

DSP56364

24-Bit Audio Digital Signal Processor

1 Overview

The DSP56364 supports digital audio applications requiring sound field processing, acoustic equalization, and other digital audio algorithms. The DSP56364 uses the high performance, single-clock-per-cycle DSP56300 core family of programmable CMOS digital signal processors (DSPs) combined with the audio signal processing capability of the Freescale Symphony™ DSP family, as shown in [Figure 1-1](#). This design provides a two-fold performance increase over Freescale's popular Symphony family of DSPs while retaining code compatibility. Significant architectural enhancements include a barrel shifter, 24-bit addressing, instruction cache, and direct memory access (DMA). The DSP56364 offers 100 million instructions per second (MIPS) using an internal 100 MHz clock at 3.3 V.

Contents

1 Overview	1-1
2 Signal/Connection Descriptions	2-1
3 Specifications	3-1
4 Packaging	4-1
5 Design Considerations	5-1
6 Ordering Information	6-1
A IBIS Model	A-1

Freescale reserves the right to change the detail specifications as may be required to permit improvements in the design of its products.

© Freescale Semiconductor, Inc., 2006, 2007. All rights reserved.



Data Sheet Conventions

This data sheet uses the following conventions:

OVERBAR Used to indicate a signal that is active when pulled low (For example, the $\overline{\text{RESET}}$ pin is active when low.)

“asserted” Means that a high true (active high) signal is high or that a low true (active low) signal is low

“deasserted” Means that a high true (active high) signal is low or that a low true (active low) signal is high

Examples:	Signal/Symbol	Logic State	Signal State	Voltage*
	$\overline{\text{PIN}}$	True	Asserted	V_{IL} / V_{OL}
	$\overline{\text{PIN}}$	False	Deasserted	V_{IH} / V_{OH}
	PIN	True	Asserted	V_{IH} / V_{OH}
	PIN	False	Deasserted	V_{IL} / V_{OL}

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

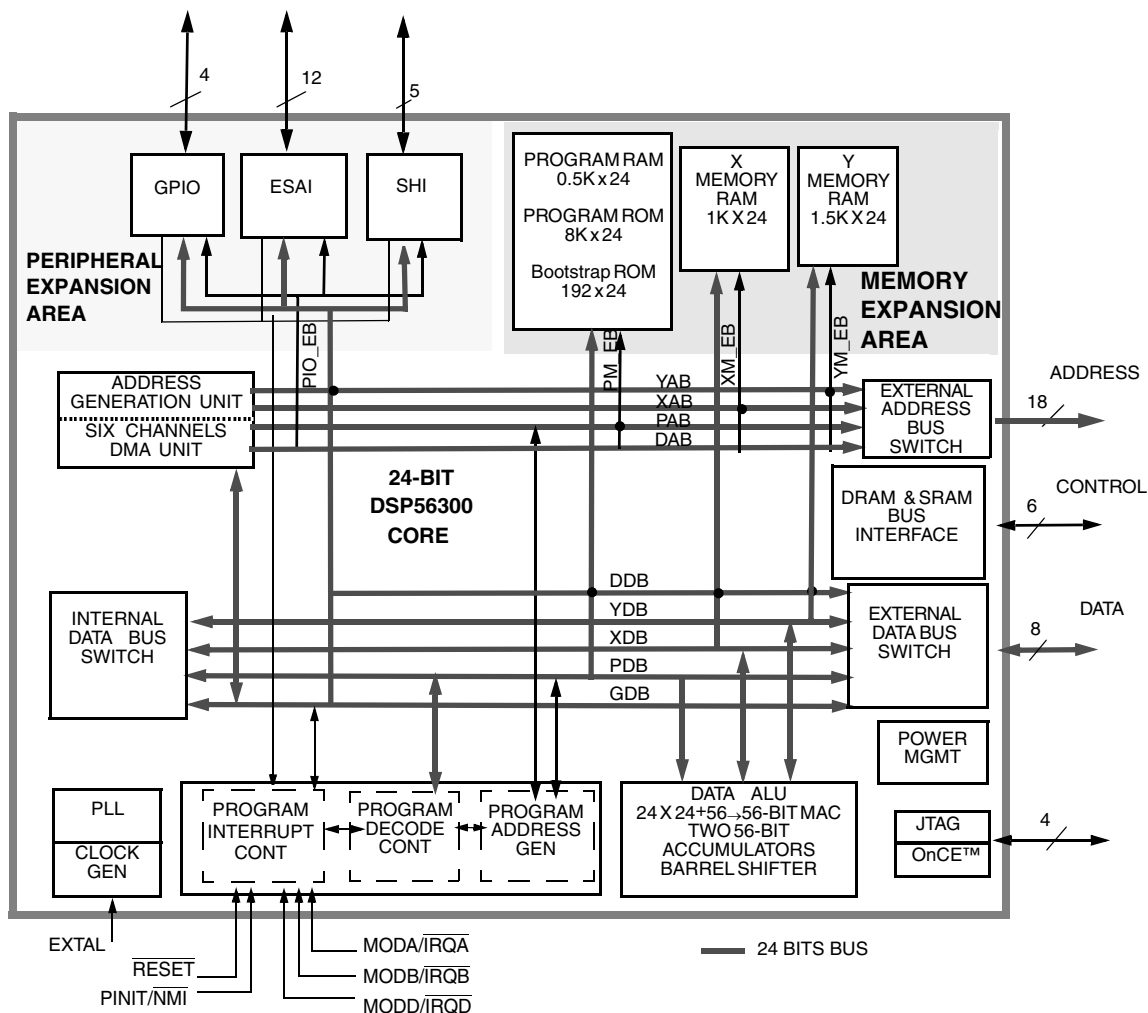


Figure 1-1 DSP56364 Block Diagram

1.1 Features

1.1.1 Digital Signal Processing Core

- 100 Million Instructions Per Second (MIPS) with an 100 MHz clock at 3.3V.
- Object Code Compatible with the 56000 core.
- Data ALU with a 24×24 bit multiplier-accumulator and a 56-bit barrel shifter. 16-bit arithmetic support.
- Program Control with position independent code support and instruction cache support.
- Six-channel DMA controller.
- PLL based clocking with a wide range of frequency multiplications (1 to 4096), predivider factors (1 to 16) and power saving clock divider (2^i : $i = 0$ to 7). Reduces clock noise.
- Internal address tracing support and OnCE™ for Hardware/Software debugging.
- JTAG port.
- Very low-power CMOS design, fully static design with operating frequencies down to DC.
- STOP and WAIT low-power standby modes.

1.1.2 On-Chip Memory Configuration

- $1.5K \times 24$ Bit Y-Data RAM.
- $1K \times 24$ Bit X-Data RAM.
- $8K \times 24$ Bit Program ROM.
- $0.5K \times 24$ Bit Program RAM and 192×24 Bit Bootstrap ROM.
- $0.75K \times 24$ Bit from Y Data RAM can be switched to Program RAM resulting in up to $1.25K \times 24$ Bit of Program RAM.

1.1.3 Off-Chip Memory Expansion

- External Memory Expansion Port with 8-bit data bus.
- Off-chip expansion up to $2 \times 16M \times 8$ -bit word of Data/Program memory when using DRAM.
- Off-chip expansion up to $2 \times 256k \times 8$ -bit word of Data/Program memory when using SRAM.
- Simultaneous glueless interface to SRAM and DRAM.

1.1.4 Peripheral Modules

- Enhanced Serial Audio Interface (ESAI): 6 serial lines, 4 selectable as receive or transmit and 2 transmit only, master or slave. I²S, Sony, AC97, network and other programmable protocols. Unused pins of ESAI may be used as GPIO lines.
- Serial Host Interface (SHI): SPI and I²C protocols, 10-word receive FIFO, support for 8, 16 and 24-bit words.
- Four dedicated GPIO lines.

1.1.5 Packaging

- 100-pin plastic TQFP package.

1.2 Documentation

Table 1-1 lists the documents that provide a complete description of the DSP56364 and are required to design properly with the part. Documentation is available from a local Freescale distributor, a Freescale semiconductor sales office, a Freescale Literature Distribution Center, or through the Freescale DSP home page on the Internet (the source for the latest information).

Table 1-1 DSP56364 Documentation

Document Name	Description	Order Number
DSP56300 Family Manual	Detailed description of the 56000-family architecture and the 24-bit core processor and instruction set	DSP56300FM
DSP56364 User's Manual	Detailed description of memory, peripherals, and interfaces	DSP56364UM
DSP56364 Product Brief	Brief description of the chip	DSP56364P
DSP56364 Technical Data Sheet (this document)	Electrical and timing specifications; pin and package descriptions	DSP56364

2 Signal/Connection Descriptions

2.1 Signal Groupings

The input and output signals of the DSP56364 are organized into functional groups, which are listed in [Table 2-1](#) and illustrated in [Figure 2-1](#).

The DSP56364 is operated from a 3.3 V supply; however, some of the inputs can tolerate 5 V. A special notice for this feature is added to the signal descriptions of those inputs.

Table 2-1 DSP56364 Functional Signal Groupings

Functional Group		Number of Signals	Detailed Description
Power (V _{CC})		18	Table 2-2
Ground (GND)		14	Table 2-3
Clock and PLL		3	Table 2-4
Address bus	Port A ¹	18	Table 2-5
Data bus		8	Table 2-6
Bus control		6	Table 2-7
Interrupt and mode control		4	Table 2-8
General Purpose I/O	Port B ²	4	Table 2-12
SHI		5	Table 2-9
ESAI	Port C ³	12	Table 2-10
JTAG/OnCE Port		4	Table 2-11

¹ Port A is the external memory interface port, including the external address bus, data bus, and control signals.

² Port B signals are the GPIO signals.

³ Port C signals are the ESAI port signals multiplexed with the GPIO signals.

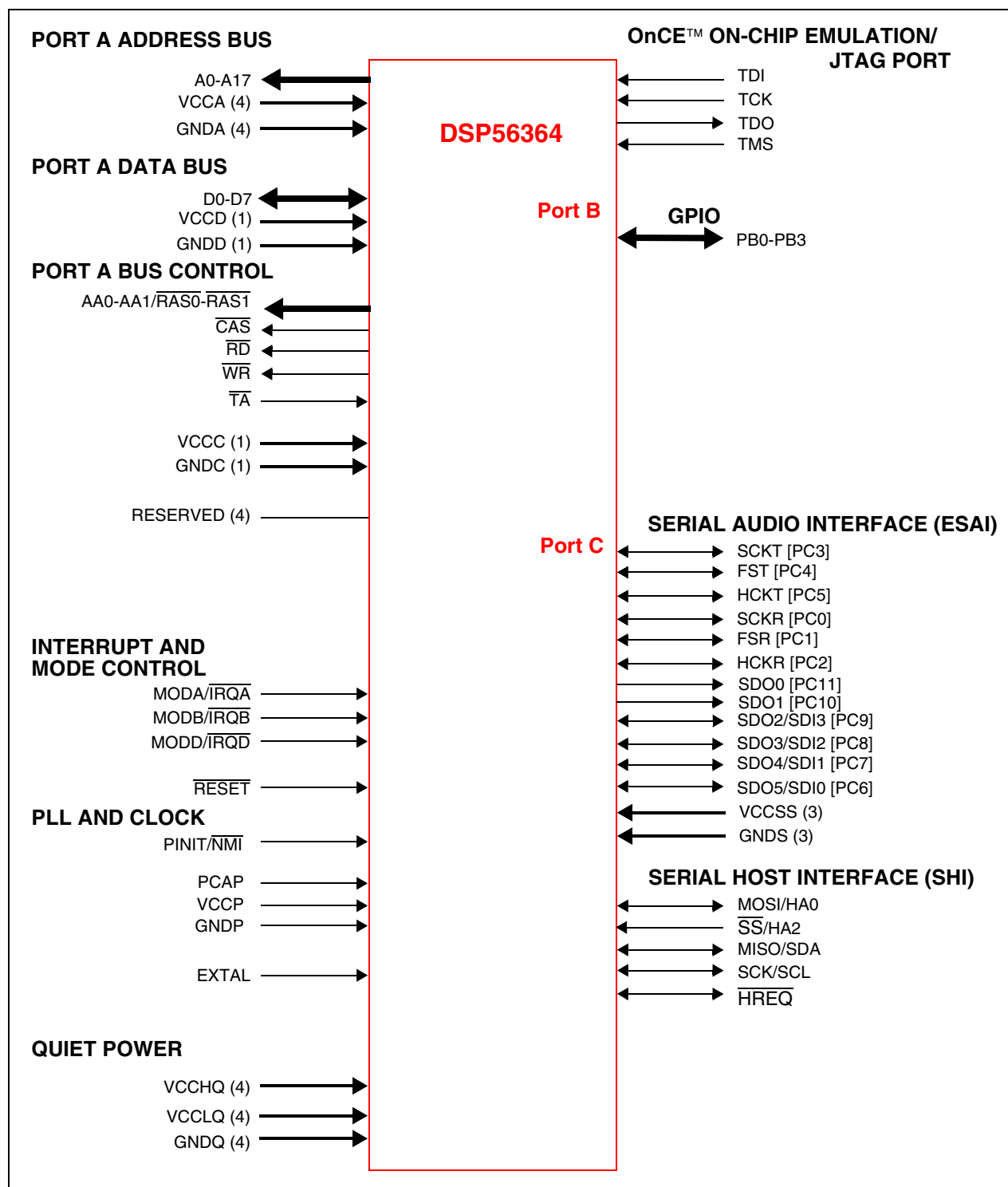


Figure 2-1 Signals Identified by Functional Group

2.2 Power

Table 2-2 Power Inputs

Power Name	Description
V_{CCP}	PLL Power — V_{CCP} is V_{CC} dedicated for PLL use. The voltage should be well-regulated and the input should be provided with an extremely low impedance path to the V_{CC} power rail. There is one V_{CCP} input.
V_{CCLQ} (4)	Quiet Core (Low) Power — V_{CCLQ} is an isolated power for the internal processing logic. This input must be tied externally to all other chip power inputs. The user must provide adequate external decoupling capacitors. There are four V_{CCLQ} inputs.
V_{CCHQ} (4)	Quiet External (High) Power — V_{CCHQ} is a quiet power source for I/O lines. This input must be tied externally to all other chip power inputs. The user must provide adequate decoupling capacitors. There are four V_{CCHQ} inputs.
V_{CCA} (4)	Address Bus Power — V_{CCA} is an isolated power for sections of the address bus I/O drivers. This input must be tied externally to all other chip power inputs. The user must provide adequate external decoupling capacitors. There are four V_{CCA} inputs.
V_{CCD} (1)	Data Bus Power — V_{CCD} is an isolated power for sections of the data bus I/O drivers. This input must be tied externally to all other chip power inputs. The user must provide adequate external decoupling capacitors. There is one V_{CCD} inputs.
V_{CCC} (1)	Bus Control Power — V_{CCC} is an isolated power for the bus control I/O drivers. This input must be tied externally to all other chip power inputs. The user must provide adequate external decoupling capacitors. There is one V_{CCC} inputs.
V_{CCS} (3)	SHI and ESAI — V_{CCS} is an isolated power for the SHI and ESAI. This input must be tied externally to all other chip power inputs _L . The user must provide adequate external decoupling capacitors. There are three V_{CCS} inputs.

