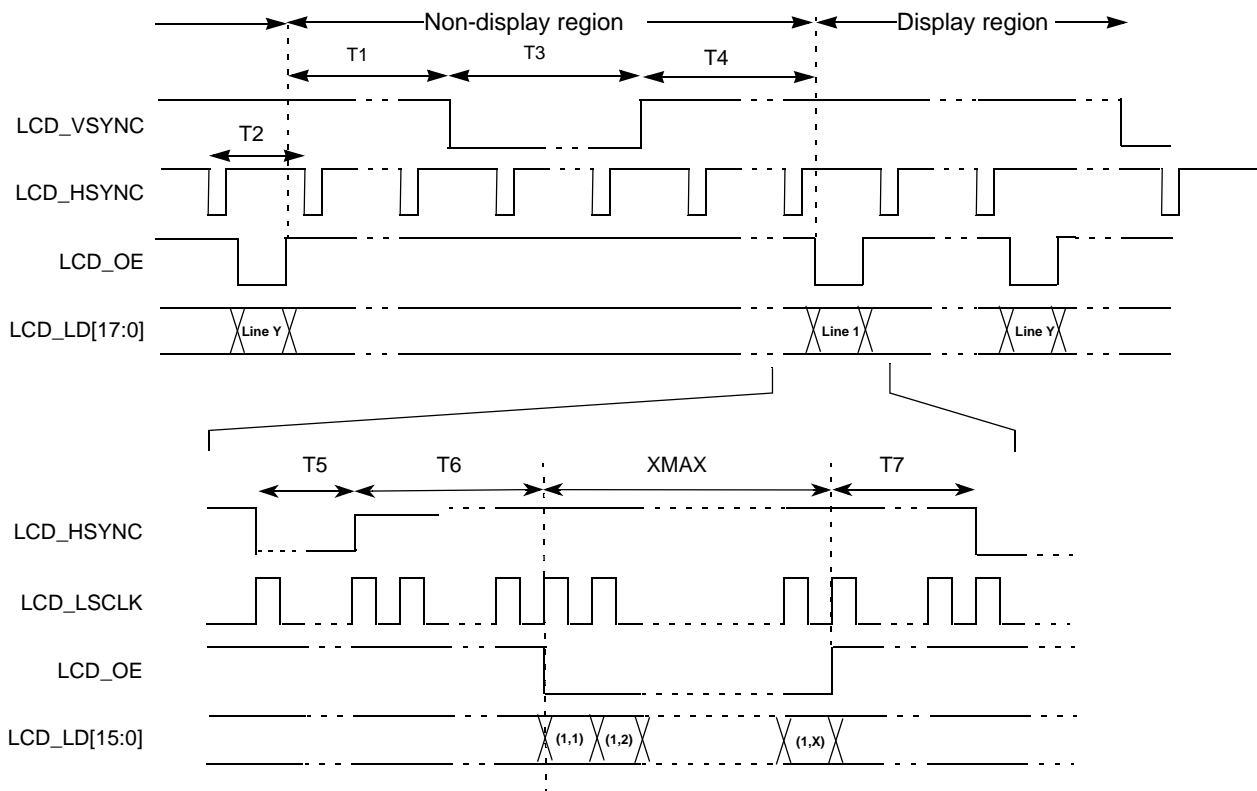
**Table 14. LCD\_LSCLK Timing**

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  $LCD\_LSCLK / (PCD + 1)$ . 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.

