

DSP56824

Advance Information 16-BIT DIGITAL SIGNAL PROCESSOR

The DSP56824 is a member of the DSP56800 core-based family of Digital Signal Processors (DSPs). This general purpose DSP combines processing power with configuration flexibility, making it an excellent cost-effective solution for signal processing and control functions. Because of its low cost, configuration flexibility, and compact program code, the DSP56824 is well-suited for cost-sensitive applications, such as digital wireless messaging, servo and motor control, digital answering machines/feature phones, modems, and digital cameras. The DSP56800 core consists of three execution units operating in parallel, allowing as many as six operations per instruction cycle. The MPU-style programming model and optimized instruction set allow straightforward generation of efficient, compact DSP and control code. The instruction set is also highly efficient for C Compilers. The DSP56824 supports program execution from either internal or external memories. Two data operands can be accessed from the on-chip data RAM per instruction cycle. The rich set of programmable peripherals and ports provides support for interfacing multiple external devices, such as codecs, microprocessors, or other DSPs. The DSP56824 also provides two external dedicated interrupt lines and sixteen to thirty-two General Purpose Input/Output (GPIO) lines, depending on peripheral configuration (see Figure 1).

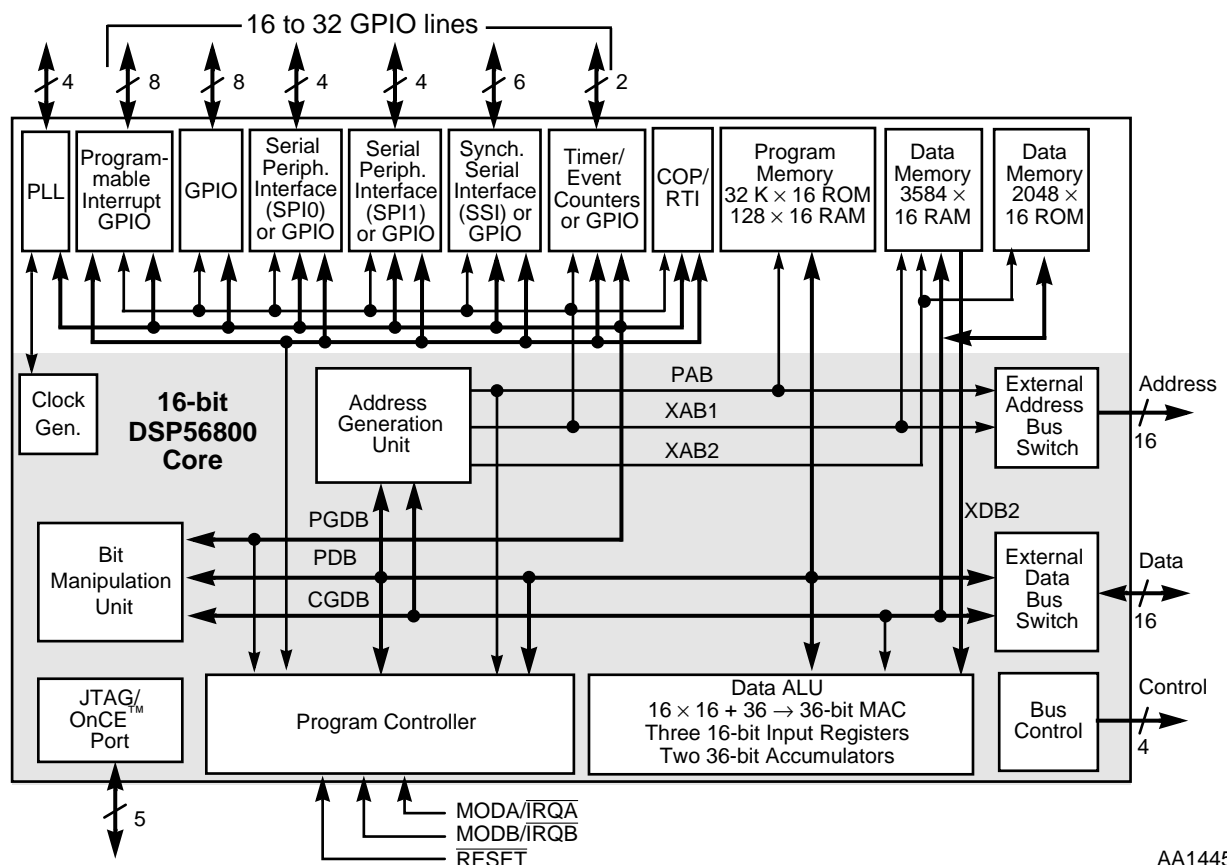


Figure 1 DSP56824 Block Diagram

This document contains information on a new product. Specifications and information herein are subject to change without notice.

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FOR TECHNICAL ASSISTANCE:

Telephone: 1-800-521-6274

Email: dsphelp@dsp.sps.mot.com

Internet: <http://www.motorola-dsp.com>

DATA SHEET CONVENTIONS

This data sheet uses the following conventions:

OVERBAR This is used to indicate a signal that is active when pulled low. For example, the RESET pin is active when low.

“asserted” A high true (active high) signal is high or a low true (active low) signal is low.

“deasserted” A high true (active high) signal is low or a low true (active low) signal is high.

| Examples: | Signal/Symbol | Logic State | Signal State | Voltage ¹ |
|-----------|------------------|-------------|--------------|----------------------|
| | \overline{PIN} | True | Asserted | V_{IL}/V_{OL} |
| | \overline{PIN} | False | Deasserted | V_{IH}/V_{OH} |
| | PIN | True | Asserted | V_{IH}/V_{OH} |
| | PIN | False | Deasserted | V_{IL}/V_{OL} |

Note: 1. Values for V_{IL} , V_{OL} , V_{IH} , and V_{OH} are defined by individual product specifications.

PRELIMINARY

DSP56824 FEATURES

Digital Signal Processing Core

- Efficient 16-bit DSP56800 family DSP engine
- As many as 35 Million Instructions Per Second (MIPS) at 70 MHz
- Single-cycle 16×16 -bit parallel Multiplier-Accumulator (MAC)
- Two 36-bit accumulators including extension bits
- 16-bit bidirectional barrel shifter
- Parallel instruction set with unique DSP addressing modes
- Hardware DO and REP loops
- Three internal address buses and one external address bus
- Four internal data buses and one external data bus
- Instruction set supports both DSP and controller functions
- Controller style addressing modes and instructions for compact code
- Efficient C Compiler and local variable support
- Software subroutine and interrupt stack with unlimited depth

Memory

- On-chip Harvard architecture permits as many as three simultaneous accesses to program and data memory
- On-chip memory
 - 32 K \times 16 Program ROM
 - 128 \times 16 Program RAM
 - 3.5 K \times 16 X RAM usable for both data and programs
 - 2 K \times 16 X data ROM
- Off-chip memory expansion capabilities
 - As much as 64 K \times 16 X data memory
 - As much as 64 K \times 16 program memory
 - External memory expansion port programmable for 1 to 15 wait states
- Programs can run out of X data RAM

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Peripheral Circuits

- External Memory Interface (Port A)
- Sixteen dedicated GPIO pins (eight pins programmable as interrupts)
- Serial Peripheral Interface (SPI) support: Two configurable four-pin ports (SPI0 and SPI1) (or eight additional GPIO lines)
 - Supports LCD drivers, A/D subsystems, and MCU systems
 - Supports inter-processor communications in a multiple master system
 - Supports demand-driven master or slave devices with high data rates
- Synchronous Serial Interface (SSI) support: One 6-pin port (or six additional GPIO lines)
 - Supports serial devices with one or more industry-standard codecs, other DSPs, microprocessors, and Motorola SPI-compliant peripherals
 - Allows implementing synchronous or asynchronous transmit and receive sections with separate or shared internal/external clocks and frame syncs
 - Supports Network mode using frame sync and as many as 32 time slots
 - Can be configured for 8-bit, 10-bit, 12-bit, and 16-bit data word lengths
- Three programmable 16-bit timers (accessed using two I/O pins that can also be programmed as two additional GPIO lines)
- Computer-Operating Properly (COP) and Real-Time Interrupt (RTI) timers
- Two external interrupt/mode control pins
- One external reset pin for hardware reset
- JTAG/On-Chip Emulation (OnCE™) 5-pin port for unobtrusive, processor speed-independent debugging
- Extended debug capability with second breakpoint and 8-level OnCE FIFO history buffer
- Software-programmable, Phase Lock Loop-based (PLL-based) frequency synthesizer for the DSP core clock

Energy Efficient Design

- A single 2.7–3.6 V power supply
- Power-saving Wait and multiple Stop modes available
- Fully static, HCMOS design for 70 MHz to dc operating frequencies
- Available in plastic 100-pin Thin Quad Flat Pack (TQFP) surface-mount package

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PRODUCT DOCUMENTATION

The three documents listed in **Table 1** are required for a complete description of the DSP56824 and are necessary to design properly with the part. Documentation is available from a local Motorola distributor, a Motorola semiconductor sales office, a Motorola Literature Distribution Center, or through the Motorola DSP home page on the Internet (the source for the latest information).

Table 1 DSP56824 Chip Documentation

| Topic | Description | Order Number |
|-------------------------------|---|---------------|
| DSP56800 Family Manual | Detailed description of the DSP56800 family architecture, and 16-bit DSP core processor and the instruction set | DSP56800FM/AD |
| DSP56824 User's Manual | Detailed description of memory, peripherals, and interfaces of the DSP56824 | DSP56824UM/AD |
| DSP56824 Technical Data Sheet | Electrical and timing specifications, pin descriptions, and package descriptions | DSP56824/D |

FOR THE LATEST INFORMATION

Refer to the back cover of this document for:

- Motorola contact addresses
- Motorola Mfax™ service
- Motorola DSP Internet address
- Motorola DSP Helpline

The Mfax service and the DSP Internet connection maintain the most current specifications, documents, and drawings. These two services are available on demand 24 hours a day.



PRELIMINARY

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SECTION 1

SIGNAL/CONNECTION DESCRIPTIONS

INTRODUCTION

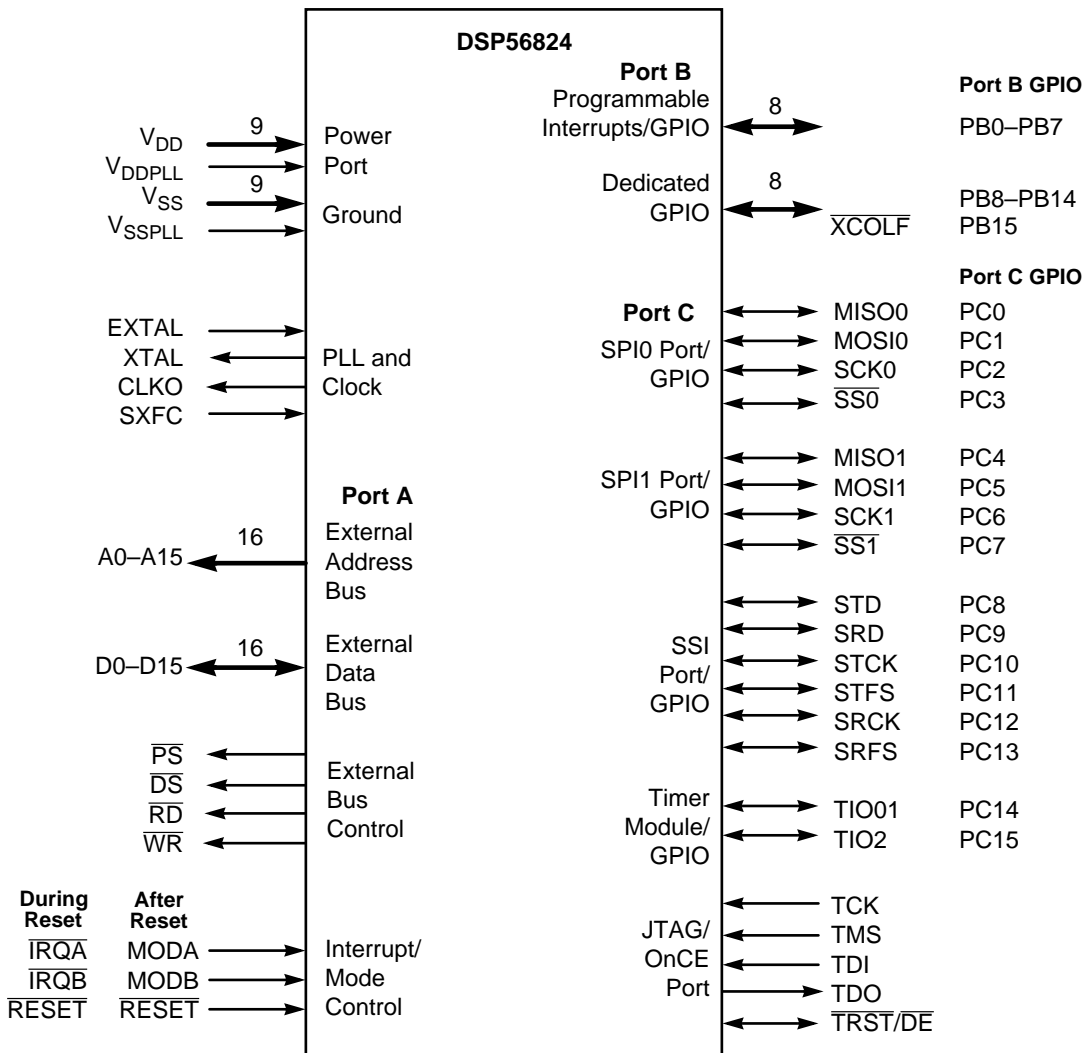
The input and output signals of the DSP56824 are organized into functional groups, as shown in **Table 1-1** and as illustrated in **Figure 1-1**. In **Table 1-2** through **Table 1-14**, each table row describes the signal or signals present on a pin. **Figure 1-1** provides a diagram of DSP56824 signals by functional group.

Table 1-1 Functional Group Pin Allocations

| Functional Group | Number of Pins | Detailed Description |
|---|----------------|----------------------|
| Power (V_{DD} or V_{DDPLL}) | 10 | Table 1-2 |
| Ground (V_{SS} or V_{SSPLL}) | 10 | Table 1-3 |
| PLL and Clock | 4 | Table 1-4 |
| Address Bus | 16 | Table 1-5 |
| Data Bus | 16 | Table 1-6 |
| Bus Control | 4 | Table 1-7 |
| Interrupt and Mode Control | 3 | Table 1-8 |
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| Serial Peripheral Interface (SPI) Ports * | 8 | Table 1-11 |
| Synchronous Serial Interface (SSI) Port * | 6 | Table 1-12 |
| Timer Module * | 2 | Table 1-13 |
| JTAG/On-Chip Emulation (OnCE) | 5 | Table 1-14 |
| * Alternately, GPIO pins | | |

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Introduction



AA1446

Figure 1-1 DSP56824 Signals Identified by Functional Group

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POWER AND GROUND SIGNALS

Table 1-2 Power Inputs

| Signal Name (number of pins) | Signal Description |
|---------------------------------|--|
| V _{DD} (9) | Power —These pins provide power to the internal structures of the chip, and should all be attached to V _{DD} . |
| V _{DDPLL} | PLL Power —This pin supplies a quiet power source to the VCO to provide greater frequency stability. |

Table 1-3 Grounds

| Signal Name (number of pins) | Signal Description |
|---------------------------------|---|
| V _{SS} (9) | GND —These pins provide grounding for the internal structures of the chip, and should all be attached to V _{SS} . |
| V _{SSPLL} | PLL Ground —This pin supplies a quiet ground to the VCO to provide greater frequency stability. |

CLOCK AND PHASE LOCK LOOP SIGNALS

Table 1-4 PLL and Clock Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-------------|--------------------|---|
| EXTAL | Input | Input | External Clock/Crystal Input —This input should be connected to an external clock or oscillator. After being squared, the input clock can be selected to provide the clock directly to the DSP core. The minimum instruction time is two input clock periods, broken up into four phases named T0, T1, T2, and T3. This input clock can also be selected as input clock for the on-chip PLL. |
| XTAL | Output | Chip-driven | Crystal Output —This output connects the internal crystal oscillator output to an external crystal. If an external clock is used, XTAL should not be connected. |
| CLKO | Output | Chip-driven | Clock Output —This pin outputs a buffered clock signal. By programming the CS[1:0] bits in the PLL Control Register (PCR1), the user can select between outputting a squared version of the signal applied to EXTAL and a version of the DSP master clock at the output of the PLL. The clock frequency on this pin can also be disabled by programming the CS[1:0] bits in PCR1. |
| SXFC | Input | Input | External Filter Capacitor —This pin is used to add an external filter circuit to the Phase Lock Loop (PLL). Refer to Figure 2-7 on page 2-8. |

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ADDRESS, DATA, AND BUS CONTROL SIGNALS

Table 1-5 Address Bus Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-------------|--------------------|--|
| A0–A15 | Output | Tri-stated | Address Bus —A0–A15 change in T0, and specify the address for external program or data memory accesses. |

Table 1-6 Data Bus Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|--------------|--------------------|--|
| D0–D15 | Input/Output | Tri-stated | Data Bus —Read data is sampled in by the trailing edge of T2, while write data output is enabled by the leading edge of T2 and tri-stated by the leading edge of T0. D0–D15 are tri-stated when the external bus is inactive. |

Table 1-7 Bus Control Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-----------------|-------------|--------------------|--|
| \overline{PS} | Output | Tri-stated | Program Memory Select — \overline{PS} is asserted low for external program memory access. If the external bus is not used during an instruction cycle (T0, T1, T2, T3), \overline{PS} goes high in T0. |
| \overline{DS} | Output | Tri-stated | Data Memory Select — \overline{DS} is asserted low for external data memory access. If the external bus is not used during an instruction cycle (T0, T1, T2, T3), \overline{DS} goes high in T0. |
| \overline{WR} | Output | Tri-stated | Write Enable — \overline{WR} is asserted during external memory write cycles. When \overline{WR} is asserted low in T1, pins D0–D15 become outputs and the DSP puts data on the bus during the leading edge of T2. When \overline{WR} is deasserted high in T3, the external data is latched inside the external device. When \overline{WR} is asserted, it qualifies the A0–A15, \overline{PS} , and \overline{DS} pins. \overline{WR} can be connected directly to the \overline{WE} pin of a Static RAM. |
| \overline{RD} | Output | Tri-stated | Read Enable — \overline{RD} is asserted during external memory read cycles. When \overline{RD} is asserted low late T0/early T1, pins D0–D15 become inputs and an external device is enabled onto the DSP data bus. When \overline{RD} is deasserted high in T3, the external data is latched inside the DSP. When \overline{RD} is asserted, it qualifies the A0–A15, \overline{PS} , and \overline{DS} pins. \overline{RD} can be connected directly to the \overline{OE} pin of a Static RAM or ROM. |

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INTERRUPT AND MODE CONTROL SIGNALS