2.3 Ground

Table 2-3 Grounds

Ground Name	Description
GND_P	PLL Ground — GND_P is ground-dedicated for PLL use. The connection should be provided with an extremely low-impedance path to ground. V_{CCP} should be bypassed to GND_P by a 0.47 μ F capacitor located as close as possible to the chip package. There is one GND_P connection.
GND_Q (4)	Quiet Ground — GND_Q is an isolated ground for the internal processing logic. This connection must be tied externally to all other chip ground connections. The user must provide adequate external decoupling capacitors. There are four GND_Q connections.
GND_A (4)	Address Bus Ground — GND_A is an isolated ground for sections of the address bus I/O drivers. This connection must be tied externally to all other chip ground connections. The user must provide adequate external decoupling capacitors. There are four GND_A connections.
GND_D (1)	Data Bus Ground — GND_D is an isolated ground for sections of the data bus I/O drivers. This connection must be tied externally to all other chip ground connections. The user must provide adequate external decoupling capacitors. There is one GND_D connections.

Table 2-3 Grounds (continued)

Ground Name	Description
GND _C (1)	Bus Control Ground —GND _C is an isolated ground for the bus control I/O drivers. This connection must be tied externally to all other chip ground connections. The user must provide adequate external decoupling capacitors. There is one GND _C connections.
GND _S (3)	SHI and ESAI —GND _S is an isolated ground for the SHI and ESAI. This connection must be tied externally to all other chip ground connections. The user must provide adequate external decoupling capacitors. There are three GND _S connections.

2.4 Clock and PLL

Table 2-4 Clock and PLL Signals

Signal Name	Type	State During Reset	Signal Description
EXTAL	Input	Input	External Clock Input —An external clock source must be connected to EXTAL in order to supply the clock to the internal clock generator and PLL.
PCAP	Input	Input	PLL Capacitor —PCAP is an input connecting an off-chip capacitor to the PLL filter. Connect one capacitor terminal to PCAP and the other terminal to V _{CCP} . If the PLL is not used, PCAP may be tied to V _{CC} , GND, or left floating.
PINIT/ $\overline{\text{NMI}}$	Input	Input	PLL Initial/Nonmaskable Interrupt —During assertion of $\overline{\text{RESET}}$, the value of PINIT/ $\overline{\text{NMI}}$ is written into the PLL Enable (PEN) bit of the PLL control register, determining whether the PLL is enabled or disabled. After $\overline{\text{RESET}}$ de assertion and during normal instruction processing, the PINIT/ $\overline{\text{NMI}}$ Schmitt-trigger input is a negative-edge-triggered nonmaskable interrupt (NMI) request internally synchronized to internal system clock. <i>This input is 5 V tolerant.</i>

2.5 External Memory Expansion Port (Port A)

When the DSP56364 enters a low-power standby mode (stop or wait), it tri-states the relevant port A signals: D0–D7, AA0, AA1, $\overline{\text{RD}}$, $\overline{\text{WR}}$, $\overline{\text{CAS}}$.

2.5.1 External Address Bus

Table 2-5 External Address Bus Signals

Signal Name	Type	State During Reset	Signal Description
A0–A17	Output	Keeper active	Address Bus —A0–A17 are active-high outputs that specify the address for external program and data memory accesses. Otherwise, the signals are kept to their previous values by internal weak keepers. To minimize power dissipation, A0–A17 do not change state when external memory spaces are not being accessed.

2.5.2 External Data Bus

Table 2-6 External Data Bus Signals

Signal Name	Type	State During Reset	Signal Description
D0–D7	Input/ Output	Tri-stated	Data Bus —D0–D7 are active-high, bidirectional input/outputs that provide the bidirectional data bus for external program and data memory accesses. D0–D7 are tri-stated during hardware reset and when the DSP is in the stop or wait low-power standby mode.

2.5.3 External Bus Control

Table 2-7 External Bus Control Signals

Signal Name	Type	State During Reset	Signal Description
AA0–AA1/ $\overline{\text{RAS0}}\text{--}\overline{\text{RAS1}}$	Output	Tri-stated	Address Attribute or Row Address Strobe —When defined as AA, these signals can be used as chip selects or additional address lines. When defined as $\overline{\text{RAS}}$, these signals can be used as $\overline{\text{RAS}}$ for DRAM interface. These signals are tri-stateable outputs with programmable polarity. These signals are tri-stated during hardware reset and when the DSP is in the stop or wait low-power standby mode.
CAS	Output	Tri-stated	Column Address Strobe — $\overline{\text{CAS}}$ is an active-low output used by DRAM to strobe the column address. This signal is tri-stated during hardware reset and when the DSP is in the stop or wait low-power standby mode.
RD	Output	Tri-stated	Read Enable — $\overline{\text{RD}}$ is an active-low output that is asserted to read external memory on the data bus. This signal is tri-stated during hardware reset and when the DSP is in the stop or wait low-power standby mode.
WR	Output	Tri-stated	Write Enable — $\overline{\text{WR}}$ is an active-low output that is asserted to write external memory on the data bus. This signal is tri-stated during hardware reset and when the DSP is in the stop or wait low-power standby mode.
TA	Input	Ignored Input	Transfer Acknowledge—If there is no external bus activity, the $\overline{\text{TA}}$ input is ignored. The $\overline{\text{TA}}$ input is a data transfer acknowledge (DTACK) function that can extend an external bus cycle indefinitely. Any number of wait states (1, 2, . . . infinity) may be added to the wait states inserted by the BCR by keeping $\overline{\text{TA}}$ deasserted. In typical operation, $\overline{\text{TA}}$ is deasserted at the start of a bus cycle, is asserted to enable completion of the bus cycle, and is deasserted before the next bus cycle. The current bus cycle completes one clock period after $\overline{\text{TA}}$ is asserted synchronous to the internal system clock. The number of wait states is determined by the $\overline{\text{TA}}$ input or by the bus control register (BCR), whichever is longer. The BCR can be used to set the minimum number of wait states in external bus cycles. In order to use the $\overline{\text{TA}}$ functionality, the BCR must be programmed to at least one wait state. A zero wait state access cannot be extended by $\overline{\text{TA}}$ deassertion, otherwise improper operation may result. $\overline{\text{TA}}$ can operate synchronously or asynchronously, depending on the setting of the TAS bit in the operating mode register (OMR). $\overline{\text{TA}}$ functionality may not be used while performing DRAM type accesses, otherwise improper operation may result.

2.6 Interrupt and Mode Control

The interrupt and mode control signals select the chip's operating mode as it comes out of hardware reset. After $\overline{\text{RESET}}$ is deasserted, these inputs are hardware interrupt request lines.

Table 2-8 Interrupt and Mode Control

Signal Name	Type	State During Reset	Signal Description
$\text{MODA}/\overline{\text{IRQA}}$	Input	Input	Mode Select A/External Interrupt Request A—$\text{MODA}/\overline{\text{IRQA}}$ is an active-low Schmitt-trigger input, internally synchronized to the internal system clock. $\text{MODA}/\overline{\text{IRQA}}$ selects the initial chip operating mode during hardware reset and becomes a level-sensitive or negative-edge-triggered, maskable interrupt request input during normal instruction processing. MODA, MODB, and MODD select one of 8 initial chip operating modes, latched into the OMR when the $\overline{\text{RESET}}$ signal is deasserted. If $\overline{\text{IRQA}}$ is asserted synchronous to the internal system clock, multiple processors can be re-synchronized using the WAIT instruction and asserting $\overline{\text{IRQA}}$ to exit the wait state. If the processor is in the stop standby state and $\overline{\text{IRQA}}$ is asserted, the processor will exit the stop state. <i>This input is 5 V tolerant.</i>
$\text{MODB}/\overline{\text{IRQB}}$	Input	Input	Mode Select B/External Interrupt Request B—$\text{MODB}/\overline{\text{IRQB}}$ is an active-low Schmitt-trigger input, internally synchronized to the internal system clock. $\text{MODB}/\overline{\text{IRQB}}$ selects the initial chip operating mode during hardware reset and becomes a level-sensitive or negative-edge-triggered, maskable interrupt request input during normal instruction processing. MODA, MODB, and MODD select one of 8 initial chip operating modes, latched into OMR when the $\overline{\text{RESET}}$ signal is deasserted. If $\overline{\text{IRQB}}$ is asserted synchronous to the internal system clock, multiple processors can be re-synchronized using the WAIT instruction and asserting $\overline{\text{IRQB}}$ to exit the wait state. <i>This input is 5 V tolerant.</i>
$\text{MODD}/\overline{\text{IRQD}}$	Input	Input	Mode Select D/External Interrupt Request D—$\text{MODD}/\overline{\text{IRQD}}$ is an active-low Schmitt-trigger input, internally synchronized to the internal system clock. $\text{MODD}/\overline{\text{IRQD}}$ selects the initial chip operating mode during hardware reset and becomes a level-sensitive or negative-edge-triggered, maskable interrupt request input during normal instruction processing. MODA, MODB, and MODD select one of 8 initial chip operating modes, latched into OMR when the $\overline{\text{RESET}}$ signal is deasserted. If $\overline{\text{IRQD}}$ is asserted synchronous to the internal system clock, multiple processors can be re-synchronized using the WAIT instruction and asserting $\overline{\text{IRQD}}$ to exit the wait state. <i>This input is 5 V tolerant.</i>
$\overline{\text{RESET}}$	Input	Input	Reset—$\overline{\text{RESET}}$ is an active-low, Schmitt-trigger input. When asserted, the chip is placed in the reset state and the internal phase generator is reset. The Schmitt-trigger input allows a slowly rising input (such as a capacitor charging) to reset the chip reliably. When the $\overline{\text{RESET}}$ signal is deasserted, the initial chip operating mode is latched from the MODA, MODB, and MODD inputs. The $\overline{\text{RESET}}$ signal must be asserted during power up. A stable EXTAL signal must be supplied before deassertion of $\overline{\text{RESET}}$. <i>This input is 5 V tolerant.</i>

2.7 Serial Host Interface

The SHI has five I/O signals that can be configured to allow the SHI to operate in either SPI or I²C mode.

Table 2-9 Serial Host Interface Signals

Signal Name	Signal Type	State During Reset	Signal Description
SCK	Input or output	Tri-stated	SPI Serial Clock —The SCK signal is an output when the SPI is configured as a master and a Schmitt-trigger input when the SPI is configured as a slave. When the SPI is configured as a master, the SCK signal is derived from the internal SHI clock generator. When the SPI is configured as a slave, the SCK signal is an input, and the clock signal from the external master synchronizes the data transfer. The SCK signal is ignored by the SPI if it is defined as a slave and the slave select ($\overline{SS}$) signal is not asserted. In both the 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. Edge polarity is determined by the SPI transfer protocol.
SCL	Input or output	Tri-stated	I²C Serial Clock —SCL carries the clock for I ² C bus transactions in the I ² C mode. SCL is a Schmitt-trigger input when configured as a slave and an open-drain output when configured as a master. SCL should be connected to V _{CC} through a pull-up resistor. This signal is tri-stated during hardware, software, and individual reset. Thus, there is no need for an external pull-up in this state. This input is 5 V tolerant.
MISO	Input or output	Tri-stated	SPI Master-In-Slave-Out —When the SPI is configured as a master, MISO is the master data input line. The MISO signal is used in conjunction with the MOSI signal for transmitting and receiving serial data. This signal is a Schmitt-trigger input when configured for the SPI Master mode, an output when configured for the SPI Slave mode, and tri-stated if configured for the SPI Slave mode when $\overline{SS}$ is deasserted. An external pull-up resistor is not required for SPI operation.
SDA	Input or open-drain output	Tri-stated	I²C Data and Acknowledge —In I ² C mode, SDA is a Schmitt-trigger input when receiving and an open-drain output when transmitting. SDA should be connected to V _{CC} through a pull-up resistor. SDA carries the data for I ² C transactions. The data in SDA must be stable during the high period of SCL. The data in SDA is only allowed to change when SCL is low. When the bus is free, SDA is high. The SDA line is only allowed to change during the time SCL is high in the case of start and stop events. A high-to-low transition of the SDA line while SCL is high is a unique situation, and is defined as the start event. A low-to-high transition of SDA while SCL is high is a unique situation defined as the stop event. This signal is tri-stated during hardware, software, and individual reset. Thus, there is no need for an external pull-up in this state. This input is 5 V tolerant.
MOSI	Input or output	Tri-stated	SPI Master-Out-Slave-In —When the SPI is configured as a master, MOSI is the master data output line. The MOSI signal is used in conjunction with the MISO signal for transmitting and receiving serial data. MOSI is the slave data input line when the SPI is configured as a slave. This signal is a Schmitt-trigger input when configured for the SPI Slave mode.

Table 2-9 Serial Host Interface Signals (continued)

Signal Name	Signal Type	State During Reset	Signal Description
HA0	Input	Tri-stated	I²C Slave Address 0—This signal uses a Schmitt-trigger input when configured for the I²C mode. When configured for I²C slave mode, the HA0 signal is used to form the slave device address. HA0 is ignored when configured for the I²C master mode. This signal is tri-stated during hardware, software, and individual reset. Thus, there is no need for an external pull-up in this state. This input is 5 V tolerant.
$\overline{SS}$	Input	Input	SPI Slave Select—This signal is an active low Schmitt-trigger input when configured for the SPI mode. When configured for the SPI Slave mode, this signal is used to enable the SPI slave for transfer. When configured for the SPI master mode, this signal should be kept deasserted (pulled high). If it is asserted while configured as SPI master, a bus error condition is flagged. If $\overline{SS}$ is deasserted, the SHI ignores SCK clocks and keeps the MISO output signal in the high-impedance state.
HA2	Input	Input	I²C Slave Address 2—This signal uses a Schmitt-trigger input when configured for the I²C mode. When configured for the I²C Slave mode, the HA2 signal is used to form the slave device address. HA2 is ignored in the I²C master mode. This signal is tri-stated during hardware, software, and individual reset. Thus, there is no need for an external pull-up in this state. <i>This input is 5 V tolerant.</i>
$\overline{HREQ}$	Input or Output	Tri-stated	Host Request—This signal is an active low Schmitt-trigger input when configured for the master mode but an active low output when configured for the slave mode. When configured for the slave mode, $\overline{HREQ}$ is asserted to indicate that the SHI is ready for the next data word transfer and deasserted at the first clock pulse of the new data word transfer. When configured for the master mode, $\overline{HREQ}$ is an input. When asserted by the external slave device, it will trigger the start of the data word transfer by the master. After finishing the data word transfer, the master will await the next assertion of $\overline{HREQ}$ to proceed to the next transfer. This signal is tri-stated during hardware, software, personal reset, or when the HREQ1–HREQ0 bits in the HCSR are cleared. There is no need for external pull-up in this state. <i>This input is 5 V tolerant.</i>

2.8 Enhanced Serial Audio Interface

Table 2-10 Enhanced Serial Audio Interface Signals

Signal Name	Signal Type	State During Reset	Signal Description
HCKR	Input or output	GPIO disconnected	High Frequency Clock for Receiver —When programmed as an input, this signal provides a high frequency clock source for the ESAI receiver as an alternate to the DSP core clock. When programmed as an output, this signal can serve as a high-frequency sample clock (e.g., for external digital to analog converters [DACs]) or as an additional system clock.
PC2	Input, output, or disconnected	GPIO disconnected	Port C 2 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. <i>This input is 5 V tolerant.</i>
HCKT	Input or output	GPIO disconnected	High Frequency Clock for Transmitter —When programmed as an input, this signal provides a high frequency clock source for the ESAI transmitter as an alternate to the DSP core clock. When programmed as an output, this signal can serve as a high frequency sample clock (e.g., for external DACs) or as an additional system clock.
PC5	Input, output, or disconnected	GPIO disconnected	Port C 5 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. <i>This input is 5 V tolerant.</i>
FSR	Input or output	GPIO disconnected	Frame Sync for Receiver —This is the receiver frame sync input/output signal. In the asynchronous mode (SYN=0), the FSR pin operates as the frame sync input or output used by all the enabled receivers. In the synchronous mode (SYN=1), it operates as either the serial flag 1 pin (TEBE=0), or as the transmitter external buffer enable control (TEBE=1, RFSD=1). When this pin is configured as serial flag pin, its direction is determined by the RFSD bit in the RCCR register. When configured as the output flag OF1, this pin will reflect the value of the OF1 bit in the SAICR register, and the data in the OF1 bit will show up at the pin synchronized to the frame sync in normal mode or the slot in network mode. When configured as the input flag IF1, the data value at the pin will be stored in the IF1 bit in the SAISR register, synchronized by the frame sync in normal mode or the slot in network mode.
PC1	Input, output, or disconnected	GPIO disconnected	Port C 1 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. <i>This input is 5 V tolerant.</i>
FST	Input or output	GPIO disconnected	Frame Sync for Transmitter —This is the transmitter frame sync input/output signal. For synchronous mode, this signal is the frame sync for both transmitters and receivers. For asynchronous mode, FST is the frame sync for the transmitters only. The direction is determined by the transmitter frame sync direction (TFSD) bit in the ESAI transmit clock control register (TCCR).

