# Intel® PXA270 Processor

## *Electrical, Mechanical, and Thermal Specification*

**Data Sheet**

- High-performance processor:
  - —Intel XScale® microarchitecture with Intel® Wireless MMX™ Technology
  - —7 Stage pipeline
  - —32 KB instruction cache
  - —32 KB data cache
  - —2 KB “mini” data cache
  - —Extensive data buffering
- 256 Kbytes of internal SRAM for high speed code or data storage preserved during low-power states
- High-speed baseband processor interface (Mobile Scalable Link)
- Rich serial peripheral set:
  - —AC’97 audio port
  - —$I^2S$ audio port
  - —USB Client controller
  - —USB Host controller
  - —USB On-The-Go controller
  - —Three high-speed UARTs (two with hardware flow control)
  - —FIR and SIR infrared communications port
- Hardware debug features — IEEE JTAG interface with boundary scan
- Hardware performance-monitoring features with on-chip trace buffer
- Real-time clock
- Operating-system timers
- LCD Controller
- Universal Subscriber Identity Module interface
- Low power:
  - —Wireless Intel Speedstep® Technology
  - —Less than 500 mW typical internal dissipation
  - —Supply voltage may be reduced to 0.85 V
  - —Four low-power modes
  - —Dynamic voltage and frequency management
- High-performance memory controller:
  - —Four banks of SDRAM: up to 104 MHz @ 2.5V, 3.0V, and 3.3V I/O interface
  - —Six static chip selects
  - —Support for PCMCIA and Compact Flash
  - —Companion chip interface
- Flexible clocking:
  - —CPU clock from 104 to 624 MHz
  - —Flexible memory clock ratios
  - —Frequency changes
  - —Functional clock gating
- Additional peripherals for system connectivity:
  - —SD Card / MMC Controller (with SPI mode support)
  - —Memory Stick card controller
  - —Three SSP controllers
  - —Two $I^2C$ controllers
  - —Four pulse-width modulators (PWMs)
  - —Keypad interface with both direct and matrix keys support
  - —Most peripheral pins double as GPIOs

*Order Number 280002-003*

# Contents

# Figures

# Tables

# Revision History

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| Date | Revision | Description |
|---|---|---|
| April 2004 | -001 | First public release of the EMTS |
| June 2004 | -002 | Added 23x23 mm 360-ball PBGA package |
| June 2004 | -003 | Added 624-MHz active and idle power consumption values to Table 5-7. |

# Introduction 1

The Intel® PXA270 processor (PXA270 processor) provides industry-leading multimedia performance, low-power capabilities, rich peripheral integration and second generation memory stacking. Designed from the ground up for wireless clients, it incorporates the latest Intel advances in mobile technology over its predecessor, the Intel® PXA255 processor. These same attributes and features also make the PXA270 processor ideal for embedded applications. The PXA270 processor redefines scalability by operating from 104 MHz up to 624 MHz, providing enough performance for the most demanding mobile applications.

The PXA270 processor is the first Intel processor to include Intel® Wireless MMX™ technology, enabling high-performance, low-power multimedia acceleration with a general-purpose instruction set. Intel® Quick Capture technology provides a flexible and powerful camera interface for capturing digital images and video. While performance is key in the PXA270 processor, power consumption is also a critical component. The new capabilities of Wireless Intel SpeedStep® technology set the standard for low-power consumption.

The PXA270 processor is offered in two packages: 13x13 mm VFBGA and 23x23 mm PBGA.

## 1.1 About This Document

This document constitutes the electrical, mechanical, and thermal specifications for the PXA270 processor. It contains a functional overview, mechanical data, package signal locations, targeted electrical specifications, and functional bus waveforms. For detailed functional descriptions other than parametric performance, refer to the *Intel® PXA27x Processor Family Developers Manual*.

### 1.1.1 Number Representation

All numbers in this document are **base 10** unless designated otherwise. Hexadecimal numbers have a prefix of 0x, and binary numbers have a prefix of 0b. For example, 107 is represented as 0x6B in hexadecimal and 0b110_1011 in binary.

### 1.1.2 Typographical Conventions

All signal and register-bit names appear in uppercase. Active low items are prefixed with a lowercase “n”.

Bits within a signal name are enclosed in angle brackets:

EXTERNAL_ADDRESS<31:0>
nCS<1>

Bits within a register bit field are enclosed in square brackets:

REGISTER_BITFIELD[3:0]

REGISTER_BIT[0]

Single-bit items have either of two states:

- **clear** — the item contains the value 0b0. To clear a bit, write 0b0 to it.
- **set** — the item contains the value 0b1. To set a bit, write 0b1 to it.

## 1.1.3 Applicable Documents

Table 1-1 lists supplemental information sources for the PXA270 processor. Contact an Intel representative for the latest document revisions and ordering instructions.

**Table 1-1. Supplemental Documentation**

| Document Title |
|---|
| *Intel® PXA27x Processor Family Developers Manual* |
| *ARM® Architecture Version 5T Specification* (Document number ARM* DDI 0100D-10), and *ARM® Architecture Reference Manual* (Document number ARM* DDI 0100B) |
| *Intel® XScale™ Core Developer's Manual* |
| *Intel® Wireless MMX™ Technology Developer's Guide* |
| *Intel® PXA27x Processor Design Guide* |
| *Intel® PXA27x Processor Power Supply Requirements Application Note* |

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# Functional Overview 2

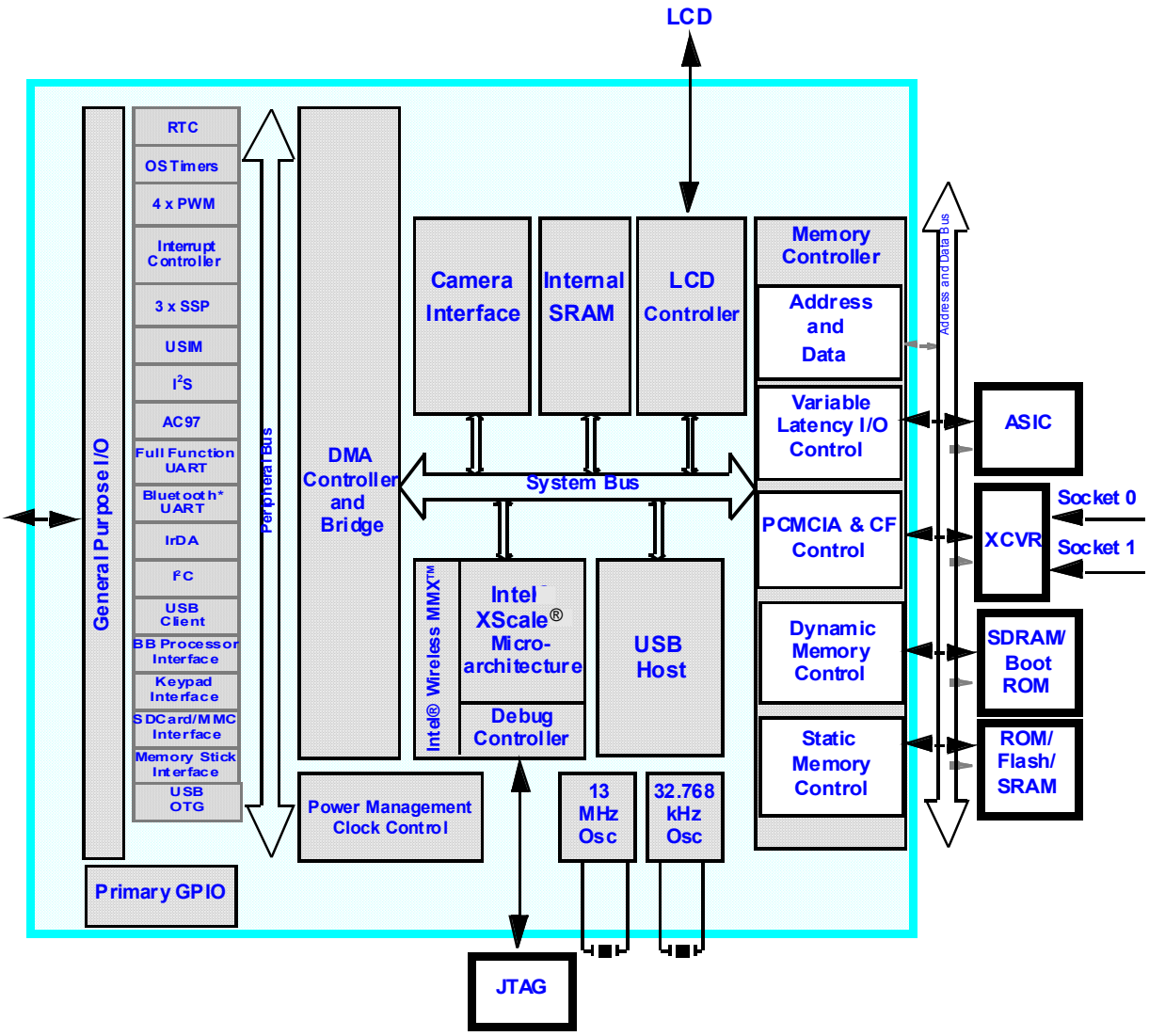
The Intel® PXA270 processor is an integrated system-on-a-chip microprocessor for high performance, dynamic, low-power portable handheld and hand-set devices as well as embedded platforms. It incorporates the Intel XScale® technology which complies with the ARM* version 5TE instruction set (excluding floating-point instructions) and follows the ARM* programmer's model. The PXA270 processor also provides Intel® Wireless MMX™ media enhancement technology, which supports integer instructions to accelerate audio and video processing. In addition, it incorporates Wireless Intel Speedstep® Technology, which provides sophisticated power management capabilities enabling excellent MIPs/mW performance.

The PXA270 processor provides a scalable, bi-directional data interface to a cellular baseband processor, supporting seven logical channels and other features. The operating-system (OS) timer channels and synchronous serial ports (SSPs) also accept an external network clock input so that they can be synchronized to the cellular network. The processor also provides a Universal Subscriber Identity Module* (USIM) card interface.

The PXA270 processor memory interface gives designers flexibility as it supports a variety of external memory types. The processor also provides four 64 kilobyte banks of on-chip SRAM, which can be used for program code or multimedia data. Each bank can be configured independently to retain its contents when the processor enters a low-power mode. An integrated LCD panel controller supports displays up to 800 by 600 pixels, permitting 1-, 2-, 4-, and 8-bit gray scale and 1-, 2-, 4-, 8-, 16-, 18-, and 24-bit color pixels. A 256-byte palette RAM provides flexible color mapping.

A set of serial devices and general-system resources offers computational and connectivity capability for a variety of applications. Figure 2-1 shows the block diagram for a typical PXA270 processor system.

**Figure 2-1. Intel® PXA270 Processor Block Diagram, Typical System**

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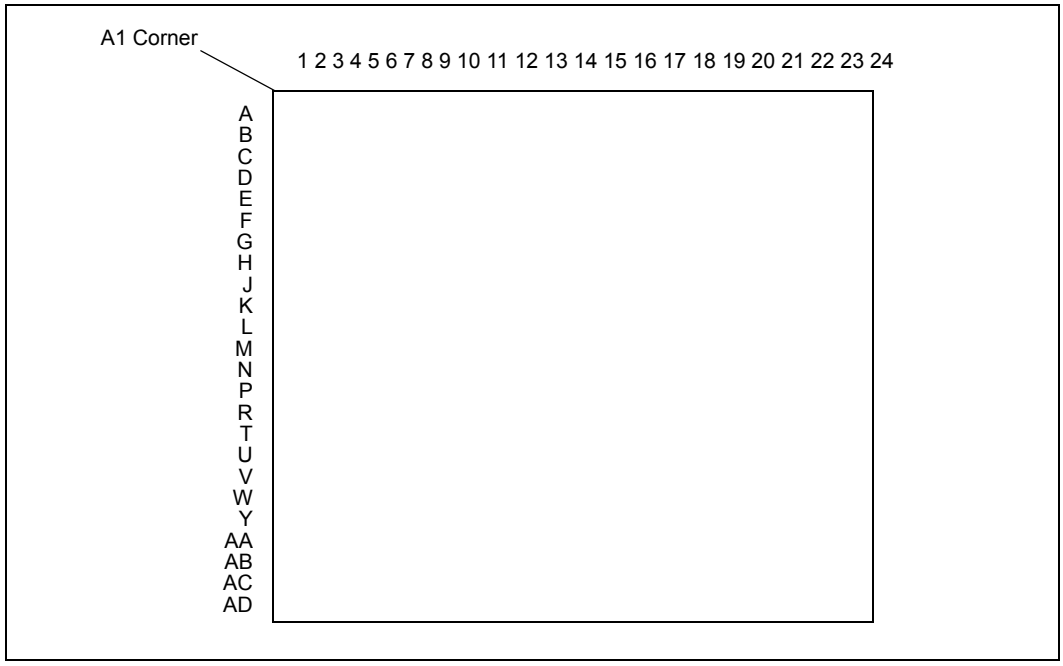
# Package Information 3

This chapter provides the mechanical specifications for the PXA270 processor.

The PXA270 processor is offered in two packages. The 13- by 13-mm, 356-ball, 0.50-mm VF-BGA molded matrix array package is shown in Figure 3-1, Figure 3-2, and Figure 3-3. The 23- by 23-mm, 360-ball, 1.0-mm PBGA molded matrix array package is shown in Figure 3-5, Figure 3-6, and Figure 3-7.

## 3.1 Package Information

**Figure 3-1. 13x13mm VF-BGA Intel® PXA270 Processor Package, top view**



***Note:*** Figure 3-2 and Figure 3-3 show all dimensions in millimeters (mm).

**Figure 3-2. 13x13mm VF-BGA Intel® PXA270 Processor Package, bottom view**

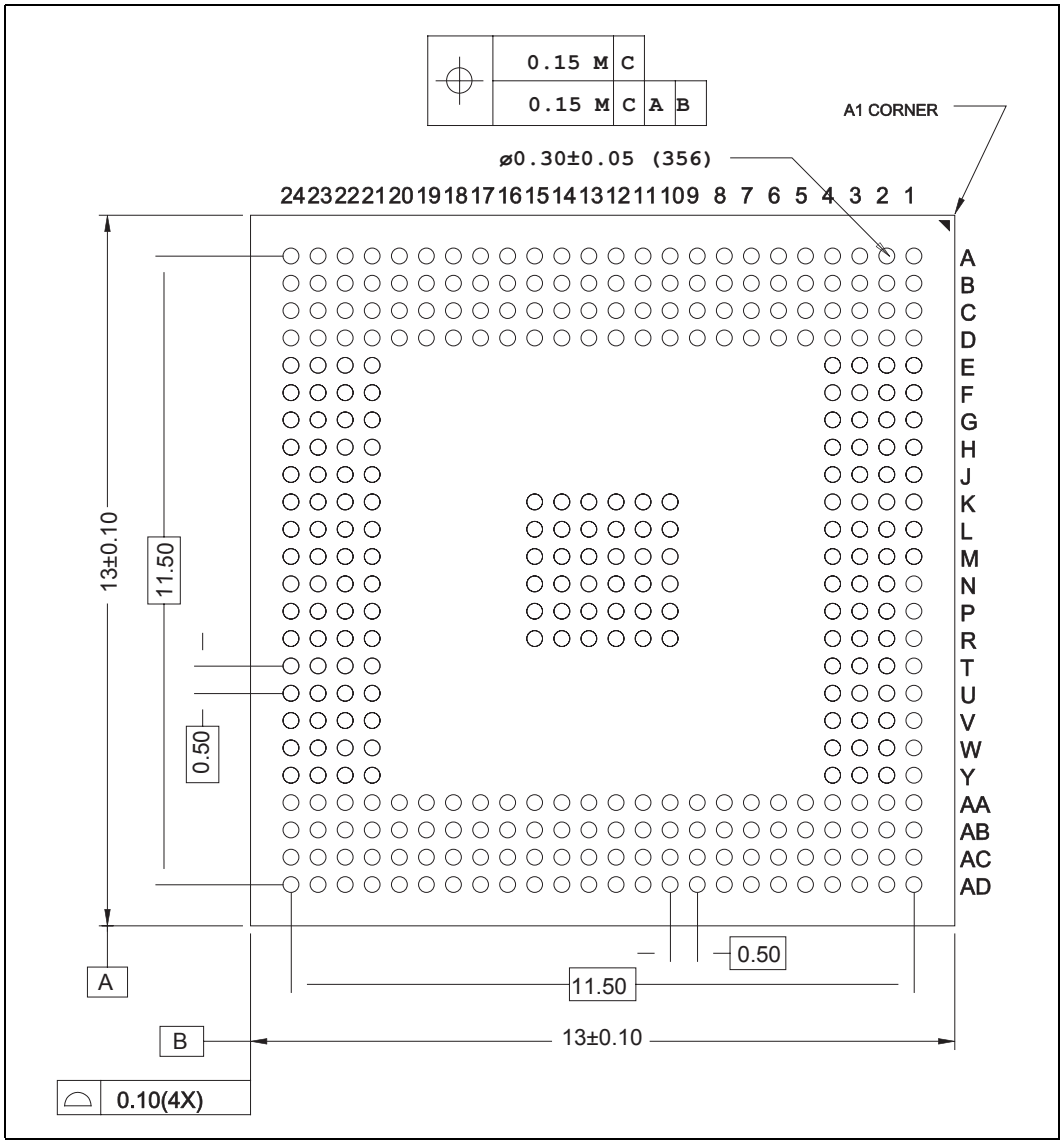


**Figure 3-3. 13x13mm VF-BGA Intel® PXA270 Processor Package, side view**

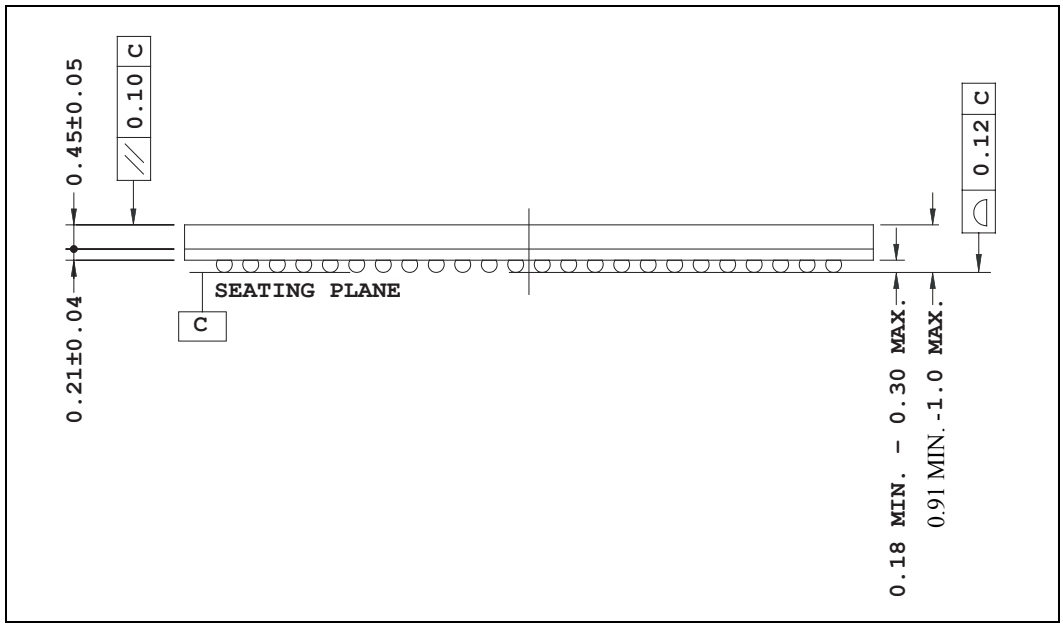
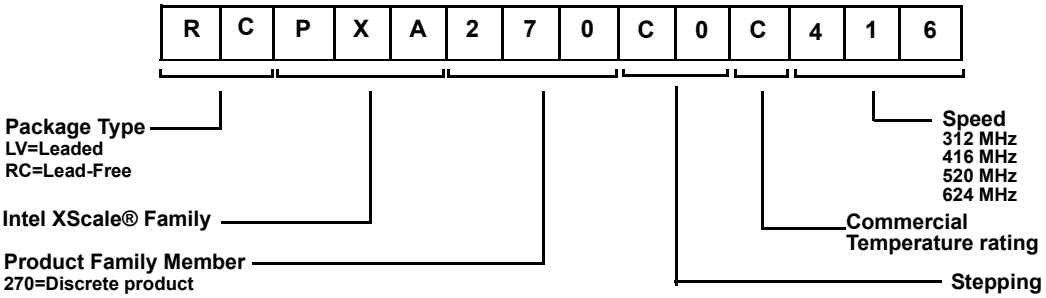



**Figure 3-4. VF-BGA Product Information Decoder**



***Note:*** Figure 3-5, Figure 3-6 and Figure 3-7 show all dimensions in millimeters (mm).

**Figure 3-5. 23x23 mm PBGA Intel® PXA270 Processor Package (Top View)**

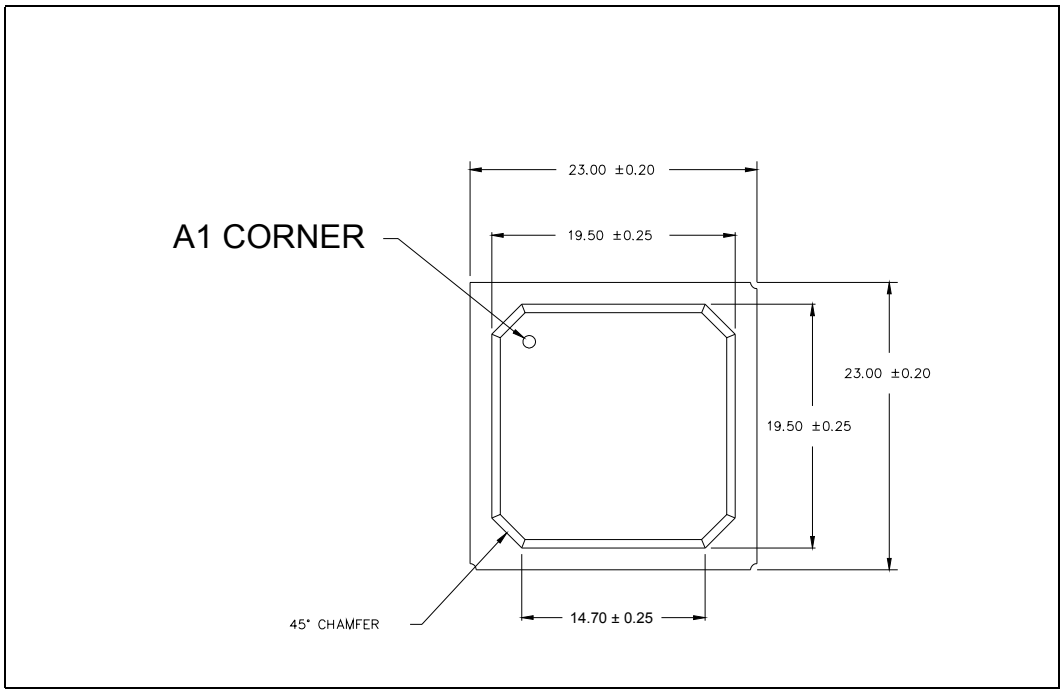



**Figure 3-6. 23x23 mm PBGA Intel® PXA270 Processor Package (Bottom View)**

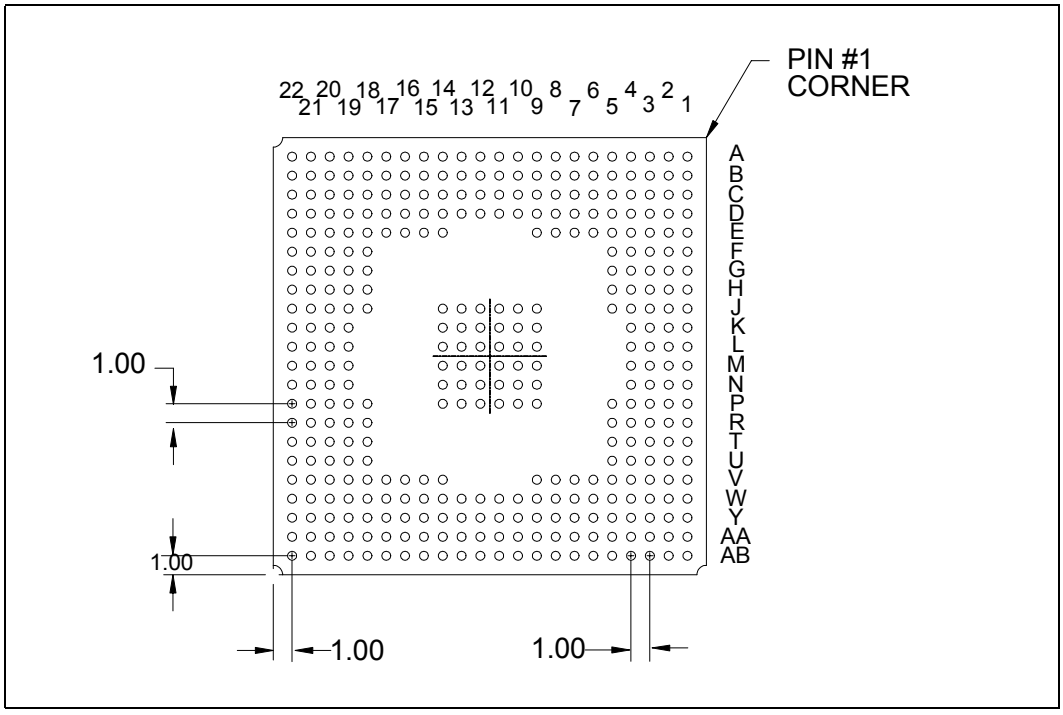


**Figure 3-7. 23x23 mm PBGA Intel® PXA270 Processor Package (Side View)**

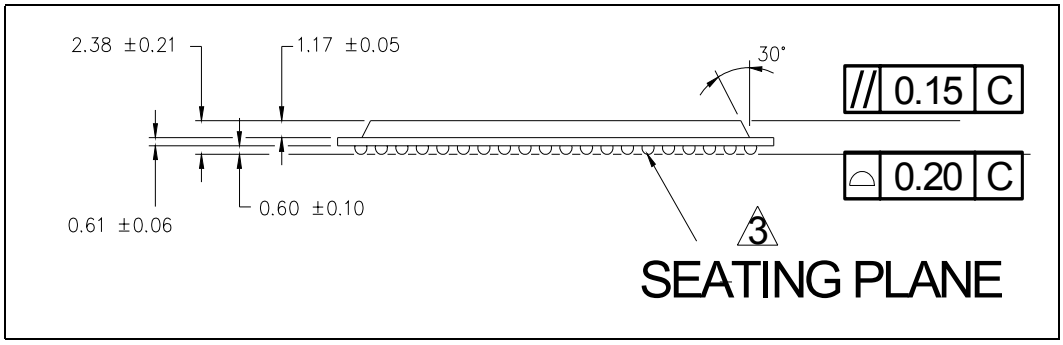
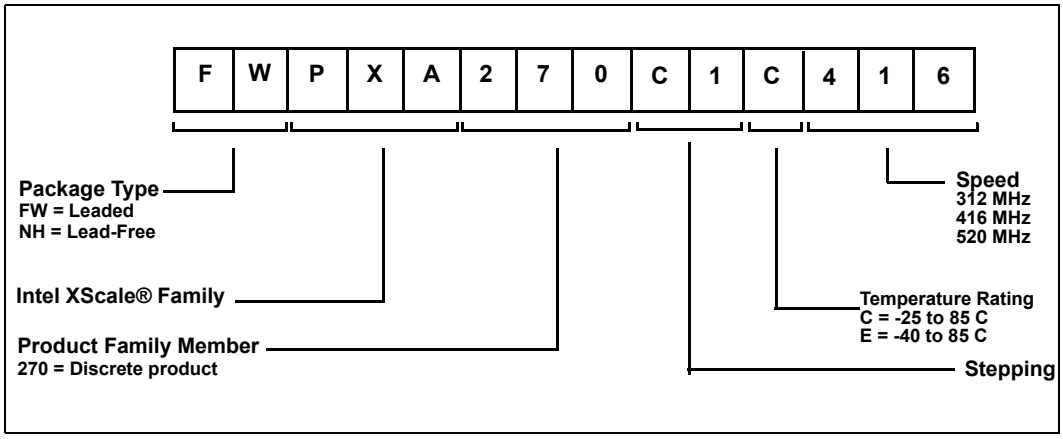



**Figure 3-8. PBGA Product Information Decoder**



## 3.2 Processor Materials

**Figure 3-9. 13x13mm VF-BGA Intel® PXA270 Processor Package, bottom view**

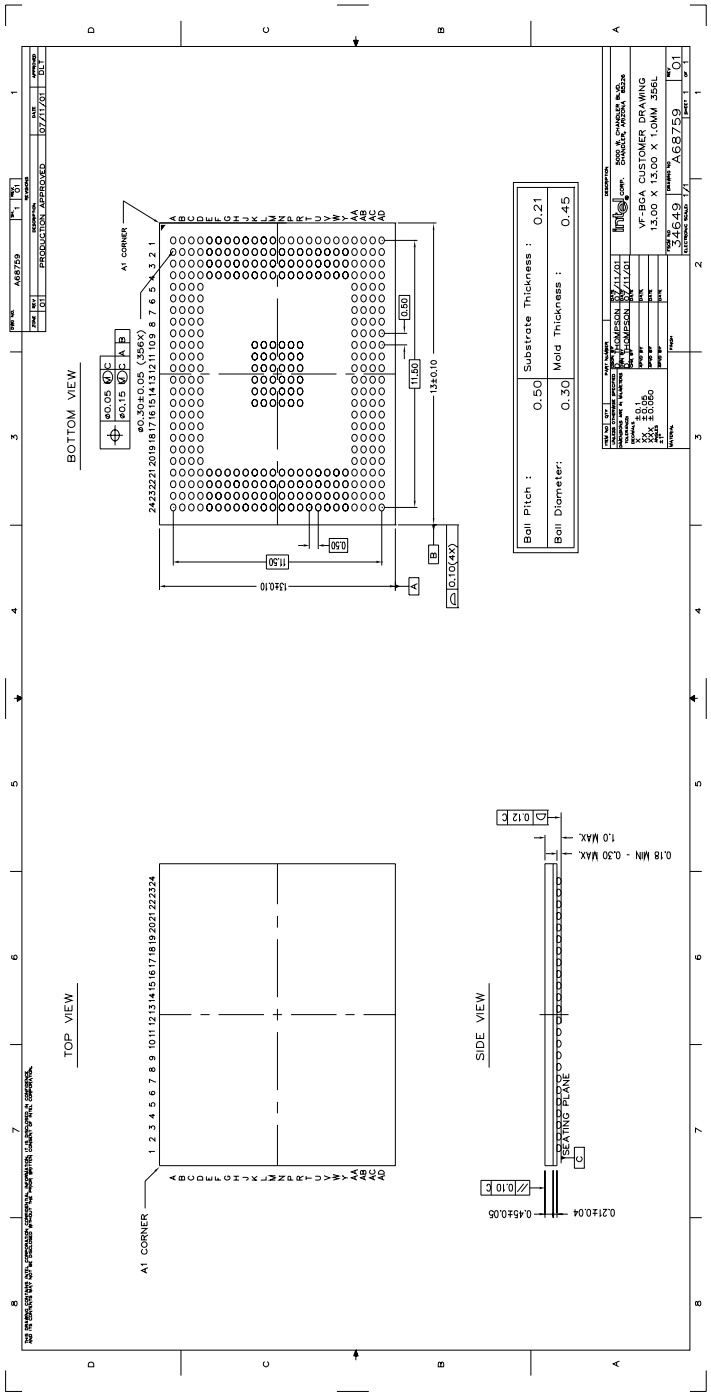



Table 3-1 describes the basic material properties of the processor components.

**Table 3-1. Processor Material Properties**

| Component | VF-BGA Material | PBGA Material |
|---|---|---|
| Mold compound | ShinEtsu KMC 2500 VAT1 | Sumitomo G770LE |
| Solder balls | 63 Sn/37 Pb† | 63 Sn/37 Pb† |
| † Subsequent processor steppings may use Pb-free (94.5 Sn/5.0 Ag/ 0.5 Cu) balls. | | |

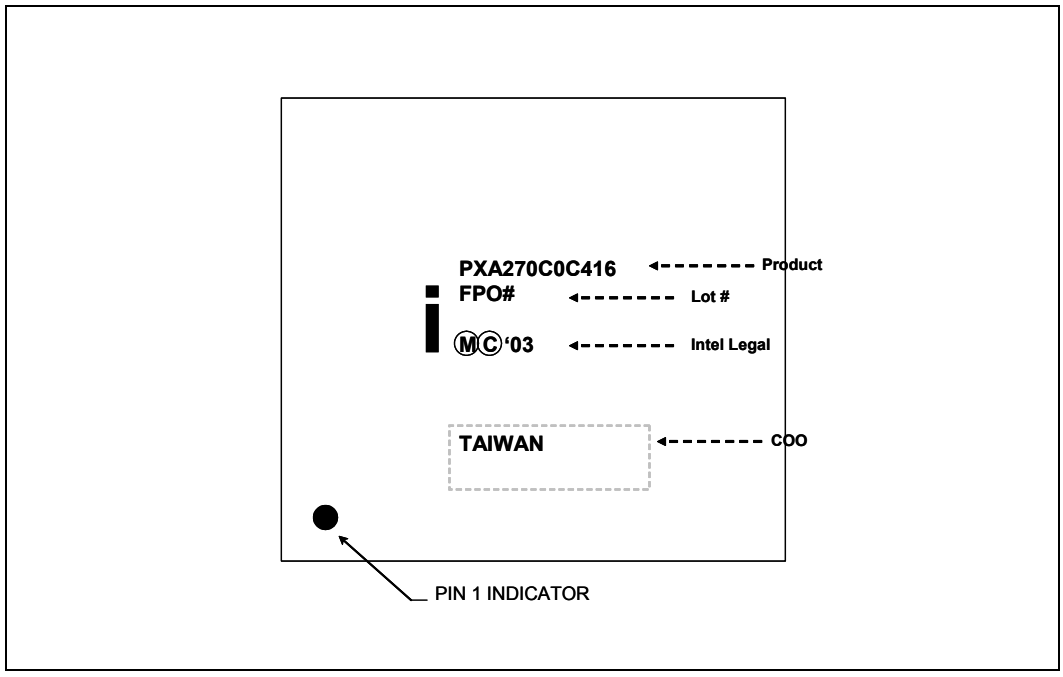
## 3.3 Junction To Case Temperature Thermal Resistance

| Parameter | VF-BGA Value and Units | PBGA Value and Units |
|---|---|---|
| Theta Jc | 2 degrees C / watt | 1.4 degrees C / watt |

## 3.4 Processor Markings

The diagram in this section details the processor's top markings, which identify the PXA270 processor in the 356-ball VF-BGA and 360-ball PBGA package. Refer to Figure 3-4 for product information. A Pb-Free (lead-free) package is indicated by the letter "E" on the 3rd line of information (Intel legal line). The "E" appears after the date stamp.

**Figure 3-10. Intel® PXA270 Processor Production Markings, (Laser Mark on Top Side)**



## 3.5 Tray Drawing

For tray drawing information, refer to the Intel Developer website for the *Intel® Wireless Communications and Computing Package Users Guide*.

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# Pin Listing and Signal Definitions 4

This chapter describes the signals and pins for the Intel® PXA270 processor.

For descriptions of all PXA270 processor signals, refer to the “System Architecture” chapter in the *Intel® PXA27x Processor Family Developer’s Manual*.

Table 4-2 lists the mapping of signals to specific package pins. Many of the package pins are multiplexed so that they can be configured for use as a general purpose I/O signal or as one of two or three alternate functions using the GPIO alternate-function select registers. Some signals can be configured to appear on one of several different package pins.

# 4.1 Ball Map View

***Note:*** In the following ball map figures the lowercase letter “n”, which normally indicates negation, appears as uppercase “N”.

## 4.1.1 13x13 mm VF-BGA Ball map

Figure 4-1 through Figure 4-4 shows the ball map for the VF-BGA PXA270 processor.