Table 1-8 Interrupt and Mode Control Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|---------------------------|-------------|--------------------|--|
| MODA | Input | Input | Mode Select A —During hardware reset, MODA and MODB select one of the four initial chip operating modes latched into the Operating Mode Register (OMR). Several clock cycles (depending on PLL setup time) after leaving the Reset state, the MODA pin changes to external interrupt request $\overline{\text{IRQA}}$. The chip operating mode can be changed by software after reset. |
| $\overline{\text{IRQA}}$ | Input | | External Interrupt Request A —The $\overline{\text{IRQA}}$ input is a synchronized external interrupt request that indicates that an external device is requesting service. It can be programmed to be level-sensitive or negative-edge-triggered. If level-sensitive triggering is selected, an external pull up resistor is required for wired-OR operation. If the processor is in the Stop state and $\overline{\text{IRQA}}$ is asserted, the processor will exit the Stop state. |
| MODB | Input | Input | Mode Select B/External Interrupt Request B —During hardware reset, MODA and MODB select one of the four initial chip operating modes latched into the Operating Mode Register (OMR). Several clock cycles (depending on PLL setup time) after leaving the Reset state, the MODB pin changes to external interrupt request $\overline{\text{IRQB}}$. After reset, the chip operating mode can be changed by software. |
| $\overline{\text{IRQB}}$ | Input | | External Interrupt Request B —The $\overline{\text{IRQB}}$ input is an external interrupt request that indicates that an external device is requesting service. It can be programmed to be level-sensitive or negative-edge-triggered. If level-sensitive triggering is selected, an external pull up resistor is required for wired-OR operation. |
| $\overline{\text{RESET}}$ | Input | Input | Reset —This input is a direct hardware reset on the processor. When $\overline{\text{RESET}}$ is asserted low, the DSP is initialized and placed in the Reset state. A Schmitt trigger input is used for noise immunity. When the $\overline{\text{RESET}}$ pin is deasserted, the initial chip operating mode is latched from the MODA and MODB pins. The internal reset signal should be deasserted synchronous with the internal clocks. To ensure complete hardware reset, $\overline{\text{RESET}}$ and $\overline{\text{TRST}}/\overline{\text{DE}}$ should be asserted together. The only exception occurs in a debugging environment when a hardware DSP reset is required and it is necessary not to reset the OnCE/JTAG module. In this case, assert $\overline{\text{RESET}}$, but do not assert $\overline{\text{TRST}}/\overline{\text{DE}}$. |

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GPIO SIGNALS

Table 1-9 Programmable Interrupt GPIO Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-----------------|--------------------|--|
| PB0–PB7 | Input or Output | Input | <p>Port B GPIO—These eight pins can be programmed to generate an interrupt for any pin programmed as an input when there is a transition on that pin. Each pin can individually be configured to recognize a low-to-high or a high-to-low transition. In addition, these pins are dedicated General Purpose I/O (GPIO) pins that can individually be programmed as input or output pins.</p> <p>After reset, the default state is GPIO input.</p> |

Table 1-10 Dedicated General Purpose Input/Output (GPIO) Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|--------------------|-----------------|-------------------------------|--|
| PB8–PB14 | Input or Output | Input | <p>Port B GPIO—These seven pins are dedicated General Purpose I/O (GPIO) pins that can individually be programmed as input or output pins.</p> <p>After reset, the default state is GPIO input.</p> |
| \overline{XCOLF} | Input | Input, pulled high internally | <p>XCOLF—During reset, the External Crystal Oscillator Low Frequency (\overline{XCOLF}) function of this pin is active. PB15/\overline{XCOLF} is tied to an on-chip pull-up transistor that is active during reset. When \overline{XCOLF} is driven low during reset (or tied to a 10 kΩ pull-down resistor), the crystal oscillator amplifier is set to a low frequency mode. In this low-frequency mode, only oscillator frequencies of 32 kHz and 38.4 kHz are supported. If \overline{XCOLF} is not driven low during reset (or if a pull-down resistor is not used), the crystal oscillator amplifier operates in the Default mode, and oscillator frequencies from 2 MHz to 10 MHz are supported. If an external clock is provided to the EXTAL pin, 40 MHz is the maximum frequency allowed. (In this case, do not connect a pull-down resistor or drive this pin low during reset.)</p> |
| PB15 | Input or Output | | <p>Port B GPIO—This pin is a dedicated GPIO pin that can individually be programmed as an input or output pin.</p> <p>After reset, the default state is GPIO input.</p> |

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SERIAL PERIPHERAL INTERFACE (SPI) SIGNALS

Table 1-11 Serial Peripheral Interface (SPI0 and SPI1) Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-----------------|--------------------|--|
| MISO0 | Input/Output | Input | SPI0 Master In/Slave Out (MISO0) —This serial data pin is an input to a master device and an output from a slave device. The MISO0 line of a slave device is placed in the high-impedance state if the slave device is not selected. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC0 | Input or Output | | Port C GPIO 0 (PC0) —This pin is a GPIO pin called PC0 when the SPI MISO0 function is not being used. After reset, the default state is GPIO input. |
| MOSI0 | Input/Output | Input | SPI0 Master Out/Slave In (MOSI0) —This serial data pin is an output from a master device and an input to a slave device. The master device places data on the MOSI0 line a half-cycle before the clock edge that the slave device uses to latch the data. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC1 | Input or Output | | Port C GPIO 1 (PC1) —This pin is a GPIO pin called PC1 when the SPI MOSI0 function is not being used. After reset, the default state is GPIO input. |
| SCK0 | Input/Output | Input | SPI0 Serial Clock —This bidirectional pin provides a serial bit rate clock for the SPI. This gated clock signal is an input to a slave device and is generated as an output by a master device. Slave devices ignore the SCK signal unless the slave select pin is active low. In both master and slave SPI devices, data is shifted on one edge of the SCK signal and is sampled on the opposite edge where data is stable. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC2 | Input or Output | | Port C GPIO 2 (PC2) —This pin is a GPIO pin called PC2 when the SPI SCK0 function is not being used. After reset, the default state is GPIO input. |

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Table 1-11 Serial Peripheral Interface (SPI0 and SPI1) Signals (Continued)

| Signal Name | Signal Type | State During Reset | Signal Description |
|------------------|-----------------|--------------------|---|
| $\overline{SS}0$ | Input | Input | SPI0 Slave Select —This input pin selects a slave device before a master device can exchange data with the slave device. \overline{SS} must be low before data transactions and must stay low for the duration of the transaction. The \overline{SS} line of the master must be held high. |
| PC3 | Input or Output | | Port C GPIO 3 (PC3) —This pin is a GPIO pin called PC3 when the SPI $\overline{SS}0$ function is not being used. After reset, the default state is GPIO input. |
| MISO1 | Input/Output | Input | SPI1 Master In/Slave Out —This serial data pin is an input to a master device and an output from a slave device. The MISO1 line of a slave device is placed in the high-impedance state if the slave device is not selected. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC4 | Input or Output | | Port C GPIO 4 (PC4) —This pin is a GPIO pin called PC4 when the SPI MISO1 function is not being used. After reset, the default state is GPIO input. |
| MOSI1 | Input/Output | Input | SPI1 Master Out/Slave In (MOSI1) —This serial data pin is an output from a master device and an input to a slave device. The master device places data on the MOSI0 line a half-cycle before the clock edge that the slave device uses to latch the data. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC5 | Input or Output | | Port C GPIO5 (PC5) —This pin is a GPIO pin called PC5 when the SPI MOSI1 function is not being used. After reset, the default state is GPIO input. |

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Table 1-11 Serial Peripheral Interface (SPI0 and SPI1) Signals (Continued)

| Signal Name | Signal Type | State During Reset | Signal Description |
|------------------|-----------------|--------------------|--|
| SCK1 | Input/Output | Input | SPI1 Serial Clock —This bidirectional pin provides a serial bit rate clock for the SPI. This gated clock signal is an input to a slave device and is generated as an output by a master device. Slave devices ignore the SCK signal unless the slave select pin is active low. In both master and slave SPI devices, data is shifted on one edge of the SCK signal and is sampled on the opposite edge where data is stable. The driver on this pin can be configured as an open-drain driver by the SPI's WOM bit when this pin is configured for SPI operation. When using Wired-OR mode, the user must provide an external pull-up device. |
| PC6 | Input or Output | | Port C GPIO 6 (PC6) —This pin is a GPIO pin called PC6 when the SPI SCK1 function is not being used. After reset, the default state is GPIO input. |
| $\overline{SS1}$ | Input | Input | SPI1 Slave Select —This input pin is used to select a slave device before a master device can exchange data with the slave device. \overline{SS} must be low before data transactions and must stay low for the duration of the transaction. The \overline{SS} line of the master must be held high. |
| PC7 | Input or Output | | Port C GPIO 7 (PC7) —This pin is a GPIO pin called PC7 when the SPI $\overline{SS1}$ function is not being used. After reset, the default state is GPIO input. |

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SYNCHRONOUS SERIAL INTERFACE SIGNALS

Table 1-12 Synchronous Serial Interface (SSI) Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-----------------|--------------------|--|
| STD | Output | Input | SSI Transmit Data (STD) —This output pin transmits serial data from the SSI Transmitter Shift Register. |
| PC8 | Input or Output | | Port C GPIO 8 (PC8) —This pin is a GPIO pin called PC8 when the SSI STD function is not being used. After reset, the default state is GPIO input. |
| SRD | Input | Input | SSI Receive Data —This input pin receives serial data and transfers the data to the SSI Receive Shift Register. |
| PC9 | Input or Output | | Port C GPIO 9 (PC9) —This pin is a GPIO pin called PC9 when the SSI SRD function is not being used. After reset, the default state is GPIO input. |
| STCK | Input/Output | Input | SSI Serial Transmit Clock —This bidirectional pin provides the serial bit rate clock for the Transmit section of the SSI. The clock signal can be continuous or gated and can be used by both the transmitter and receiver in Synchronous mode. |
| PC10 | Input or Output | | Port C GPIO 10 (PC10) —This pin is a GPIO pin called PC10 when the SSI STCK function is not being used. After reset, the default state is GPIO input. |
| STFS | Input/Output | Input | Serial Transmit Frame Sync —This bidirectional pin is used by the Transmit section of the SSI as frame sync I/O or flag I/O. The STFS can be used by both the transmitter and receiver in Synchronous mode. It is used to synchronize data transfer and can be an input or an output. |
| PC11 | Input or Output | | Port C GPIO 11 (PC11) —This pin is a GPIO pin called PC11 when the SSI STFS function is not being used. This pin is not required by the SSI in Gated Clock mode. After reset, the default state is input. |

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Table 1-12 Synchronous Serial Interface (SSI) Signals (Continued)

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|--------------------|--------------------|---|
| SRCK | Input/ Output | Input | SSI Serial Receive Clock —This bidirectional pin provides the serial bit rate clock for the Receive section of the SSI. The clock signal can be continuous or gated and can be used only by the receiver. |
| PC12 | Input or Output | | Port C GPIO 12 (PC12) —This pin is a GPIO pin called PC12 when the SSI STD function is not being used. After reset, the default state is GPIO input. |
| SRFS | Input/ Output | Input | Serial Receive Frame Sync (SRFS) —This bidirectional pin is used by the Receive section of the SSI as frame sync I/O or flag I/O. The STFS can be used only by the receiver. It is used to synchronize data transfer and can be an input or an output. |
| PC13 | Input or Output | | Port C GPIO 13 (PC13) —This pin is a GPIO pin called PC13 when the SSI SRFS function is not being used. After reset, the default state is GPIO input. |

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TIMER MODULE SIGNALS

Table 1-13 Timer Module Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|-------------|-----------------|--------------------|---|
| TIO01 | Input/Output | Input | Timer 0 and Timer 1 Input/Output (TIO01) —This bidirectional pin receives external pulses to be counted by either the on-chip 16-bit Timer 0 or Timer 1 when configured as input and external clocking is selected. The pulses are internally synchronized to the DSP core internal clock. When configured as output, it generates pulses or toggles on a Timer 0 or Timer 1 overflow event. Selection of Timer 0 or Timer 1 is programmable through an internal register. |
| PC14 | Input or Output | | Port C GPIO 14 (PC14) —This pin is a GPIO pin called PC14 when the Timer TIO01 function is not being used. After reset, the default state is GPIO input. |
| TIO2 | Input/Output | Input | Timer 2 Input/Output (TIO2) —This bidirectional pin receives external pulses to be counted by the on-chip 16-bit Timer 2 when configured as input and external clocking is selected. The pulses are internally synchronized to the DSP core internal clock. When configured as output, it generates pulses or toggles on a Timer 2 overflow event. |
| PC15 | Input or Output | | Port C GPIO 15 (PC15) —This pin is a GPIO pin called PC15 when the Timer TIO2 function is not being used. After reset, the default state is GPIO input. |

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JTAG/OnCE

Table 1-14 JTAG/On-Chip Emulation (OnCE) Signals

| Signal Name | Signal Type | State During Reset | Signal Description |
|--|-----------------|-------------------------------|---|
| TCK | Input | Input, pulled low internally | Test Clock Input —This input pin provides a gated clock to synchronize the test logic and shift serial data to the JTAG/OnCE port. The pin is connected internally to a pull-down resistor. |
| TMS | Input | Input, pulled high internally | Test Mode Select Input —This input pin is used to sequence the JTAG TAP controller's state machine. It is sampled on the rising edge of TCK and has an on-chip pull-up resistor. |
| TDI | Input | Input, pulled high internally | Test Data Input —This input pin provides a serial input data stream to the JTAG/OnCE port. It is sampled on the rising edge of TCK and has an on-chip pull-up resistor. |
| TDO | Output | Tri-stated | Test Data Output —This tri-statable output pin provides a serial output data stream from the JTAG/OnCE port. It is driven in the Shift-IR and Shift-DR controller states, and changes on the falling edge of TCK. |
| $\overline{\text{TRST}}$ $\overline{\text{DE}}$ | Input Output | Input, pulled high internally | <p>Test Reset—As an input, a low signal on this pin provides a reset signal to the JTAG TAP controller.</p> <p>Debug Event—When programmed within the OnCE port as an output, $\overline{\text{DE}}$ provides a low pulse on recognized debug events; when configured as an output signal, the $\overline{\text{TRST}}$ input is disabled.</p> <p>To ensure complete hardware reset, $\overline{\text{TRST}}/\overline{\text{DE}}$ should be asserted whenever $\overline{\text{RESET}}$ is asserted. The only exception occurs in a debugging environment when a hardware DSP reset is required and it is necessary not to reset the OnCE/JTAG module. In this case, assert $\overline{\text{RESET}}$, but do not assert $\overline{\text{TRST}}/\overline{\text{DE}}$.</p> <p>This pin is connected internally to a pull-up resistor.</p> |



PRELIMINARY

PRELIMINARY

SECTION 2

SPECIFICATIONS

GENERAL CHARACTERISTICS

The DSP56824 is fabricated in high-density CMOS with Transistor-Transistor Logic (TTL)-compatible inputs, 5-volt tolerant Input/Output (I/O), and CMOS-compatible outputs.

Absolute maximum ratings given in **Table 2-1** are stress ratings only, and functional operation at the maximum is not guaranteed. Stress beyond these ratings may affect device reliability or cause permanent damage to the device.

The DSP56824 dc/ac electrical specifications are preliminary and are from design simulations. These specifications may not be fully tested or guaranteed at this early stage of the product life cycle. Finalized specifications will be published after complete characterization and device qualifications have been completed.

CAUTION

This device contains protective circuitry to guard against damage due to high static voltage or electrical fields. However, normal precautions are advised to avoid application of any voltages higher than maximum rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either or V_{CC} or GND).

PRELIMINARY

Specifications

General Characteristics

Table 2-1 Absolute Maximum Ratings (GND = 0 V)

| Rating | Symbol | Value | Unit |
|--|-----------|-----------------------------------|------|
| Supply voltage | V_{DD} | -0.3 to 4.0 | V |
| All other input voltages | V_{IN} | (GND - 0.3) to ($V_{DD} + 0.3$) | V |
| Current drain per pin excluding V_{DD} and GND | I | 10 | mA |
| Storage temperature range | T_{STG} | -55 to 150 | °C |

Table 2-2 Recommended Operating Conditions

| Characteristic | Symbol | Value | Unit |
|---------------------|----------|------------|------|
| Supply voltage | V_{DD} | 2.7 to 3.6 | V |
| Ambient temperature | T_A | -40 to 85 | °C |

Table 2-3 Package Thermal Characteristics

| Thermal Resistance ¹ | 100-pin TQFP | | |
|---|-----------------|-------|------|
| | Symbol | Value | Unit |
| Junction-to-ambient (estimated) ² | | 65 | °C/W |
| Junction-to-case (estimated) ³ | $R_{\theta JC}$ | 10 | °C/W |
| Notes: 1. See discussion under Design Considerations , page 4-1. 2. Junction-to-ambient thermal resistance is based on measurements on a horizontal single-sided Printed Circuit Board per SEMI G38-87 in natural convection. SEMI is Semiconductor Equipment and Materials International, 805 East Middlefield Road, Mountain View, CA 94043, (415) 964-5111. 3. Junction-to-case thermal resistance is based on measurements using a cold plate per SEMI G30-88 with the exception that the cold plate temperature is used for the case temperature. | | | |

PRELIMINARY

DC ELECTRICAL CHARACTERISTICS

Table 2-4 DC Electrical Characteristics

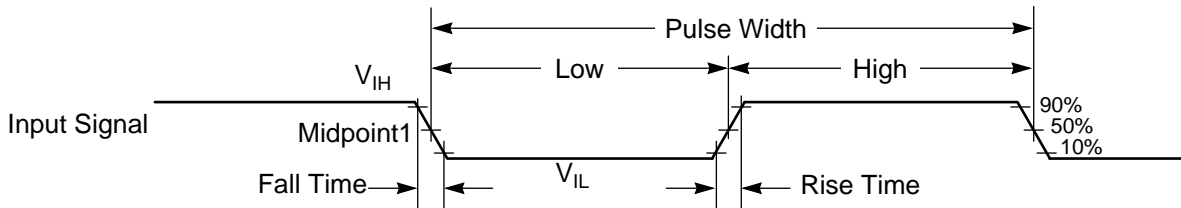
| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|-----------------------|----------------------------------|--------|----------------------------|---------|
| Supply voltage | V_{DD} | 2.7 | — | 3.6 | V |
| Input high voltage: • EXTAL • All other inputs | V_{IHC} V_{IH} | $0.8 \times V_{DD}$ 2.0 | — — | V_{DD} 5 | V |
| Input low voltage • EXTAL • All other inputs | V_{ILC} V_{IL} | -0.3 -0.3 | — — | $0.2 \times V_{DD}$ 0.8 | V |
| Input leakage current @ 2.4 V/0.4 V with $V_{DD} = 3.6$ V | I_{IN} | -1 | — | 1 | μ A |
| Input/output tri-state (off-state) leakage current @ 2.4 V/0.4 V with $V_{DD} = 3.6$ V | I_{TSI} | -10 | — | +10 | μ A |
| Output high voltage • $I_{OH} = -0.3$ mA • $I_{OH} = -50$ μ A | V_{OH} | $V_{DD} - 0.7$ $V_{DD} - 0.3$ | — — | — — | V |
| Output low voltage • $I_{OL} = 2$ mA • $I_{OL} = 50$ μ A | V_{OL} | — — | — — | 0.4 0.2 | V |
| Core CPU supply current ¹ ($F_{PLL} = 70$ MHz) | I_{CORE} | — | 20 | 30 | mA |
| Stop mode current ^{1, 2} | I_{STOP} | — | 2 | 5 | μ A |
| Input capacitance (estimated) | C_{IN} | — | 10 | — | pF |
| Notes: 1. To obtain these results, all inputs must be terminated (i.e., not allowed to float) using CMOS levels. 2. At 25°C, $V_{DD} = 3.0$ V, $V_{IH} = V_{DD}$, $V_{IL} = 0$ V. | | | | | |

PRELIMINARY

AC ELECTRICAL CHARACTERISTICS

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Timing waveforms in **AC Electrical Characteristics** are tested with a V_{IL} maximum of 0.8 V and a V_{IH} minimum of 2.0 V for all pins except EXTAL, which is tested using the input levels in **DC Electrical Characteristics**. **Figure 2-1** shows the levels of V_{IH} and V_{IL} for an input signal.