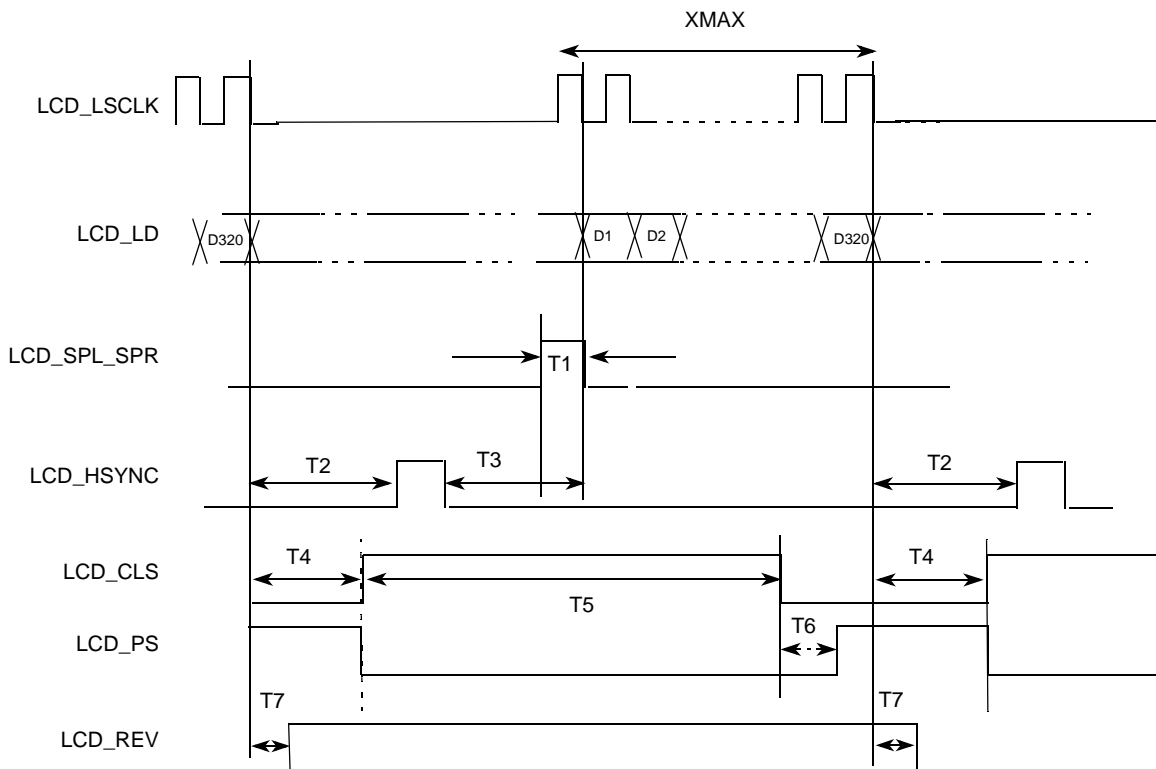


Figure 17. Sharp TFT Panel Timing

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.

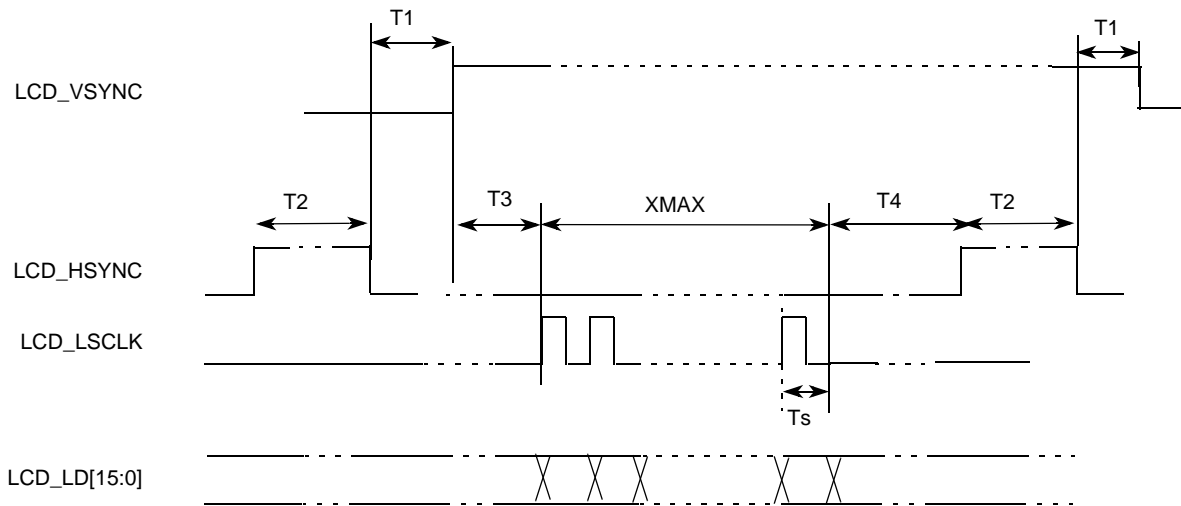


Figure 18. Non-TFT Mode Panel Timing

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.

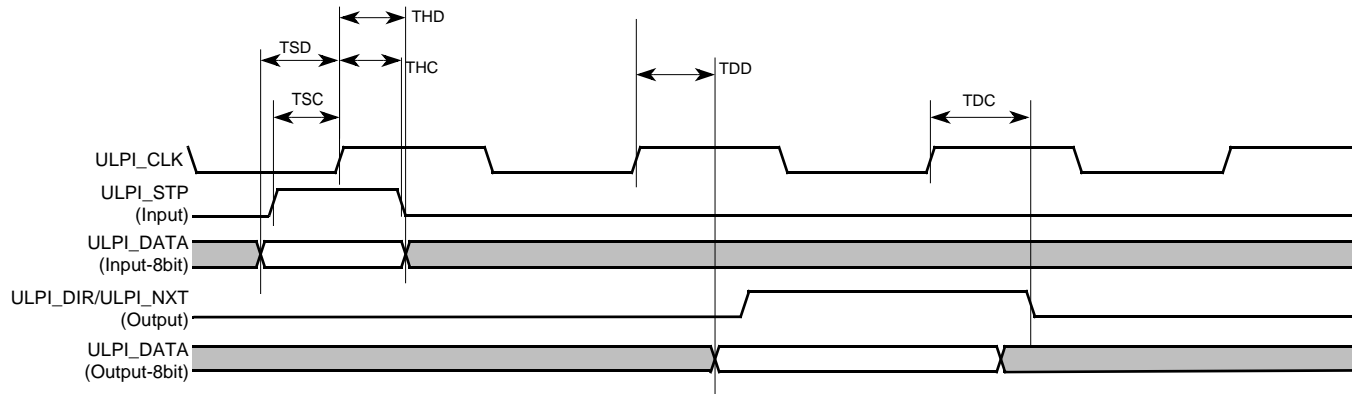


Figure 19. ULPI Timing Diagram

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  $4 \times f_{SYS}$ .

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

Num	Description	Symbol	Min	Max	Units
S11	SSI_BCLK cycle time	$t_{BCLK}$	$8 \times t_{SYS}$	—	ns
S12	SSI_BCLK pulse width high/low		45%	55%	$t_{BCLK}$
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.

