



## NS7520 Data Sheet

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The Digi NS7520 is a high-performance, highly integrated, 32-bit system-on-a chip ASIC designed for use in intelligent networked devices and Internet appliances. The NS7520 is based on the standard architecture in the **NET+ARM™** family of devices.



The NS7520 can support most any networking scenario, and includes a 10/100 BaseT Ethernet MAC and two independent serial ports (each of which can run in UART or SPI mode).

The CPU is an ARM7TDMI 32-bit RISC processor core with a rich complement of support peripherals and memory controllers for various types of memory (including Flash, SDRAM, EEPROM, and others), programmable timers, a 13-channel DMA controller, an external bus expansion module, and 16 general-purpose input/output (GPIO) pins.

NET+ARM is the hardware foundation for the **NET+Works™** family of integrated hardware and software solutions for device networking. These comprehensive platforms include drivers, popular operating systems, networking software, development tools, APIs, and complete development boards.



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## NS7520 Overview

Figure 1 shows the NS7520 modules. Dashed lines indicate shared pins.

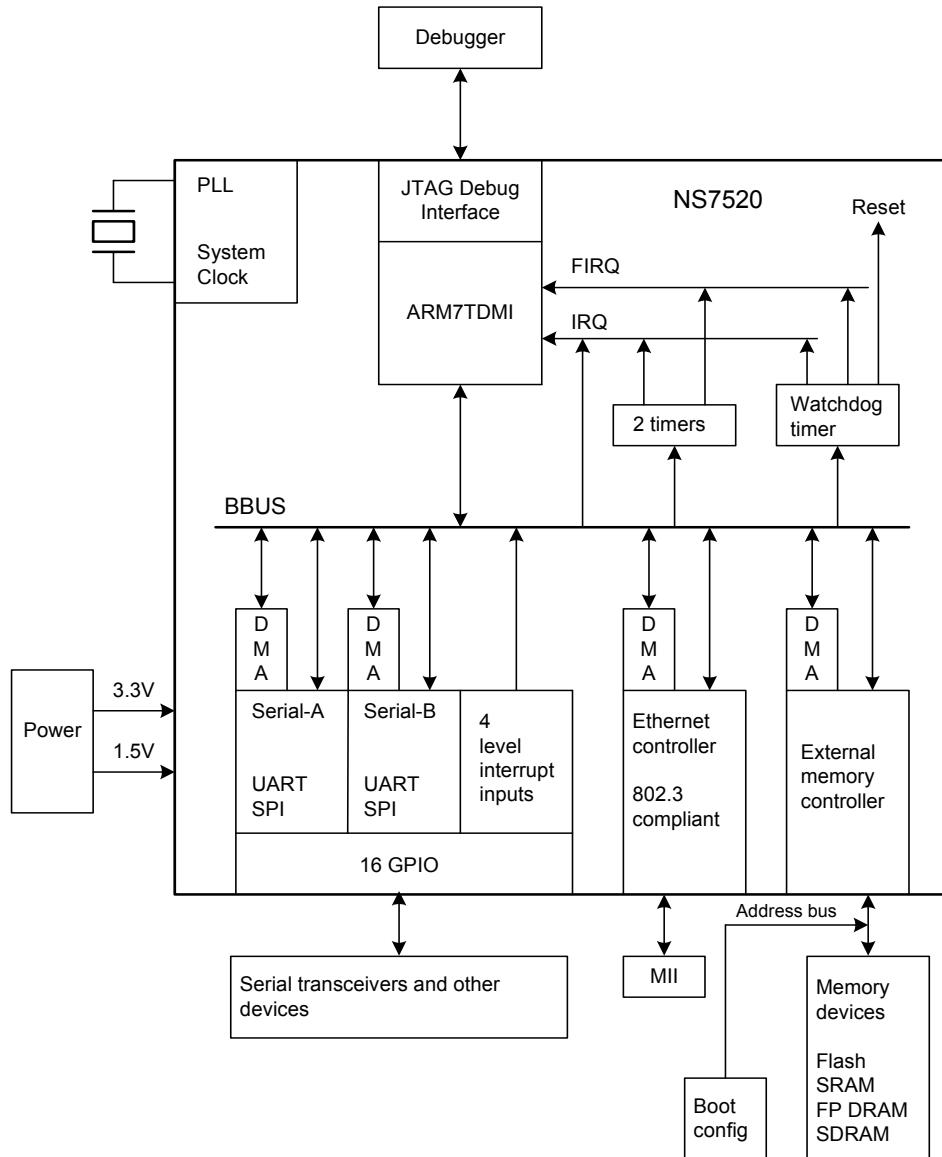


Figure 1: NS7520 module overview

## Key Features

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This table lists the key features of the NS7520.

|   |   |
|---|---|
| <b>CPU core</b>   | <b>Integrated 10/100 Ethernet MAC</b>   |
| <ul style="list-style-type: none"> <li>■ ARM7TDMI 32-bit RISC processor</li> <li>■ 32-bit internal bus</li> <li>■ 32-bit ARM and 16-bit Thumb mode</li> <li>■ 15 general purpose 32-bit registers</li> <li>■ 32-bit program counter (PC) and status register</li> <li>■ Five supervisor modes, one user mode</li> </ul>   | <ul style="list-style-type: none"> <li>■ 10/100 Mbps MII-based PHY interface</li> <li>■ 10 Mbps ENDEC interface</li> <li>■ TP-PMD and fiber-PMD device support</li> <li>■ Full-duplex and half-duplex modes</li> <li>■ Optional 4B/5B coding</li> <li>■ Station, broadcast, and multicast address detection</li> <li>■ 512-byte transmit FIFO, 2 Kbyte receive FIFO</li> <li>■ Intelligent receive-side buffer selection</li> </ul>   |
| <b>13-Channel DMA controller</b>  | <b>Programmable Timers</b>  |
| <ul style="list-style-type: none"> <li>■ Two channels dedicated to Ethernet transmit and receive</li> <li>■ Four channels dedicated to two serial modules' transmit and receive</li> <li>■ Four channels for external peripherals. Only two channels — either 3 and 5 or 4 and 6 — can be configured at one time.</li> <li>■ Three channels available for memory-to-memory transfers</li> <li>■ Flexible buffer management</li> </ul> | <ul style="list-style-type: none"> <li>■ Two independent timers (2<math>\mu</math>s–20.7 hours)</li> <li>■ Watchdog timer (interrupt or reset on expiration)</li> <li>■ Programmable bus monitor or timer</li> </ul>  |
| <b>General purpose I/O pins</b>   | <b>Operating frequency</b>  |
| <ul style="list-style-type: none"> <li>■ 16 programmable GPIO interface pins</li> <li>■ 4 pins programmable with level-sensitive interrupt</li> </ul>   | <ul style="list-style-type: none"> <li>■ 36, 46, or 55 MHz internal clock operation from 18.432 MHz crystal</li> <li>■ <math>f_{MAX} = 36, 46, \text{ or } 55</math> (grade-dependent)</li> <li>■ System clock source by external quartz crystal or crystal oscillator, or clock signal</li> <li>■ Programmable PLL, which allows a range of operating frequencies from 10 to <math>f_{MAX}</math></li> <li>■ Maximum operating frequency from external clock or using PLL multiplication <math>f_{MAX}</math></li> </ul> |

**Serial ports**

- Two fully independent serial ports (UART, SPI)
- Digital phase lock loop (DPLL) for receive clock extractions
- 32-byte transmit/receive FIFOs
- Internal programmable bit-rate generators
- Bit rates 75–230400 in 16X mode
- Bit rates 1200 bps–4 Mbps in 1X mode
- Flexible baud rate generator, external clock for synchronous operation
- Receive-side character and buffer gap timers
- Four receive-side data match detectors

**Bus interface**

- Five independent programmable chip selects with 256 Mb addressing per chip select
- Chip select support for SRAM, FP/EDO DRAM, SDRAM, Flash, and EEPROM without external glue
- 8-, 16-, and 32-bit peripheral support
- External address decoding and cycle termination
- Dynamic bus sizing
- Internal DRAM/SDRAM controller with address multiplexer and programmable refresh frequency
- Internal refresh controller (CAS before RAS)
- Burst-mode support
- 0–63 wait states per chip select
- Address pins that configurem chip operating modes (see "NS7520 bootstrap initialization" on page 22)

**Power and Operating Voltages**

- 500 mW maximum at 55 MHz (all outputs switching)
- 418 mW maximum at 46 MHz (all outputs switching)
- 291 mW maximum at 36 MHz (all outputs switching)
- 3.3 V — I/O
- 1.5 V — Core

**Operating frequency**

The NS7520 is available in grades operating at three maximum operating frequencies: 36 MHz, 46 MHz, and 55 MHz. The operating frequency is set during bootstrap initialization, using pins A[8:0]. These address pins load the PLL Settings register on powerup reset. A[8:7] determines IS (charge pump current); A[6:5] determines FS (output divider), and A[4:0] defines ND (PLL multiplier). Each bit in A[8:0] can be set individually. See the discussion of the PLL Settings register in the *NS7520 Hardware Reference* for more information.

## Packaging and pinout

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Table 1 provides the NS7520 packaging dimensions. Figure 2 shows the NS7520 pinout and dimensions.

| Symbol | Min  | Nom      | Max  |
|--------|------|----------|------|
| A      | —    | —        | 1.4  |
| A1     | 0.35 | 0.40     | 0.45 |
| A2     | —    | —        | 0.95 |
| b      | 0.45 | 0.50     | 0.55 |
| D      |      | 13.0 BSC |      |
| D1     |      | 11.2 BSC |      |
| E      |      | 13.0 BSC |      |
| E1     |      | 11.2 BSC |      |
| e      |      | 0.8 BSC  |      |
| aaa    |      | 0.1      |      |

*Table 1: NS7520 packaging dimensions*

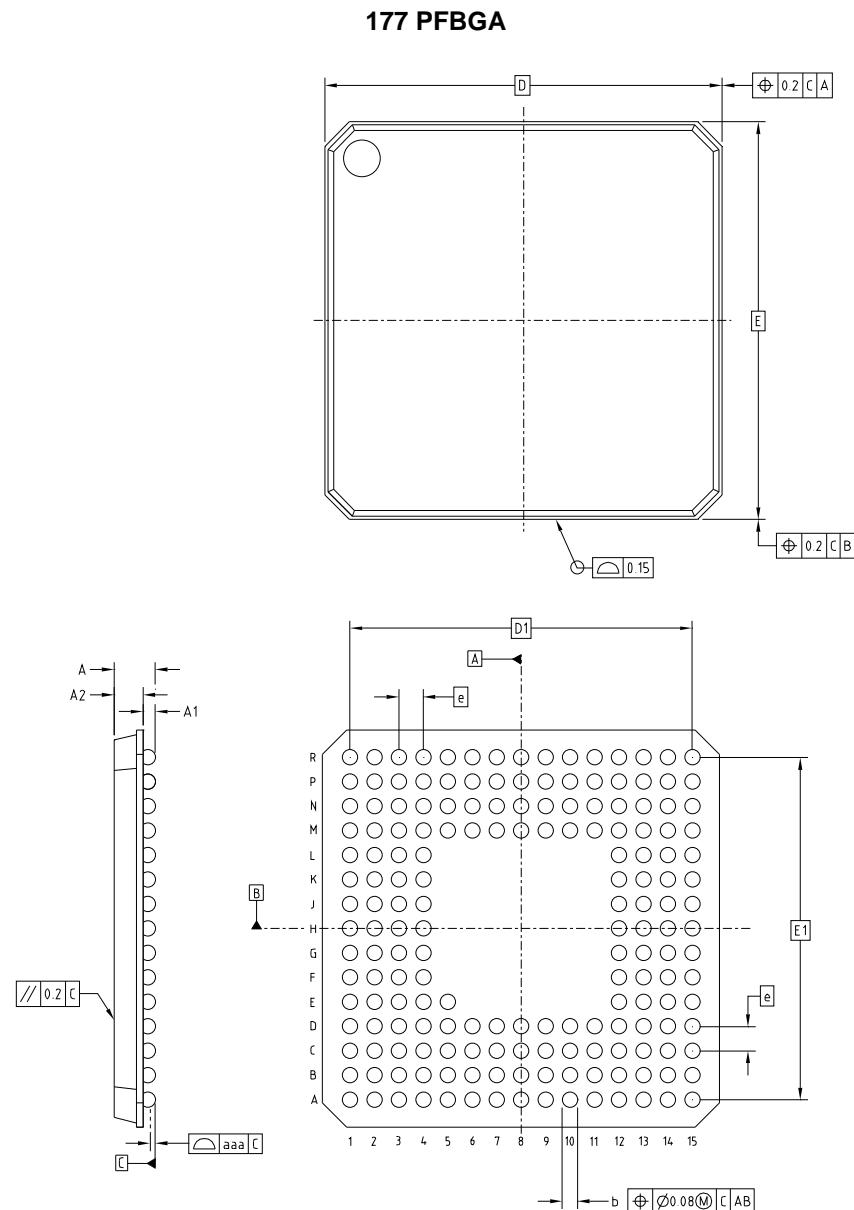


Figure 2: NS7520 pinout and dimensions

## Pinout detail tables

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Each pinout table applies to a specific interface and contains the following information:

|        |  |
|--------|--|
| Signal | The pin name for each I/O signal. Some signals have multiple function modes and are identified accordingly. The mode is configured through firmware using one or more configuration registers.   |
| Pin    | <p>The pin number assignment for a specific I/O signal.</p> <ul style="list-style-type: none"> <li>■ <b>U</b> next to the pin number indicates that the pin is a pullup resistor.</li> <li>■ <b>D</b> next to the pin number indicates that the pin is a pulldown resistor.</li> <li>■ <b>No value</b> next to the pin indicates that the pin has neither a pullup nor pulldown resistor.</li> </ul> <p>See Figure 5, "Internal pullup characteristics," on page 24 and Figure 6, "Internal pulldown characteristics," on page 25 for an illustration of the characteristics of these pins. Use the figures to select the appropriate value of the complimentary resistor to drive the signal to the opposite logic state. For those pins with no pullup or pulldown resistor, you must select the appropriate value per your design requirements.</p> |
| _      | An underscore (bar) indicates that the pin is <i>active low</i> .  |
| I/O    | The type of signal — input, output, or input/output.   |
| OD     | <p>The output drive strength of an output buffer. The NS7520 uses one of three drivers:</p> <ul style="list-style-type: none"> <li>■ 2 mA</li> <li>■ 4 mA</li> <li>■ 8 mA</li> </ul>   |

**Notes:**

- NO CONNECT as a pin description means *do not connect to this pin*.
- The 177th pin (package ball) is for alignment of the package on the PCB.

### System Bus interface

| Symbol       | Pin    | I/O   | OD  | Description                              |
|--------------|--------|-------|-----|--|
| BCLK         | A6     | 0     | 8   | Synchronous bus clock                    |
| External bus | Other  |       |     |  |
| ADDR27       | CS0OE_ | N10 U | I/O | 4  |
| ADDR26       | CS0WE_ | P10 U | I/O | 4  |
| External bus |        |       |     | <b>External bus</b>                      |
| ADDR25       | M10 U  | I/O   | 4   | Remainder of address bus (through ADDR0) |
| ADDR24       | R10 U  | I/O   | 4   |  |
| ADDR23       | N9 U   | I/O   | 4   |  |
| ADDR22       | R9 U   | I/O   | 4   |  |
| ADDR21       | M9 U   | I/O   | 4   |  |

| Symbol | Pin  | I/O | OD | Description |
|--------|------|-----|----|-------------|
| ADDR20 | N8 U | I/O | 4  |             |
| ADDR19 | P8 U | I/O | 4  |             |
| ADDR18 | M7 U | I/O | 4  |             |
| ADDR17 | R7 U | I/O | 4  |             |
| ADDR16 | N7 U | I/O | 4  |             |
| ADDR15 | R6 U | I/O | 4  |             |
| ADDR14 | M6 U | I/O | 4  |             |
| ADDR13 | P6 U | I/O | 4  |             |
| ADDR12 | N6 U | I/O | 4  |             |
| ADDR11 | M5 U | I/O | 4  |             |
| ADDR10 | P5 U | I/O | 4  |             |
| ADDR9  | N5 U | I/O | 4  |             |
| ADDR8  | R4 U | I/O | 4  |             |
| ADDR7  | R3 U | I/O | 4  |             |
| ADDR6  | R2 U | I/O | 4  |             |
| ADDR5  | M4 U | I/O | 4  |             |
| ADDR4  | N4 U | I/O | 4  |             |
| ADDR3  | R1 U | I/O | 4  |             |
| ADDR2  | M3 U | I/O | 4  |             |
| ADDR1  | N2 U | I/O | 4  |             |
| ADDR0  | P1 U | I/O | 4  |             |
| DATA31 | N1   | I/O | 4  | Data bus    |
| DATA30 | M1   | I/O | 4  |             |
| DATA29 | L3   | I/O | 4  |             |
| DATA28 | L2   | I/O | 4  |             |
| DATA27 | L4   | I/O | 4  |             |
| DATA26 | L1   | I/O | 4  |             |
| DATA25 | K3   | I/O | 4  |             |
| DATA24 | K2   | I/O | 4  |             |
| DATA23 | K1   | I/O | 4  |             |
| DATA22 | J2   | I/O | 4  |             |
| DATA21 | J3   | I/O | 4  |             |
| DATA20 | J1   | I/O | 4  |             |

| Symbol | Pin  | I/O | OD | Description   |
|--------|------|-----|----|---|
| DATA19 | H3   | I/O | 4  |   |
| DATA18 | H4   | I/O | 4  |   |
| DATA17 | H1   | I/O | 4  |   |
| DATA16 | H2   | I/O | 4  |   |
| DATA15 | G4   | I/O | 4  |   |
| DATA14 | G1   | I/O | 4  |   |
| DATA13 | G3   | I/O | 4  |   |
| DATA12 | G2   | I/O | 4  |   |
| DATA11 | F4   | I/O | 4  |   |
| DATA10 | F2   | I/O | 4  |   |
| DATA9  | F3   | I/O | 4  |   |
| DATA8  | E1   | I/O | 4  |   |
| DATA7  | E2   | I/O | 4  |   |
| DATA6  | E3   | I/O | 4  |   |
| DATA5  | D1   | I/O | 4  |   |
| DATA4  | C1   | I/O | 4  |   |
| DATA3  | B1   | I/O | 4  |   |
| DATA2  | D4   | I/O | 4  |   |
| DATA1  | D3   | I/O | 4  |   |
| DATA0  | C2   | I/O | 4  |   |
| BE3_   | D9   | I/O | 2  | Byte enable D31:D24   |
| BE2_   | A9   | I/O | 2  | Byte enable D23:D16   |
| BE1_   | C9   | I/O | 2  | Byte enable D15:D08   |
| BE0_   | B9   | I/O | 2  | Byte enable D07:D00   |
| TS_    | A8   | I/O | 4  | DO NOT USE<br>Add an external 820 ohm pullup to 3.3 V.  |
| TA_    | D8 U | I/O | 4  | Data transfer acknowledge<br>Add an external 820 ohm pullup to 3.3 V.<br>TA_ is bidirectional. It is used in input mode to terminate a memory cycle externally. It is used in output mode for reference purposes only.        |
| TEA_   | C8 U | I/O | 4  | Data transfer error acknowledge<br>Add an external 820 ohm pullup to 3.3 V.<br>TEA_ is bidirectional. It is used in input mode to terminate a memory cycle externally. It is used in output mode for reference purposes only. |

| Symbol | Pin | I/O | OD | Description        |
|--------|-----|-----|----|--------------------|
| RW_    | D6  | I/O | 2  | Transfer direction |
| BR_    | D7  |     |    | NO CONNECT         |
| BG_    | C7  |     |    | NO CONNECT         |
| BUSY_  | B7  |     |    | NO CONNECT         |