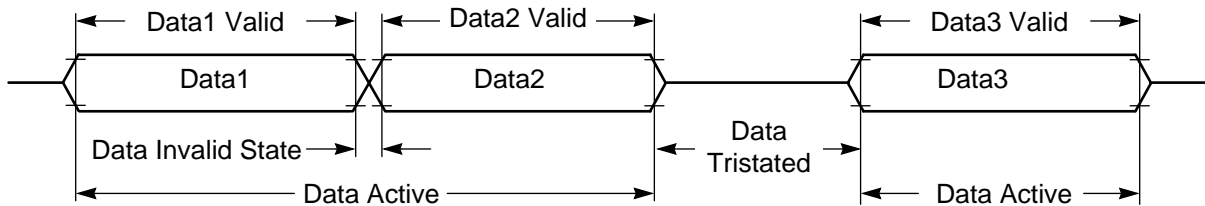
Note: The midpoint is $V_{IL} + (V_{IH} - V_{IL})/2$.

AA1447

Figure 2-1 Input Signal Measurement Reference

Figure 2-2 shows the definitions of the following signal states:

- Active state, when a bus or signal is driven, and enters a low impedance state.
- Tristated, when a bus or signal is placed in a high impedance state.
- Data Valid state, when a signal level has reached V_{OL} or V_{OH} .
- Data Invalid state, when a signal level is in transition between V_{OL} and V_{OH} .



AA1448

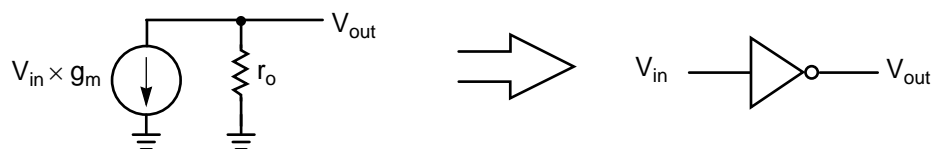
Figure 2-2 Signal States

PRELIMINARY

External Clock Operation

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

The DSP56824 system clock can be derived from a crystal or an external system clock signal. To generate a reference frequency using the internal oscillator, a reference crystal must be connected between the EXTAL and XTAL pins. **Figure 2-3** shows the transconductance model for XTAL. **Table 2-5** shows the electrical characteristics for EXTAL and XTAL pins.



AA0118

Figure 2-3 XTAL Transconductance Model

Table 2-5 EXTAL/XTAL Electrical Characteristics

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|--------|-------|-------|-------|------------|
| EXTAL peak-to-peak swing (for any value of \overline{XCOLF}) | | | | | |
| • $V_{DDPLL} = 2.7\text{ V}$ | — | 1.27 | — | 1.9 | V p-p |
| • $V_{DDPLL} = 3.0\text{ V}$ | — | 1.38 | — | 2.1 | V p-p |
| • $V_{DDPLL} = 3.6\text{ V}$ | — | 1.58 | — | 2.75 | V p-p |
| XTAL transconductance | g_m | | | | |
| • $\overline{XCOLF} = 0$ | | 0.206 | 0.465 | 1.02 | mA/V |
| • $\overline{XCOLF} = V_{DD}$ | | 2.06 | 4.65 | 10.2 | mA/V |
| XTAL output resistance | r_o | | | | |
| • $\overline{XCOLF} = 0$ | | 28.3 | 80.6 | 209.4 | k Ω |
| • $\overline{XCOLF} = V_{DD}$ | | 2.83 | 8.06 | 20.94 | k Ω |

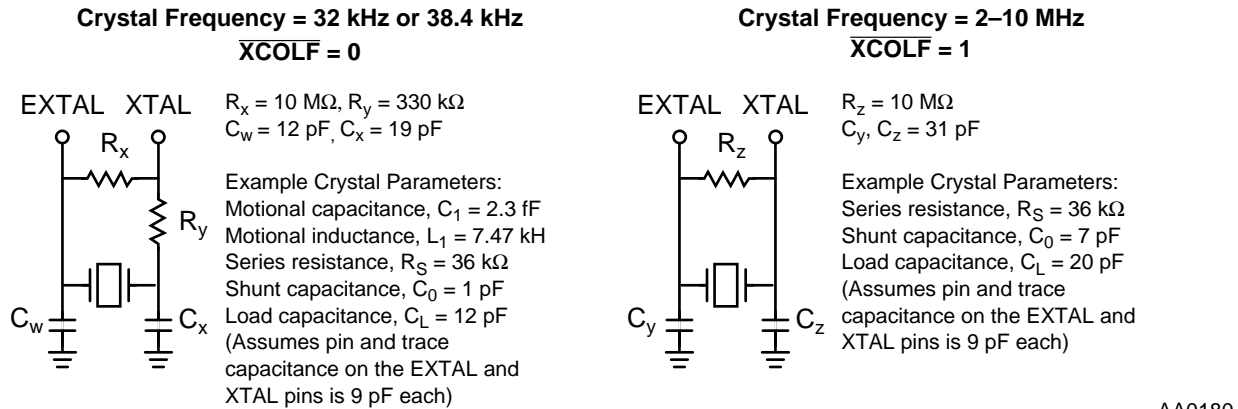
The internal oscillator is designed to interface with a parallel-resonant crystal resonator in the frequency range specified for the external crystal in **Table 2-6**. **Figure 2-4** shows typical crystal oscillator circuits. Follow the crystal supplier's recommendations when selecting a crystal, since crystal parameters determine the component values required to provide maximum stability and reliable start-up. The load capacitance values used in the oscillator circuit design should include all stray layout capacitances. The crystal and associated components should be mounted as close as possible to the EXTAL and XTAL pins to minimize output distortion and start-up stabilization time.

PRELIMINARY

Specifications

AC Electrical Characteristics

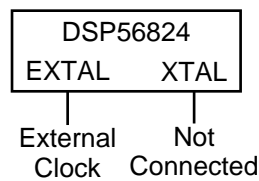
When using the on-chip oscillator in conjunction with an external crystal to generate the DSP clock, the following specifications apply. When driving the clock directly into EXTAL (not using a crystal), the input clock should follow normal digital DSP56824 requirements.



AA0180

Figure 2-4 Examples of Crystal Oscillator Circuits

If the design uses an external clock circuit, apply the external clock input to the EXTAL input with the XTAL pin left unconnected, as shown in **Figure 2-5**.



AA1449

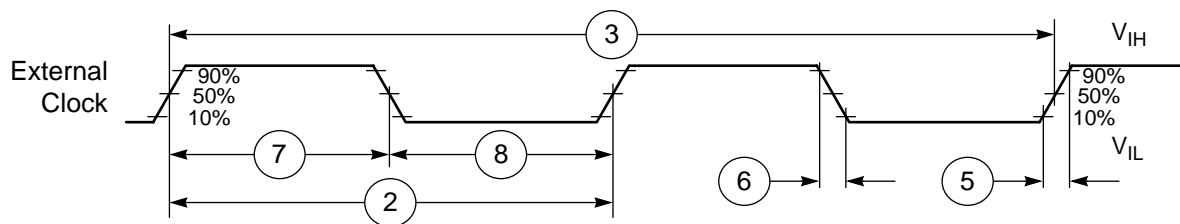
Figure 2-5 Connecting an External Clock Signal

PRELIMINARY

Table 2-6 Clock Operation Timing

| No. | Characteristics | 70 MHz | | Unit |
|-----|---|-------------------|-----------------------|--------------------------|
| | | Min | Max | |
| 1 | Frequency of operation (external clock) | 0 | 70 | MHz |
| 2 | Clock cycle time | 14.29 | — | ns |
| 3 | Instruction cycle time | 28.57 | — | ns |
| 4 | External reference frequency <ul style="list-style-type: none"> • Crystal option, $\overline{XCOLF} = 0^1$ • Crystal option, $\overline{XCOLF} = 1$ • External clock option, $\overline{XCOLF} = 0$ • External clock option, $\overline{XCOLF} = 1$ | 32 2 0 2 | 38.4 10 2 70 | kHz MHz MHz MHz |
| 5 | External clock input rise time | — | 3 | ns |
| 6 | External clock input fall time | — | 3 | ns |
| 7 | External clock input high time | 11.25 | — | ns |
| 8 | External clock input low time | 11.25 | — | ns |
| 9 | PLL output frequency | 10 | 70 | MHz |
| 10 | PLL stabilization time after crystal oscillator start-up time ² | — | 10 | ms |

Notes: 1. When the crystal option is used and $\overline{XCOLF} = 0$, only frequencies of 32 kHz and 38.4 kHz are supported.
 2. This is the minimum time required after the PLL setup is changed to ensure reliable operation.



Note: 1. The midpoint is $V_{IL} + (V_{IH} - V_{IL})/2$.

AA0182

Figure 2-6 External Clock Timing

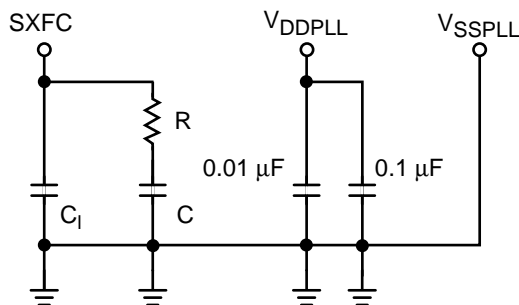
PRELIMINARY

External Components for the PLL

The on-chip PLL requires an extra circuit connected to the SXFC pin, as shown in **Figure 2-7**. As indicated in **Table 2-7**, the values of R, C₁, and C should be chosen based on the Multiplication Factor used to derive the desired operating frequency from the input frequency selected. This circuit affects the performance of the PLL.

Table 2-7 Recommended Component Values for PLL Multiplication Factors

| Multiplication Factor | C ₁ | R | C |
|--|----------------|-------|-------|
| 1024 | 10 nF | 15 kΩ | 15 nF |
| 512 | 2.7 nF | 15 kΩ | 15 nF |
| 256 | 2.7 nF | 15 kΩ | 15 nF |
| 128 | 2.7 nF | 15 kΩ | 15 nF |
| 100 | 2.7 nF | 15 kΩ | 15 nF |
| 80 | 2.7 nF | 15 kΩ | 15 nF |
| 40 | 2.7 nF | 15 kΩ | 15 nF |
| 10 | 750 pF | 2 kΩ | 10 nF |
| 4 | 750 pF | 2 kΩ | 10 nF |
| 2 | 750 pF | 2 kΩ | 10 nF |
| Note: Because of the high number of Multiplication Factors available, these are the only Multiplication Factors evaluated. | | | |



AA0836

Figure 2-7 Schematic of Required External Components for the PLL

PRELIMINARY

Port A External Bus Synchronous Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Capacitance Derating

The DSP56824 external bus synchronous timing specifications are designed and tested at the maximum capacitive load of 50 pF, including stray capacitance. Typically, the drive capability of the pins A0–A15, D0–D15, \overline{PS} , \overline{DS} , \overline{RD} , and \overline{WR} derates linearly at 1.7 ns per 20 pF of additional capacitance from 50 pF to 250 pF of loading. The CLKO pin drive capability is 20 pF. When an internal memory access follows an external memory access, the \overline{PS} , \overline{DS} , \overline{RD} , and \overline{WR} strobes remain deasserted and A0–A15 do not change from their previous state.

Note: In **Figure 2-8** and **Figure 2-9**, T_0 , T_1 , T_2 , and T_3 refer to the internal clock phases and T_W refers to wait state.

Table 2-8 External Bus Synchronous Timing

| No | Characteristic | Min | Max | Unit |
|----|--|------------|--------------|------|
| 20 | External Input Clock High to CLKO High <ul style="list-style-type: none"> • XCO Asserted High • XCO Asserted Low | 3.4 9.0 | 13.8 18.5 | ns |
| 21 | CLKO High to A0–A15 Valid | 0.9 | 2.0 | ns |
| 22 | CLKO High to \overline{PS} , \overline{DS} Valid | 0.3 | 3.1 | ns |
| 23 | CLKO Low to \overline{WR} Asserted Low | 1.1 | 6.4 | ns |
| 24 | CLKO High to \overline{RD} Asserted Low | 0.4 | 4.8 | ns |
| 25 | CLKO High to D0–D15 Out Valid | 0.9 | 3.1 | ns |
| 26 | CLKO High to D0–D15 Out Invalid | 4.4 | 11.2 | ns |
| 27 | D0–D15 In Valid to CLKO Low (Setup) | 15.4 | — | ns |
| 28 | CLKO Low to D0–D15 Invalid (Hold) | 0.7 | — | ns |
| 29 | CLKO Low to \overline{WR} Deasserted | 1.9 | — | ns |
| 30 | CLKO Low to \overline{RD} Deasserted | 1.8 | — | ns |
| 31 | \overline{WR} Hold Time from CLKO Low | 0.2 | — | ns |
| 32 | \overline{RD} Hold Time from CLKO Low | 0.2 | — | ns |
| 33 | CLKO High to D0–D15 Out Active | –1.3 | 0.6 | ns |

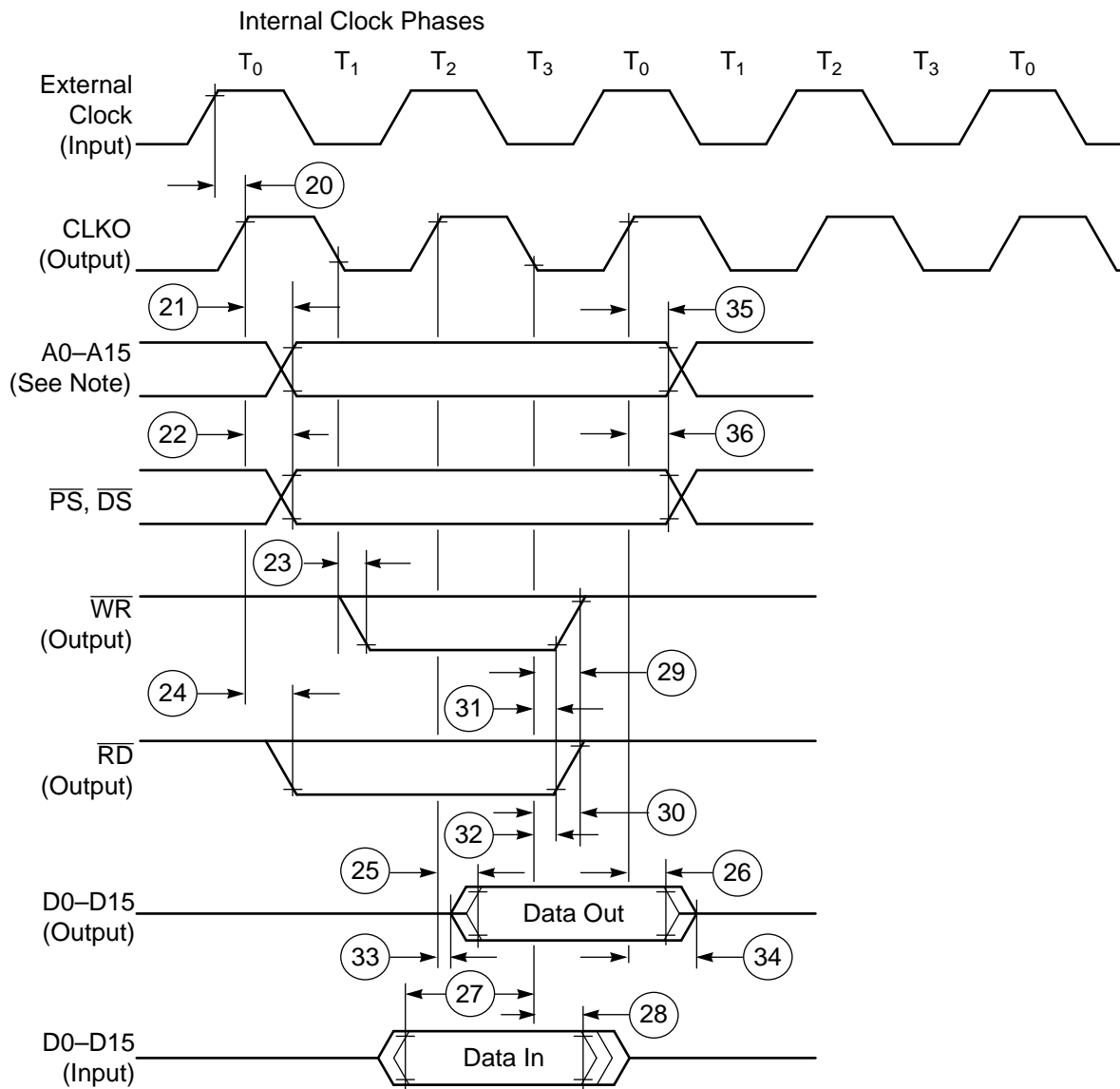
PRELIMINARY

Specifications

AC Electrical Characteristics

Table 2-8 External Bus Synchronous Timing (Continued)

| No | Characteristic | Min | Max | Unit |
|----|--|------|------|------|
| 34 | CLKO High to D0–D15 Out Tri-state | — | 0.3 | ns |
| 35 | CLKO High to A0–A15 Invalid | -0.9 | -2.6 | ns |
| 36 | CLKO High to \overline{PS} , \overline{DS} Invalid | -0.7 | -1.7 | ns |

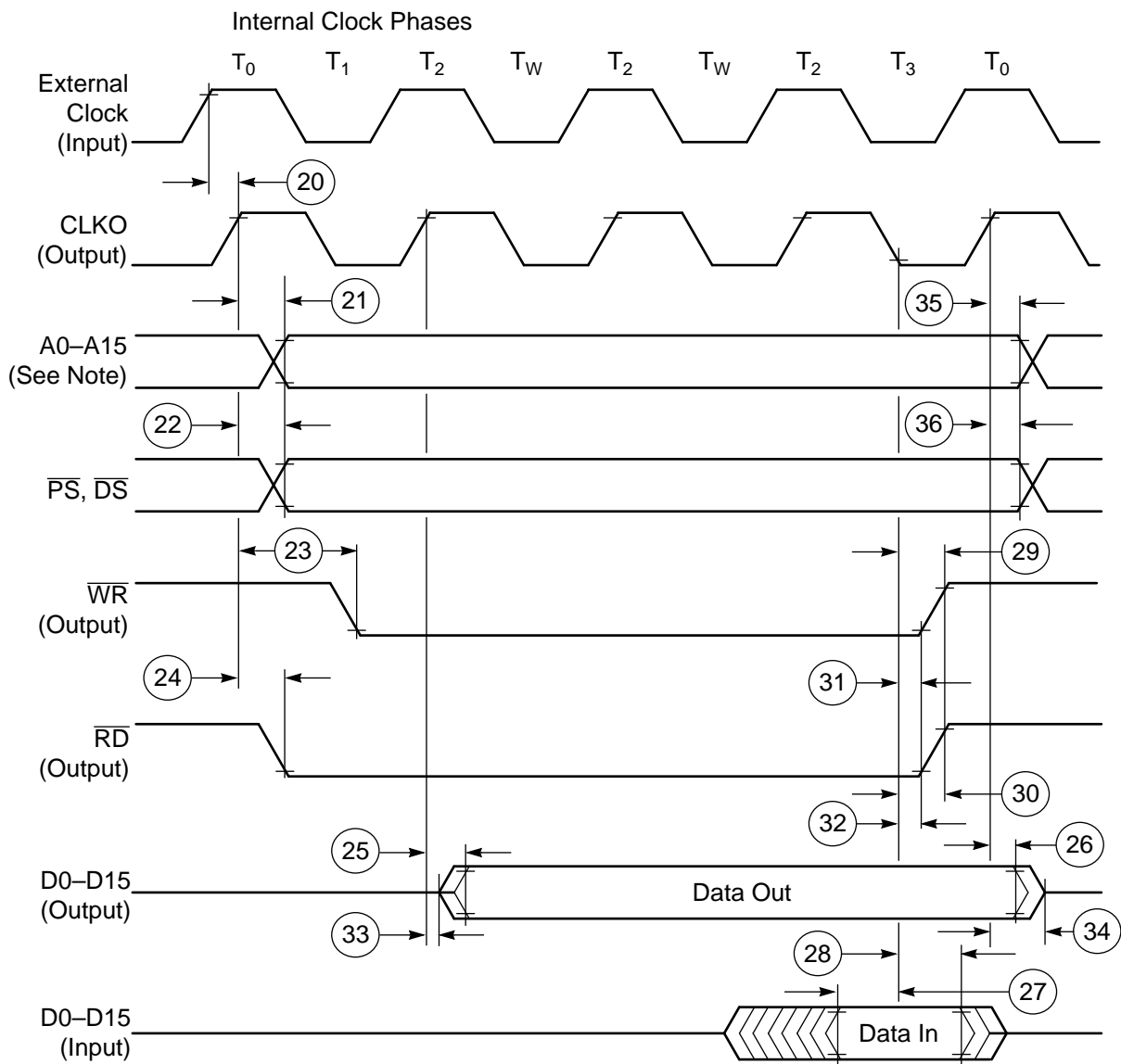


Note: During Read-Modify-Write instructions and internal instructions, the address lines do not change state.