**Figure 4-1. 13x13 mm VF-BGA Ball Map, Top View (upper left quarter)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | VSS_CORE | VSS_CORE | GPIO<15> | VCC_MEM | VCC_SRAM | MA<1> | VCC_CORE | VCC_SRAM | VCC_SRAM | GPIO<49> | GPIO<47> | VCC_IO |
| **B** | VSS_CORE | VSS_CORE | NCS<0> | VCC_SRAM | VSS_CORE | GPIO<33> | GPIO<78> | VCC_MEM | GPIO<18> | GPIO<12> | GPIO<46> | VCC_CORE |
| **C** | MA<18> | MA<22> | VCC_MEM | MA<24> | VSS_MEM | MA<0> | GPIO<80> | GPIO<79> | RDNWR | GPIO<13> | GPIO<11> | GPIO<31> |
| **D** | MA<17> | MA<21> | VCC_CORE | MA<23> | VSS_MEM | MA<25> | VSS_CORE | VSS_CORE | VSS_MEM | VSS_CORE | VSS_IO | VSS_CORE |
| **E** | MA<13> | VCC_MEM | MA<19> | MA<20> | | | | | | | | |
| **F** | VCC_MEM | MA<14> | MA<16> | VSS_MEM | | | | | | | | |
| **G** | MA<8> | MA<11> | MA<12> | MA<15> | | | | | | | | |
| **H** | VCC_MEM | MA<9> | MA<10> | VSS_MEM | | | | | | | | |
| **J** | MA<3> | MA<6> | MA<7> | VSS_MEM | | | | | | | | |
| **K** | MD<15> | MA<4> | MA<5> | MA<2> | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **L** | MD<14> | MD<31> | VCC_MEM | VSS_MEM | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **M** | VCC_MEM | MD<30> | MD<29> | MD<13> | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |

## Figure 4-2. 13x13 mm VF-BGA Ball Map, Top View (upper right quarter)

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GPIO<113> | GPIO<28> | GPIO<37> | VCC_IO | GPIO<24> | GPIO<16> | GPIO<92> | GPIO<32> | GPIO<34> | GPIO<118> | VCC_USB | VCC_USB | A |
| GPIO<29> | GPIO<38> | GPIO<26> | GPIO<23> | GPIO<110> | GPIO<112> | GPIO<35> | GPIO<44> | VCC_CORE | USBC_P | VCC_USB | VCC_USB | B |
| GPIO<30> | GPIO<36> | GPIO<27> | GPIO<17> | GPIO<111> | GPIO<41> | GPIO<45> | USBC_N | GPIO<42> | GPIO<43> | GPIO<88> | GPIO<116> | C |
| GPIO<22> | GPIO<40> | VSS_IO | GPIO<25> | GPIO<109> | VSS_IO | GPIO<39> | GPIO<117> | VSS_CORE | GPIO<89> | USBH_N<1> | GPIO<114> | D |
| | | | | | | | | GPIO<115> | USBH_P<1> | UIO | VCC_USIM | E |
| | | | | | | | | VSS_IO | GPIO<90> | GPIO<91> | VCC_CORE | F |
| | | | | | | | | VSS_CORE | GPIO<59> | GPIO<60> | GPIO<58> | G |
| | | | | | | | | VSS_IO | GPIO<62> | GPIO<63> | GPIO<61> | H |
| | | | | | | | | VSS_CORE | GPIO<64> | VCC_CORE | VCC_LCD | J |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | VSS_CORE | GPIO<66> | GPIO<67> | GPIO<65> | K |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | GPIO<68> | GPIO<71> | GPIO<69> | VCC_CORE | L |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | VSS_CORE | GPIO<73> | VCC_CORE | GPIO<70> | M |

## Figure 4-3. 13x13 mm VF-BGA Ball Map, Top View (bottom left quarter)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | MD<27> | MD<28> | MD<12> | VSS_MEM | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **P** | VCC_MEM | MD<11> | MD<26> | MD<10> | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **R** | MD<24> | VSS_MEM | MD<25> | MD<9> | | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **T** | MD<23> | VCC_CORE | MD<8> | VSS_MEM | | | | | | | | |
| **U** | MD<7> | VCC_MEM | VSS_CORE | MD<5> | | | | | | | | |
| **V** | MD<21> | MD<22> | MD<6> | VSS_MEM | | | | | | | | |
| **W** | MD<20> | VCC_MEM | VCC_CORE | VSS_CORE | | | | | | | | |
| **Y** | MD<19> | MD<4> | MD<3> | VSS_MEM | | | | | | | | |
| **AA** | MD<18> | VCC_MEM | MD<2> | MD<16> | VSS_MEM | NSDCAS | VSS_CORE | VSS_MEM | VSS_MEM | GPIO<55> | GPIO<84> | VSS_CORE |
| **AB** | MD<1> | VSS_MEM | MD<17> | MD<0> | NWE | GPIO<20> | NSDCS<0> | NSDCS<1> | DQM<0> | DQM<1> | GPIO<56> | GPIO<81> |
| **AC** | VCC_MEM | VCC_MEM | VSS_MEM | SDCLK<0> | NOE | VCC_MEM | NSDRAS | VCC_MEM | DQM<2> | DQM<3> | GPIO<57> | GPIO<85> |
| **AD** | VCC_MEM | VCC_MEM | SDCLK<2> | VCC_CORE | GPIO<21> | SDCKE | SDCLK<1> | VCC_MEM | GPIO<82> | GPIO<83> | VCC_CORE | VCC_BB |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |

## Figure 4-4. 13x13 mm VF-BGA Ball Map, Top View (bottom right quarter)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | VSS_IO | GPIO<86> | GPIO<87> | GPIO<72> | **N** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | VSS_CORE | GPIO<76> | GPIO<75> | VCC_LCD | **P** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | | GPIO<77> | GPIO<19> | GPIO<74> | VCC_CORE | **R** |
| | | | | | | | | TMS | TCK | TESTCLK | GPIO<14> | **T** |
| | | | | | | | | NTRST | GPIO<9> | TDI | VSS_IO | **U** |
| | | | | | | | | VSS | GPIO<0> | GPIO<10> | TDO | **V** |
| | | | | | | | | GPIO<3> | NVDD_FAULT | GPIO<4> | CLK_REQ | **W** |
| | | | | | | | | NRESET_OUT | NRESET | PWR_EN | GPIO<1> | **Y** |
| VSS_BB | GPIO<54> | VSS_CORE | VSS_IO | GPIO<97> | GPIO<95> | VSS_IO | PWR_CAP<3> | VSS | TXTAL_IN | TXTAL_OUT | SYS_EN | **AA** |
| GPIO<50> | GPIO<53> | GPIO<106> | GPIO<105> | GPIO<102> | GPIO<99> | GPIO<93> | VCC_BATT | PWR_CAP<0> | PWR_OUT | BOOT_SEL | NBATT_FAULT | **AB** |
| GPIO<48> | GPIO<52> | GPIO<107> | GPIO<103> | GPIO<101> | GPIO<100> | GPIO<96> | VCC_PLL | PXTAL_IN | PWR_CAP<2> | VSS | VSS | **AC** |
| GPIO<51> | GPIO<108> | GPIO<104> | VCC_CORE | VCC_IO | GPIO<98> | GPIO<94> | VSS_PLL | PXTAL_OUT | PWR_CAP<1> | VSS | VSS | **AD** |
| **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | |

## 4.1.2 23x23 mm PBGA Ball map

**Figure 4-5. 23x23 mm PBGA Ball Map, Top View (Upper Left Quarter)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | VSS_MEM | VSS_MEM | MA[25] | GPIO[15] | GPIO[79] | GPIO[13] | GPIO[12] | GPIO[11] | GPIO[46] | GPIO[113] | GPIO[29] |
| **B** | VSS_MEM | VCC_MEM | VSS_MEM | VCC_RAM | MA[1] | VSS_MEM | VCC_RAM | VCC_RAM | VSS_MEM | VCC_IO | GPIO[30] |
| **C** | MA[16] | MA[17] | VCC_MEM | MA[24] | VCC_RAM | VCC_MEM | GPIO[33] | RDNWR | VCC_MEM | GPIO[47] | GPIO[31] |
| **D** | MA[14] | MA[15] | MA[19] | MA[22] | MA[0] | NCS_0 | GPIO[80] | GPIO[78] | GPIO[18] | GPIO[49] | VCC_CORE |
| **E** | MA[11] | MA[12] | MA[21] | MA[23] | VSS_CORE | VCC_CORE | VSS_CORE | VCC_CORE | VSS_CORE | | |
| **F** | MA[9] | VSS_MEM | VCC_MEM | MA[20] | VCC_CORE | | | | | | |
| **G** | MA[7] | MA[8] | MA[13] | MA[18] | VSS_CORE | | | | | | |
| **H** | MA[4] | VSS_MEM | VCC_MEM | MA[10] | VCC_CORE | | | | | | |
| **J** | MA[3] | MA[2] | MA[6] | MA[5] | VSS_CORE | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **K** | MD[15] | MD[30] | VCC_MEM | MD[31] | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **L** | MD[14] | VSS_MEM | MD[29] | VCC_CORE | | | | | VSS_CORE | VSS_CORE | VSS_CORE |

## Figure 4-6. 23x23 mm PBGA Ball Map, Top View (Upper Right Quarter)

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GPIO[22] | GPIO[38] | GPIO[26] | GPIO[25] | GPIO[23] | GPIO[111] | GPIO[92] | GPIO[41] | GPIO[44] | VCC_USB | VCC_USB | **A** |
| VSS_IO | GPIO[36] | GPIO[24] | VSS_IO | GPIO[112] | GPIO[39] | VSS_IO | GPIO[34] | GPIO[118] | GPIO[43] | VCC_USB | **B** |
| GPIO[40] | GPIO[27] | GPIO[16] | GPIO[110] | GPIO[32] | GPIO[45] | GPIO[117] | NC | NC | GPIO[89] | GPIO[88] | **C** |
| GPIO[28] | GPIO[37] | VCC_IO | GPIO[17] | GPIO[109] | GPIO[35] | USBC_P | VCC_USB | GPIO[42] | VSS_IO | USBH_N[1] | **D** |
| | | VSS_CORE | VCC_CORE | VSS_CORE | VCC_CORE | VSS_CORE | USBC_N | GPIO[116] | GPIO[115] | USBH_P[1] | **E** |
| | | | | | | VCC_CORE | GPIO[114] | UIO | VCC_USIM | GPIO[61] | **F** |
| | | | | | | VSS_CORE | GPIO[91] | GPIO[58] | GPIO[60] | GPIO[62] | **G** |
| | | | | | | VCC_CORE | GPIO[90] | GPIO[59] | VSS_IO | GPIO[64] | **H** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | VSS_CORE | GPIO[66] | GPIO[63] | VCC_LCD | GPIO[69] | **J** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | GPIO[67] | GPIO[65] | GPIO[68] | GPIO[70] | **K** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | VCC_CORE | GPIO[71] | GPIO[72] | GPIO[73] | **L** |

## Figure 4-7. 23x23 mm PBGA Ball Map, Top View (Lower Left Quarter)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **M** | MD[13] | MD[11] | VCC_MEM | MD[12] | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **N** | MD[28] | MD[26] | MD[24] | MD[25] | | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **P** | MD[27] | VSS_MEM | VCC_MEM | MD[8] | VSS_CORE | | | | VSS_CORE | VSS_CORE | VSS_CORE |
| **R** | MD[10] | MD[23] | MD[21] | MD[7] | VCC_CORE | | | | | | |
| **T** | MD[9] | VSS_MEM | VCC_MEM | MD[5] | VSS_CORE | | | | | | |
| **U** | MD[22] | MD[6] | MD[4] | MD[2] | VCC_CORE | | | | | | |
| **V** | MD[20] | VSS_MEM | VCC_MEM | MD[16] | VSS_CORE | VCC_CORE | VSS_CORE | VCC_CORE | VSS_CORE | | |
| **W** | MD[19] | MD[18] | MD[1] | MD[0] | GPIO[20] | NSDRAS | SDCKE | DQM[0] | GPIO[55] | GPIO[81] | VCC_CORE |
| **Y** | MD[3] | MD[17] | VCC_MEM | NSDCAS | VCC_MEM | GPIO[21] | VCC_MEM | NSDCS[1] | VCC_MEM | GPIO[84] | GPIO[48] |
| **AA** | VSS_MEM | VCC_MEM | NWE | NOE | NSDCS[0] | VSS_MEM | DQM[1] | GPIO[82] | VSS_MEM | GPIO[85] | VCC_BB |
| **AB** | VSS_MEM | VSS_MEM | SDCLK[0] | SDCLK[2] | SDCLK[1] | DQM[2] | DQM[3] | GPIO[56] | GPIO[57] | GPIO[83] | VSS_BB |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |

**Figure 4-8. 23x23 mm PBGA Ball Map, Top View (Lower Right Quarter)**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | VCC_LCD | GPIO[86] | VSS_IO | GPIO[87] | **M** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | | VSS_IO | GPIO[75] | GPIO[76] | GPIO[74] | **N** |
| VSS_CORE | VSS_CORE | VSS_CORE | | | | VSS_CORE | GPIO[19] | GPIO[14] | GPIO[77] | TESTCLK | **P** |
| | | | | | | VCC_CORE | TCK | TMS | TDO | TDI | **R** |
| | | | | | | VSS_CORE | GPIO[4] | NTRST | CLK_REQ | GPIO[9] | **T** |
| | | | | | | VCC_CORE | NBATT_FAULT | GPIO[0] | GPIO[1] | GPIO[10] | **U** |
| | | VSS_CORE | VCC_CORE | VSS_CORE | VCC_CORE | VSS_CORE | BOOT_SEL | NVDD_FAULT | SYS_EN | GPIO[3] | **V** |
| GPIO[50] | GPIO[106] | GPIO[104] | VCC_IO | GPIO[96] | PWR_CAP [3] | VSS | PWR_OUT | NRESET | NRESET_OUT | PWR_EN | **W** |
| GPIO[52] | GPIO[105] | GPIO[102] | GPIO[97] | GPIO[93] | VCC_BATT | PWR_CAP [2] | PWR_CAP [0] | VSS | TXTAL_IN | TXTAL_OUT | **Y** |
| GPIO[53] | GPIO[108] | VSS_IO | GPIO[100] | GPIO[98] | GPIO[94] | VSS_IO | VSS_PLL | PXTAL_OUT | PWR_CAP [1] | VSS | **AA** |
| GPIO[51] | GPIO[54] | GPIO[107] | GPIO[103] | GPIO[101] | GPIO[99] | GPIO[95] | VCC_PLL | PXTAL_IN | VSS | VSS | **AB** |
| **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | |

## 4.2 Pin Usage

The pin usage summary shown in Table 4-1 does not include the 36 center balls identified as K10 through R15 (VF-BGA) or J9 through P14 (PBGA), all of which function as VSS_CORE (see the recommendations for connecting the 36 center balls in the *Intel® PXA27x Processor Family Design Guide*).

Each signal's alternate function inputs are shown in the upper section of each signal row and the outputs are shown in the lower section of each signal row. For example, GPIO<48> has a primary input function of CIF_DD<5> and a secondary output function of nPOE.

### Table 4-1. Pin Usage Summary (Sheet 1 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| VCC_MEM | | | | | | | | | |
| D6 | A3 | MA<25> | OCZ | MA<25> | MA<25> | — | — | Refer to Table 4-4 | |
| C4 | C4 | MA<24> | OCZ | MA<24> | MA<24> | — | — | Refer to Table 4-4 | |
| D4 | E4 | MA<23> | OCZ | MA<23> | MA<23> | — | — | Refer to Table 4-4 | |
| C2 | D4 | MA<22> | OCZ | MA<22> | MA<22> | — | — | Refer to Table 4-4 | |
| D2 | E3 | MA<21> | OCZ | MA<21> | MA<21> | — | — | Refer to Table 4-4 | |
| E4 | F4 | MA<20> | OCZ | MA<20> | MA<20> | — | — | Refer to Table 4-4 | |
| E3 | D3 | MA<19> | OCZ | MA<19> | MA<19> | — | — | Refer to Table 4-4 | |
| C1 | G4 | MA<18> | OCZ | MA<18> | MA<18> | — | — | Refer to Table 4-4 | |
| D1 | C2 | MA<17> | OCZ | MA<17> | MA<17> | — | — | Refer to Table 4-4 | |
| F3 | C1 | MA<16> | OCZ | MA<16> | MA<16> | — | — | Refer to Table 4-4 | |
| G4 | D2 | MA<15> | OCZ | MA<15> | MA<15> | — | — | Refer to Table 4-4 | |
| F2 | D1 | MA<14> | OCZ | MA<14> | MA<14> | — | — | Refer to Table 4-4 | |
| E1 | G3 | MA<13> | OCZ | MA<13> | MA<13> | — | — | Refer to Table 4-4 | |
| G3 | E2 | MA<12> | OCZ | MA<12> | MA<12> | — | — | Refer to Table 4-4 | |
| G2 | E1 | MA<11> | OCZ | MA<11> | MA<11> | — | — | Refer to Table 4-4 | |
| H3 | H4 | MA<10> | OCZ | MA<10> | MA<10> | — | — | Refer to Table 4-4 | |
| H2 | F1 | MA<9> | OCZ | MA<9> | MA<9> | — | — | Refer to Table 4-4 | |
| G1 | G2 | MA<8> | OCZ | MA<8> | MA<8> | — | — | Refer to Table 4-4 | |
| J3 | G1 | MA<7> | OCZ | MA<7> | MA<7> | — | — | Refer to Table 4-4 | |
| J2 | J3 | MA<6> | OCZ | MA<6> | MA<6> | — | — | Refer to Table 4-4 | |
| K3 | J4 | MA<5> | OCZ | MA<5> | MA<5> | — | — | Refer to Table 4-4 | |
| K2 | H1 | MA<4> | OCZ | MA<4> | MA<4> | — | — | Refer to Table 4-4 | |
| J1 | J1 | MA<3> | OCZ | MA<3> | MA<3> | — | — | Refer to Table 4-4 | |
| K4 | J2 | MA<2> | OCZ | MA<2> | MA<2> | — | — | Refer to Table 4-4 | |
| A6 | B5 | MA<1> | OCZ | MA<1> | MA<1> | — | — | Refer to Table 4-4 | |
| C6 | D5 | MA<0> | OCZ | MA<0> | MA<0> | — | — | Refer to Table 4-4 | |
| L2 | K4 | MD<31> | ICOCZ | MD<31> | MD<31> | — | — | Refer to Table 4-4 | |
| M2 | K2 | MD<30> | ICOCZ | MD<30> | MD<30> | — | — | Refer to Table 4-4 | |
| M3 | L3 | MD<29> | ICOCZ | MD<29> | MD<29> | — | — | Refer to Table 4-4 | |
| N2 | N1 | MD<28> | ICOCZ | MD<28> | MD<28> | — | — | Refer to Table 4-4 | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 2 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| N1 | P1 | MD<27> | ICOCZ | MD<27> | MD<27> | — | — | Refer to Table 4-4 | |
| P3 | N2 | MD<26> | ICOCZ | MD<26> | MD<26> | — | — | Refer to Table 4-4 | |
| R3 | N4 | MD<25> | ICOCZ | MD<25> | MD<25> | — | — | Refer to Table 4-4 | |
| R1 | N3 | MD<24> | ICOCZ | MD<24> | MD<24> | — | — | Refer to Table 4-4 | |
| T1 | R2 | MD<23> | ICOCZ | MD<23> | MD<23> | — | — | Refer to Table 4-4 | |
| V2 | U1 | MD<22> | ICOCZ | MD<22> | MD<22> | — | — | Refer to Table 4-4 | |
| V1 | R3 | MD<21> | ICOCZ | MD<21> | MD<21> | — | — | Refer to Table 4-4 | |
| W1 | V1 | MD<20> | ICOCZ | MD<20> | MD<20> | — | — | Refer to Table 4-4 | |
| Y1 | W1 | MD<19> | ICOCZ | MD<19> | MD<19> | — | — | Refer to Table 4-4 | |
| AA1 | W2 | MD<18> | ICOCZ | MD<18> | MD<18> | — | — | Refer to Table 4-4 | |
| AB3 | Y2 | MD<17> | ICOCZ | MD<17> | MD<17> | — | — | Refer to Table 4-4 | |
| AA4 | V4 | MD<16> | ICOCZ | MD<16> | MD<16> | — | — | Refer to Table 4-4 | |
| K1 | K1 | MD<15> | ICOCZ | MD<15> | MD<15> | — | — | Refer to Table 4-4 | |
| L1 | L1 | MD<14> | ICOCZ | MD<14> | MD<14> | — | — | Refer to Table 4-4 | |
| M4 | M1 | MD<13> | ICOCZ | MD<13> | MD<13> | — | — | Refer to Table 4-4 | |
| N3 | M4 | MD<12> | ICOCZ | MD<12> | MD<12> | — | — | Refer to Table 4-4 | |
| P2 | M2 | MD<11> | ICOCZ | MD<11> | MD<11> | — | — | Refer to Table 4-4 | |
| P4 | R1 | MD<10> | ICOCZ | MD<10> | MD<10> | — | — | Refer to Table 4-4 | |
| R4 | T1 | MD<9> | ICOCZ | MD<9> | MD<9> | — | — | Refer to Table 4-4 | |
| T3 | P4 | MD<8> | ICOCZ | MD<8> | MD<8> | — | — | Refer to Table 4-4 | |
| U1 | R4 | MD<7> | ICOCZ | MD<7> | MD<7> | — | — | Refer to Table 4-4 | |
| V3 | U2 | MD<6> | ICOCZ | MD<6> | MD<6> | — | — | Refer to Table 4-4 | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 3 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| U4 | T4 | MD<5> | ICOCZ | MD<5> | MD<5> | — | — | Refer to Table 4-4 | |
| Y2 | U3 | MD<4> | ICOCZ | MD<4> | MD<4> | — | — | Refer to Table 4-4 | |
| Y3 | Y1 | MD<3> | ICOCZ | MD<3> | MD<3> | — | — | Refer to Table 4-4 | |
| AA3 | U4 | MD<2> | ICOCZ | MD<2> | MD<2> | — | — | Refer to Table 4-4 | |
| AB1 | W3 | MD<1> | ICOCZ | MD<1> | MD<1> | — | — | Refer to Table 4-4 | |
| AB4 | W4 | MD<0> | ICOCZ | MD<0> | MD<0> | — | — | Refer to Table 4-4 | |
| AC5 | AA4 | NOE | OCZ | nOE | nOE | — | — | Refer to Table 4-4 | |
| AB5 | AA3 | NWE | OCZ | nWE | nWE | — | — | Refer to Table 4-4 | |
| AC7 | W6 | NSDRAS | OCZ | nSDRAS | nSDRAS | — | — | Refer to Table 4-4 | |
| AA6 | Y4 | NSDCAS | OCZ | nSDCAS | nSDCAS | — | — | Refer to Table 4-4 | |
| AB9 | W8 | DQM<0> | OCZ | DQM<0> | DQM<0> | — | — | Refer to Table 4-4 | |
| AB10 | AA7 | DQM<1> | OCZ | DQM<1> | DQM<1> | — | — | Refer to Table 4-4 | |
| AC9 | AB6 | DQM<2> | OCZ | DQM<2> | DQM<2> | — | — | Refer to Table 4-4 | |
| AC10 | AB7 | DQM<3> | OCZ | DQM<3> | DQM<3> | — | — | Refer to Table 4-4 | |
| AB7 | AA5 | NSDCS<0> | OCZ | nSDCS<0> | nSDCS<0> | — | — | Refer to Table 4-4 | |
| AB8 | Y8 | NSDCS<1> | OC | nSDCS<1> | nSDCS<1> | — | — | Refer to Table 4-4 | |
| AD6 | W7 | SDCKE | OC | SDCKE | SDCKE | — | — | Refer to Table 4-4 | |
| AC4 | AB3 | SDCLK<0> | OC | SDCLK<0> | SDCLK<0> | — | — | Refer to Table 4-4 | |
| AD7 | AB5 | SDCLK<1> | OCZ | SDCLK<1> | SDCLK<1> | — | — | Refer to Table 4-4 | |
| AD3 | AB4 | SDCLK<2> | OC | SDCLK<2> | SDCLK<2> | — | — | Refer to Table 4-4 | |
| C9 | C8 | RDNWR | OCZ | RDnWR | RDnWR | — | — | Refer to Table 4-4 | |
| B3 | D6 | NCS<0> | OCZ | nCS<0> | nCS<0> | — | — | Refer to Table 4-4 | |
| A3 | A4 | GPIO<15> | ICOCZ | GPIO<15> | — | — | — | Pu-1 Note[1] | Note[4] |
| | | | | | nPCE<1> | nCS<1> Refer to Table 4-4 | — | | |
| B9 | D9 | GPIO<18> | ICOCZ | GPIO<18> | RDY | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | — | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 4 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| AB6 | W5 | GPIO<20> | ICOCZ | GPIO<20> | DREQ<0> | MBREQ | — | Pu-1 Note[1] | Note[3] |
| | | | | | nSDCS<2> Refer to Table 4-4 | — | — | | |
| AD5 | Y6 | GPIO<21> | ICOCZ | GPIO<21> | — | — | — | Pu-1 Note[1] | Note[3] |
| | | | | | nSDCS<3> Refer to Table 4-4 | DVAL<0> | MBGNT | | |
| B6 | C7 | GPIO<33> | ICOCZ | GPIO<33> | FFRXD[19] | FFDSR[19] | — | Pu-1 Note[1] | Note [4] |
| | | | | | DVAL<1> | nCS<5> Refer to Table 4-4 | MBGNT | | |
| A10 | D10 | GPIO<49> | ICOCZ | GPIO<49> | — | — | — | Pu-1 Note[1] | Note [5] |
| | | | | | — | nPWE Refer to Table 4-4 | — | | |
| B7 | D8 | GPIO<78> | ICOCZ | GPIO<78> | — | — | — | Pu-1 Note[1] | Note[4] |
| | | | | | nPCE<2> | nCS<2> Refer to Table 4-4 | — | | |
| C8 | A5 | GPIO<79> | ICOCZ | GPIO<79> | — | — | — | Pu-1 Note[1] | Note[4] |
| | | | | | PSKTSEL | nCS<3> Refer to Table 4-4 | PWM_OUT<2> | | |
| C7 | D7 | GPIO<80> | ICOCZ | GPIO<80> | DREQ<1> | MBREQ | — | Pu-1 Note[1] | Note[4] |
| | | | | | — | nCS<4> Refer to Table 4-4 | PWM_OUT<3> | | |
| VCC_BB | | | | | | | | | |
| AC13 | Y11 | GPIO<48> | ICOCZ | GPIO<48> | CIF_DD<5> | — | — | Pu-1 Note[1] | Note [5] |
| | | | | | BB_OB_DAT<1> | nPOE Refer to Table 4-4 | — | | |
| AB13 | W12 | GPIO<50> | ICOCZ | GPIO<50> | CIF_DD<3> | — | SSPSCLK<2> | Pu-1 Note[1] | Note [5] |
| | | | | | BB_OB_DAT<2> | nPIOIR Refer to Table 4-4 | SSPSCLK<2> | | |
| AD13 | AB12 | GPIO<51> | ICOCZ | GPIO<51> | CIF_DD<2> | — | — | Pu-1 Note[1] | Note [5] |
| | | | | | BB_OB_DAT<3> | nPIOIW Refer to Table 4-4 | — | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 5 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| AC14 | Y12 | GPIO<52> | ICOCZ | GPIO<52> | CIF_DD<4> | SSPSCLK<3> | — | Pd-0 Note[1] | Note [3] |
| | | | | | BB_OB_CLK | SSPSCLK<3> | — | | |
| AB14 | AA12 | GPIO<53> | ICOCZ | GPIO<53> | FFRXD | USB_P2_3 | — | Pd-0 Note[1] | Note [3] |
| | | | | | BB_OB_STB | CIF_MCLK | SSPSYSCLK | | |
| AA14 | AB13 | GPIO<54> | ICOCZ | GPIO<54> | — | BB_OB_WAIT | CIF_PCLK | Pd-0 Note[1] | Note [3] |
| | | | | | | nPCE<2> | — | | |
| AA10 | W9 | GPIO<55> | ICOCZ | GPIO<55> | CIF_DD<1> | BB_IB_DAT<1> | — | Pu-1 Note[1] | Note [5] |
| | | | | | — | nPREG | — | | |
| AB11 | AB8 | GPIO<56> | ICOCZ | GPIO<56> | nPWAIT | BB_IB_DAT<2> | — | Pu-1 Note[1] | Note [5] |
| | | | | | USB_P3_4 | — | — | | |
| AC11 | AB9 | GPIO<57> | ICOCZ | GPIO<57> | nIOIS16 | BB_IB_DAT<3> | — | Pu-1 Note[1] | Note [5] |
| | | | | | — | — | SSPTXD | | |
| AB12 | W10 | GPIO<81> | ICOCZ | GPIO<81> | — | CIF_DD<0> | — | Pu-1 Note[1] | Note [3] |
| | | | | | SSPTXD3 | BB_OB_DAT<0> | — | | |
| AD9 | AA8 | GPIO<82> | ICOCZ | GPIO<82> | SSPRXD3 | BB_IB_DAT<0> | CIF_DD<5> | Pu-1 Note[1] | Note [3] |
| | | | | | — | — | FFDTR | | |
| AD10 | AB10 | GPIO<83> | ICOCZ | GPIO<83> | SSPSFRM3 | BB_IB_CLK | CIF_DD<4> | Pd-0 Note[1] | Note [3] |
| | | | | | SSPSFRM3 | FFTXD | FFRTS | | |
| AA11 | Y10 | GPIO<84> | ICOCZ | GPIO<84> | SSPSCLK3 | BB_IB_STB | CIF_FV | Pd-0 Note[1] | Note [3] |
| | | | | | SSPSCLK3 | — | CIF_FV | | |
| AC12 | AA10 | GPIO<85> | ICOCZ | GPIO<85> | FFRXD | DREQ<2> | CIF_LV | Pd-0 Note[1] | Note [3] |
| | | | | | nPCE<1> | BB_IB_WAIT | CIF_LV | | |
| VCC_LCD | | | | | | | | | |
| T24 | P20 | GPIO<14> | ICOCZ | GPIO<14> | L_VSYNC | SSPSFRM2 | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | SSPSFRM2 | UCLK | | |
| R22 | P19 | GPIO<19> | ICOCZ | GPIO<19> | SSPSCLK2 | — | FFRXD | Pd-0 Note[1] | Note [3] |
| | | | | | SSPSCLK2 | L_CS | nURST | | |
| G24 | G20 | GPIO<58> | ICOCZ | GPIO<58> | — | LDD<0> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<0> | — | | |
| G22 | H20 | GPIO<59> | ICOCZ | GPIO<59> | — | LDD<1> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<1> | — | | |
| G23 | G21 | GPIO<60> | ICOCZ | GPIO<60> | — | LDD<2> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<2> | — | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 6 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| H24 | F22 | GPIO<61> | ICOCZ | GPIO<61> | — | LDD<3> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<3> | — | | |
| H22 | G22 | GPIO<62> | ICOCZ | GPIO<62> | — | LDD<4> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<4> | — | | |
| H23 | J20 | GPIO<63> | ICOCZ | GPIO<63> | — | LDD<5> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<5> | — | | |
| J22 | H22 | GPIO<64> | ICOCZ | GPIO<64> | — | LDD<6> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<6> | — | | |
| K24 | K20 | GPIO<65> | ICOCZ | GPIO<65> | — | LDD<7> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<7> | — | | |
| K22 | J19 | GPIO<66> | ICOCZ | GPIO<66> | — | LDD<8> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<8> | — | | |
| K23 | K19 | GPIO<67> | ICOCZ | GPIO<67> | — | LDD<9> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<9> | — | | |
| L21 | K21 | GPIO<68> | ICOCZ | GPIO<68> | — | LDD<10> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<10> | — | | |
| L23 | J22 | GPIO<69> | ICOCZ | GPIO<69> | — | LDD<11> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<11> | — | | |
| M24 | K22 | GPIO<70> | ICOCZ | GPIO<70> | — | LDD<12> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<12> | — | | |
| L22 | L20 | GPIO<71> | ICOCZ | GPIO<71> | — | LDD<13> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<13> | — | | |
| N24 | L21 | GPIO<72> | ICOCZ | GPIO<72> | — | LDD<14> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<14> | — | | |
| M22 | L22 | GPIO<73> | ICOCZ | GPIO<73> | — | LDD<15> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | LDD<15> | — | | |
| R23 | N22 | GPIO<74> | ICOCZ | GPIO<74> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | L_FCLK_RD | — | | |
| P23 | N20 | GPIO<75> | ICOCZ | GPIO<75> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | L_LCLK _A0 | — | | |
| P22 | N21 | GPIO<76> | ICOCZ | GPIO<76> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | L_PCLK_WR | — | | |
| R21 | P21 | GPIO<77> | ICOCZ | GPIO<77> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | L_BIAS | — | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 7 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| N22 | M20 | GPIO<86> | ICOCZ | GPIO<86> | SSPRXD2 | LDD<16> | USB_P3_5 | Pd-0 Note[1] | Note [3] |
| | | | | | nPCE<1> | LDD<16> | — | | |
| N23 | M22 | GPIO<87> | ICOCZ | GPIO<87> | nPCE<2> | LDD<17> | USB_P3_1 | Pd-0 Note[1] | Note [3] |
| | | | | | SSPTXD2 | LDD<17> | SSPSFRM2 | | |
| VCC_IO | | | | | | | | | |
| C11 | A8 | GPIO<11> | ICOCZ | GPIO<11> | EXT_SYNC<0> | SSPRXD2 | USB_P3_1 | Pd-0 Note[1] | Note [3], Note[11 |
| | | | | | CHOUT<0> | PWM_OUT2 | 48_MHz | | |
| B10 | A7 | GPIO<12> | ICOCZ | GPIO<12> | EXT_SYNC<1> | CIF_DD<7> | — | Pd-0 Note[1] | Note [3], Note[11 |
| | | | | | CHOUT<1> | PWM_OUT3 | 48_MHz | | |
| C10 | A6 | GPIO<13> | ICOCZ | GPIO<13> | CLK_EXT | KP_DKIN<7> | KP_MKIN<7> | Pd-0 Note[1] | Note [3], Note[11 ] |
| | | | | | SSPTXD2 | — | — | | |
| A18 | C14 | GPIO<16> | ICOCZ | GPIO<16> | KP_MKIN<5> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | PWM_OUT<0> | FFTXD | | |
| C16 | D15 | GPIO<17> | ICOCZ | GPIO<17> | KP_MKIN<6> | CIF_DD<6> | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | PWM_OUT<1> | — | | |
| D13 | A12 | GPIO<22> | ICOCZ | GPIO<22> | SSPEXTCLK2 | SSPSCLKEN2 | SSPSCLK2 | Pd-0 Note[1] | Note [3] |
| | | | | | KP_MKOUT<7> | SSPSYSCLK2 | SSPSCLK2 | | |
| B16 | A16 | GPIO<23> | ICOCZ | GPIO<23> | — | SSPSCLK | — | Pd-0 Note[1] | Note [3] |
| | | | | | CIF_MCLK | SSPSCLK | — | | |
| A17 | B14 | GPIO<24> | ICOCZ | GPIO<24> | CIF_FV | SSPSFRM | — | Pd-0 Note[1] | Note [3] |
| | | | | | CIF_FV | SSPSFRM | — | | |
| D16 | A15 | GPIO<25> | ICOCZ | GPIO<25> | CIF_LV | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | CIF_LV | SSPTXD | — | | |
| B15 | A14 | GPIO<26> | ICOCZ | GPIO<26> | SSPRXD | CIF_PCLK | FFCTS | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | — | | |
| C15 | C13 | GPIO<27> | ICOCZ | GPIO<27> | SSPEXTCLK | SSPSCLKEN | CIF_DD<0> | Pd-0 Note[1] | Note [3] |
| | | | | | SSPSYSCLK | — | FFRTS | | |
| A14 | D12 | GPIO<28> | ICOCZ | GPIO<28> | AC97_BITCLK | I2S_BITCLK | SSPSFRM | Pd-0 Note[1] | Note [3] |
| | | | | | I2S_BITCLK | — | SSPSFRM | | |
| B13 | A11 | GPIO<29> | ICOCZ | GPIO<29> | AC97_SDATA_IN_0 | I2S_SDATA_IN | SSPSCLK | Pd-0 Note[1] | Note [3] |
| | | | | | SSPRXD2 | — | SSPSCLK | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 8 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| C13 | B11 | GPIO<30> | ICOCZ | GPIO<30> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | I2S_SDATA_OUT | AC97_SDATA_OUT | USB_P3_2 | | |
| C12 | C11 | GPIO<31> | ICOCZ | GPIO<31> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | I2S_SYNC | AC97_SYNC | USB_P3_6 | | |
| A20 | C16 | GPIO<32> | ICOCZ | GPIO<32> | — | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | MSSCLK | MMCLK | — | | |
| A21 | B19 | GPIO<34> | ICOCZ | GPIO<34> | FFRXD | KP_MKIN<3> | SSPSCLK3 | Pd-0 Note[1] | Note [3] |
| | | | | | USB_P2_2 | — | SSPSCLK3 | | |
| B19 | D17 | GPIO<35> | ICOCZ | GPIO<35> | FFCTS | USB_P2_1 | SSPSFRM3 | Pd-0 Note[1] | Note [3] |
| | | | | | — | KP_MKOUT<6> | SSPTXD3 | | |
| C14 | B13 | GPIO<36> | ICOCZ | GPIO<36> | FFDCD | SSPSCLK2 | KP_MKIN<7> | Pd-0 Note[1] | Note [3] |
| | | | | | USB_P2_4 | SSPSCLK2 | — | | |
| A15 | D13 | GPIO<37> | ICOCZ | GPIO<37> | FFDSR | SSPSFRM2 | KP_MKIN<3> | Pd-0 Note[1] | Note [3] |
| | | | | | USB_P2_8 | SSPSFRM2 | FFTXD | | |
| B14 | A13 | GPIO<38> | ICOCZ | GPIO<38> | FFRI | KP_MKIN<4> | USB_P2_3 | Pd-0 Note[1] | Note [3] |
| | | | | | SSPTXD3 | SSPTXD2 | PWM_OUT<1> | | |
| D19 | B17 | GPIO<39> | ICOCZ | GPIO<39> | KP_MKIN<4> | — | SSPSFRM3 | Pd-0 Note[1] | Note [3] |
| | | | | | USB_P2_6 | FFTXD | SSPSFRM3 | | |
| D14 | C12 | GPIO<40> | ICOCZ | GPIO<40> | SSPRXD2 | — | USB_P2_5 | Pd-0 Note[1] | Note [3] |
| | | | | | KP_MKOUT<6> | FFDTR | SSPSCLK3 | | |
| C18 | A19 | GPIO<41> | ICOCZ | GPIO<41> | FFRXD | USB_P2_7 | SSPRXD3 | Pd-0 Note[1] | Note [3] |
| | | | | | KP_MKOUT<7> | FFRTS | — | | |
| C21 | D20 | GPIO<42> | ICOCZ | GPIO<42> | BTRXD | ICP_RXD | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | CIF_MCLK | | |
| C22 | B21 | GPIO<43> | ICOCZ | GPIO<43> | — | — | CIF_FV | Pd-0 Note[1] | Note [3] |
| | | | | | ICP_TXD | BTTXD | CIF_FV | | |
| B20 | A20 | GPIO<44> | ICOCZ | GPIO<44> | BTCTS | — | CIF_LV | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | CIF_LV | | |
| C19 | C17 | GPIO<45> | ICOCZ | GPIO<45> | — | — | CIF_PCLK | Pd-0 Note[1] | Note [3] |
| | | | | | AC97_SYSCLK | BTRTS | SSPSYSCLK3 | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 9 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| B11 | A9 | GPIO<46> | ICOCZ | GPIO<46> | ICP_RXD | STD_RXD | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | PWM_OUT<2> | — | | |
| A11 | C10 | GPIO<47> | ICOCZ | GPIO<47> | CIF_DD<0> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | STD_TXD | ICP_TXD | PWM_OUT<3> | | |
| C23 | C22 | GPIO<88> | ICOCZ | GPIO<88> | USBHPWR<1> | SSPRXD2 | SSPSFRM2 | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | SSPSFRM2 | | |
| D22 | C21 | GPIO<89> | ICOCZ | GPIO<89> | SSPRXD3 | — | FFRI | Pd-0 Note[1] | Note [3] |
| | | | | | AC97_SYSCLK | USBHPEN<1> | SSPTXD2 | | |
| A19 | A18 | GPIO<92> | ICOCZ | GPIO<92> | MMDAT<0> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | MMDAT<0> | MSBS | — | | |
| AB19 | Y16 | GPIO<93> | ICOCZ | GPIO<93> | KP_DKIN<0> | CIF_DD<6> | — | Pd-0 Note[1] | Note [3] |
| | | | | | AC97_SDATA_OUT | — | — | | |
| AD19 | AA17 | GPIO<94> | ICOCZ | GPIO<94> | KP_DKIN<1> | CIF_DD<5> | — | Pd-0 Note[1] | Note [3] |
| | | | | | AC97_SYNC | — | — | | |
| AA18 | AB18 | GPIO<95> | ICOCZ | GPIO<95> | KP_DKIN<2> | CIF_DD<4> | KP_MKIN<6> | Pd-0 Note[1] | Note [3] |
| | | | | | AC97_RESET_n | — | — | | |
| AC19 | W16 | GPIO<96> | ICOCZ | GPIO<96> | KP_DKIN<3> | MBREQ | FFRXD | Pd-0 Note[1] | Note [3] |
| | | | | | | DVAL<1> | KP_MKOUT<6> | | |
| AA17 | Y15 | GPIO<97> | ICOCZ | GPIO<97> | KP_DKIN<4> | DREQ<1> | KP_MKIN<3> | Pd-0 Note[1] | Note [3] |
| | | | | | — | MBGNT | — | | |
| AD18 | AA16 | GPIO<98> | ICOCZ | GPIO<98> | KP_DKIN<5> | CIF_DD<0> | KP_MKIN<4> | Pd-0 Note [1] | Note [3] |
| | | | | | AC97_SYSCLK | — | FFRTS | | |
| AB18 | AB17 | GPIO<99> | ICOCZ | GPIO<99> | KP_DKIN<6> | AC97_SDATA_IN_1 | KP_MKIN<5> | Pd-0 Note [1] | Note [3] |
| | | | | | — | — | FFTXD | | |
| AC18 | AA15 | GPIO<100> | ICOCZ | GPIO<100> | KP_MKIN<0> | DREQ<2> | FFCTS | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | — | | |
| AC17 | AB16 | GPIO<101> | ICOCZ | GPIO<101> | KP_MKIN<1> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | — | — | | |
| AB17 | Y14 | GPIO<102> | ICOCZ | GPIO<102> | KP_MKIN<2> | — | FFRXD | Pd-0 Note[1] | Note [3] |
| | | | | | nPCE<1> | — | — | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 10 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| AC16 | AB15 | GPIO<103> | ICOCZ | GPIO<103> | CIF_DD<3> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | KP_MKOUT<0> | — | | |
| AD15 | W14 | GPIO<104> | ICOCZ | GPIO<104> | CIF_DD<2> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | PSKTSEL | KP_MKOUT<1> | — | | |
| AB16 | Y13 | GPIO<105> | ICOCZ | GPIO<105> | CIF_DD<1> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | nPCE<2> | KP_MKOUT<2> | — | | |
| AB15 | W13 | GPIO<106> | ICOCZ | GPIO<106> | CIF_DD<9> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | KP_MKOUT<3> | — | | |
| AC15 | AB14 | GPIO<107> | ICOCZ | GPIO<107> | CIF_DD<8> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | — | KP_MKOUT<4> | — | | |
| AD14 | AA13 | GPIO<108> | ICOCZ | GPIO<108> | CIF_DD<7> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | CHOUT<0> | KP_MKOUT<5> | — | | |
| D17 | D16 | GPIO<109> | ICOCZ | GPIO<109> | MMDAT<1> | MSSDIO | — | Pd-0 Note[1] | Note [3] |
| | | | | | MMDAT<1> | MSSDIO | — | | |
| B17 | C15 | GPIO<110> | ICOCZ | GPIO<110> | MMDAT<2>/ MMCCS<0> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | MMDAT<2>/ MMCCS<0> | — | — | | |
| C17 | A17 | GPIO<111> | ICOCZ | GPIO<111> | MMDAT<3>/ MMCCS<1> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | MMDAT<3>/ MMCCS<1> | — | — | | |
| B18 | B16 | GPIO<112> | ICOCZ | GPIO<112> | MMCMD | nMSINS | — | Pd-0 Note[1] | Note [3] |
| | | | | | MMCMD | — | — | | |
| A13 | A10 | GPIO<113> | ICOCZ | GPIO<113> | — | — | USB_P3_3 | Pd-0 Note[1] | Note [3] |
| | | | | | I2S_SYSCLK | AC97_RESET_n | — | | |
| D24 | F19 | GPIO<114> Note [17] | ICOCZ | GPIO<114> Note [17] | CIFDD_<1> | — | — | Pd-0 Note[1] | Note [3] |
| | | | | | | UVS0 | — | | |
| E21 | E21 | GPIO<115> Note [17] | ICOCZ | GPIO<115> Note [17] | DREQ<0> | CIF_DD<3> | MBREQ | Pu-1 Note[1] | Note [3] |
| | | | | | UEN | nUVS1 | PWM_OUT<1> | | |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 11 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| C24 | E20 | GPIO<116> | ICOCZ | GPIO<116> | CIF_DD<2> | AC97_SDATA_IN_0 | UDET | Pu-1 Note[1] | Note [3] |
| | | | | | DVAL<0> | nUVS2 | MBGNT | | |
| D20 | C18 | GPIO<117> | ICOCZ | GPIO<117> | SCL | — | — | Pu-1 Note[1] | Note [3], Note[12] |
| | | | | | SCL | — | — | | |
| A22 | B20 | GPIO<118> | ICOCZ | GPIO<118> | SDA | — | — | Pu-1 Note[1] | Note [3], Note[12] |
| | | | | | SDA | — | — | | |
| VCC_USB | | | | | | | | | |
| B22 | D18 | USBC_P | IAOAZ | USBC_P | USBC_P | — | — | Hi-Z | Hi-Z |
| C20 | E19 | USBC_N | IAOAZ | USBC_N | USBC_N | — | — | Hi-Z | Hi-Z |
| E22 | E22 | USBH_P<1> | IAOAZ | USBH_P<1> | USBH_P<1> | — | — | Hi-Z | Hi-Z |
| D23 | D22 | USBH_N<1> | IAOAZ | USBH_N<1> | USBH_N<1> | — | — | Hi-Z | Hi-Z |
| VCC_USIM | | | | | | | | | |
| F22 | H19 | GPIO<90> | ICOCZ | GPIO<90> | KP_MKIN<5> | USB_P3_5 | CIF_DD<4> | Pd-0 Note[1] | Note [3] |
| | | | | | — | nURST | — | | |
| F23 | G19 | GPIO<91> | ICOCZ | GPIO<91> | KP_MKIN<6> | USB_P3_1 | CIF_DD<5> | Pd-0 Note[1] | Note [3] |
| | | | | | — | UCLK | — | | |
| E23 | F20 | UIO | ICOCZ | UIO | UIO | — | — | Driven Low | Hi-Z |
| VCC_REG | | | | | | | | | |
| V22 | U20 | GPIO<0> | ICOCZ | GPIO<0> | GPIO<0> | — | — | Pd-0 Note[1] | Note [3] |
| Y24 | U21 | GPIO<1> | ICOCZ | GPIO<1> | GPIO<1> | — | — | Pu-1 Note[1] | Note [7] |
| W21 | V22 | GPIO<3> | ICOCZ | GPIO<3> | PWR_SCL | — | — | Pu-1 Note[1] | Hi-Z |
| W23 | T19 | GPIO<4> | ICOCZ | GPIO<4> | PWR_SDA | — | — | Pu-1 Note[1] | Hi-Z |
| U22 | T22 | GPIO<9> Note [18] | ICOCZ | GPIO<9> Note [18] | — | — | FFCTS | Pd-0 Note[1] | Note [7] |
| | | | | | HZ_CLK | — | CHOUT<0> | | |
| V23 | U22 | GPIO<10> Note [18] | ICOCZ | GPIO<10> Note [18] | FFDCD | — | USB_P3_5 | Pd-0 Note[1] | Note [7] |
| | | | | | HZ_CLK | — | CHOUT<1> | Pd-0 Note[1] | Note [7] |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 12 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| W24 | T21 | CLK_REQ | ICOCZ | CLK_REQ | CLK_REQ | — | — | Pu-1 | Note [8] |
| Y22 | W20 | NRESET | IC | nRESET | nRESET | — | — | Input - Note [9] | Input |
| Y21 | W21 | NRESET_OUT | OC | nRESET_OUT | nRESET_OUT | — | — | Low | Note [8] |
| AB23 | V19 | BOOT_SEL | IC | BOOT_SEL | BOOT_SEL | — | — | Input | Input |
| Y23 | W22 | PWR_EN | OC | PWR_EN | PWR_EN | — | — | Note[16] | Note [8] |
| AB24 | U19 | NBATT_FAULT | IC | nBATT_FAULT | nBATT_FAULT | — | — | Low | Input |
| W22 | V20 | NVDD_FAULT | IC | nVDD_FAULT | nVDD_FAULT | — | — | Low | Input |
| AA24 | V21 | SYS_EN | ICOCZ | SYS_EN | SYS_EN | — | — | — | Note [7] |
| AB21 | Y19 | PWR_CAP<0> | OA | — | PWR_CAP<0> | — | — | — | Note [7] |
| AD22 | AA21 | PWR_CAP<1> | OA | — | PWR_CAP<1> | — | — | — | Note [7] |
| AC22 | Y18 | PWR_CAP<2> | OA | — | PWR_CAP<2> | — | — | — | Note [7] |
| AA20 | W17 | PWR_CAP<3> | OA | — | PWR_CAP<3> | — | — | — | Note [7] |
| U21 | T20 | NTRST | IC | nTRST | nTRST | — | — | Input - Note [9] | Input |
| U23 | R22 | TDI | IC | TDI | TDI | — | — | Input - Note [9] | Input |
| V24 | R21 | TDO | OCZ | TDO | TDO | — | — | Hi-Z | Hi-Z |
| T21 | R20 | TMS | IC | TMS | TMS | — | — | Input - Note [9] | Input |
| T22 | R19 | TCK | IC | TCK | TCK | — | — | Input | Input |
| T23 | P22 | TESTCLK | IC | TESTCLK | TESTCLK | — | — | Pd-0 | Input |
| VCC_OSC | | | | | | | | | |
| AC21 | AB20 | PXTAL_IN | IA | PXTAL_IN | PXTAL_IN | — | — | Note[2] | Note [2] |
| AD21 | AA20 | PXTAL_OUT | OA | PXTAL_OUT | PXTAL_OUT | — | — | Note[2] | Note [2] |
| AA22 | Y21 | TXTAL_IN | IA | TXTAL_IN | TXTAL_IN | — | — | Note[2] | Note [2] |
| AA23 | Y22 | TXTAL_OUT | OA | TXTAL_OUT | TXTAL_OUT | — | — | Note[2] | Note [2] |
| AB22 | W19 | PWR_OUT | OA | PWR_OUT | PWR_OUT | — | — | Hi-Z | Hi-Z |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 13 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| SUPPLIES | | | | | | | | | |
| AB20 | Y17 | VCC_BATT | PS | VCC_BATT | VCC_BATT | — | — | Input | Input |
| A12 | B10 | VCC_IO | PS | VCC_IO | VCC_IO | — | — | Input | Input |
| AD17 | W15 | VCC_IO | PS | VCC_IO | VCC_IO | — | — | Input | Input |
| A16 | D14 | VCC_IO | PS | VCC_IO | VCC_IO | — | — | Input | Input |
| B24 | A21 | VCC_USB | PS | VCC_USB | VCC_USB | — | — | Input | Input |
| A24 | A22 | VCC_USB | PS | VCC_USB | VCC_USB | — | — | Input | Input |
| A23 | B22 | VCC_USB | PS | VCC_USB | VCC_USB | — | — | Input | Input |
| B23 | D19 | VCC_USB | PS | VCC_USB | VCC_USB | — | — | Input | Input |
| P24 | M19 | VCC_LCD | PS | VCC_LCD0 | VCC_LCD | — | — | Input | Input |
| J24 | J21 | VCC_LCD | PS | VCC_LCD1 | VCC_LCD | — | — | Input | Input |
| P1 | B2 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| C3 | C3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| E2 | C6 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| L3 | C9 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AD2 | F3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AC2 | H3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AC1 | K3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AD1 | M3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| M1 | P3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| H1 | T3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| F1 | V3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AD8 | Y3 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 14 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| U2 | Y5 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AA2 | Y7 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AC8 | Y9 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| B8 | AA2 | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| A4 | N/A | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AC6 | N/A | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| W2 | N/A | VCC_MEM | PS | VCC_MEM | VCC_MEM | — | — | Input | Input |
| AD12 | AA11 | VCC_BB | PS | VCC_BB | VCC_BB | — | — | Input | Input |
| AC20 | AB19 | VCC_PLL | PS | VCC_PLL | VCC_PLL | — | — | Input | Input |
| A9 | B4 | VCC_SRAM | PS | VCC_SRAM | VCC_SRAM | — | — | Input | Input |
| A8 | B7 | VCC_SRAM | PS | VCC_SRAM | VCC_SRAM | — | — | Input | Input |
| A5 | B8 | VCC_SRAM | PS | VCC_SRAM | VCC_SRAM | — | — | Input | Input |
| B4 | C5 | VCC_SRAM | PS | VCC_SRAM | VCC_SRAM | — | — | Input | Input |
| B12 | D11 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| A7 | E6 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| D3 | E8 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| J23 | F5 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| L24 | H5 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| F24 | L4 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| AD16 | E15 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| R24 | E17 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| M23 | F18 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| B21 | H18 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 15 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| W3 | L19 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| AD4 | R5 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| T2 | U5 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| AD11 | V6 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | V8 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | W11 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | R18 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | U18 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | V15 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| N/A | V17 | VCC_CORE | PS | VCC_CORE | VCC_CORE | — | — | Input | Input |
| E24 | F21 | VCC_USIM | PS | VCC_USIM | VCC_USIM | — | — | Input | Input |
| AA21 | W18 | VSS | PS | VSS | VSS | — | — | Input | Input |
| AC24 | Y20 | VSS | PS | VSS | VSS | — | — | Input | Input |
| AD24 | AA22 | VSS | PS | VSS | VSS | — | — | Input | Input |
| AC23 | AB21 | VSS | PS | VSS | VSS | — | — | Input | Input |
| AD23 | AB22 | VSS | PS | VSS | VSS | — | — | Input | Input |
| V21 | N/A | VSS | PS | VSS | VSS | — | — | Input | Input |
| D11 | B12 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| AA19 | B15 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| D15 | B18 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| N21 | D21 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| AA16 | H21 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| H21 | M21 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| F21 | N19 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| D18 | AA14 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| U24 | AA18 | VSS_IO | PS | VSS_IO | VSS_IO | — | — | Input | Input |
| D5 | A1 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| F4 | A2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