Table 2-10 Enhanced Serial Audio Interface Signals (continued)

Signal Name	Signal Type	State During Reset	Signal Description
PC4	Input, output, or disconnected	GPIO disconnected	Port C 4 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SCKR	Input or output	GPIO disconnected	Receiver Serial Clock —SCKR provides the receiver serial bit clock for the ESAI. The SCKR operates as a clock input or output used by all the enabled receivers in the asynchronous mode (SYN=0), or as serial flag 0 pin in the synchronous mode (SYN=1). When this pin is configured as serial flag pin, its direction is determined by the RCKD bit in the RCCR register. When configured as the output flag OF0, this pin will reflect the value of the OF0 bit in the SAICR register, and the data in the OF0 bit will show up at the pin synchronized to the frame sync in normal mode or the slot in network mode. When configured as the input flag IF0, the data value at the pin will be stored in the IF0 bit in the SAISR register, synchronized by the frame sync in normal mode or the slot in network mode.
PC0	Input, output, or disconnected	GPIO disconnected	Port C 0 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SCKT	Input or output	GPIO disconnected	Transmitter Serial Clock —This signal provides the serial bit rate clock for the ESAI. SCKT is a clock input or output used by all enabled transmitters and receivers in synchronous mode, or by all enabled transmitters in asynchronous mode.
PC3	Input, output, or disconnected	GPIO disconnected	Port C 3 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO5	Output	GPIO disconnected	Serial Data Output 5 —When programmed as a transmitter, SDO5 is used to transmit data from the TX5 serial transmit shift register.
SDI0	Input	GPIO disconnected	Serial Data Input 0 —When programmed as a receiver, SDI0 is used to receive serial data into the RX0 serial receive shift register.
PC6	Input, output, or disconnected	GPIO disconnected	Port C 6 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO4	Output	GPIO disconnected	Serial Data Output 4 —When programmed as a transmitter, SDO4 is used to transmit data from the TX4 serial transmit shift register.

Table 2-10 Enhanced Serial Audio Interface Signals (continued)

Signal Name	Signal Type	State During Reset	Signal Description
SDI1	Input	GPIO disconnected	Serial Data Input 1 —When programmed as a receiver, SDI1 is used to receive serial data into the RX1 serial receive shift register.
PC7	Input, output, or disconnected	GPIO disconnected	Port C 7 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO3	Output	GPIO disconnected	Serial Data Output 3 —When programmed as a transmitter, SDO3 is used to transmit data from the TX3 serial transmit shift register.
SDI2	Input	GPIO disconnected	Serial Data Input 2 —When programmed as a receiver, SDI2 is used to receive serial data into the RX2 serial receive shift register.
PC8	Input, output, or disconnected	GPIO disconnected	Port C 8 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO2	Output	GPIO disconnected	Serial Data Output 2 —When programmed as a transmitter, SDO2 is used to transmit data from the TX2 serial transmit shift register
SDI3	Input	GPIO disconnected	Serial Data Input 3 —When programmed as a receiver, SDI3 is used to receive serial data into the RX3 serial receive shift register.
PC9	Input, output, or disconnected	GPIO disconnected	Port C 9 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO1	Output	GPIO disconnected	Serial Data Output 1 —SDO1 is used to transmit data from the TX1 serial transmit shift register.
PC10	Input, output, or disconnected	GPIO disconnected	Port C 10 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.
SDO0	Output	GPIO disconnected	Serial Data Output 0 —SDO0 is used to transmit data from the TX0 serial transmit shift register.
PC11	Input, output, or disconnected	GPIO disconnected	Port C 11 —When the ESAI is configured as GPIO, this signal is individually programmable as input, output, or internally disconnected. The default state after reset is GPIO disconnected. This input is 5 V tolerant.

2.9 JTAG/OnCE Interface

Table 2-11 JTAG/OnCE Interface

Signal Name	Signal Type	State During Reset	Signal Description
TCK	Input	Input	Test Clock —TCK is a test clock input signal used to synchronize the JTAG test logic. It has an internal pull-up resistor. <i>This input is 5 V tolerant.</i>
TDI	Input	Input	Test Data Input —TDI is a test data serial input signal used for test instructions and data. TDI is sampled on the rising edge of TCK and has an internal pull-up resistor. This input is 5 V tolerant.
TDO	Output	Tri-stated	Test Data Output —TDO is a test data serial output signal used for test instructions and data. TDO is tri-statable and is actively driven in the shift-IR and shift-DR controller states. TDO changes on the falling edge of TCK.
TMS	Input	Input	Test Mode Select —TMS is an input signal used to sequence the test controller's state machine. TMS is sampled on the rising edge of TCK and has an internal pull-up resistor. <i>This input is 5 V tolerant.</i>

Table 2-12 GPIO Signals

Signal Name	Signal Type	State During Reset	Signal Description
GPIO0–GPIO3	Input, output or disconnected	Disconnected	GPIO0–3—The General Purpose I/O pins are used for control and handshake functions between the DSP and external circuitry. Each Port B GPIO pin may be individually programmed as an input, output or disconnected

3 Specifications

3.1 Introduction

The DSP56364 is a high density CMOS device with Transistor-Transistor Logic (TTL) compatible inputs and outputs. The DSP56364 specifications are preliminary and are from design simulations, and may not be fully tested or guaranteed. Finalized specifications will be published after full characterization and device qualifications are complete.

3.2 Maximum Ratings

CAUTION

This device contains circuitry protecting against damage due to high static voltage or electrical fields. However, normal precautions should be taken to avoid exceeding maximum voltage ratings. Reliability of operation is enhanced if unused inputs are pulled to an appropriate logic voltage level (e.g., either GND or V_{CC}). The suggested value for a pull-up or pull-down resistor is 10 k Ω .

NOTE

In the calculation of timing requirements, adding a maximum value of one specification to a minimum value of another specification does not yield a reasonable sum. A maximum specification is calculated using a worst case variation of process parameter values in one direction. The minimum specification is calculated using the worst case for the same parameters in the opposite direction. Therefore, a “maximum” value for a specification will never occur in the same device that has a “minimum” value for another specification; adding a maximum to a minimum represents a condition that can never exist.

Table 3-1 Maximum Ratings

Rating ¹	Symbol	Value ^{1, 2}	Unit
Supply Voltage	V_{CC}	-0.3 to +4.0	V
All input voltages excluding "5 V tolerant" inputs ³	V_{IN}	GND -0.3 to $V_{CC} + 0.3$	V
All "5 V tolerant" input voltages ³	V_{IN5}	GND - 0.3 to $V_{CC} + 3.95$	V
Current drain per pin excluding V_{CC} and GND	I	10	mA
Operating temperature range	T_J	-40 to +105	°C
Storage temperature	T_{STG}	-55 to +125	°C

¹ GND = 0 V, $V_{CC} = 3.3 \text{ V} \pm 0.16 \text{ V}$, $T_J = -0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50 \text{ pF}$

² Absolute maximum ratings are stress ratings only, and functional operation at the maximum is not guaranteed. Stress beyond the maximum rating may affect device reliability or cause permanent damage to the device.

³ **CAUTION:** All "5 V Tolerant" input voltages must not be more than 3.95 V greater than the supply voltage; this restriction applies to "power on", as well as during normal operation. In any case, the input voltages cannot be more than 5.75 V. "5 V Tolerant" inputs are inputs that tolerate 5 V.

3.3 Thermal Characteristics

Table 3-2 Thermal Characteristics

Characteristic	Symbol	TQFP Value	Unit
Junction-to-ambient thermal resistance ¹	$R_{\theta JA}$ or θ_{JA}	49.87	°C/W
Junction-to-case thermal resistance ²	$R_{\theta JC}$ or θ_{JC}	9.26	°C/W
Thermal characterization parameter	Ψ_{JT}	2.0	°C/W

¹ 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 Rd., Mountain View, CA 94043, (415) 964-5111.)

Measurements were done with parts mounted on thermal test boards conforming to specification EIA/JESD51-3.

² 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.

3.4 DC Electrical Characteristics

Table 3-3 DC Electrical Characteristics¹

Characteristics	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	3.14	3.3	3.46	V
Input high voltage					V
• D(0:7), $\overline{TA}$	V_{IH}	2.0	—	V_{CC}	
• $MOD^2/\overline{IRQ^2}$, $\overline{RESET}$, $PINIT/\overline{NMI}$ and all JTAG/ESAI/GPIO/SHI (SPI mode) pins	V_{IHP}	2.0	—	$V_{CC} + 3.95$	
• SHI (I2C mode) pins	V_{IHP}	1.5	—	$V_{CC} + 3.95$	
• $EXTAL^3$	V_{IHX}	$0.8 \times V_{CC}$	—	V_{CC}	
Input low voltage					V
• D(0:7), $\overline{TA}$, $MOD^2/\overline{IRQ^2}$, $\overline{RESET}$, $PINIT$	V_{IL}	-0.3	—	0.8	
• JTAG/ESAI/GPIO/SHI (SPI mode) pins	V_{ILP}	-0.3	—	0.8	
• SHI (I2C mode) pins	V_{ILP}	-0.3	—	$0.3 \times V_{CC}$	
• $EXTAL^3$	V_{ILX}	-0.3	—	$0.2 \times V_{CC}$	
Input leakage current	I_{IN}	-10	—	10	μA
High impedance (off-state) input current (@ 2.4 V / 0.4 V)	I_{TSI}	-10	—	10	μA
Output high voltage	V_{OH}				V
• TTL ($I_{OH} = -0.4$ mA) ^{4,5}		2.4	—	—	
• CMOS ($I_{OH} = -10$ μA) ⁴		$V_{CC} - 0.01$	—	—	V
Output low voltage	V_{OL}				V
• TTL ($I_{OL} = 3.0$ mA, open-drain pins $I_{OL} = 6.7$ mA) ^{4,5}		—	—	0.4	
• CMOS ($I_{OL} = 10$ μA) ⁴		—	—	0.01	
Internal supply current ⁶ at internal clock of 100 MHz					
• In Normal mode	I_{CCI}	—	127	181	mA
• In Wait mode ⁷	I_{CCW}	—	7.5	11	mA
• In Stop mode ⁸	I_{CCS}	—	100	150	μA
PLL supply current		—	1	2.5	mA
Input capacitance ⁴	C_{IN}	—	—	10	pF

¹ $V_{CC} = 3.3 \text{ V} \pm .16 \text{ V}$; $T_J = 0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50 \text{ pF}$ ² Refers to $MODA/\overline{IRQA}$, $MODB/\overline{IRQB}$, and $MODD/\overline{IRQD}$ pins³ Driving $EXTAL$ to the low V_{IHX} or the high V_{ILX} value may cause additional power consumption (DC current). To minimize power consumption, the minimum V_{IHX} should be no lower than $0.9 \times V_{CC}$ and the maximum V_{ILX} should be no higher than $0.1 \times V_{CC}$.⁴ Periodically sampled and not 100% tested

AC Electrical Characteristics

- ⁵ This characteristic does not apply to PCAP.
- ⁶ [Section 5, "Design Considerations"](#) provides a formula to compute the estimated current requirements in Normal mode. In order to obtain these results, all inputs must be terminated (i.e., not allowed to float). Measurements are based on synthetic intensive DSP benchmarks. The power consumption numbers in this specification are 90% of the measured results of this benchmark. This reflects typical DSP applications. Typical internal supply current is measured with $V_{CC} = 3.3\text{ V}$ at $T_J = 105^\circ\text{C}$. Maximum internal supply current is measured with $V_{CC} = 3.46\text{ V}$ at $T_J = 105^\circ\text{C}$.
- ⁷ In order to obtain these results, all inputs must be terminated (i.e., not allowed to float). PLL signal is disabled during Stop state.
- ⁸ In order to obtain these results, all inputs, which are not disconnected at Stop mode, must be terminated (i.e., not allowed to float).

3.5 AC Electrical Characteristics

The timing waveforms shown in the AC electrical characteristics section are tested with a V_{IL} maximum of 0.3 V and a V_{IH} minimum of 2.4 V for all pins except EXTAL, which is tested using the input levels shown in [Note 8](#) of the previous table. AC timing specifications, which are referenced to a device input signal, are measured in production with respect to the 50% point of the respective input signal's transition. DSP56364 output levels are measured with the production test machine V_{OL} and V_{OH} reference levels set at 0.4 V and 2.4 V, respectively.

NOTE

Although the minimum value for the frequency of EXTAL is 0 MHz, the device AC test conditions are 15 MHz and rated speed.

3.6 Internal Clocks

Table 3-4 Internal Clocks

Characteristics	Symbol	Expression ^{1, 2}		
		Min	Typ	Max
Internal operation frequency with PLL enabled	f	—	$(Ef \times MF) / (PDF \times DF)$	—
Internal operation frequency with PLL disabled	f	—	$Ef/2$	—
Internal clock high period	T_H			
• With PLL disabled		—	ET_C	—
• With PLL enabled and $MF \leq 4$		$0.49 \times ET_C \times PDF \times DF/MF$	—	$0.51 \times ET_C \times PDF \times DF/MF$
• With PLL enabled and $MF > 4$		$0.47 \times ET_C \times PDF \times DF/MF$	—	$0.53 \times ET_C \times PDF \times DF/MF$

Table 3-4 Internal Clocks (continued)

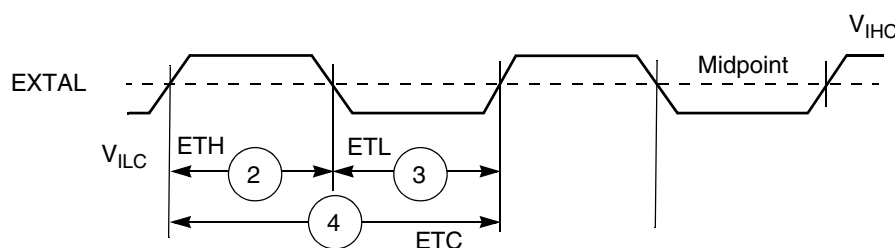
Characteristics	Symbol	Expression ^{1, 2}		
		Min	Typ	Max
Internal clock low period	T_L	—	ET_C	—
• With PLL disabled		—	ET_C	—
• With PLL enabled and $MF \leq 4$		$0.49 \times ET_C \times PDF \times DF/MF$	—	$0.51 \times ET_C \times PDF \times DF/MF$
• With PLL enabled and $MF > 4$		$0.47 \times ET_C \times PDF \times DF/MF$	—	$0.53 \times ET_C \times PDF \times DF/MF$
Internal clock cycle time with PLL enabled	T_C	—	$ET_C \times PDF \times DF/MF$	—
Internal clock cycle time with PLL disabled	T_C	—	$2 \times ET_C$	—
Instruction cycle time	I_{CYC}	—	T_C	—

¹ DF = Division Factor
Ef = External frequency
 ET_C = External clock cycle
MF = Multiplication Factor
PDF = Predivision Factor
 T_C = internal clock cycle

² See the *PLL and Clock Generation* section in the *DSP56300 Family Manual* for a detailed discussion of the PLL.