AA1450

Figure 2-8 Synchronous Timing—No Wait State

PRELIMINARY



Note: During Read-Modify-Write instructions and internal instructions, the address lines do not change state.

AA0184

Figure 2-9 Synchronous Timing—Two Wait States

PRELIMINARY

Specifications

AC Electrical Characteristics

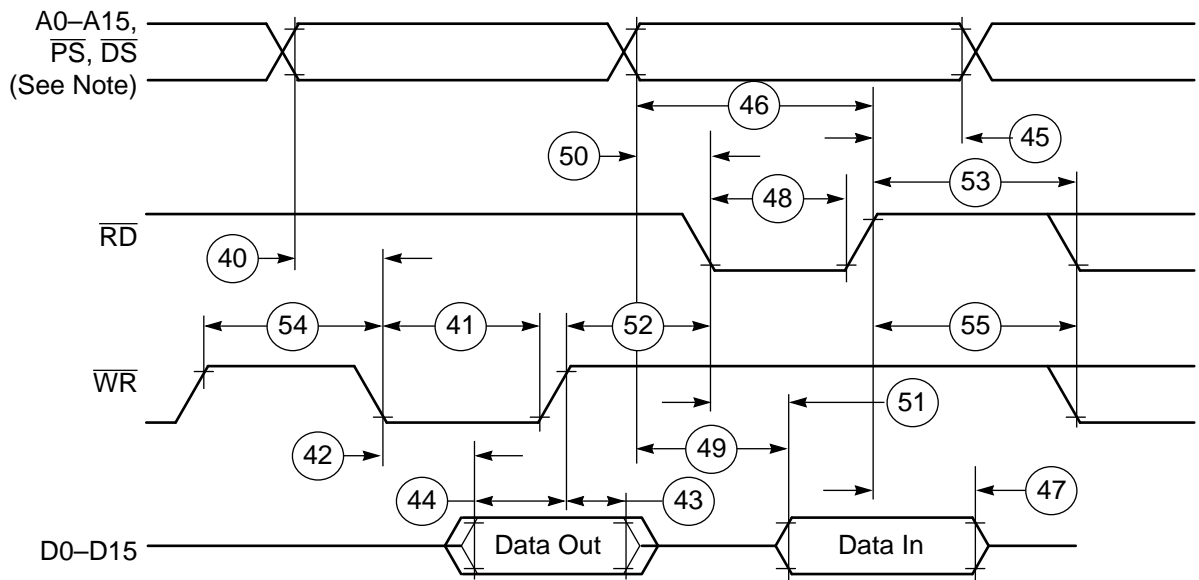
Port A External Bus Asynchronous Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Table 2-9 External Bus Asynchronous Timing

| No. | Characteristic | Min | Max | Unit |
|-------|---|-----------------------------------|-----------------------------------|----------|
| 40 | Address Valid to \overline{WR} Asserted | $T - 0.5$ | — | ns |
| 41 | \overline{WR} Width Asserted <ul style="list-style-type: none"> • Wait states = 0 • Wait states > 0 | $2T - 6.4$ $2T(WS + 1) - 6.4$ | — — | ns ns |
| 42 | \overline{WR} Asserted to D0–D15 Out Valid | — | $T + 0.7$ | ns |
| 43 | Data Out Hold Time from \overline{WR} Deasserted | $T - 5.6$ | — | ns |
| 44 | Data Out Set Up Time to \overline{WR} Deasserted <ul style="list-style-type: none"> • Wait states = 0 • Wait states > 0 | $T + 0.2$ $T(2WS + 1) + 0.2$ | — — | ns ns |
| 45 | \overline{RD} Deasserted to Address Not Valid | $T - 5.6$ | — | ns |
| 46 | Address Valid to \overline{RD} Deasserted | $3T + 0.3$ | — | ns |
| 47 | Input Data Hold to \overline{RD} Deasserted | 2.6 | — | ns |
| 48 | \overline{RD} Assertion Width <ul style="list-style-type: none"> • Wait states = 0 • Wait states > 0 | $3T - 5.8$ $2T(WS) + 3T - 5.8$ | — — | ns ns |
| 49 | Address Valid to Input Data Valid <ul style="list-style-type: none"> • Wait states = 0 • Wait states > 0 | — — | $3T - 5.4$ $2T(WS) + 3T - 5.4$ | ns ns |
| 50 | Address Valid to \overline{RD} Asserted | 0.0 | — | ns |
| 51 | \overline{RD} Asserted to Input Data Valid <ul style="list-style-type: none"> • Wait states = 0 • Wait states > 0 | — — | $3T - 4.7$ $2T(WS) + 3T - 4.7$ | ns ns |
| 52 | \overline{WR} Deasserted to \overline{RD} Asserted | $T - 0.9$ | — | ns |
| 53 | \overline{RD} Deasserted to \overline{RD} Asserted | $T - 0.8$ | — | ns |
| 54 | \overline{WR} Deasserted to \overline{WR} Asserted | $2T - 1.0$ | — | ns |
| 55 | \overline{RD} Deasserted to \overline{WR} Asserted | $2T - 0.8$ | — | ns |
| Note: | Timing is both wait state and frequency dependent. In the formulas listed, WS = the number of wait states and $T = 1/2$ the clock cycle. For 70 MHz operation, $T = 7.14\text{ ns}$. | | | |

PRELIMINARY



Note: During Read-Modify-Write instructions and internal instructions, the address lines do not change state.

AA1451

Figure 2-10 External Bus Asynchronous Timing

PRELIMINARY

Specifications

AC Electrical Characteristics

Reset, Stop, Wait, Mode Select, and Interrupt Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Table 2-10 Reset, Stop, Wait, Mode Select, and Interrupt Timing

| No. | Characteristics | 70 MHz | | Unit |
|-----|--|----------------------|------------------|----------|
| | | Min ¹ | Max ¹ | |
| 60 | $\overline{\text{RESET}}$ Assertion to Address, Data and Control Signals High Impedance | 4.6 | 14.0 | ns |
| 61 | Minimum $\overline{\text{RESET}}$ Assertion Duration ² <ul style="list-style-type: none"> • OMR Bit 6 = 0 • OMR Bit 6 = 1 | 524,329 + 38T 38T | — — | ns ns |
| 62 | Asynchronous $\overline{\text{RESET}}$ Deassertion to First External Address Output ³ | 67T + 4.5 | 67T + 12.3 | ns |
| 63 | Synchronous Reset Setup Time from $\overline{\text{RESET}}$ Deassertion to CLK0 Low | 3.8 | 5.6 | ns |
| 64 | Synchronous Reset Delay Time from CLK0 High to the First External Access ³ | 66T + 2.5 | 66T + 7.5 | ns |
| 65 | Mode and $\overline{\text{XCOLF}}$ Select Setup Time | 0.3 | — | ns |
| 66 | Mode and $\overline{\text{XCOLF}}$ Select Hold Time | 0 | — | ns |
| 67 | Edge-sensitive Interrupt Request Width | 2T + 3.8 | — | ns |
| 68 | $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$ Assertion to External Data Memory Access Out Valid, caused by first instruction execution in the interrupt service routine | 28 + 2.5 | — | ns |
| 69 | $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$ Assertion to General Purpose Output Valid, caused by first instruction execution in the interrupt service routine | 31T + 3.7 | — | ns |
| 70 | Synchronous setup time from $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$ assertion to Synchronous CLK0 High ^{4,5} | 1.9 | 2T | ns |
| 71 | CLK0 Low to First Interrupt Vector Address Out Valid after Synchronous recovery from Wait State ⁶ | 24T + 4.4 | — | ns |
| 72 | $\overline{\text{IRQA}}$ Width Assertion to Recover from Stop State ⁷ | 2T + 3.8 | — | ns |
| 73 | Delay from $\overline{\text{IRQA}}$ Assertion to Fetch of first instruction (exiting Stop) ² <ul style="list-style-type: none"> • OMR Bit 6 = 0 • OMR Bit 6 = 1 | 524,329T 22T | — — | ns ns |

PRELIMINARY

Table 2-10 Reset, Stop, Wait, Mode Select, and Interrupt Timing (Continued)

| No. | Characteristics | 70 MHz | | Unit |
|--------|---|-----------------------------|------------------|----------|
| | | Min ¹ | Max ¹ | |
| 74 | Duration for Level Sensitive $\overline{\text{IRQA}}$ Assertion to Cause the Fetch of First $\overline{\text{IRQA}}$ Interrupt Instruction (exiting Stop) ² <ul style="list-style-type: none"> • OMR Bit 6 = 0 • OMR Bit 6 = 1 | 524,329T 22T | — — | ns ns |
| 75 | Delay from Level Sensitive $\overline{\text{IRQA}}$ Assertion to First Interrupt Vector Address Out Valid (exiting Stop) ² <ul style="list-style-type: none"> • OMR Bit 6 = 0 • OMR Bit 6 = 1 | 524,336T + 2.5 22T + 2.5 | — — | ns ns |
| Notes: | <ol style="list-style-type: none"> 1. In the formulas, T = 1/2 the clock cycle and WS = the number of wait states. For an internal frequency of 70 MHz, T = 7.14 ns. 2. Circuit stabilization delay is required during reset when using an external clock or crystal oscillator in two cases: <ul style="list-style-type: none"> • After power-on reset • When recovering from Stop state 3. The instruction fetch is visible on the pins only in Mode 2 and Mode 3. 4. Timing No. 72 is for all $\overline{\text{IRQx}}$ interrupts, while timing No. 73 is only when exiting the Wait state. 5. Timing No. 72 triggers off T0 in the Normal state and off phi0 when exiting the Wait state. 6. The minimum is specified for the duration of an edge-sensitive $\overline{\text{IRQA}}$ interrupt required to recover from the Stop state. This is not the minimum required so that the $\overline{\text{IRQA}}$ interrupt is accepted. 7. The interrupt instruction fetch is visible on the pins only in Mode 3. | | | |

PRELIMINARY

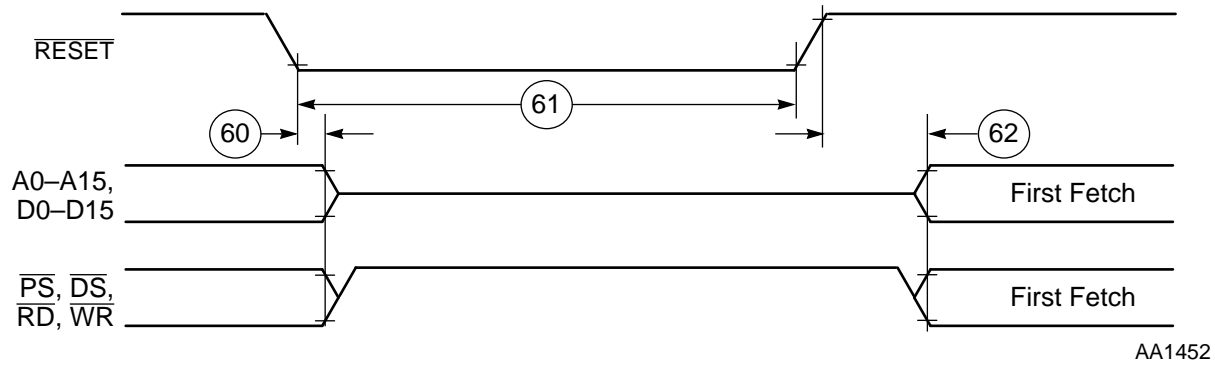


Figure 2-11 Asynchronous Reset Timing

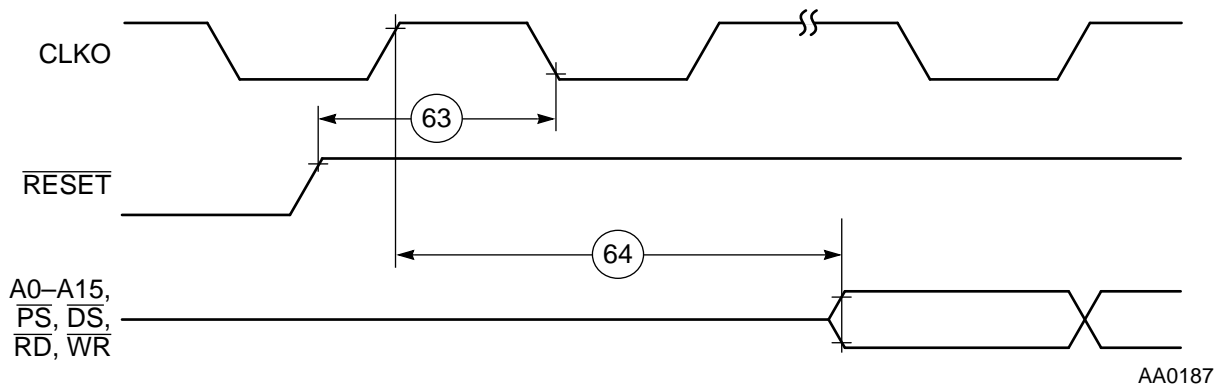


Figure 2-12 Synchronous Reset Timing

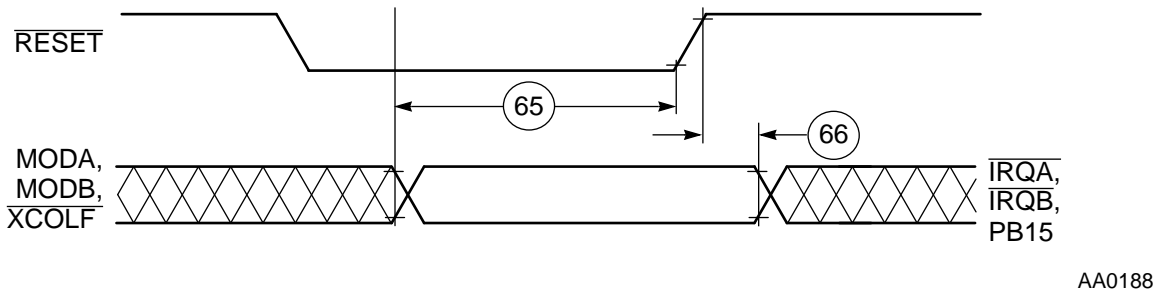


Figure 2-13 Operating Mode Select Timing

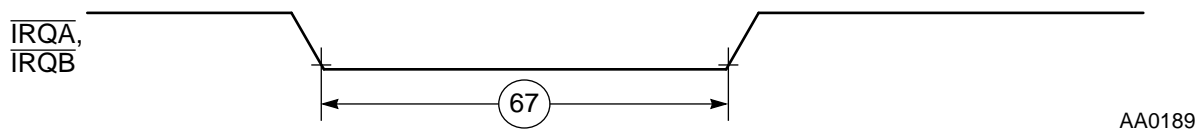
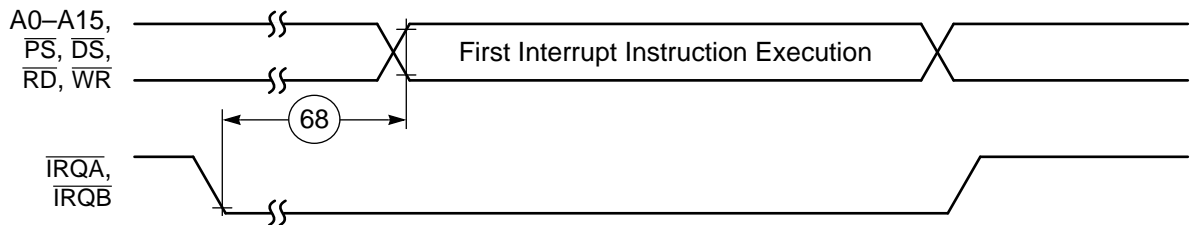
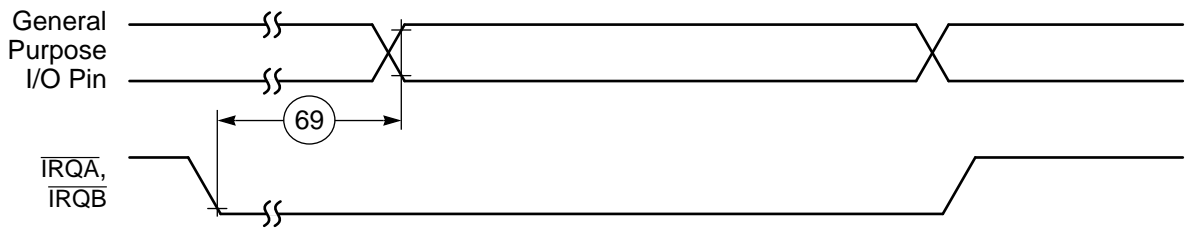


Figure 2-14 External Interrupt Timing (Negative-Edge-Sensitive)