## Table 4-1. Pin Usage Summary (Sheet 16 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| H4 | B1 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| J4 | B3 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AC3 | B6 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AB2 | B9 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| L4 | F2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| T4 | H2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| V4 | L2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AA5 | P2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AA8 | T2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AA9 | V2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| D9 | AA1 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| N4 | AA6 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| R2 | AA9 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| C5 | AB1 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| Y4 | AB2 | VSS_MEM | PS | VSS_MEM | VSS_MEM | — | — | Input | Input |
| AA13 | AB11 | VSS_BB | PS | VSS_BB | VSS_BB | — | — | Input | Input |
| AD20 | AA19 | VSS_PLL | PS | VSS_PLL | VSS_PLL | — | — | Input | Input |
| B2 | E5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| A2 | E7 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| B1 | E9 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| A1 | G5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| J21 | J5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| D10 | E14 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

### Table 4-1. Pin Usage Summary (Sheet 17 of 17)

| VF-BGA Ball# (13x13) | PBGA Ball# (23x23) | Name | Type | Function After Reset | Primary Function | Secondary Alternate Function | Third Alternate Function | Reset State | Sleep State |
|---|---|---|---|---|---|---|---|---|---|
| AA15 | E16 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| M21 | E18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| U3 | G18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| AA7 | J18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| P21 | P5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| K21 | T5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| G21 | V5 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| D21 | V7 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| D12 | V9 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| D8 | P18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| W4 | T18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| AA12 | V14 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| B5 | V16 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |
| D7 | V18 | VSS_CORE | PS | VSS_CORE | VSS_CORE | — | — | Input | Input |

**NOTE:** Refer to Table 4-2 for Numbered Notes on Reset and Sleep States.

# 4.3 Signal Types

### Table 4-2. Pin Usage and Mapping Notes

| Note | Description |
|---|---|
| [1] | *GPIO reset/deep sleep operation:* After any reset is asserted or if the PXA270 processor is in deep sleep mode, these pins are configured as GPIO inputs by default. The input buffers for these pins are disabled to prevent current drain and must be enabled prior to use by clearing the *read disable hold* bit, PSSR[RDH]. Until RDH is cleared, each pin is pulled high (Pu-1), pulled low (Pd-0), or floated (Hi-Z). |
| [2] | *Crystal oscillator pins:* These pins connect the external crystals to the on-chip oscillators and are not affected by either reset or sleep. For more information, see the “Clocks and Power” chapter in the *Intel® PXA27x Processor Family Developer’s Manual*. |
| [3] | *GPIO sleep operation:* During the transition into sleep mode, the configuration of these pins is determined by the corresponding GPIO setting. This pin is not driven during sleep if the direction of the pin is selected to be an input. If the direction of the pin is selected as an output, the value contained in the Power Manager GPIO Sleep-State register (PGSR0/1/2/3) is driven out onto the pin and held while the PXA270 processor is in sleep mode.<br>Upon exit from sleep mode, GPIOs that are configured as outputs continue to hold the standby, sleep, or deep-sleep state until software clears the peripheral control hold bit, PSSR[PH]. Software must clear this bit (by writing 0b1 to it) after the peripherals have been fully configured, as described in Note[1], but before the process actually uses them.<br>GPIOs that are configured as inputs immediately after exiting sleep mode cannot be used until PSSR[RDH] is cleared. |
| [4] | *Static memory control pins:* During sleep mode, these pins can be programmed either to drive the value in the Power Manager GPIO Sleep-State register (PGSR0/1/2/3) or to be placed in a Hi-Z (undriven) state. To select the Hi-Z state, software must set PCFR[FS]. If FS is not set, these pins function as described in Note[3] during the transition to sleep mode. |
| [5] | *PCMCIA control pins:* During sleep mode, these pins can be programmed either to drive the value in the Power Manager GPIO Sleep-State register (PGSR0/1/2/3) or to be placed in a Hi-Z (undriven) state. To select the Hi-Z state, software must set PCFR[FP]. If FP is not set, these pins function as described in Note[3] during the transition to sleep mode. |
| [6] | (reserved) |
| [7] | When the power manager overrides the GPIO alternate function, the Power Manager GPIO Sleep-State registers (PGSR0/1/2/3) and the PSSR[RDH] bit are ignored. Pullup and pulldown are disabled immediately after the power manager overrides the GPIO function. |
| [8] | Output functions during sleep mode |
| [9] | Pull-up always enabled |
| [10] | (reserved) |
| [11] | Pins do not function during sleep mode if the OS timer is active |
| [12] | Pins must be floated by software during sleep mode (floating does not happen automatically) |
| [13] | (reserved) |
| [14] | (reserved) |
| [15] | The pin is three-stateable (Hi-Z) based on the value of PCFR[FS]. There is no PGSR0/1/2/3 setting associated with the pin because it is not a GPIO. |
| [16] | PWR_EN goes high during reset, between the assertion of the reset pin and the de-assertion of internal reset within the PXA270 processor, after SYS_EN is driven high. |
| [17] | *GPIOs 114 and115:* The alternate function configuration of these pins is ignored when either PUCR[USIM114] or PUCR[USIM115] bits are set. Setting these bits forces the USIM enable signal onto these GPIOs. |
| [18] | When software sets the OSCC[PIO_EN] or OSCC[TOUT_EN] bits, then any GPIO alternate function setting applied to GPIO<9> or GPIO <10> is overridden with the CLK_PIO function on GPIO<9> and CLK_TOUT on GPIO<10>. |
| [19] | Refer to Table 4-4. |

**Table 4-3. Signal Types**

| Type | Description |
|---|---|
| IC | CMOS input |
| OC | CMOS output |
| OCZ | CMOS output, three-stateable |
| ICOCZ | CMOS bidirectional, three-stateable |
| IA | Analog input |
| OA | Analog output |
| IAOA | Analog bidirectional |
| IAOAZ | Analog bidirectional - three-stateable |
| PS | Power supply |

## 4.4 Memory Controller Reset and Initialization

On reset, the SDRAM interface is disabled. Reset values for the boot ROM are determined by BOOT_SEL (see the *Intel® PXA27x Processor Family Developers Manual*, Memory Controller chapter). Boot ROM is immediately available for reading upon exit from reset, and all memory interface control registers are available for writing.

On hardware reset, the memory pins and controller are in the state shown in Table 4-4.

**Table 4-4. Memory Controller Pin Reset Values (Sheet 1 of 2)**

| Pin Name | Reset, Sleep, Standby, Deep-Sleep, Frequency Change, and Manual Self-Refresh Mode Values |
|---|---|
| SDCLK <3[1]:0> | 0b000 |
| SDCKE | 0 |
| DQM <3:0> | 0b0000 |
| nSDCS <3:2> | GPIO (memory controller drives 0b11)[†] |
| nSDCS <1:0> | 0b11 |
| nWE | 1 |
| nSDRAS | 1 |
| nSDCAS | 1 |
| nOE | 1 |
| MA <25:0> | 0x0000_0000[1] |
| RDnWR | 0 |
| MD <31:0> | 0x0000_0000[2] |
| nCS <0> | 1 |
| nCS <5:1> | GPIO (memory controller drives 0b11111) |
| nPIOIR | GPIO (memory controller drives high) |
| nPIOIW | GPIO (memory controller drives high) |

**Table 4-4. Memory Controller Pin Reset Values (Sheet 2 of 2)**

| Pin Name | Reset, Sleep, Standby, Deep-Sleep, Frequency Change, and Manual Self-Refresh Mode Values |
|---|---|
| nPOE | GPIO (memory controller drives high) |
| nPWE | GPIO (memory controller drives high) |
| **NOTE:**<br>† This indicates that the GPIO pin, if configured for the alternate function used by the memory controller during reset, drives the represented value.<br>**NOTE:** SCLK<3> is only available on PXA270 processor family packages<br>1. MA pins are driven<br>2. MD pins are pulled low | |

The address signals are driven low and data signals are pulled low during sleep, standby, deep-sleep, frequency-change modes, and manual self-refresh. All other memory control signals are in the same state that they are in after a hardware reset. If the SDRAMs are in self-refresh mode, they are kept there by driving SDCKE low.

## 4.5 Power-Supply Pins

Table 4-5 summarize the power-supply ball count.

**Table 4-5. Discrete (13x13 VF-BGA) Power Supply Pin Summary**

| Name | Number of Package Balls 13x13 mm VF-BGA | Number of Pachage Balls 23x23 mm PBGA |
|---|---|---|
| VCC_BATT | 1 | 1 |
| VCC_IO | 3 | 3 |
| VCC_USB | 4 | 4 |
| VCC_LCD | 2 | 2 |
| VCC_MEM | 19 | 16 |
| VCC_BB | 1 | 1 |
| VCC_PLL | 1 | 1 |
| VCC_SRAM | 4 | 4 |
| VCC_CORE | 14 | 20 |
| VCC_USIM | 1 | 1 |
| VSS | 6 | 5 |
| VSS_IO | 9 | 9 |
| VSS_MEM | 17 | 17 |
| VSS_BB | 1 | 1 |
| VSS_PLL | 1 | 1 |
| VSS_CORE | 56 | 56 |

§§

# Electrical Specifications 5

## 5.1 Absolute Maximum Ratings

The absolute maximum ratings (shown in Table 5-1) define limitations for electrical and thermal stresses. These limits prevent permanent damage to the Intel® PXA270 processor.

***Note:*** Absolute maximum ratings are not operating ranges.

**Table 5-1. Absolute Maximum Ratings**

| Symbol | Description | Min | Max | Units |
|---|---|---|---|---|
| $T_S$ | Storage temperature | –40 | 125 | °C |
| $V_{CC\_OL1}$ | Offset voltage between any of the following pins:<br>VCC_CORE | –0.3 | 0.3 | V |
| $V_{CC\_OL2}$ | Offset voltage between any of the following pins:<br>VCC_SRAM | –0.3 | 0.3 | V |
| $V_{CC\_OH1}$ | Offset voltage between any of the following pins:<br>VCC_MEM | –0.3 | 0.3 | V |
| $V_{CC\_OH2}$ | Offset voltage between any of the following pins:<br>VCC_IO | –0.3 | 0.3 | V |
| $V_{CC\_OH3}$ | Offset voltage between VCC_LCD<0> and VCC_LCD<1> | –0.3 | 0.3 | V |
| $V_{CC\_HV}$ | Voltage applied to high-voltage supply pins (VCC_BB, VCC_USB, VCC_USIM, VCC_MEM, VCC_IO<, VCC_LCD) | VSS–0.3 | VSS+4.0 | V |
| $V_{CC\_LV}$ | Voltage applied to low-voltage supply pins (VCC_CORE, VCC_PLL, VCC_SRAM) | VSS–0.3 | VSS+1.45 | V |
| $V_{IP}$ | Voltage applied to non-supply pins except PXTAL_IN, PXTAL_OUT, TXTAL_IN, and TXTAL_OUT pins | VSS–0.3 | VSS+4.0 | V |
| $V_{IP\_X}$ | Voltage applied to XTAL pins (PXTAL_IN, PXTAL_OUT, TXTAL_IN, TXTAL_OUT) | VSS–0.3 | VSS+1.45 | V |
| $V_{ESD}$ | Maximum ESD stress voltage, three stresses maximum:<br>• Any pin to any supply pin, either polarity, or<br>• Any pin to all non-supply pins together, either polarity | — | 2000 | V |
| $I_{EOS}$ | Maximum DC input current (electrical overstress) for any non-supply pin | — | 5 | mA |

## 5.2 Operating Conditions

This section shows operating voltage, frequency, and temperature specifications for the PXA270 processor.

Table 5-2 shows each power domains supported voltages (except for VCC_MEM and VCC_CORE). Table 5-3 shows all of the supported memory voltages and frequency operating ranges (VCC_MEM). Table Note: shows all of the supported core voltage and frequency ranges (VCC_CORE).

The operating temperature specification is a function of voltage and frequency.

**Table 5-2. Voltage, Temperature, and Frequency Electrical Specifications (Sheet 1 of 2)**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Operating Temperature | | | | | |
| Tcase | Package operating temperature† (Standard Temp) | -25 | — | +85 | °C |
| | Package operating temperature† (Extended Temp - PBGA ONLY) | -40 | — | +85 | |
| Theta Jc | Junction-to-case temperature gradient (VF-BGA) | — | 2 | — | °C / watt |
| | Junction-to-case temperature gradient (PBGA) | — | 1.4 | — | |
| VCC_BATT Voltage | | | | | |
| VVCC0 | Voltage applied on VCC_BATT @3.0V | 2.25 | 3.00 | 3.75 | V |
| VVDF1 | Voltage difference between VCC_BATT and VCC_IO during power-on reset or deep-sleep wake-up (from the assertion of SYS_EN to the de-assertion of nRESET_OUT) | 0 | — | 0.30 | V |
| VVDF2 | Voltage difference between VCC_BATT and VCC_IO when VCC_IO is enabled | 0 | — | 0.20 | V |
| Tbramp | Ramp Rate | — | 10 | 12 | mV/uS |
| VCC_PLL Voltage | | | | | |
| VVCC1 | Voltage applied on VCC_PLL @1.3V (+10 / -10%) | 1.17 | 1.30 | 1.43 | V |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| VCC_BB Voltages | | | | | |
| VVCC2a | Voltage applied on VCC_BB @1.8V (+20 / -5%) | 1.71 | 1.80 | 2.16 | V |
| VVCC2b | Voltage applied on VCC_BB @2.5V (+10 / -10%) | 2.25 | 2.50 | 2.75 | V |
| VVCC2c | Voltage applied on VCC_BB @3.0V (+10 / -10%) | 2.70 | 3.0 | 3.30 | V |
| VVCC2d | Voltage applied on VCC_BB @3.3V (+10 / -10%) | 2.97 | 3.3 | 3.63 | V |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| VCC_LCD Voltages | | | | | |
| VVCC3a | Voltage applied on VCC_LCD @1.8V (+20 / -5%) | 1.71 | 1.80 | 2.16 | V |

## Table 5-2. Voltage, Temperature, and Frequency Electrical Specifications (Sheet 2 of 2)

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| VVCC3b | Voltage applied on VCC_LCD @2.5V (+10 / -10%) | 2.25 | 2.50 | 2.75 | V |
| VVCC3c | Voltage applied on VCC_LCD @3.0V (+10 / -10%) | 2.70 | 3.0 | 3.30 | V |
| VVCC3d | Voltage applied on VCC_LCD @3.3V (+10 / -10%) | 2.97 | 3.3 | 3.63 | V |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| VCC_IO Voltages | | | | | |
| VVCC4a | Voltage applied on VCC_IO @3.0V (+10 / -10.3%) | 2.69175 | 3.0 | 3.30 | V |
| VVCC4b | Voltage applied on VCC_IO @3.3V (+10 / -10%) | 2.97 | 3.3 | 3.63 | V |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| **NOTE:** VCC_IO must be maintained at a voltage as high as or higher than, all other supplies except for VCC_BATT and VCC_USB | | | | | |
| VCC_USIM Voltages | | | | | |
| VVCC5a | Voltage applied on VCC_USIM @1.8V (+20 / -5%) | 1.71 | 1.80 | 2.16 | V |
| VVCC5b | Voltage applied on VCC_USIM @3.0V (+10 / -10%) | 2.70 | 3.0 | 3.30 | V |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| **NOTE:** If the system does NOT use the USIM module, VCC_USIM can be tied to VCC_IO (at any supported VCC_IO voltage level). This allows the GPIO's on VCC_USIM to be used at the same voltage level as VCC_IO GPIO's. **NOTE:** Software must NOT configure USIM signals to be used if this is done. | | | | | |
| VCC_SRAM Voltage | | | | | |
| VVCC6 | Voltage applied on VCC_SRAM @1.1V (+10 / -10%) | 0.99 | 1.10 | 1.21 | V |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| VCC_USB Voltage | | | | | |
| VVCC7a | Voltage applied on VCC_USB @3.0V (+10 / -10%) | 2.70 | 3.00 | 3.30 | V |
| VVCC7b | Voltage applied on VCC_USB @3.3V (+10 / -10%) | 2.97 | 3.30 | 3.63 | V |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| † System design must ensure that the device case temperature is maintained within the specified limits. In some system applications it may be necessary to use external thermal management (for example, a package-mounted heat spreader) or configure the device to limit power consumption and maintain acceptable case temperatures. | | | | | |

Table 5-3 shows the supported memory frequency and memory supply voltage operating ranges for the PXA270 processor.

### Table 5-3. Memory Voltage and Frequency Electrical Specifications

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Memory Voltage and Frequency Range 1 | | | | | |
| VMEM1 | Voltage applied on VCC_MEM | 1.71 | 1.80 | 2.16 | V |
| fSM1A | External synchronous memory frequency, SDCLK1, SDCLK2 | 13 | — | 104 | MHz |
| fSM1B | External synchronous memory frequency, SDCLK0 | 13 | — | 104 | MHz |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Memory Voltage and Frequency Range 2 | | | | | |
| VMEM2 | Voltage applied on VCC_MEM | 2.25 | 2.50 | 2.75 | V |
| fSM2A | External synchronous memory frequency, SDCLK1, SDCLK2 | 13 | — | 104 | MHz |
| fSM2B | External synchronous memory frequency, SDCLK0 | 13 | — | 104 | MHz |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Memory Voltage and Frequency Range 3 | | | | | |
| VMEM3 | Voltage applied on VCC_MEM | 2.70 | 3.0 | 3.3 | V |
| fSM3A | External synchronous memory frequency, SDCLK1, SDCLK2 | 13 | — | 104 | MHz |
| fSM3B | External synchronous memory frequency, SDCLK0 | 13 | — | 104 | MHz |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Memory Voltage and Frequency Range 4 | | | | | |
| VMEM4 | Voltage applied on VCC_MEM | 2.97 | 3.30 | 3.63 | V |
| fSM4A | External synchronous memory frequency, SDCLK1, SDCLK2 | 13 | — | 104 | MHz |
| fSM4B | External synchronous memory frequency, SDCLK0 | 13 | — | 104 | MHz |
| Tsysramp | Ramp Rate | — | 10 | 12 | mV/uS |

Table 5-4 shows the supported core frequency and core supply voltage operating ranges for the PXA270 processor. Each frequency range is specified in the following format:

(core frequency/internal system bus frequency/memory controller frequency/SDRAM frequency)

***Note:*** Refer to the "Clocks and Power" section of the *Intel® PXA27x Processor Family Developers Manual* for supported frequencies, clock register settings as listed in Table 5-4.

### Table 5-4. Core Voltage and Frequency Electrical Specifications (Sheet 1 of 2)

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Core Voltage and Frequency Range 1 (13/13/13/13) | | | | | |
| VVCCC1 | Voltage applied on VCC_CORE | 0.8075 | 0.85 | 1.705 | V |
| fCORE1 | Core operating frequency | 13 | — | 13 | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |

## Table 5-4. Core Voltage and Frequency Electrical Specifications (Sheet 2 of 2)

| | | | | | |
|---|---|---|---|---|---|
| Core Voltage and Frequency Range 2 (91/45.5/91/45.5) and (104/104/104/104) | | | | | |
| VVCCC2 | Voltage applied on VCC_CORE | 0.855 | 0.9 | 1.705 | V |
| fCORE2 | Core operating frequency | 91 | — | 104 | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 3 (156/104/104/104) | | | | | |
| VVCCC3 | Voltage applied on VCC_CORE | 0.95 | 1.00 | 1.705 | V |
| fCORE3 | Core operating frequency | — | 156 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 4 (208/208/208/104) | | | | | |
| VVCCC4 | Voltage applied on VCC_CORE | 1.0925 | 1.15 | 1.705 | V |
| fCORE4 | Core operating frequency | — | 208 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 4a (208/104/104/104) | | | | | |
| VVCCC4a | Voltage applied on VCC_CORE | 0.9975 | 1.05 | 1.705 | V |
| fCORE4a | Core operating frequency | — | 208 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 5 (312/208/208/104) | | | | | |
| VVCCC5 | Voltage applied on VCC_CORE | 1.1875 | 1.25 | 1.705 | V |
| fCORE5 | Core operating frequency | — | 312 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 5a (312/104/104/104) | | | | | |
| VVCCC5a | Voltage applied on VCC_CORE | 0.99 | 1.1 | 1.705 | V |
| fCORE5a | Core operating frequency | — | 312 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 6 (416/208/208/104) | | | | | |
| VVCCC6 | Voltage applied on VCC_CORE | 1.2825 | 1.35 | 1.705 | V |
| fCORE6 | Core operating frequency | — | 416 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 7 (520/208/208/104) | | | | | |
| VVCCC7 | Voltage applied on VCC_CORE | 1.3775 | 1.45 | 1.705 | V |
| fCORE7 | Core operating frequency | — | 520 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |
| Core Voltage and Frequency Range 8 (624/208/208/104)† | | | | | |
| VVCCC8 | Voltage applied on VCC_CORE | 1.4725 | 1.55 | 1.705 | V |
| fCORE8 | Core operating frequency | — | 624 | — | MHz |
| Tpwrramp | Ramp Rate | — | 10 | 12 | mV/uS |

†Core operating frequency not offered in PBGA package.

### 5.2.1 Internal Power Domains

The external power supplies are used to generate several internal power domains, which are shown in Table 5-5. Refer to the Power Manager / Internal Power Domain Block Diagram in the "Clocks and Power" section of the *Intel® PXA27x Processor Family Developers Manual* for more information on internal power domains.

**Table 5-5. Internally Generated Power Domain Descriptions**

| Name | Units | Generation | Tolerance |
|---|---|---|---|
| VCC_REG | IO associated with deep-sleep-active units | Switched between VCC_BATT and VCC_IO | - |
| VCC_OSC | Oscillator power supplies | Generated from VCC_REG | +/- 30% |
| VCC_RTC | RTC and power manager supply | Switched between VCC_OSC and VCC_CORE | - |
| VCC_PI | Power manager $I^2C$ supply | Switched between VCC_OSC and VCC_CORE | - |
| VCC_CPU | CPU core | Independent power-down from VCC_CORE | - |
| VCC_PER | Peripheral units | Independent power-down from VCC_CORE | - |
| VCC_Rx | Particular internal SRAM unit | Switched between VCC_OSC and VCC_SRAM | - |

Table 5-6 shows the recommended core voltage specification for each of the lower power modes.

**Table 5-6. Core Voltage Specifications For Lower Power Modes**

| Mode | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Standby | Voltage applied on VCC_CORE | 1.045 | 1.1 | 1.21 | V |
| Deep-Idle | Voltage applied on VCC_CORE | 0.8075 | 0.85 | 0.935 | V |

## 5.3 Power-Consumption Specifications

Power consumption depends on the operating voltage and frequency, peripherals enabled, external switching activity, and external loading and other factors.

Table 5-7 contains the power consumption information. There are three sets of data: Active Power Consumption, Idle Power Consumption and Low Power Modes Power Consumption. Data was taken at room temperature. For Active Power Consumption data, no peripherals are enabled except for UART.

## Table 5-7. Power-Consumption Specifications (Sheet 1 of 2)

| Parameter Description | Typical | Units | Conditions |
|---|---|---|---|
| Active Power Consumption | | | |
| 624 MHz Active Power (208 MHz System bus) | 925 | mW | VCC_CORE = 1.55V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 520 MHz Active Power (208 MHz System bus) | 747 | mW | VCC_CORE = 1.45V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 416 MHz Active Power (208 MHz System bus) | 570 | mW | VCC_CORE = 1.35V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 312 MHz Active Power (208 MHz System bus) | 390 | mW | VCC_CORE = 1.25V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 312 MHz Active Power (104 MHz System bus) | 375 | mW | VCC_CORE = 1.1V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 208 MHz Active Power (208 MHz System bus) | 279 | mW | VCC_CORE = 1.15V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 104 MHz Active Power (104 MHz System bus) | 116 | mW | VCC_CORE = 0.9V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 13 MHz Active Power (CCCR[CPDIS=1) | 44.2 | mW | VCC_CORE = 0.85V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| Idle Power Consumption | | | |
| 624 MHz Idle Power (208 MHz System bus) | 260 | mW | VCC_CORE = 1.55V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 520 MHz Idle Power (208 MHz System bus) | 222 | mW | VCC_CORE = 1.45V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 416 MHz Idle Power (208 MHz System bus) | 186 | mW | VCC_CORE = 1.35V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 312 MHz Idle Power (208 MHz System bus) | 154 | mW | VCC_CORE = 1.25V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 312 MHz Idle Power (104 MHz System bus) | 109 | mW | VCC_CORE = 1.1V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 208 MHz Idle Power (208 MHz System bus) | 129 | mW | VCC_CORE = 1.15V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 104 MHz Idle Power (104 MHz System bus) | 64 | mW | VCC_CORE = 0.9V VCC_SRAM = 1.1V VCC_PLL = 1.3V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |

**Table 5-7. Power-Consumption Specifications (Sheet 2 of 2)**

| Parameter Description | Typical | Units | Conditions |
|---|---|---|---|
| Low Power modes Power Consumption | | | |
| 13 MHz Idle Mode[1] Power (LCD on) | 15.4 | mW | VCC_CORE, VCC_SRAM, VCC_PLL = 0.85V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| 13 MHz Idle Mode[1] Power (LCD off) | 8.5 | mW | VCC_CORE, VCC_SRAM, VCC_PLL = 0.85V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| Deep-Sleep mode | 0.1014 | mW | VCC_CORE, VCC_SRAM, VCC_PLL = 0V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| Sleep mode | 0.1630 | mW | VCC_CORE, VCC_SRAM, VCC_PLL = 0V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| Standby mode | 1.7224 | mW | VCC_CORE, VCC_SRAM, VCC_PLL = 1.1V VCC_MEM, VCC_BB, VCC_USIM, VCC_LCD = 1.8V VCC_IO, VCC_BATT, VCC_USB= 3.0V |
| **NOTE:** 1) 13 MHz Idle Mode (CCCR[CPDIS] =1 (CCCR[PPDIS] = 1) | | | |

# 5.4 DC Specification

The DC characteristics for each pin include input sense levels, output drive levels, and currents. These parameters can be used to determine maximum DC loading and to determine maximum transition times for a given load. Table 5-8 shows the DC operating conditions for the high- and low-strength input, output, and I/O pins.