### System bus interface signal descriptions

| Mnemonic   | Signal                     | Description  |
|------------|----------------------------|--|
| BCLK       | Bus clock                  | Provides the bus clock. All system bus interface signals are referenced to the BCLK signal.  |
| ADDR[27:0] | Address bus                | Identifies the address of the peripheral being addressed by the current bus master. The address bus is bi-directional.   |
| DATA[31:0] | Data bus                   | Provides the data transfer path between the NS7520 and external peripheral devices. The data bus is bi-directional.<br><b>Recommendation:</b> Less than x32 (S)DRAM/SRAM memory configurations. Unconnected data bus pins will float during memory read cycles. Floating inputs can be a source of wasted power.<br>For other than x32 DRAM/SRAM configurations, the unused data bus signals should be pulled up.  |
| TS_        | Transfer start             | NO CONNECT   |
| BE_        | Byte enable                | Identifies which 8-bit bytes of the 32-bit data bus are active during any given system bus memory cycle. The BE_ signals are active low and bi-directional.  |
| TA_        | Transfer acknowledge       | Indicates the end of the current system bus memory cycle. This signal is driven to 1 prior to tri-stating its driver.<br>TA_ is bi-directional.  |
| TEA_       | Transfer error acknowledge | Indicates an error termination or burst cycle termination: <ul style="list-style-type: none"><li>■ In conjunction with TA_ to signal the end of a burst cycle.</li><li>■ Independently of TA_ to signal that an error occurred during the current bus cycle. TEA_ terminates the current burst cycle.</li></ul><br>This signal is driven to 1 prior to tri-stating its driver.<br>TEA_ is bi-directional. The NS7520 or the external peripheral can drive this signal. |
| RW_        | Read/write indicator       | Indicates the direction of the system bus memory cycle. RW_ high indicates a read operation; RW_ low indicates a write operation. The RW_ signal is bi-directional.  |
| BR_        | Bus request                | NO CONNECT   |
| BG_        | Bus grant                  | NO CONNECT   |
| BUSY_      | Bus busy                   | NO CONNECT   |

## Chip select controller

The NS7520 supports five unique chip select configurations.

| Symbol | Pin | I/O | OD | Description                                     |
|--------|-----|-----|----|---|
| CS4_   | B4  | O   | 4  | Chip select/DRAM RAS_                           |
| CS3_   | A4  | O   | 4  | Chip select/DRAM RAS_                           |
| CS2_   | C5  | O   | 4  | Chip select/DRAM RAS_                           |
| CS1_   | B5  | O   | 4  | Chip select/DRAM RAS_                           |
| CS0_   | D5  | O   | 4  | Chip select (boot select)                       |
| CAS3_  | A1  | O   | 4  | FP/EDO DRAM column strobe D31:D24/SDRAM RAS_    |
| CAS2_  | C4  | O   | 4  | FP/EDO DRAM column strobe D23:D16/SDRAM CAS_    |
| CAS1_  | B3  | O   | 4  | FP/EDO DRAM column strobe D15:D08/SDRAM WE_     |
| CAS0_  | A2  | O   | 4  | FP/EDO DRAM column strobe D07:D00/SDRAM A10(AP) |
| WE_    | C6  | O   | 4  | Write enable for NCC Ctrl'd cycles              |
| OE_    | B6  | O   | 4  | Output enable for NCC Ctrl'd cycles             |

### Chip select controller signal descriptions

| Mnemonic | Signal                        | Description   |
|----------|-------------------------------|---|
| CS0_     | Chip select 0                 | Unique chip select outputs supported by the NS7520. Each chip select can be configured to decode a portion of the available address space and can address a maximum of 256 Mbytes of address space. The chip selects are configured using registers in the memory module. |
| CS1_     | Chip select 1                 |   |
| CS2_     | Chip select 2                 |   |
| CS3_     | Chip select 3                 |   |
| CS4_     | Chip select 4                 | A chip select signal is driven low to indicate the end of the current memory cycle. For FP/EDO DRAM, these signals provide the RAS signal.  |
| CAS0_    | Column address strobe signals | Activated when an address is decoded by a chip select module configured for DRAM mode. The CAS_ signals are active low and provide the column address strobe function for DRAM devices.   |
| CAS1_    |                               | The CAS_ signals also identify which 8-bit bytes of the 32-bit data bus are active during any given system bus memory cycle.  |
| CAS2_    |                               | For SDRAM, CAS[3:1]_ provides the SDRAM command field. CAS0_ provides the auto-precharge signal.  |
| CAS3_    |                               | For non-DRAM settings, these signals are 1.   |
| WE_      | Write enable                  | Active low signal that indicates that a memory write cycle is in progress. This signal is activated only during write cycles to peripherals controlled by one of the chip selects in the memory module.   |
| OE_      | Output enable                 | Active low signal that indicates that a memory read cycle is in progress. This signal is activated only during read cycles from peripherals controlled by one of the chip selects in the memory module.   |

## Ethernet interface MAC

**Note:** ENDEC values for general-purpose output and TXD refer to bits in the Ethernet General Control register. ENDEC values for general-purpose input and RXD refer to bits in the Ethernet General Status register.

In this table, *GP* designates *general-purpose*.

| Symbol     | Pin          | I/O   | OD  | Description |  |
|------------|--------------|-------|-----|-------------|--|
| <b>MII</b> | <b>ENDEC</b> |       |     | <b>MII</b>  | <b>ENDEC</b>   |
| MDC        | GP output    | D10   | O   | 2           | MII management clock<br>State of (LPBK bit XOR (Mode=SEQ)) |
| MDIO       | GP output    | B10 U | I/O | 2           | MII data<br>State of UTP_STP bit                           |
| TXCLK      |              | C10   | I   |             | TX clock   |
| TXD3       | GP output    | A12   | O   | 2           | TX data 3<br>State of AUI_TP[0] bit                        |
| TXD2       | GP output    | B11   | O   | 2           | TX data 2<br>State of AUI_TP[1] bit                        |
| TXD1       | GP output    | D11   | O   | 2           | TX data 1<br>Inverted state of PDN bit, open collector     |
| TXD0       | TXD          | A11   | O   | 2           | TX data 0<br>Transmit data                                 |
| TXER       | GP output    | A13   | O   | 2           | TX code error<br>State of LNK_DIS bit                      |
| TXEN       |              | B12   | O   | 2           | TX enable  |
| TXCOL      |              | A14   | I   |             | Collision  |
| RXCRS      |              | D12   | I   |             | Carrier sense  |
| RXCLK      |              | C12   | I   |             | RX clock   |
| RXD3       | GP input     | D14   | I   |             | RX data 3<br>Read state in bit 12                          |
| RXD2       | GP input     | B15   | I   |             | RX data 2<br>Read state in bit 15                          |
| RXD1       | GP input     | A15   | I   |             | RX data 1<br>Read state in bit 13                          |
| RXD0       | RXD          | B13   | I   |             | RX data 0<br>Receive data                                  |
| RXER       | GP input     | C15   | I   |             | RX error<br>Read state in bit 11                           |
| RXDV       | GP input     | D15   | I   |             | RX data valid<br>Read state in bit 10                      |

### Ethernet interface MAC signal descriptions

The Ethernet MII (media independent interface) provides the connection between the Ethernet PHY and the MAC (media access controller).

| Mnemonic | Signal               | Description  |
|----------|----------------------|--|
| MDC      | MII management clock | Provides the clock for the MDIO serial data channel. The MDC signal is an NS7520 output. The frequency is derived from the system operating frequency per the CLKS field setting (see the CLKS field in Table 69: "MII Management Configuration register bit definition" on page 191). |

| Mnemonic                     | Signal                | Description   |
|------------------------------|-----------------------|---|
| MDIO                         | Management data IO    | A bi-directional signal that provides a serial data channel between the NS7520 and the external Ethernet PHY module.  |
| TXCLK                        | Transmit clock        | An input to the NS7520 from the external PHY module. TXCLK provides the synchronous data clock for transmit data.   |
| TXD3<br>TXD2<br>TXD1<br>TXD0 | Transmit data signals | Nibble bus used by the NS7520 to drive data to the external Ethernet PHY. All transmit data signals are synchronized to TXCLK.<br>In ENDEC mode, only TXD0 is used for transmit data.         |
| TXER                         | Transmit coding error | Output asserted by the NS7520 when an error has occurred in the transmit data stream.   |
| TXEN                         | Transmit enable       | Asserted when the NS7520 drives valid data on the TxD outputs. This signal is synchronized to TXCLK.  |
| COL                          | Transmit collision    | Input signal asserted by the external Ethernet PHY when a collision is detected.  |
| CRS                          | Receive carrier sense | Asserted by the external Ethernet PHY whenever the receive medium is non-idle.  |
| RXCLK                        | Receive clock         | An input to the NS7520 from the external PHY module. The receive clock provides the synchronous data clock for receive data.  |
| RXD3<br>RXD2<br>RXD1<br>RXD0 | Receive data signals  | Nibble bus used by the NS7520 to input receive data from the external Ethernet PHY. All receive data signals are synchronized to RXCLK.<br>In ENDEC mode, only RXD0 is used for receive data. |
| RXER                         | Receive error         | Input asserted by the external Ethernet PHY when the Ethernet PHY encounters invalid symbols from the network.  |
| RXDV                         | Receive data valid    | Input asserted by the external Ethernet PHY when the PHY drives valid data on the RXD inputs.   |

## “No connect” pins

| Pin | Description   |
|-----|---|
| R13 | Add a 15K ohm pulldown to GND (15K ohm is the recommended value; 10–20K ohms is acceptable) |
| P12 | Add a 15K ohm pulldown to GND (15K ohm is the recommended value; 10–20K ohms is acceptable) |
| N12 | Tie to GND  |
| R15 | XTALB2: NO CONNECT  |
| M11 | NO CONNECT  |
| P11 | NO CONNECT  |
| N11 | NO CONNECT  |
| R12 | NO CONNECT  |
| R14 | NO CONNECT  |
| P13 | NO CONNECT  |

**Note:** If your design implements 10-2-K ohm *pullups* instead of *pulldowns* on R13 and P12, and a pullup on N12 instead of *GND*, no action is required.

## General Purpose I/O

| GPIO signal | Serial signal        | Other signal | Pin   | I/O | OD | Serial channel description   | Other description        |
|-------------|----------------------|--------------|-------|-----|----|--|--------------------------|
| PORTA7      | TXDA                 |              | J14 U | I/O | 2  | Channel 1 TXD  |                          |
| PORTA6      | DTRA_                | DREQ1_       | J13 U | I/O | 2  | Channel 1 DTR_   | DMA channel 3/5 Req      |
| PORTA5      | RTSA_                |              | J15 U | I/O | 2  | Channel 1 RTS_   |                          |
| PORTA4      | RXCA/RIA_ / OUT1A_   |              | J12 U | I/O | 2  | Pgm'able Out/ Channel 1 RXCLK/ Channel 1 ring signal/Channel 1 SPI clock (CLK) |                          |
| PORTA3      | RXDA                 | DACK1_       | H15 U | I/O | 2  | Channel 1 RXD  | DMA channel 3/5 ACK      |
| PORTA2      | DSRA_                | AMUX         | H12 U | I/O | 2  | Channel 1 DSR_   | DRAM addr mux            |
| PORTA1      | CTSA_                | DONE1_(O)    | H13 U | I/O | 2  | Channel 1 CTS_   | DMA channel 3/5 DONE_Out |
| PORTA0      | TXCA/ OUT2A_ / DCDA_ | DONE1_(I)    | G12 U | I/O | 2  | Pgm'able Out/ Channel 1 DCD/ Channel 1 SPI enable (SEL_)/ Channel 1 TXCLK      | DMA channel 3/5 DONE_In  |

| GPIO signal         | Serial signal        | Other signal     | Pin   | I/O | OD | Serial channel description   | Other description                              |
|---------------------|----------------------|------------------|-------|-----|----|--|--|
| PORTC7              | TXDB                 |                  | G13 U | I/O | 2  | Channel 2 TXD  | GEN interrupt out                              |
| PORTC6              | DTRB_                | DREQ2_           | G14 U | I/O | 2  | Channel 2 DTR_   | DMA Channel 4/6 Req                            |
| PORTC5              | RTSB_                | REJECT_          | F15 U | I/O | 2  | Channel 2 RTS_   | CAM reject                                     |
| PORTC4 <sup>1</sup> | RXCB/RIB_ / OUT1B_   | RESET_           | F12 U | I/O | 2  | Pgm'able Out/ Channel 2 RXCLK/ Channel 2 ring signal/Channel 2 SPI clock (CLK) | RESET output                                   |
| PORTC3 <sup>2</sup> | RXDB                 | LIRQ3/ DACK2_    | F13 U | I/O | 2  | Channel 2 RXD  | Level sensitive IRQ / DMA channel 4/6 ACK      |
| PORTC2 <sup>2</sup> | DSRB_                | LIRQ2/RPSF_      | E15 U | I/O | 2  | Channel 2 DSR_   | Level sensitive IRQ/ CAM request               |
| PORTC1 <sup>2</sup> | CTSB_                | LIRQ1/ DONE2_(O) | E12 U | I/O | 2  | Channel 2 CTS_   | Level sensitive IRQ / DMA channel 4/6 DONE_Out |
| PORTC0 <sup>2</sup> | TXCB/ OUT2B_ / DCDB_ | LIRQ0/ DONE2_(I) | E14 U | I/O | 2  | Pgm'able Out/ Channel 2 DCD/ Channel 2 SPI enable (SEL_)/ Channel 2 TXCLK      | Level sensitive IRQ / DMA channel 4/6 DONE_In  |

**Notes:**

- 1 RESET output indicates the reset state of the NS7520. PORTC4 persists beyond the negation of RESET\_ for approximately 512 clock cycles if the PLL is disabled. When the PLL is enabled, PORTC4 persists beyond the negation of RESET\_ to allow for PLL lock for 100 microseconds times the ratio of the VCO to XTALA.

This GPIO is left in output mode active following a hardware RESET.

- 2 PORTC[3:0] pins provide level-sensitive interrupts. The inputs do not need to be synchronous to any clock. The interrupt remains active until cleared by a change in the input signal level.