3.7 External Clock Operation

The DSP56364 system clock is an externally supplied square wave voltage source connected to EXTAL (See [Figure 3-1](#)).



Note: The midpoint is $0.5 (V_{IHC} + V_{ILC})$.

Figure 3-1 External Clock Timing

Table 3-5 Clock Operation

No.	Characteristics	Symbol	Min	Max
1	Frequency of EXTAL (EXTAL Pin Frequency) The rise and fall time of this external clock should be 3 ns maximum.	E_f	0	100.0
2	EXTAL input high ^{1, 2} • With PLL disabled (46.7%–53.3% duty cycle ⁶) • With PLL enabled (42.5%–57.5% duty cycle ⁶)	ET_H	4.67 ns 4.25 ns	∞ 157.0 μ s
3	EXTAL input low ^{1, 2} • With PLL disabled (46.7%–53.3% duty cycle ⁶) • With PLL enabled (42.5%–57.5% duty cycle ⁶)	ET_L	4.67 ns 4.25 ns	∞ 157.0 μ s
4	EXTAL cycle time ² • With PLL disabled • With PLL enabled	ET_C	10.00 ns 10.00 ns	∞ 273.1 μ s

¹ Measured at 50% of the input transition.

² The maximum value for PLL enabled is given for minimum V_{CO} and maximum MF.

3.8 Phase Lock Loop (PLL) Characteristics

Table 3-6 PLL Characteristics

Characteristics	Min	Max	Unit
V_{CO} frequency when PLL enabled ($MF \times E_f \times 2/PDF$)	30	200	MHz
PLL external capacitor (PCAP pin to V_{CCP}) (C_{PCAP} ¹) • @ $MF \leq 4$ • @ $MF > 4$	$(MF \times 580) - 100$ $MF \times 830$	$(MF \times 780) - 140$ $MF \times 1470$	pF

¹ C_{PCAP} is the value of the PLL capacitor (connected between the P_{CAP} pin and V_{CCP}). The recommended value in pF for C_{PCAP} can be computed from one of the following equations:
 $(MF \times 680) - 120$, for $MF \leq 4$, or
 $MF \times 1100$, for $MF > 4$.

3.9 Reset, Stop, Mode Select, and Interrupt Timing

Table 3-7 Reset, Stop, Mode Select, and Interrupt Timing¹

No.	Characteristics	Expression ²	Min	Max	Unit
8	Delay from $\overline{\text{RESET}}$ assertion to all pins at reset value ³	—	—	26.0	ns
9	Required $\overline{\text{RESET}}$ duration ⁴				
	• Power on, external clock generator, PLL disabled	$50 \times \text{ET}_C$	500.0	—	ns
	• Power on, external clock generator, PLL enabled	$1000 \times \text{ET}_C$	10.0	—	ns
	• Power on, internal oscillator	$75000 \times \text{ET}_C$	0.75	—	μs
	• During STOP, XTAL disabled (PCTL Bit 16 = 0)	$75000 \times \text{ET}_C$	0.75	—	ms
	• During STOP, XTAL enabled (PCTL Bit 16 = 1)	$2.5 \times \text{T}_C$	25.0	—	ms
10	Delay from asynchronous $\overline{\text{RESET}}$ deassertion to first external address output (internal reset deassertion) ⁵				
	• Minimum	$3.25 \times \text{T}_C + 2.0$	34.5	—	ns
	• Maximum	$20.25 \text{T}_C + 7.50$	—	211.5	ns
13	Mode select setup time		30.0	—	ns
14	Mode select hold time		0.0	—	ns
15	Minimum edge-triggered interrupt request assertion width		6.6	—	ns
16	Minimum edge-triggered interrupt request deassertion width		6.6	—	ns
17	Delay from $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$, $\overline{\text{IRQD}}$, $\overline{\text{NMI}}$ assertion to external memory access address out valid				
	• Caused by first interrupt instruction fetch	$4.25 \times \text{T}_C + 2.0$	44.5	—	ns
	• Caused by first interrupt instruction execution	$7.25 \times \text{T}_C + 2.0$	74.5	—	ns
18	Delay from $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$, $\overline{\text{IRQD}}$, $\overline{\text{NMI}}$ assertion to general-purpose transfer output valid caused by first interrupt instruction execution	$10 \times \text{T}_C + 5.0$	105.0	—	ns
19	Delay from address output valid caused by first interrupt instruction execute to interrupt request deassertion for level sensitive fast interrupts ^{6, 7}	$3.75 \times \text{T}_C + \text{WS} \times \text{T}_C - 10.94$	—	—	ns
20	Delay from $\overline{\text{RD}}$ assertion to interrupt request deassertion for level sensitive fast interrupts ^{6, 7}	$3.25 \times \text{T}_C + \text{WS} \times \text{T}_C - 10.94$	—	—	ns

Table 3-7 Reset, Stop, Mode Select, and Interrupt Timing¹ (continued)

No.	Characteristics	Expression ²	Min	Max	Unit
21	Delay from $\overline{WR}$ assertion to interrupt request deassertion for level sensitive fast interrupts ^{6, 7} • DRAM for all WS • SRAM WS = 1 • SRAM WS = 2, 3 • SRAM WS $\geq$ 4	$(WS + 3.5) \times T_C - 10.94$ $(WS + 3.5) \times T_C - 10.94$ $(WS + 3) \times T_C - 10.94$ $(WS + 2.5) \times T_C - 10.94$	—	—	ns
24	Duration for $\overline{IRQA}$ assertion to recover from Stop state		5.9	—	
25	Delay from $\overline{IRQA}$ assertion to fetch of first instruction (when exiting Stop) ^{3, 8} • PLL is not active during Stop (PCTL Bit 17 = 0) and Stop delay is enabled (OMR Bit 6 = 0) • PLL is not active during Stop (PCTL Bit 17 = 0) and Stop delay is not enabled (OMR Bit 6 = 1) • PLL is active during Stop (PCTL Bit 17 = 1) (Implies No Stop Delay)	$PLC \times ET_C \times PDF + (128 K - PLC/2) \times T_C$ $PLC \times ET_C \times PDF + (23.75 \pm 0.5) \times T_C$ $(8.25 \pm 0.5) \times T_C$	1.3 232.5 ns 77.5	13.6 12.3 ms 87.5	ms ms ns
26	Duration of level sensitive $\overline{IRQA}$ assertion to ensure interrupt service (when exiting Stop) ^{3, 8} • PLL is not active during Stop (PCTL Bit 17 = 0) and Stop delay is enabled (OMR Bit 6 = 0) • PLL is not active during Stop (PCTL Bit 17 = 0) and Stop delay is not enabled (OMR Bit 6 = 1) • PLL is active during Stop (PCTL Bit 17 = 1) (implies no Stop delay)	$PLC \times ET_C \times PDF + (128 K - PLC/2) \times T_C$ $PLC \times ET_C \times PDF + (20.5 \pm 0.5) \times T_C$ $5.5 \times T_C$	13.6 12.3 55.0	— — —	ms ms ns
27	Interrupt Requests Rate • ESAI, SCI • DMA • $\overline{IRQ}$, $\overline{NMI}$ (edge trigger) • $\overline{IRQ}$, $\overline{NMI}$ (level trigger)	$12T_C$ $8T_C$ $8T_C$ $12T_C$	— — — —	120.0 80.0 80.0 120.0	ns ns ns ns
28	DMA Requests Rate • Data read from ESAI, SCI • Data write to ESAI, SCI • $\overline{IRQ}$, $\overline{NMI}$ (edge trigger)	$6T_C$ $7T_C$ $3T_C$	— — —	60.0 70.0 30.0	ns ns ns

Table 3-7 Reset, Stop, Mode Select, and Interrupt Timing¹ (continued)

No.	Characteristics	Expression ²	Min	Max	Unit
29	Delay from $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$, $\overline{\text{IRQD}}$, $\overline{\text{NMI}}$ assertion to external memory (DMA source) access address out valid	$4.25 \times T_C + 2.0$	44.0	—	ns

¹ $V_{CC} = 3.3 \text{ V} \pm 0.16 \text{ V}$; $T_J = 0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50 \text{ pF}$

² Use expression to compute maximum value.

³ Periodically sampled and not 100% tested

⁴ For an external clock generator, $\overline{\text{RESET}}$ duration is measured during the time in which $\overline{\text{RESET}}$ is asserted, V_{CC} is valid, and the EXTAL input is active and valid.

For internal oscillator, $\overline{\text{RESET}}$ duration is measured during the time in which $\overline{\text{RESET}}$ is asserted and V_{CC} is valid. The specified timing reflects the crystal oscillator stabilization time after power-up. This number is affected both by the specifications of the crystal and other components connected to the oscillator and reflects worst case conditions.

When the V_{CC} is valid, but the other “required $\overline{\text{RESET}}$ duration” conditions (as specified above) have not been yet met, the device circuitry will be in an uninitialized state that can result in significant power consumption and heat-up. Designs should minimize this state to the shortest possible duration.

⁵ For an external clock generator, $\overline{\text{RESET}}$ duration is measured during the time in which $\overline{\text{RESET}}$ is asserted, V_{CC} is valid, and the EXTAL input is active and valid.

For internal oscillator, $\overline{\text{RESET}}$ duration is measured during the time in which $\overline{\text{RESET}}$ is asserted and V_{CC} is valid. The specified timing reflects the crystal oscillator stabilization time after power-up. This number is affected both by the specifications of the crystal and other components connected to the oscillator and reflects worst case conditions.

When the V_{CC} is valid, but the other “required $\overline{\text{RESET}}$ duration” conditions (as specified above) have not been yet met, the device circuitry will be in an uninitialized state that can result in significant power consumption and heat-up. Designs should minimize this state to the shortest possible duration.

⁶ When using fast interrupts and $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$, and $\overline{\text{IRQD}}$ are defined as level-sensitive, timings 19 through 21 apply to prevent multiple interrupt service. To avoid these timing restrictions, the deasserted Edge-triggered mode is recommended when using fast interrupts. Long interrupts are recommended when using Level-sensitive mode.

⁷ WS = number of wait states (measured in clock cycles, number of T_C)

⁸ This timing depends on several settings:

For PLL disable, using internal oscillator (PLL Control Register (PCTL) Bit 16 = 0) and oscillator disabled during Stop (PCTL Bit 17 = 0), a stabilization delay is required to assure the oscillator is stable before executing programs. In that case, resetting the Stop delay (OMR Bit 6 = 0) will provide the proper delay. While it is possible to set OMR Bit 6 = 1, it is not recommended and these specifications do not guarantee timings for that case.

For PLL disable, using internal oscillator (PCTL Bit 16 = 0) and oscillator enabled during Stop (PCTL Bit 17 = 1), no stabilization delay is required and recovery time will be minimal (OMR Bit 6 setting is ignored).

For PLL disable, using external clock (PCTL Bit 16 = 1), no stabilization delay is required and recovery time will be defined by the PCTL Bit 17 and OMR Bit 6 settings.

For PLL enable, if PCTL Bit 17 is 0, the PLL is shutdown during Stop. Recovering from Stop requires the PLL to get locked. The PLL lock procedure duration, PLL Lock Cycles (PLC), may be in the range of 0 to 1000 cycles. This procedure occurs in parallel with the stop delay counter, and stop recovery will end when the last of these two events occurs. The stop delay counter completes count or PLL lock procedure completion.

PLC value for PLL disable is 0.

The maximum value for ET_C is 4096 (maximum MF) divided by the desired internal frequency (i.e., for 100 MHz it is $4096/100 \text{ MHz} = 40 \mu\text{s}$). During the stabilization period, T_C , T_H , and T_L will not be constant, and their width may vary, so timing may vary as well.

⁹ If PLL does not lose lock.

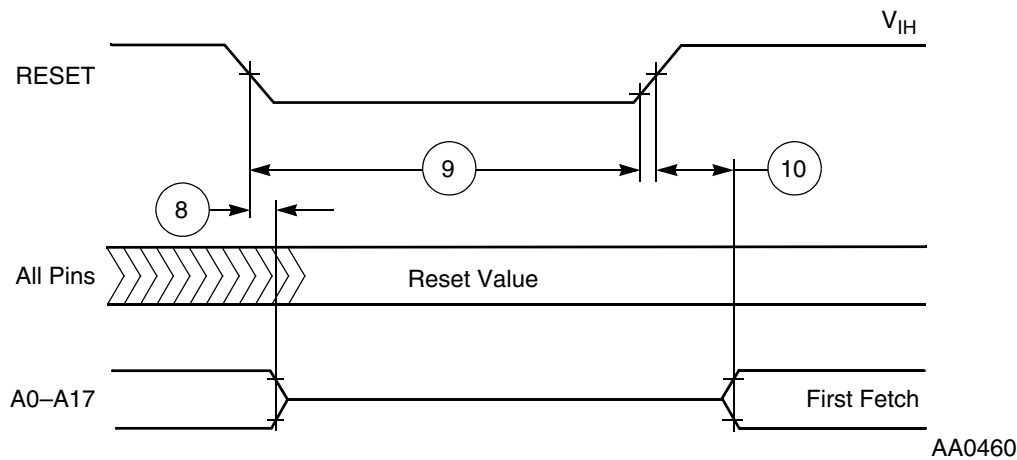
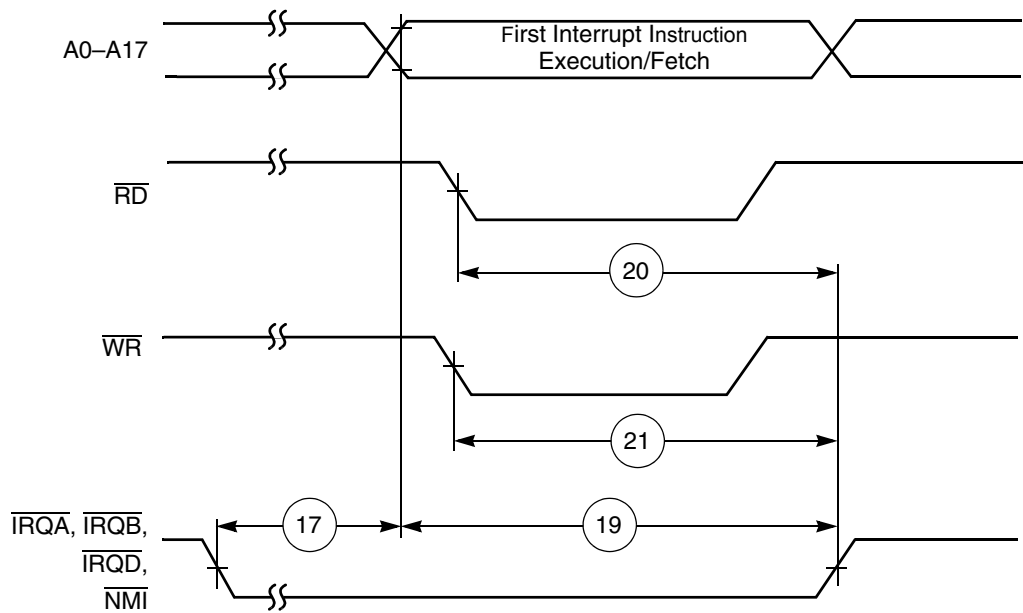
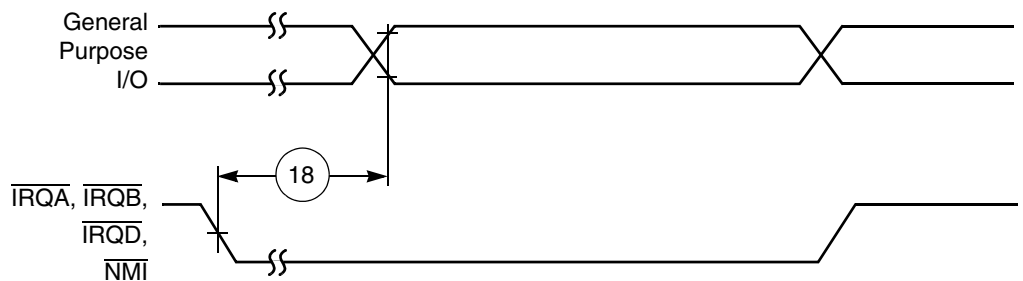