***Note:*** VCC_IO must be maintained at a voltage as high as or higher than all other supplies except VCC_BATT and VCC_USB and VCC_USB.

**Table 5-8. Standard Input, Output, and I/O Pin DC Operating Conditions (Sheet 1 of 2)**

| Symbol | Description | Min | Max | Units | Testing Conditions / Notes |
|---|---|---|---|---|---|
| Input DC Operating Conditions (VCC = 1.8V, 2.5, 3.0, 3.3 Typical) | | | | | |
| VIH[1] | Input high voltage, all standard input and I/O pins, relative to applicable VCC (VCC_IO, VCC_MEM, VCC_BB, VCC_LCD, VCC_USB, or VCC_USIM) | 0.8 * VCC | VCC + 0.1 | V | — |
| VIL[1] | Input low voltage, all standard input and I/O pins, relative to applicable VSS (VSS_IO, VSS_MEM, or VSS_BB) and VCC (VCC_IO, VCC_MEM, VCC_BB, VCC_LCD, VCC_USB, or VCC_USIM) | VSS - 0.1 | 0.2 * VCC | V | — |
| OS | DC Overshoot voltage / duration | — | +1 | V | Max duration of 4nS |
| US | DC Undershoot voltage / duration | — | -1 | V | Max duration of 4nS |
| Output DC Operating Conditions (VCC = 1.8, 2.5, 3.0, 3.3 Typical) | | | | | |

**Table 5-8. Standard Input, Output, and I/O Pin DC Operating Conditions (Sheet 2 of 2)**

| Symbol | Description | Min | Max | Units | Testing Conditions / Notes |
|---|---|---|---|---|---|
| VOH[1] | Output high voltage, all standard output and I/O pins, relative to applicable VCC (VCC_IO, VCC_MEM, VCC_BB, VCC_LCD, VCC_USB, or VCC_USIM) | VCC - 0.3 | VCC | V | IOH = -4 mA[2], -3 mA[3] |
| VOL[1] | Output low voltage, all standard output and I/O pins, relative to applicable VSS (VSS_IO, VSS_MEM, or VSS_BB) | VSS | VSS + 0.3 | V | IOH = 4 mA[2], 3 mA[3] |

**NOTES:**
1. Programmable drive strengths set to 0x5 for memory and LCD programmable signals.
2. The current for the high-strength pins are MA<25:0>, MD<31:0>, nOE, nWE, nSDRAS, nSDCAS, DQM<3:0>, nSDCS<3:0>, SDCKE<1>, SDCLK<3:0>, RDnWR, nCS<5:0>, and nPWE.
3. The current for all other output and I/O pins are low strength.

# 5.5 Oscillator Electrical Specifications

The PXA270 processor contains two oscillators: a 32.768-kHz oscillator and a 13.000-MHz oscillator. Each oscillator requires a specific crystal.

## 5.5.1 32.768-kHz Oscillator Specifications

The 32.768-kHz oscillator is connected between the TXTAL_IN (amplifier input) and TXTAL_OUT (amplified output). Table 5-9 and Table 5-10 list the appropriate 32.768-kHz specifications.

To drive the 32.768-kHz crystal pins from an external source:

1. Drive the TXTAL_IN pin with a digital signal that has low and high levels as listed in Table 5-10. Do not exceed VCC_PLL or go below VSS_PLL by more than 100 mV. The minimum slew rate is 1 volt per 1 µs. The maximum current drawn from the external clock source when the clock is at its maximum positive voltage is typically 1 mA.
2. Float the TXTAL_OUT pin or drive it in complement to the TXTAL_IN pin, with the same voltage level and slew rate.

***Caution:*** The TXTAL_IN and TXTAL_OUT pins must not be driven from an external source if the PXA270 processor sleep / deep sleep DC-DC converter is enabled.

**Table 5-9. Typical 32.768-kHz Crystal Requirements (Sheet 1 of 2)**

| Parameter | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|
| Frequency range | — | 32.768 | — | kHz |
| Frequency tolerance | –30 | — | +30 | ppm |
| Frequency stability, parabolic coefficient | — | — | –0.04 | ppm/$(\Delta°C)^2$ |
| Drive level | — | — | 1.0 | uW |
| Load capacitance ($C_L$) | — | 12.5 | — | pf |
| Shunt capacitance ($C_O$) | — | 0.9 | — | pf |

### Table 5-9. Typical 32.768-kHz Crystal Requirements (Sheet 2 of 2)

| Parameter | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|
| Motional capacitance ($C_l$) | — | 2.1 | — | fF |
| Equivalent series resistance ($R_S$) | — | 18 | 35 | k Ω |
| Insulation resistance at 100 $V_{DC}$ | 100 | — | — | M Ω |
| Aging, at operating temperature per year | — | — | ±3.0 | ppm |

**Table 5-10. Typical External 32.768-kHz Oscillator Requirements**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Amplifier Specifications | | | | | |
| VIH_X | Input high voltage, TXTAL_IN | 0.99 | 1.10 | 1.21 | V |
| VIL_X | Input low voltage, TXTAL_IN | –0.10 | 0.00 | 0.10 | V |
| IIN_XT | Input leakage, TXTAL_IN | — | — | 1 | µA |
| CIN_XT | Input capacitance, TXTAL_IN/ TXTAL_OUT | — | 18 | 25 | pf |
| tS_XT | Stabilization time | — | — | 10 | s |
| Board Specifications | | | | | |
| RP_XT | Parasitic resistance, TXTAL_IN/ TXTAL_OUT to any node | 20 | — | — | MΩ |
| CP_XT | Parasitic capacitance, TXTAL_IN/ TXTAL_OUT, total | — | — | 5 | pf |
| COP_XT | Parasitic shunt capacitance, TXTAL_IN to TXTAL_OUT | — | — | 0.4 | pf |

## 5.5.2 13.000-MHz Oscillator Specifications

The 13.000-MHz oscillator is connected between the PXTAL_IN (amplifier input) and PXTAL_OUT (amplified output). Table 5-11 and Table 5-12 list the 13.000-MHz specifications.

To drive the 13.000-MHz crystal pins from an external source:

1. Drive the PXTAL_IN pin with a digital signal with low and high levels as listed in Table 5-12. Do not exceed VCC_PLL or go below VSS_PLL by more than 100 mV. The minimum slew rate is 1 volt / 100 ns. The maximum current drawn from the external clock source when the clock is at its maximum positive voltage typically is 1 mA.
2. Float the PXTAL_OUT pin or drive it in complement to the PXTAL_IN pin, with the same voltage level, slew rate, and input current restrictions.

***Caution:*** The PXTAL_IN and PXTAL_OUT pins must not be driven from an external source if the PXA270 processor sleep / deep sleep DC-DC converter is enabled.

**Table 5-11. Typical 13.000-MHz Crystal Requirements**

| Parameter | Minimum | Typical | Maximum | Units |
|---|---|---|---|---|
| Frequency range | 12.997 | 13.000 | 13.002 | MHz |
| Frequency tolerance at 25°C | –50 | — | +50 | ppm |
| Oscillation mode | — | Fnd | — | — |
| Maximum change over temperature range | –50 | — | +50 | ppm |
| Drive level | — | 10 | 100 | uW |
| Load capacitance ($C_L$) | — | 10 | — | pf |
| Maximum series resistance ($R_S$) | — | 50 | — | Ω |
| Aging per year, at operating temperature | — | — | ±5.0 | ppm |

### Table 5-12. Typical External 13.000-MHz Oscillator Requirements

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Amplifier Specifications | | | | | |
| VIH_X | Input high voltage, PXTAL_IN | 0.99 | 1.10 | 1.21 | V |
| VIL_X | Input low voltage, PXTAL_IN | –0.10 | 0.00 | 0.10 | V |
| IIN_XP | Input leakage, PXTAL_IN | — | — | 10 | µA |
| CIN_XP | Input capacitance, PXTAL_IN/PXTAL_OUT | — | 40 | 50 | pf |
| tS_XP | Stabilization time | — | — | 67.8 | ms |
| Board Specifications | | | | | |
| RP_XP | Parasitic resistance, PXTAL_IN/PXTAL_OUT to any node | 20 | — | — | MΩ |
| CP_XP | Parasitic capacitance, PXTAL_IN/PXTAL_OUT, total | — | — | 5 | pf |
| COP_XP | Parasitic shunt capacitance, PXTAL_IN to PXTAL_OUT | — | — | 0.4 | pf |

## 5.6 CLK_PIO and CLK_TOUT Specifications

CLK_PIO can be used to drive a buffered version of the PXTAL_IN oscillator input or can be used as a clock input alternative to PXTAL_IN. Refer to Table 5-13 for CLK_PIO specifications.

A buffered and inverted version of the TXTAL_IN oscillator output is driven out on CLK_TOUT. Refer to Table 5-14 for CLK_TOUT specifications.

***Note:*** CLK_TOUT and CLK_PIO are only available when software sets the OSCC[PIO_EN] and OSCC[TOUT_EN] bits.

### Table 5-13. CLK_PIO Specifications

| Parameter | Specifications |
|---|---|
| Frequency | 13 MHz |
| Frequency Accuracy (derived from 13 MHz crystal) | +/-200ppm |
| Symmetry/Duty Cycle variation | 30/70 to 70/30% at VCC |
| Jitter | +/-20pS max |
| Load capacitance ($C_L$) | 50pf max |
| Rise and Fall time (Tr & Tf) | 15nS max with 50pF load |

### Table 5-14. CLK_TOUT Specifications

| Parameter | Specifications |
|---|---|
| Frequency | 32KHz |
| Frequency Accuracy (derived from 32 kHz crystal) | +/-200ppm |
| Symmetry/Duty Cycle variation | 30/70 to 70/30% at VCC |

**Table 5-14. CLK_TOUT Specifications**

| Parameter | Specifications |
|---|---|
| Jitter | +/-20pS max |
| Load capacitance ($C_L$) | 50pf max |
| Rise and Fall time (Tr & Tf) | 15nS max with 50pF load |

## 5.7 48 MHz Output Specifications

Software may configure GPIO<11> or GPIO<12> alternate functions to enable the 48-MHz clock output. The 48-MHz output clock is a divided-down output generated from the 312-MHz peripheral PLL. Refer to Table 5-15 for the 48-MHz output specifications. Refer to Section 3 of this document for GPIO alternate functions in the pin usage table.

**Table 5-15. 48 MHz Output Specifications**

| Parameter | Specifications |
|---|---|
| Frequency (derived from 13 MHz crystal) | 48 MHz |
| Frequency Accuracy (derived from 13 MHz crystal) | +/-200ppm (maximum) |
| Symmetry/Duty Cycle variation | 30/70 to 70/30% at VCC |
| Jitter | +/-20pS max |
| Load capacitance ($C_L$) | 50pf max |
| Rise and Fall time (Tr & Tf) | 15nS max with 50pF load |

# AC Timing Specifications 6

A pin's alternating-current (AC) characteristics include input and output capacitance. These factors determine the loading for external drivers and other load analyses. The AC characteristics also include a derating factor, which indicates how much the AC timings might vary with different loads.

***Note:*** The timing diagrams in this chapter show bursts that start at 0 and proceed to 3 or 7. However, the least significant address (0) is not always received first during a burst transfer, because the Intel® PXA270 processor requests the critical word first during burst accesses.

Table 6-1 shows the AC operating conditions for the high- and low-strength input, output, and I/O pins. All AC specification values are valid for the device's entire temperature range.

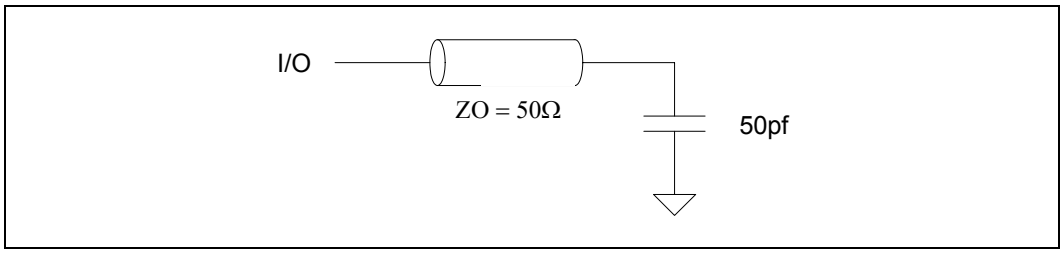
**Table 6-1. Standard Input, Output, and I/O-Pin AC Operating Conditions**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $C_{IN}$ | Input capacitance, all standard input and I/O pins | — | — | 10 | pf |
| $C_{OUT\_H}$ | Output capacitance, all standard high-strength output and I/O pins | 20 | — | 50 | pf |
| $td_{F\_H}$ | Output derating, falling edge on all standard, high-strength output and I/O pins, from 50-pf load. | — | TBD | — | ns/pf |
| $td_{R\_H}$ | Output derating, rising edge on all standard, high-strength output and I/O pins, from 50-pf load. | — | TBD | — | ns/pf |
| $C_{OUT\_L}$ | Output capacitance, all standard low-strength output and I/O pins | 20 | — | 50 | pf |
| $td_{F\_L}$ | Output derating, falling edge on all standard, low-strength output and I/O pins, from 50-pf load. | — | TBD | — | ns/pf |
| $td_{R\_L}$ | Output derating, rising edge on all standard, low-strength output and I/O pins, from 50-pf load. | — | TBD | — | ns/pf |

## 6.1 AC Test Load Specifications

Figure 6-1 represents the timing reference load used in defining the relevant timing parameters of the part. It is not intended to be either a precise representation of the typical system environment nor a depiction of the actual load presented by a production tester. System designers use IBIS or other simulation tools to correlate the timing reference load to system environment. Manufacturers correlate to their production test conditions (generally a coaxial transmission line terminated at the tester electronics).

**Figure 6-1. AC Test Load**




## 6.2 Reset and Power Manager Timing Specifications

The processor asserts the nRESET_OUT pin in one of several different modes:

- Power-on reset
- Hardware reset
- Watchdog reset
- GPIO reset
- Sleep mode
- Deep-sleep mode

The following sections give the timing and specifications for entry into and exit from these modes.

### 6.2.1 Power-On Timing Specifications

Power-on reset begins when a power supply is detected on the backup battery pin, VCC_BATT, after the processor has been powered off. A power-on reset is equivalent to a hardware reset, in that all units are reset to the same known state as with a hardware reset. A power-on reset is a complete and total reset that occurs only at initial power on.

The external power-supply system must enable the power supplies for the processor in a specific sequence to ensure proper operation. Figure 6-2 shows the timing diagram for a power-on reset sequence. Table 6-2 details the timing.

The sequence for power-on reset is as follows:

1. VCC_BATT is established, then nRESET should be de-asserted to initiate power-on reset.
2. PWR_OUT is asserted. The processor asserts nRESET_OUT.
3. The external power-control subsystem de-asserts nBATT_FAULT to signal that the main battery is connected and not discharged.
4. The processor asserts the SYS_EN signal to enable the power supplies VCC_IO, VCC_MEM, VCC_BB, VCC_USB, and VCC_LCD. VCC_USIM can be established at this time also but can be independently controlled through its own control signals. VCC_IO must be established first. The other supplies can turn on in any order, but they must all be established within 125 milliseconds of the assertion of SYS_EN.

5. The processor asserts the PWR_EN signal to enable the power supplies VCC_CORE, VCC_SRAM, and VCC_PLL. These supplies can turn on in any order but must all be established within 125 milliseconds of the assertion of PWR_EN.
6. The external power-control subsystem de-asserts nVDD_FAULT to signal that all system power supplies have been properly established.
7. The processor de-asserts nRESET_OUT and enters run mode, executing code from the reset vector.

***Note:*** nBATT_FAULT must be high before nRESET is de-asserted. Otherwise, the processor will not begin the power-on sequencing event. nVDD_FAULT is sampled only when the SYS_DEL and PWR_DEL timers have expired. Refer to the *Intel® PXA27x Processor Family Developer's Manual*, "Initial Power On" and "Deep-Sleep Exit States" for a state diagram.

**Figure 6-2. Power On Reset Timing**

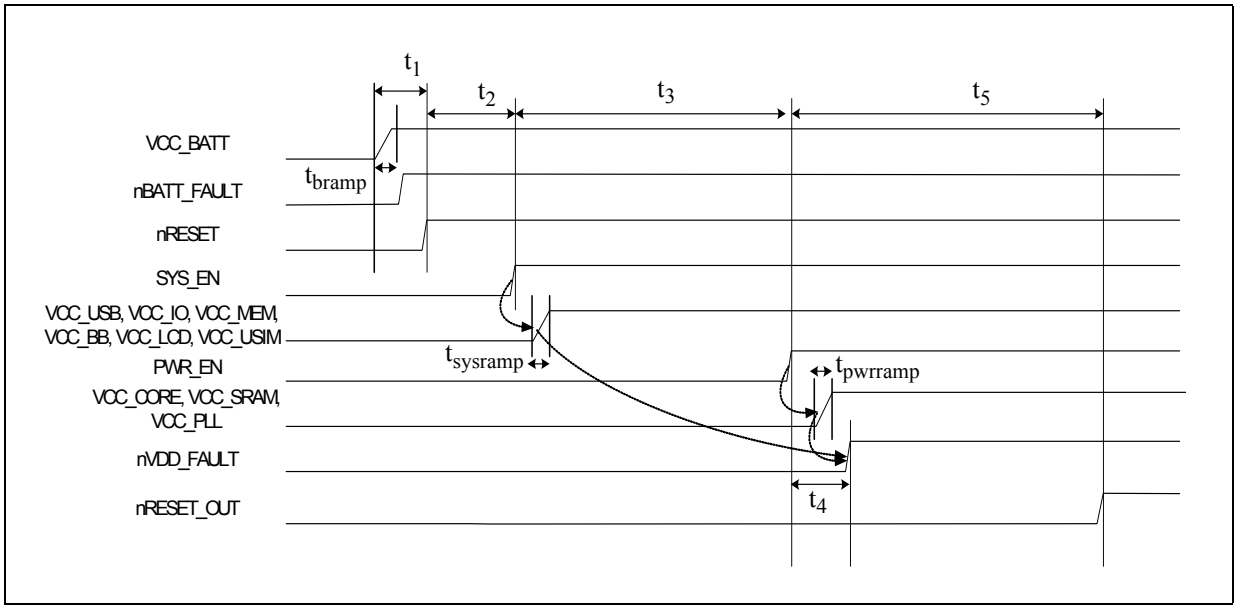



**Table 6-2. Power-On Timing Specifications (Sheet 1 of 2)(OSCC[CRI] = 0)**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $t_1$ | Delay from VCC_BATT assertion to nRESET de-assertion | 10 | — | — | ms |
| $t_2$ | Delay from nRESET de-assertion to SYS_EN assertion | — | 10[1] | — | ms |
| $t_3$ | Delay from SYS_EN assertion to PWR_EN assertion | — | 125 | — | ms |
| $t_4$ | Power supply stabilization time (time to the deassertion of nVDD_FAULT after the assertion of PWR_EN) | — | — | 120 | ms |
| $t_5$ | Delay from the assertion of PWR_EN to the de-assertion of nRESET_OUT | — | 125 | — | ms |
| $t_{bramp}$ | VCC_BATT power-on Ramp Rate | — | 10 | 12 | mV/uS |

**Table 6-2. Power-On Timing Specifications (Sheet 2 of 2)(OSCC[CRI] = 0)**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $t_{sysramp}$ | Power-on Ramp Rate for all external high -voltage power domains | — | 10 | 12 | mV/uS |
| $t_{pwrramp}$ | Power-on Ramp Rate for all external low -voltage power domains (including dynamic voltage changes on VCC_CORE) | — | 10 | 12 | mV/uS |

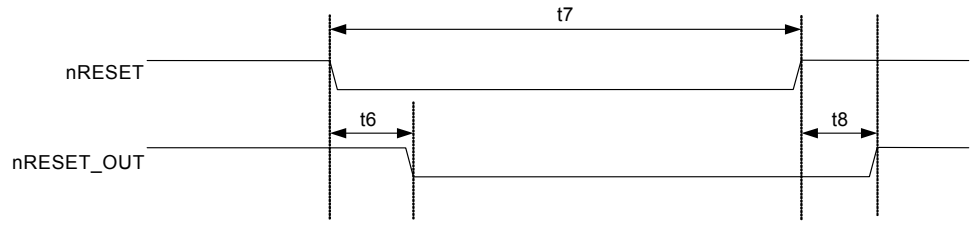
**NOTES:**
1. If the OSCC[CRI] =1 then the delay from nRESET de-assertion to SYS_EN assertion is 3000mS

**NOTE:** This long delay is attributed to the fact that when the CRI bit is read as 1, (which indicates that the CLK_REQ pin was floated during a hardware or power-on reset) the processor oscillator is supplied externally. This then forces the system to wait for the 32 kHz oscillator and the 13 MHz oscillator to stabilize.

## 6.2.2 Hardware Reset Timing

The timing sequences shown in Figure 6-3 for hardware reset and the specifications in Table 6-3 and Table 6-4 assume stable power supplies at the assertion of nRESET. Follow the timings indicated in Section 6.2.1 if the power supplies are unstable.

**Figure 6-3. Hardware Reset Timing**




**NOTE: nBATT_FAULT and nVDD_FAULT must be deasserted during the reset sequence.**

**Table 6-3. Hardware Reset Timing Specifications (OSCC[CRI] = 0)**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $t_6$ | Delay between nRESET asserted and nRESET_OUT asserted | — | < 100 ns | 10 | ms |
| $t_7$ | Assertion time of nRESET | 6 | — | — | ms |
| $t_8$ | Delay between nRESET de-asserted and nRESET_OUT de-asserted | 256 | — | 265 | ms |

**Table 6-4. Hardware Reset Timing Specifications (OSCC[CRI] = 1)**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $t_6$ | Delay between nRESET asserted and nRESET_OUT asserted | — | < 100 ns | 10 | ms |
| $t_7$ | Assertion time of nRESET | 6 | — | — | ms |
| $t_8$ | Delay between nRESET de-asserted and nRESET_OUT de-asserted | 2256 | — | 3265 | ms |

## 6.2.3 Watchdog Reset Timing

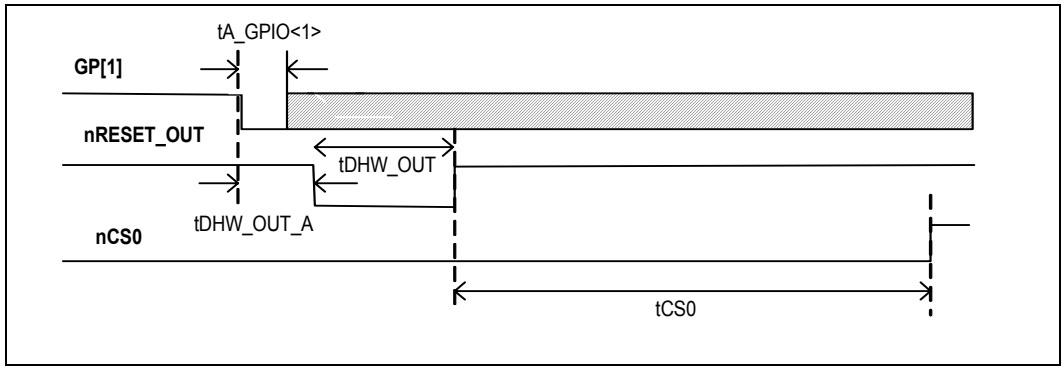
Watchdog reset is generated internally and therefore has no external pin dependencies. The nRESET_OUT pin is the only indicator of watchdog reset; it stays asserted for $t_{DHW\_OUT}$. The timing is similar to that for GPIO reset — see Figure 6-4 for details.

## 6.2.4 GPIO Reset Timing

GPIO reset is generated externally, and the source is reconfigured as a standard GPIO as soon as the reset propagates internally. The clocks module is not reset by GPIO reset, so the timing varies based on the selected clock frequency. If the clocks and power manager is in a frequency-change sequence when GPIO reset is asserted (see Section 5.5.1, "32.768-kHz Oscillator Specifications" on page 5-9.), then Figure 6-4 shows the timing of GPIO reset, and Table 6-5 shows the GPIO reset timing specifications.

***Note:*** When bit GPROD is set in the Power Manager General Configuration register, nRESET_OUT is not asserted during GPIO reset. For register details, see the "Clocks and Power Manager" chapter in the *Intel® PXA27x Processor Family Developer's Manual*.

**Figure 6-4. GPIO Reset Timing**



### Table 6-5. GPIO Reset Timing Specifications

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| tA_GPIO<1> | Minimum assert time of GPIO<1>[1] in 13.000-MHz input clock cycles | 4[4] | — | — | cycles |
| tDHW_OUT_A | Delay between GPIO<1> asserted and nRESET_OUT asserted in 13.000-MHz input clock cycles | 6[4] | — | 8 | cycles |
| tDHW_OUT | Delay between nRESET_OUT asserted and nRESET_OUT de-asserted, run or turbo mode[2] | 230 | — | — | nsec |
| tDHW_OUT_F | Delay between nRESET_OUT asserted and nRESET_OUT de-asserted, during frequency change sequence[3] | 5 | — | 380 | µs |
| tCS0[5] | Delay between nRESET_OUT de-assertion and nCS0 assertion | 1000 | — | — | ns |

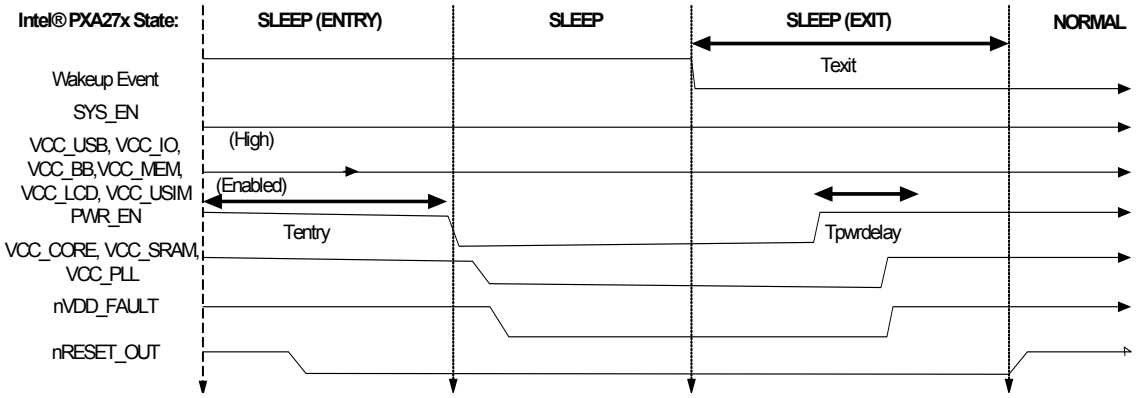
**NOTES:**
1. GPIO<1> is not recognized as a reset source again until configured to do so in software. Software must check the state of GPIO<1> before configuring as a reset to ensure that no spurious reset is generated. For details, see the "Clocks and Power Manager" chapter in the *Intel® PXA27x Processor Family Developer's Manual*.
2. Time is 512*N processor clock cycles plus up to 4 cycles of the 13.000-MHz input clock.
3. Time during the frequency-change sequence depends on the state of the PLL lock detector at the assertion of GPIO reset. The lock detector has a maximum time of 350 µs plus synchronization.
4. In standby, sleep, and deep-sleep modes, this time is in addition to the wake-up time from the low-power mode.
5. The tCS0 specification is also applicable to Power-On reset, Hardware reset, Watchdog reset and Deep-Sleep/Sleep mode exit.

## 6.2.5 Sleep Mode Timing

Sleep mode is internally asserted, and it asserts the nRESET_OUT and PWR_EN signals. Figure 6-5 and Table 6-6 show the required timing parameters for sleep mode.

***Note:*** When bit SL_ROD is set in the Power Manager Sleep Configuration register, nRESET_OUT, is not asserted during GPIO reset. See the "Clocks and Power Manager" chapter in the *Intel® PXA27x Processor Family Developer's Manual* for register details.

### Figure 6-5. Sleep Mode Timing




### Table 6-6. Sleep-Mode Timing Specifications

| Symbol | Description | Min | Typical | Max[3] | Units |
|---|---|---|---|---|---|
| $t_{entry}$[5] | Delay between MCR sleep command issue to de-assertion of PWR_EN | 0.56 | — | 2.5[1] | msec |
| $t_{exit}$ | Delay between wakeup event and run mode | 0.50 | — | 136.65[2,4] | msec |
| $t_{pwrdelay}$ | Delay between assertion of PWR_EN to PLL enable[2] | 0 | — | 125 | msec |

**NOTES:**
1. -1mS if not using DC2DC and -0.94mS if any internal SRAM banks are not powered
2. 0.15ms less time if exiting from sleep mode to 13M mode
3. Add 0.1ms if the wake up event is external
4. Oscillator start/crystal stable times are programmable (300uS-11mS)

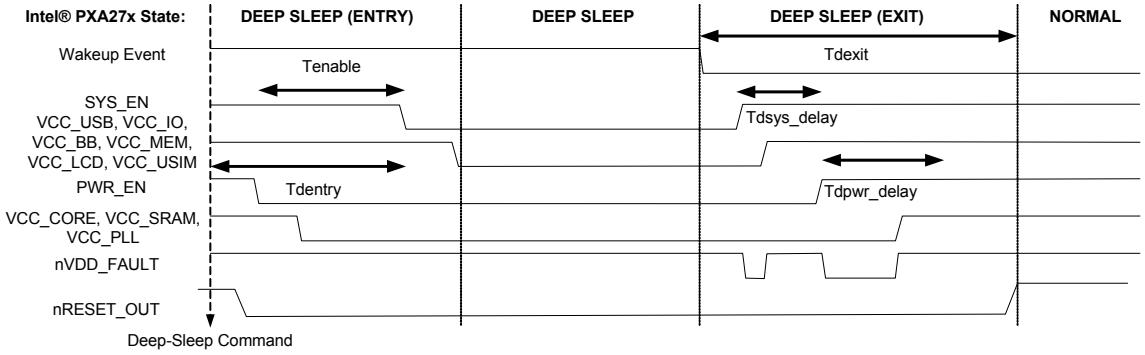
**NOTE:** 6ms is user programmable using the OSCC[OSD] bit. The remaining 5ms is an internal timer which counts until the oscillator is stable. (Typical stabilization is 500µs. Maximum can be upto 5ms)

5. nRESET_OUT and nVDD_FAULT are programmable during sleep mode

## 6.2.6 Deep-Sleep Mode Timing

Deep-sleep mode is internally asserted, and it asserts the nRESET_OUT and PWR_EN signals. Figure 6-6 and Table 6-7 show the required timing parameters for sleep mode. The timing specifications listed are for software invoked (not battery or VDD fault) Deep-sleep entry, unless specified.

## Figure 6-6. Deep-Sleep-Mode Timing




## Table 6-7. Deep-Sleep Mode Timing Specifications

| Symbol | Description | Min | Typical | Max[3] | Units |
|---|---|---|---|---|---|
| $t_{dentry}$[5] | Delay between deep-sleep command issue to de-assertion of SYS_EN | 0.66 | — | 1.66[1] | msec |
| $t_{enable}$ | Delay between de-assertion of PWR_EN and SYS_EN | — | 30 | — | usec |
| $t_{dexit}$ | Delay between wakeup event and run mode | 0.60 | — | 261.75[2,4] | msec |
| $t_{dsysdelay}$ | Delay between assertion of SYS_EN to PWR_EN[2] | 0 | — | 125 | msec |
| $t_{dpwrdelay}$ | Delay between assertion of PWR_EN to PLL enable[2] | 0 | — | 125 | msec |
| **NOTE:** Timing specifications for nBATT_FAULT and/or nVDD_FAULT asserted deep-sleep mode entry are below: | | | | | |
| Fault assert | Delay between nBATT_FAULT or nVDD_FAULT assertion (during all modes of operation including sleep mode) and deep-sleep mode entry[6](The de-assertion of SYS_EN defines when the processor is in deep-sleep mode) | 0.33 | — | 1.56 | msec |

**NOTES:**
1. -1ms if not using DC2DC
2. 0.15ms less time if exiting from Deep-sleep mode to 13M mode
3. Add 0.1ms if the wake up event is external
4. Oscillator start/crystal stable times are programmable (300uS-11mS)

**NOTE:** 6ms is user programmable using the OSCC[OSD] bit. The remaining 5ms is an internal timer which counts until the oscillator is stable. (Typical stabilization is 500µs. Maximum can be upto 5ms)

5. nRESET_OUT and nVDD_FAULT are programmable during sleep mode
6. Assumes PMCR[BIDAE or VIDAE] bits are set to zero (default state) - The PMCR[BIDAE or VIDAE] bits are only read by the processor if nBATT_FAULT or nVDD_FAULT signals are asserted

### 6.2.6.1 GPIO states in Deep-Sleep mode

If the external high voltage power domains (VCC_IO, VCC_MEM, VCC_BB, VCC_LCD, VCC_USB, VCC_USIM) remain powered on during deep-sleep, the PGSR values are driven onto all the GPIO pins (that are configured as outputs) for a finite time period, then the pins default to the reset state (Pu/Pd) as described in Chapter 2 of this manual. This sequence occurs for either software initiated or fault initiated deep-sleep entry.

***Note:*** GPIOs<0,1,3,4,9,10> never float. They are powered from VCC_BATT so when the system and the core power domains are removed (controlled by SYS_EN and PWR_EN), the Pu/Pd resistors are still enabled due to VCC_BATT remaining on.

The delay between the initiation of deep-sleep mode and enabling the GPIO Pu/Pd states, is system dependant because the processor is performing an unpredictable workload and requires an unknown amount of time to complete current processes. Refer to the deep-sleep mode, "Clocks and Power" section of the *Intel® PXA27x Processor Family Developers Manual* for a description on deep-sleep mode entry sequence.

Table 6-8 shows the time period that the GPIO pull-up/pull-downs are enabled. Listed below are the regulators and converter naming conventions:

L1 = Sleep/Deep-Sleep Linear Regulator

L2 = High-Current Linear Regulator

DC2DC = Sleep/Deep-Sleep DC-DC Converter

**Table 6-8. GPIO Pu/Pd Timing Specifications for Deep-Sleep Mode**

| Description | L2 | L1 | DC2DC | Units |
|---|---|---|---|---|
| Duration of the GPIO Pu/Pd states being enabled and the de-assertion of PWR_EN | 0.1 | 0.13 | 1.13 | msec |

***Note:*** If the *external high voltage power domains* (VCC_IO, VCC_MEM, VCC_BB, VCC_LCD, VCC_USB, VCC_USIM) are powered off during deep-sleep mode, the GPIOs behave the same as described above; however, they float after the supplies are removed.

## 6.2.7 Standby-Mode Timing

### Table 6-9. Standby-Mode Timing Specifications

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| — | 13M mode to standby mode entry | — | 0.34 | — | msec |
| — | Standby mode exit to 13M mode[1] | 0.28 | — | 11.28[2] | msec |
| — | Run mode to standby mode entry | — | 0.34 | — | msec |
| — | Standby mode exit to run mode[1] | 0.43 | 0.39 | 11.43[2] | msec |

**NOTES:**
1. The 13M oscillator is programmable
2. Add 0.1ms if the wake up event is external

## 6.2.8 Idle-Mode Timing

### Table 6-10. Idle-Mode Timing Specifications

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| — | 13M mode to deep idle mode entry | — | 1 | — | µs |
| — | Deep idle mode exit to 13M mode | — | 1 | — | µs |
| — | Run mode to idle run mode entry | — | 1 | — | µs |
| — | Idle run mode exit to run mode | — | 1 | — | µs |

## 6.2.9 Frequency-Change Timing

### Table 6-11. Frequency-Change Timing Specifications

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| — | Delay between MCR command to frequency change sequence completion | — | 150[1] | — | µs |
| — | Delay to change between turbo, half-turbo and run modes | — | 1[2] | — | µs |
| — | Delay to enter 13M mode from any Run mode [3] | — | 1 | — | µs |
| — | Delay to exit 13M mode to any Run mode | — | 2[4] | — | µs |

**NOTES:**
1. Any change to the CCCR[2N or L] bits followed by a write to CLFCFG[F] to initiate a frequency change sequence, results in a PLL restart
2. Changing between turbo, half-turbo and run modes does not require a PLL restart
3. Software can only change into 13M mode from any run mode
4. Assuming software uses the PLL early enable feature (CCCR[PLL_EARLY_EN] prior to a frequency change sequence

### 6.2.10 Voltage-Change Timing

The PWR $I^2C$ uses the regular $I^2C$ protocol. The PWR $I^2C$ is clocked at 40 kHz (160 kHz fast-mode operation is supported). Software controls the time required for initiating the voltage change sequence through completion. The voltage-change timing is a product of the number of commands issued plus the number of software programmed delays. Table 6-12 shows the timing of a 1 byte command issued to the power manager IC.

Set the $I^2C$ programmable output ramp rate with a default/reset ramp rate of 10mV/µs (refer to VCC_CORE ramp rate specification in the *Electrical Section*) to support VCC_CORE dynamic voltage management.