## System clock and reset

| Symbol        | Pin | I/O | OD | Description                   |
|---------------|-----|-----|----|-------------------------------|
| XTALA1        | K14 | I   |    | ARM/system oscillator circuit |
| XTALA2        | K12 | O   |    |                               |
| PLLVDD (1.5V) | L15 | P   |    | PLL clean power               |
| PLLVSS        | L12 | P   |    | PLL return                    |
| RESET_        | A10 | I   |    | System reset                  |

### Signal descriptions

The NS7520 has three clock domains:

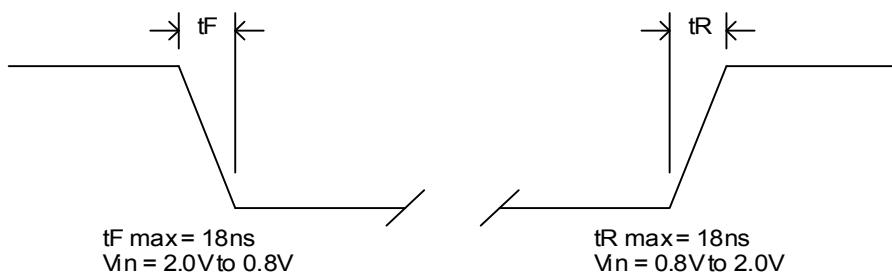
- System clock (SYSCLK)
- Bit rate generation and programmable timer reference clock (XTALA1/2)
- System bus clock (BCLK)

The SYS module provides the NS7520 with these clocks, as well as system reset and backup resources.

| Mnemonic | Signal                            | Description   |
|----------|-----------------------------------|---|
| XTALA1   | Oscillator input                  | A standard parallel quartz crystal or crystal oscillator can be attached to these pins to provide the main input clock to the NS7520. |
| XTALA2   | Oscillator output                 |   |
| PLLVDD   | Clean PLL power                   | Power and ground for PLL circuit.   |
| PLLVSS   | Connect directly to the GND plane |   |
| RESET_   | System reset                      | Resets the NS7520 hardware.   |

Table 2: Clock generation and reset signal description

This figure shows the timing and specification for RESET\_ rise/fall times:



## System mode (test support)

PLLTST<sub>\_</sub>, BISTEN<sub>\_</sub>, and SCANEN<sub>\_</sub> primary inputs control different test modes for both functional and manufacturing test operations (see Table 3: "NS7520 test modes" on page 22).

| Symbol              | Pin | I/O | OD | Description  |
|---------------------|-----|-----|----|--|
| PLLTST <sub>_</sub> | N15 | I   |    | Encoded with BISTEN <sub>_</sub> and SCANEN <sub>_</sub><br>Add an external pullup to 3.3V or pulldown to GND. |
| BISTEN <sub>_</sub> | M15 | I   |    | Encoded with PLLTST <sub>_</sub> and SCANEN <sub>_</sub><br>Add an external pullup to 3.3V or pulldown to GND. |
| SCANEN <sub>_</sub> | L13 | I   |    | Encoded with BISTEN <sub>_</sub> and PLLTST <sub>_</sub><br>Add an external pullup to 3.3V or pulldown to GND. |

## JTAG test

JTAG boundary scan allows a tester to check the soldering of all signal pins and tri-state all outputs.

| Symbol            | Pin   | I/O | OD | Description  |
|-------------------|-------|-----|----|--|
| TDI               | N14 U | I   |    | Test data in.  |
| TDO               | M13   | O   | 2  | Test data out.   |
| TMS               | M12 U | I   |    | Test mode select.  |
| TRST <sub>_</sub> | M14   | I   |    | Test mode reset.<br>Requires external termination when not being used (see Figure 3, "TRST <sub>_</sub> termination," on page 17 for an illustration of the termination circuit on the development PCB). |
| TCK               | P15   | I   |    | Test mode clock.<br>Add an external pullup to 3.3V.  |

## ARM debugger signal descriptions

| Mnemonic          | Signal           | Description   |
|-------------------|------------------|---|
| TDI               | Test data in     | TDI operates the JTAG standard. Consult the JTAG specifications for use in boundary-scan testing. These signals meet the requirements of the Raven and Jeeni debuggers.               |
| TDO               | Test data out    | TDO operates the JTAG standard. Consult the JTAG specifications for use in boundary-scan testing. These signals meet the requirements of the Raven and Jeeni debuggers.               |
| TMS               | Test mode select | TMS operates the JTAG standard. Consult the JTAG specifications for use in boundary-scan testing. These signals meet the requirements of the Raven and Jeeni debuggers.               |
| TRST <sub>_</sub> | Test mode reset  | TRST <sub>_</sub> operates the JTAG standard. Consult the JTAG specifications for use in boundary-scan testing. These signals meet the requirements of the Raven and Jeeni debuggers. |

| Mnemonic | Signal          | Description   |
|----------|-----------------|---|
| TCK      | Test mode clock | TCK operates the JTAG standard. Consult the JTAG specifications for use in boundary-scan testing. These signals meet the requirements of the Raven and Jeeni debuggers. |

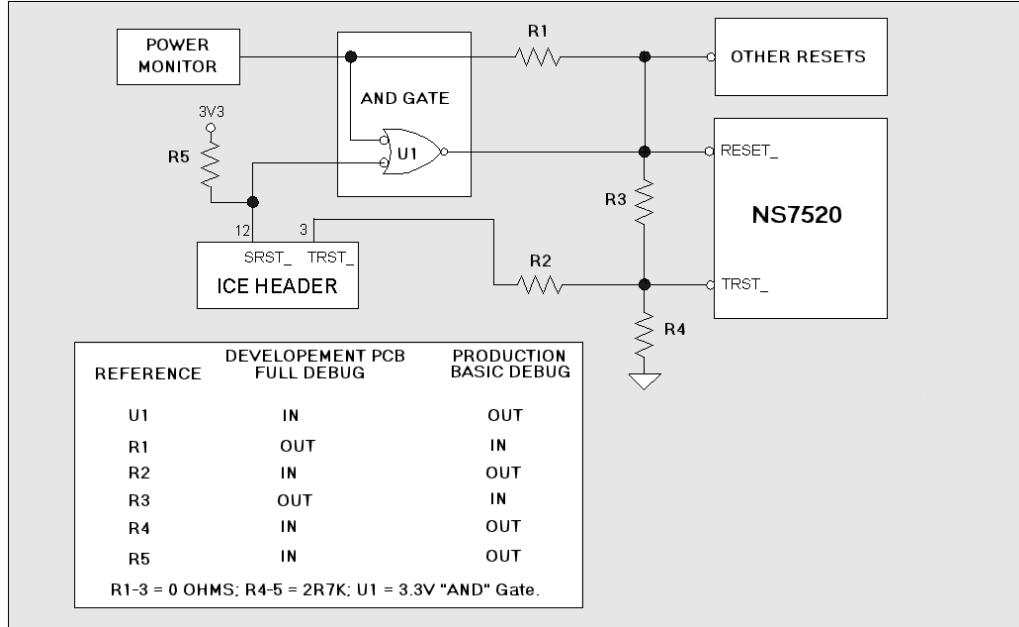


Figure 3: TRST\_ termination

## Power supply

| Signal                | Pin   | Description             |
|-----------------------|---|-------------------------|
| Oscillator VCC (3.3V) | N13, C3   | Oscillator power supply |
| Core VCC (1.5V)       | R8, L14, C14, C13   | Core power supply       |
| I/O VCC (3.3V)        | E4, K4, M2, N3, P3, R5, H14, F14, B8, A3  | I/O power supply        |
| GND                   | D2, F1, J4, P4, P7, M8, P9, R11, K15, G15, E13, D13, B14, C11, A7, A5, B2, P2, P14, K13 | Ground                  |

## NS7520 modules

### CPU module

The CPU uses an ARM7TDMI core processor. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, which result in high instruction throughput and impressive real-time interrupt response for a small, cost-effective circuit. For more information about ARM7TDMI, see the ARM7TDMI Data Sheet from ARM Ltd. ([www.arm.com](http://www.arm.com)).

### GEN module

The GEN module provides the NS7520 with its main system control functions, as well as these features:

- Two programmable timers with interrupt
- One programmable bus-error timer
- One programmable watchdog timer
- Two 8-bit programmable general-purpose I/O ports

### System (SYS) module

The system module provides the system clock (SYS\_CLK) and system reset (SYS\_RESET) resources.

The system control signals determine the basic operation of the chip:

| Signal mnemonic               | Signal name    | Description   |
|-------------------------------|----------------|---|
| {XTALA1, XTALA2}              | Clock source   | Operate in one of two ways: <ul style="list-style-type: none"> <li>■ The signals are affixed with a 10-20 MHz parallel mode quartz crystal or crystal oscillator and the appropriate components per the component manufacturer.</li> <li>■ XTALA1 is driven with a clock signal and XTALA2 is left open.</li> </ul> |
| {PLLVDD, PLLVSS}              | PLL power      | Provide an isolated power supply for the PLL.   |
| RESET_                        | Chip reset     | Active low signal asserted to initiate a hardware reset of the chip.  |
| {TDI, TDO, TNS, TRST_, TCK}   | JTAG interface | Provide a JTAG interface for the chip. This interface is used for both boundary scan and ICE control of the internal processor.   |
| {PLLTTEST_, BISTEN_, SCANEN_} | Chip mode      | Encoded to determine the chip mode.   |

The NS7520 clock module creates the BCLK and FXTAL signals. Both signals are used internally, but BCLK can also be accessed at ball A6 by setting the BCLKD field in the System Control register to 0.

- BCLK functions as the system clock and provides the majority of the NS7520's timing.
- FXTAL provides the timing for the DRAM refresh counter, can be selected instead of BCLK to provide timing for the watchdog timer, the two internal timers, and the Serial module.

## **B Bus module**

The B Bus module provides the data path among NS7520 internal modules. This module provides the address and data multiplexing logic that supports the data flow through the NS7520. The B Bus module is the central arbiter for all the NS7520 bus masters and, once mastership is granted, handles the decoding of each address to one (or none) of the NS7520 modules.

## **Memory module (MEM)**

The MEM module provides a glueless interface to external memory devices such as Flash, DRAM, and EEPROM. The memory controller contains an integrated DRAM controller and supports five unique chip select configurations.

The MEM module monitors the B Bus interface for access to the bus module; that is, any access not addressing internal resources. If the address to be used corresponds to a Base Address register in the MEM module, the MEM module provides the memory access signals and responds to the B Bus with the necessary completion signal.

The MEM module can be configured to interface with FP, EDO, or SDRAM (synchronous DRAM), although the NS7520 cannot interface with more than one device type at a time.

## **DMA controller**

The NS7520 contains one DMA controller, with 13 DMA channels. Each DMA channel moves blocks of data between memory and a memory peripheral.

The DMA controller supports both fly-by operations and memory-to-memory operations:

- When configured for fly-by operation, the DMA controller transfers data between one of the NS7520 peripherals and a memory location.
- When configured for memory-to-memory operations, the DMA controller uses a temporary holding register between read and write operations. Two memory cycles are executed.

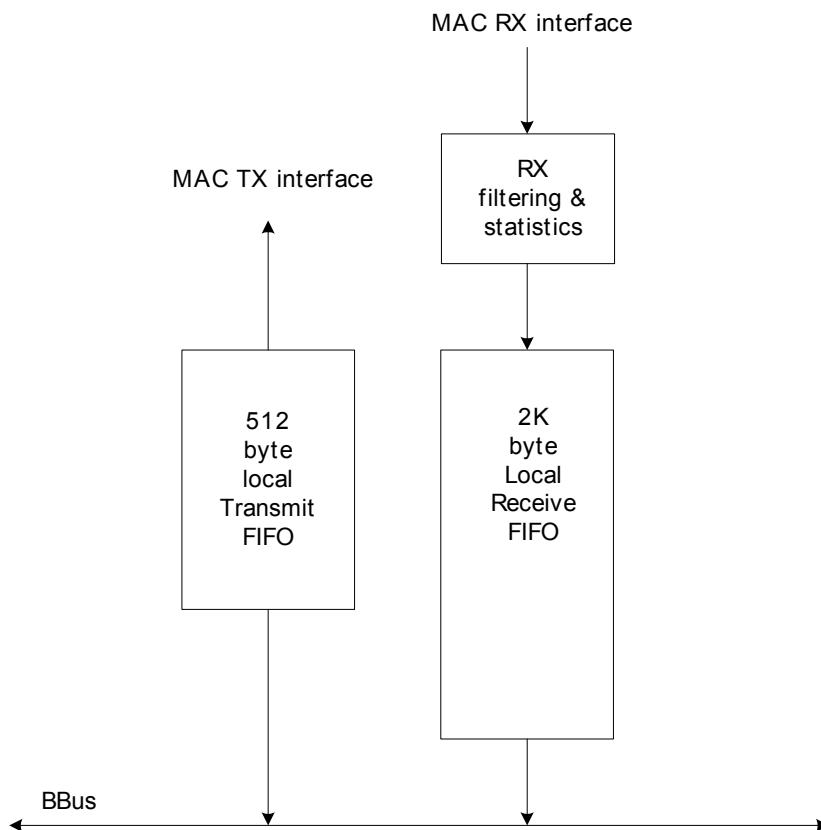
## **Ethernet controller**

The Ethernet controller provides the NS7520 with one IEEE 802.3u compatible Ethernet interface. The Ethernet interface includes the Ethernet front-end (EFE) and media access controller (MAC).

The Ethernet module supports both media independent interface (MII) and ENDEC modes.

The MAC module interfaces to an external physical layer (PHY) device using the MII standard defined by IEEE 802.3u. The MAC interface includes the MII clock and data signals.

Figure 4 shows a high-level block diagram of the EFE module, which provides the FIFO handling interface between the NS7520 BBus and the MAC modules.



**Figure 4: EFE module block diagram**

## Serial controller

The NS7520 supports two independent universal asynchronous/synchronous receiver/transmitter channels. Each channel supports these features:

- Independent programmable bit-rate generator
- UART and SPI (master) modes
- High-speed data transfer:
  - x1 mode: 4Mbits/sec
  - x16 mode: 230 Kbits/sec
- 32-byte TX FIFO
- 32-byte RX FIFO
- Programmable data format: 5-8 data bits; odd, even, or no parity; 1, 2 stop bits
- Programmable channel modes: normal, local loopback, remote loopback
- Control signal support
- Maskable interrupt conditions:
  - Receive break detection
  - Receive framing error
  - Receive parity error
  - Receive overrun error
  - Receive FIFO ready
  - Receive FIFO half-full
  - Transmit FIFO ready
  - Transmit FIFO half-empty
  - CTS, DSR, DCD, RI state change detection
- Clock/data encoding: NRZ, NRZB, NRZI, FM, Manchester
- Multi-drop capable

## NS7520 bootstrap initialization

Many internal NS7520 features are configured when the RESET pin is asserted. The address bus configures the appropriate control register bits at powerup. This table shows which bits control which functions:

| Address bit | Name                    | Description                    |                                 |
|-------------|-------------------------|--------------------------------|---------------------------------|
| ADDR[27]    | Endian configuration    | 0                              | Little Endian configuration     |
|             |                         | 1                              | Big Endian configuration        |
| ADDR[26]    | CPU bootstrap           | 0                              | CPU disabled; GEN_BUSER=1       |
|             |                         | 1                              | CPU enabled; GEN_BUSER=0        |
| ADDR[24:23] | CS0/MMCR[19:18] setting | 00                             | 8-bit SRAM, 63 wait-states/b00  |
|             |                         | 01                             | 32-bit SRAM, 63 wait-states/b01 |
|             |                         | 10                             | 32-bit SRAM                     |
|             |                         | 11                             | 16-bit SRAM, 63 wait-states/b11 |
| ADDR[19:9]  | GEN_ID setting          | GEN_ID=A[19:09], default='h3ff |                                 |
| ADDR[8:7]   | PLL IS setting          | IS=A[8:7], default='b10        |                                 |
| ADDR[6:5]   | PLL FS setting          | FS=A[6:5], default='b00        |                                 |
| ADDR[4:0]   | PLL ND setting          | ND=A[4:0], default='b01011     |                                 |

**Table 3: NS7520 test modes**

## JTAG

The NS7520 provides full support for 1149.1 JTAG boundary scan testing. All NS7520 pins can be controlled using the JTAG interface port. The JTAG interface provides access to the ARM7TDMI debug module when the appropriate combination of `PLLTST_`, `BISTEN_`, and `SCANEN_` is selected (as shown in Table 3: "NS7520 test modes").

## ARM Debug

The ARM7TDMI core uses a JTAG TAP controller that shares the pins with the TAP controller used for 1149.1 JTAG boundary scan testing. To enable the ARM7TDMI TAP controller, `{PLLTST_,BISTEN_,SCANEN_}` must be set as shown in Table 3: "NS7520 test modes".

## DC characteristics and other operating specifications

The NS7520 operates using an internal core  $V_{DD}$  supply voltage of 1.5V. A 3.3V supply is required for the I/O cells, which drive/accept 3.3V levels.

Table 4 provides the DC characteristics for inputs; Table 5 provides the DC characteristics for outputs.

| Sym      | Parameter          | Conditions | Min            | Typ | Max | Unit |
|----------|--------------------|------------|----------------|-----|-----|------|
| $V_{IH}$ | Input high voltage |            | 2.0            | 3.6 |     | V    |
| $V_{IL}$ | Input low voltage  |            | $V_{SS} - 0.3$ | 0.8 |     | V    |

**Table 4: DC characteristics — Inputs**

| Sym      | Parameter             | Conditions               | Min | Max      | Unit |   |
|----------|-----------------------|--------------------------|-----|----------|------|---|
| P        | Power consumption     | $F_{SYSCLK} = 55$ MHz    | 508 |          | mW   |   |
|          |                       | Core                     |     | 192      | mW   |   |
|          |                       | I/O                      |     | 316      | mW   |   |
|          | $F_{SYSCLK} = 46$ MHz |                          | 425 |          | mW   |   |
|          |                       | Core                     |     | 161      | mW   |   |
|          |                       | I/O                      |     | 264      | mW   |   |
|          | $F_{SYSCLK} = 36$ MHz |                          | 333 |          | mW   |   |
|          |                       | Core                     |     | 126      | mW   |   |
|          |                       | I/O                      |     | 207      | mW   |   |
| $V_{OL}$ | Output low voltage    | Outputs & bi-directional | 0   | 0.4      |      | V |
| $V_{OH}$ | Output high voltage   | Outputs & bi-directional | 2.4 | $V_{DD}$ |      | V |

**Table 5: DC characteristics — Outputs**

Table 6 defines the DC operating (thermal) conditions for the NS7520. Operating the NS7520 outside these conditions results in unpredictable behavior.

| Sym        | Parameter              | Conditions | Min | Typ | Max | Unit |
|------------|------------------------|------------|-----|-----|-----|------|
| $V_{DD}$   | Core supply voltage    |            | 1.4 | 1.5 | 1.6 | V    |
| $V_{CC}$   | I/O supply voltage     |            | 3.0 | 3.3 | 3.6 | V    |
| $T_{OP}$   | Ambient temperature    |            | -40 |     | 85  | °C   |
| $T_J$      | Junction temperature   |            |     | 110 |     | °C   |
| $T_{STG}$  | Storage temperature    |            | -40 |     | 125 | °C   |
| $\theta_J$ | Pkg thermal resistance |            |     | 50  |     | °C/W |
| $I_{IH}$   | Input threshold        | No pullup  | -10 |     | 10  | µA   |

**Table 6: Recommended operating temperatures**

## Absolute maximum ratings

| Sym      | Parameter             | Conditions | Min | Typ | Max | Unit    |
|----------|-----------------------|------------|-----|-----|-----|---------|
| $I_{IL}$ | Input current as "0"  | No pullup  | 10  | 10  | 10  | $\mu A$ |
| $I_{OZ}$ | HighZ leakage current | Any input  | -10 | -10 | 10  | $\mu A$ |
| $C_{IO}$ | Pin capacitance       | $V_O=0$    |     | 7   | 7   | pF      |

Table 6: Recommended operating temperatures

## Absolute maximum ratings

This table defines the maximum values for the voltages that the NS7520 can withstand without being damaged.

| Sym       | Parameter           | Min  | Max  |
|-----------|---------------------|------|------|
| $V_{DD}$  | Core supply voltage | -0.3 | 3.15 |
| $V_{CC}$  | I/O supply voltage  | -0.3 | 3.9  |
| $V_{IN}$  | Input voltage       | -0.3 | 3.9  |
| $V_{OUT}$ | Output voltage      | -0.3 | 3.9  |

## Pad pullup and pulldown characteristics

Figure 5 illustrates characteristics for a pad with internal pullup; Figure 6 illustrates characteristics for a pad with internal pulldown. See "Pinout detail tables," beginning on page 6, for information about which pins use pullup and pulldown resistors.