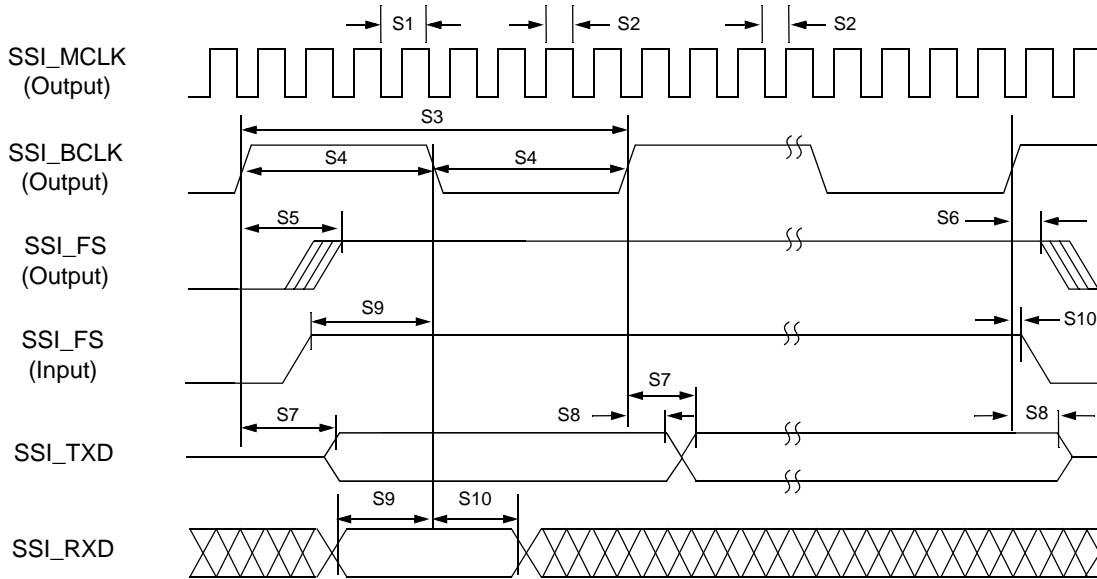


Figure 20. SSI Timing – Master Modes

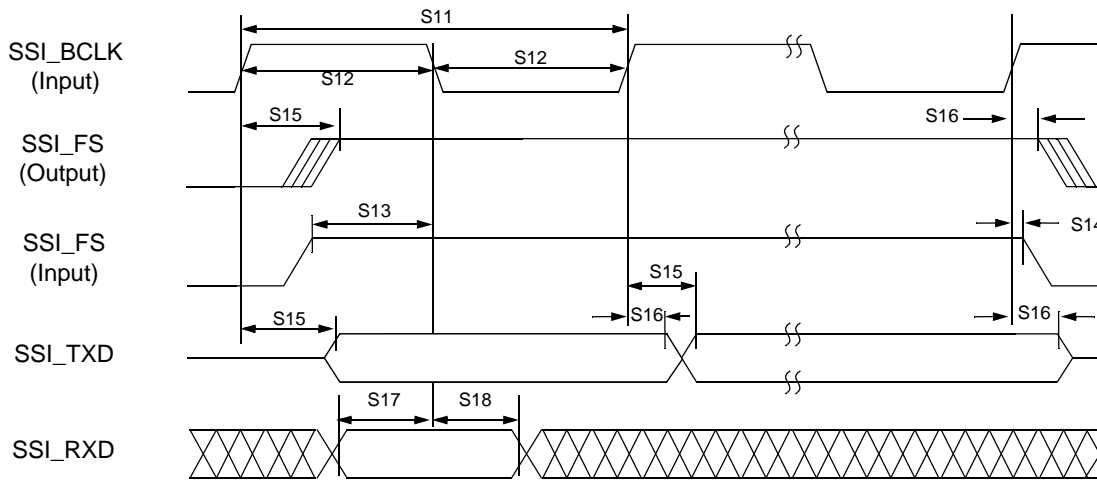


Figure 21. SSI Timing – Slave Modes

## 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 <sub>cyc</sub>
I2	Clock low period	8	—	t <sub>cyc</sub>
I3	I2C_SCL/I2C_SDA rise time (V <sub>IL</sub> = 0.5 V to V <sub>IH</sub> = 2.4 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**

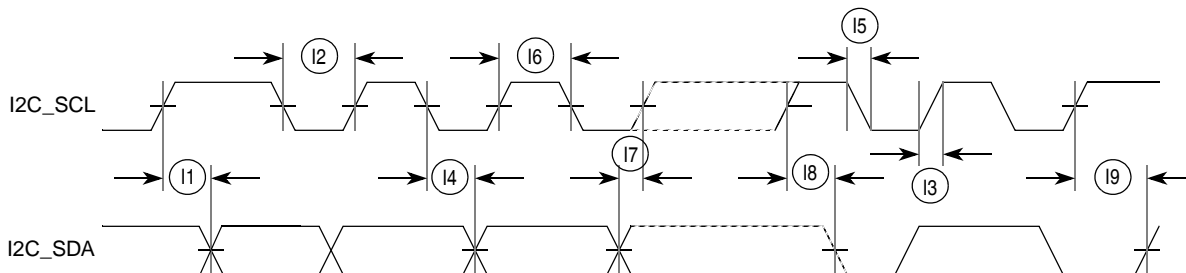
Num	Characteristic	Min	Max	Units
I1 <sup>1</sup>	Start condition hold time	6	—	$t_{cyc}$
I2 <sup>1</sup>	Clock low period	10	—	$t_{cyc}$
I3 <sup>2</sup>	I2C_SCL/I2C_SDA rise time ( $V_{IL} = 0.5\text{ V}$ to $V_{IH} = 2.4\text{ V}$ )	—	—	$\mu\text{s}$
I4 <sup>1</sup>	Data hold time	7	—	$t_{cyc}$
I5 <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