**Table 6-12. Voltage-Change Timing Specification for a 1-Byte Command**

| Symbol | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| — | Delay between voltage change sequence start[1] to command received by PMIC | — | 18 | — | cycles[2] |

**NOTES:**
1. Write 1 to PWRMODE[VC]
2. 40 kHz cycles

## 6.3 GPIO Timing Specifications

Table 6-13 shows the general-purpose I/O (GPIO) AC timing specifications.

**Table 6-13. GPIO Timing Specifications**

| Symbol | Parameter | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| taGPIO[1] | Assertion time required to detect GPIO edge | 154 | — | ns | run, idle, or sense power modes |
| taGPIOLP[2] | Assertion time required to detect GPIO low-power edge | 62.5 | — | µs | standby, sleep, or deep-sleep power modes |
| tdGPIO[1] | De-assertion time required to detect GPIO edge | 154 | — | ns | run, idle, or sense power modes |
| tdGPIOLP[2] | De-assertion time required to detect GPIO low-power edge | 62.5 | — | µs | standby, sleep, or deep-sleep power modes |
| tdiGPIO[3] | Time it takes for a GPIO edge to be detected internally | 231 | — | ns | run, idle, or sense power modes |
| tdiGPIOLP[4] | Time it takes for a GPIO low-power edge to be detected internally | 93.75 | — | µs | standby, sleep, or deep-sleep power modes |

**NOTES:**
1. Period equal to two 13-MHz cycles
2. Period equal to two 32-kHz cycles
3. Period equal to three 13-MHz cycles
4. Period equal to three 32-kHz cycles

Note 4 describes the complete timing for a standby, sleep, or deep-sleep wake up source to be asserted and detected internally (2 cycles for assertion (note 2) and 1 additional cycle for detection).

## 6.4 Memory and Expansion-Card Timing Specifications

Interfaces with the following memories must observe the AC timing requirements given in the following subsections:

- Section 6.4.1, “Internal SRAM Read/Write Timing Specifications”
- Section 6.4.2, “SDRAM Parameters and Timing Diagrams”
- Section 6.4.3, “ROM Parameters and Timing Diagrams”
- Section 6.4.4, “Flash Memory Parameters and Timing Diagrams”
- Section 6.4.5, “SRAM Parameters and Timing Diagrams”
- Section 6.4.6, “Variable-Latency I/O Parameters and Timing Diagrams”
- Section 6.4.7, “Expansion-Card Interface Parameters and Timing Diagrams”

***Note:*** The diagrams in this section use the following conventions:

- Input signals to the processor are represented using dashed waveforms.
- Outputs and bidirectional signals are represented using solid waveforms.
- Fixed parameters are shown using double arrows in grey (black and white print) or green (color print).
- Programmable parameters are shown using bold single arrows.
- The processor register that is used to change a specific timing is given in the corresponding timing table.

### 6.4.1 Internal SRAM Read/Write Timing Specifications

**Table 6-14. SRAM Read/Write AC Specification**

| Symbols | Parameters | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|
| tsramRD | 4-beat read transfer | — | 9 | — | system bus clocks |
| tsramWR | 4-beat write transfer | — | 7 | — | system bus clocks |

### 6.4.2 SDRAM Parameters and Timing Diagrams

Table 6-15 shows the timing parameters used in Figure 6-7. Also see Section 6.4.3 and Figure 6-11 for additional SDRAM bus tenure information. See Figure 6-10 for SDRAM fly-by bus tenures.

## Table 6-15. SDRAM Interface AC Specifications (Sheet 1 of 2)

| Symbols | Parameters | VCC_MEM = 1.8V +20% / –5%[3] | | | VCC_MEM = 2.5V +/- 10%[4] | | | VCC_MEM = 3.3V +/- 10%[5] | | | Units | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | |
| tsdCLK | SDCLK1, SDCLK2 period | 9.6 | — | 76.9 | 9.6 | — | 76.9 | 9.6 | — | 76.9 | ns | 1, 2 |
| tsdCMD | nSDCAS, nSDRAS, nWE, nSDCS assert time | 1 | — | 1 | 1 | — | 1 | 1 | — | 1 | SDCLK | — |
| tsdCAS | nSDCAS to nSDCAS assert time | 2 | — | — | 2 | — | — | 2 | — | — | SDCLK | — |
| tsdRCD | nSDRAS to nSDCAS assert time | 1 | MDCNFG [DTCx] | 3 | 1 | MDCNFG [DTCx] | 3 | 1 | MDCNFG [DTCx] | 3 | SDCLK | 6 |
| tsdRP | nSDRAS Pre charge | 2 | MDCNFG [DTCx] | 3 | 2 | MDCNFG [DTCx] | 3 | 2 | MDCNFG [DTCx] | 3 | SDCLK | 6 |
| tsdCL | nSDRAS to nSDCAS delay | 2 | MDCNFG [DTCx] | 3 | 2 | MDCNFG [DTCx] | 3 | 2 | MDCNFG [DTCx] | 3 | SDCLK | 6 |
| tsdRAS | nSDRAS active time | 3 | MDCNFG [DTCx] | 7 | 3 | MDCNFG [DTCx] | 7 | 3 | MDCNFG [DTCx] | 7 | SDCLK | 6 |
| tsdRC | nSDRAS cycle time | 4 | MDCNFG [DTCx] | 11 | 4 | MDCNFG [DTCx] | 11 | 4 | MDCNFG [DTCx] | 11 | SDCLK | 6 |
| tsdWR | write recovery time (time from last data in the PRECHARGE) | 2 | — | 2 | 2 | — | 2 | 2 | — | 2 | SDCLK | — |
| tsdSDOS | MA<24:10>, MD<31:0>, DQM<3:0>, nSDCS<3:0>, nSDRAS, nSDCAS, nWE, nOE, SDCKE1, RDnWR output setup time to SDCLK<2:1> rise | TBD | — | — | TBD | — | | TBD | — | — | ns | — |
| tsdSDOH | MA<24:10>, MD<31:0>, DQM<3:0>, nSDCS<3:0>, nSDRAS, nSDCAS, nWE, nOE, SDCKE1, RDnWR output hold time from SDCLK<2:1> rise | TBD | — | — | TBD | — | | TBD | — | — | ns | — |
| | | VCC_CORE = 0.85 V +/– 10%, with 1.71 V<= VCC_MEM <= 3.63 V | | | VCC_CORE = 1.1 V +/– 10%, with 1.71 V <= VCC_MEM <= 3.63 V | | | VCC_CORE = 1.3 V +/– 10%, with 1.71 V <= VCC_MEM <= 3.63 V | | | | |

### Table 6-15. SDRAM Interface AC Specifications (Sheet 2 of 2)

| Symbols | Parameters | VCC_MEM = 1.8V +20% / –5%[3] | | | VCC_MEM = 2.5V +/- 10%[4] | | | VCC_MEM = 3.3V +/- 10%[5] | | | Units | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | |
| tsdSDIS | MD<31:0> read data input setup time from SDCLK<2:1> rise | TBD | — | — | 0.5 | — | — | 0.5 | — | — | ns | — |
| tsdSDIH | MD<31:0> read data input hold time from SDCLK<2:1> rise | TBD | — | — | 1.8 | — | — | 1.8 | — | — | ns | — |

**NOTES:**
1. SDCLK for SDRAM slowest period is accomplished by divide-by-2 of the 26-MHz CLK_MEM. The fastest possible SDCLK is accomplished by configuring CLK_MEM at 104 MHz and not setting MDREFR[KxDB2].
2. SDCLK1 and SDCLK2 frequencies are configured to be CLK_MEM frequency divided by 1 or 2, depending on the bit fields MDREFR[K1DB2] and MDREFR[K2DB2] settings.
3. These numbers are for VCC_MEM = 1.8 V +20% / –5%, VOL = 0.4 V, and VOH = 1.4 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCNTRP and BSCNTRN) set to TBD (msb:lsb) and each applicable SDCLK<2:1> divide-by-2 and divide-by-4 register bits MDREFR[KxDB2] clear.
4. These numbers are for VCC_MEM = 2.5 V +/– 10%, VOL = 0.4 V, and VOH = 2.1 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCNTRP and BSCNTRN) set to 0b1010 (msb:lsb) and each applicable SDCLK<2:1> divide-by-2 and divide-by-4 register bit MDREFR[KxDB2] clear.
5. These numbers are for VCC_MEM = 3.3 V +/– 10%, VOL = 0.4 V, and VOH = 2.4 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCNTRP and BSCNTRN) set to 0b1010 (msb:lsb) and each applicable SDCLK<2:1> divide-by-2 and divide-by-4 register bit MDREFR[KxDB2] clear.
6. Refer to the “Memory Controller” chapter in the *Intel® PXA27x Processor Family Developer’s Manual* for register configuration.

**Figure 6-7. SDRAM Timing**

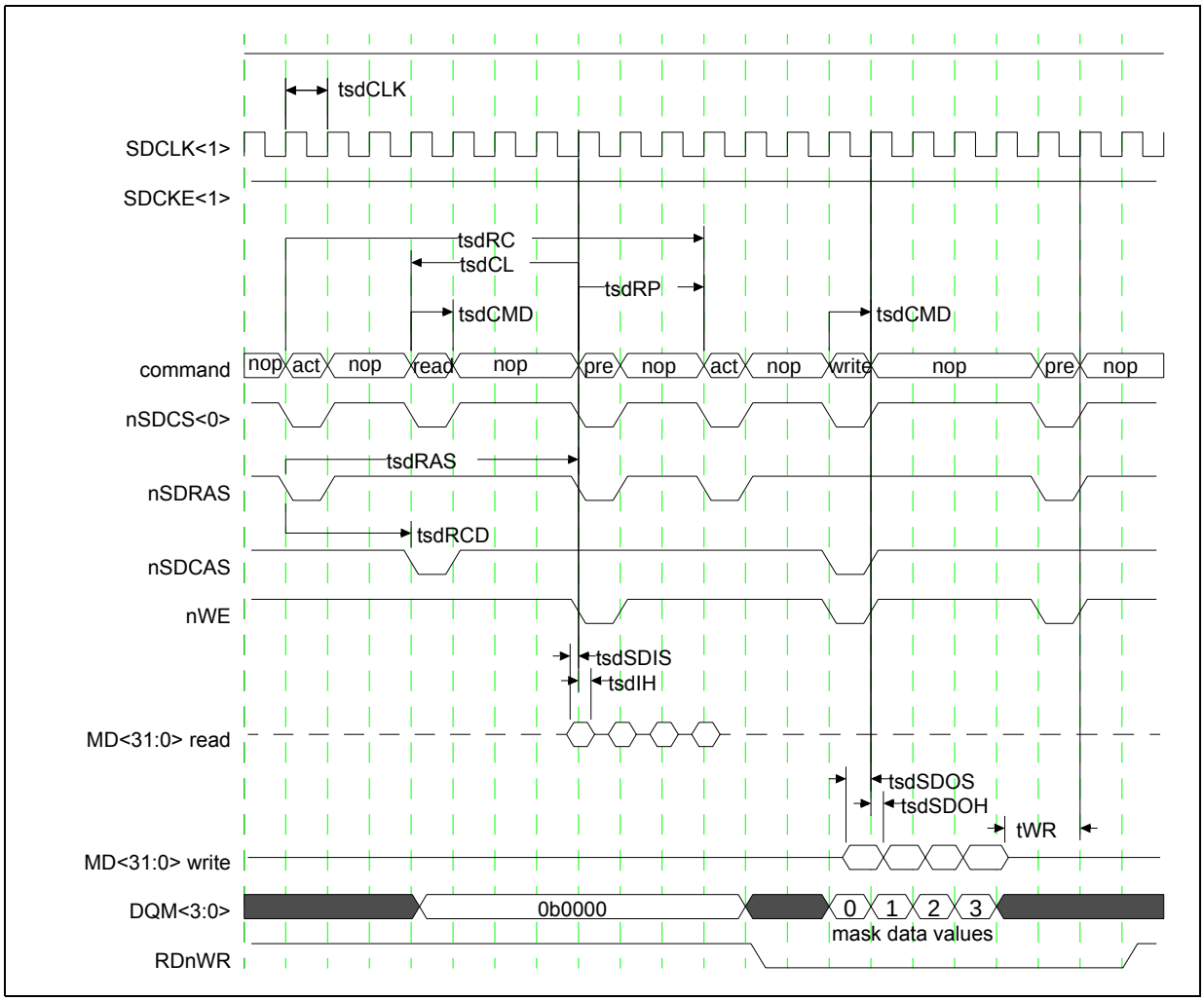
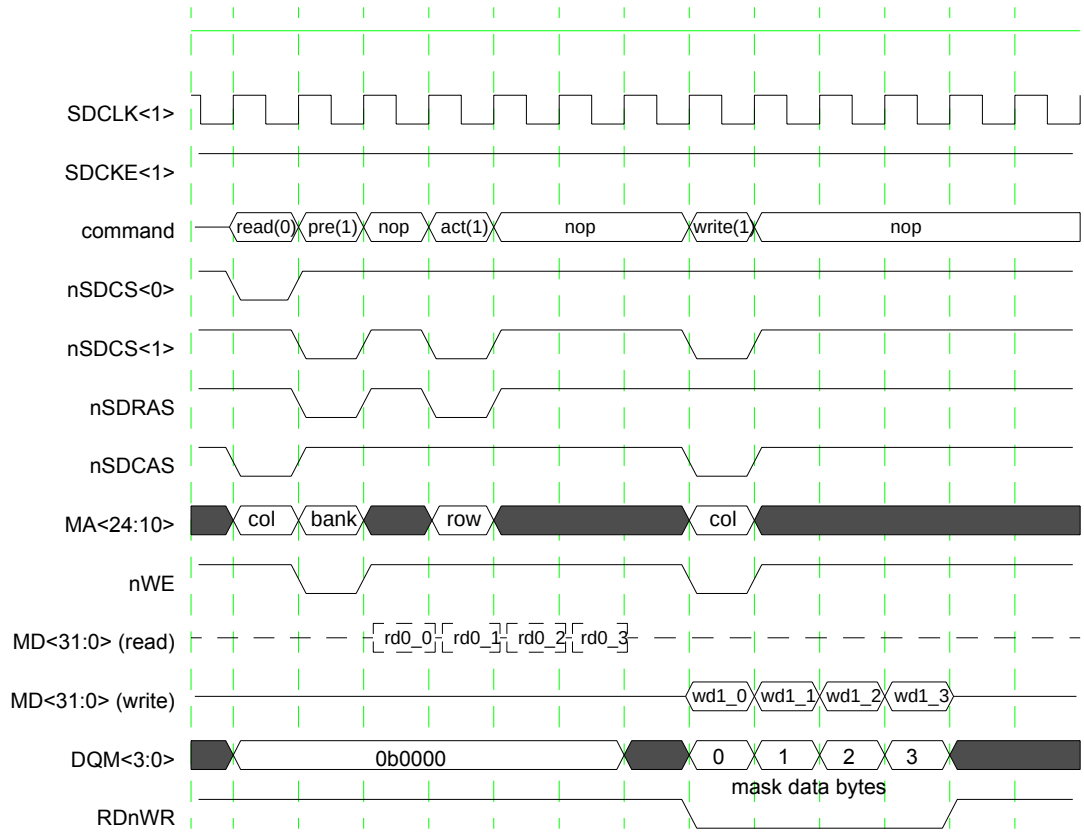


**Figure 6-8. SDRAM 4-Beat Read/4-Beat Write, Different Banks Timing**




**NOTES:**

1. MDCNFG[DTC] = 0b00 (CL = 2, tRP = 2 clk, tRCD = 1 clk), MDCNFG[STACK] = 0b00
2. See the SDRAM timing diagram.

**Figure 6-9. SDRAM 4-Beat Write/4-Beat Write, Same Bank-Same Row Timing**

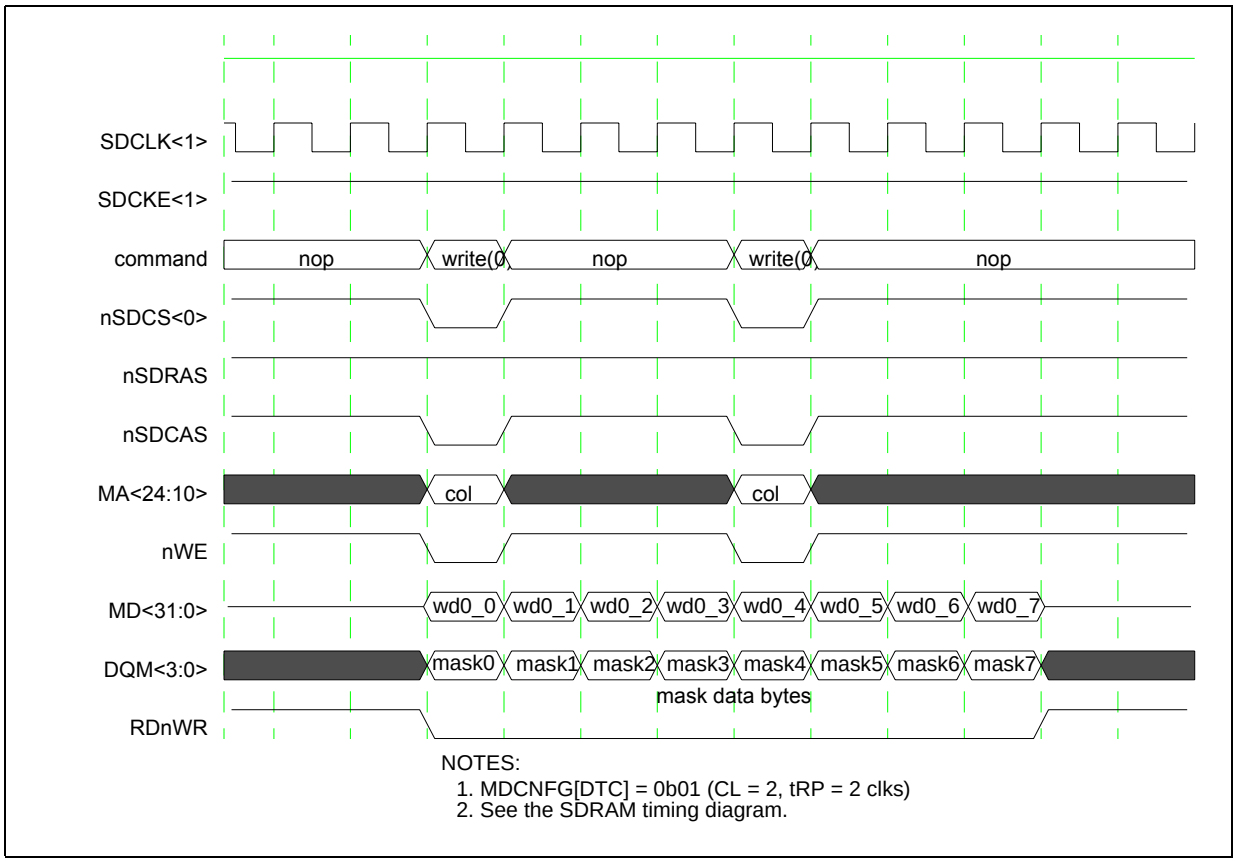
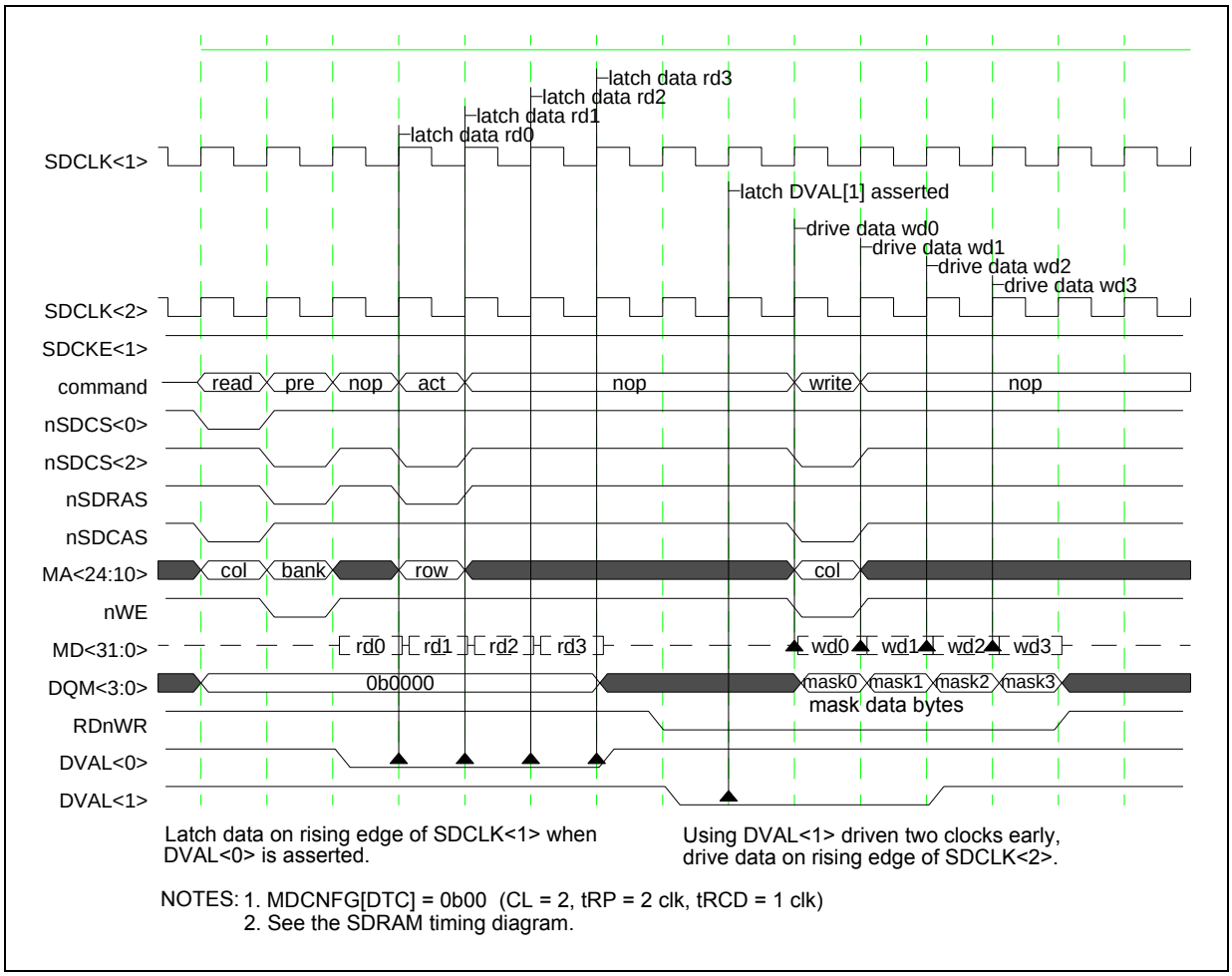


**Figure 6-10. SDRAM Fly-by DMA Timing**




NOTES: 1. MDCNFG[DTC] = 0b00 (CL = 2, tRP = 2 clk, tRCD = 1 clk)
2. See the SDRAM timing diagram.

## 6.4.3 ROM Parameters and Timing Diagrams

Table 6-16 lists the timings for ROM reads. See Figure 6-11, Figure 6-12, Figure 6-13, and Figure 6-14 for timings diagrams representing burst and non-burst ROM reads.

***Note:*** Table 6-16 lists programmable register items. See the "Memory Controller" chapter in the *Intel® PXA27x Processor Family Developer's Manual* for register configurations for more information on these items.

**Table 6-16. ROM AC Specification (Sheet 1 of 2)**

| Symbols | Parameters | MIN | TYP | MAX | Units† | Notes |
|---|---|---|---|---|---|---|
| tromAS | Address setup to nCS assert | 1 | — | 1 | clk_mem | — |
| tromCES | nCS setup to nOE asserted | — | — | 0 | clk_mem | — |
| tromCEH | nCS hold from nOE deasserted | — | — | 0 | clk_mem | — |
| tromDSOH | MD setup to address valid | 1.5 | — | — | clk_mem | — |

### Table 6-16. ROM AC Specification (Sheet 2 of 2)

| Symbols | Parameters | MIN | TYP | MAX | Units† | Notes |
|---|---|---|---|---|---|---|
| tromDOH | MD hold from address valid | 0 | — | — | clk_mem | — |
| tromAVDVF | Address valid to data valid for the first read access | 2 | MSCx[RDF]+2 | 32 | clk_mem | — |
| tromAVDVS | Address valid to data valid for subsequent reads of non-burst devices | 1 | MSCx[RDF]+1 | 31 | clk_mem | — |
| tflashAVDVS | Address valid to data valid for subsequent reads of burst devices | 1 | MSCx[RDN]+1 | 31 | clk_mem | — |
| tromCD | nCS deasserted after a read of next nCS or nSDCS asserted (minimum) | 1 | MSCx[RRR]*2+1 | 15 | clk_mem | — |

† Numbers shown as integer multiples of the clk_mem period are ideal. Actual numbers vary with pin-to-pin differences in loading and transition direction (rise or fall). For more information, refer to the “Memory Control” chapter in the *Intel® PXA27x Processor Family Developer’s Manual*.

### Figure 6-11. 32-Bit Non-burst ROM, SRAM, or Flash Read Timing

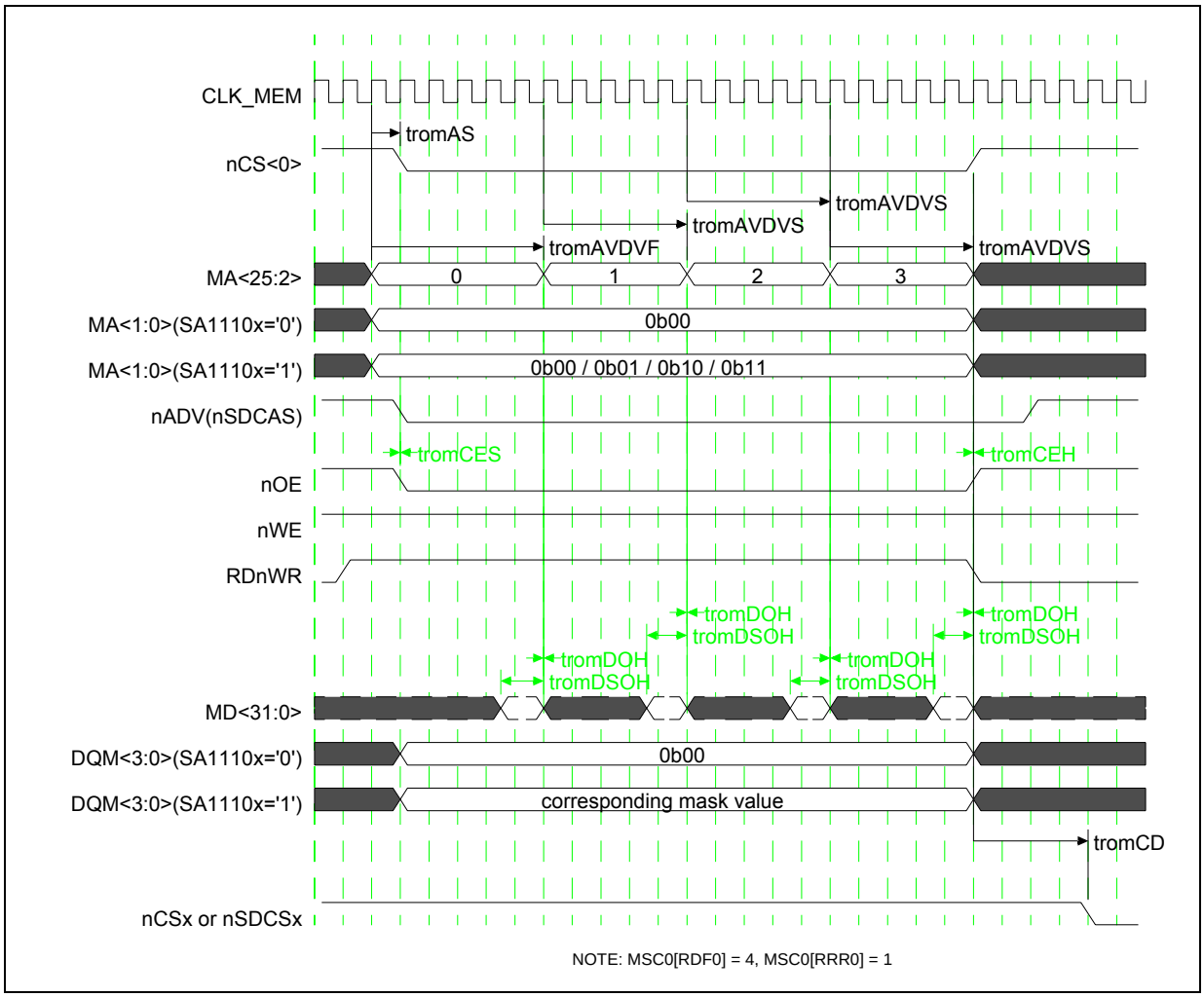
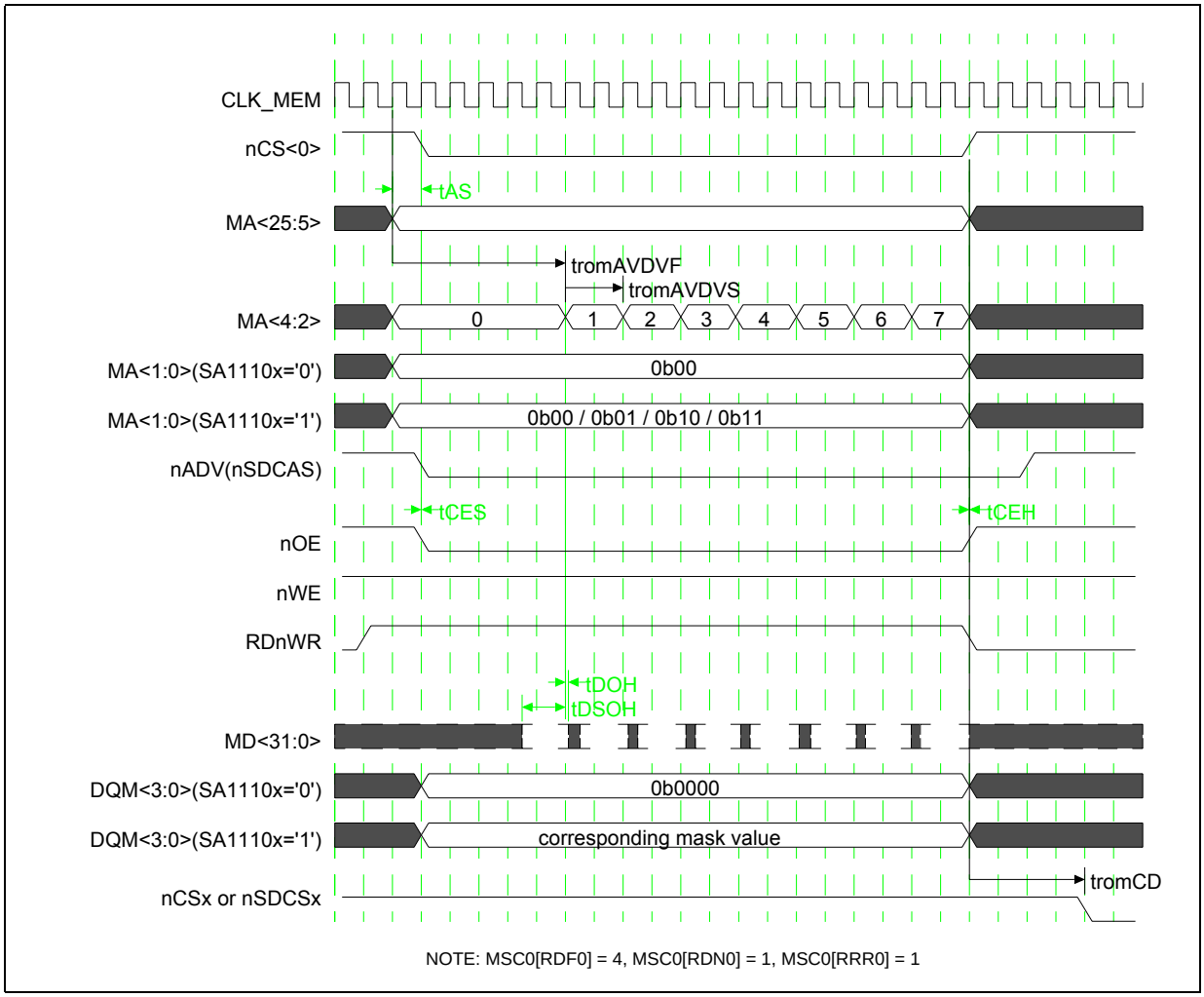


**Figure 6-12. 32-Bit Burst-of-Eight ROM or Flash Read Timing**




NOTE: MSC0[RDF0] = 4, MSC0[RDN0] = 1, MSC0[RRR0] = 1

### Figure 6-13. Eight-Beat Burst Read from 16-Bit Burst-of-Four ROM or Flash Timing

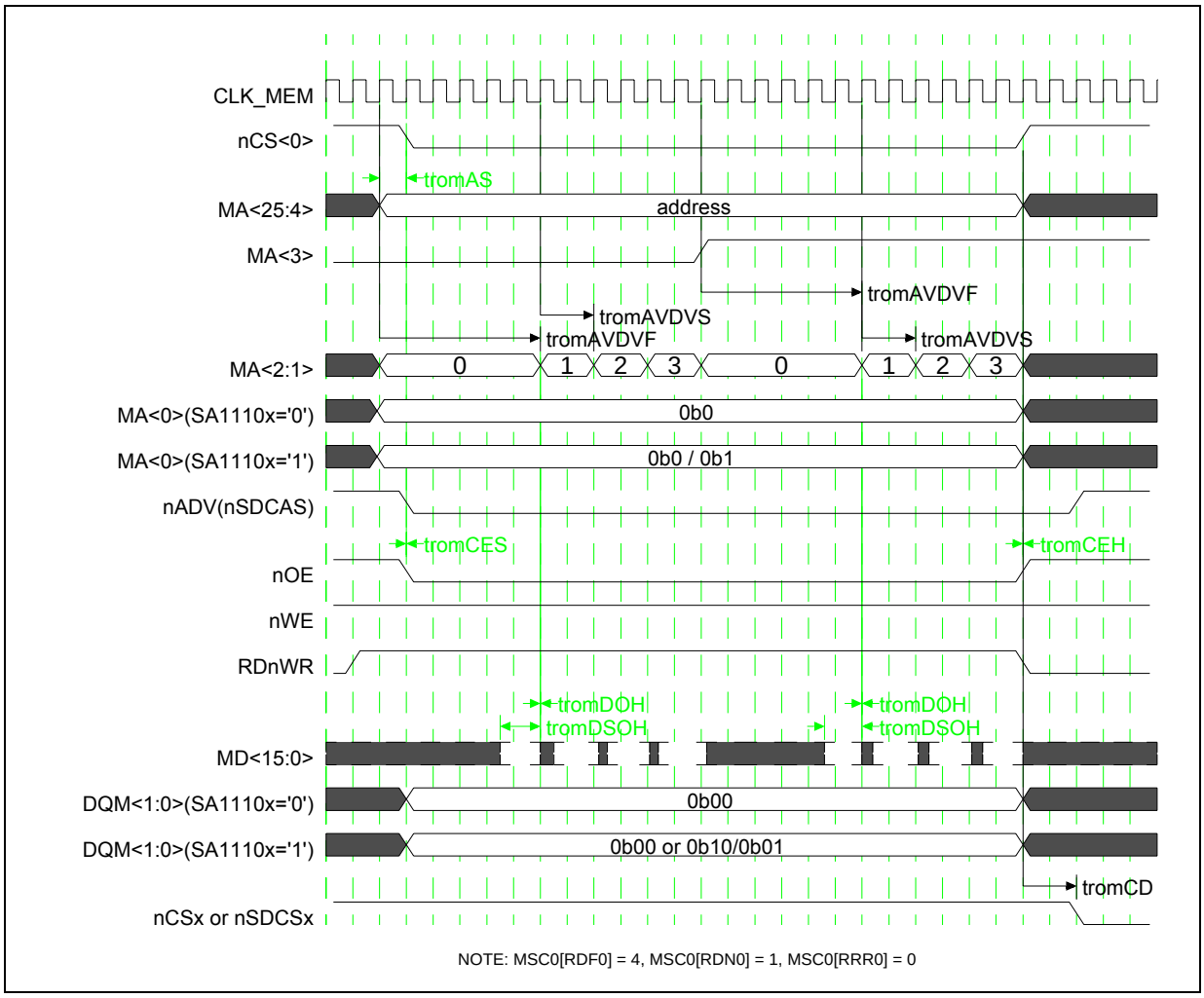
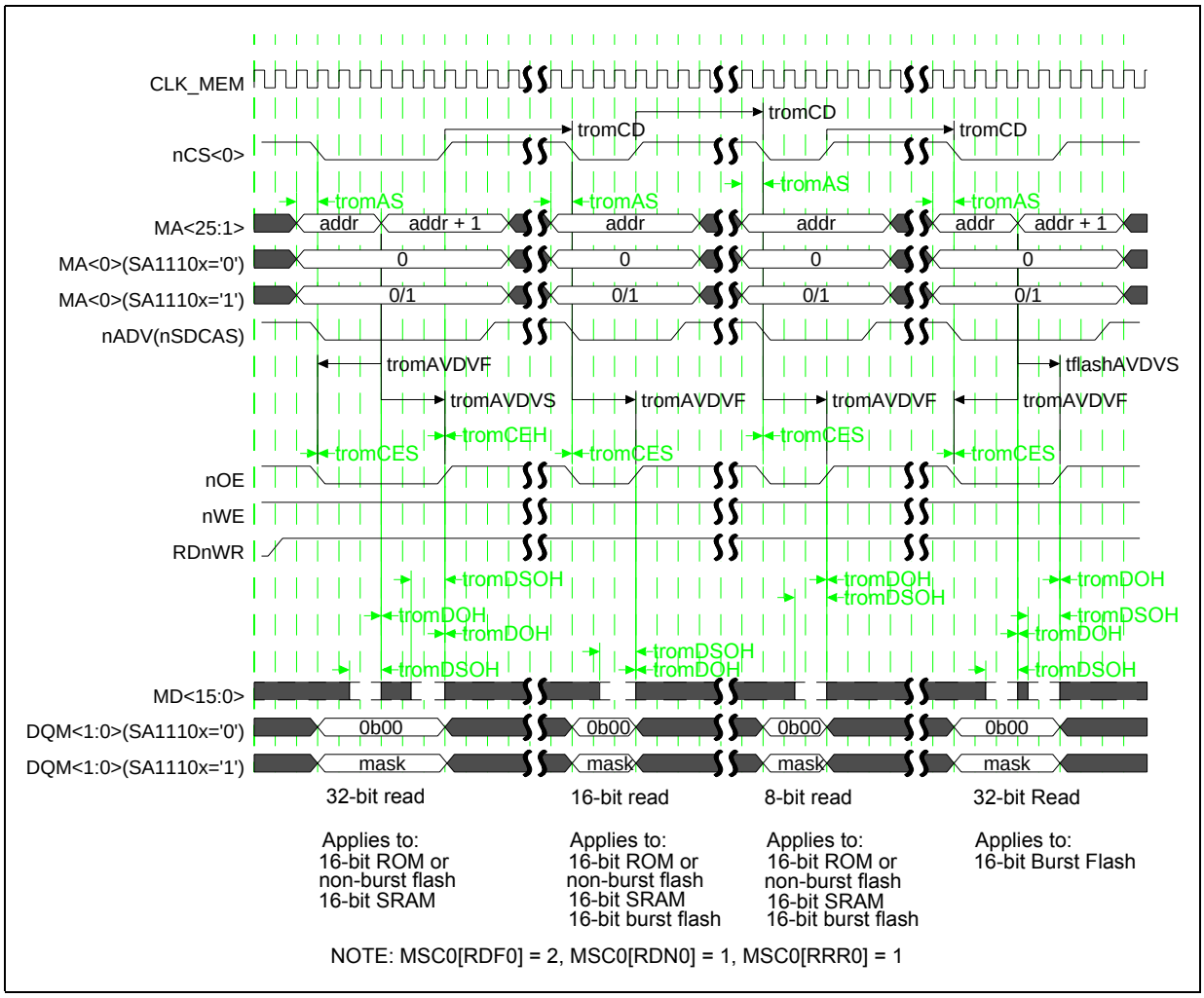


**Figure 6-14. 16-bit ROM/Flash/SRAM Read for 4/2/1 Bytes Timing**




## 6.4.4 Flash Memory Parameters and Timing Diagrams

The following sections describe the read/write parameters and timing diagrams for asynchronous and synchronous flash-memory interfaces with the memory controller.