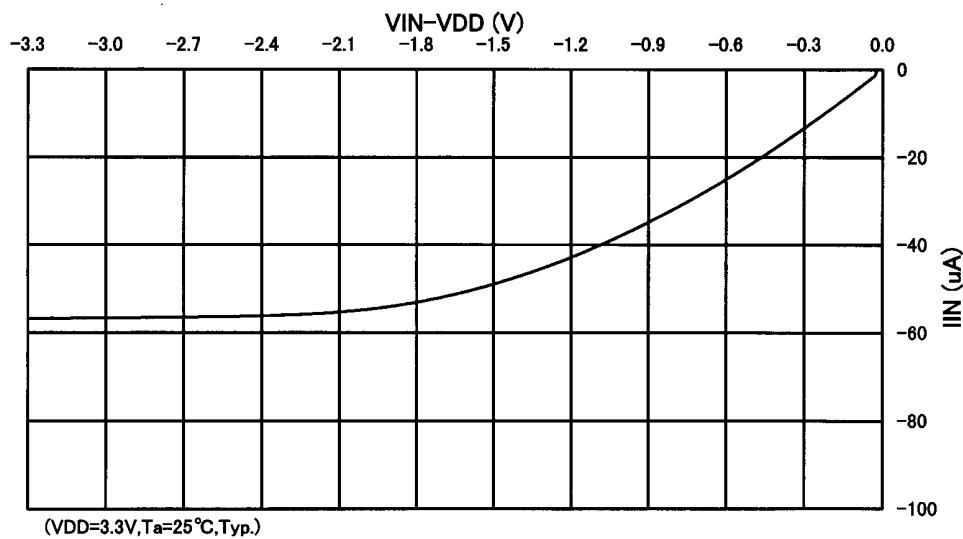
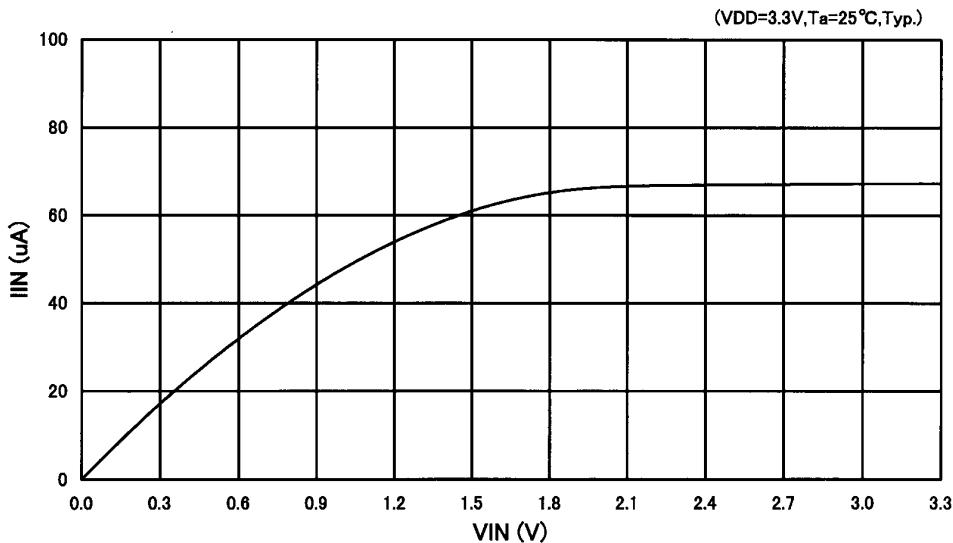


Figure 5: Internal pullup characteristics



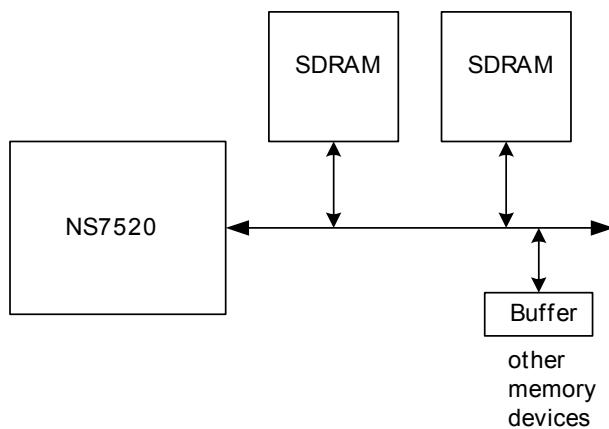
*Figure 6: Internal pulldown characteristics*

## AC characteristics

AC electrical specifications define the timing relationship between signals for interfaces and modes within a given interface.

### AC electrical specifications

The AC electrical specifications are based on the system configuration shown in Figure 7, with a 5pF allowance for PCB capacitance and a 0.25 ns allowance for PCB delay. The timing of the buffers, SDRAM, and the like must be added to complete timing analysis. In systems where SDRAM is not used, two devices are expected to replace the SDRAMs shown in Figure 7; that is, they are tied directly to the chip. System loading information is shown in Table 7: "System loading details" on page 26.

**Figure 7: System configuration for specified timing**

| Signal   | Estimated load (pF) | Device loads                                  |
|--|---------------------|---|
| BCLK   | 23                  | Two SDRAMs, 1 clock buffer/clock input to PLD |
| A[27:0], CAS[3:0]_   | 23                  | Two SDRAM An, 1 buffer/PLD                    |
| CS[4:0]_   | 13                  | Two SDRAM CSn, 1 buffer PLD                   |
| DATA[31:0]   | 18                  | One SDRAM DQ, 1 buffer/PLD                    |
| BE* _  | 19                  | One SDRAM DQ, 1 buffer/PLD                    |
| TS_, TA_, TEA_, BR_, BG_, BUSY_, WE_,<br>OE_               | 15                  | 1 buffer/PLD                                  |
| PORTA3, PORTA1, PORTC3, PORTC1<br>(operating external DMA) | 15                  | 1 buffer/PLD                                  |
| Other PORTA[*] and PORTC[*], TDO                           | 85                  | Tester load                                   |
| MDC, MDIO, TXEN, TXER, TXD[3:0]                            | 20                  | One PHY                                       |

**Table 7: System loading details**

Exceeding the loading shown in Table 7 can result in additional signal delay. The delay can be approximated by derating the output buffer based on the expected load capacitance per the values shown in Table 8.

| Signal   | Derating (ns/pF) |
|--|------------------|
| BCLK   | 0.069            |
| A[27:0], TS_, TA_, TEA_, BR_, BG_, BUSY_, DATA[31:0] | 0.150            |
| BE[3:0]  | 0.300            |

**Table 8: Output buffer derating by load capacitance**

| Signal                            | Derating (ns/pF) |
|-----------------------------------|------------------|
| CS[4:0]_, CAS[3:0], RW_, WE_, OE_ | 0.137            |
| MDC, TXD[3:0], TXER, TXEN, TDO    | 0.274            |

Table 8: Output buffer derating by load capacitance

## Oscillator Characteristics

Figure 8 illustrates the recommended oscillator circuit details.

- **Rise/fall time.** The max rise/fall time on the system clock input pin is 1.5ns when used with an external oscillator.
- **Duty cycle.** The duty cycle is system-dependent with an external oscillator. It affects the setup and hold times of signals that change in the falling clock edges, such as WE\_/OE\_.

**Recommendation:** Use a 3.3V, 50±10% duty cycle oscillator with a 100 ohm series resistor at the output. The PLLs can handle a 25% duty cycle clock (minimum high/low time 4.5nS).

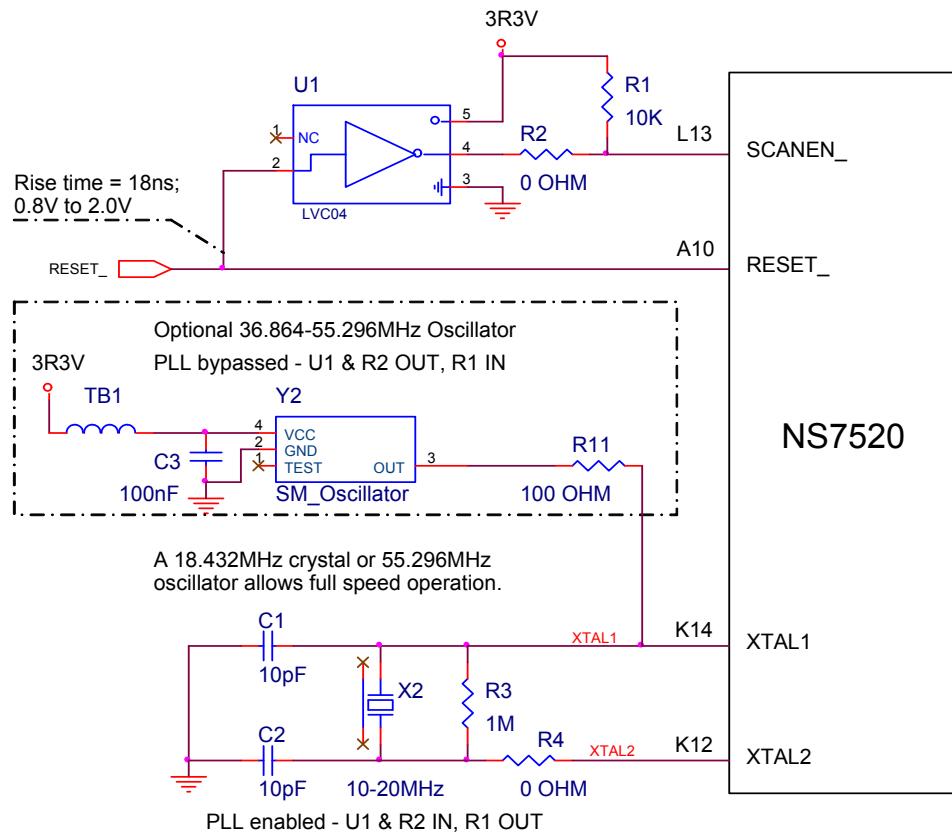


Figure 8: Oscillator circuit details

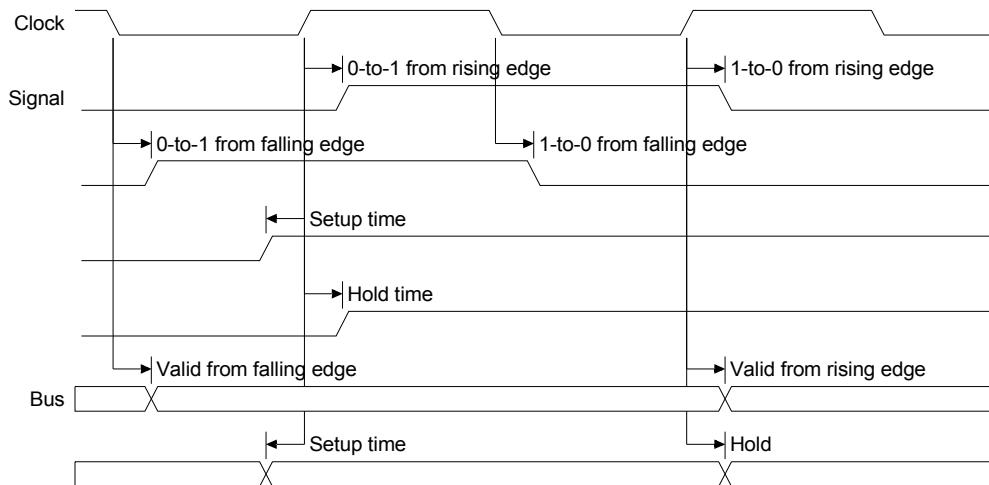
## Timing Diagrams

### Timing Specifications

All timing specifications consist of the relationship between a reference clock and a signal:

- There are bussed and non-bussed signals. Non-bussed signals separately illustrate 0-to-1 and 1-to-0 transitions.
- Inputs have setup/hold times versus clock rising.
- Outputs have switching time relative to either clock rising or clock falling.

**Note:** Timing relationships in this diagram are drawn without proportion to actual delay.



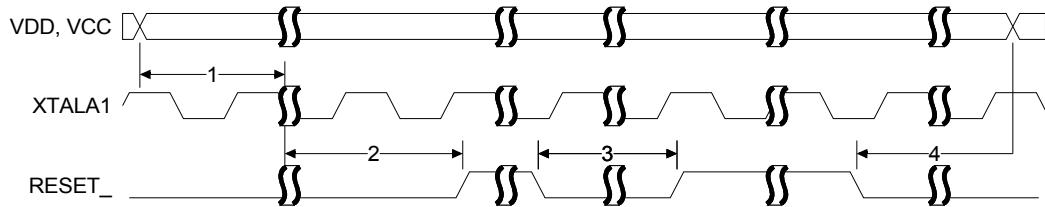
## Reset\_timing

From a cold start, RESET\_ must be asserted until all power supplies are above their specified thresholds. An additional 8 microseconds is required for oscillator settling time (allow 40ms for crystal startup).

Due to an internal three flip-flop delay on the external RESET\_ signal, after the oscillator is settled, RESET\_ must be asserted for three periods of the XTALA1 clock in these situations:

- Before release of reset after application of power
- While valid power is maintained to initiate *hot reset* (reset while power is at or above specified thresholds)
- Before loss of valid power during power outage/power down

The PORTC4 output indicates the reset state of the chip. PORTC4 persists beyond the negation of RESET\_ for approximately 512 system clock cycles if the PLL is disabled. When the PLL is enabled, PORTC4 persists beyond the negation of RESET\_ to allow for PLL lock for 100 microseconds times the ratio of the VCO to XTALA.



### Reset timing parameters

| Num | Description                         | Min | Typ | Max | Units   |
|-----|-------------------------------------|-----|-----|-----|---|
| 1   | Power valid before reset negated    | 40  |     |     | ms  |
|     |                                     |     |     |     | <b>Note:</b> RESET_ should remain low for at least 40ms after power reaches 3.0V. |
| 2   | Reset asserted after power valid    | 3   |     |     | $T_{XTALA1}$  |
| 3   | Reset asserted while power valid    | 3   |     |     | $T_{XTALA1}$  |
| 4   | Reset asserted before power invalid | 3   |     |     | $T_{XTALA1}$  |

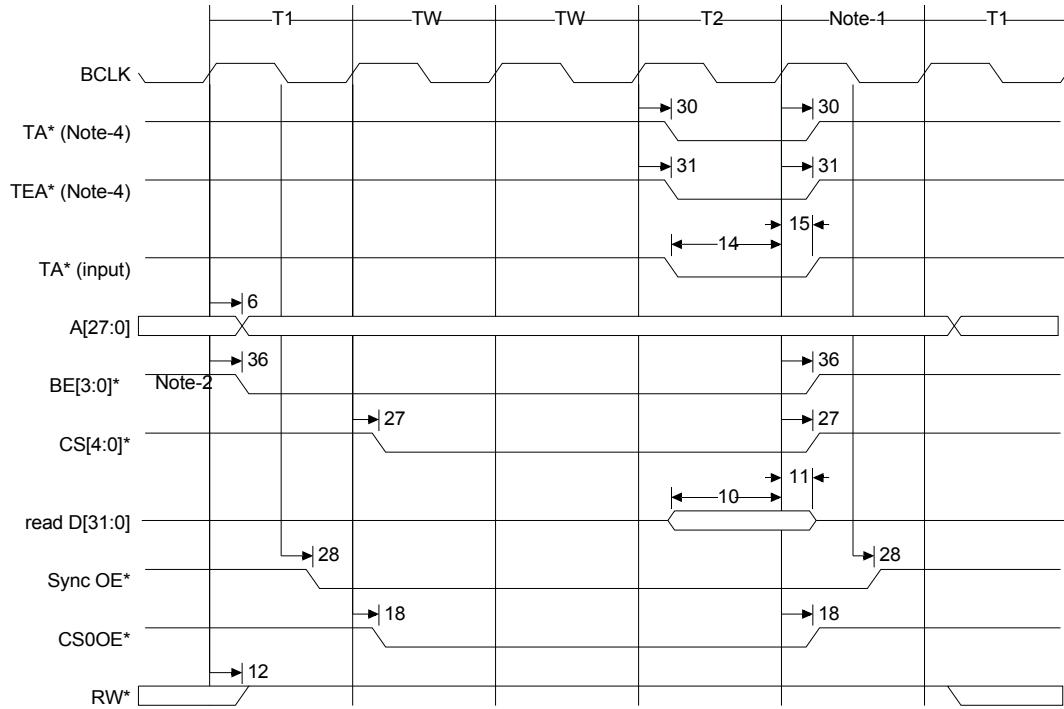
**SRAM timing***BCLK max frequency: 55.296 MHz*

Operating conditions:

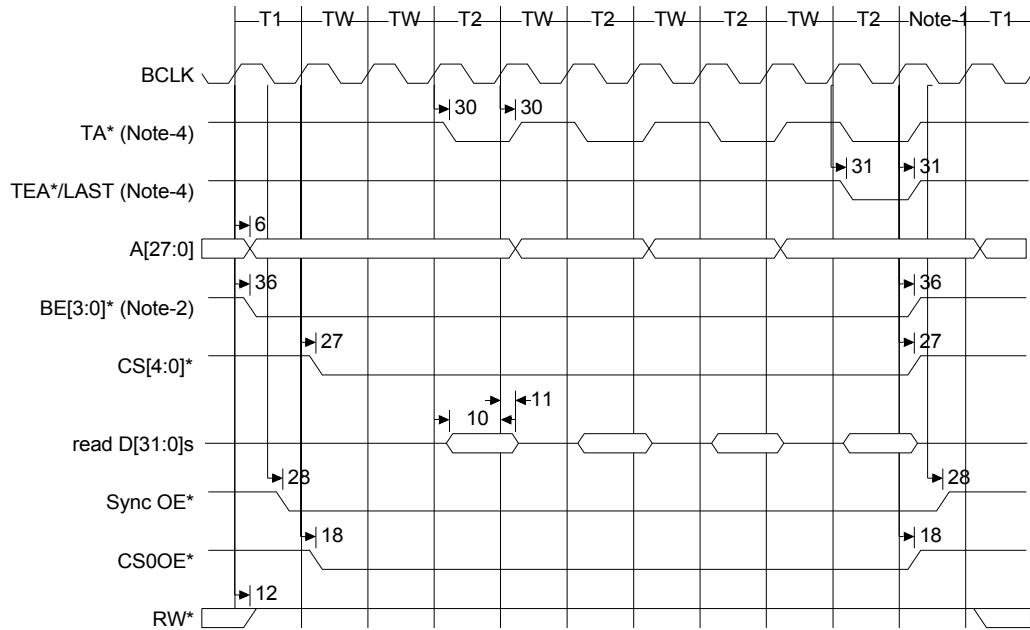
Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

***SRAM timing parameters***

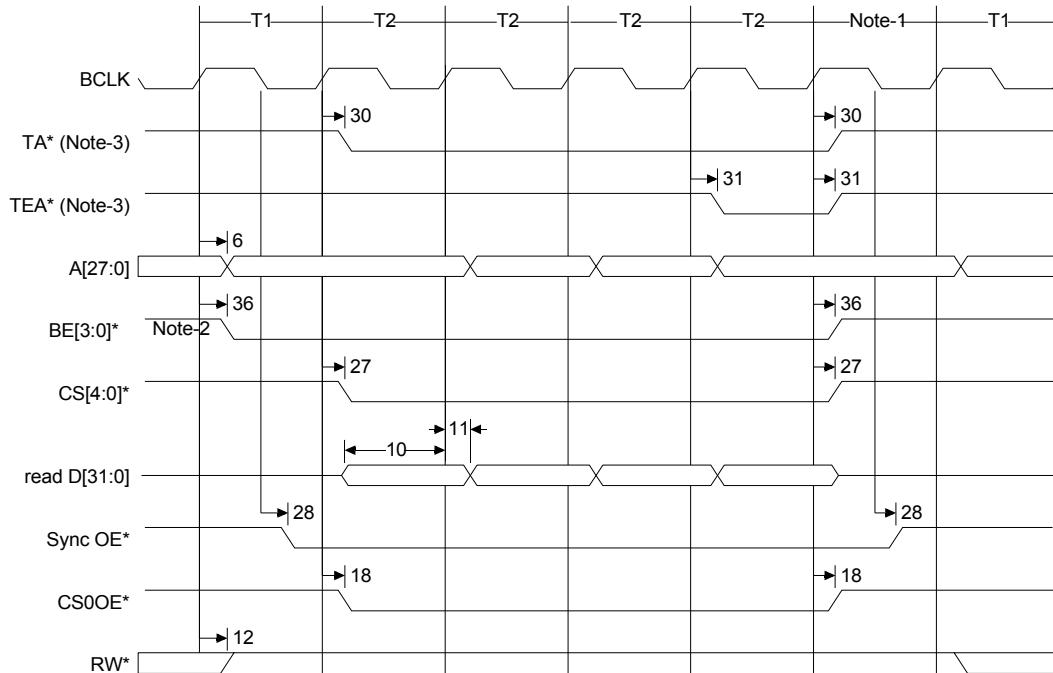
| Num | Description                          | Min | Max  | Unit |
|-----|--------------------------------------|-----|------|------|
| 36  | BCLK high to BE* valid               |     | 15.5 | ns   |
| 6   | BCLK high to address valid           | 5   | 13.5 | ns   |
| 9   | BCLK high to data out valid          |     | 14   | ns   |
| 13  | BCLK high to data out high impedance |     | 13   | ns   |
| 10  | Data in valid to BCLK high (setup)   | 5   |      | ns   |
| 11  | BCLK high to data in invalid (hold)  | 3   |      | ns   |
| 14  | TA* valid to BCLK high (setup)       | 5   |      | ns   |
| 15  | BCLK high to TA* invalid (hold)      | 3   |      | ns   |
| 27  | BCLK high to CS* valid               |     | 12.5 | ns   |
| 28  | BCLK low to OE* valid                |     | 12.5 | ns   |
| 29  | BCLK low to WE* valid                |     | 13   | ns   |
| 30  | BCLK high to TA* valid               |     | 13.5 | ns   |
| 31  | BCLK high to TEA* valid              |     | 16   | ns   |
| 18  | BCLK low to A27 (CS0OE*) valid       |     | 13.5 | ns   |
| 19  | BCLK low A26 (CS0WE*) valid          |     | 13.5 | ns   |
| 12  | BCLK high to RW* valid               |     | 13.5 | ns   |

***SRAM read*****CS\* controlled read (wait = 2)****Notes:**

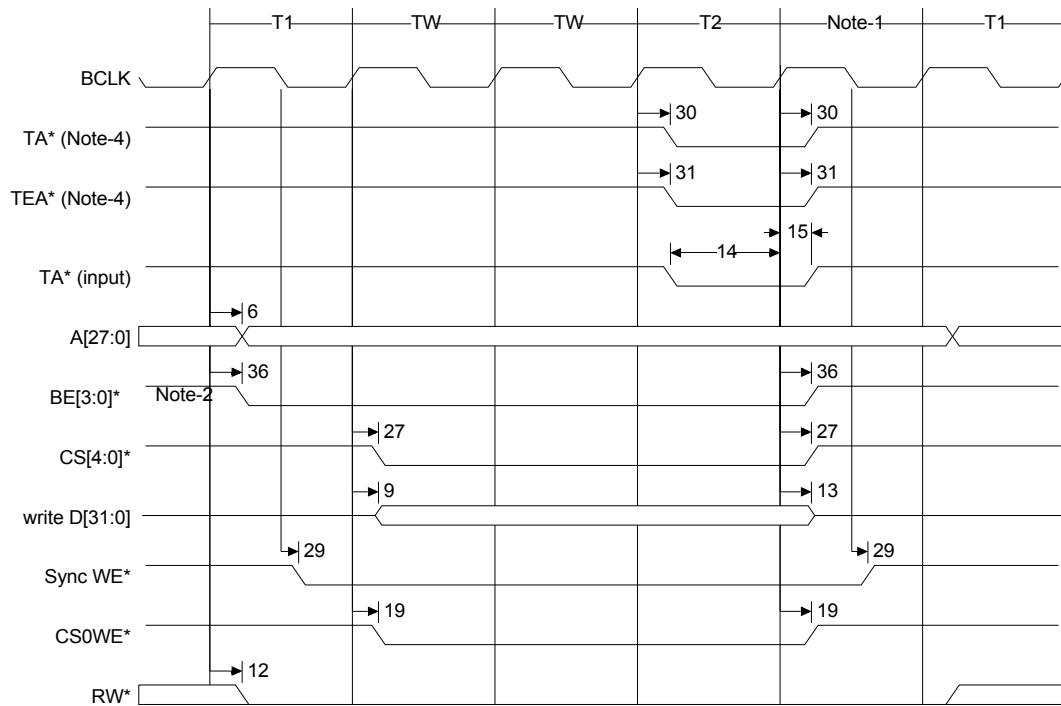
- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

***SRAM burst read*****CS\* controlled, four word (4-2-2-2), burst read (wait = 2, BCYC = 01)****Notes:**

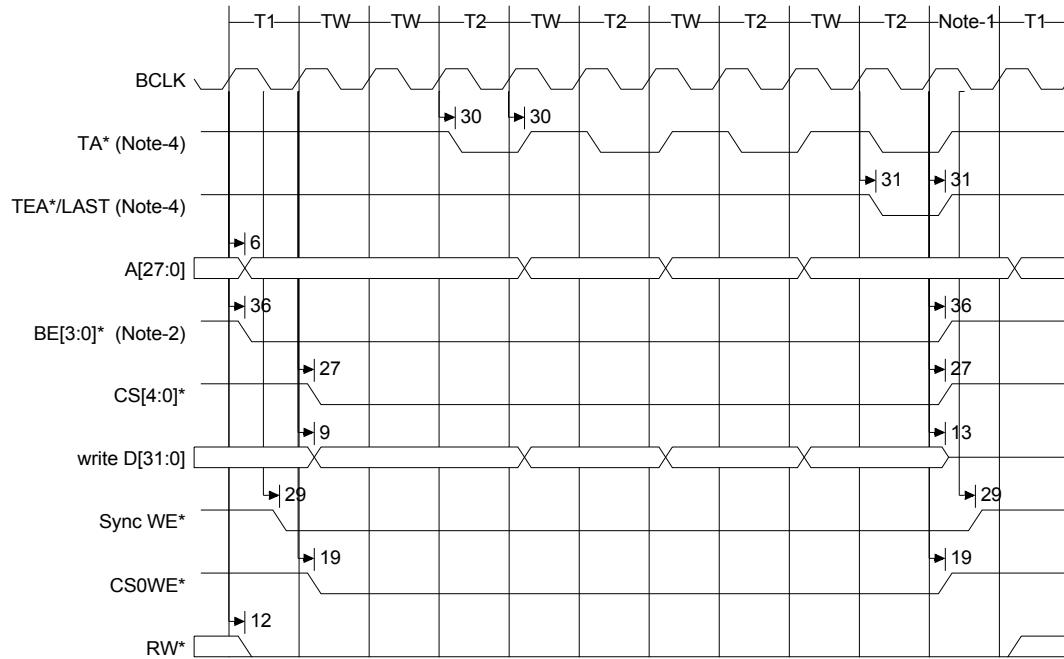
- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

***SRAM burst read (2111)*****CS\* controlled read (wait = 0, BCYC = 00)****Notes:**

- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TA\* and TEA\*/LAST signals are for reference only.

**SRAM write****CS controlled write (internal and external), (wait = 2)****Notes:**

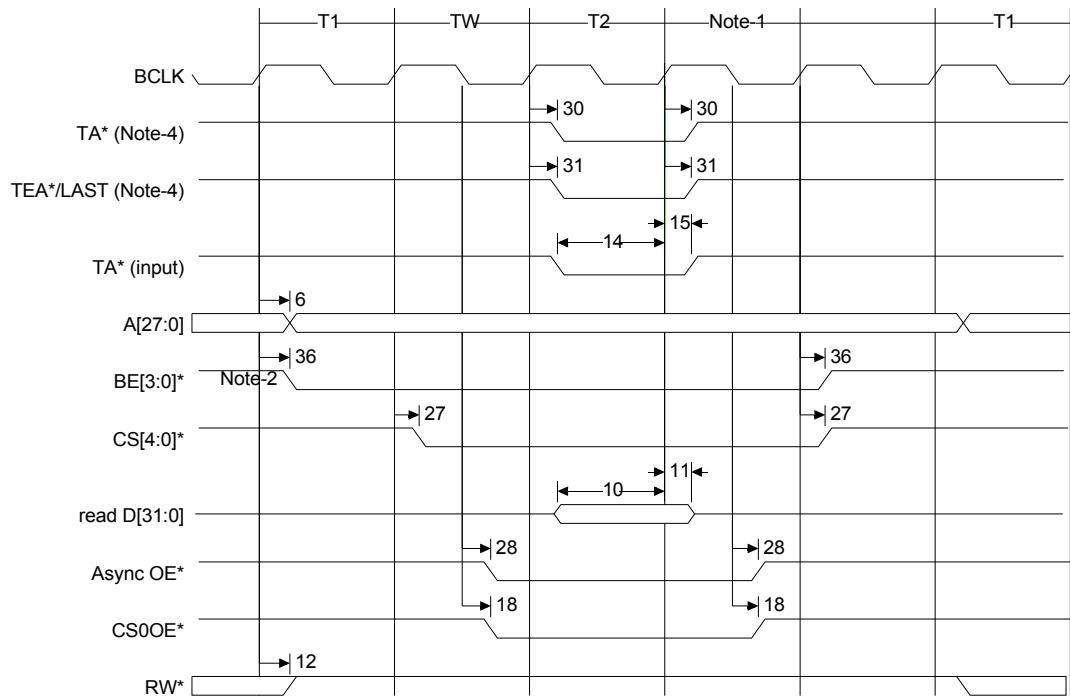
- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

***SRAM burst write*****CS controlled, four word (4-2-2-2), burst write (wait = 2, BCYC = 01)****Notes:**

- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

### *SRAM OE read*

### OE\* controlled read (wait = 2)

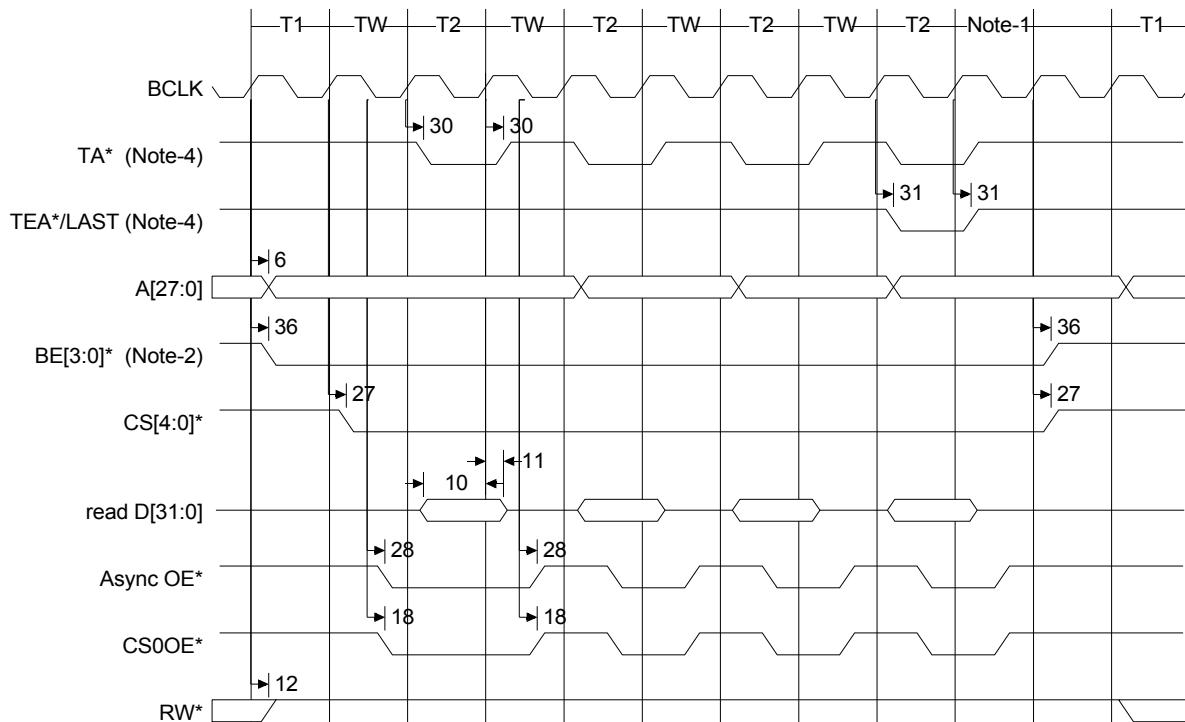


## Notes:

- 1 At least one null period occurs between memory transfers. More null periods can occur if the next transfer is DMA. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