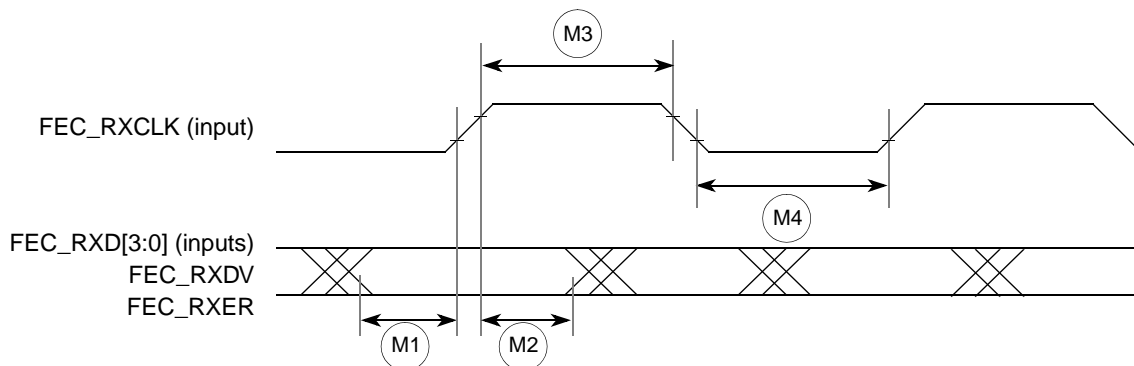
The receiver functions correctly up to a FEC\_RXCLK maximum frequency of 25 MHz +1%. The processor clock frequency must exceed twice the FEC\_RXCLK frequency.

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.