PRELIMINARY



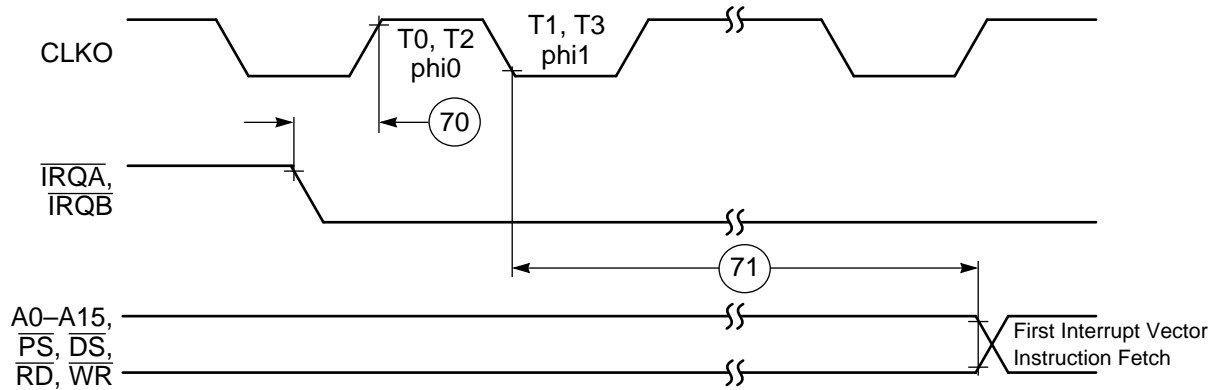
a) First Interrupt Instruction Execution



b) General Purpose I/O

AA0190

Figure 2-15 External Level-Sensitive Interrupt Timing



AA0191

Figure 2-16 Synchronous Interrupt from Wait State Timing

PRELIMINARY

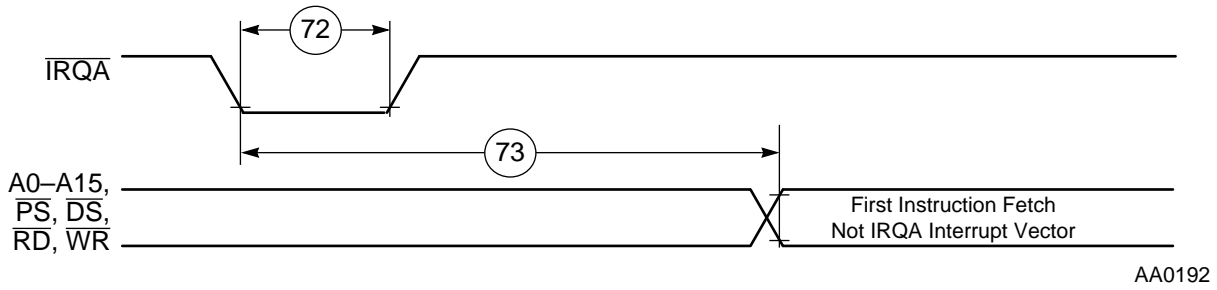


Figure 2-17 Recovery from Stop State Using Asynchronous Interrupt Timing

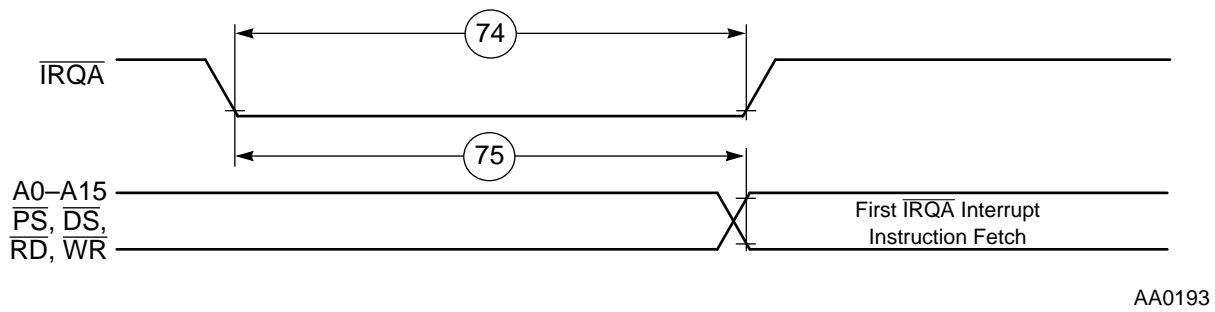


Figure 2-18 Recovery from Stop State Using $\overline{\text{IRQA}}$ Interrupt Service

PRELIMINARY

Port B and C Pin GPIO Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

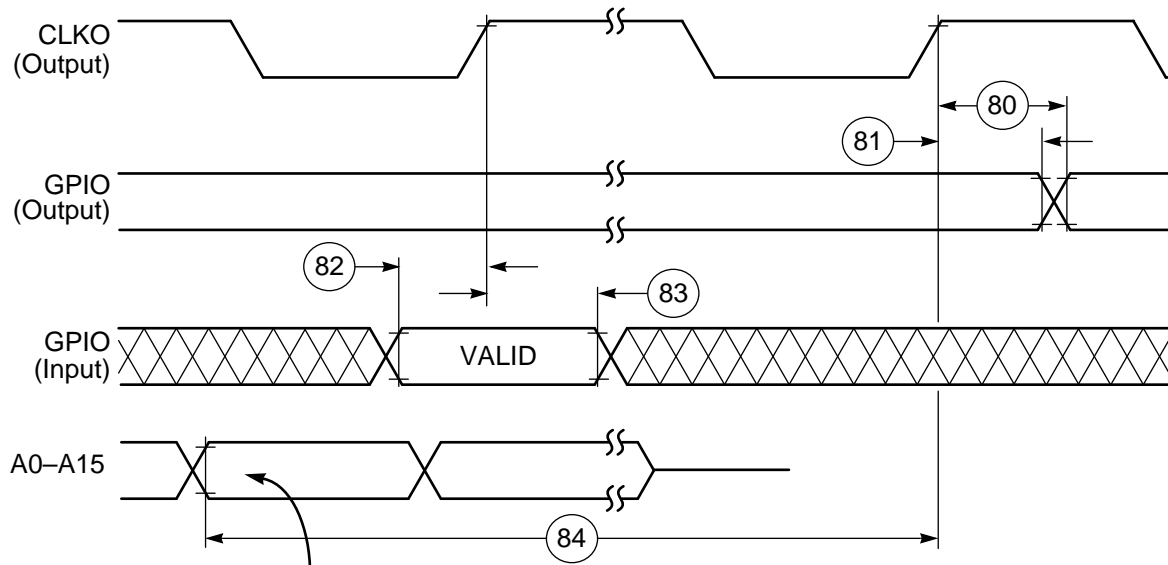
Table 2-11 GPIO Timing

| No. | Characteristics | Min ¹ | Max ¹ | Unit |
|--------|---|------------------|------------------|------|
| 80 | CLKO high to GPIO out valid (GPIO out delay time) ² | — | 10.7 | ns |
| 81 | CLKO high to GPIO out not valid (GPIO out hold time) | 1.5 | — | ns |
| 82 | GPIO in valid to CLKO high (GPIO in set-up time) | 7.8 | — | ns |
| 83 | CLKO high to GPIO in not valid (GPIO in hold time) | 0.5 | — | ns |
| 84 | Fetch to CLKO high before GPIO change | 12T – 1.7 | — | ns |
| 85 | Port B interrupt pulse width | 4T | — | ns |
| 86 | Port B interrupt assertion to external data memory access out valid, caused by first instruction execution in the interrupt service routine | 19T + 9.6 | — | ns |
| 87 | Port B interrupt assertion to general purpose output valid, caused by first instruction execution in the interrupt service routine | 31T + 10.8 | — | ns |
| Notes: | <ol style="list-style-type: none"> In the formulas, T = 1/2 the clock cycle. For an internal frequency of 70 MHz, T = 7.14 ns. If a 10 kΩ pullup or pulldown resistor is connected to $\overline{\text{XCOLF}}$/PB15, add 3.9 ns for timings on $\overline{\text{XCOLF}}$/PB15. | | | |

PRELIMINARY

Specifications

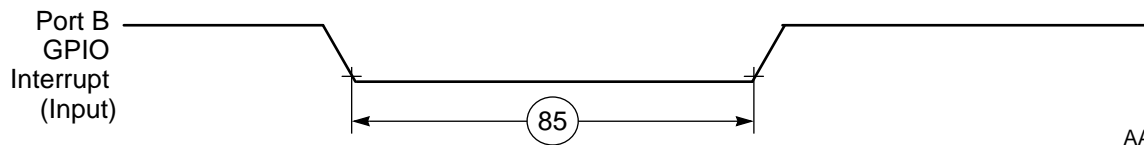
AC Electrical Characteristics



Fetch the instruction MOVE X0,X:(R0); X0 contains the new value of GPIO and R0 contains the address of GPIO data register.

AA0194

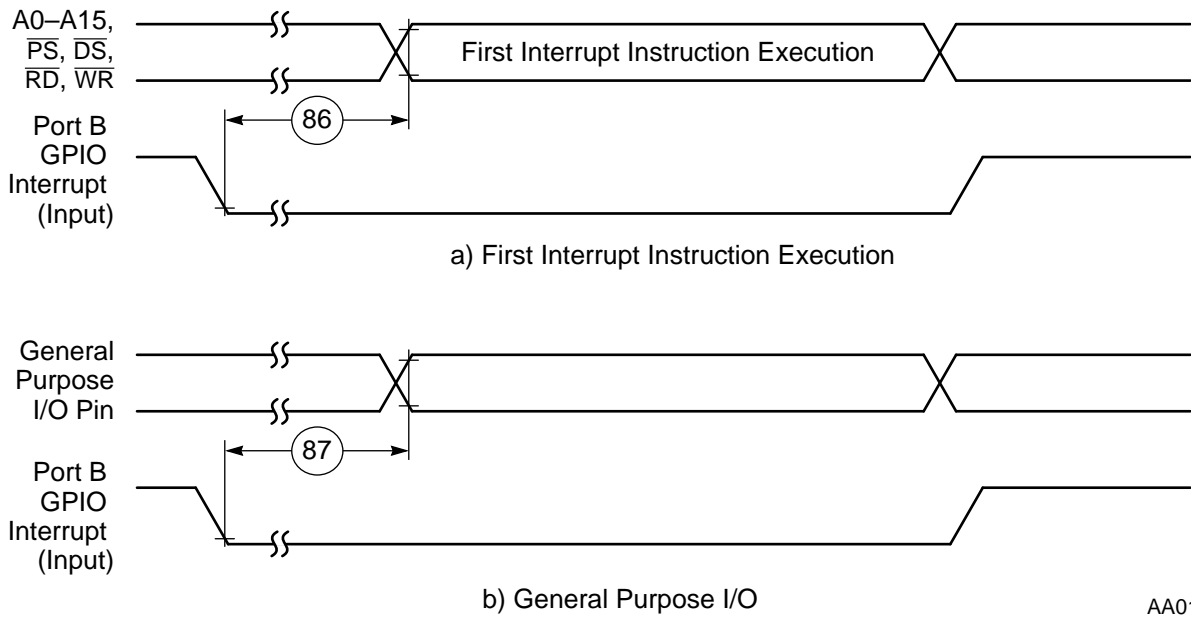
Figure 2-19 GPIO Timing



AA0195

Figure 2-20 Port B Interrupt Timing (Negative-Edge-Sensitive)

PRELIMINARY



AA0196

Figure 2-21 Port B GPIO Interrupt Timing

PRELIMINARY

Specifications

AC Electrical Characteristics

Serial Peripheral Interface (SPI) Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$)

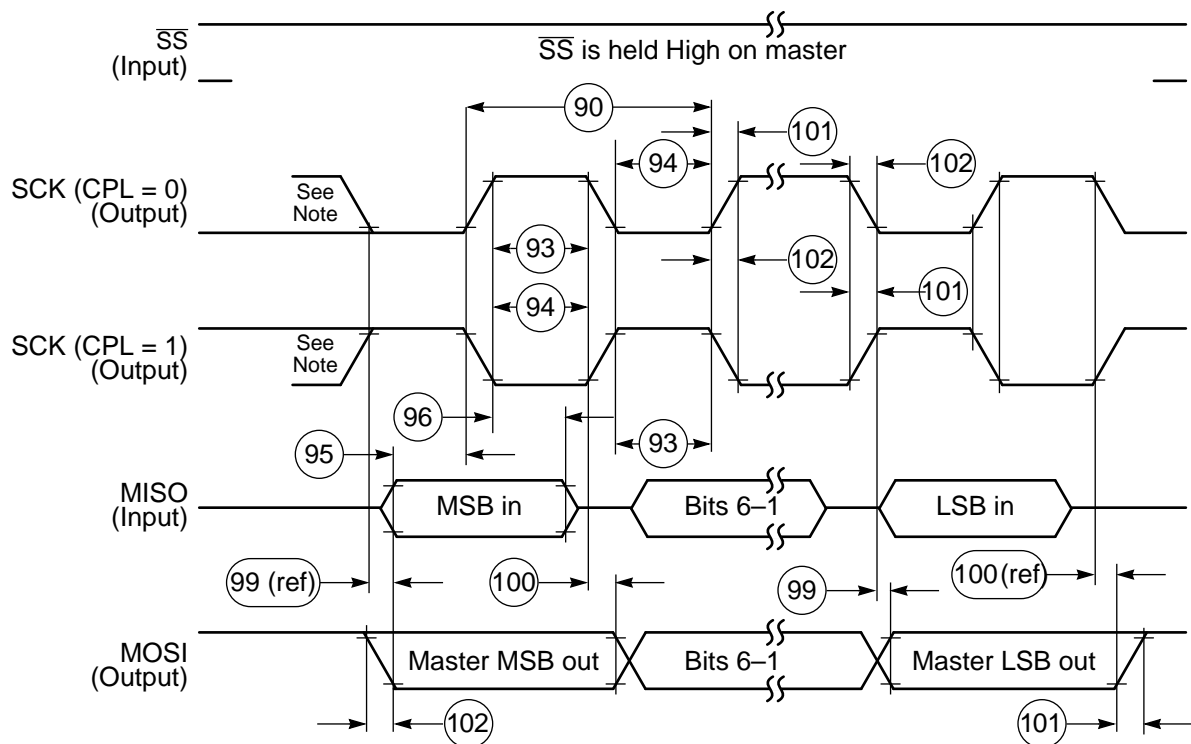
Table 2-12 SPI Timing

| No. | Characteristic | 70 MHz | | | | Unit |
|-----|---|-------------------|-------------|-------------------|-------------|----------|
| | | 20 pF Output Load | | 50 pF Output Load | | |
| | | Min | Max | Min | Max | |
| 90 | Cycle time | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 100 100 | — — | 100 100 | — — | ns ns |
| 91 | Enable lead time | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | — 6.8 | — — | — 25 | — — | ns ns |
| 92 | Enable lag time | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | — 6.5 | — — | — 100 | — — | ns ns |
| 93 | Clock (SCK) high time | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 17.6 25 | — — | 17.6 25 | — — | ns ns |
| 94 | Clock (SCK) low time | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 24.1 25 | — — | 24.1 25 | — — | ns ns |
| 95 | Data setup time (inputs) | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 15.6 -3.2 | — — | 20 0 | — — | ns ns |
| 96 | Data hold time (inputs) | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 0 0 | — — | 0 0 | — — | ns ns |
| 97 | Access time (time to data active from high-impedance state) | | | | | |
| | <ul style="list-style-type: none"> • Slave | 4.8 | 10.7 | 4.8 | 15 | ns ns |
| 98 | Disable time (hold time to high-impedance state) | | | | | |
| | <ul style="list-style-type: none"> • Slave | 3.7 | 15.2 | 3.7 | 15.2 | ns ns |
| 99 | Data Valid | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave (after enable edge) | 4.5 4.6 | 3.5 20.4 | 4.5 4.6 | 3.5 20.4 | ns ns |

PRELIMINARY

Table 2-12 SPI Timing (Continued)

| No. | Characteristic | 70 MHz | | | | Unit |
|-----|---|-------------------|-----|-------------------|------|------|
| | | 20 pF Output Load | | 50 pF Output Load | | |
| | | Min | Max | Min | Max | |
| 100 | Data invalid | | | | | |
| | <ul style="list-style-type: none"> • Master • Slave | 0 | — | 0 | — | ns |
| 101 | Rise time | 4.1 | 5.5 | 4.1 | 11.5 | ns |
| | <ul style="list-style-type: none"> • Master • Slave | 0 | 4.0 | 0 | 10.0 | ns |
| 102 | Fall time | 1.5 | 4.7 | 2.0 | 9.7 | ns |
| | <ul style="list-style-type: none"> • Master • Slave | 0 | 4.0 | 2.0 | 9.0 | ns |

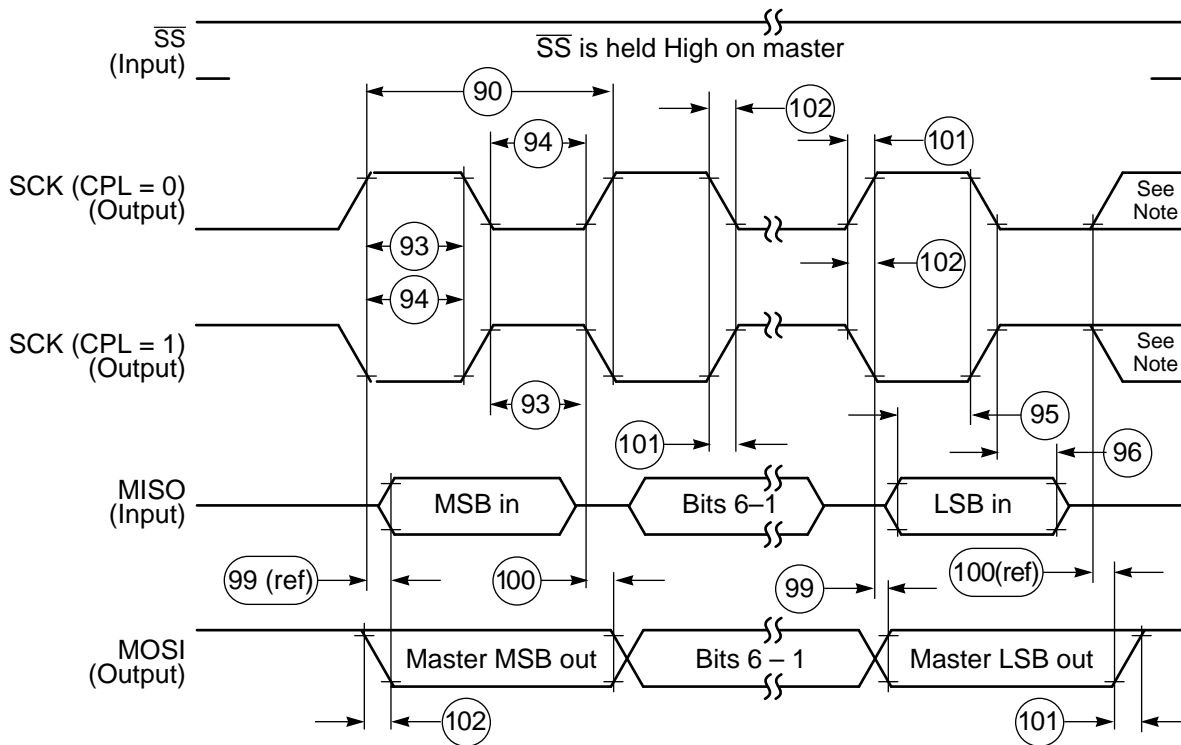


Note: This first clock edge is generated internally, but is not seen at the SCK pin.