### 6.4.4.1 Flash Memory Read Parameters and Timing Diagrams

Section 6.4.4.1.1 describes asynchronous flash reads. Section 6.4.4.1.2 describes synchronous flash reads.

#### 6.4.4.1.1 Asynchronous Flash Read Parameters and Timing Diagrams

The timings listed in Table 6-16 for ROM reads also apply to asynchronous flash reads. See Figure 6-11, Figure 6-12, Figure 6-13, and Figure 6-14 for timings diagrams representative of an asynchronous flash read.

#### 6.4.4.1.2 Synchronous Flash Read Parameters and Timing Diagrams

Table 6-17 lists the timing parameters used in Figure 6-15, and, for stacked flash packages, Figure 6-16.

**Table 6-17. Synchronous Flash Read AC Specifications (Sheet 1 of 2)**

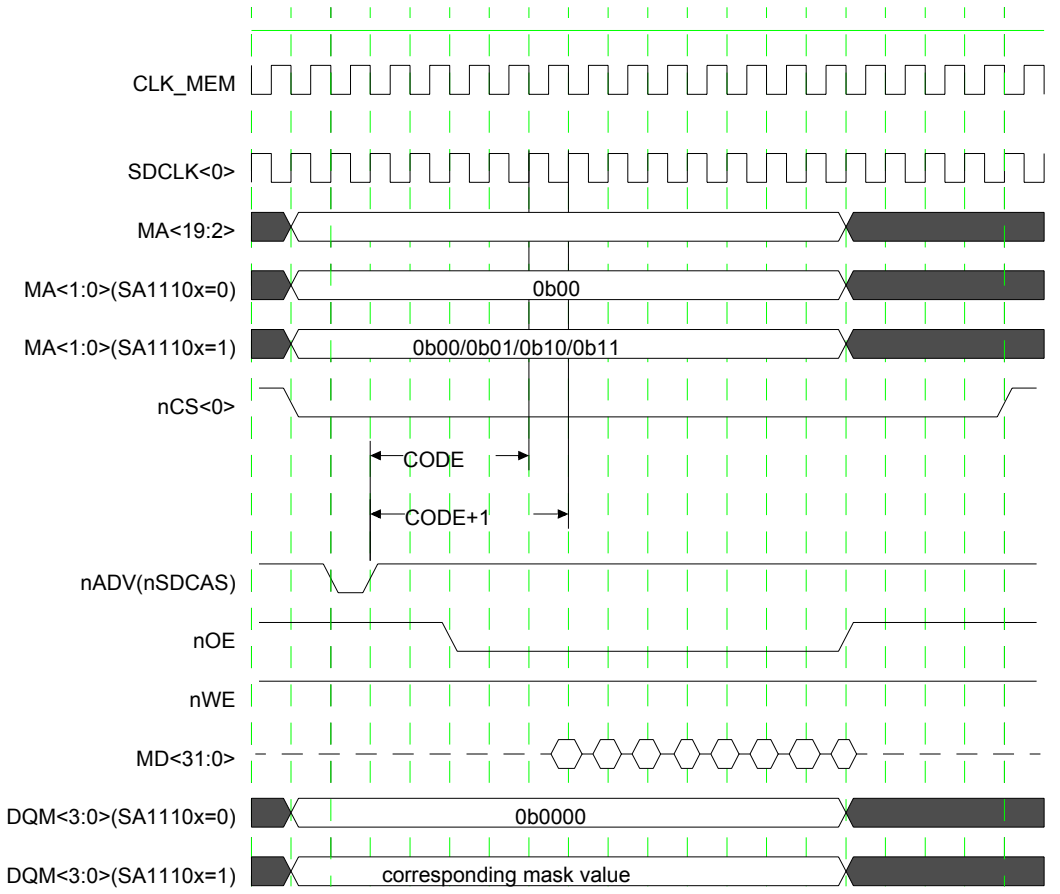
| Symbols | Parameters | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | Units | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Divide by 1[2] | | | Divide by 2[3] | | | Divide by 4[4] | | | | |
| tffCLK | SDCLK0 period | 9.6 | — | 38.5 | 19.2 | — | 76.9 | 38.5 | — | 154 | ns | 1 |
| tffAS | MA<25:0> setup to nSDCAS (as nADV) asserted | 1 | — | 1 | 1 | — | 2 | 1 | — | 4 | CLK_MEM | — |
| tffCES | nCS setup to nSDCAS (as nADV) asserted | 1 | — | 1 | 1 | — | 2 | 1 | — | 4 | CLK_MEM | — |
| tffADV | nSDCAS (as nADV) pulse width | 1 | — | 1 | 3 | — | 3 | 7 | — | 7 | CLK_MEM | — |
| tffOS | nSDCAS (as nADV) deassertion to nOE assertion | 1 | FCC – 1 (for FCC<5) FCC – 2 (for FCC>=5) | 13 | 2 | (FCC – 1) * 2 (for FCC<5) (FCC – 2) * 2 (for FCC>=5) | 26 | 7 | (FCC * 4) – 7 (for FCC<5) (FCC – 2) * 4 (for FCC>=5) | 52 | CLK_MEM | 5 |
| tffCEH | nOE deassertion to nCS deassertion | 4 | — | 4 | 8 | — | 8 | 16 | — | 16 | CLK_MEM | — |
| tffDS | CLK to data valid | 2 | FCC | 15 | 2 | FCC | 15 | 2 | FCC | 15 | CLK_MEM | 5 |
| | | VCC_MEM = 1.8V +20% / -5%[6] | | | VCC_MEM = 2.5V +/- 10%[7] | | | VCC_MEM = 3.3V +/- 10%[8] | | | | |
| tffSDOS | MA<25:0>, MD<31:0>, DQM<3:0>, nCS<3:0>, nSDCAS (nADV), nWE, nOE, RDnWR output setup time to SDCLK<2:1> rise | TBD | — | — | TBD | — | — | TBD | — | — | ns | — |
| tffSDOH | MA<25:0>, MD<31:0>, DQM<3:0>, nCS<3:0>, nSDCAS (nADV), nWE, nOE, RDnWR output hold time from SDCLK<2:1> rise | TBD | — | — | TBD | — | — | TBD | — | — | ns | — |
| | | VCC_CORE = 0.85 V +/– 10%, with 1.71 V<= VCC_MEM <= 3.63 V | | | VCC_CORE = 1.1 V +/– 10%, with 1.71 V <= VCC_MEM <= 3.63 V | | | VCC_CORE = 1.3 V +/– 10%, with 1.71 V <= VCC_MEM <= 3.63 V | | | | |

### Table 6-17. Synchronous Flash Read AC Specifications (Sheet 2 of 2)

| Symbols | Parameters | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | Units | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tffSDIS | MD<31:0> read data input setup time from SDCLK<2:0> rise | TBD | — | — | 0.5 | — | — | 0.5 | — | — | ns | — |
| tffSDIH | MD<31:0> read data input hold time from SDCLK<2:0> rise | TBD | — | — | 1.8 | — | — | 1.8 | — | — | ns | — |

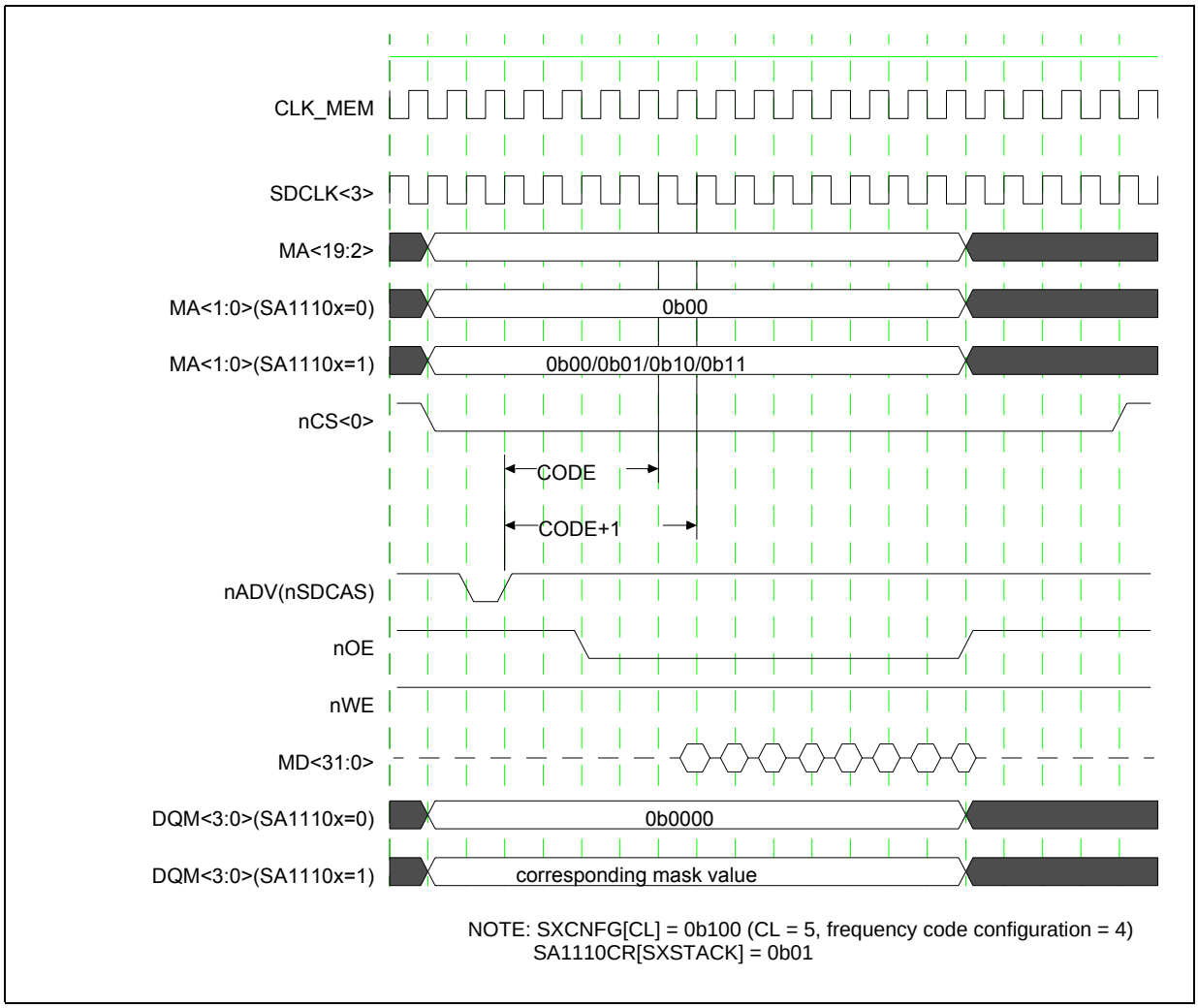
**NOTES:**
1. SDCLK0 may be configured to be CLK_MEM divided by 1, 2 or 4. SDCLK0 for synchronous flash memory can be at the slowest, divide-by-4 of the 26-MHz CLK_MEM. The fastest possible SDCLK0 is accomplished by configuring CLK_MEM at 104 MHz and clearing the MDREFR[K0DB2] or MDREFR[K0DB4] bit fields.
2. SDCLK0 frequency equals CLK_MEM frequency (MDREFR[K0DB4] and MDREFR[K0DB2] bit fields are clear)
3. SDCLK0 frequency equals CLK_MEM/2 frequency (MDREFR[K0DB2] is set and MDREFR[K0DB4] is clear).
4. SDCLK0 frequency equals CLK_MEM/4 frequency (MDREFR[K0DB4] is set).
5. Use SXCNFG[SXCLx] to configure the value for the frequency configuration code (FCC).
6. These numbers are for VCC_MEM = 1.8 V +20% / -5%, VOL = 0.4 V, and VOH = 1.4 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCN TRP and BSCNTRN) set to TBD (msb:lsb) and each applicable SDCLK0 divide-by-2 and divide-by-4 register bits (MDREFR[K0DB2] and MDREFR[K0DB4]) clear. If MDREFR[K0DB2 is set, the corresponding output setup and hold times are increased and decreased, respectively, by 0.25 times the SDCLK0 period.
7. These numbers are for VCC_MEM = 2.5 V +/– 10%, VOL = 0.4 V, and VOH = 2.1 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCNTRP and BSCNTRN) set to 0b1010 (msb:lsb) and each applicable SDCLK0 divide-by-2 and divide-by-4 register bit (MDREFR[K0DB2] and MDREFR[K0DB4]) clear. If MDREFR[K0DB2 is set, the corresponding output setup and hold times are increased and decreased, respectively, by 0.25 times the SDCLK0 period.
8. These numbers are for VCC_MEM = 3.3 V +/– 10%, VOL = 0.4 V, and VOH = 2.4 V, with each applicable 4-bit field of the system memory buffer strength registers (BSCNTRP and BSCNTRN) set to 0b1010 (msb:lsb) and each applicable SDCLK0 divide-by-2 and divide-by-4 register bit (MDREFR[K0DB2] and MDREFR[K0DB4]) clear. If MDREFR[K0DB2 is set, the corresponding output setup and hold times are increased and decreased, respectively, by 0.25 times the SDCLK0 period.

### Figure 6-15. Synchronous Flash Burst-of-Eight Read Timing




NOTES: 1) SXCNFG[CL] = 0b100 (CL = 5, frequency code configuration = 4)
2) CODE = frequency configuration code

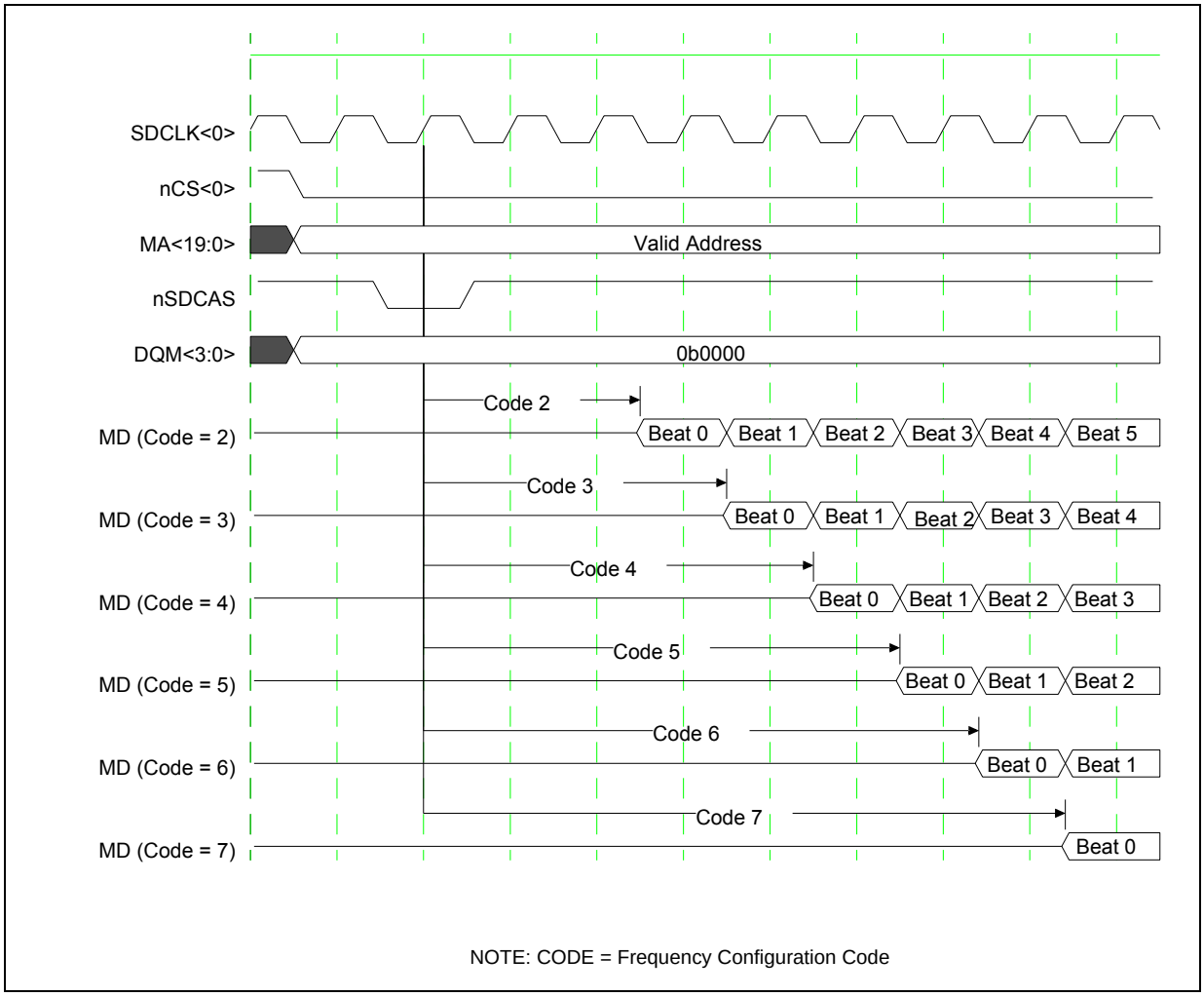
**Figure 6-16. Synchronous Flash Stacked Burst-of-Eight Read Timing**




NOTE: SXCNFG[CL] = 0b100 (CL = 5, frequency code configuration = 4)
SA1110CR[SXSTACK] = 0b01

Figure 6-17 indicates which clock data would be latched following the assertion of nSDCAS(ADV), depending on the configuration of the SXCNFG[SXCLx] bit field. The period in the diagram indicated by different frequency configuration codes (Fcodes or FCCs) is equal to the number of SDCLK0 cycles between the READ command and the clock edge on which data is driven onto the bus.

**Figure 6-17. First-Access Latency Configuration Timing**



The burst read example shown in Figure 6-18 represents waveforms that result when SXCNFG[SXCLx] is configured as 0b0100, representing a frequency configuration code equal to 3. The following example can be used to help determine the appropriate setting for SXCNFG[SXCLx].

Parameters defined by the processor:

- tffSDOH (max) = SDCLK<0> to CE# (nCE), ADV# (nADV), or address valid, whichever occurs last
- tffSDIS (min) = Data setup to SDCLK<0>

Parameters defined by flash memory:

- tVLQV (min) = ADV# low to output delay
- tVLCH (min) = ADV# low to clock
- tCHQV (max) = SDCLK<0> to output valid

Use the following equations when calculating the frequency configuration code:

```
(1) SDCLK period = (1 / frequency)
(2) n (SDCLK period) ≥ tVLQV - tVLCH - tCHQV
(3) n = (tVLQV - tVLCH - tCHQV) / SDCLK period, where
    n = frequency configuration code rounded up to integer value
(4) SDCLK period ≥ tCHQV + tffSDIS
```

### Example

The timing information below is only an example. See Table 6-17 for actual synchronous AC timings.

```
SDCLK<0> frequency = 50 MHz
tVLQV = 70 ns (typical timing from synchronous flash memory)
tVLCH = 10 ns (min)
tCHQV = 14 ns (min)
From Eq.(1):     1 / 50 (MHz) = 20 ns
From Eq.(2):     n(20 ns) ≥ 70 ns - 10 ns - 14 ns
                 n(20 ns) ≥ 46 ns
                 n = (46 / 20) ns = 2.3 ns
                 n = 3
```

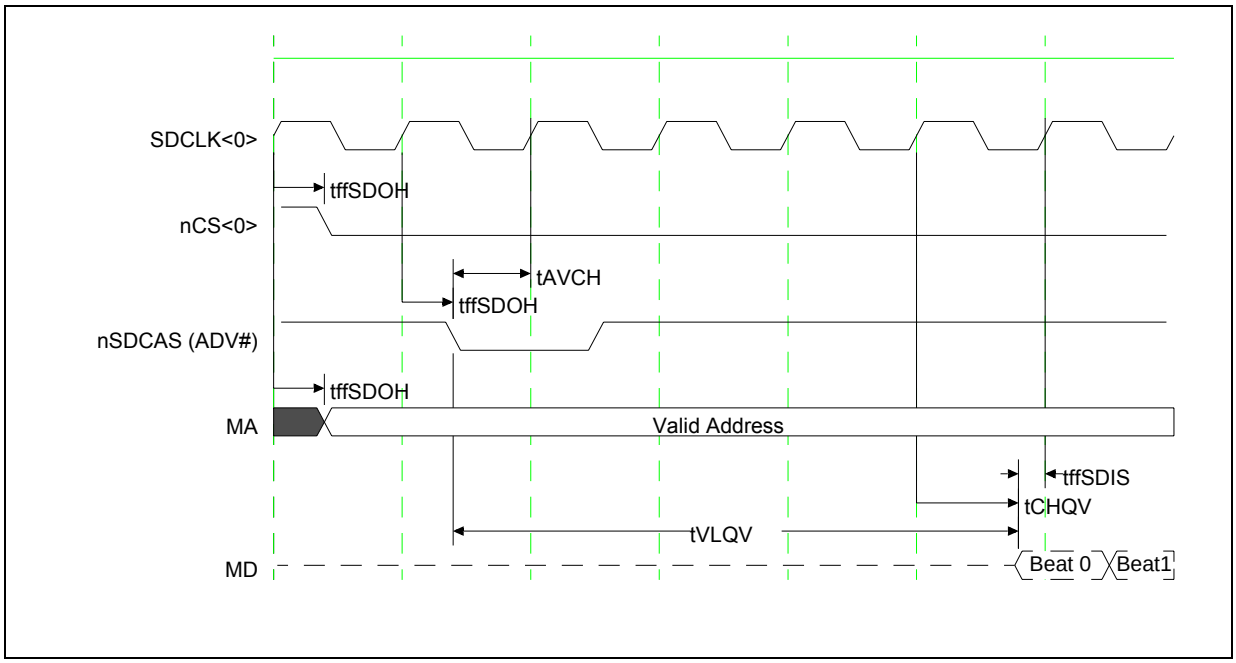
Use equation 4 to help verify the maximum possible frequency at which the synchronous flash memory can run with the memory controller. The following example uses equation 4:

```
SDCLK<0> frequency = 66 MHz
tCHQV = 11 ns (max)
tffSDIS = 3 ns (min)
From Eq. (1):    1 / 66 (MHz) = 15.15 ns
From Eq. (4):    15.15 ns ≥ 11 ns + 3 ns
                 15.15 ns ≥ 14 ns
```

The results from this example indicate that the 66-MHz memory works without problems with the memory controller.

***Note:*** All AC timings must be considered to avoid timing violations in the memory-to-memory-controller interface.

**Figure 6-18. Synchronous Flash Burst Read Example**




### 6.4.4.2 Flash Memory Write Parameters and Timing Diagrams

Table 6-18 lists the AC specification for both burst and non-burst flash writes shown in Figure 6-19 and, for stacked flash packages, Figure 6-20.

**Table 6-18. Flash Memory AC Specification (Sheet 1 of 2)**

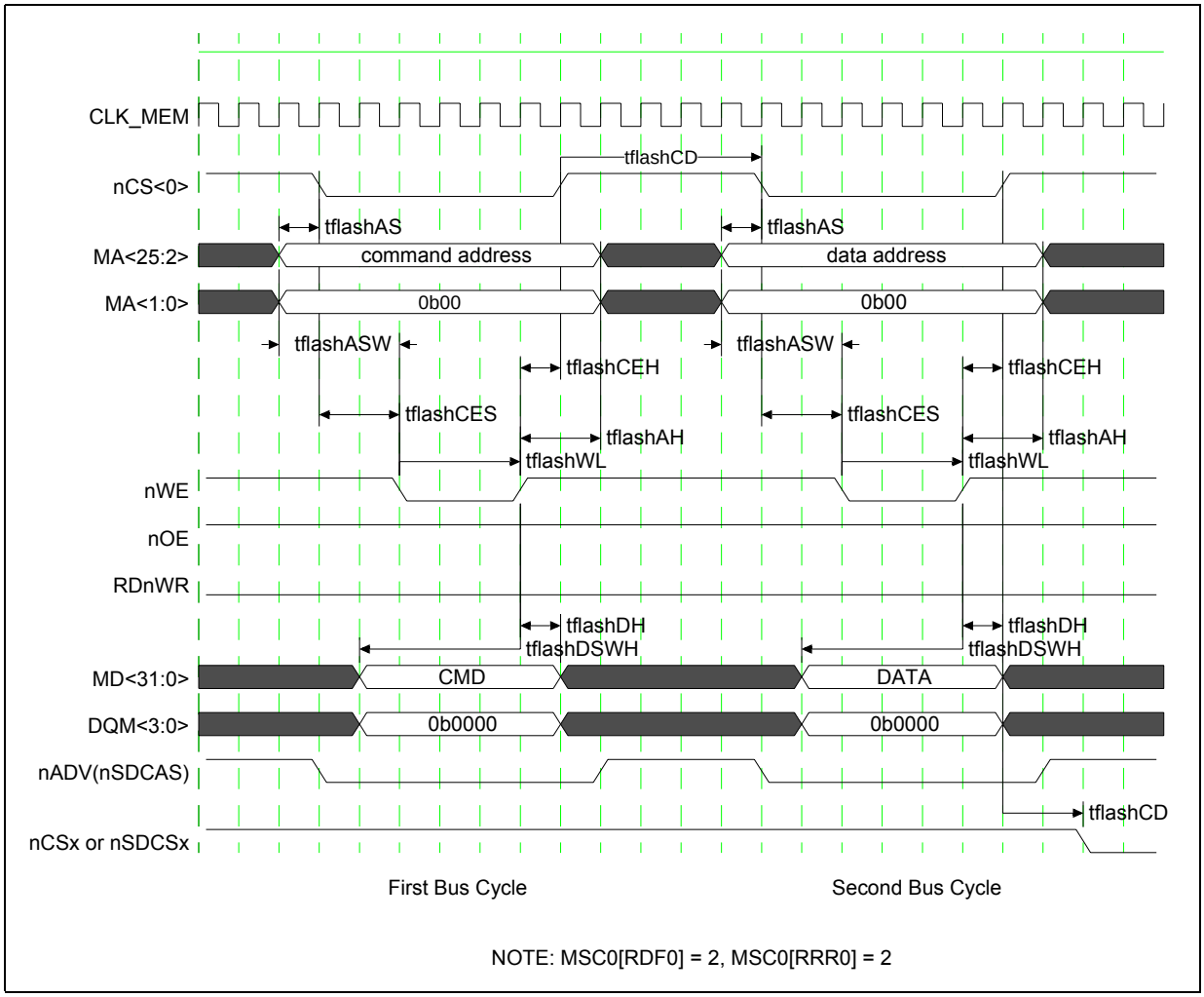
| Symbols | Parameters | MIN | TYP | MAX | Units[1] | Notes |
|---|---|---|---|---|---|---|
| tflashAS | Address setup to nCS assert | 1 | — | 1 | clk_mem | — |
| tflashAH | Address hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tflashASW | Address setup to nWE asserted | 1 | — | 3 | clk_mem | 2 |
| tflashCES | nCS setup to nWE asserted | 2 | — | 2 | clk_mem | — |
| tflashCEH | nCS hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tflashWL | nWE asserted time | 1 | MSCx[RDF]+1 | 31 | clk_mem | — |
| tflashDSWH | MD/DQM setup to nWE de-asserted | 2 | MSCx[RDF]+2 | 32 | clk_mem | — |
| tflashDH | MD/DQM hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tflashDSOH | MD setup to address valid | 1.5 | — | — | clk_mem | — |

### Table 6-18. Flash Memory AC Specification (Sheet 2 of 2)

| Symbols | Parameters | MIN | TYP | MAX | Units[1] | Notes |
|---|---|---|---|---|---|---|
| tflashDOH | MD hold from address valid | 0 | — | — | clk_mem | — |
| tflashCD | nCS de-asserted after a read/write to next nCS or nSDCS asserted (minimum) | 1 | MSCx[RRR]*2 + 1 | 15 | clk_mem | — |

**NOTES:**
1. Numbers shown as integer multiples of the CLK_MEM period are ideal. Actual numbers vary with pin-to-pin differences in loading and transition direction (rise or fall).
2. On the first data beat of burst transfer, the tflashASW is 3 CLK_MEM periods. On subsequent data beats, the tflashASW is 1 CLK_MEM period.

### Figure 6-19. 32-Bit Flash Write Timing




NOTE: MSC0[RDF0] = 2, MSC0[RRR0] = 2

### Figure 6-20. 32-Bit Stacked Flash Write Timing

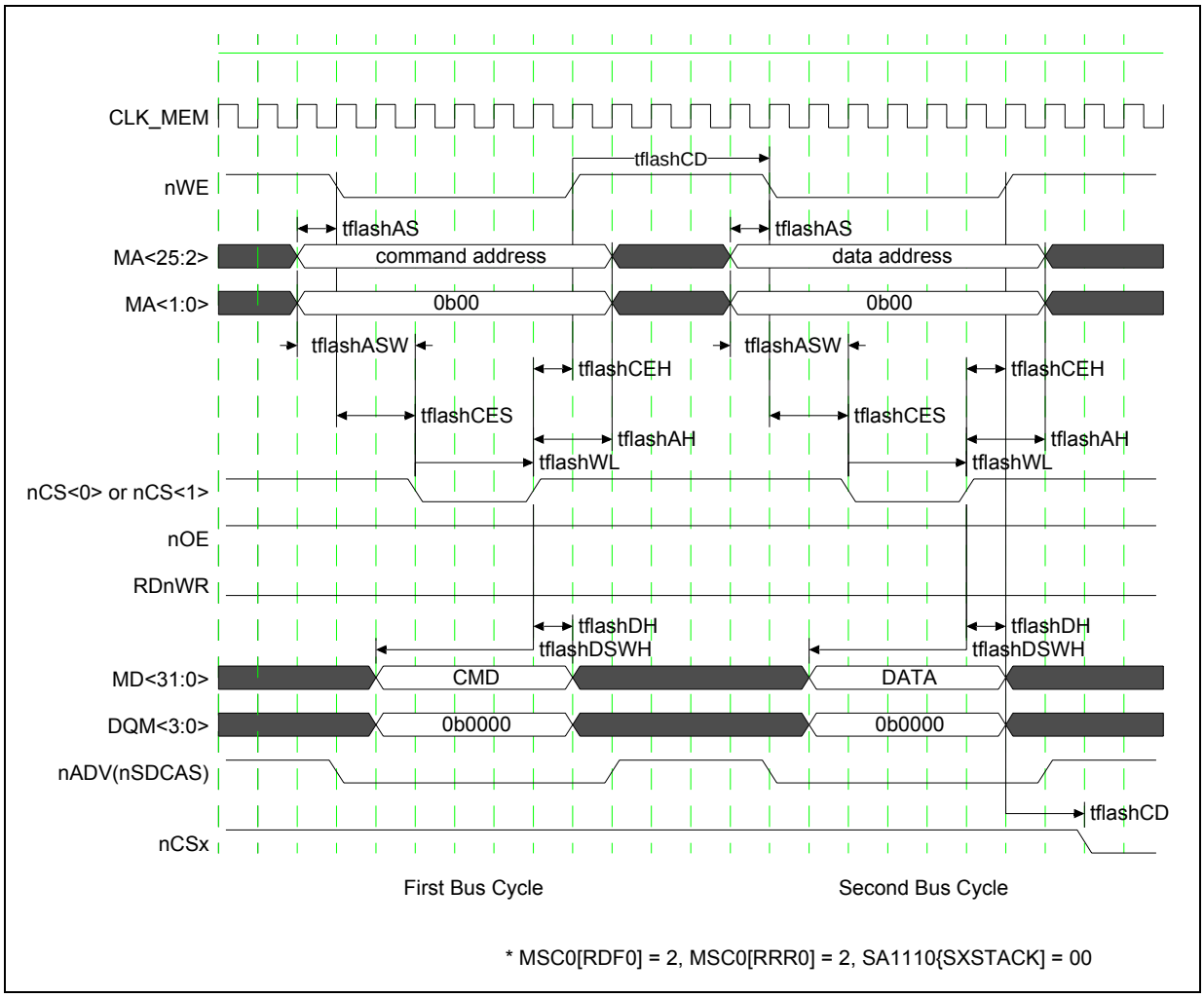
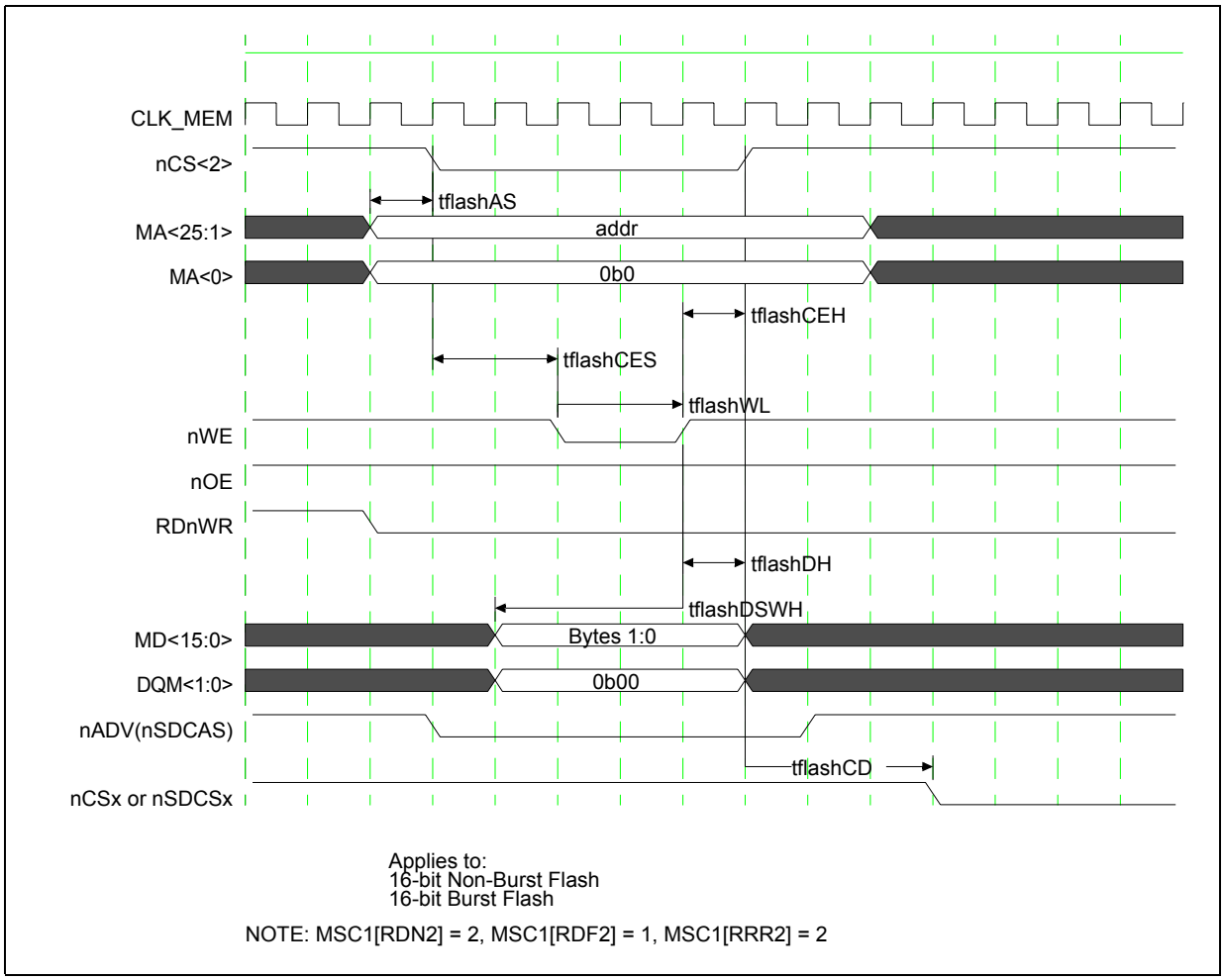


**Figure 6-21. 16-Bit Flash Write Timing**




## 6.4.5 SRAM Parameters and Timing Diagrams

The following sections describe the read/write parameters and timing diagrams for SRAM interfaces with the memory controller.

### 6.4.5.1 SRAM Read Parameters and Timing Diagrams

The timing for a read access is identical to that for a non-burst ROM read (see Figure 6-11). The timings listed in Table 6-16 for ROM reads are also used for SRAM reads. See Figure 6-11 and Figure 6-14 for timings diagrams representing 16-bit SRAM transferring four, two, and one byte(s) during read-bus tenures.

### 6.4.5.2 SRAM Write Parameters and Timing Diagrams

Figure 6-22 and Figure 6-23 show the timing for 32-bit and 16-bit SRAM writes. Table 6-19 lists the timings used in Figure 6-22 and Figure 6-23.

During writes, data pins are actively driven by the processor and are not three-stated, regardless of the states of the individual DQM signals. For SRAM writes, the DQM signals are used as byte enables.