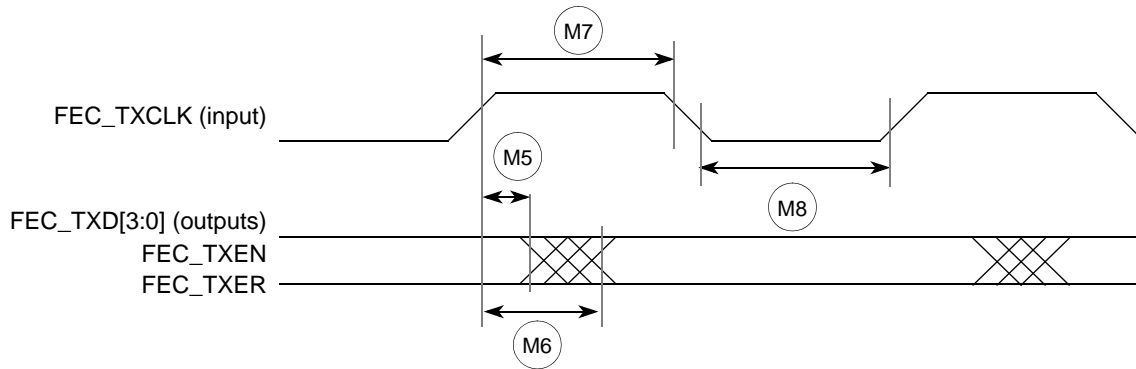


Figure 24. MII Transmit Signal Timing Diagram

### 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_CRCS, 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

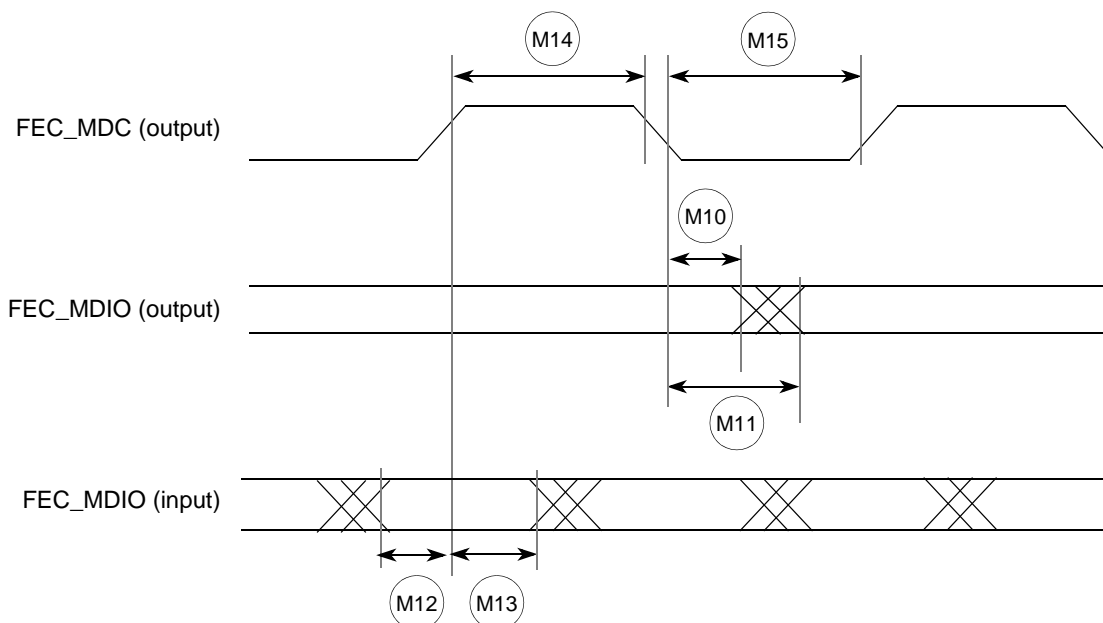


Figure 26. MII Serial Management Channel Timing Diagram

## 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

## Electrical Characteristics

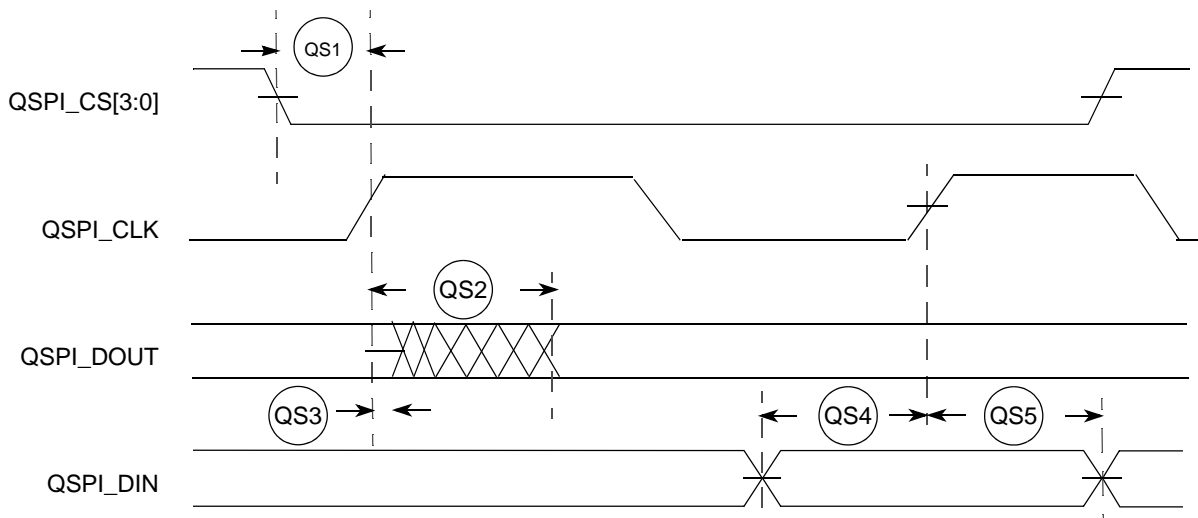


Figure 27. QSPI Timing