AA0197

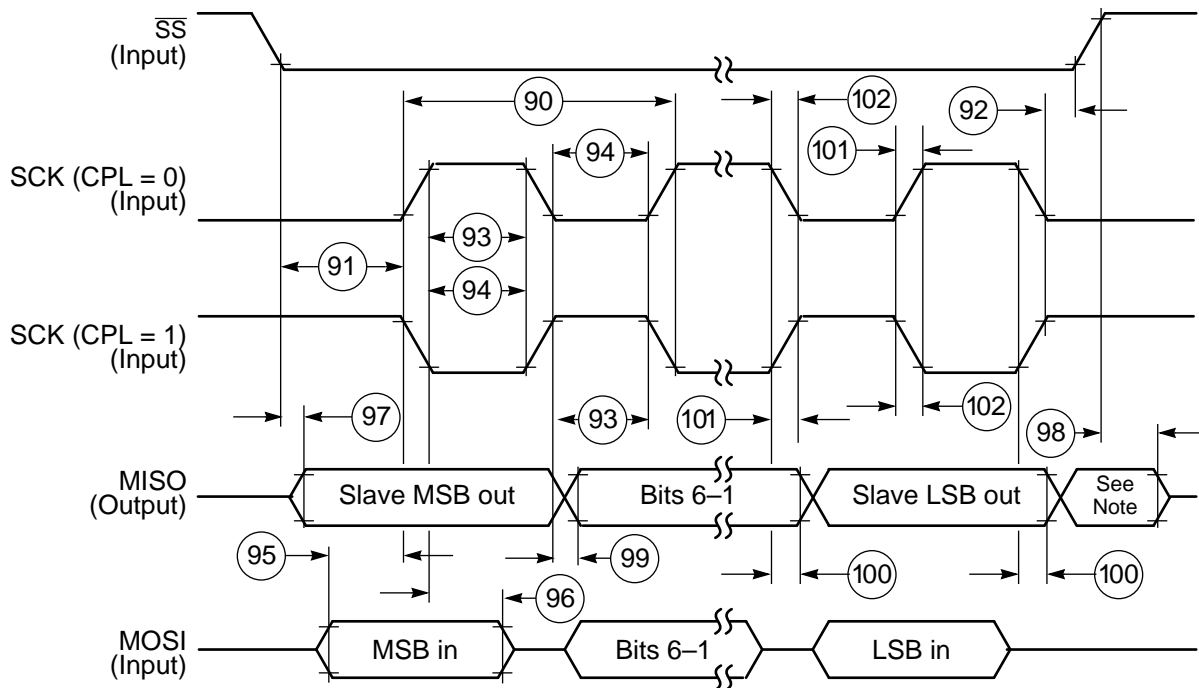
Figure 2-22 SPI Master Timing (CPH = 0)

PRELIMINARY



Note: This last clock edge is generated internally, but is not seen at the SCK pin. AA0198

Figure 2-23 SPI Master Timing (CPH = 1)

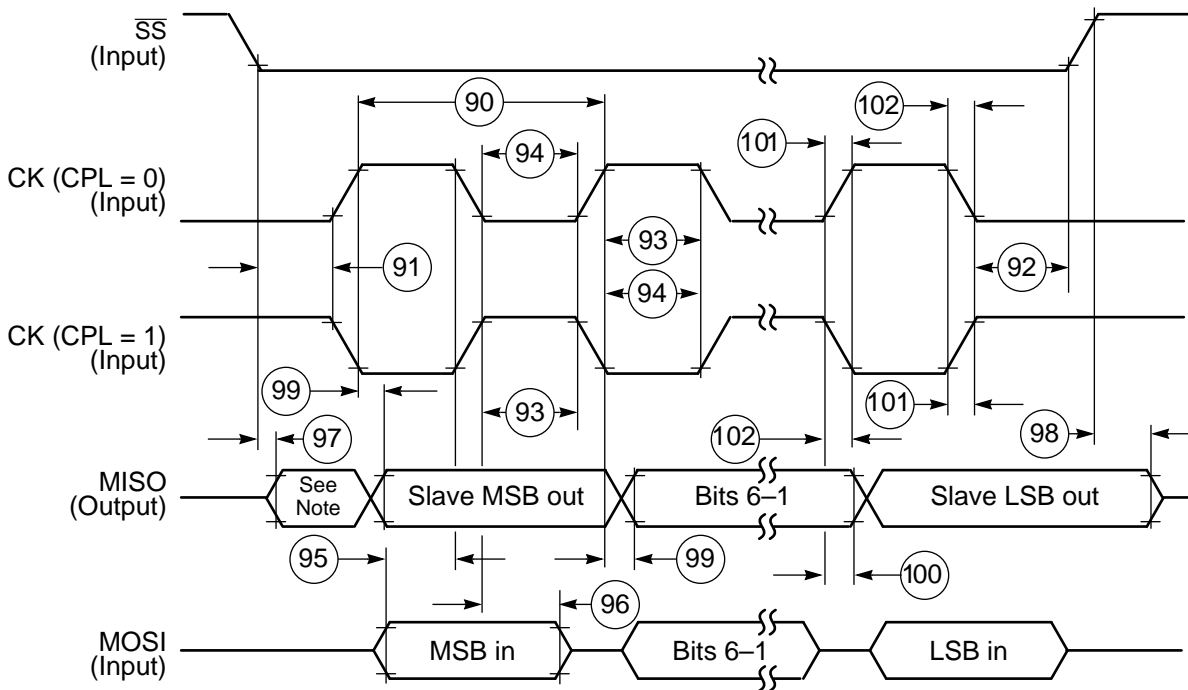


Note: Not defined, but normally MSB of character just received

AA0199

Figure 2-24 SPI Slave Timing (CPH = 0)

PRELIMINARY



Note: Not defined, but normally LSB of character previously transmitted

AA0200

Figure 2-25 SPI Slave Timing (CPH = 1)

PRELIMINARY

Synchronous Serial Interfaces (SSI) Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Table 2-13 SSI Timing

| No. | Characteristic | 70 MHz | | Case ¹ | Unit |
|---------------------------------|---|--------|------|-------------------|------|
| | | Min | Max | | |
| Internal Clock Operation | | | | | |
| 110 | Clock cycle ² | 100 | — | i ck | ns |
| 111 | Clock high period | 33.2 | — | i ck | ns |
| 112 | Clock low period | 30.6 | — | i ck | ns |
| 113 | Output clock rise/fall time | — | 7.5 | i ck | ns |
| 114 | STCK high to STFS (bl) high ³ | 1.8 | 9.7 | i ck | ns |
| 115 | SRCK high to SRFS (bl) high ³ | 1.3 | 10 | i ck | ns |
| 116 | STCK high to STFS (bl) low ³ | -2.9 | 8 | i ck | ns |
| 117 | SRCK high to SRFS (bl) low ³ | -2.7 | 8.7 | i ck | ns |
| 118 | SRD setup time before SRCK low | 9 | — | i ck | ns |
| 119 | SRD hold time after SRCK low | 0 | — | i ck | ns |
| 120 | STCK high to STFS (wl) high ³ | 13.8 | 24.4 | i ck | ns |
| 121 | SRCK high to SRFS (wl) high ³ | 14.5 | 25.9 | i ck | ns |
| 122 | STCK high to STFS (wl) low ³ | -2.9 | 9.0 | i ck | ns |
| 123 | SRCK high to SRFS (wl) low ³ | -2.2 | 10.6 | i ck | ns |
| 124 | STCK high to STD enable from high impedance | 1.5 | 1.7 | i ck | ns |
| 125 | STCK high to STD valid | -3.4 | 7.9 | i ck | ns |
| 126 | STCK High to STD not valid | -5.7 | 0.7 | i ck | ns |
| 127 | STCK high to STD high impedance | 6.8 | 11.3 | i ck | ns |
| External Clock Operation | | | | | |
| 128 | Clock cycle ² | 100 | — | x ck | ns |
| 129 | Clock high period | 50 | — | x ck | ns |
| 130 | Clock low period | 50 | — | x ck | ns |
| 132 | SRD Setup time before SRCK low | -8.7 | — | x ck | ns |
| 133 | SRD hold time after SRCK low ⁴ | 1.7 | — | x ck | ns |

PRELIMINARY

Specifications

AC Electrical Characteristics

Table 2-13 SSI Timing (Continued)

| No. | Characteristic | 70 MHz | | Case ¹ | Unit |
|--|---|--------|------|-------------------|------|
| | | Min | Max | | |
| 134 | STCK high to STFS (bl) high ³ | 0.4 | 100 | x ck | ns |
| 135 | SRCK high to SRFS (bl) high ³ | 0.5 | 100 | x ck | ns |
| 136 | STCK high to STFS (bl) low ³ | 0 | 99 | x ck | ns |
| 137 | SRCK high to SRFS (bl) low ³ | 0 | 99 | x ck | ns |
| 138 | STCK high to STFS (wl) high ³ | 0.4 | 100 | x ck | ns |
| 139 | SRCK high to SRFS (wl) high ³ | 0.5 | 100 | x ck | ns |
| 140 | STCK high to STFS (wl) low ³ | 0 | 99 | x ck | ns |
| 141 | SRCK high to SRFS (wl) low ³ | 0 | 99 | x ck | ns |
| 142 | STCK high to STD enable from high impedance | 7.8 | 19 | x ck | ns |
| 143 | STCK high to STD valid | 11.7 | 28.5 | x ck | ns |
| 144 | STCK high to STD not valid | 5.8 | 21.1 | x ck | ns |
| 145 | STCK high to STD high impedance | 9.2 | 22.9 | x ck | ns |
| Synchronous Internal Clock Operation (in addition to standard internal clock parameters) | | | | | |
| 146 | SRD setup before STCK falling | 18.4 | — | i ck s | ns |
| 147 | SRD hold after STCK falling ⁴ | 0 | — | i ck s | ns |
| Synchronous External Clock Operation (in addition to standard external clock parameters) | | | | | |
| 148 | SRD setup before STCK falling | -4.7 | — | x ck s | ns |
| 149 | SRD hold after STCK falling ⁴ | 1.7 | — | x ck s | ns |
| Notes: 1. The following abbreviations are used to represent the various operational cases: i ck = Internal Clock and Frame Sync x ck = External Clock and Frame Sync i ck s = Internal Clock, Synchronous mode (implies that only one frame sync FS is used) x ck s = External Clock, Synchronous mode (implies that only one frame sync FS is used) 2. All the timings for the SSI are given for a non-inverted serial clock polarity (SCKP = 0 in CRB) and a non-inverted frame sync (FSI = 0 in CRB). If the polarity of the clock and/or the frame sync have been inverted, all the timings remain valid by inverting the clock signal SCK and/or the frame sync FSR/FST in the tables and in the figures. 3. bl = bit length; wl = word length. | | | | | |

PRELIMINARY

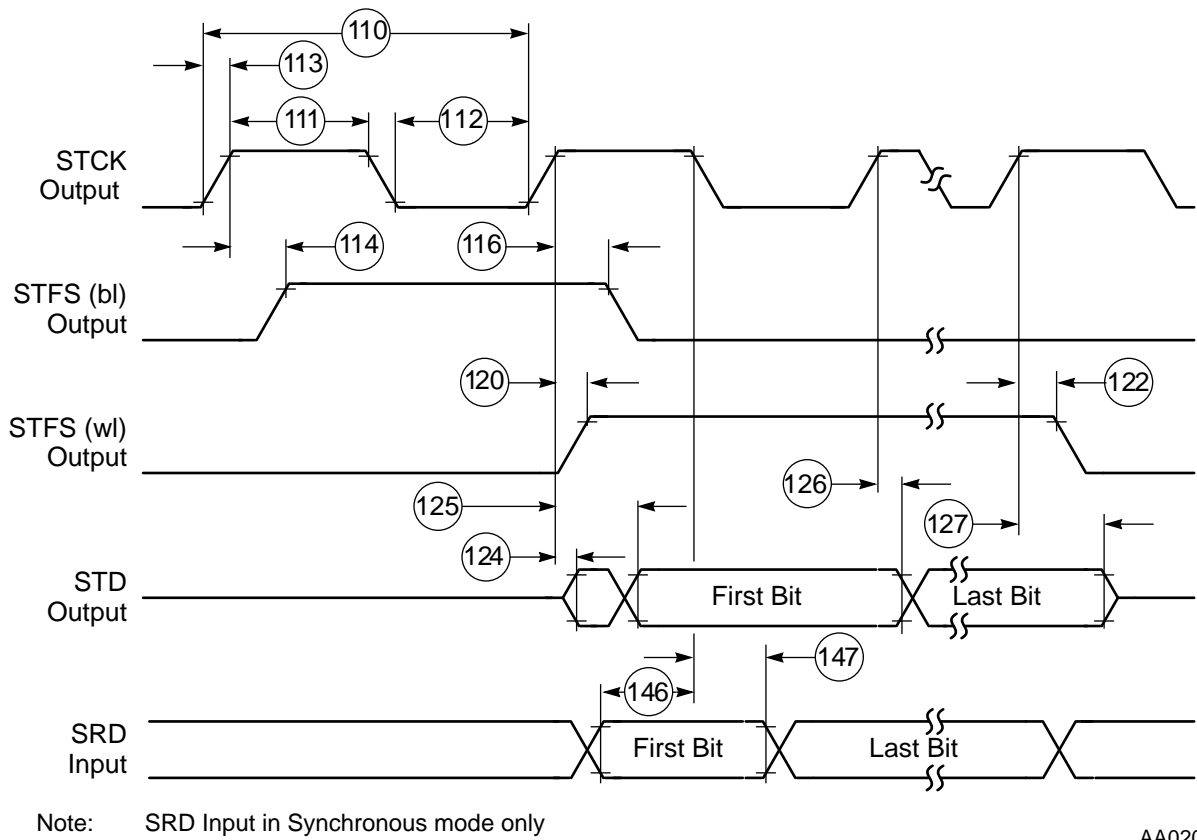
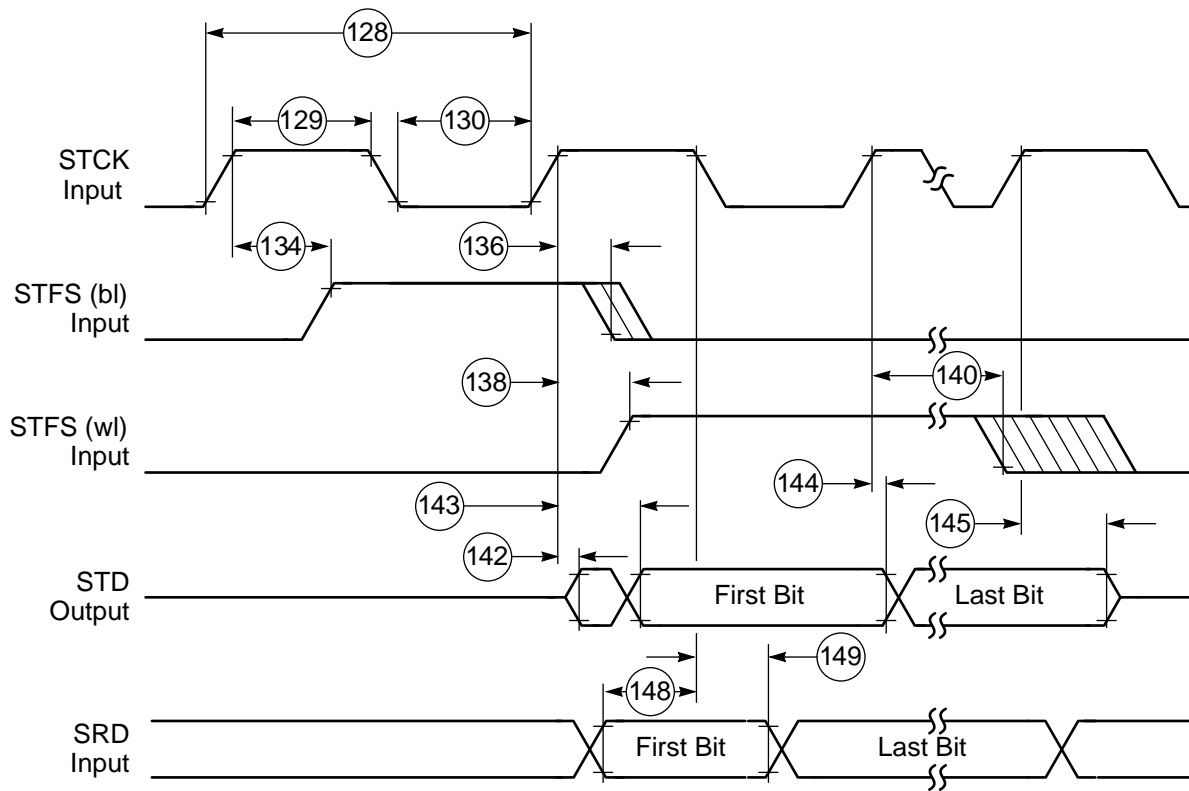


Figure 2-26 SSI Transmitter Internal Clock Timing

PRELIMINARY

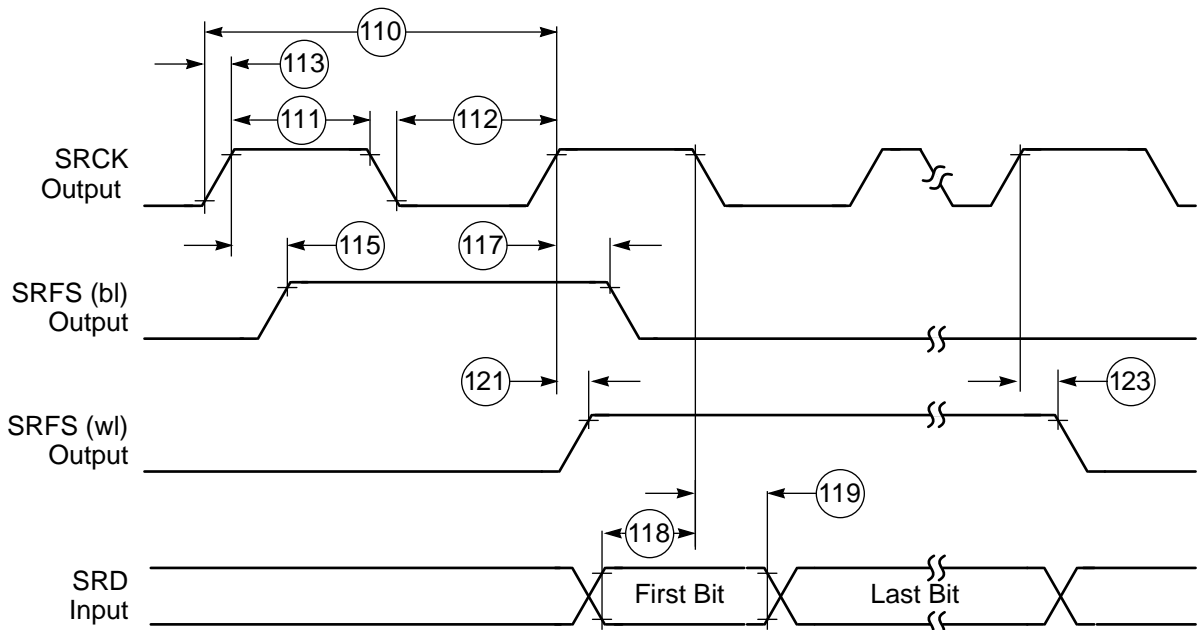


Note: SRD Input in Synchronous mode only

AA0202

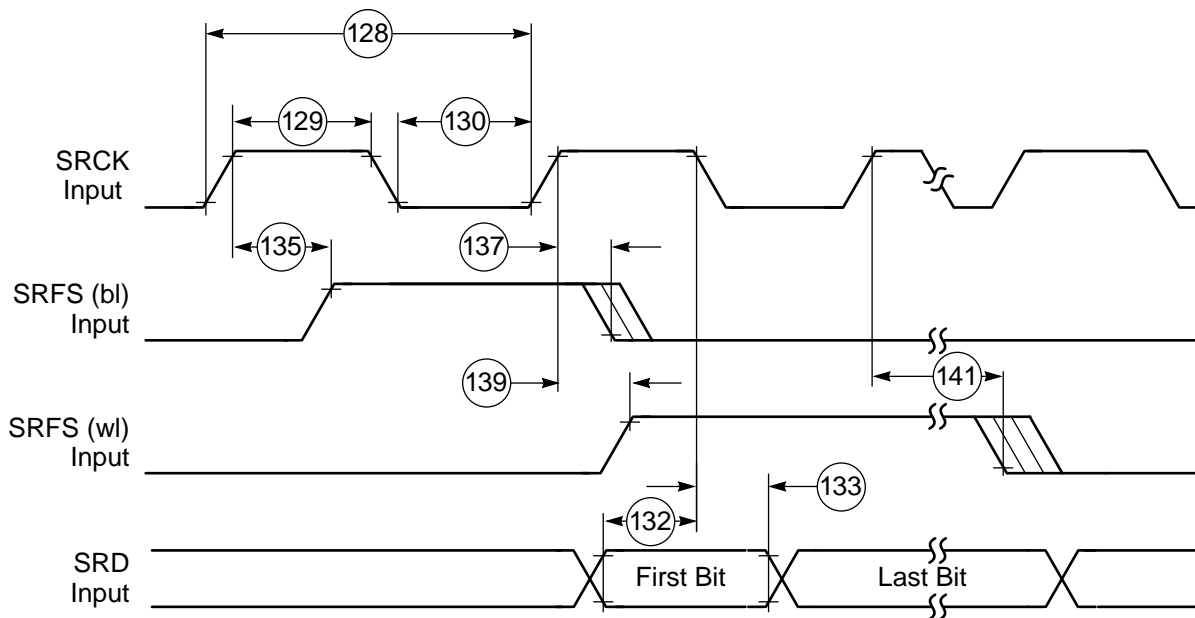
Figure 2-27 SSI Transmitter External Clock Timing