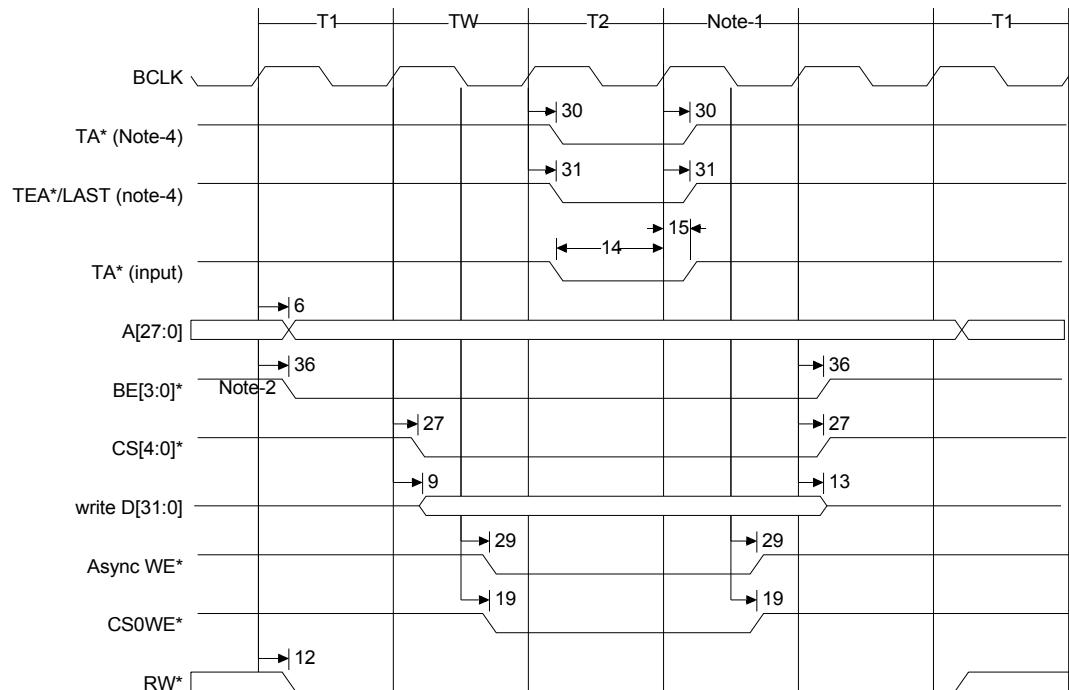
### *SRAM OE burst read*

### OE\* controlled, four word (3-2-2-2), burst read (wait = 2, BCYC = 01)

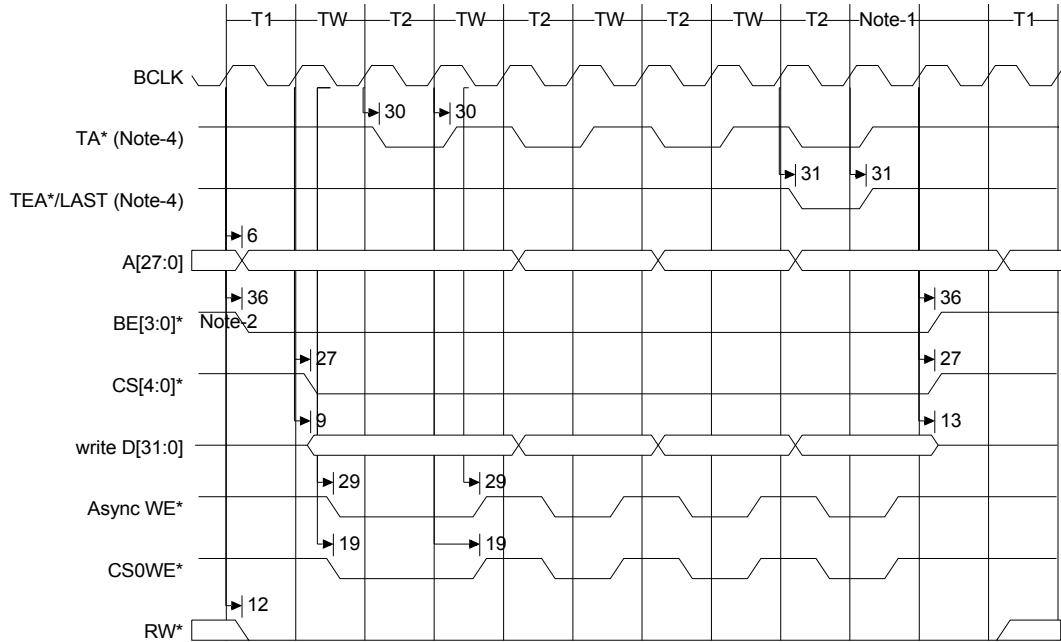


## Notes:

- 1 At least one null period occurs between memory transfers. More null periods can occur if the next transfer is DMA. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

**SRAM WE write****WE\* controlled write (wait = 2)****Notes:**

- 1 At least one null period occurs between memory transfers. More null periods can occur if the next transfer is DMA. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

**SRAM WE burst write****WE\* controlled, four word (3-2-2-2), burst write (wait = 2, BCYC = 01)****Notes:**

- 1 At least one null period occurs between memory transfers. More null periods can occur if the next transfer is DMA. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:0]
  - 32-bit port = BE[3:0]
- 3 The TW cycles are present when the WAIT field is set to 2 or more.
- 4 The TA\* and TEA\*/LAST signals are for reference only.

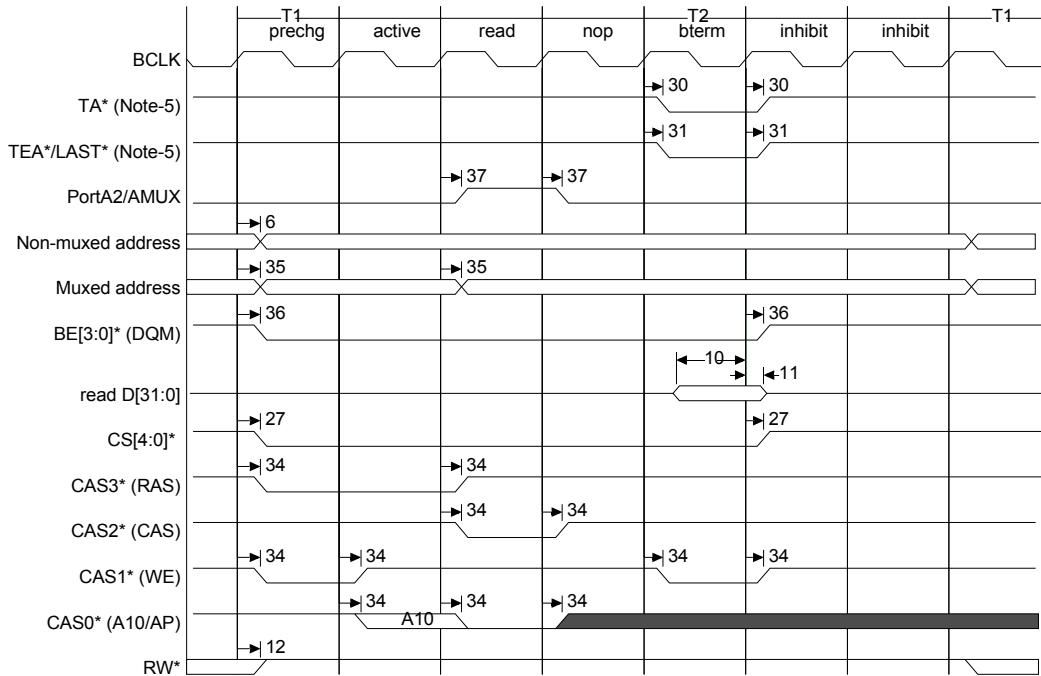
**SDRAM timing***BCLK max frequency: 55.296 MHz*

Operating conditions:

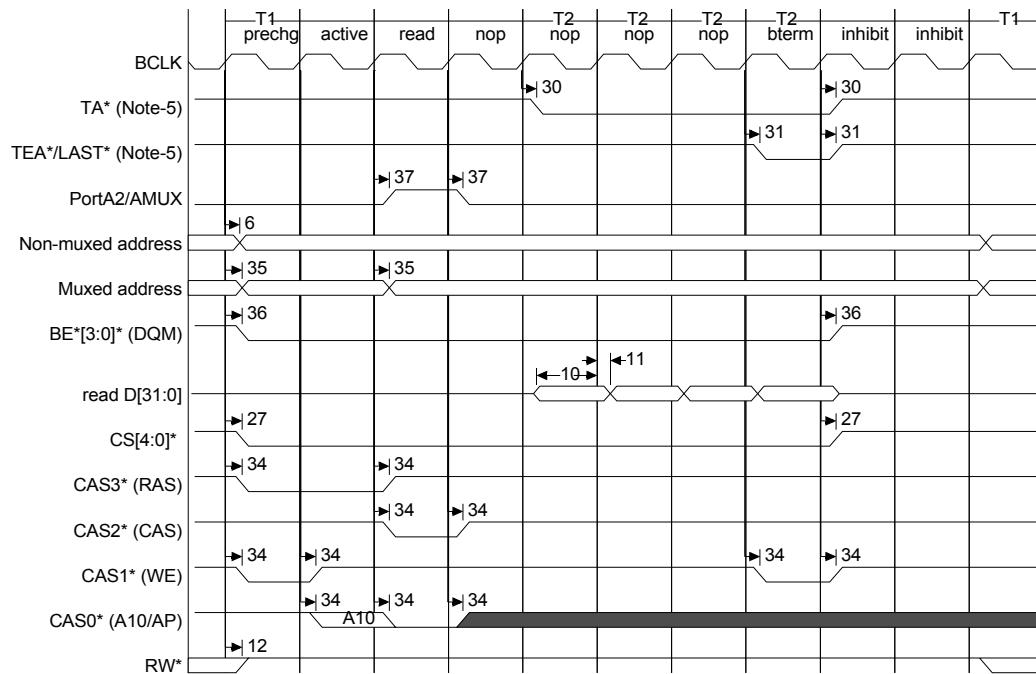
Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

***SDRAM timing parameters***

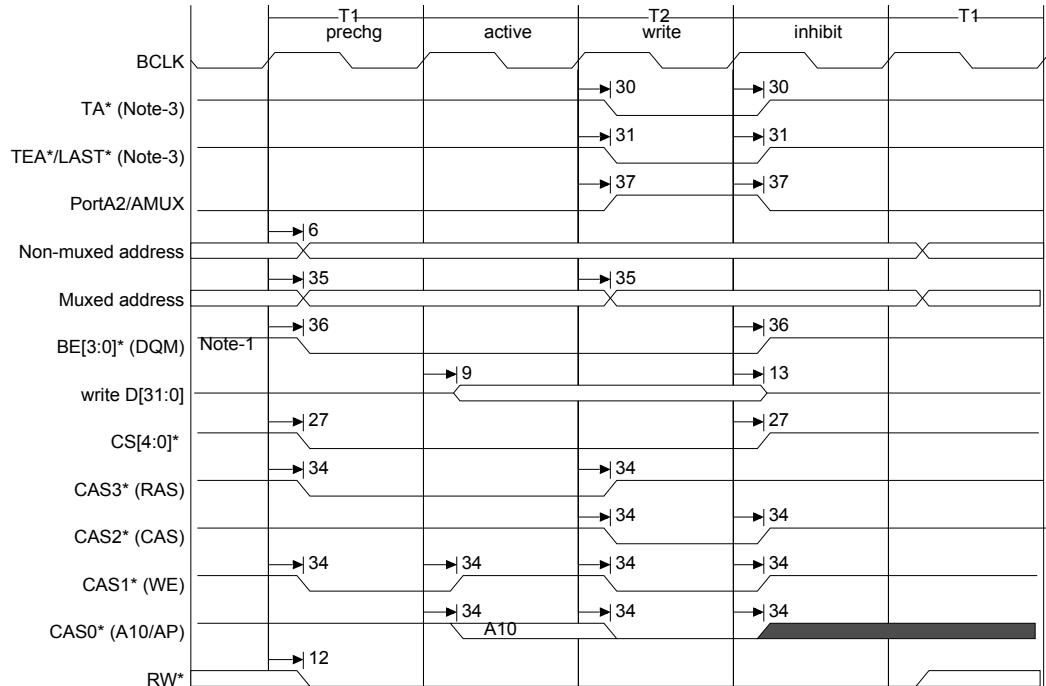
| Num | Description                          | Min | Max  | Unit |
|-----|--------------------------------------|-----|------|------|
| 36  | BCLK high to BE*/DQM* valid          |     | 15.5 | ns   |
| 6   | BCLK high to non-muxed address valid | 5   | 13.5 | ns   |
| 9   | BCLK high to data out valid          |     | 14   | ns   |
| 13  | BCLK high to data out high impedance |     | 13   | ns   |
| 10  | Data in valid to BCLK high (setup)   | 5   |      | ns   |
| 11  | BCLK high to data in invalid (hold)  | 3   |      | ns   |
| 27  | BCLK high to CS* valid               |     | 15.5 | ns   |
| 30  | BCLK high to TA* valid               |     | 13.5 | ns   |
| 31  | BCLK high to TEA* valid              |     | 16   | ns   |
| 37  | BCLK high to PORTA2/AMUX valid       |     | 14   | ns   |
| 35  | BCLK high to muxed address valid     | 6   | 14.5 | ns   |
| 34  | BCLK high to CAS* valid              |     | 12   | ns   |
| 12  | BCLK high to RW* valid               |     | 13.5 | ns   |

**SDRAM read****SDRAM read, CAS latency = 2****Notes:**

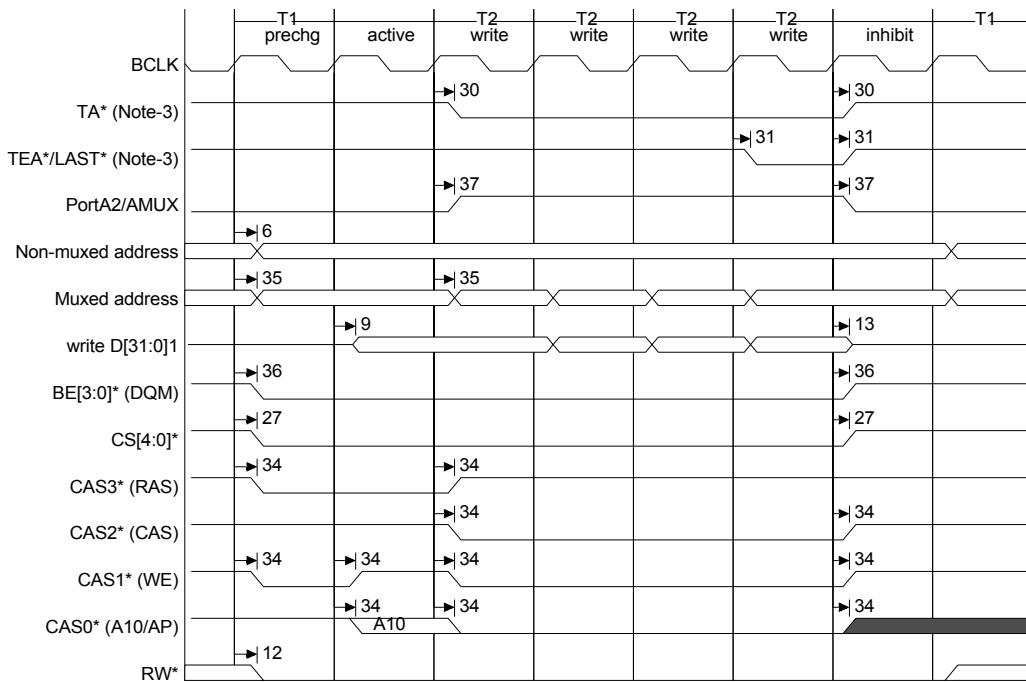
- 1 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 2 The precharge and/or active commands are not always present. These commands depend on the address of the previous SDRAM access.
- 3 If CAS latency = 3, 2 NOPs occur between the read and burst terminate commands.
- 4 If CAS latency = 3, 3 inhibits occur after burst terminate.
- 5 The TA\* and TEA\*/LAST signals are for reference only.

**SDRAM burst read****SDRAM read, CAS latency = 2****Notes:**

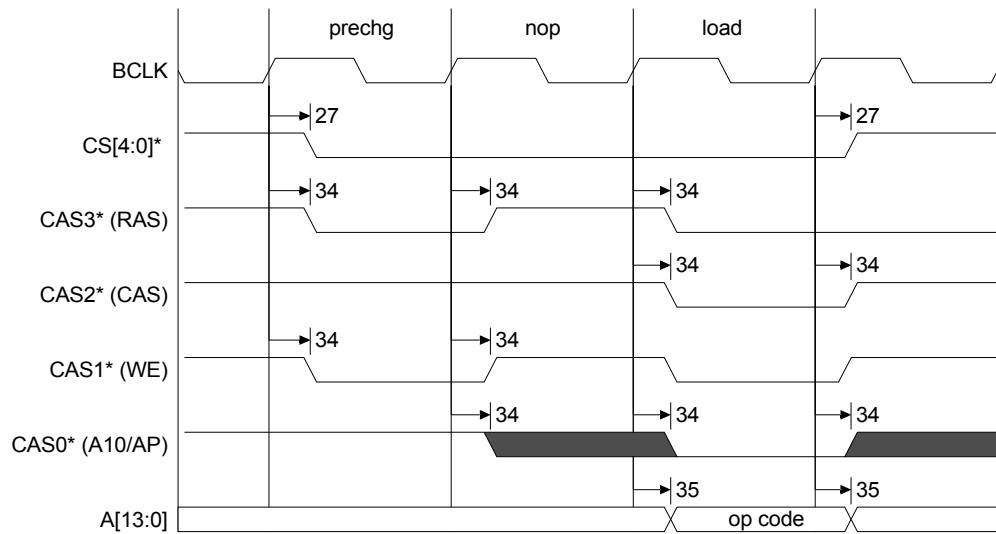
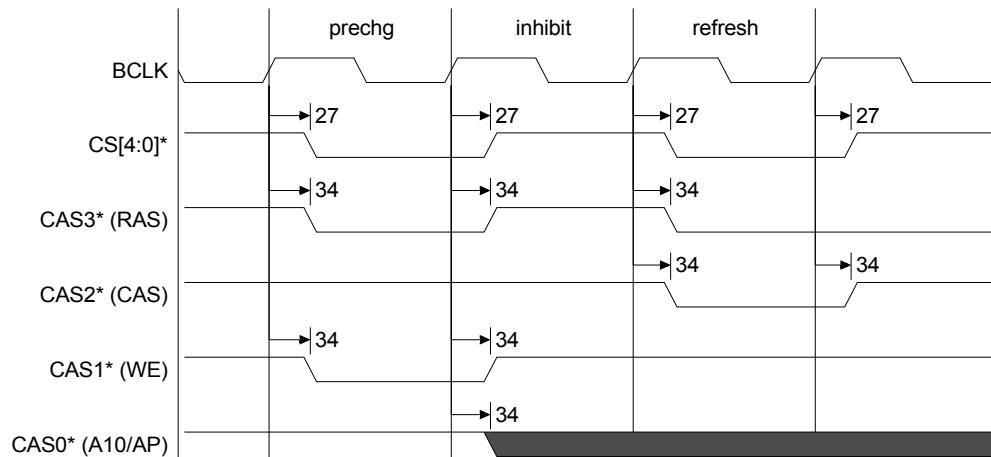
- 1 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 2 The precharge and/or active commands are not always present. These commands depend on the address of the previous SDRAM access.
- 3 If CAS latency = 3, 5 NOPs occur between the read and burst terminate commands.
- 4 If CAS latency = 3, 3 inhibits occur after burst terminate.
- 5 The TA\* and TEA\*/LAST signals are for reference only.

**SDRAM write****SDRAM write****Notes:**

- 1 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 2 The precharge and/or active commands are not always present. These commands depend on the address of the previous SDRAM access.
- 3 The TA\* and TEA\*/LAST signals are for reference only.