Figure 3-2 Reset Timing



a) First Interrupt Instruction Execution



b) General Purpose I/O

AA0462

Figure 3-3 External Fast Interrupt Timing

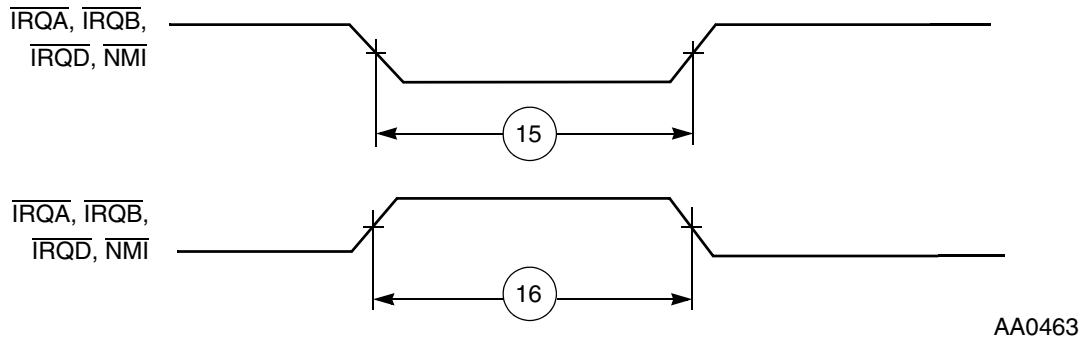


Figure 3-4 External Interrupt Timing (Negative Edge-Triggered)

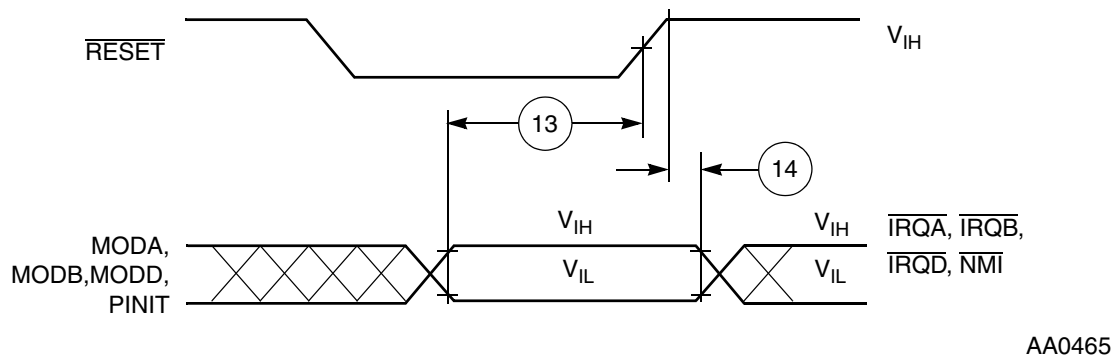
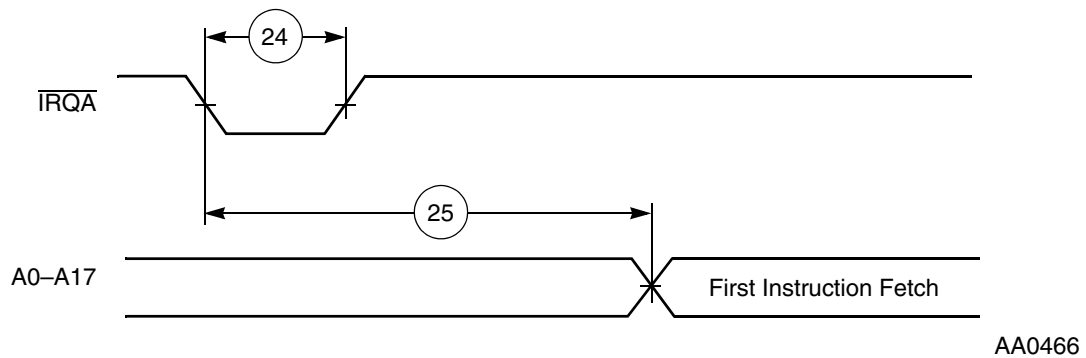


Figure 3-5 Operating Mode Select Timing

Figure 3-6 Recovery from Stop State Using $\overline{\text{IRQA}}$

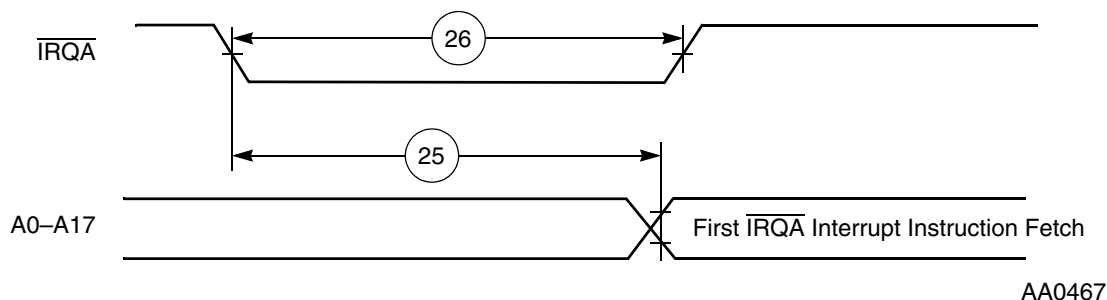


Figure 3-7 Recovery from Stop State Using $\overline{\text{IRQA}}$ Interrupt Service

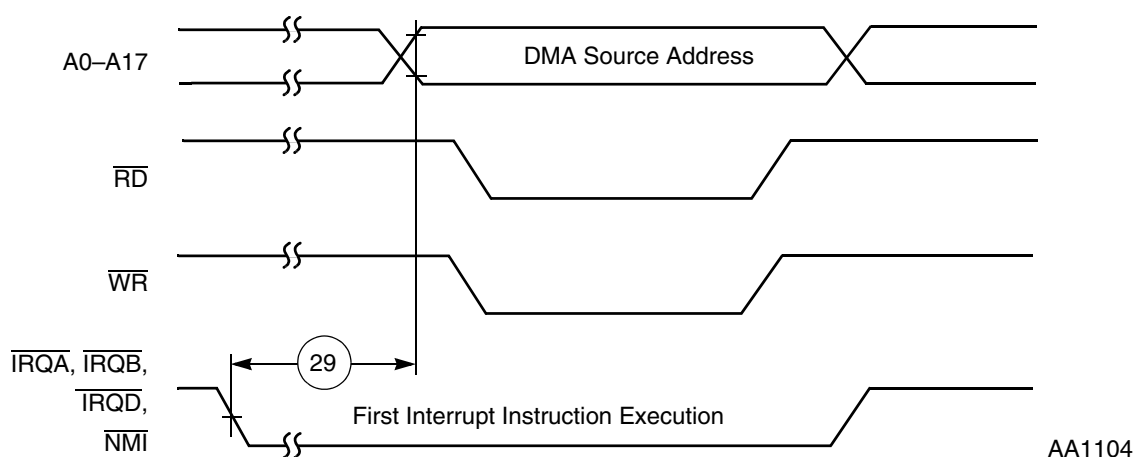


Figure 3-8 External Memory Access (DMA Source) Timing

3.10 External Memory Expansion Port (Port A)

3.10.1 SRAM Timing

Table 3-8 SRAM Read and Write Accesses¹

No.	Characteristics	Symbol	Expression ²	Min	Max	Unit
100	Address valid and AA assertion pulse width	$t_{\text{RC}}, t_{\text{WC}}$	$(\text{WS} + 1) \times T_{\text{C}} - 4.0$ [$1 \leq \text{WS} \leq 3$]	16.0	—	ns
			$(\text{WS} + 2) \times T_{\text{C}} - 4.0$ [$4 \leq \text{WS} \leq 7$]	56.0	—	ns
			$(\text{WS} + 3) \times T_{\text{C}} - 4.0$ [$\text{WS} \geq 8$]	106.0	—	ns

Table 3-8 SRAM Read and Write Accesses¹ (continued)

No.	Characteristics	Symbol	Expression ²	Min	Max	Unit
101	Address and AA valid to $\overline{WR}$ assertion	t_{AS}	$0.25 \times T_C - 2.0$ [WS = 1]	0.5	—	ns
			$0.75 \times T_C - 2.0$ [2 ≤ WS ≤ 3]	5.5	—	ns
			$1.25 \times T_C - 2.0$ [WS ≥ 4]	10.5	—	ns
102	$\overline{WR}$ assertion pulse width	t_{WP}	$1.5 \times T_C - 4.0$ [WS = 1]	11.0	—	ns
			All frequencies: $WS \times T_C - 4.0$ [2 ≤ WS ≤ 3]	16.0	—	ns
			$(WS - 0.5) \times T_C - 4.0$ [WS ≥ 4]	31.0	—	ns
103	$\overline{WR}$ deassertion to address not valid	t_{WR}	$0.25 \times T_C - 2.0$ [1 ≤ WS ≤ 3]	0.5	—	ns
			$1.25 \times T_C - 2.0$ [4 ≤ WS ≤ 7]	10.5	—	ns
			$2.25 \times T_C - 2.0$ [WS ≥ 8]	20.5	—	ns
			All frequencies: $1.25 \times T_C - 4.0$ [4 ≤ WS ≤ 7]	8.5	—	ns
			$2.25 \times T_C - 4.0$ [WS ≥ 8]	18.5	—	ns
104	Address and AA valid to input data valid	t_{AA}, t_{AC}	$(WS + 0.75) \times T_C - 7.0$ [WS ≥ 1]	—	10.5	ns
105	$\overline{RD}$ assertion to input data valid	t_{OE}	$(WS + 0.25) \times T_C - 7.0$ [WS ≥ 1]	—	5.5	ns
106	$\overline{RD}$ deassertion to data not valid (data hold time)	t_{OHZ}		0.0	—	ns
107	Address valid to $\overline{WR}$ deassertion ³	t_{AW}	$(WS + 0.75) \times T_C - 4.0$ [WS ≥ 1]	13.5	—	ns

Table 3-8 SRAM Read and Write Accesses¹ (continued)

No.	Characteristics	Symbol	Expression ²	Min	Max	Unit
108	Data valid to $\overline{WR}$ deassertion (data setup time)	t_{DS} (t_{DW})	$(WS - 0.25) \times T_C - 3.0$ [$WS \geq 1$]	4.5	—	ns
109	Data hold time from $\overline{WR}$ deassertion	t_{DH}	$0.25 \times T_C - 2.0$ [$1 \leq WS \leq 3$]	0.5	—	ns
			$1.25 \times T_C - 2.0$ [$4 \leq WS \leq 7$]	10.5	—	ns
			$2.25 \times T_C - 2.0$ [$WS \geq 8$]	20.5	—	ns
113	$\overline{RD}$ deassertion time		$0.75 \times T_C - 4.0$ [$1 \leq WS \leq 3$]	3.5	—	ns
			$1.75 \times T_C - 4.0$ [$4 \leq WS \leq 7$]	13.5	—	ns
			$2.75 \times T_C - 4.0$ [$WS \geq 8$]	23.5	—	ns
114	$\overline{WR}$ deassertion time		$0.5 \times T_C - 4.0$ [$WS = 1$]	1.0	—	ns
			$T_C - 2.0$ [$2 \leq WS \leq 3$]	6.0	—	ns
			$2.5 \times T_C - 4.0$ [$4 \leq WS \leq 7$]	21.0	—	ns
			$3.5 \times T_C - 4.0$ [$WS \geq 8$]	31.0	—	ns
115	Address valid to $\overline{RD}$ assertion		$0.5 \times T_C - 4.0$	1.0	—	ns
116	$\overline{RD}$ assertion pulse width		$(WS + 0.25) \times T_C - 4.0$	8.5	—	ns
117	$\overline{RD}$ deassertion to address not valid		$0.25 \times T_C - 2.0$ [$1 \leq WS \leq 3$]	0.5	—	ns
			$1.25 \times T_C - 2.0$ [$4 \leq WS \leq 7$]	10.5	—	ns
			$2.25 \times T_C - 2.0$ [$WS \geq 8$]	20.5	—	ns

Table 3-8 SRAM Read and Write Accesses¹ (continued)

No.	Characteristics	Symbol	Expression ²	Min	Max	Unit
118	$\overline{TA}$ setup before $\overline{RD}$ or $\overline{WR}$ deassertion ⁴		$0.25 \times T_C + 2.0$	4.5	—	ns
119	$\overline{TA}$ hold after $\overline{RD}$ or $\overline{WR}$ deassertion			0	—	ns

¹ All timings for 100 MHz are measured from $0.5 \cdot V_{CC}$ to $.05 \cdot V_{CC}$

² WS is the number of wait states specified in the BCR.

³ Timings 100, 107 are guaranteed by design, not tested.

⁴ In the case of $\overline{TA}$ negation: timing 118 is relative to the deassertion edge of $\overline{RD}$ or $\overline{WR}$ were $\overline{TA}$ to remain active.