***Note:*** Table 6-19 lists programmable register items. See the "Memory Controller"chapter in the *Intel® PXA27x Processor Family Developer's Manual* for register configurations for more information on these items.

### Table 6-19. SRAM Write AC Specification

| Symbols | Parameters | MIN | TYP | MAX | Units[1] | Notes |
|---|---|---|---|---|---|---|
| tsramAS | Address setup to nCS assert | 1 | — | 1 | clk_mem | — |
| tsramAH | Address hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tsramASW | Address setup to nWE asserted | 1 | — | 3 | clk_mem | 2 |
| tsramCES | nCS setup to nWE asserted | 2 | — | 2 | clk_mem | — |
| tsramCEH | nCS hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tsramWL | nWE asserted time | 1 | MSCx[RDN]+1 | 31 | clk_mem | — |
| tsramDSWH | MD/DQM setup to nWE de-asserted | 2 | MSCx[RDN]+2 | 32 | clk_mem | — |
| tsramDH | MD/DQM hold from nWE de-asserted | 1 | — | 1 | clk_mem | — |
| tramCD | nCS de-asserted after a read to next nCS or nSDCS asserted (minimum) | 1 | MSCx[RRR]*2+1 | 15 | clk_mem | — |

**NOTES:**
1. Numbers shown as integer multiples of the CLK_MEM period are ideal. Actual numbers vary with pin-to-pin differences in loading and transition direction (rise or fall).
2. On the first data beat of burst transfer, the tsramASW is 3 CLK_MEM periods. On subsequent data beats, the tsramASW is 1 CLK_MEM period.

**Figure 6-22. 32-Bit SRAM Write Timing**

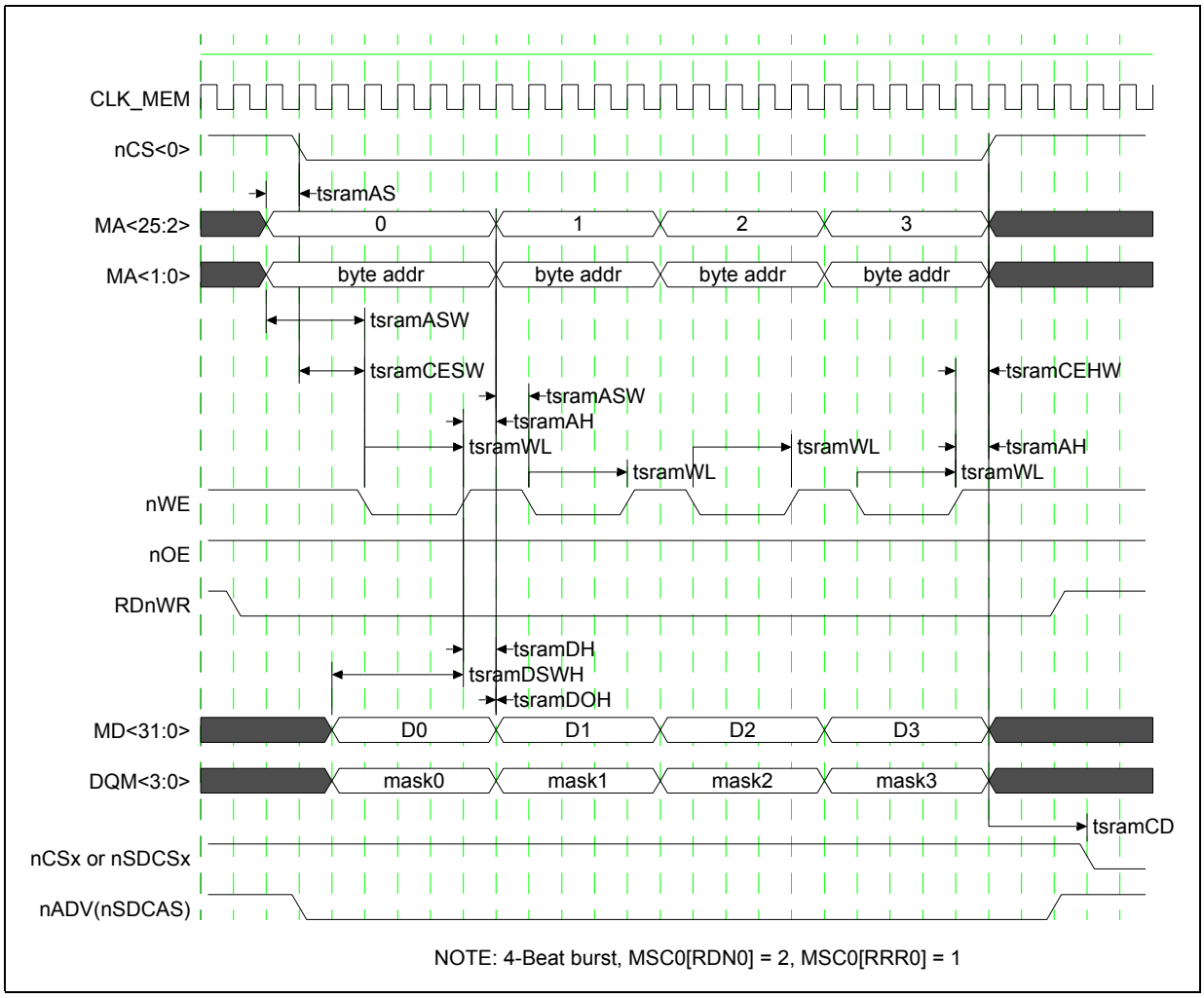
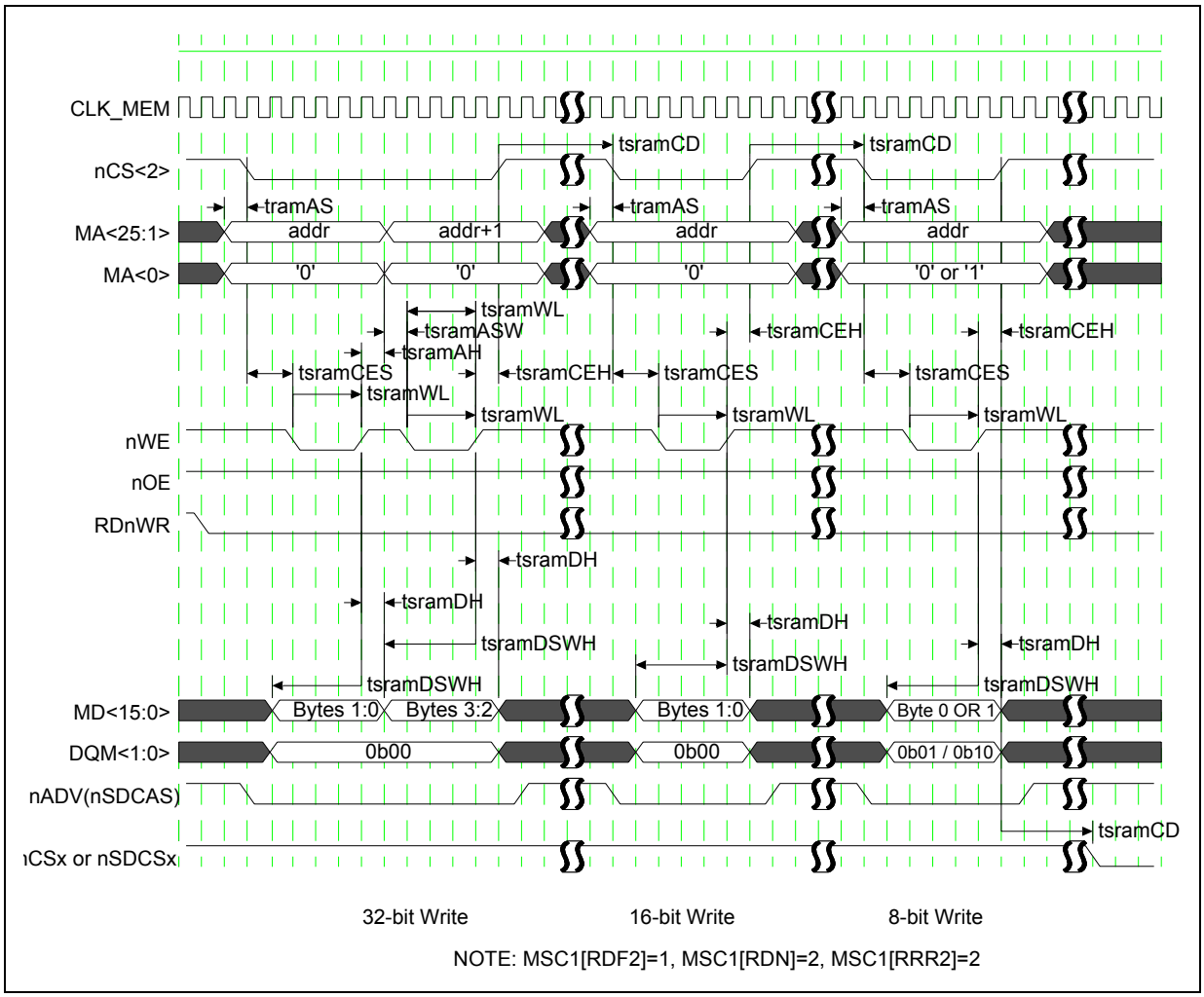


**Figure 6-23. 16-bit SRAM Write for 4/2/1 Byte(s) Timing**




## 6.4.6 Variable-Latency I/O Parameters and Timing Diagrams

The following sections describe the read/write parameters and timing diagrams for VLIO memory interfaces with the memory controller.

Table 6-20 lists the timing-information references for both the read and the write timing diagrams.

***Note:*** Table 6-20 lists programmable register items. For more information on these items, see the "Memory Controller" chapter in the *Intel® PXA27x Processor Family Developer's Manual* for register configurations.

### Table 6-20. VLIO Timing

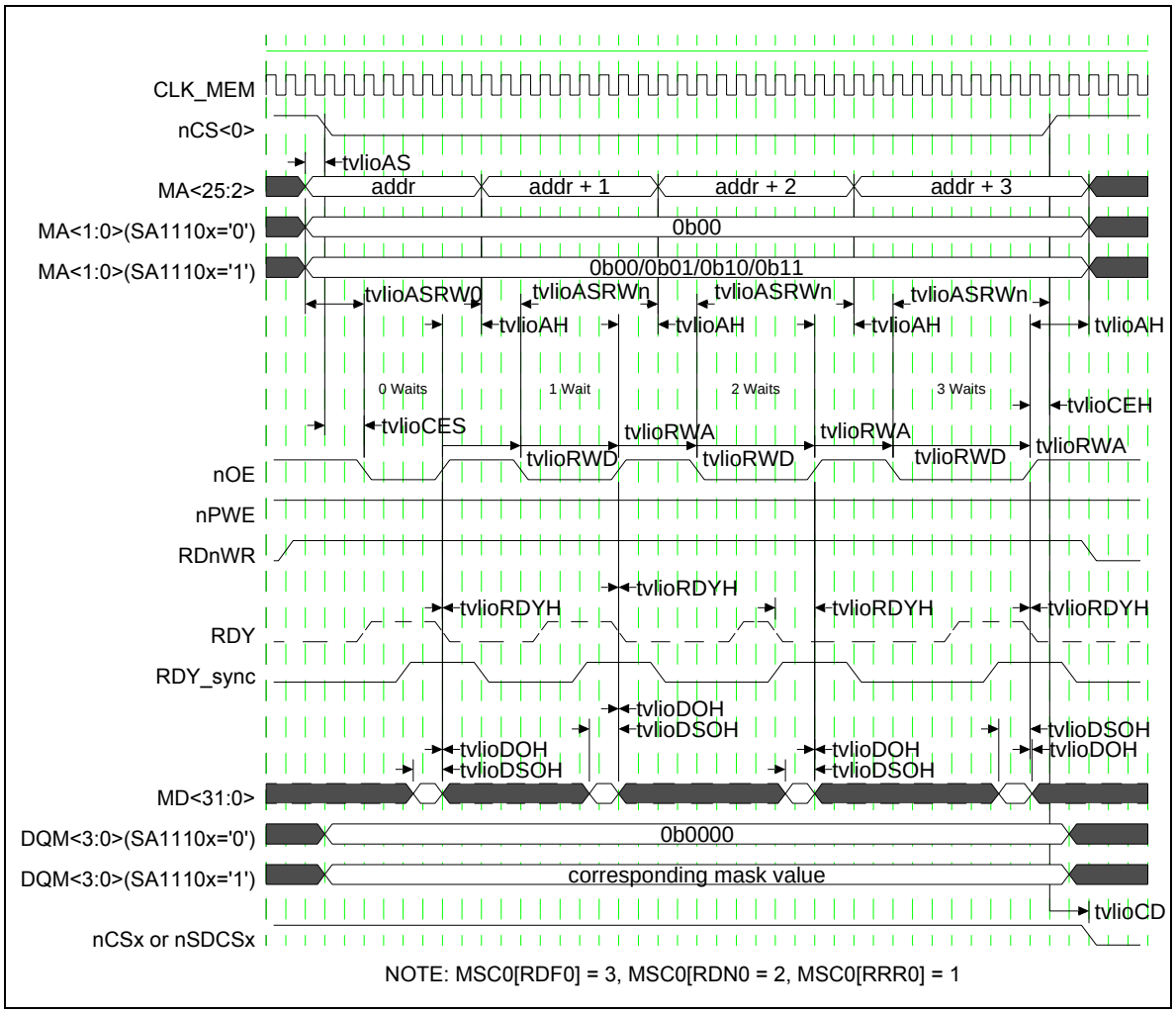
| Symbols | Parameters | MIN | TYP | MAX[2] | Units[1] | Notes |
|---|---|---|---|---|---|---|
| tvlioAS | Address setup to nCS asserted | 1 | — | 1 | clk_mem | — |
| tvlioAH | Address hold from nPWE/nOE de-asserted | 2 | MSCx[RDN] | 30 | clk_mem | — |
| tvlioASRW0 | Address setup to nPWE/nOE asserted (1st access) | 3 | — | 3 | clk_mem | — |
| tvlioASRWn | Address setup to nPWE/nOE asserted (next access(es)) | 2 | MSCx[RDN] | 30 | clk_mem | — |
| tvlioCES | nCS setup to nPWE/nOE asserted | 2 | — | 2 | clk_mem | — |
| tvlioCEH | nCS hold from nPWE/nOE de-asserted | 1 | — | 1 | clk_mem | — |
| tvlioDSWH | MD/DQM setup (minimum) to nPWE de-asserted | 5 | MSCx[RDF]+2 | 32 | clk_mem | — |
| tvlioDH | MD/DQM hold from nPWE de-asserted | 1 | — | 1 | clk_mem | — |
| tvlioDSOH | MD setup to address changing | 1.5 | | — | clk_mem | — |
| tvlioDOH | MD hold from address changing | 0 | | — | ns | — |
| tvlioRDYH | RDY hold from nPWE/nOE de-asserted | 0 | — | — | ns | — |
| tvlioRWA | nPWE/nOE assert period between writes | 4 | MSC[RDF]+1 + Waits | 31 + Waits | clk_mem | — |
| tvlioRWD | nPWE/nOE de-asserted period between writes | 4 | MSCx[RDN*2] | 60 | clk_mem | 3 |
| tvlioCD | nCS de-asserted after a read/write to next nCS or nSDCS asserted (minimum) | 1 | MSCx[RRR]*2 + 1 | 15 | clk_mem | — |

**NOTES:**
1. Numbers shown as integer multiples of the CLK_MEM period are ideal. Actual numbers vary with pin-to-pin differences in loading and transition direction (rise or fall).
2. Maximum values reflect the register dynamic ranges.
3. Depending on the programmed value of MSC[RDN] and the clk_mem speed, this can be a significant amount of time. Processor does not drive the data bus during this time between transfers. If the VLIO does not drive the data bus during this time between transfers, the data bus is not driven for this period of time. If MSC[RDN] is programmed to 60 (which equals 60 CLK_MEM cycles), then the data bus could potentially not be driven for 30*2 = 60 CLK_MEM cycles.

## 6.4.6.1 Variable Latency I/O Read Timing

Figure 6-24 shows the timing for 32-bit variable-latency I/O (VLIO) memory reads. Table 6-20 lists the timing parameters used in these diagrams.

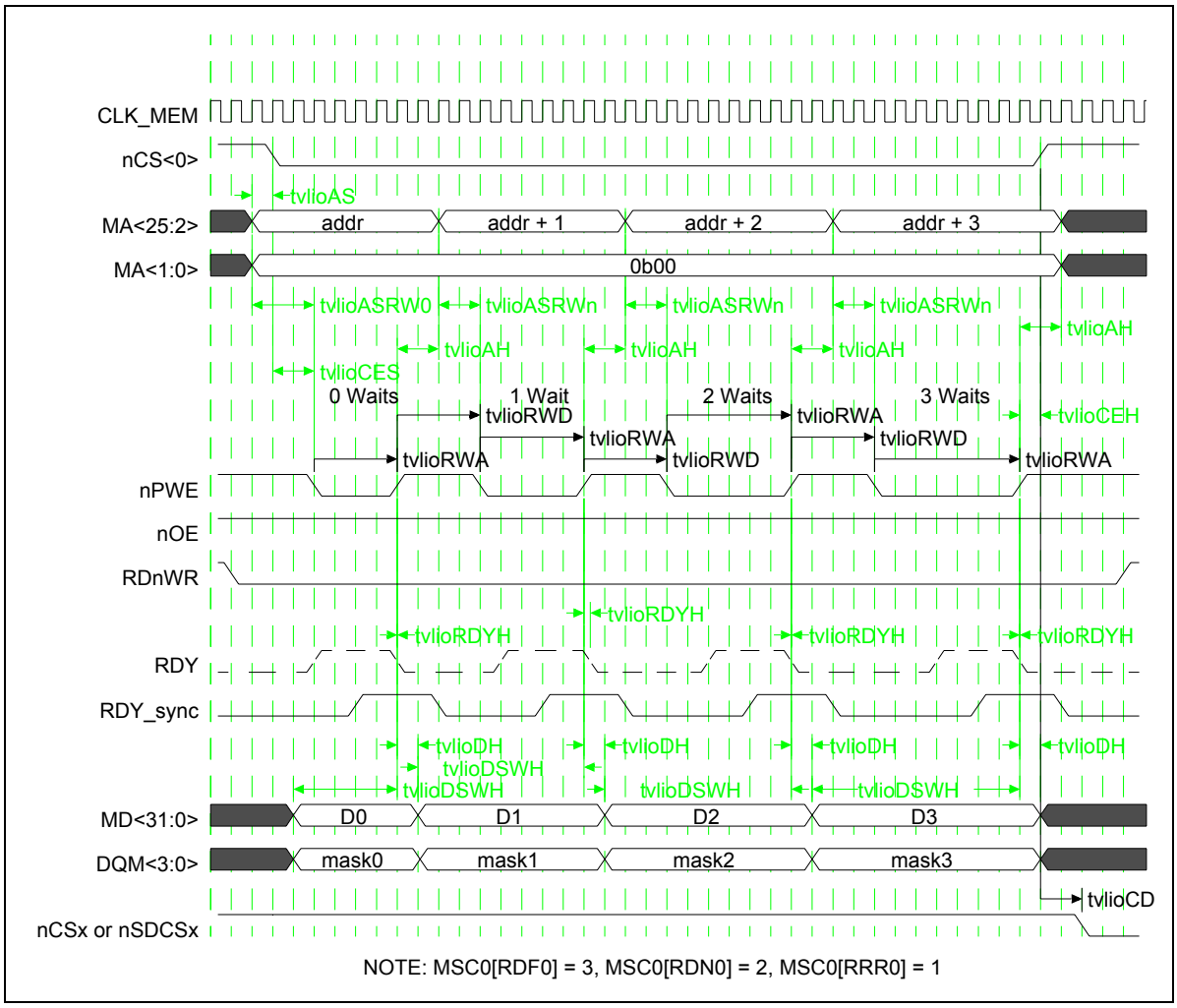
**Figure 6-24. 32-Bit VLIO Read Timing**




## 6.4.6.2 Variable-Latency I/O Write Timing

Figure 6-25 shows the timing for 32-bit VLIO memory writes. Table 6-20 list the timing parameters used in Figure 6-25.

**Figure 6-25. 32-Bit VLIO Write Timing**




NOTE: MSC0[RDF0] = 3, MSC0[RDN0] = 2, MSC0[RRR0] = 1

## 6.4.7 Expansion-Card Interface Parameters and Timing Diagrams

The following sections describe the read/write parameters and timing diagrams for CompactFlash* and PC Card* (expansion card) memory interfaces with the memory controller.

Table 6-21 shows the timing parameters used in the timing diagrams, Figure 6-26 and Figure 6-27.

***Note:*** Table 6-21 lists programmable register items. See the "Memory Controller" chapter in the *Intel® PXA27x Processor Family Developer's Manual* for register configurations for more information on these items.

**Table 6-21. Expansion-Card Interface AC Specifications**

| Symbols | Parameters | MIN | TYP | MAX | Units | Notes |
|---|---|---|---|---|---|---|
| tcdAVCL | Address Valid to CMD Low | 2 | MCx[SET] | 127 | CLK_MEM | 1,2,3,4 |
| tcdCHAI | CMD High to Address Invalid | 0 | MCx[HOLD] | 63 | CLK_MEM | 1,2,3,5 |
| tcdDVCL | Write Data Valid to CMD Low | — | 1 | — | CLK_MEM | 1,3 |
| tcdCHWDI | CMD High to Write Data Invalid | — | 4 | — | CLK_MEM | 1,3 |
| tcdDVCH | Read Data Valid to CMD High | 2 | — | — | CLK_MEM | 1,3 |
| tcdCHRDI | CMD High to Read Data Invalid | 0 | — | — | ns | 3 |
| tcdCMD | CMD Assert During Transfers | — | tcdCLPS + tcdPHCH + nPWAIT assertion | — | CLK_MEM | 1,3 |
| tcdILCL | nIOIS16 Low to CMD Low | 4 | — | — | CLK_MEM | 1,3 |
| tcdCHIH | CMD High to nIOIS16 High | 2 | — | — | CLK_MEM | 1,3 |
| tcdCLPS | CMD Low to nPWAIT Sample | — | x_ASST_WAIT | — | CLK_MEM | 1,3,6,7 |
| tcdPHCH | nPWAIT High to CMD High | — | x_ASST_HOLD | — | CLK_MEM | 1,3,6,8 |

**NOTES:**
1. All numbers shown are ideal, integer multiples of the CLK_MEM period. Actual numbers vary with pin-to-pin differences in loading and transition direction (rise or fall).
2. Includes signals MA[25:0], nPREG, and nPSKTSEL.
3. CMD refers to signals nPWE, nPOE, nPIOW, and nPIOR
4. Refer to the *Intel® PXA27x Processor Family Developer's Manual*, Expansion Memory Timing Configuration registers to change the assertion of CMD using the MCx[SET] bit fields.
5. Refer to the *Intel® PXA27x Processor Family Developer's Manual*, Expansion Memory Timing Configuration registers to increase the assertion of CMD using the MCx[HOLD] bit fields.
6. Refer to the *Intel® PXA27x Processor Family Developer's Manual*, Expansion Memory Timing Configuration registers to increase timings. The timings are changed by programming the MCx[ASST] respective bit fields. Refer to the PC Card Interface Command Assertion Code table to see the effect of MCx[ASST].
7. tcdCLPS equals CLK_MEM * x_ASST_WAIT. Refer to the PC Card Interface Command Assertion Code table in the *Intel® PXA27x Processor Family Developer's Manual* for the correlation between x_ASST_WAIT and the MCx[ASST] bit field.
8. tcdPHCH equals CLK_MEM * x_ASST_HOLD. Refer to the PC Card Interface Command Assertion Code table in the *Intel® PXA27x Processor Family Developer's Manual* for the correlation between x_ASST_HOLD and the MCx[ASST] bit field.

**Figure 6-26. Expansion-Card Memory or I/O 16-Bit Access Timing**

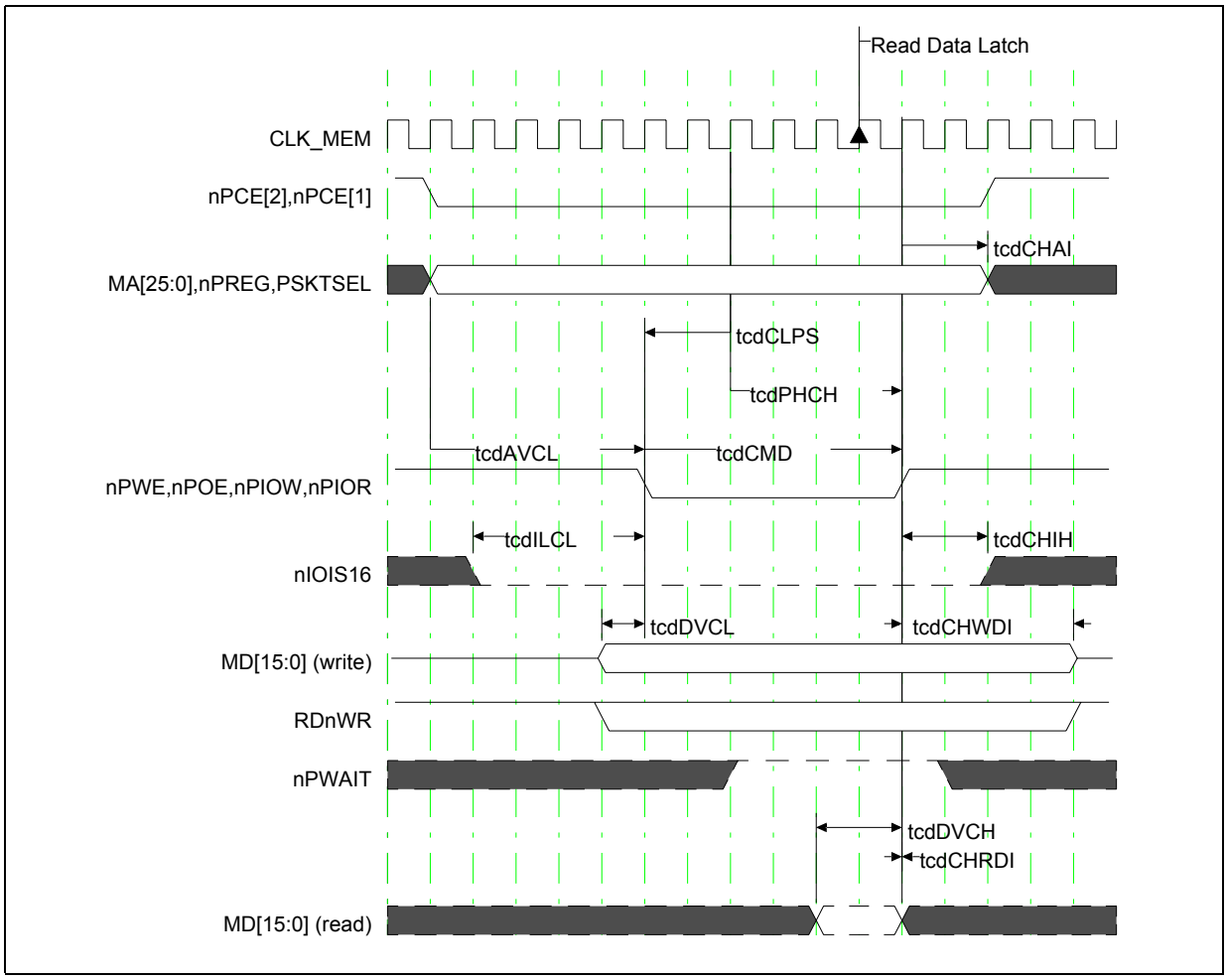
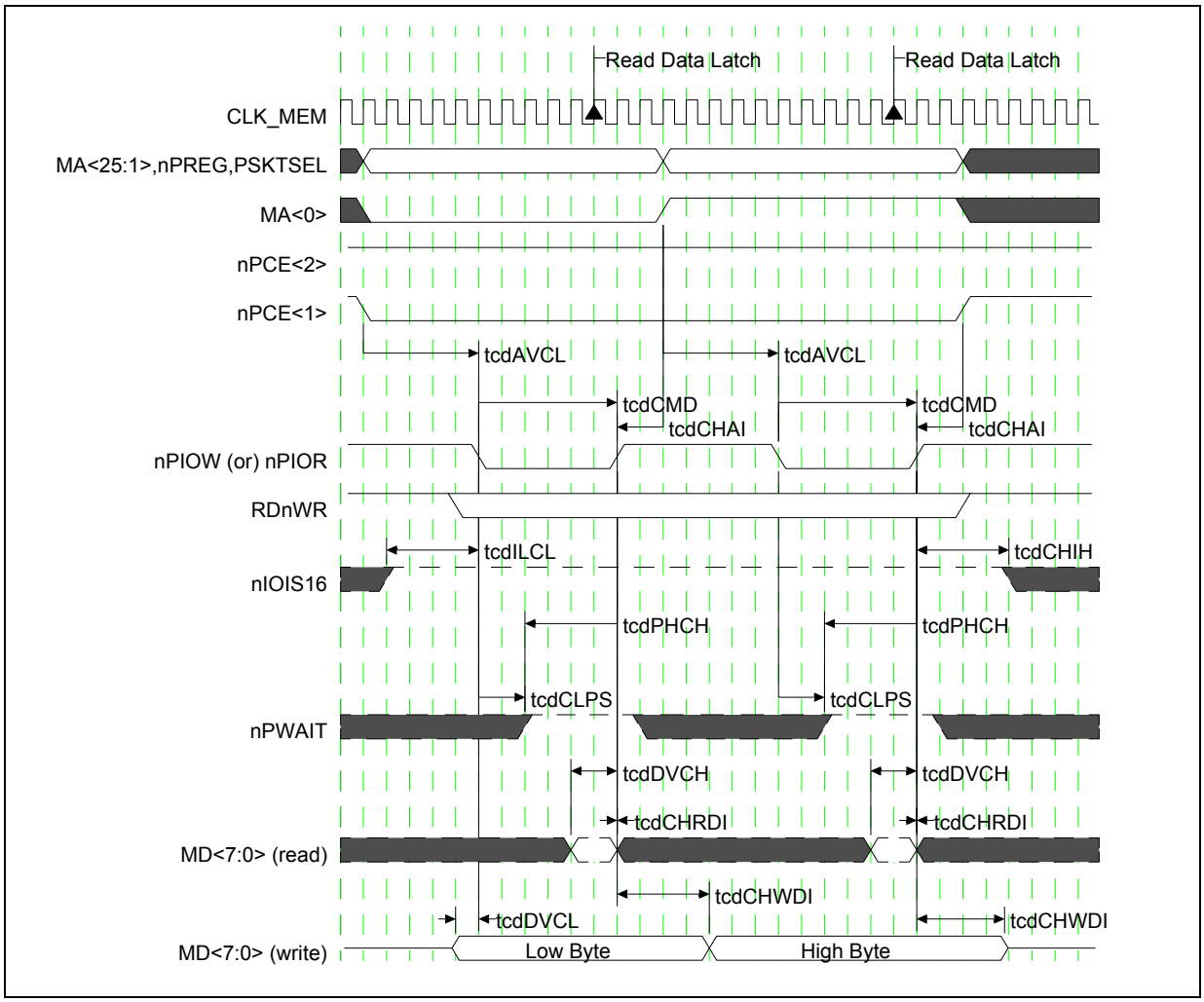


**Figure 6-27. Expansion-Card Memory or I/O 16-Bit Access to 8-Bit Device Timing**



# 6.5 LCD Timing Specifications

Figure 6-28 describes the LCD timing parameters. The LCD pin timing specifications are referenced to the pixel clock (L_PCLK_WR). Table 6-22 gives the values for the parameters.

**Figure 6-28. LCD Timing Definitions**

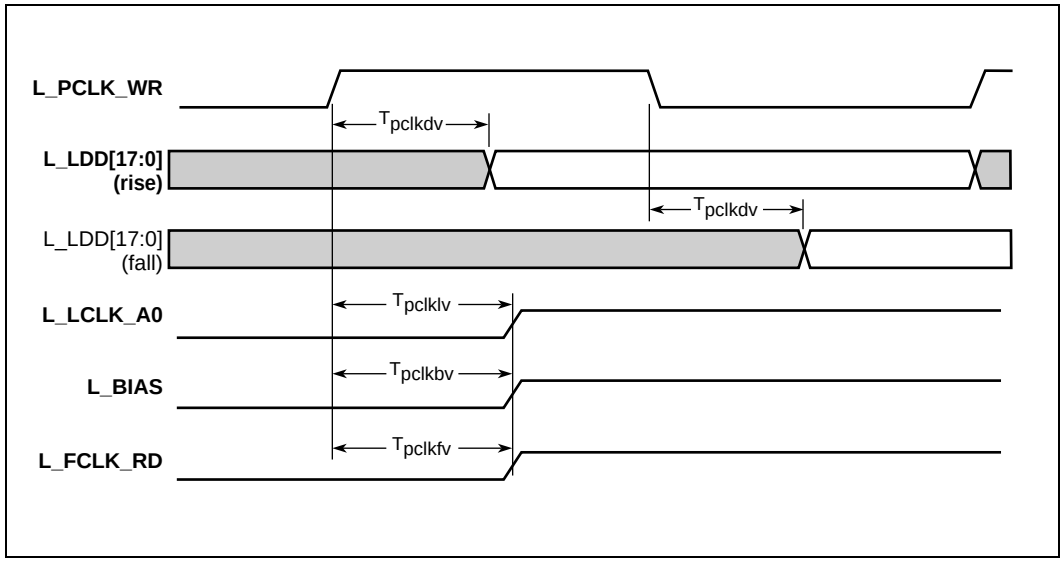



**Table 6-22. LCD Timing Specifications**

| Symbol | Description | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| Tpclkdv | L_PCLK_WR rise/fall to L_LDD<17:0> driven valid | — | 14 | ns | 1 |
| Tpclklv | L_PCLK_WR fall to L_LCLK_A0 driven valid | — | 14 | ns | 2 |
| Tpclkfv | L_PCLK_WR fall to L_FCLK_RD driven valid | — | 14 | ns | 2 |
| Tpclkbv | L_PCLK_WR rise to L_BIAS driven valid | — | 14 | ns | 2 |

**NOTES:**
1. The LCD data pins can be programmed to be driven on either the rising or falling edge of the pixel clock (L_PCLK_WR).
2. These LCD signals can toggle when L_PCLK_WR is not clocking (between frames). At this time, they are clocked with the internal version of the pixel clock before it is driven out onto the L_PCLK_WR pin.

# 6.6 SSP Timing Specifications

Figure 6-29 describes the SSP timing parameters. The SSP pin timing specifications are referenced to SSPCLK. Table 6-23 gives the values for the parameters.

***Note:*** In Figure 6-29, read the term "tSFMV" as "TSTXV."

**Figure 6-29. SSP Master Mode Timing Definitions**

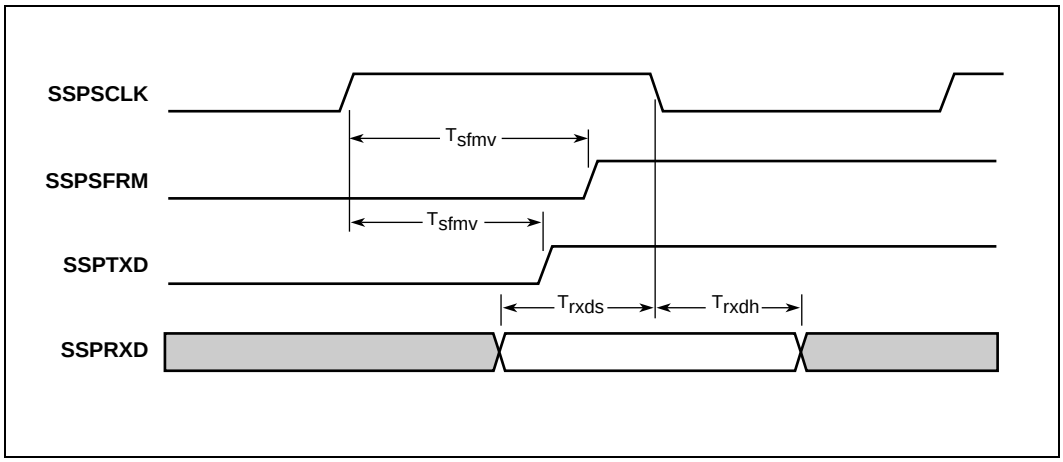


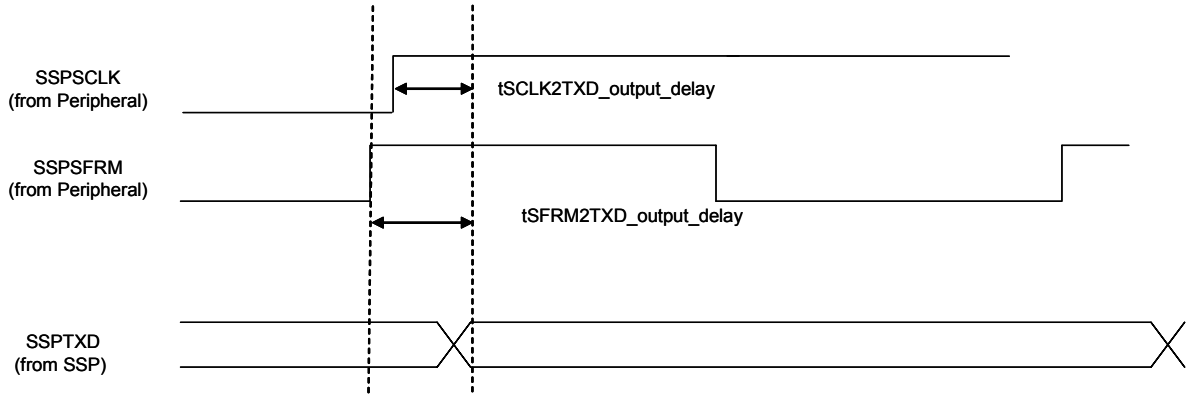

**Table 6-23. SSP Master Mode Timing Specifications**

| Symbol | Description | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| Tsfmv | SSPSCLK rise to SSPSFRM driven valid | | 21 | ns | |
| Trxds | SSPRXD valid to SSPSCLK fall (input setup) | 11 | | ns | |
| Trxdh | SSPSCLK fall to SSPRXD invalid (input hold) | 0 | | ns | |
| Tsfmv | SSPSCLK rise to SSPTXD valid | | 22 | ns | |

**Figure 6-30. Timing Diagram for SSP Slave Mode Transmitting Data to an External Peripheral**

**PXA27x processor transmitting data**

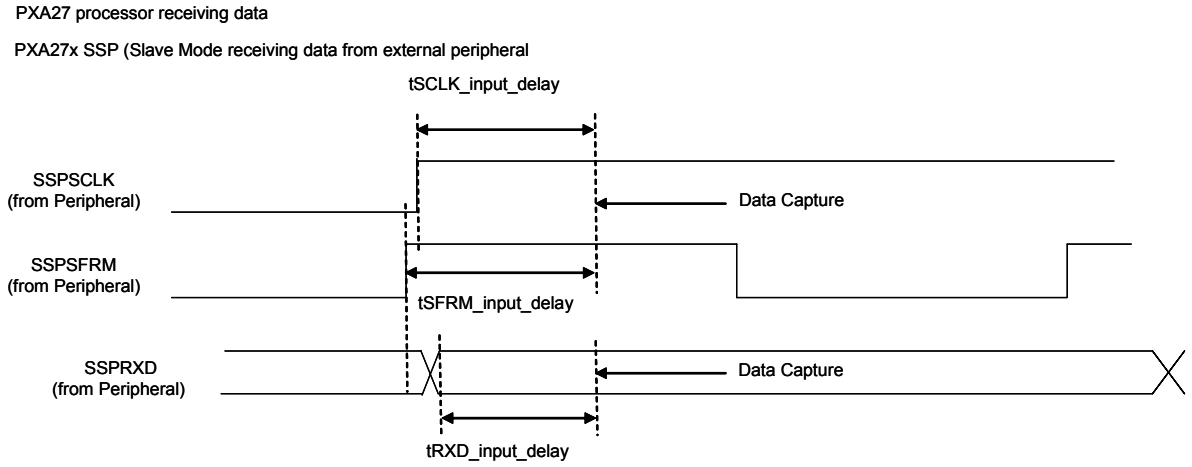
**PXA27x SSP (Slave Mode) transmitting data to external peripheral**



### Table 6-24. Timing Specification SSP Slave Mode Transmitting Data to External Peripheral

| Parameter | Description | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| tSFRM2TXD_output_delay | Frame to TX Data Out | | 10.58 | | ns |
| tSCLK2TXD_output_delay | Clock to Tx Data Out | | 10.52 | | ns |

### Figure 6-31. Timing Diagram for SSP Slave Mode Receiving Data from External Peripheral




### Table 6-25. Timing Specification for SSP Slave Mode Receiving Data from External Peripheral

| Parameter | Description | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| tSFRM_input_delay | Frame to Rx Data Capture | | 5.21 | | ns |
| tSCLK_input_delay | Clock to Rx Data Capture | | 5.04 | | ns |
| tRXD_input_delay | Rx Data Setup to Capture | | 4.81 | | ns |

## 6.7 JTAG Boundary Scan Timing Specifications

Table 6-26 shows the AC specifications for the JTAG boundary-scan test-signals. Figure 6-32 shows the timing diagram.