**SDRAM burst write****SDRAM burst write****Notes:**

- 1 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 2 The precharge and/or active commands are not always present. These commands depend on the address of the previous SDRAM access. When the active command is not present, parameter #35 is valid during the write (T2) cycle.
- 3 The TA\* and TEA\*/LAST signals are for reference only.

**SDRAM load mode****SDRAM refresh**

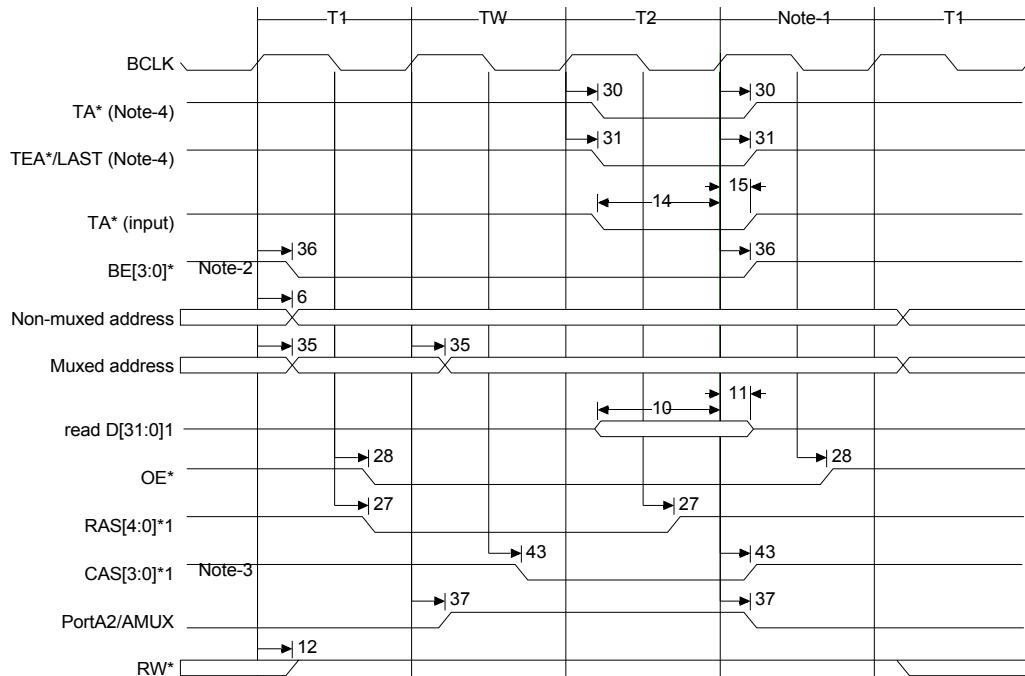
**FP DRAM timing***BCLK max frequency: 55.296 MHz*

Operating conditions:

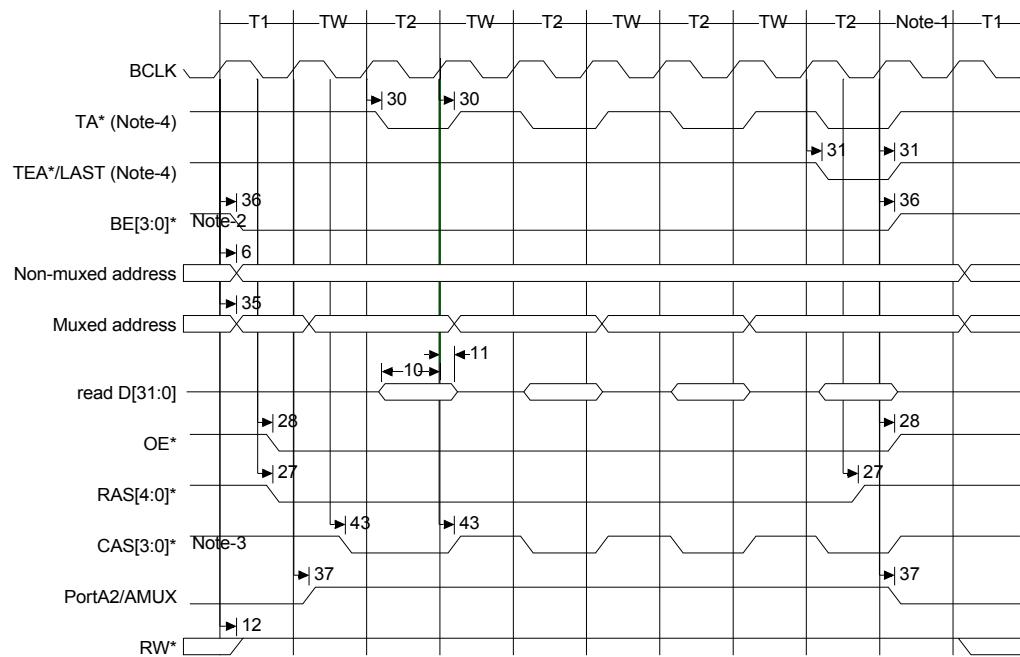
Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

**FP DRAM timing parameters**

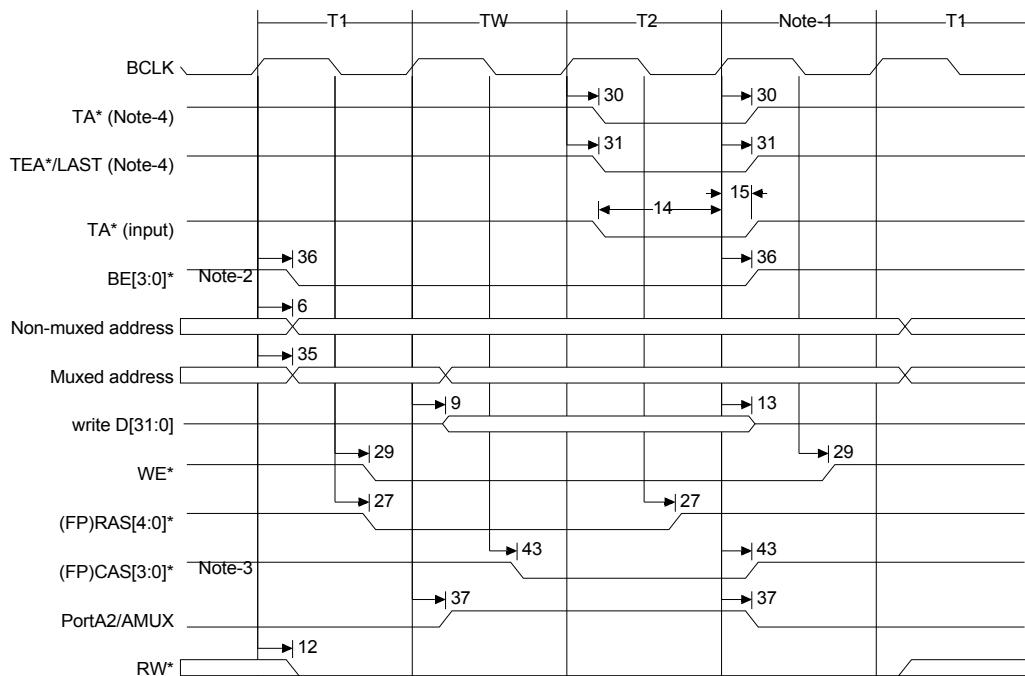
| Num | Description                          | Min | Max  | Unit |
|-----|--------------------------------------|-----|------|------|
| 36  | BCLK high to BE* valid               |     | 15.5 | ns   |
| 6   | BCLK high to address valid           | 5   | 13.5 | ns   |
| 9   | BCLK high to data out valid          |     | 14   | ns   |
| 13  | BCLK high to data out high impedance |     | 13   | ns   |
| 10  | Data in valid to BCLK high (setup)   | 5   |      | ns   |
| 11  | BCLK high to data in invalid (hold)  | 3   |      | ns   |
| 14  | TA* valid to BCLK high (setup)       | 5   |      | ns   |
| 15  | BCLK high to TA* invalid (hold)      | 3   |      | ns   |
| 28  | BCLK low to OE* valid                |     | 12.5 | ns   |
| 29  | BCLK low to WE* valid                |     | 13   | ns   |
| 30  | BCLK high to TA* valid               |     | 13.5 | ns   |
| 31  | BCLK high to TEA* valid              |     | 16   | ns   |
| 37  | BCLK high to PORTA2/AMUX valid       |     | 14   | ns   |
| 35  | BCLK high to muxed address valid     | 6   | 14.5 | ns   |
| 43  | BCLK low to CAS* valid               |     | 13   | ns   |
| 27  | BCLK low to RAS* valid               |     | 12   | ns   |
| 12  | BCLK high to RW* valid               |     | 13.5 | ns   |

**FP DRAM read****Fast Page read****Notes:**

- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 3 Port size determines which CAS signals are active:
  - 8-bit port = CAS3\*
  - 16-bit port = CAS[3:2]
  - 32-bit port = CAS[3:0]
- 4 The TA\* and TEA\*/LAST signals are for reference only.

**FP DRAM burst read****Fast Page burst read****Notes:**

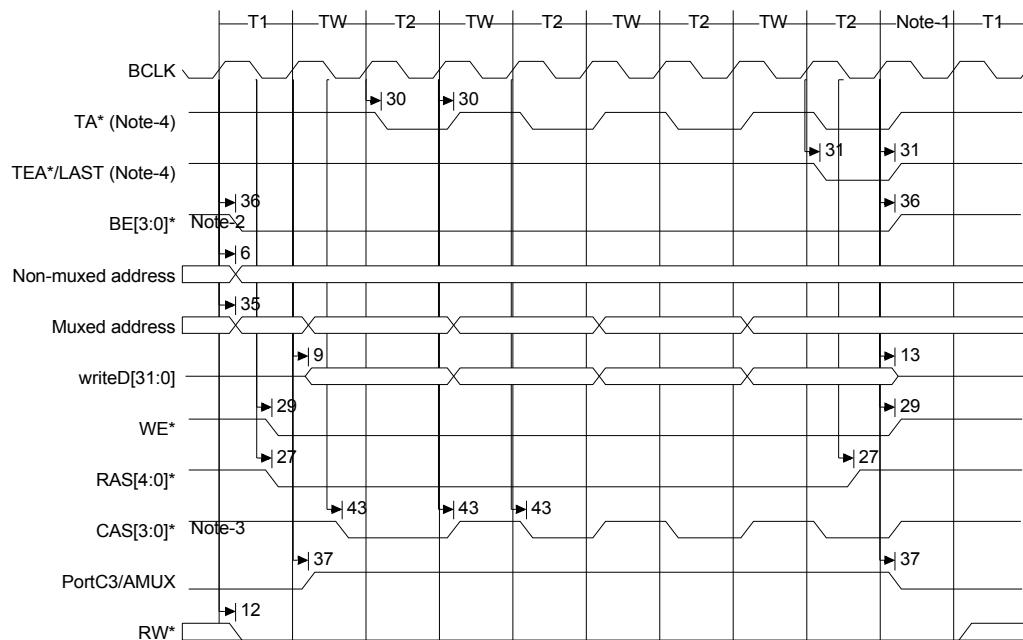
- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 3 Port size determines which CAS signals are active:
  - 8-bit port = CAS3\*
  - 16-bit port = CAS[3:2]
  - 32-bit port = CAS[3:0]
- 4 The TA\* and TEA\*/LAST signals are for reference only.

**FP DRAM write****Fast Page write****Notes:**

- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 3 Port size determines which CAS signals are active:
  - 8-bit port = CAS3\*
  - 16-bit port = CAS[3:2]
  - 32-bit port = CAS[3:0]
- 4 The TA\* and TEA\*/LAST signals are for reference only.

### *FP DRAM burst write*

## Fast Page burst write

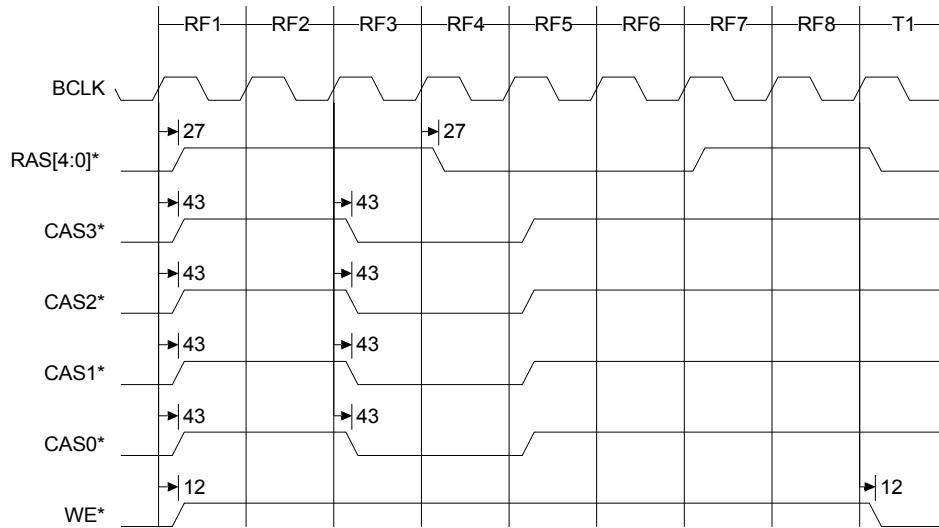


## Notes:

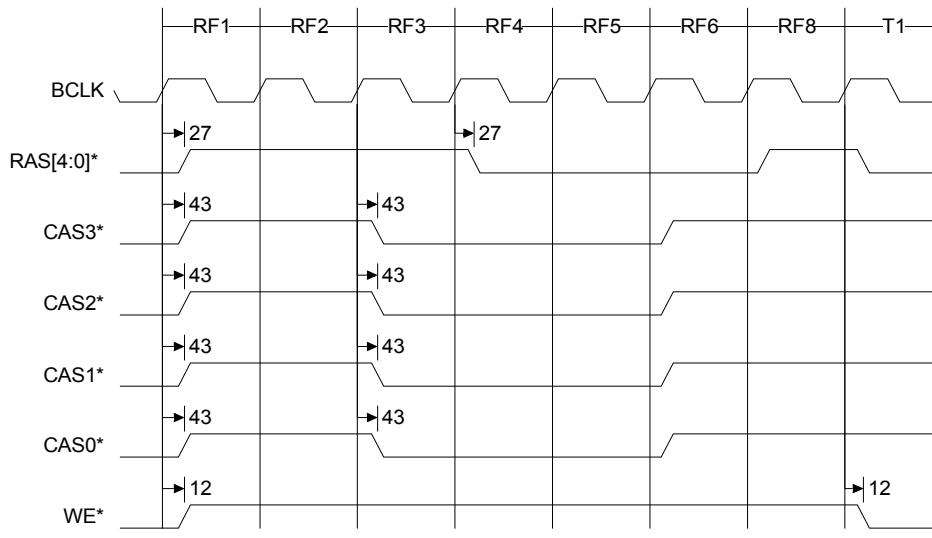
- 1 If the next transfer is DMA, null periods between memory transfers can occur. Thirteen clock pulses are required for DMA context switching.
- 2 Port size determines which byte enable signals are active:
  - 8-bit port = BE3\*
  - 16-bit port = BE[3:2]
  - 32-bit port = BE[3:0]
- 3 Port size determines which CAS signals are active:
  - 8-bit port = CAS3\*
  - 16-bit port = CAS[3:2]
  - 32-bit port = CAS[3:0]
- 4 The TA\* and TEA\*/LAST signals are for reference only.
- 5 The BCYC field should never be set to 00.