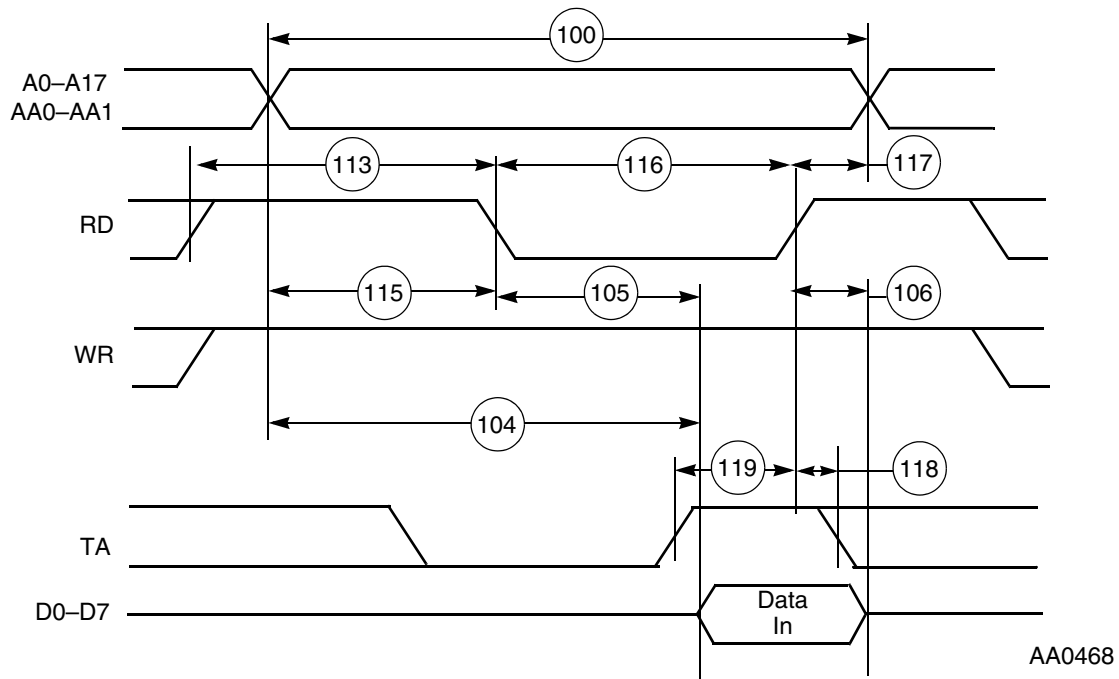


Figure 3-9 SRAM Read Access

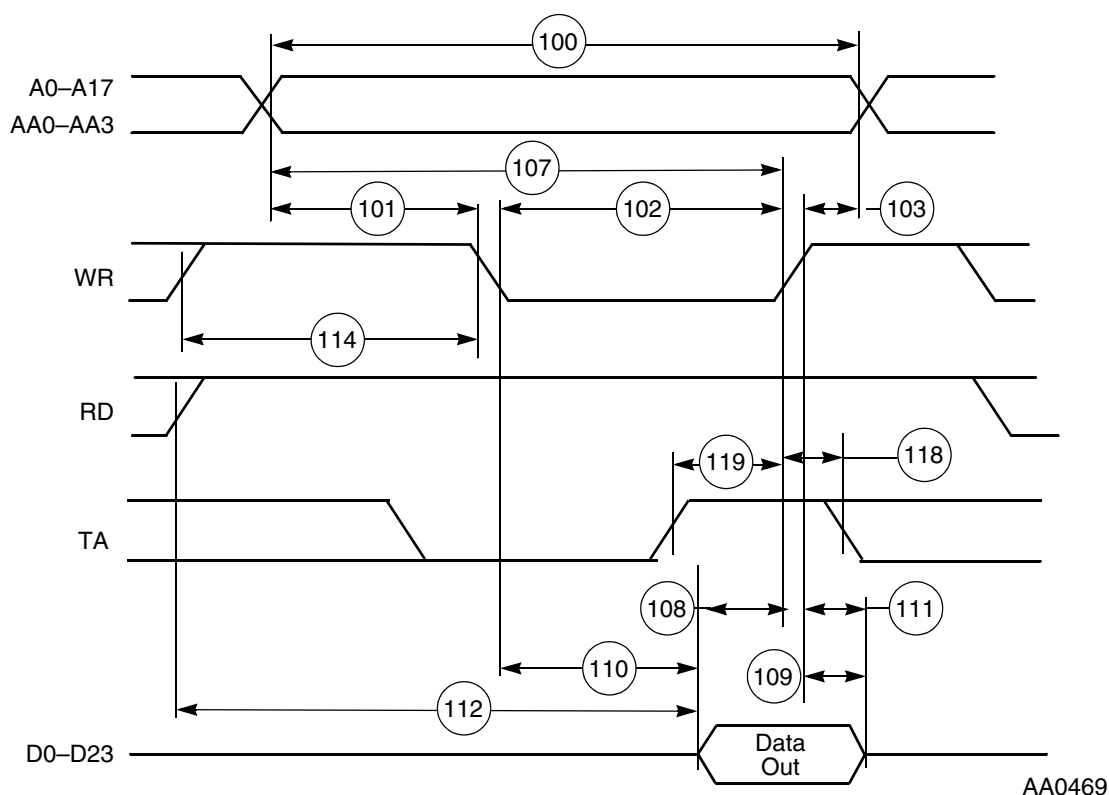


Figure 3-10 SRAM Write Access

3.10.2 DRAM Timing

The selection guides provided in [Figure 3-11](#) and [Figure 3-14](#) should be used for primary selection only. Final selection should be based on the timing provided in the following tables. As an example, the selection guide suggests that 4 wait states must be used for 100 MHz operation when using Page Mode DRAM. However, by using the information in the appropriate table, a designer may choose to evaluate whether fewer wait states might be used by determining which timing prevents operation at 100 MHz, running the chip at a slightly lower frequency (e.g., 95 MHz), using faster DRAM (if it becomes available), and control factors such as capacitive and resistive load to improve overall system performance.

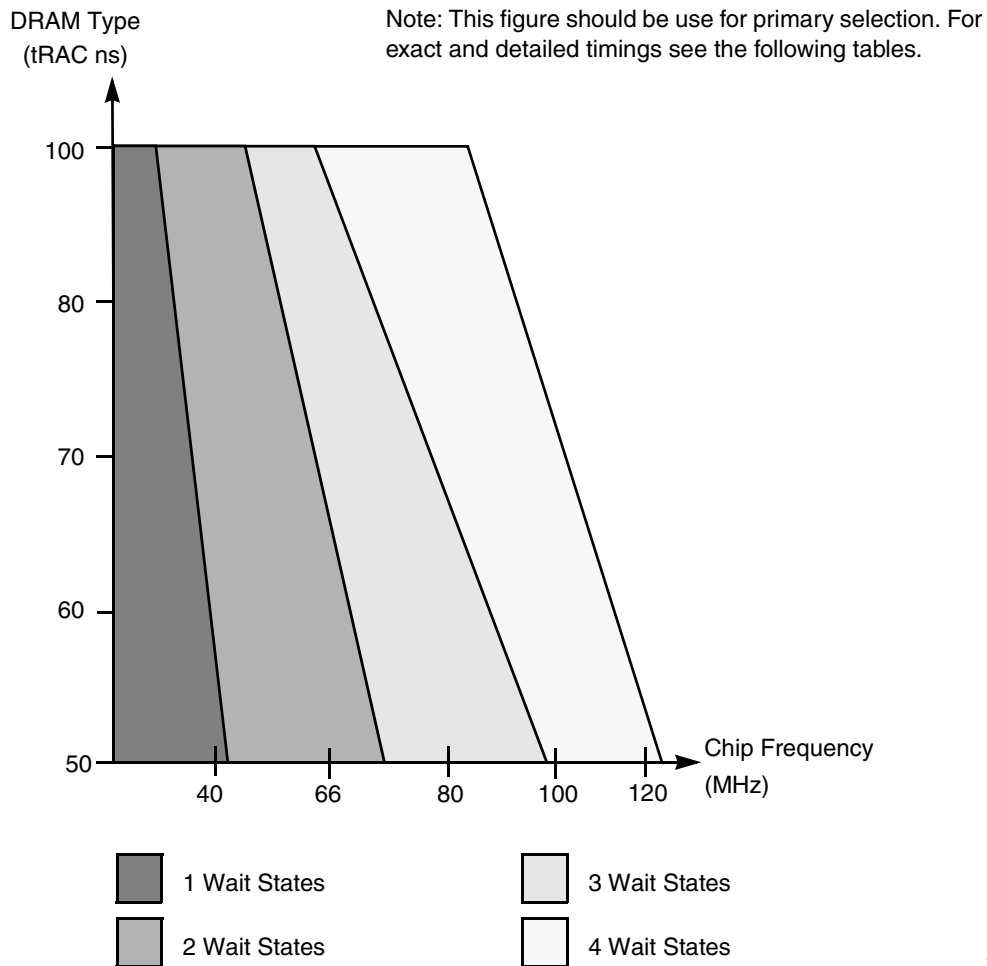


Figure 3-11 DRAM Page Mode Wait States Selection Guide

Table 3-9 DRAM Page Mode Timings, One Wait State (Low-Power Applications)^{1, 2, 3}

No.	Characteristics	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
131	Page mode cycle time for two consecutive accesses of the same direction	t_{PC}	$2 \times T_C$	100.0	—	66.7	—	ns
	Page mode cycle time for mixed (read and write) accesses		$1.25 \times T_C$	62.5	—	41.7	—	
132	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$T_C - 7.5$	—	42.5	—	25.8	ns
133	Column address valid to data valid (read)	t_{AA}	$1.5 \times T_C - 7.5$	—	67.5	—	42.5	ns

Table 3-9 DRAM Page Mode Timings, One Wait State (Low-Power Applications)^{1, 2, 3} (continued)

No.	Characteristics	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
134	CAS deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	0.0	—	ns
135	Last $\overline{CAS}$ assertion to $\overline{RAS}$ deassertion	t_{RSH}	$0.75 \times T_C - 4.0$	33.5	—	21.0	—	ns
136	Previous $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion	t_{RHCP}	$2 \times T_C - 4.0$	96.0	—	62.7	—	ns
137	$\overline{CAS}$ assertion pulse width	t_{CAS}	$0.75 \times T_C - 4.0$	33.5	—	21.0	—	ns
138	Last $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion ⁵ BRW[1:0] = 00 • BRW[1:0] = 01 • BRW[1:0] = 10 • BRW[1:0] = 11	t_{CRP}	$1.75 \times T_C - 6.0$	81.5	—	52.3	—	ns
			$3.25 \times T_C - 6.0$	156.5	—	102.2	—	ns
			$4.25 \times T_C - 6.0$	206.5	—	135.5	—	ns
			$6.25 \times T_C - 6.0$	306.5	—	202.1	—	ns
139	$\overline{CAS}$ deassertion pulse width	t_{CP}	$0.5 \times T_C - 4.0$	21.0	—	12.7	—	ns
140	Column address valid to $\overline{CAS}$ assertion	t_{ASC}	$0.5 \times T_C - 4.0$	21.0	—	12.7	—	ns
141	$\overline{CAS}$ assertion to column address not valid	t_{CAH}	$0.75 \times T_C - 4.0$	33.5	—	21.0	—	ns
142	Last column address valid to $\overline{RAS}$ deassertion	t_{RAL}	$2 \times T_C - 4.0$	96.0	—	62.7	—	ns
143	$\overline{WR}$ deassertion to $\overline{CAS}$ assertion	t_{RCS}	$0.75 \times T_C - 3.8$	33.7	—	21.2	—	ns
144	$\overline{CAS}$ deassertion to $\overline{WR}$ assertion	t_{RCH}	$0.25 \times T_C - 3.7$	8.8	—	4.6	—	ns
145	$\overline{CAS}$ assertion to $\overline{WR}$ deassertion	t_{WCH}	$0.5 \times T_C - 4.2$	20.8	—	12.5	—	ns
146	$\overline{WR}$ assertion pulse width	t_{WP}	$1.5 \times T_C - 4.5$	70.5	—	45.5	—	ns
147	Last $\overline{WR}$ assertion to $\overline{RAS}$ deassertion	t_{RWL}	$1.75 \times T_C - 4.3$	83.2	—	54.0	—	ns
148	$\overline{WR}$ assertion to $\overline{CAS}$ deassertion	t_{CWL}	$1.75 \times T_C - 4.3$	83.2	—	54.0	—	ns
149	Data valid to $\overline{CAS}$ assertion (Write)	t_{DS}	$0.25 \times T_C - 4.0$	8.5	—	4.3	—	ns
150	$\overline{CAS}$ assertion to data not valid (write)	t_{DH}	$0.75 \times T_C - 4.0$	33.5	—	21.0	—	ns
151	$\overline{WR}$ assertion to $\overline{CAS}$ assertion	t_{WCS}	$T_C - 4.3$	45.7	—	29.0	—	ns

Table 3-9 DRAM Page Mode Timings, One Wait State (Low-Power Applications)^{1, 2, 3} (continued)

No.	Characteristics	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
152	Last $\overline{RD}$ assertion to $\overline{RAS}$ deassertion	t_{ROH}	$1.5 \times T_C - 4.0$	71.0	—	46.0	—	ns
153	$\overline{RD}$ assertion to data valid	t_{GA}	$T_C - 7.5$	—	42.5	—	25.8	ns
154	$\overline{RD}$ deassertion to data not valid ⁶	t_{GZ}		0.0	—	0.0	—	ns
155	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 0.3$	37.2	—	24.7	—	ns
156	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	12.5	—	8.3	ns

¹ The number of wait states for Page mode access is specified in the DCR.

² The refresh period is specified in the DCR.

³ All the timings are calculated for the worst case. Some of the timings are better for specific cases (e.g., t_{PC} equals $2 \times T_C$ for read-after-read or write-after-write sequences).

⁴ Reduced DSP clock speed allows use of Page Mode DRAM with one Wait state (See [Figure 3-14](#)).

⁵ BRW[1:0] (DRAM control register bits) defines the number of wait states that should be inserted in each DRAM out-of-page access.

⁶ $\overline{RD}$ deassertion will always occur after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

Table 3-10 DRAM Page Mode Timings, Two Wait States^{1, 2, 3, 4}

No.	Characteristics	Symbol	Expression ⁵	66 MHz		80 MHz		Unit
				Min	Max	Min	Max	
131	Page mode cycle time for two consecutive accesses of the same direction	t_{PC}	$2 \times T_C$	45.4	—	37.5	—	ns
	Page mode cycle time for mixed (read and write) accesses		$1.25 \times T_C$	41.1	—	34.4	—	ns
132	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$1.5 \times T_C - 7.5$	—	15.2	—	—	ns
			$1.5 \times T_C - 6.5$	—	—	—	12.3	ns
133	Column address valid to data valid (read)	t_{AA}	$2.5 \times T_C - 7.5$	—	30.4	—	—	ns
			$2.5 \times T_C - 6.5$	—	—	—	24.8	ns
134	$\overline{CAS}$ deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	0.0	—	ns
135	Last $\overline{CAS}$ assertion to $\overline{RAS}$ deassertion	t_{RSH}	$1.75 \times T_C - 4.0$	22.5	—	17.9	—	ns
136	Previous $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion	t_{RHCP}	$3.25 \times T_C - 4.0$	45.2	—	36.6	—	ns
137	$\overline{CAS}$ assertion pulse width	t_{CAS}	$1.5 \times T_C - 4.0$	18.7	—	14.8	—	ns
138	Last $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion ⁶ • BRW[1:0] = 00	t_{CRP}	$2.0 \times T_C - 6.0$	24.4	—	19.0	—	ns
			$3.5 \times T_C - 6.0$	47.2	—	37.8	—	ns
			$4.5 \times T_C - 6.0$	62.4	—	50.3	—	ns
			$6.5 \times T_C - 6.0$	92.8	—	75.3	—	ns
139	$\overline{CAS}$ deassertion pulse width	t_{CP}	$1.25 \times T_C - 4.0$	14.9	—	11.6	—	ns
140	Column address valid to $\overline{CAS}$ assertion	t_{ASC}	$T_C - 4.0$	11.2	—	8.5	—	ns
141	$\overline{CAS}$ assertion to column address not valid	t_{CAH}	$1.75 \times T_C - 4.0$	22.5	—	17.9	—	ns
142	Last column address valid to $\overline{RAS}$ deassertion	t_{RAL}	$3 \times T_C - 4.0$	41.5	—	33.5	—	ns
143	$\overline{WR}$ deassertion to $\overline{CAS}$ assertion	t_{RCS}	$1.25 \times T_C - 3.8$	15.1	—	11.8	—	ns
144	$\overline{CAS}$ deassertion to $\overline{WR}$ assertion	t_{RCH}	$0.5 \times T_C - 3.7$	3.9	—	2.6	—	ns
145	$\overline{CAS}$ assertion to $\overline{WR}$ deassertion	t_{WCH}	$1.5 \times T_C - 4.2$	18.5	—	14.6	—	ns
146	$\overline{WR}$ assertion pulse width	t_{WP}	$2.5 \times T_C - 4.5$	33.5	—	26.8	—	ns