PRELIMINARY



AA0203

Figure 2-28 SSI Receiver Internal Clock Timing



AA0204

Figure 2-29 SSI Receiver External Clock Timing

PRELIMINARY

Specifications

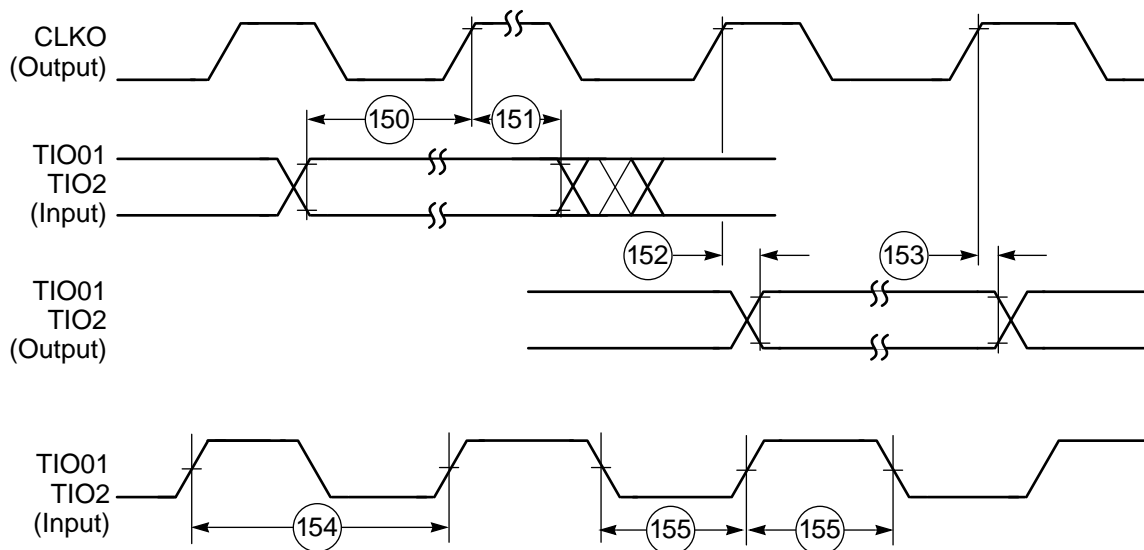
AC Electrical Characteristics

Timer Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Table 2-14 Timer Timing

| No. | Characteristic | 70 MHz | | Unit |
|-----|--|--------|------|------|
| | | Min | Max | |
| 150 | Timer input valid to CLKO high (setup time) | 11.4 | — | ns |
| 151 | CLKO high to timer input not valid (hold time) | 0 | — | ns |
| 152 | CLKO high to timer output asserted | 9.5 | 18.7 | ns |
| 153 | CLKO high to timer output deasserted | 5.1 | 20.7 | ns |
| 154 | Timer input period | 8T | — | ns |
| 155 | Timer input high/low period | 4T | — | ns |



AA0205

Figure 2-30 Timer Timing

PRELIMINARY

JTAG Timing

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{--}3.6\text{ V}$, $T_A = -40^\circ\text{ to }+85^\circ\text{C}$, $C_L = 50\text{ pF}$)

Table 2-15 JTAG Timing

| No. | Characteristics | 70 MHz | | Unit |
|-------|---|--------|------|------|
| | | Min | Max | |
| 160 | TCK frequency of operation | 0.0 | 8.75 | MHz |
| | <ul style="list-style-type: none"> • In OnCE Debug mode (EXTAL/8) • In JTAG mode | 0.0 | 10 | MHz |
| 161 | TCK cycle time | 100 | — | ns |
| 162 | TCK clock pulse width | 50 | — | ns |
| 164 | Boundary scan input data setup time | 34.5 | — | ns |
| 165 | Boundary scan input data hold time | 0 | — | ns |
| 166 | TCK low to output data valid | — | 40.6 | ns |
| 167 | TCK low to output tri-state | — | 43.4 | ns |
| 168 | TMS, TDI data setup time | 0.4 | — | ns |
| 169 | TMS, TDI data hold time | 1.2 | — | ns |
| 170 | TCK low to TDO data valid | — | 26.6 | ns |
| 171 | TCK low to TDO tri-state | — | 23.5 | ns |
| 172 | $\overline{\text{TRST}}$ assertion time | 50 | — | ns |
| 173 | $\overline{\text{DE}}$ assertion time | 8T | — | ns |
| Note: | Timing is both wait state and frequency dependent. In the formulas listed, WS = the number of wait states and T = 1/2 the clock cycle. For 70 MHz operation, T = 7.14 ns. | | | |

PRELIMINARY

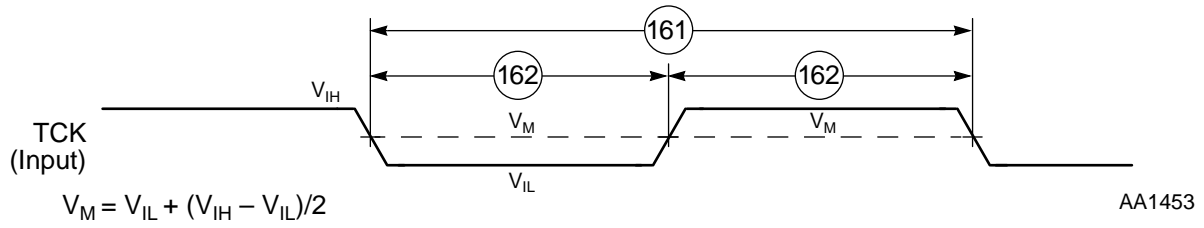


Figure 2-31 Test Clock Input Timing Diagram

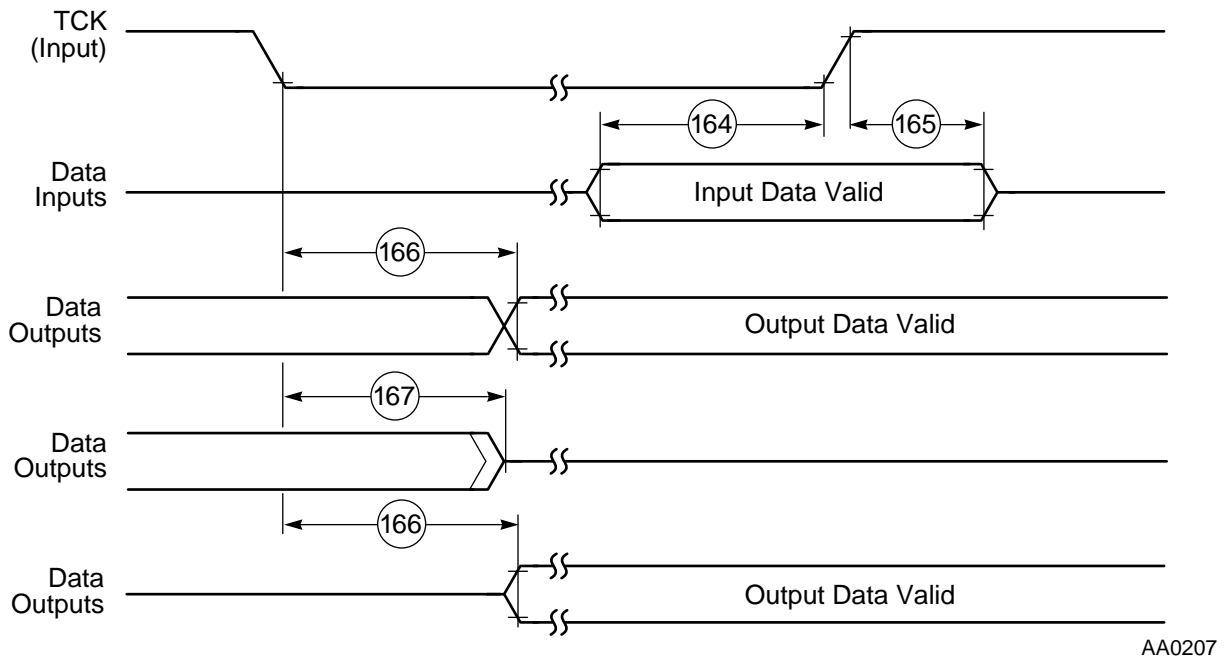
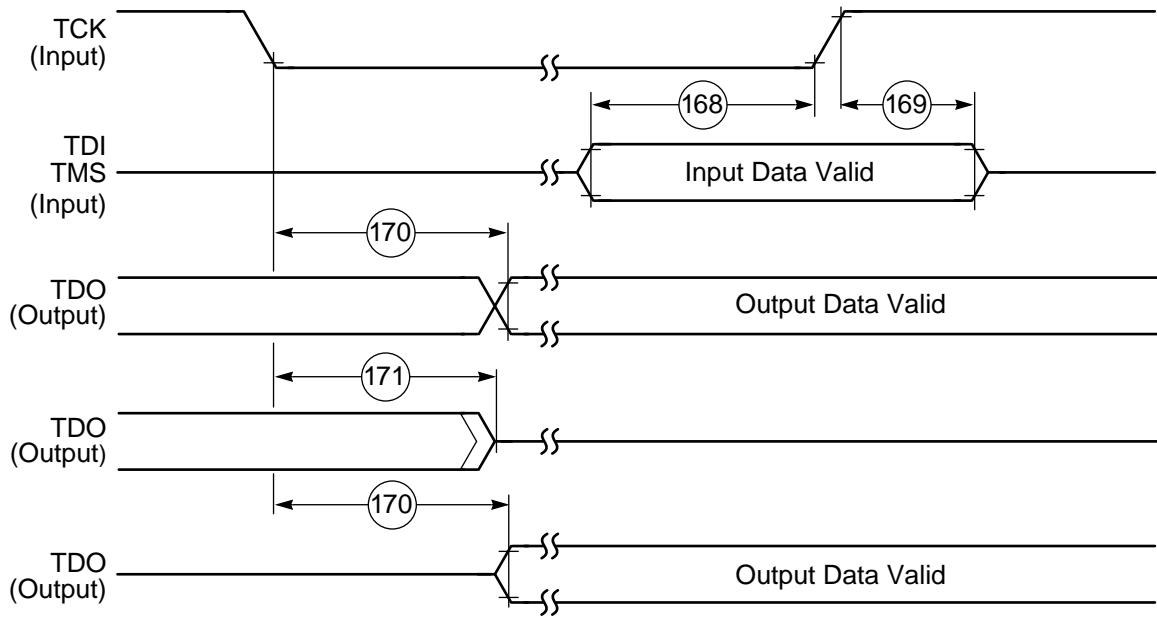


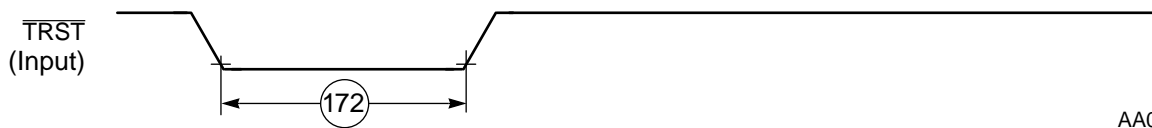
Figure 2-32 Boundary Scan (JTAG) Timing Diagram

PRELIMINARY



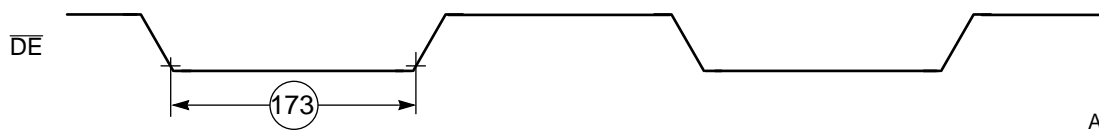
AA0208

Figure 2-33 Test Access Port Timing Diagram



AA0209

Figure 2-34 TRST Timing Diagram



AA0210

Figure 2-35 OnCE—Debug Event



PRELIMINARY

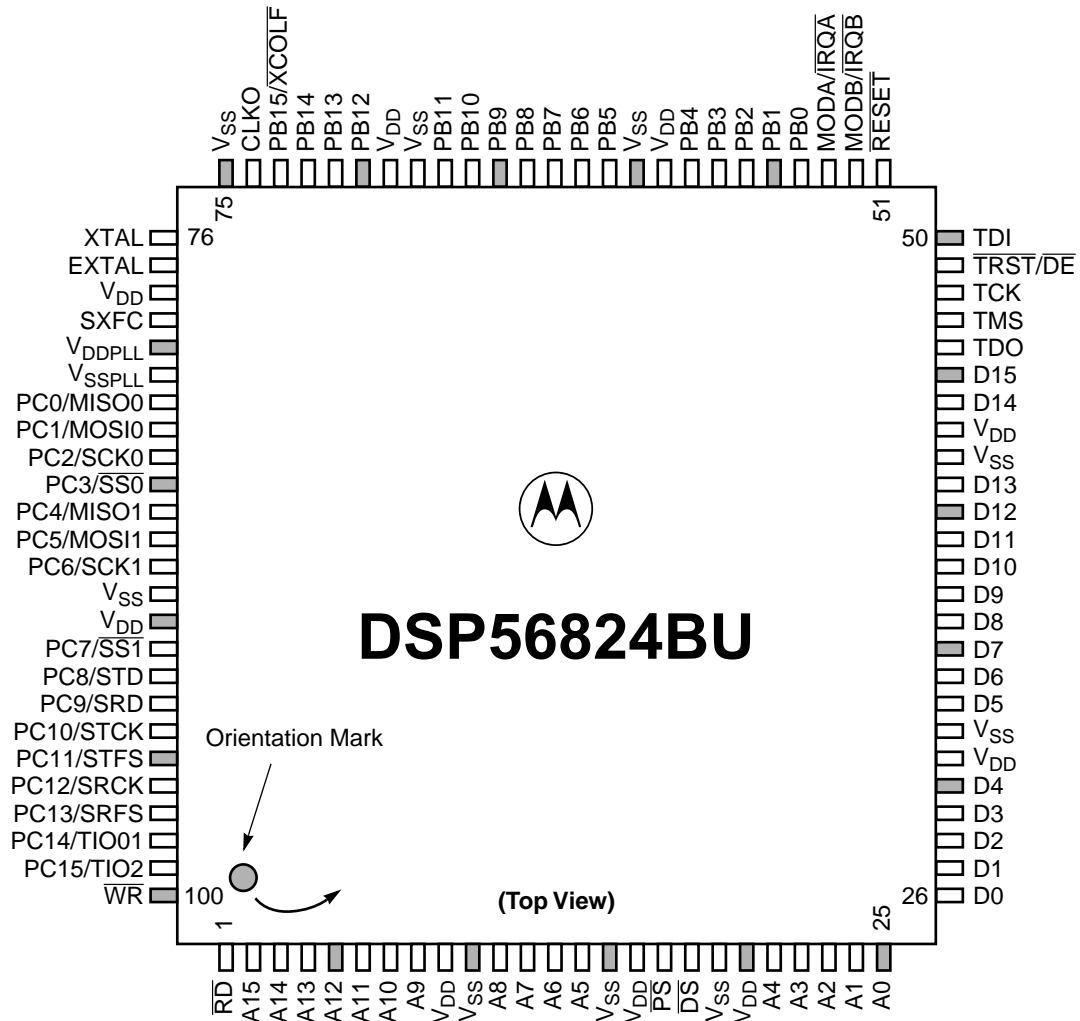
PRELIMINARY

SECTION 3

PACKAGING

PACKAGE AND PIN-OUT INFORMATION

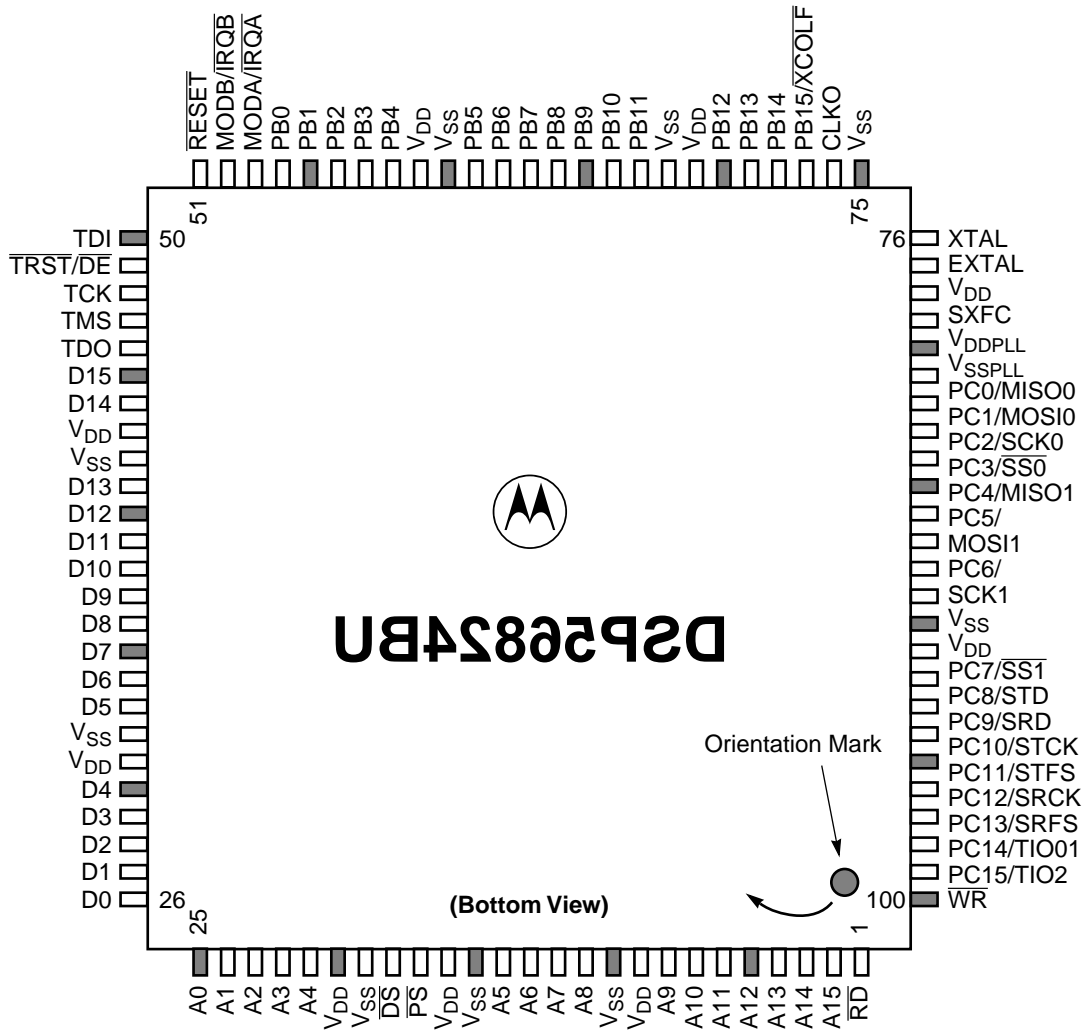
This section contains package and pin-out information for the 100-pin Thin Quad Flat Pack (TQFP) configuration of the DSP56824.