*fp\_refresh\_cycles*

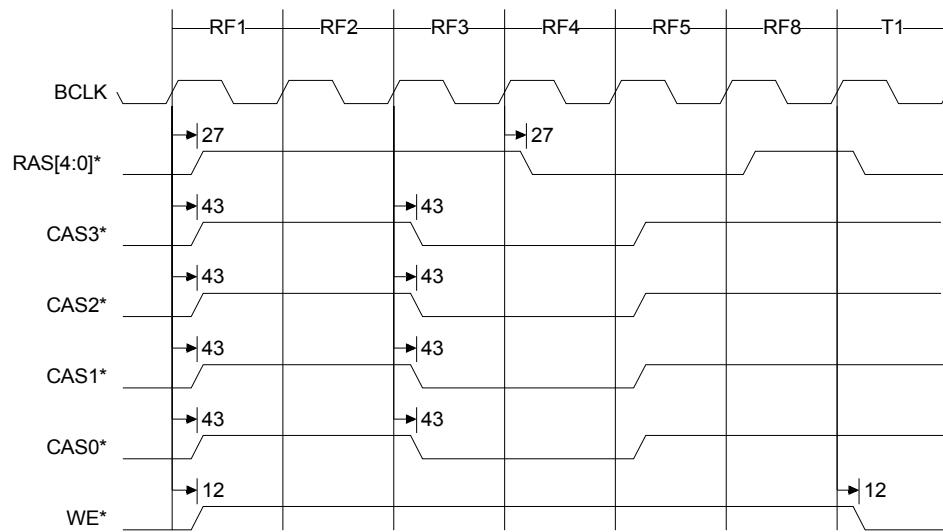
## Fast page refresh (RCYC = 00)



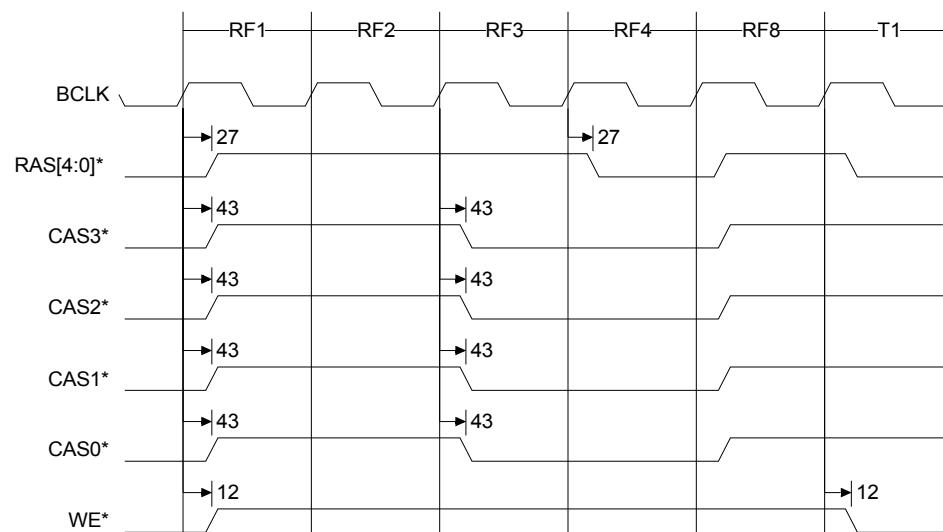
## Fast page refresh (RCYC = 01)



## Fast page refresh (RCYC = 10)



## Fast page refresh (RCYC = 11)



## Ethernet timing

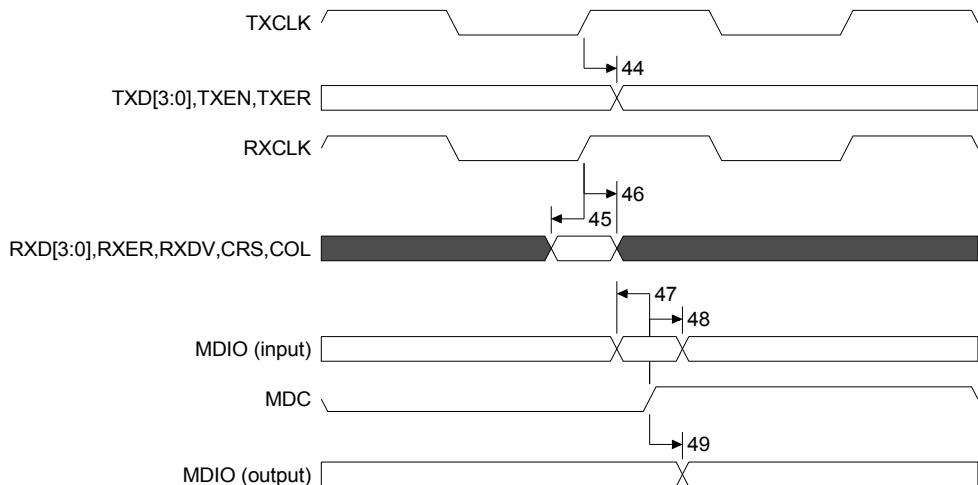
Operating conditions:

Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

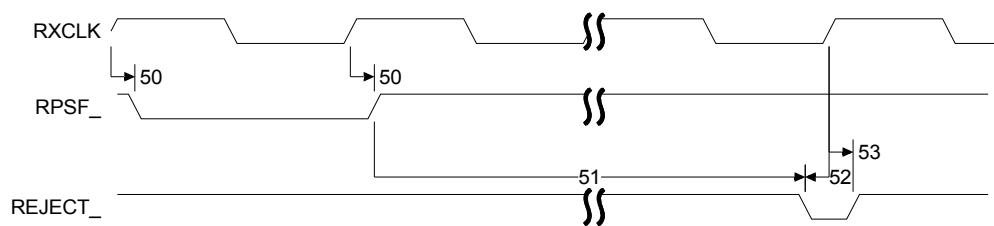
### Ethernet timing parameters

| Num | Description  | Min | Max  | Unit |
|-----|--|-----|------|------|
| 44  | TXCLK high to TXD*, TXEN, TXER valid                       |     | 11.5 | ns   |
| 45  | RXD*, RXER, RXDV, TXCOL, RXCRS valid to RXCLK high (setup) | 3   |      | ns   |
| 46  | RXCLK high to RXD*, RXER, RXDV, TXCOL, RXCRS hold time     | 2   |      | ns   |
| 49  | MDC high to MDIO valid                                     |     | 50   | ns   |
| 47  | MDIO valid to MDC high (setup)                             | 3   |      | ns   |
| 48  | MDC high to MDIO hold time                                 | 3   |      | ns   |
| 50  | RXCLK high to RSPF* valid                                  |     | 15.5 | ns   |
| 52  | REJECT* valid to RXCLK high (setup)                        | 3   |      | ns   |
| 53  | REJECT* valid from RXCLK high (hold)                       | 1.5 |      | ns   |

### Ethernet PHY timing



*Ethernet cam timing*



## JTAG timing

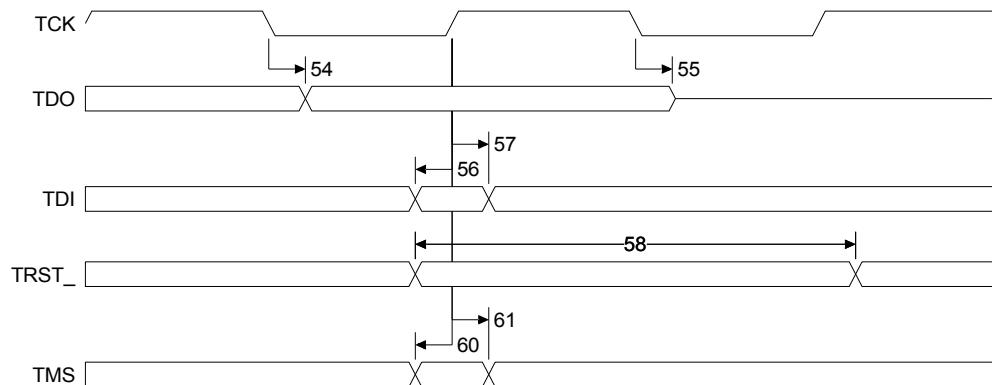
Operating conditions:

Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

### *jtag arm ice timing parameters*

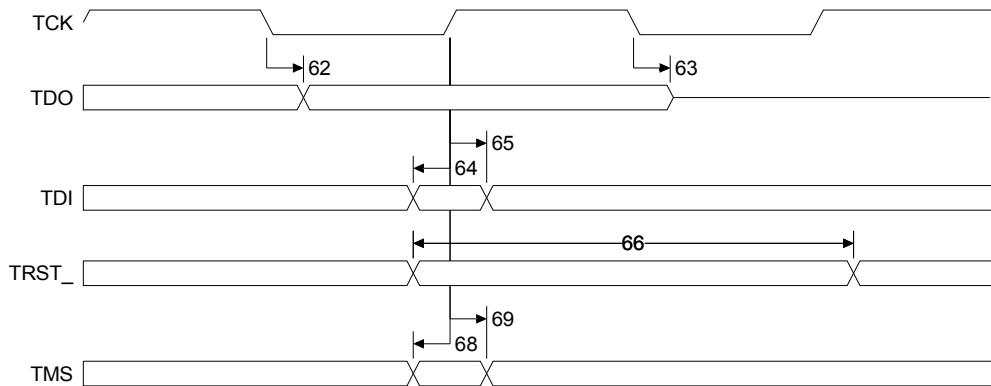
| Num | Description              | Min | Max | Units            |
|-----|--------------------------|-----|-----|------------------|
| 54  | TCK to TDO valid         |     | 21  | ns               |
| 55  | TCK to TDO HighZ         |     | 21  | ns               |
| 56  | TDI setup to TCK rising  | 1   |     | ns               |
| 57  | TDI hold from TCK rising | 3   |     | ns               |
| 58  | TRST* width              | 1   |     | T <sub>TCK</sub> |
| 60  | TMS setup to TCK rising  | 1   |     | ns               |
| 61  | TMS hold from TCK rising | 3   |     | ns               |

### *jtag arm ice timing diagram*



***jtag bscan timing parameters***

| Num | Description              | Min | Max | Units     |
|-----|--------------------------|-----|-----|-----------|
| 62  | TCK to TDO valid         |     | 21  | ns        |
| 63  | TCK to TDO HighZ         |     | 21  | ns        |
| 64  | TDI setup to TCK rising  | 1   |     | ns        |
| 65  | TDI hold from TCK rising | 3   |     | ns        |
| 66  | TRST* width              | 1   |     | $T_{TCK}$ |
| 68  | TMS setup to TCK rising  | 1   |     | ns        |
| 69  | TMS hold to TCK rising   | 3   |     | ns        |

***jtag bscan timing diagram***

## External DMA timing

*BCLK max frequency: 55.296 MHz*

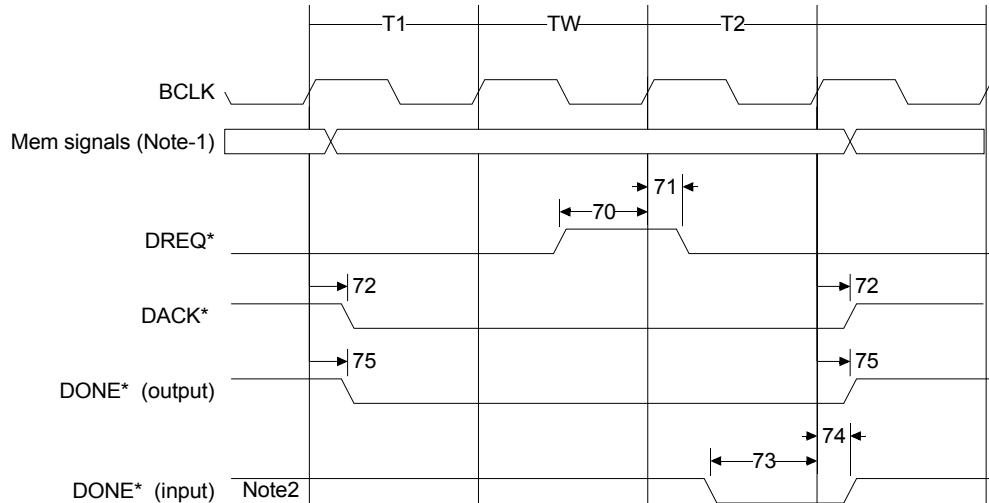
Operating conditions:

Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

### External DMA timing parameters

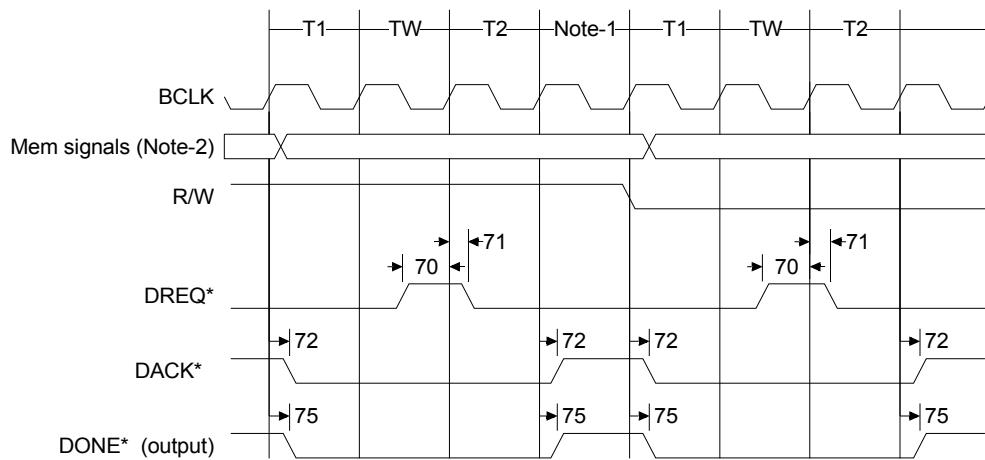
| Num | Description                             | Min | Max | Unit |
|-----|---|-----|-----|------|
| 72  | BCLK high to DACK* valid                |     | 14  | ns   |
| 75  | BCLK high to DONE* (output) valid       |     | 15  | ns   |
| 70  | DREQ* low to BCLK high (setup)          | 5   |     | ns   |
| 71  | BCLK high to DREQ* valid (hold)         | 0   |     | ns   |
| 73  | DONE* (input) valid BCLK high (setup)   | 5   |     | ns   |
| 74  | BCLK high to DONE* (input) valid (hold) | 0   |     | ns   |

### Fly-by external DMA



#### Notes:

- 1 The memory signals are data[31:0], addr[27:0], BE[3:0], CS/RAS[4:0], CAS[3:0], RW, OE\*, WE\*, and PORTC3/AMUX. The timing of these signals depends on how the memory is configured (Sync SRAM, Async SRAM, FP DRAM, or SDRAM).
- 2 The DONE\* signal works as an input only when the DMA channel is configured as fly-by write.

**Memory-to-memory external DMA****Notes:**

- 1 A null period sometimes occurs between memory cycles.
- 2 The memory signals are data[31:0], addr[27:0], BE[3:0], CS/RAS[4:0], CAS[3:0], RW, OE\*, WE\*, and PORTA2/AMUX. The timing of these signals depends on how the memory is configured (Sync SRAM, Async SRAM, FP DRAM, or SDRAM).

## Serial internal/external timing

### Operating conditions:

|              |              |              |
|--------------|--------------|--------------|
| Temperature: | -15.00 (min) | 110.00 (max) |
| Voltage:     | 1.60 (min)   | 1.40 (max)   |
| Output load: | 25.0pf       |              |
| Input drive: | CMOS buffer  |              |

**Note:** SPI timing diagrams are in Chapter 10, "Serial Controller Module." See Figure 25, "SPI master mode 0 and 1 two-byte transfer," on page 219 and Figure 26, "SPI slave mode 0 and 1 two-byte transfer," on page 222. Only SPI modes 0 and 1 are supported.

### Serial internal timing characteristics

| Num | Description                   | Min | Max           | Unit       |
|-----|-------------------------------|-----|---------------|------------|
| 76  | SCLK to ENABLE high           | 1   |               | $T_{SCLK}$ |
| 77  | SCLK to TXD (PORTA7/C7)       |     | $1 T_{SYS}^*$ | ns         |
| 78  | RXD (PORTA3/C3) setup to SCLK | 1   |               | ns         |
| 79  | RXD hold to SCLK              | 1   |               | ns         |

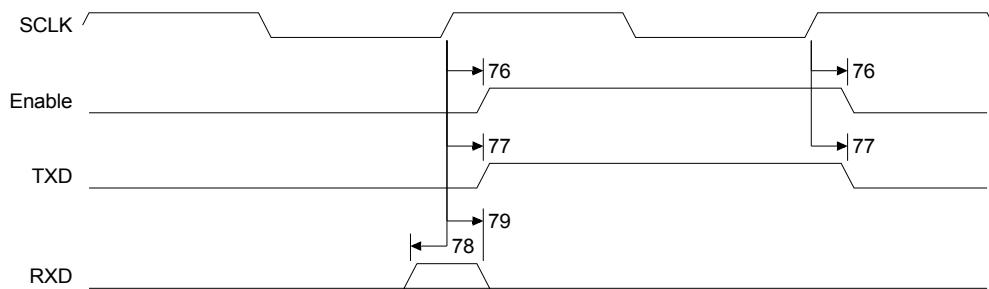
\* The  $T_{SYS}$  parameter represents one period of the internal system clock.

### Serial external timing characteristics

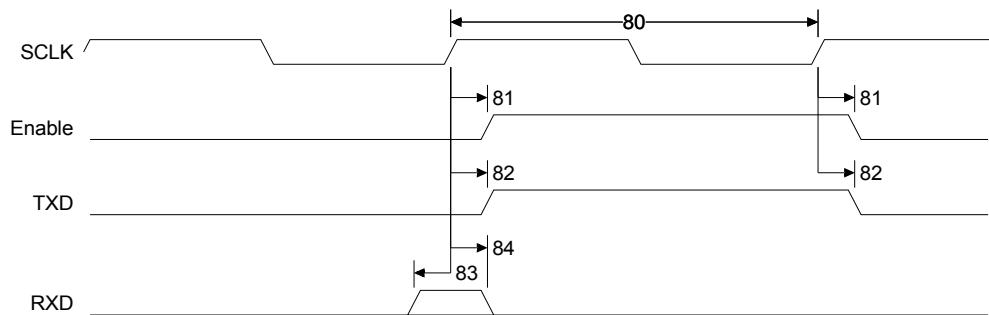
| Num | Description                   | Min | Max           | Unit       |
|-----|-------------------------------|-----|---------------|------------|
| 80  | SCLK frequency                | 10  |               | MHz        |
|     | SCLK duty cycle               | 45  | 55            | %          |
| 81  | SCLK to ENABLE                | 1   |               | $T_{SCLK}$ |
| 82  | SCLK to TXD (PORTA7/C7)       |     | $2 T_{SYS}^*$ | ns         |
| 83  | RXD (PORTA3/C3) setup to SCLK | 2   |               | ns         |
| 84  | RXD hold to SCLK              | 1.5 |               | ns         |

\* The  $T_{SYS}$  parameter represents one period of the internal system clock.

***synchronous serial internal clock***



***synchronous serial external clock***



## GPIO timing

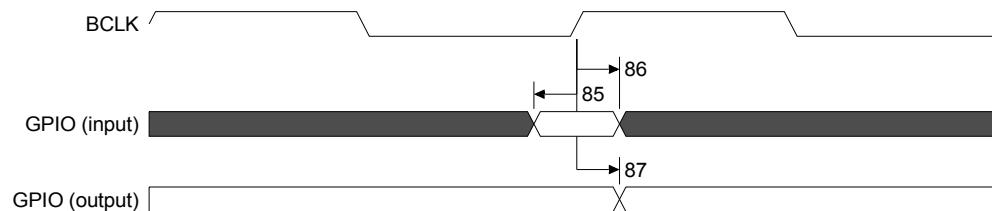
Operating conditions:

Temperature: -15.00 (min) 110.00 (max)  
 Voltage: 1.60 (min) 1.40 (max)  
 Output load: 25.0pf  
 Input drive: CMOS buffer

### GPIO timing parameters

| Num | Description                  | Min | Max | Unit |
|-----|------------------------------|-----|-----|------|
| 85  | GPIO (setup) to BCLK rising  | 3   |     | ns   |
| 86  | GPIO (hold) from BCLK rising | 0   |     | ns   |
| 87  | BCLK to GPIO (output)        |     | 17  | ns   |

### GPIO timing diagram



P/N: 90000303\_E

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