Table 3-10 DRAM Page Mode Timings, Two Wait States^{1, 2, 3, 4} (continued)

No.	Characteristics	Symbol	Expression ⁵	66 MHz		80 MHz		Unit
				Min	Max	Min	Max	
147	Last $\overline{WR}$ assertion to $\overline{RAS}$ deassertion	t_{RWL}	$2.75 \times T_C - 4.3$	33.4	—	26.8	—	ns
148	$\overline{WR}$ assertion to $\overline{CAS}$ deassertion	t_{CWL}	$2.5 \times T_C - 4.3$	33.6	—	27.0	—	ns
149	Data valid to $\overline{CAS}$ assertion (write)	t_{DS}	$0.25 \times T_C - 3.7$	0.1	—	—	—	ns
			$0.25 \times T_C - 3.0$	—	—	0.1	—	ns
150	$\overline{CAS}$ assertion to data not valid (write)	t_{DH}	$1.75 \times T_C - 4.0$	22.5	—	17.9	—	ns
151	$\overline{WR}$ assertion to $\overline{CAS}$ assertion	t_{WCS}	$T_C - 4.3$	10.9	—	8.2	—	ns
152	Last $\overline{RD}$ assertion to $\overline{RAS}$ deassertion	t_{ROH}	$2.5 \times T_C - 4.0$	33.9	—	27.3	—	ns
153	$\overline{RD}$ assertion to data valid	t_{GA}	$1.75 \times T_C - 7.5$	—	19.0	—	—	ns
			$1.75 \times T_C - 6.5$	—	—	—	15.4	ns
154	$\overline{RD}$ deassertion to data not valid ⁷	t_{GZ}		0.0	—	0.0	—	ns
155	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 0.3$	11.1	—	9.1	—	ns
156	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	3.8	—	3.1	ns

¹ The number of wait states for Page mode access is specified in the DCR.

² The refresh period is specified in the DCR.

³ The asynchronous delays specified in the expressions are valid for DSP56364.

⁴ There are no DRAMs fast enough to fit to two wait states Page mode @ 100 MHz (See [Figure 3-11](#)).

⁵ All the timings are calculated for the worst case. Some of the timings are better for specific cases (e.g., t_{PC} equals $3 \times T_C$ for read-after-read or write-after-write sequences).

⁶ BRW[1:0] (DRAM Control Register bits) defines the number of wait states that should be inserted in each DRAM out-of-page access.

⁷ $\overline{RD}$ deassertion will always occur after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

Table 3-11 DRAM Page Mode Timings, Three Wait States^{1, 2, 3}

No.	Characteristics	Symbol	Expression ⁴	Min	Max	Unit
131	Page mode cycle time for two consecutive accesses of the same direction	t_{PC}	$2 \times T_C$	40.0	—	ns
	Page mode cycle time for mixed (read and write) accesses		$1.25 \times T_C$	35.0	—	
132	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$2 \times T_C - 7.0$	—	13.0	ns
133	Column address valid to data valid (read)	t_{AA}	$3 \times T_C - 7.0$	—	23.0	ns
134	$\overline{CAS}$ deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	ns
135	Last $\overline{CAS}$ assertion to $\overline{RAS}$ deassertion	t_{RSH}	$2.5 \times T_C - 4.0$	21.0	—	ns
136	Previous $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion	t_{RHCP}	$4.5 \times T_C - 4.0$	41.0	—	ns
137	$\overline{CAS}$ assertion pulse width	t_{CAS}	$2 \times T_C - 4.0$	16.0	—	ns
138	Last $\overline{CAS}$ deassertion to $\overline{RAS}$ assertion ⁵ • BRW[1:0] = 00 • BRW[1:0] = 01 • BRW[1:0] = 10 • BRW[1:0] = 11	t_{CRP}	$2.25 \times T_C - 6.0$	—	—	ns
			$3.75 \times T_C - 6.0$	—	—	ns
			$4.75 \times T_C - 6.0$	41.5	—	ns
			$6.75 \times T_C - 6.0$	61.5	—	ns
139	$\overline{CAS}$ deassertion pulse width	t_{CP}	$1.5 \times T_C - 4.0$	11.0	—	ns
140	Column address valid to $\overline{CAS}$ assertion	t_{ASC}	$T_C - 4.0$	6.0	—	ns
141	$\overline{CAS}$ assertion to column address not valid	t_{CAH}	$2.5 \times T_C - 4.0$	21.0	—	ns
142	Last column address valid to $\overline{RAS}$ deassertion	t_{RAL}	$4 \times T_C - 4.0$	36.0	—	ns
143	$\overline{WR}$ deassertion to $\overline{CAS}$ assertion	t_{RCS}	$1.25 \times T_C - 4.0$	8.5	—	ns
144	$\overline{CAS}$ deassertion to $\overline{WR}$ assertion	t_{RCH}	$0.75 \times T_C - 4.0$	3.5	—	ns
145	$\overline{CAS}$ assertion to $\overline{WR}$ deassertion	t_{WCH}	$2.25 \times T_C - 4.2$	18.3	—	ns
146	$\overline{WR}$ assertion pulse width	t_{WP}	$3.5 \times T_C - 4.5$	30.5	—	ns
147	Last $\overline{WR}$ assertion to $\overline{RAS}$ deassertion	t_{RWL}	$3.75 \times T_C - 4.3$	33.2	—	ns
148	$\overline{WR}$ assertion to $\overline{CAS}$ deassertion	t_{CWL}	$3.25 \times T_C - 4.3$	28.2	—	ns
149	Data valid to $\overline{CAS}$ assertion (write)	t_{DS}	$0.5 \times T_C - 4.0$	1.0	—	ns
150	$\overline{CAS}$ assertion to data not valid (write)	t_{DH}	$2.5 \times T_C - 4.0$	21.0	—	ns
151	$\overline{WR}$ assertion to $\overline{CAS}$ assertion	t_{WCS}	$1.25 \times T_C - 4.3$	8.2	—	ns

Table 3-11 DRAM Page Mode Timings, Three Wait States^{1, 2, 3} (continued)

No.	Characteristics	Symbol	Expression ⁴	Min	Max	Unit
152	Last $\overline{RD}$ assertion to $\overline{RAS}$ deassertion	t_{ROH}	$3.5 \times T_C - 4.0$	31.0	—	ns
153	$\overline{RD}$ assertion to data valid	t_{GA}	$2.5 \times T_C - 7.0$	—	18.0	ns
154	$\overline{RD}$ deassertion to data not valid ⁶	t_{GZ}		0.0	—	ns
155	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 0.3$	7.2	—	ns
156	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	2.5	ns

¹ The number of wait states for Page mode access is specified in the DCR.

² The refresh period is specified in the DCR.

³ The asynchronous delays specified in the expressions are valid for DSP56364.

⁴ All the timings are calculated for the worst case. Some of the timings are better for specific cases (e.g., t_{PC} equals $4 \times T_C$ for read-after-read or write-after-write sequences).

⁵ BRW[1:0] (DRAM control register bits) defines the number of wait states that should be inserted in each DRAM out-of-page-access.

⁶ $\overline{RD}$ deassertion will always occur after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

Table 3-12 DRAM Page Mode Timings, Four Wait States^{1, 2, 3}

No.	Characteristics	Symbol	Expression ⁴	Min	Max	Unit
131	Page mode cycle time for two consecutive accesses of the same direction.	t_{PC}	$2 \times T_C$	50.0	—	ns
	Page mode cycle time for mixed (read and write) accesses.		$1.25 \times T_C$	45.0	—	ns
132	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$2.75 \times T_C - 7.0$	—	20.5	ns
133	Column address valid to data valid (read)	t_{AA}	$3.75 \times T_C - 7.0$	—	30.5	ns
134	$\overline{CAS}$ deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	ns
135	Last $\overline{CAS}$ assertion to $\overline{RAS}$ deassertion	t_{RSH}	$3.5 \times T_C - 4.0$	31.0	—	ns
136	Previous $\overline{CAS}$ deassertion to $\overline{RAS}$ deassertion	t_{RHCP}	$6 \times T_C - 4.0$	56.0	—	ns
137	$\overline{CAS}$ assertion pulse width	t_{CAS}	$2.5 \times T_C - 4.0$	21.0	—	ns
138	Last $\overline{CAS}$ deassertion to $\overline{RAS}$ assertion ⁵ - BRW[1:0] = 00 - BRW[1:0] = 01 - BRW[1:0] = 10 - BRW[1:0] = 11	t_{CRP}	$2.75 \times T_C - 6.0$	—	—	ns
			$4.25 \times T_C - 6.0$	—	—	ns
			$5.25 \times T_C - 6.0$	46.5	—	ns
			$7.25 \times T_C - 6.0$	66.5	—	ns
139	$\overline{CAS}$ deassertion pulse width	t_{CP}	$2 \times T_C - 4.0$	16.0	—	ns

Table 3-12 DRAM Page Mode Timings, Four Wait States^{1, 2, 3} (continued)

No.	Characteristics	Symbol	Expression ⁴	Min	Max	Unit
140	Column address valid to $\overline{\text{CAS}}$ assertion	t_{ASC}	$T_{\text{C}} - 4.0$	6.0	—	ns
141	$\overline{\text{CAS}}$ assertion to column address not valid	t_{CAH}	$3.5 \times T_{\text{C}} - 4.0$	31.0	—	ns
142	Last column address valid to $\overline{\text{RAS}}$ deassertion	t_{RAL}	$5 \times T_{\text{C}} - 4.0$	46.0	—	ns
143	$\overline{\text{WR}}$ deassertion to $\overline{\text{CAS}}$ assertion	t_{RCS}	$1.25 \times T_{\text{C}} - 4.0$	8.5	—	ns
144	$\overline{\text{CAS}}$ deassertion to $\overline{\text{WR}}$ assertion	t_{RCH}	$1.25 \times T_{\text{C}} - 4.0$	8.5	—	ns
145	$\overline{\text{CAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCH}	$3.25 \times T_{\text{C}} - 4.2$	28.3	—	ns
146	$\overline{\text{WR}}$ assertion pulse width	t_{WP}	$4.5 \times T_{\text{C}} - 4.5$	40.5	—	ns
147	Last $\overline{\text{WR}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RWL}	$4.75 \times T_{\text{C}} - 4.3$	43.2	—	ns
148	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CWL}	$3.75 \times T_{\text{C}} - 4.3$	33.2	—	ns
149	Data valid to $\overline{\text{CAS}}$ assertion (write)	t_{DS}	$0.5 \times T_{\text{C}} - 4.0$	1.0	—	ns
150	$\overline{\text{CAS}}$ assertion to data not valid (write)	t_{DH}	$3.5 \times T_{\text{C}} - 4.0$	31.0	—	ns
151	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{WCS}	$1.25 \times T_{\text{C}} - 4.3$	8.2	—	ns
152	Last $\overline{\text{RD}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{ROH}	$4.5 \times T_{\text{C}} - 4.0$	41.0	—	ns
153	$\overline{\text{RD}}$ assertion to data valid	t_{GA}	$3.25 \times T_{\text{C}} - 7.0$	—	25.5	ns
154	$\overline{\text{RD}}$ deassertion to data not valid ⁶	t_{GZ}		0.0	—	ns
155	$\overline{\text{WR}}$ assertion to data active		$0.75 \times T_{\text{C}} - 0.3$	7.2	—	ns
156	$\overline{\text{WR}}$ deassertion to data high impedance		$0.25 \times T_{\text{C}}$	—	2.5	ns

¹ The number of wait states for Page mode access is specified in the DCR.

² The refresh period is specified in the DCR.

³ The asynchronous delays specified in the expressions are valid for DSP56364.

⁴ All the timings are calculated for the worst case. Some of the timings are better for specific cases (e.g., t_{PC} equals $3 \times T_{\text{C}}$ for read-after-read or write-after-write sequences).

⁵ BRW[1:0] (DRAM control register bits) defines the number of wait states that should be inserted in each DRAM out-of-page access.

⁶ $\overline{\text{RD}}$ deassertion will always occur after $\overline{\text{CAS}}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