AA1454

Figure 3-1 Top View, DSP56824 100-pin TQFP Package

PRELIMINARY



AA1455

Figure 3-2 Bottom View, DSP56824 TQFP Package

PRELIMINARY

Table 3-1 DSP56824 Pin Identification by Pin Number

| 100-pin Package Pin # | Signal Name | 100-pin Package Pin # | Signal Name | 100-pin Package Pin # | Signal Name | 100-pin Package Pin # | Signal Name |
|-----------------------|------------------------|-----------------------|-----------------------------|-----------------------|---------------------------------|-----------------------|------------------------------|
| 1 | $\overline{\text{RD}}$ | 26 | D0 | 51 | $\overline{\text{RESET}}$ | 76 | XTAL |
| 2 | A15 | 27 | D1 | 52 | MODB/ $\overline{\text{IRQB}}$ | 77 | EXTAL |
| 3 | A14 | 28 | D2 | 53 | MODA/ $\overline{\text{IRQA}}$ | 78 | V _{DD} |
| 4 | A13 | 29 | D3 | 54 | PB0 | 79 | SXFC |
| 5 | A12 | 30 | D4 | 55 | PB1 | 80 | V _{DDPLL} |
| 6 | A11 | 31 | V _{DD} | 56 | PB2 | 81 | V _{SSPLL} |
| 7 | A10 | 32 | V _{SS} | 57 | PB3 | 82 | PC0/MISO0 |
| 8 | A9 | 33 | D5 | 58 | PB4 | 83 | PC1/MOSI0 |
| 9 | V _{DD} | 34 | D6 | 59 | V _{DD} | 84 | PC2/SCK0 |
| 10 | V _{SS} | 35 | D7 | 60 | V _{SS} | 85 | PC3/ $\overline{\text{SS0}}$ |
| 11 | A8 | 36 | D8 | 61 | PB5 | 86 | PC4/MISO1 |
| 12 | A7 | 37 | D9 | 62 | PB6 | 87 | PC5/MOSI1 |
| 13 | A6 | 38 | D10 | 63 | PB7 | 88 | PC6/SCK1 |
| 14 | A5 | 39 | D11 | 64 | PB8 | 89 | V _{SS} |
| 15 | V _{SS} | 40 | D12 | 65 | PB9 | 90 | V _{DD} |
| 16 | V _{DD} | 41 | D13 | 66 | PB10 | 91 | PC7/ $\overline{\text{SS1}}$ |
| 17 | PS | 42 | V _{SS} | 67 | PB11 | 92 | PC8/STD |
| 18 | DS | 43 | V _{DD} | 68 | V _{SS} | 93 | PC9/SRD |
| 19 | V _{SS} | 44 | D14 | 69 | V _{DD} | 94 | PC10/STCK |
| 20 | V _{DD} | 45 | D15 | 70 | PB12 | 95 | PC11/STFS |
| 21 | A4 | 46 | TDO | 71 | PB13 | 96 | PC12/SRCK |
| 22 | A3 | 47 | TMS | 72 | PB14 | 97 | PC13/SRFS |
| 23 | A2 | 48 | TCK | 73 | $\overline{\text{XCOLF}}$ /PB15 | 98 | PC14/TIO01 |
| 24 | A1 | 49 | $\overline{\text{TRST/DE}}$ | 74 | CLKO | 99 | PC15/TIO2 |
| 25 | A0 | 50 | TDI | 75 | V _{SS} | 100 | $\overline{\text{WR}}$ |

PRELIMINARY

Packaging

Package and Pin-Out Information

Table 3-2 DSP56824 Pin Identification by Signal Name

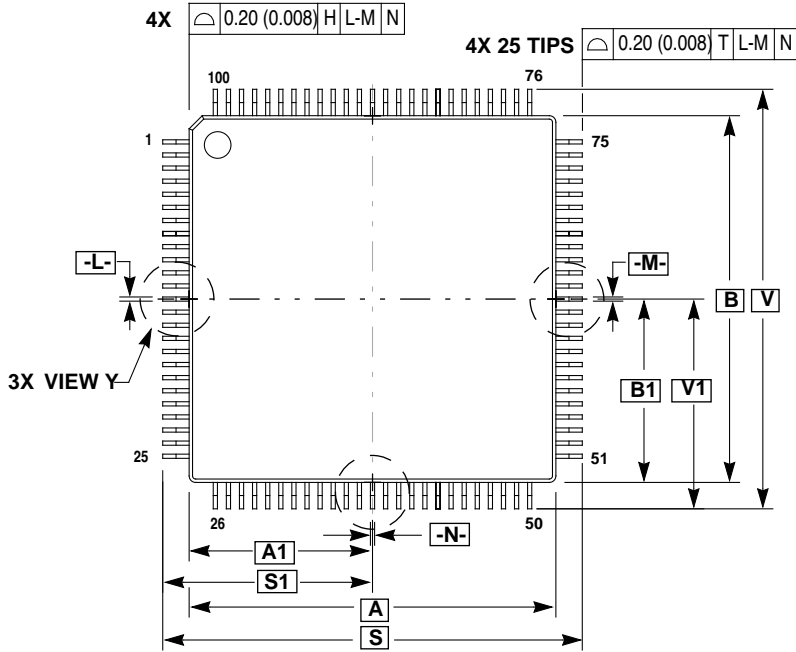
| Signal Name | Pin # | Signal Name | Pin # | Signal Name | Pin # | Signal Name | Pin # |
|-------------|-------|-------------------|-------|--------------------|-------|--------------------|-------|
| A0 | 25 | D13 | 41 | PC0 | 82 | TCK | 48 |
| A1 | 24 | D14 | 44 | PC1 | 83 | TDI | 50 |
| A2 | 23 | D15 | 45 | PC2 | 84 | TD0 | 46 |
| A3 | 22 | \overline{DE} | 49 | PC3 | 85 | TIO01 | 98 |
| A4 | 21 | \overline{DS} | 18 | PC4 | 86 | TIO2 | 99 |
| A5 | 14 | EXTAL | 77 | PC5 | 87 | TMS | 47 |
| A6 | 13 | \overline{IRQA} | 53 | PC6 | 88 | \overline{TRST} | 49 |
| A7 | 12 | \overline{IRQB} | 52 | PC7 | 91 | V _{DD} | 9 |
| A8 | 11 | MISO0 | 82 | PC8 | 92 | V _{DD} | 16 |
| A9 | 8 | MISO1 | 86 | PC9 | 93 | V _{DD} | 20 |
| A10 | 7 | MODA | 53 | PC10 | 94 | V _{DD} | 31 |
| A11 | 6 | MODB | 52 | PC11 | 95 | V _{DD} | 43 |
| A12 | 5 | MOSI0 | 83 | PC12 | 96 | V _{DD} | 59 |
| A13 | 4 | MOSI1 | 87 | PC13 | 97 | V _{DD} | 69 |
| A14 | 3 | PB0 | 54 | PC14 | 98 | V _{DD} | 78 |
| A15 | 2 | PB1 | 54 | PC15 | 99 | V _{DD} | 90 |
| CLKO | 74 | PB2 | 55 | \overline{PS} | 17 | V _{DDPLL} | 80 |
| D0 | 26 | PB3 | 56 | \overline{RD} | 1 | V _{SS} | 10 |
| D1 | 27 | PB4 | 57 | \overline{RESET} | 51 | V _{SS} | 15 |
| D2 | 28 | PB5 | 61 | SCK0 | 84 | V _{SS} | 19 |
| D3 | 29 | PB6 | 62 | SCK1 | 88 | V _{SS} | 32 |
| D4 | 30 | PB7 | 63 | SRFS | 97 | V _{SS} | 42 |
| D5 | 33 | PB8 | 64 | SRCK | 96 | V _{SS} | 60 |
| D6 | 34 | PB9 | 65 | SRD | 93 | V _{SS} | 68 |
| D7 | 35 | PB10 | 66 | $\overline{SS0}$ | 5 | V _{SS} | 75 |
| D8 | 36 | PB11 | 67 | $\overline{SS1}$ | 91 | V _{SS} | 89 |
| D9 | 37 | PB12 | 70 | STCK | 94 | V _{SSPLL} | 81 |
| D10 | 38 | PB13 | 71 | STD | 92 | \overline{WR} | 100 |
| D11 | 39 | PB14 | 72 | STFS | 95 | \overline{XCOLF} | 73 |
| D12 | 40 | PB15 | 73 | SXFC | 79 | XTAL | 76 |

PRELIMINARY

Table 3-3 DSP56824 Power Supply Pins

| Pin # | Power Signal | Circuits Supplied | Pin # | Power Signal | Circuits Supplied |
|-------|--------------------|--|-------|-----------------|---|
| 9 | V _{DD} | Address Bus Buffers and Bus Control | 16 | V _{DD} | Internal Logic |
| 20 | V _{DD} | | 69 | V _{DD} | |
| 10 | V _{SS} | | 15 | V _{SS} | |
| 19 | V _{SS} | | 68 | V _{SS} | |
| 31 | V _{DD} | Data Bus Buffers | 59 | V _{DD} | Clock, Bus Control, Port B, Port C , and JTAG/OnCE Port |
| 43 | V _{DD} | | 78 | V _{DD} | |
| 32 | V _{SS} | | 90 | V _{DD} | |
| 42 | V _{SS} | | 60 | V _{SS} | |
| 90 | V _{DDPLL} | PLL | 75 | V _{SS} | |
| 89 | V _{SSPLL} | | 89 | V _{SS} | |

PRELIMINARY



CASE 983-01

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DATUM PLANE -H- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
4. DATUMS -L-, -M- AND -N- TO BE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -T-.
6. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 (0.010) PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.350 (0.014). MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD OR PROTRUSION 0.070 (0.003).

| MILLIMETERS | | |
|-------------|-------|------|
| DIM | MIN | MAX |
| A | 14.00 | BSC |
| A1 | 7.00 | BSC |
| B | 14.00 | BSC |
| B1 | 7.00 | BSC |
| C | --- | 1.70 |
| C1 | 0.05 | 0.20 |
| C2 | 1.30 | 1.50 |
| D | 0.10 | 0.30 |
| E | 0.45 | 0.75 |
| F | 0.15 | 0.23 |
| G | 0.50 | BSC |
| J | 0.07 | 0.20 |
| K | 0.50 | REF |
| R1 | 0.08 | 0.20 |
| S | 16.00 | BSC |
| S1 | 8.00 | BSC |
| U | 0.09 | 0.16 |
| V | 16.00 | BSC |
| V1 | 8.00 | BSC |
| W | 0.20 | REF |
| Z | 1.00 | REF |
| Ø | 0° | 7° |
| Ø1 | 0° | --- |
| Ø2 | 12° | REF |
| Ø3 | 4° | 13° |

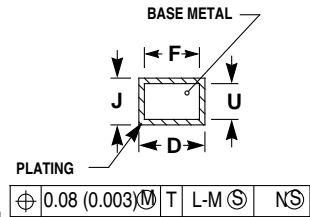
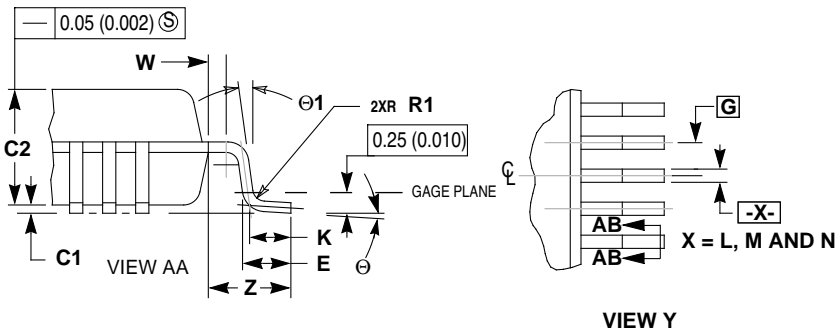
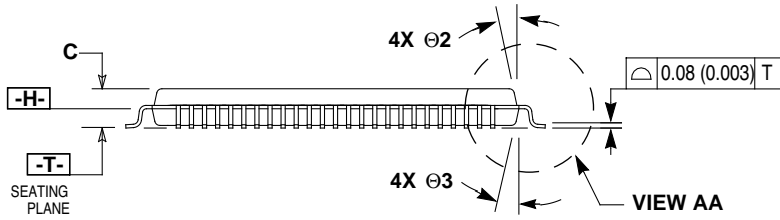


Figure 3-3 100-pin Thin Quad Flat Pack (TQFP) Mechanical Information

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ORDERING DRAWINGS

Complete mechanical information regarding DSP56824 packaging is available by facsimile through Motorola's Mfax™ system. Call the following number to obtain instructions for using this system:

(602) 244-6609

The automated system requests the following information:

- The receiving fax telephone number including area code or country code
- The caller's Personal Identification Number (PIN)

Note: For first time callers, the system provides instructions for setting up a PIN, which requires entry of a name and telephone number.

- The type of information requested:
 - Instructions for using the system
 - A literature order form
 - Specific part technical information or data sheets
 - Other information described by the system messages

A total of three documents can be ordered per call.

The mechanical drawings for the 100-pin TQFP package are referenced as 983-01.



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SECTION 4

DESIGN CONSIDERATIONS

THERMAL DESIGN CONSIDERATIONS

An estimation of the chip junction temperature, T_J , in °C can be obtained from the equation:

Equation 1: $T_J = T_A + (P_D \times R_{\theta JA})$

Where:

T_A = ambient temperature °C

$R_{\theta JA}$ = package junction-to-ambient thermal resistance °C/W

P_D = power dissipation in package

Historically, thermal resistance has been expressed as the sum of a junction-to-case thermal resistance and a case-to-ambient thermal resistance:

Equation 2: $R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$

Where:

$R_{\theta JA}$ = package junction-to-ambient thermal resistance °C/W

$R_{\theta JC}$ = package junction-to-case thermal resistance °C/W

$R_{\theta CA}$ = package case-to-ambient thermal resistance °C/W

$R_{\theta JC}$ is device-related and cannot be influenced by the user. The user controls the thermal environment to change the case-to-ambient thermal resistance, $R_{\theta CA}$. For example, the user can change the air flow around the device, add a heat sink, change the mounting arrangement on the Printed Circuit Board (PCB), or otherwise change the thermal dissipation capability of the area surrounding the device on the PCB. This model is most useful for ceramic packages with heat sinks; some 90% of the heat flow is dissipated through the case to the heat sink and out to the ambient environment. For ceramic packages, in situations where the heat flow is split between a path to the case and an alternate path through the PCB, analysis of the device thermal performance may need the additional modeling capability of a system level thermal simulation tool.

The thermal performance of plastic packages is more dependent on the temperature of the PCB to which the package is mounted. Again, if the estimations obtained from

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$R_{\theta JA}$ do not satisfactorily answer whether the thermal performance is adequate, a system level model may be appropriate.

A complicating factor is the existence of three common definitions for determining the junction-to-case thermal resistance in plastic packages:

- Measure the thermal resistance from the junction to the outside surface of the package (case) closest to the chip mounting area when that surface has a proper heat sink. This is done to minimize temperature variation across the surface.
- Measure the thermal resistance from the junction to where the leads are attached to the case. This definition is approximately equal to a junction to board thermal resistance.
- Use the value obtained by the equation $(T_J - T_T)/P_D$ where T_T is the temperature of the package case determined by a thermocouple.

As noted above, the junction-to-case thermal resistances quoted in this data sheet are determined using the first definition. From a practical standpoint, that value is also suitable for determining the junction temperature from a case thermocouple reading in forced convection environments. In natural convection, using the junction-to-case thermal resistance to estimate junction temperature from a thermocouple reading on the case of the package will estimate a junction temperature slightly hotter than actual. Hence, the new thermal metric, Thermal Characterization Parameter, or Ψ_{JT} , has been defined to be $(T_J - T_T)/P_D$. This value gives a better estimate of the junction temperature in natural convection when using the surface temperature of the package. Remember that surface temperature readings of packages are subject to significant errors caused by inadequate attachment of the sensor to the surface and to errors caused by heat loss to the sensor. The recommended technique is to attach a 40-gauge thermocouple wire and bead to the top center of the package with thermally conductive epoxy.

Note: Table 2-3 Package Thermal Characteristics on page 2-2 contains the package thermal values for this chip.

ELECTRICAL DESIGN CONSIDERATIONS

CAUTION

This device contains protective circuitry to guard against damage due to high static voltage or electrical fields. However, normal precautions are advised to avoid application of any voltages higher than maximum rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either GND or V_{CC}).

Use the following list of considerations to assure correct DSP operation:

- Provide a low-impedance path from the board power supply to each V_{DD} pin on the DSP, and from the board ground to each V_{SS} (GND) pin.
- The minimum bypass requirement is to place six 0.01–0.1 μF capacitors positioned as close as possible to the package supply pins, one capacitor for each of the “Circuits Supplied” groups listed in **Table 3-3** on page 3-5. The recommended bypass configuration is to place one bypass capacitor on each of the ten V_{DD}/V_{SS} pairs, including V_{DDPLL}/V_{SSPLL} .
- Ensure that capacitor leads and associated printed circuit traces that connect to the chip V_{DD} and V_{SS} (GND) pins are less than 0.5” per capacitor lead.
- Use at least a four-layer Printed Circuit Board (PCB) with two inner layers for V_{DD} and GND.
- Bypass the V_{DD} and GND layers of the PCB with approximately 100 μF , preferably with a high-grade capacitor such as a tantalum capacitor.
- Because the DSP output signals have fast rise and fall times, PCB trace lengths should be minimal.
- Consider all device loads as well as parasitic capacitance due to PCB traces when calculating capacitance. This is especially critical in systems with higher capacitive loads that could create higher transient currents in the V_{DD} and GND circuits.
- All inputs must be terminated (i.e., not allowed to float) using CMOS levels.
- Take special care to minimize noise levels on the V_{DDPLL} and V_{SSPLL} pins.

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Electrical Design Considerations

- When using Wired-OR mode on the SPI or the MOD_x/ $\overline{\text{IRQ}}_x$ pins, the user must provide an external pull-up device.
- Designs that utilize the $\overline{\text{TRST}}/\overline{\text{DE}}$ pin for JTAG port or OnCE module functionality (such as development or debugging systems) should allow a means to assert $\overline{\text{TRST}}$ whenever $\overline{\text{RESET}}$ is asserted, as well as a means to assert $\overline{\text{TRST}}$ independently of $\overline{\text{RESET}}$. Designs that do not require debugging functionality, such as consumer products, should tie these pins together.
- Because the Flash memory is programmed through the JTAG/OnCE port, designers should provide an interface to this port to allow in-circuit Flash programming.



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SECTION 5

ORDERING INFORMATION

Table 5-1 lists the pertinent information needed to place an order. Consult a Motorola Semiconductor sales office or authorized distributor to determine availability and to order parts.

Table 5-1 DSP56824 Ordering Information

| Part | Supply Voltage | Package Type | Pin Count | Frequency (MHz) | Order Number |
|----------|----------------|------------------------------------|-----------|-----------------|--------------|
| DSP56824 | 2.7–3.6 V | Plastic Thin Quad Flat Pack (TQFP) | 100 | 70 | XC56824BU70 |




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Shinagawa-ku, Tokyo 141, Japan
81-3-5487-8488

Motorola Fax Back System (Mfax™):

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<http://www.motorola.com/mfax>

Technical Resource Center:

1 (800) 521-6274

DSP Helpline

dsphelp@dsp.sps.mot.com

Internet:

<http://www.motorola-dsp.com/>