## 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.



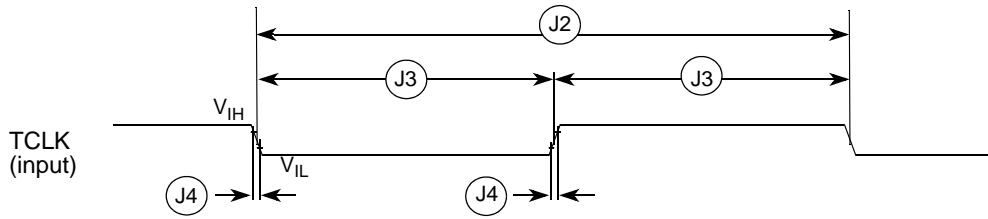


Figure 28. Test Clock Input Timing

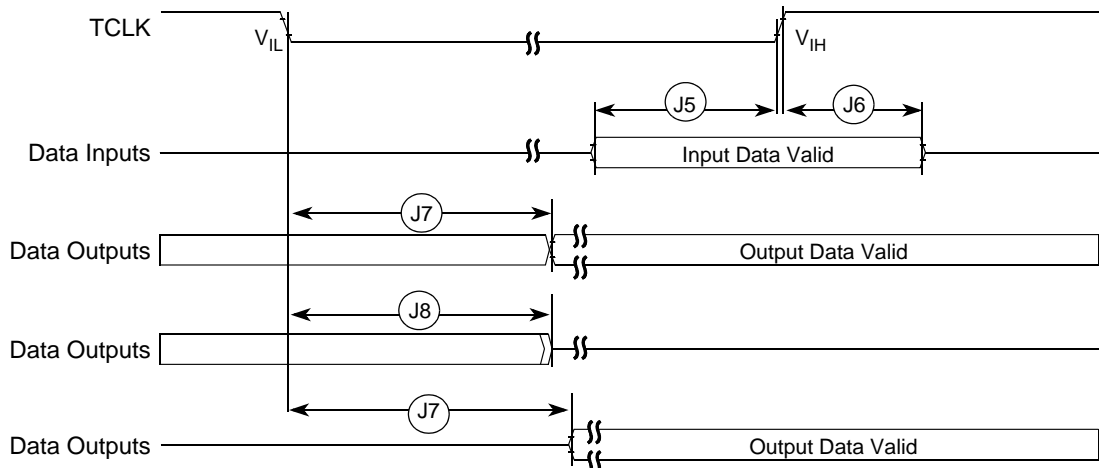


Figure 29. Boundary Scan (JTAG) Timing

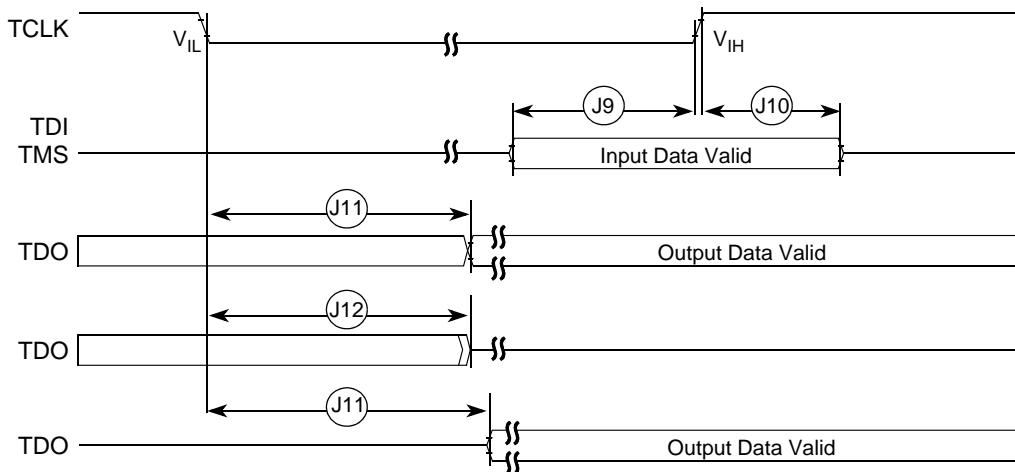


Figure 30. Test Access Port Timing

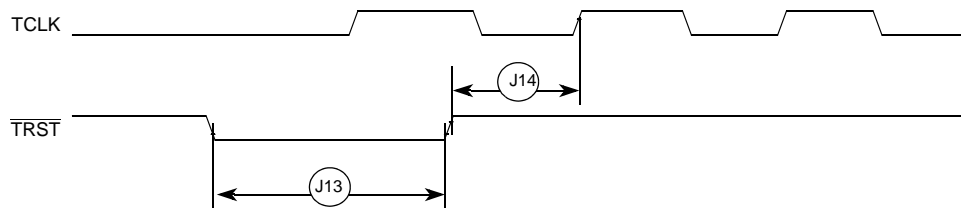


Figure 31. TRST Timing

## 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.

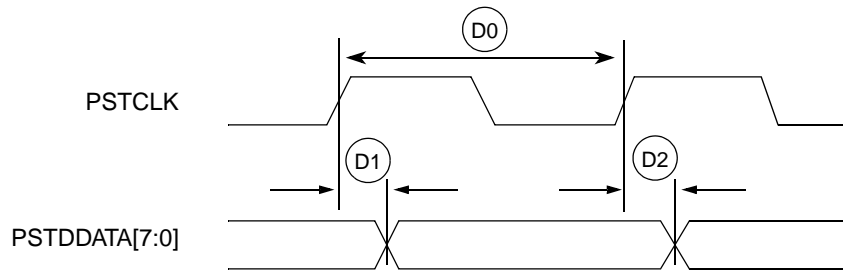