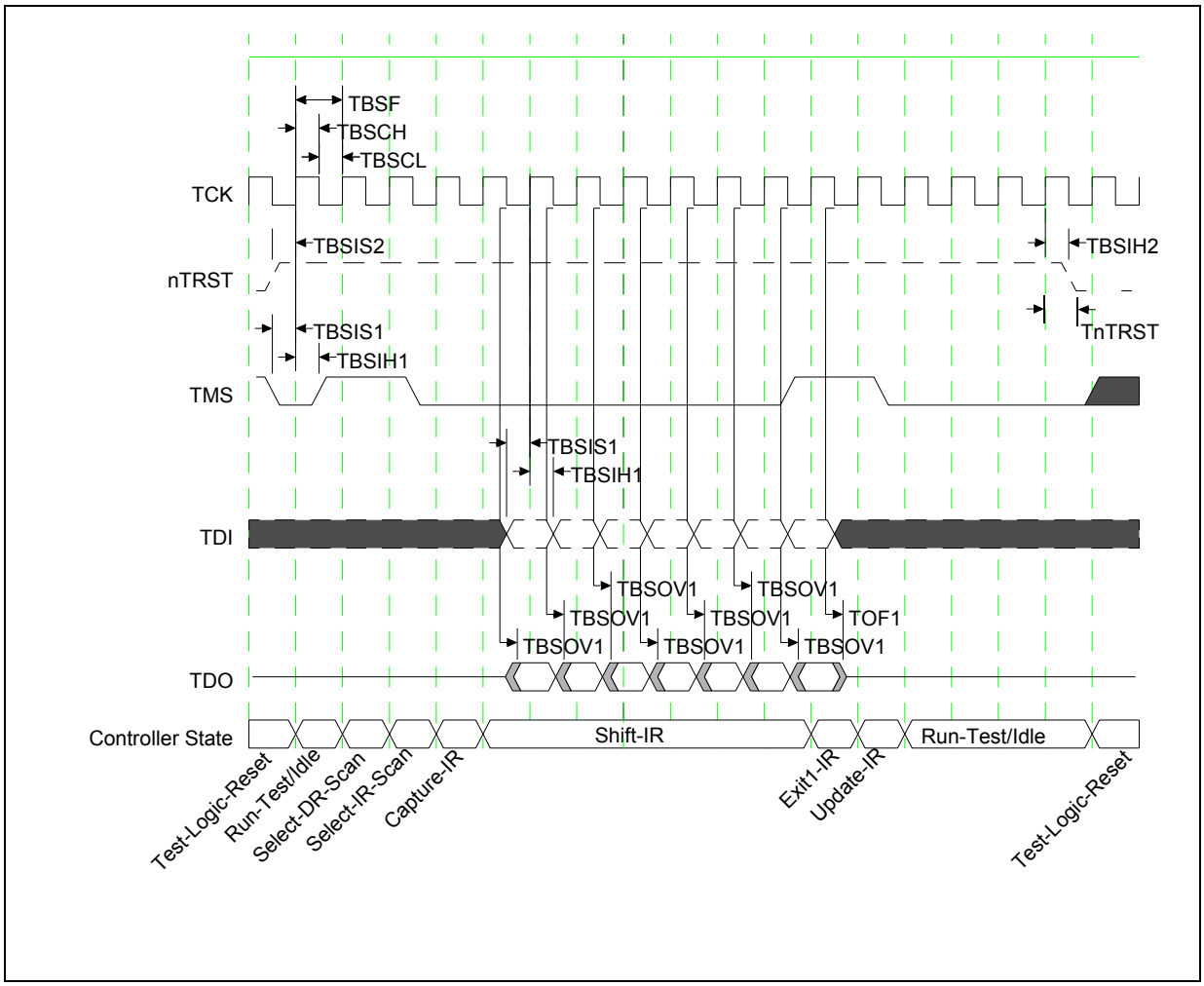
### Table 6-26. Boundary Scan Timing Specifications (Sheet 1 of 2)

| Symbol | Parameter | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| TBSF | TCK Frequency | 0.0 | 33.33 | MHz | — |
| TBSCH | TCK High Time | 15.0 | — | ns | Measured at 1.5 V |
| TBSCL | TCK Low Time | 15.0 | — | ns | Measured at 1.5 V |
| TBSCR | TCK Rise Time | — | 5.0 | ns | 0.8 V to 2.0 V |
| TBSCF | TCK Fall Time | — | 5.0 | ns | 2.0 V to 0.8 V |

### Table 6-26. Boundary Scan Timing Specifications (Sheet 2 of 2)

| Symbol | Parameter | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| TBSIS1 | Input Setup to TCK TDI, TMS | 4.0 | — | ns | — |
| TBSIH1 | Input Hold from TCK TDI, TMS | 6.0 | — | ns | — |
| TBSIS2 | Input Setup to TCK nTRST | 25.0 | — | ns | — |
| TBSIH2 | Input Hold from TCK nTRST | 3.0 | — | ns | — |
| TnTRST | Assertion time of nTRST | 6 | — | ms | — |
| TBSOV1 | TDO Valid Delay | 1.5 | 6.9 | ns | Relative to falling edge of TCK |
| TOF1 | TDO Float Delay | 1.1 | 5.4 | ns | Relative to falling edge of TCK |

### Figure 6-32. JTAG Boundary-Scan Timing




§§

# Glossary

**3G:** An industry term used to describe the next, still-to-come generation of wireless applications. It represents a move from circuit-switched communications (where a device user has to dial in to a network) to broadband, high-speed, packet-based wireless networks (which are always on). The first generation of wireless communications relied on analog technology, followed by digital wireless communications. The third generation expands the digital capabilities by including high-speed connections and increased reliability.

**802.11:** Wireless specifications developed by the IEEE, outlining the means to manage packet traffic over a network and ensure that packets do not collide, which could result in the loss of data, when travelling from device to device.

**8PSK:** 8 phase shift key modulation scheme. Used in the EDGE standard.

AC ’97 AC-link standard serial interface for modem and audio

**ACK:** Handshake packet indicating a positive acknowledgment.

**Active device:** A device that is powered and is not in the suspended state.

**Air interface:** the RF interface between a mobile cellular handset and the base station

**AMPS:** Advanced Mobile Phone Service. A term used for analog technologies, the first generation of wireless technologies.

**Analog:** Radio signals that are converted into a format that allows them to carry data. Cellular phones and other wireless devices use analog in geographic areas with insufficient digital networks.

**ARM* V5te:** An ARM* architecture designation indicating the processor is conforms to ARM* architecture version 5, including “Thumb” mode and the “El Segundo” DSP extensions.

**Asynchronous Data:** Data transferred at irregular intervals with relaxed latency requirements.

**Asynchronous RA:** The incoming data rate, Fs i, and the outgoing data rate, Fs o, of the RA process are independent (i.e., there is no shared master clock). See also *rate adaptation*.

**Asynchronous SRC:** The incoming sample rate, Fsi, and outgoing sample rate, Fso, of the SRC process are independent (i.e., there is no shared master clock). See also sample *rate conversion*.

**Audio device:** A device that sources or sinks sampled analog data.

**AWG#:** The measurement of a wire’s cross-section, as defined by the American Wire Gauge standard.

**Babble:** Unexpected bus activity that persists beyond a specified point in a (micro)frame.

**Backlight Inverter:** A device to drive cold cathode fluorescent lamps used to illuminate LCD panels.

**Bandwidth:** The amount of data transmitted per unit of time, typically bits per second (b/s) or bytes per second (B/s). The size of a network “pipe” or channel for communications in wired networks. In wireless, it refers to the range of available frequencies that carry a signal.

**Base Station**:The telephone company’s interface to the Mobile Station

**BGA:** Ball Grid Array

**BFSK:** binary frequency shift keying. A coding scheme for digital data.

**Bit:** A unit of information used by digital computers. Represents the smallest piece of addressable memory within a computer. A bit expresses the choice between two possibilities and is typically represented by a logical one (1) or zero (0).

**Bit Stuffing:** Insertion of a “0” bit into a data stream to cause an electrical transition on the data wires, allowing a PLL to remain locked.

**Blackberry**: A two-way wireless device (pager) made by Research In Motion (RIM) that allows users to check e-mail and voice mail translated into text, as well as page other users of a wireless network service. It has a miniature “qwerty” keyboard that can be used by your thumbs, and uses SMS protocol. A Blackberry user must subscribe to the proprietary wireless service that allows for data transmission.

**Bluetooth:** A short-range wireless specification that allows for radio connections between devices within a 30-foot range of each other. The name comes from 10th-century Danish King Harald Blatand (Bluetooth), who unified Denmark and Norway.

**BPSK**: binary phase shift keying. A means of encoding digital data into a signal using phase-modulated communications.

**b/s:** Transmission rate expressed in bits per second.

**B/s:** Transmission rate expressed in bytes per second.

**BTB:** Branch Target Buffer

**BTS**: Base Transmitter Station

**Buffer:** Storage used to compensate for a difference in data rates or time of occurrence of events, when transmitting data from one device to another.

**Bulk Transfer:** One of the four USB transfer types. Bulk transfers are non-periodic, large bursty communication typically used for a transfer that can use any available bandwidth and can also be delayed until bandwidth is available. See also *transfer type*.

**Bus Enumeration:** Detecting and identifying USB devices.

**Byte:** A data element that is eight bits in size.

**Capabilities:** Those attributes of a USB device that are administrated by the host.

**CAS**: Cycle Accurate Simulator

**CAS-B4-RAS:** See CBR.

**CBR:** CAS Before RAS. Column Address Strobe Before Row Address Strobe. A fast refresh technique in which the DRAM keeps track of the next row it needs to refresh, thus simplifying what a system would have to do to refresh the part.

**CDMA:** Code Division Multiple Access U.S. wireless carriers Sprint PCD and Verizon use CDMA to allocate bandwidth for users of digital wireless devices. CDMA distinguishes between multiple transmissions carried simultaneously on a single wireless signal. It carries the transmissions on that signal, freeing network room for the

wireless carrier and providing interference-free calls for the user. Several versions of the standard are still under development. CDMA should increase network capacity for wireless carriers and improve the quality of wireless messaging. CDMA is an alternative to GSM.

**CDPD**: Cellular Digital Packet Data Telecommunications companies can use DCPD to transfer data on unused cellular networks to other users. IF one section, or “cell” of the network is overtaxed, DCPD automatically allows for the reallocation of services.

**Cellular:** Technology that senses analog or digital transmissions from transmitters that have areas of coverage called cells. As a user of a cellular phone moves between transmitters from one cell to another, the users’ call travels from transmitter to transmitter uninterrupted.

**Circuit Switched**: Used by wireless carriers, this method lets a user connect to a network or the Internet by dialing in, such as with a traditional phone line. Circuit switched connections are typically slower and less reliable than packet-switched networks, but are currently the primary method of network access for wireless users in the U.S.

**CF**: Compact Flash memory and I/O card interface

**Characteristics:** Those qualities of a USB device that are unchangeable; for example, the device class is a device characteristic.

**Client:** Software resident on the host that interacts with the USB System Software to arrange data transfer between a function and the host. The client is often the data provider and consumer for transferred data.

**CML:** Current mode logic

**Configuring Software:** Software resident on the host software that is responsible for configuring a USB device. This may be a system configuration or software specific to the device.

**Control Endpoint**: A pair of device endpoints with the same endpoint number that are used by a control pipe. Control endpoints transfer data in both directions and, therefore, use both endpoint directions of a device address and endpoint number combination. Thus, each control endpoint consumes two endpoint addresses.

**Control Pipe:** Same as a message pipe.

**Control Transfer:** One of the four USB transfer types. Control transfers support configuration/command/status type communications between client and function. See also *transfer type*.

**CRC:** See Cyclic Redundancy Check.

**CSP:** Chip Scale Package.

**CTE:** Coefficient of thermal expansion

**CTI:** Computer Telephony Integration.

**Cyclic Redundancy Check** (CRC): A check performed on data to see if an error has occurred in transmitting, reading, or writing the data. The result of a CRC is typically stored or transmitted with the checked data. The stored or transmitted result is compared to a CRC calculated for the data to determine if an error has occurred.

**D-cache**: Data cache

**DECT**: the Digital European Cordless Telecommunications standard

**Default Address:** An address defined by the USB Specification and used by a USB device when it is first powered or reset. The default address is 00H.

**Default Pipe:** The message pipe created by the USB System Software to pass control and status information between the host and a USB device's endpoint zero.

**Device:** A logical or physical entity that performs a function. The actual entity described depends on the context of the reference. At the lowest level, "device" may refer to a single hardware component, as in a memory device. At a higher level, it may refer to a collection of hardware components that perform a particular function, such as a USB interface device. At an even higher level, device may refer to the function performed by an entity attached to the USB; for example, a data/FAX modem device. Devices may be physical, electrical, addressable, and logical. When used as a non-specific reference, a USB device is either a hub or a function.

**Device Address:** A seven-bit value representing the address of a device on the USB. The device address is the default address (00H) when the USB device is first powered or the device is reset. Devices are assigned a unique device address by the USB System Software.

**Device Endpoint:** A uniquely addressable portion of a USB device that is the source or sink of information in a communication flow between the host and device. See also *endpoint address*.

**Device Resources:** Resources provided by USB devices, such as buffer space and endpoints. See also *Host Resources and Universal Serial Bus Resources*.

**Device Software:** Software that is responsible for using a USB device. This software may or may not also be responsible for configuring the device for use.

**DMA**: Direct Memory Access

**Downstream:** The direction of data flow from the host or away from the host. A downstream port is the port on a hub electrically farthest from the host that generates downstream data traffic from the hub. Downstream ports receive upstream data traffic.

**DQPSK**: Differential Quadrature Phase Shift Keying a modulation technique used in TDMA.

**Driver:** When referring to hardware, an I/O pad that drives an external load. When referring to software, a program responsible for interfacing to a hardware device, that is, a device driver.

**DSP**: Digital Signal Processing

**DSTN** Passive LCD Panel.

**Dual band mobile phone:** A phone that supports both analog and digital technologies by picking up analog signals when digital signals fade. Most mobile phones are not dual-band.

**DWORD:** Double word. A data element that is two words (i.e., four bytes or 32 bits) in size.

**Dynamic Insertion and Removal:** The ability to attach and remove devices while the host is in operation.

**E2PROM**: See Electrically Erasable Programmable Read Only Memory.

**EAV:** End of active video

**EDGE:** Enhanced Data GSM Environment. A faster version of the GSM standard. It is faster because it can carry messages using broadband networks that employ more bandwidth than standard GSM networks.

**EEPROM:** See Electrically Erasable Programmable Read Only Memory.

**Electrically Erasable Programmable Read Only Memory (EEPROM):** Non-volatile re-writable memory storage technology.

**End User:** The user of a host.

**Endpoint:** See device endpoint.

**Endpoint Address:** The combination of an endpoint number and an endpoint direction on a USB device. Each endpoint address supports data transfer in one direction.

**Endpoint Direction:** The direction of data transfer on the USB. The direction can be either IN or OUT. IN refers to transfers to the host; OUT refers to transfers from the host.

**Endpoint Number:** A four-bit value between 0H and FH, inclusive, associated with an endpoint on a USB device.

**Envelope detector:** An electronic circuit inside a USB device that monitors the USB data lines and detects certain voltage related signal characteristics.

**EOF:** End-of-(micro)Frame.

**EOP:** End-of-Packet.

**EOTD:** Enhanced Observed Time Difference

**ETM**: Embedded Trace Macrocell, the ARM* real-time trace capability

**External Port:** See port.

**Eye pattern:** A representation of USB signaling that provides minimum and maximum voltage levels as well as signal jitter.

**FAR**: Fault Address Register, part of the ARM* architecture.

**False EOP:** A spurious, usually noise-induced event that is interpreted by a packet receiver as an EOP.

**FDD**: The Mobile Station transmits on one frequency; the Base Station transmits on another frequency

**FDM:** Frequency Division Multiplexing. Each Mobile station transmits on a different frequency (within a cell).

**FDMA:** Frequency Division Multiple Access. An analog standard that lets multiple users access a group of radio frequency bands and eliminates interference of message traffic.

**FHSS**: See Frequency Hopping Spread Spectrum.

**FIQ**: Fast Interrupt Request. See Interrupt Request.

**Frame:** A 1 millisecond time base established on full-/low-speed buses.

**Frame Pattern:** A sequence of frames that exhibit a repeating pattern in the number of samples transmitted per frame. For a 44.1 kHz audio transfer, the frame pattern could be nine frames containing 44 samples followed by one frame containing 45 samples.

**Frequency Hopping Spread Spectrum**: A method by which a carrier spreads out packets of information (voice or data) over different frequencies. For example, a phone call is carried on several different frequencies so that when one frequency is lost another picks up the call without breaking the connection.

**Fs:** See sample rate.

**FSR**: Fault Status Register, part of the ARM* architecture.

**Full-duplex:** Computer data transmission occurring in both directions simultaneously.

**Full-speed:** USB operation at 12 Mb/s. See also *low-speed and high-speed*.

**Function:** A USB device that provides a capability to the host, such as an ISDN connection, a digital microphone, or speakers.

**GMSK:** Gaussian Minimum Shift Keying. A modulation scheme used in GSM.

**GPRS:** General Packet Radio Service A technology that sends packets of data across a wireless network at speeds up to 114 Kbps. Unlike circuit-switched networks, wireless users do not have to dial in to networks to download information; GPRS wireless devices are “always on” in that they can send and receive data without dial-ins. GPRS works with GSM.

**GPS:** Global Positioning Systems

**GSM:** Global System for Mobile Communications. A standard for how data is coded and transferred through the wireless spectrum. The European wireless standard, also used in parts of Asia, GSM is an alternative to CDMA. GSM digitizes and compresses data and sends it across a channel with two other streams of user data. GSM is based on TDMA technology.

**Hamming Distance:** The distance (number of bits) between encoded values that can change without causing a decode into the wrong value.

**Handshake Packet:** A packet that acknowledges or rejects a specific condition. For examples, see ACK and NAK.

**HDML:** Handheld Device Markup Language. HDML uses hypertext transfer protocol (HTTP) to display text versions of web pages on wireless devices. Unlike WML, HDML is not based on XML. HDML does not allow scripts, while WML uses a variant of JavaScript. Web site developers using HDML must re-code their web pages in HDML to be viewed on the smaller screen sizes of handheld devices.

**HARP:** Windows CE standard development platform spec (Hardware Adaptation Reference Platform)

**High-bandwidth endpoint:** A high-speed device endpoint that transfers more than 1024 bytes and less than 3073 bytes per microframe.

**High-speed:** USB operation at 480 Mb/s. See also *low-speed and full-speed*.

**Host :**The host computer system where the USB Host controller is installed. This includes the host hardware platform (CPU, bus, and so forth.) and the operating system in use.

**Host Controller:** The host’s USB interface.

**Host Controller Driver (HCD):** The USB software layer that abstracts the Host controller hardware. The Host controller driver provides an SPI for interaction with a Host controller. The Host controller driver hides the specifics of the Host controller hardware implementation.

**Host Resources:** Resources provided by the host, such as buffer space and interrupts. See also *Device Resources and Universal Serial Bus Resources*.

**HSTL:** High-speed transceiver logic

**Hub:** A USB device that provides additional connections to the USB.

**Hub Tier:** One plus the number of USB links in a communication path between the host and a function.

**IMMU:** Instruction Memory Management Unit, part of the Intel XScale® core.

**I-Mode:** A Japanese wireless service for transferring packet-based data to handheld devices created by NTT DoCoMo. I-Mode is based on a compact version of HTML and does not currently use WAP.

**I-cache:** Instruction cache

**IBIS:** I/O Buffer Information Specification is a behavioral description of the I/O buffers and package characteristics of a semiconductor device. IBIS models use a standard format to make it easier to import data into circuit simulation software packages.

**iDEN:** Integrated Digital Enhanced Network. A technology that allows users to access phone calls, two-way radio transmissions, paging and data transmissions from one wireless device. iDEN was developed by Motorola and based on TDMA.

**Interrupt Request** (IRQ): A hardware signal that allows a device to request attention from a host. The host typically invokes an interrupt service routine to handle the condition that caused the request.

**Interrupt Transfer:** One of the four USB transfer types. Interrupt transfer characteristics are small data, non-periodic, low-frequency, and bounded-latency. Interrupt transfers are typically used to handle service needs. See also *transfer type*.

**I/O Request Packet:** An identifiable request by a software client to move data between itself (on the host) and an endpoint of a device in an appropriate direction.

**IrDA:** Infrared Development Association

**IRP:** See I/O Request Packet.

**IRQ:** See Interrupt Request.

**ISI:** Inter-signal interference. Data ghosting caused when multi-path delay causes previous symbols to interfere with the one currently being processed.

**ISM:** Industrial, Scientific, and Medical band. Part of the wireless spectrum that is less regulated, such as 802.11.

**Isochronous Data:** A stream of data whose timing is implied by its delivery rate.

**Isochronous Device:** An entity with isochronous endpoints, as defined in the USB Specification, that sources or sinks sampled analog streams or synchronous data streams.

**Isochronous Sink Endpoint :** An endpoint that is capable of consuming an isochronous data stream that is sent by the host.

**Isochronous Source Endpoint:** An endpoint that is capable of producing an isochronous data stream and sending it to the host.

**Isochronous Transfer:** One of the four USB transfer types. Isochronous transfers are used when working with isochronous data. Isochronous transfers provide periodic, continuous communication between host and device. See also *transfer type*.

**Jitter:** A tendency toward lack of synchronization caused by mechanical or electrical changes. More specifically, the phase shift of digital pulses over a transmission medium.

**kb/s:** Transmission rate expressed in kilobits per second. A measurement of bandwidth in the U.S.

**kB/s:** Transmission rate expressed in kilobytes per second.

**Little endian:** Method of storing data that places the least significant byte of multiple-byte values at lower storage addresses. For example, a 16-bit integer stored in little endian format places the least significant byte at the lower address and the most significant byte at the next address.

**LOA:** Loss of bus activity characterized by an SOP without a corresponding EOP.

**Low-speed:** USB operation at 1.5 Mb/s. See also *full-speed and high-speed*.

**LSb:** Least significant bit.

**LSB:** Least significant byte.

**LVDS:** Low-voltage differential signal

**MAC**: Multiply Accumulate unit

**Mb/s:** Transmission rate expressed in megabits per second.

**MB/s:** Transmission rate expressed in megabytes per second.

**MC:** Media Center. A combination digital set-top box, video and music jukebox, personal video recorder and an Internet gateway and firewall that hooks up to a broadband connection.

**Message Pipe:** A bidirectional pipe that transfers data using a request/data/status paradigm. The data has an imposed structure that allows requests to be reliably identified and communicated.

**Microframe:** A 125 microsecond time base established on high-speed buses.

**MMC:** Multimedia Card - small form factor memory and I/O card

**MMX Technology**: The Intel® MMX™ technology comprises a set of instructions that are designed to greatly enhance the performance of advanced media and communications applications. See chapter 10 of the *Intel® Architecture Software Developers Manual, Volume 3: System Programming Guid*e, Order #245472.

**Mobile Station:** Cellular Telephone handset

**M-PSK:** multilevel phase shift keying. A convention for encoding digital data in which there are multiple states.

**MMU:** Memory Management Unit, part of the Intel XScale® core.

**MSb:** Most significant bit.

**MSB:** Most significant byte.

**MSL:** Mobile Scalable Link.

**NAK:** Handshake packet indicating a negative acknowledgment.

**Non Return to Zero Invert** (NRZI): A method of encoding serial data in which ones and zeroes are represented by opposite and alternating high and low voltages where there is no return to zero (reference) voltage between encoded bits. Eliminates the need for clock pulses.

**NRZI:** See Non Return to Zero Invert.

**Object:** Host software or data structure representing a USB entity.

**OFDM**: See Orthogonal Frequency Division Multiplexing.

**Orthogonal Frequency Division Multiplexing:** A special form of multi-carrier modulation. In a multi-path channel, most conventional modulation techniques are sensitive to inter-symbol interference unless the channel symbol rate is small compared to the delay spread of the channel. OFDM is significantly less sensitive to inter-symbol interference, because a special set of signals is used to build the composite transmitted signal. The basic idea is that each bit occupies a frequency-time window that ensures little or no distortion of the waveform. In practice, it means that bits are transmitted in parallel over a number of frequency-nonselective channels.

**Packet:** A bundle of data organized in a group for transmission. Packets typically contain three elements: control information (for example, source, destination, and length), the data to be transferred, and error detection and correction bits. Packet data is the basis for packet-switched networks, which eliminate the need to dial-in to send or receive information, because they are "always on."

**Packet Buffer:** The logical buffer used by a USB device for sending or receiving a single packet. This determines the maximum packet size the device can send or receive.

**Packet ID (PID):** A field in a USB packet that indicates the type of packet, and by inference, the format of the packet and the type of error detection applied to the packet.

**Packet Switched Network:** Networks that transfer packets of data.

**PCMCIA**: Personal Computer Memory Card Interface Association (PC Card)

**PCS:** Personal Communications services. An alternative to cellular, PCD works like cellular technology because it sends calls from transmitter to transmitter as a caller moves. But PCS uses its own network, not a cellular network, and offers fewer "blind spots" than cellular, where calls are not available. PCS transmitters are generally closer together than their cellular counterparts.

**PDA**: Personal Digital Assistant. A mobile handheld device that gives users access to text-based information. Users can synchronize their PDAs with a PC or network; some models support wireless communication to retrieve and send e-mail and get information from the Internet.

**Phase:** A token, data, or handshake packet. A transaction has three phases.

**Phase Locked Loop** (PLL): A circuit that acts as a phase detector to keep an oscillator in phase with an incoming frequency.

**Physical Device:** A device that has a physical implementation; for example, speakers, microphones, and CD players.

**PID:** See Packet ID or Process ID.

**PIO**: Programmed input/output

**Pipe:** A logical abstraction representing the association between an endpoint on a device and software on the host. A pipe has several attributes; for example, a pipe may transfer data as streams (stream pipe) or messages (message pipe). See also *stream pipe and message pipe*.

**PLL:** See Phase Locked Loop.

**PM**: Phase Modulation.

**Polling:** Asking multiple devices, one at a time, if they have any data to transmit.

**POR:** See Power On Reset.

**Port:** Point of access to or from a system or circuit. For the USB, the point where a USB device is attached.

**Power On Reset (POR):** Restoring a storage device, register, or memory to a predetermined state when power is applied.

**Process ID**: Process identifier

**Programmable Data Rate:** Either a fixed data rate (single-frequency endpoints), a limited number of data rates (32 kHz, 44.1 kHz, 48 kHz, …), or a continuously programmable data rate. The exact programming capabilities of an endpoint must be reported in the appropriate class-specific endpoint descriptors.

**Protocol:** A specific set of rules, procedures, or conventions relating to format and timing of data transmission between two devices.

**PSP:** Programmable Serial Protocol

**PWM:** Pulse Width Modulator

**QBS:** Qualification By Similarity. A technique allowed by JEDEC for part qualification when target parameters are fully understood and data exist to warrant omitting a specific test.

**QAM:** quadrature amplitude modulation. A coding scheme for digital data.

**QPSK:** quadrature phase shift keying. A convention for encoding digital data into a signal using phase-modulated communications.

**RA:** See rate adaptation.

**Radio Frequency Device:** These devices use radio frequencies to transmit data. One typical use is for bar code scanning of products in a warehouse or distribution center, and sending that information to an ERP database.

**Rate Adaptation:** The process by which an incoming data stream, sampled at Fs i, is converted to an outgoing data stream, sampled at Fs o, with a certain loss of quality, determined by the rate adaptation algorithm. Error control mechanisms are required for the process. Fs i and Fs o can be different and asynchronous. Fs i is the input data rate of the RA; Fs o is the output data rate of the RA.

**Request:** A request made to a USB device contained within the data portion of a SETUP packet.

**Retire:** The action of completing service for a transfer and notifying the appropriate software client of the completion.

**RGBT:** Red, Green, Blue, Transparency

**ROM:** Read Only Memory.

**Root Hub:** A USB hub directly attached to the Host controller. This hub (tier 1) is attached to the host.

**Root Port:** The downstream port on a Root Hub.

**RTC:** Real-Time Clock

**SA-1110:** StrongARM* based applications processor for handheld products

**Intel® StrongARM* SA-1111:** Companion chip for the Intel® SA-1110 processor

**SAD:** Sum of absolute differences

**Sample:** The smallest unit of data on which an endpoint operates; a property of an endpoint.

**Sample Rate (Fs):** The number of samples per second, expressed in Hertz (Hz).

**Sample Rate Conversion (SRC):** A dedicated implementation of the RA process for use on sampled analog data streams. The error control mechanism is replaced by interpolating techniques. Service A procedure provided by a System Programming Interface (SPI).

**Satellite Phone:** Phones that connect callers by satellite. Users have a world-wide alternative to terrestrial connections. Typical use is for isolated users, such as crews of deep-see oil rigs with phones configured to connect to a satellite service.

**SAV:** Start of active video

**SAW:** Surface Acoustic Wave filter

**SDRAM:** Synchronous Dynamic Random Access Memory.

**Service Interval:** The period between consecutive requests to a USB endpoint to send or receive data.

**Service Jitter:** The deviation of service delivery from its scheduled delivery time.

**Service Rate:** The number of services to a given endpoint per unit time.

**SIMD:** Single Instruction Multiple Data (a parallel processing architecture).

**Smart Phone:** A combination of a mobile phone and a PDA, which allow users to communicate as well as perform tasks; such as, accessing the Internet and storing contacts in a database. Smart phones have a PDA-like screen.

**SMROM:** Synchronous Mask ROM

**SMS:** Short Messaging Service. A service through which users can send text-based messages from one device to another. The message can be up to 160 characters and appears on the screen of the receiving device. SMS works with GSM networks.

**SOC:** System On Chip

**SOF:** See Start-of-Frame.

**SOP:** Start-of-Packet.

**SPI:** See System Programming Interface. Also, “Serial Peripheral Interface protocol.

**SPI:** Serial Peripheral Interface

**Split transaction:** A transaction type supported by host controllers and hubs. This transaction type allows full- and low-speed devices to be attached to hubs operating at high-speed.

**Spread Spectrum:** An encoding technique patented by actress Hedy Lamarr and composer George Antheil, which broadcasts a signal over a range of frequencies.

**SRAM:** Static Random Access Memory.

**SRC:** See Sample Rate Conversion.

**SSE:** Streaming SIMD Extensions

**SSE2:** Streaming SIMD Extensions 2: for Intel Architecture machines, 144 new instructions, a 128-bit SIMD integer arithmetic and 128-bit SIMD double precision floating point instructions, enabling enhanced multimedia experiences.

**SSP:** Synchronous Serial Port

**SSTL:** Stub series terminated logic

**Stage:** One part of the sequence composing a control transfer; stages include the Setup stage, the Data stage, and the Status stage.

**Start-of-Frame** (SOF): The first transaction in each (micro)frame. An SOF allows endpoints to identify the start of the (micro)frame and synchronize internal endpoint clocks to the host.

**Stream Pipe:** A pipe that transfers data as a stream of samples with no defined USB structure

**SWI:** Software interrupt.

**Synchronization Type:** A classification that characterizes an isochronous endpoint's capability to connect to other isochronous endpoints.

**Synchronous RA:** The incoming data rate, Fsi, and the outgoing data rate, Fso, of the RA process are derived from the same master clock. There is a fixed relation between Fsi and Fso.

**Synchronous SRC:** The incoming sample rate, Fsi, and outgoing sample rate, Fso, of the SRC process are derived from the same master clock. There is a fixed relation between Fsi and Fso.

**System Programming Interface (SPI):** A defined interface to services provided by system software.

**TC:** Temperature Cycling

**TDD:** Time Division Duplexing The Mobile Station and the Base Station transmit on same frequency at different times.

**TDM:** See Time Division Multiplexing.

**TDMA:** Time Division Multiple Access. TDMA protocol allows multiple users to access a single radio frequency by allocating time slots for use to multiple voice or data calls. TDMA breaks down data transmissions, such as a phone conversation, into fragments and transmits each fragment in a short burst, assigning each fragment a time slot. With a cell phone, the caller would not detect this fragmentation. TDMA works with GSM and digital cellular services.

**TDR:** See Time Domain Reflectometer.

**Termination:** Passive components attached at the end of cables to prevent signals from being reflected or echoed.

**TFT:** Thin Film Twist, a type of active LCD panel.

**Three-state:** a high-impedance state in which the output is floating and is electrically isolated from the buffer's circuitry.

**Time Division Multiplexing (TDM):** A method of transmitting multiple signals (data, voice, and/or video) simultaneously over one communications medium by interleaving a piece of each signal one after another.

**Time Domain Reflectometer (TDR):** An instrument capable of measuring impedance characteristics of the USB signal lines.

**Time-out:** The detection of a lack of bus activity for some predetermined interval.

**Token Packet:** A type of packet that identifies what transaction is to be performed on the bus.

**TPV:** Third Party Vendor

**Transaction:** The delivery of service to an endpoint; consists of a token packet, optional data packet, and optional handshake packet. Specific packets are allowed/required based on the transaction type.

**Transaction translator:** A functional component of a USB hub. The Transaction Translator responds to special high-speed transactions and translates them to full/low-speed transactions with full/low-speed devices attached on downstream facing ports.

**Transfer:** One or more bus transactions to move information between a software client and its function.

**Transfer Type:** Determines the characteristics of the data flow between a software client and its function. Four standard transfer types are defined: control, interrupt, bulk, and isochronous.

**TS:** Thermal Shock

**Turn-around Time:** The time a device needs to wait to begin transmitting a packet after a packet has been received to prevent collisions on the USB. This time is based on the length and propagation delay characteristics of the cable and the location of the transmitting device in relation to other devices on the USB.

**UART:** Universal Asynchronous Receiver/Transmitter serial port

**Universal Serial Bus Driver** (USBD): The host resident software entity responsible for providing common services to clients that are manipulating one or more functions on one or more Host controllers.

**Universal Serial Bus Resources:** Resources provided by the USB, such as bandwidth and power. See also *Device Resources and Host Resources*.

**Upstream:** The direction of data flow towards the host. An upstream port is the port on a device electrically closest to the host that generates upstream data traffic from the hub. Upstream ports receive downstream data traffic.

**USBD:** See **Universal Serial Bus Driver**.

**USB-IF:** USB Implementers Forum, Inc. is a nonprofit corporation formed to facilitate the development of USB compliant products and promote the technology.

**VBI:** Vertical Blanking Interval, also known as the “backporch”.

**Virtual Device:** A device that is represented by a software interface layer. An example of a virtual device is a hard disk with its associated device driver and client software that makes it able to reproduce an audio.WAV file.

**VLIO:** Variable Latency Input/Output interface.

**YUV:** A method of characterizing video signals typically used in digital cameras and PAL television specifying luminance and chrominance.

**WAP:** Wireless Application Protocol. WAP is a set of protocols that lets users of mobile phones and other digital wireless devices access Internet content, check voice mail and e-mail, receive text of faxes and conduct transactions. WAP works with multiple standards, including CDMA and GSM. Not all mobile devices support WAP.

**W-CDMA:** Wideband CDMA, a third generation wireless technology under development that allows for high-speed, high-quality data transmission. Derived from CDMA, W-CDMA digitizes and transmits wireless data over a broad range of frequencies. It requires more bandwidth than CDMA, but offers faster transmission because it optimizes the use of multiple wireless signals, instead of one, as does CDMA.

**Wireless LAN:** A wireless LAN uses radio frequency technology to transmit network messages through the air for relatively short distances, like across an office building or a college campus. A wireless LAN can serve as a replacement for, or an extension to, a traditional wired LAN.

**Wireless Spectrum:** A band of frequencies where wireless signals travel carrying voice and data information.

**Word:** A data element that is four bytes (32 bits) in size.

**WML:** Wireless Markup Language, a version of HDML is based on XML. Wireless applications developers use WML to re-target content for wireless devices.

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# Index