Figure 32. Real-Time Trace AC Timing

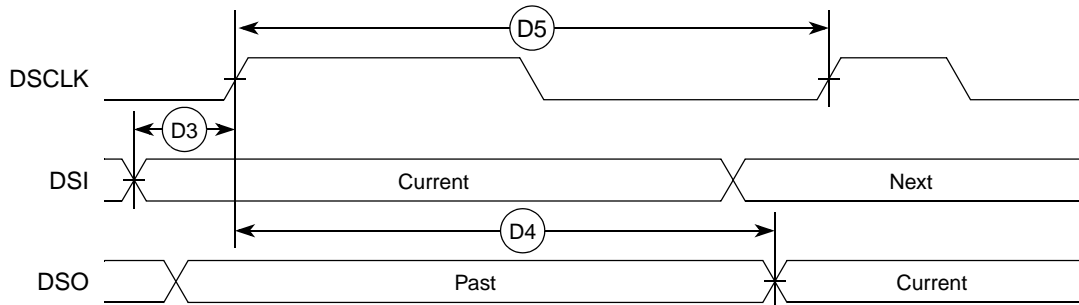


Figure 33. BDM Serial Port AC Timing

## 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.

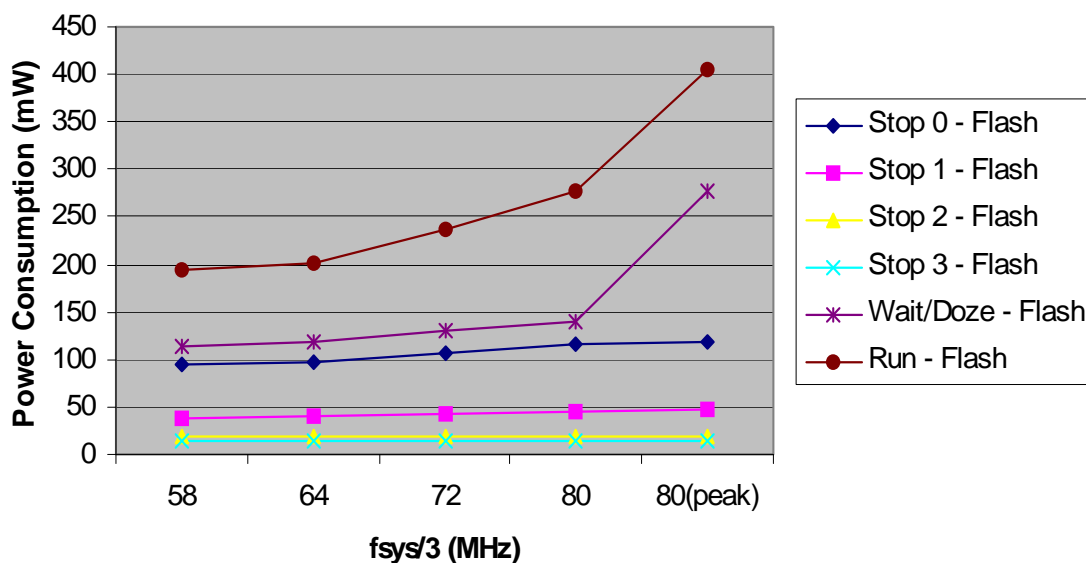


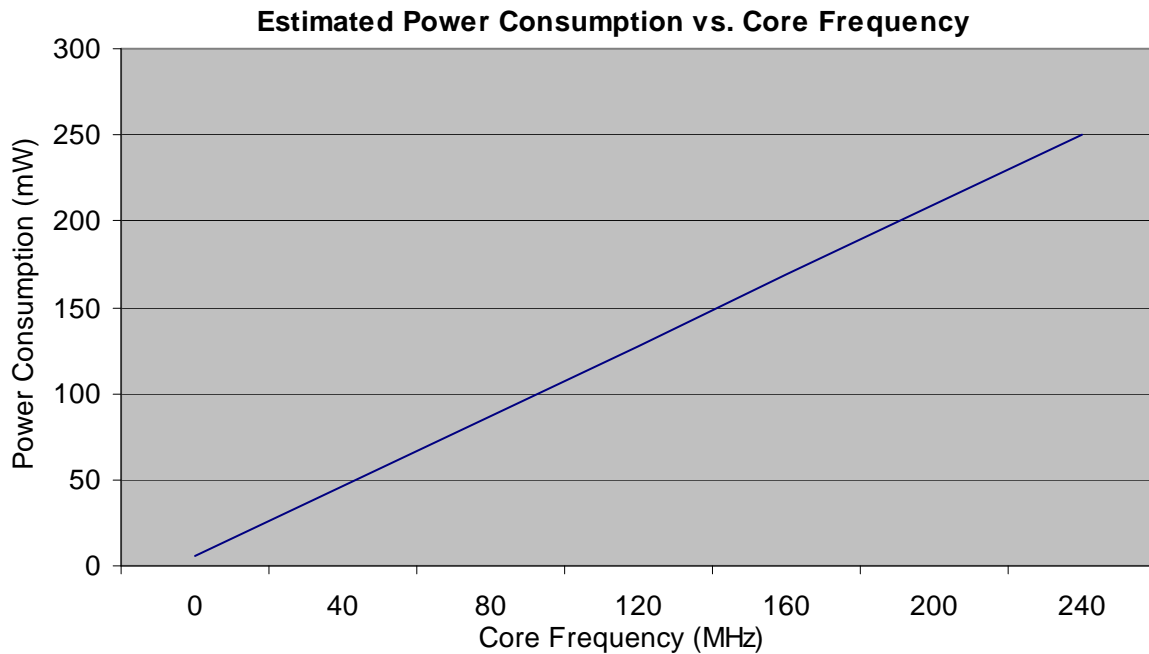
Figure 34. Current Consumption in Low-Power Modes

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

$f_{sys/3}$ 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.

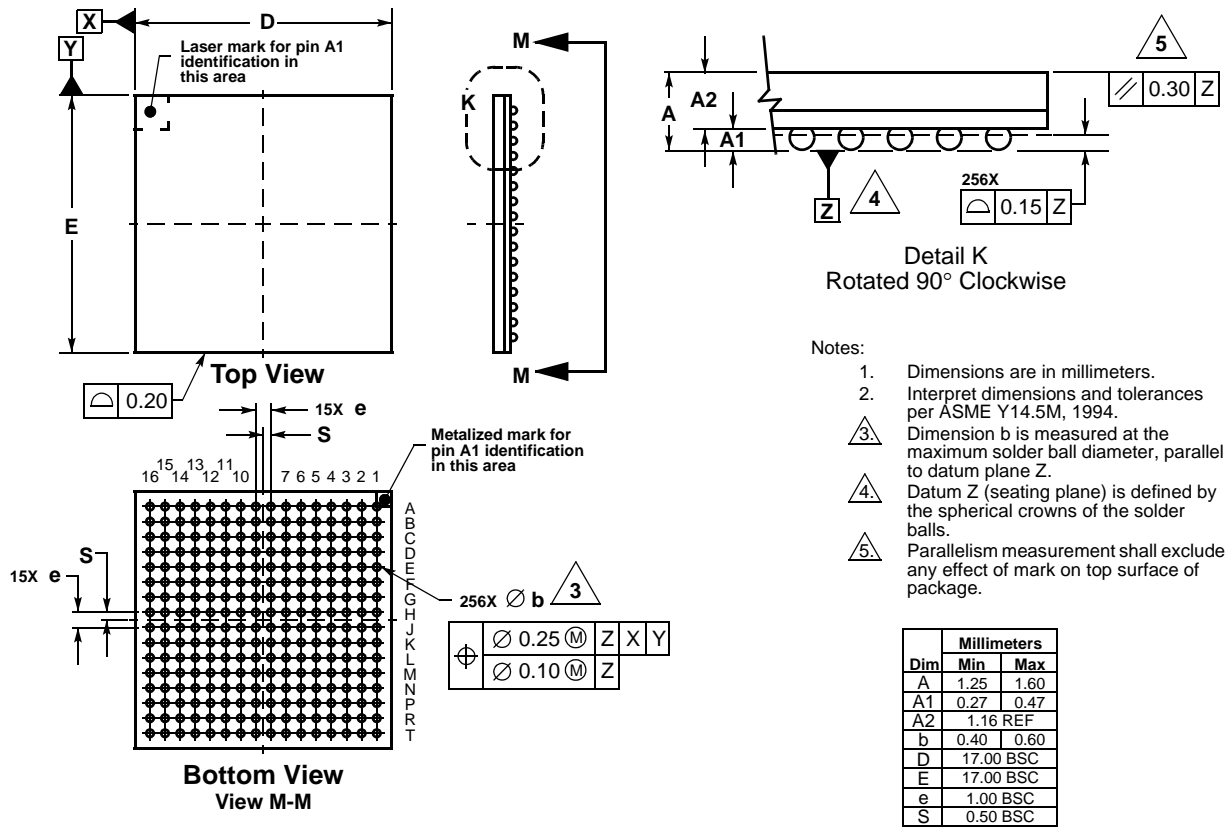


Figure 36. 256 MAPBGA Package Outline

## 7.2 Package Dimensions—196 MAPBGA

Figure 37 shows the MCF5327CVM240 package dimensions.

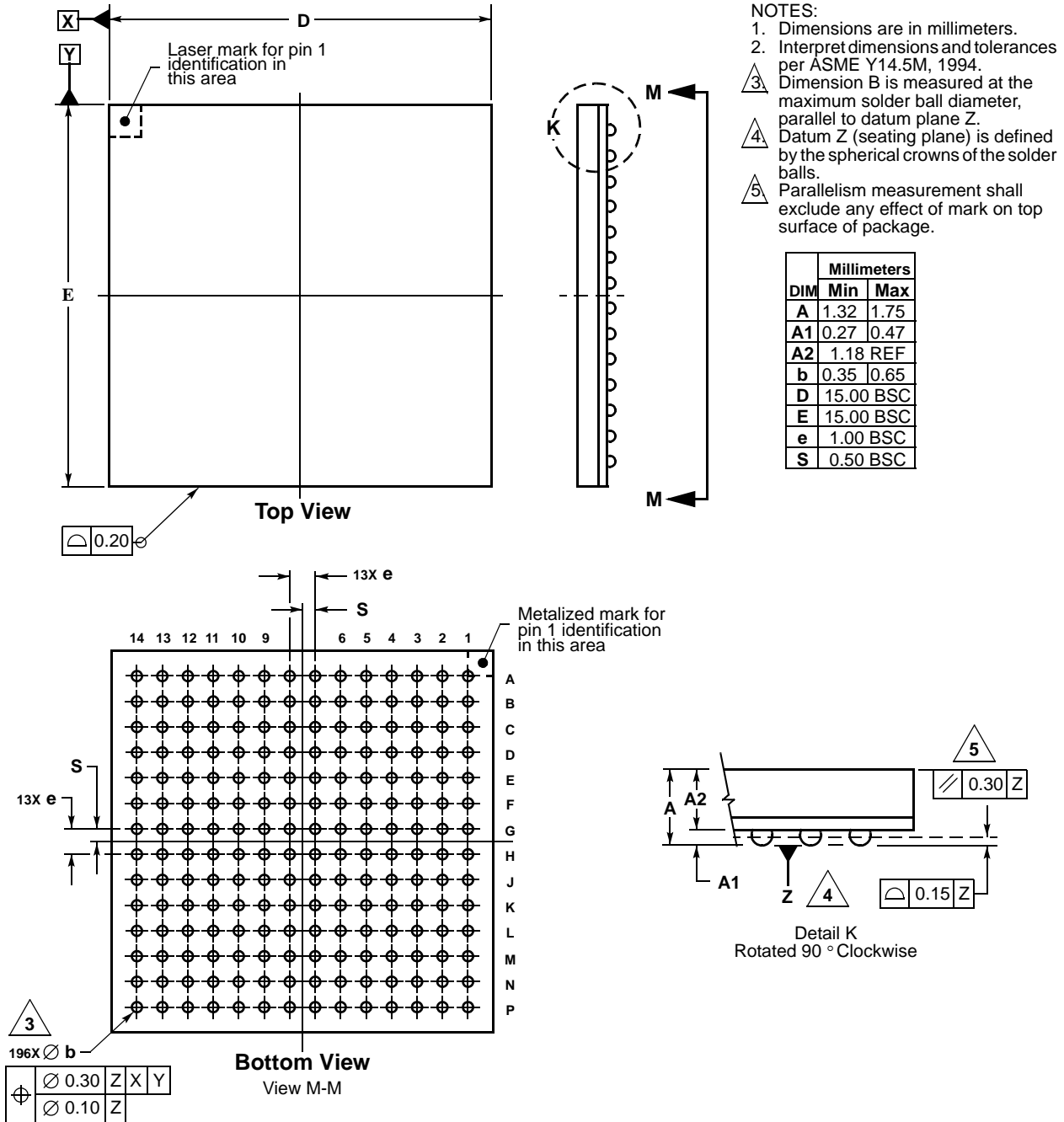


Figure 37. 196 MAPBGA Package Dimensions (Case No. 1128A-01)

## 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: Changed D[15:1] entry from "F4–F1, G4–G2..." to "F4–F1, G5–G2..." 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 balues.</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>. The following locations are affected: G10–12, H12–14, J11–14, K12–13, L12–13, M12–14, N13. 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>, RESET, 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



Because of an order from the United States International Trade Commission, BGA-packaged product lines and part numbers indicated here currently are not available from Freescale for import or sale in the United States prior to September 2010: MCF5327CVM240, MCF53281CVM240, MCF5328CVM240, MCF5329CVM240

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