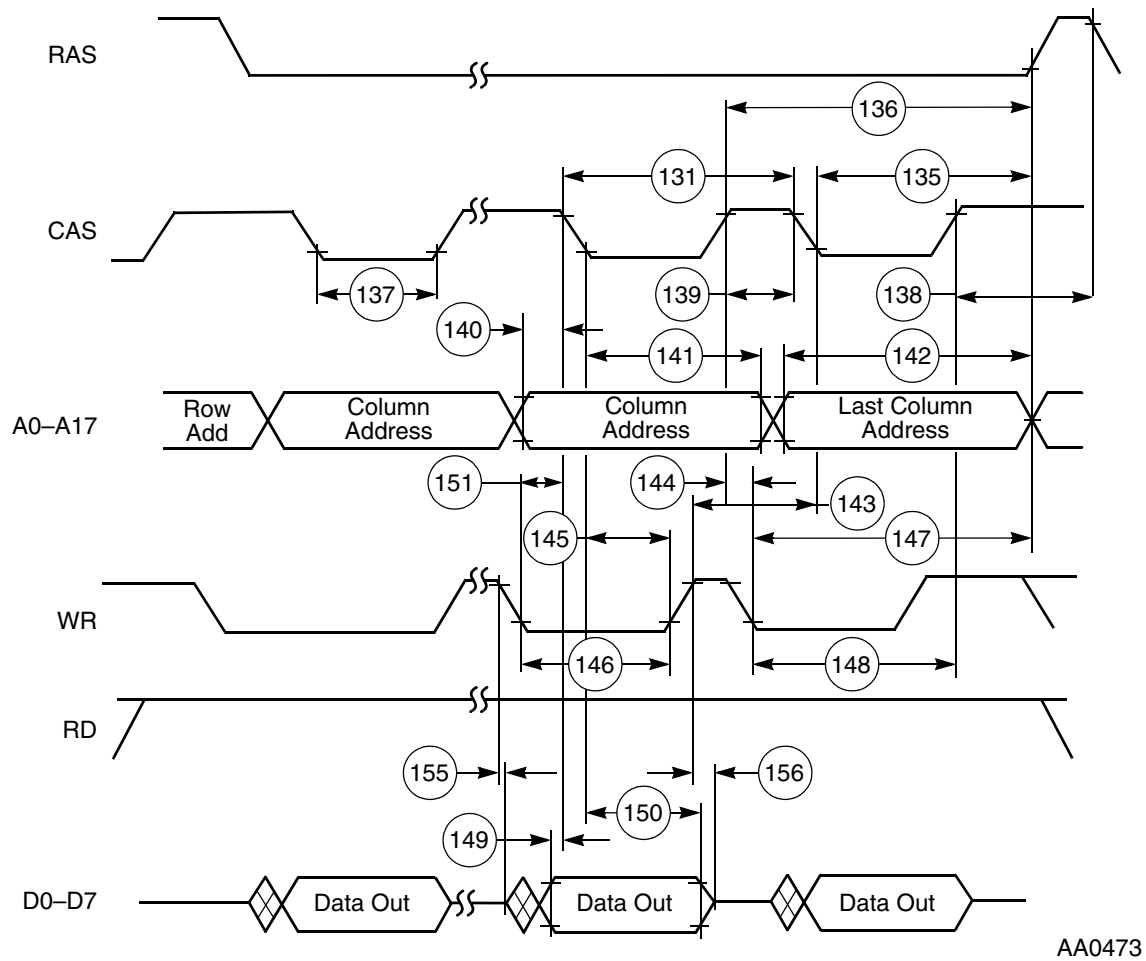


Figure 3-12 DRAM Page Mode Write Accesses

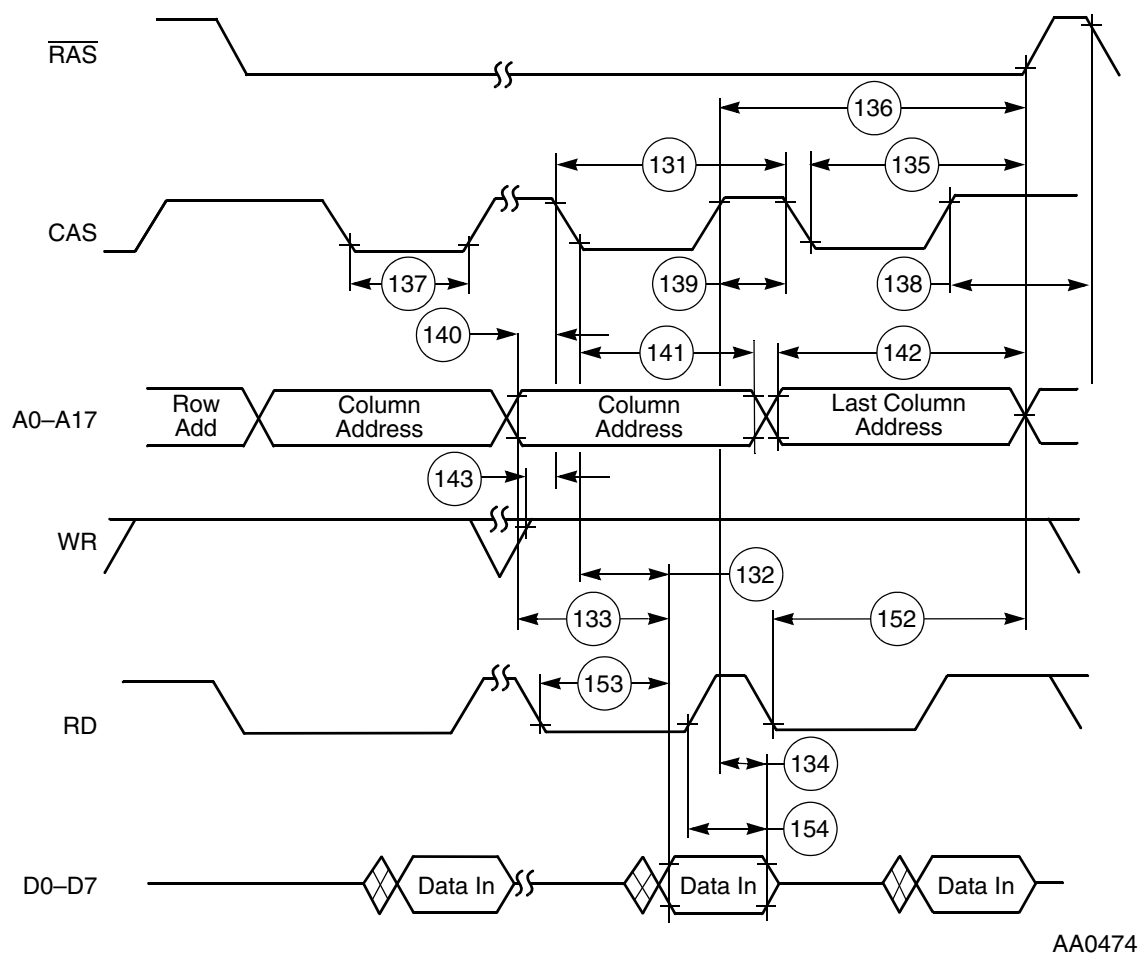


Figure 3-13 DRAM Page Mode Read Accesses

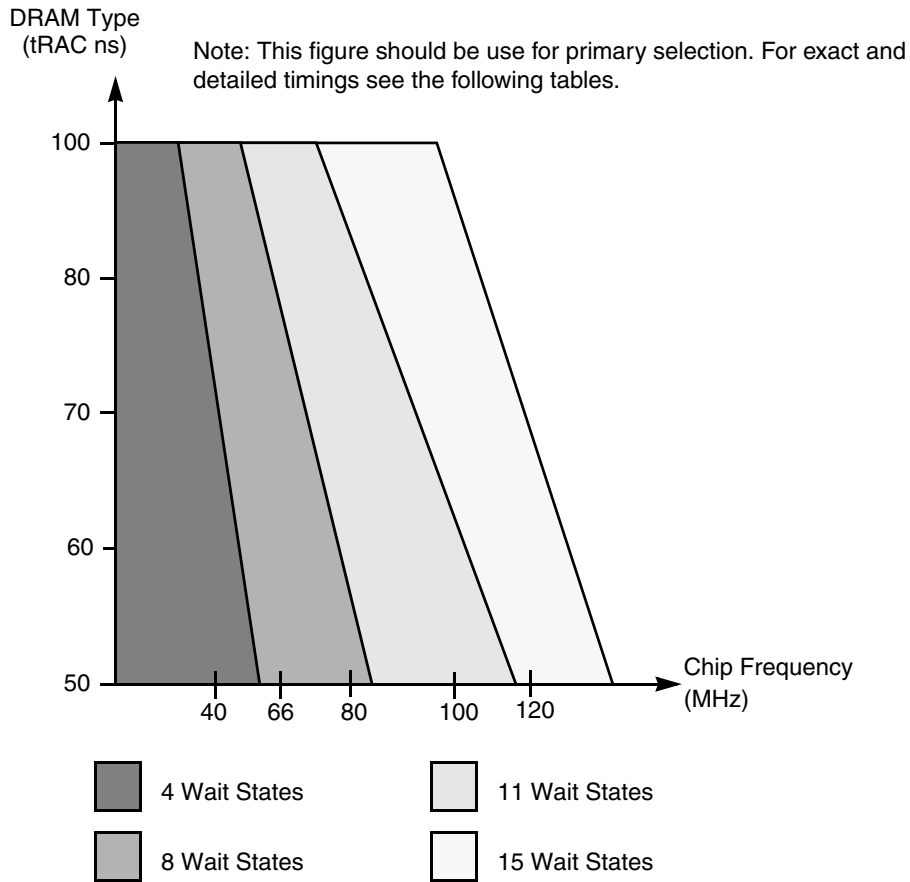


Figure 3-14 DRAM Out-of-Page Wait States Selection Guide

Table 3-13 DRAM Out-of-Page and Refresh Timings, Four Wait States^{1, 2}

No.	Characteristics ³	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
157	Random read or write cycle time	t _{RC}	5 × T _C	250.0	—	166.7	—	ns
158	$\overline{\text{RAS}}$ assertion to data valid (read)	t _{RAC}	2.75 × T _C – 7.5	—	130.0	—	84.2	ns
159	$\overline{\text{CAS}}$ assertion to data valid (read)	t _{CAC}	1.25 × T _C – 7.5	—	55.0	—	34.2	ns
160	Column address valid to data valid (read)	t _{AA}	1.5 × T _C – 7.5	—	67.5	—	42.5	ns
161	$\overline{\text{CAS}}$ deassertion to data not valid (read hold time)	t _{OFF}		0.0	—	0.0	—	ns
162	$\overline{\text{RAS}}$ deassertion to $\overline{\text{RAS}}$ assertion	t _{RP}	1.75 × T _C – 4.0	83.5	—	54.3	—	ns
163	$\overline{\text{RAS}}$ assertion pulse width	t _{RAS}	3.25 × T _C – 4.0	158.5	—	104.3	—	ns
164	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ deassertion	t _{RSH}	1.75 × T _C – 4.0	83.5	—	54.3	—	ns

Table 3-13 DRAM Out-of-Page and Refresh Timings, Four Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
165	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CSH}	$2.75 \times T_C - 4.0$	133.5	—	87.7	—	ns
166	$\overline{\text{CAS}}$ assertion pulse width	t_{CAS}	$1.25 \times T_C - 4.0$	58.5	—	37.7	—	ns
167	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{RCD}	$1.5 \times T_C \pm 2$	73.0	77.0	48.0	52.0	ns
168	$\overline{\text{RAS}}$ assertion to column address valid	t_{RAD}	$1.25 \times T_C \pm 2$	60.5	64.5	39.7	43.7	ns
169	$\overline{\text{CAS}}$ deassertion to $\overline{\text{RAS}}$ assertion	t_{CRP}	$2.25 \times T_C - 4.0$	108.5	—	71.0	—	ns
170	$\overline{\text{CAS}}$ deassertion pulse width	t_{CP}	$1.75 \times T_C - 4.0$	83.5	—	54.3	—	ns
171	Row address valid to $\overline{\text{RAS}}$ assertion	t_{ASR}	$1.75 \times T_C - 4.0$	83.5	—	54.3	—	ns
172	$\overline{\text{RAS}}$ assertion to row address not valid	t_{RAH}	$1.25 \times T_C - 4.0$	58.5	—	37.7	—	ns
173	Column address valid to $\overline{\text{CAS}}$ assertion	t_{ASC}	$0.25 \times T_C - 4.0$	8.5	—	4.3	—	ns
174	$\overline{\text{CAS}}$ assertion to column address not valid	t_{CAH}	$1.75 \times T_C - 4.0$	83.5	—	54.3	—	ns
175	$\overline{\text{RAS}}$ assertion to column address not valid	t_{AR}	$3.25 \times T_C - 4.0$	158.5	—	104.3	—	ns
176	Column address valid to $\overline{\text{RAS}}$ deassertion	t_{RAL}	$2 \times T_C - 4.0$	96.0	—	62.7	—	ns
177	$\overline{\text{WR}}$ deassertion to $\overline{\text{CAS}}$ assertion	t_{RCS}	$1.5 \times T_C - 3.8$	71.2	—	46.2	—	ns
178	$\overline{\text{CAS}}$ deassertion to $\overline{\text{WR}}$ assertion	t_{RCH}	$0.75 \times T_C - 3.7$	33.8	—	21.3	—	ns
179	$\overline{\text{RAS}}$ deassertion to $\overline{\text{WR}}$ assertion	t_{RRH}	$0.25 \times T_C - 3.7$	8.8	—	4.6	—	ns
180	$\overline{\text{CAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCH}	$1.5 \times T_C - 4.2$	70.8	—	45.8	—	ns
181	$\overline{\text{RAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCR}	$3 \times T_C - 4.2$	145.8	—	95.8	—	ns
182	$\overline{\text{WR}}$ assertion pulse width	t_{WP}	$4.5 \times T_C - 4.5$	220.5	—	145.5	—	ns
183	$\overline{\text{WR}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RWL}	$4.75 \times T_C - 4.3$	233.2	—	154.0	—	ns
184	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CWL}	$4.25 \times T_C - 4.3$	208.2	—	137.4	—	ns
185	Data valid to $\overline{\text{CAS}}$ assertion (write)	t_{DS}	$2.25 \times T_C - 4.0$	108.5	—	71.0	—	ns
186	$\overline{\text{CAS}}$ assertion to data not valid (write)	t_{DH}	$1.75 \times T_C - 4.0$	83.5	—	54.3	—	ns
187	$\overline{\text{RAS}}$ assertion to data not valid (write)	t_{DHR}	$3.25 \times T_C - 4.0$	158.5	—	104.3	—	ns

Table 3-13 DRAM Out-of-Page and Refresh Timings, Four Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression	20 MHz ⁴		30 MHz ⁴		Unit
				Min	Max	Min	Max	
188	$\overline{WR}$ assertion to $\overline{CAS}$ assertion	t_{WCS}	$3 \times T_C - 4.3$	145.7	—	95.7	—	ns
189	$\overline{CAS}$ assertion to $\overline{RAS}$ assertion (refresh)	t_{CSR}	$0.5 \times T_C - 4.0$	21.0	—	12.7	—	ns
190	$\overline{RAS}$ deassertion to $\overline{CAS}$ assertion (refresh)	t_{RPC}	$1.25 \times T_C - 4.0$	58.5	—	37.7	—	ns
191	$\overline{RD}$ assertion to $\overline{RAS}$ deassertion	t_{ROH}	$4.5 \times T_C - 4.0$	221.0	—	146.0	—	ns
192	$\overline{RD}$ assertion to data valid	t_{GA}	$4 \times T_C - 7.5$	—	192.5	—	125.8	ns
193	$\overline{RD}$ deassertion to data not valid ³	t_{GZ}		0.0	—	0.0	—	ns
194	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 0.3$	37.2	—	24.7	—	ns
195	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	12.5	—	8.3	ns

¹ The number of wait states for out of page access is specified in the DCR.

² The refresh period is specified in the DCR.

³ $\overline{RD}$ deassertion will always occur after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

⁴ Reduced DSP clock speed allows use of DRAM out-of-page access with four Wait states (See [Figure 3-17](#)).

Table 3-14 DRAM Out-of-Page and Refresh Timings, Eight Wait States^{1, 2}

No.	Characteristics ³	Symbol	Expression ⁴	66 MHz		80 MHz		Unit
				Min	Max	Min	Max	
157	Random read or write cycle time	t_{RC}	$9 \times T_C$	136.4	—	112.5	—	ns
158	$\overline{RAS}$ assertion to data valid (read)	t_{RAC}	$4.75 \times T_C - 7.5$	—	64.5	—	—	ns
			$4.75 \times T_C - 6.5$	—	—	—	52.9	ns
159	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$2.25 \times T_C - 7.5$	—	26.6	—	—	ns
			$2.25 \times T_C - 6.5$	—	—	—	21.6	ns
160	Column address valid to data valid (read)	t_{AA}	$3 \times T_C - 7.5$	—	40.0	—	—	ns
			$3 \times T_C - 6.5$	—	—	—	31.0	ns
161	$\overline{CAS}$ deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	0.0	—	ns
162	$\overline{RAS}$ deassertion to $\overline{RAS}$ assertion	t_{RP}	$3.25 \times T_C - 4.0$	45.2	—	36.6	—	ns
163	$\overline{RAS}$ assertion pulse width	t_{RAS}	$5.75 \times T_C - 4.0$	83.1	—	67.9	—	ns

Table 3-14 DRAM Out-of-Page and Refresh Timings, Eight Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression ⁴	66 MHz		80 MHz		Unit
				Min	Max	Min	Max	
164	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RSH}	$3.25 \times T_C - 4.0$	45.2	—	36.6	—	ns
165	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CSH}	$4.75 \times T_C - 4.0$	68.0	—	55.5	—	ns
166	$\overline{\text{CAS}}$ assertion pulse width	t_{CAS}	$2.25 \times T_C - 4.0$	30.1	—	24.1	—	ns
167	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{RCD}	$2.5 \times T_C \pm 2$	35.9	39.9	29.3	33.3	ns
168	$\overline{\text{RAS}}$ assertion to column address valid	t_{RAD}	$1.75 \times T_C \pm 2$	24.5	28.5	19.9	23.9	ns
169	$\overline{\text{CAS}}$ deassertion to $\overline{\text{RAS}}$ assertion	t_{CRP}	$4.25 \times T_C - 4.0$	59.8	—	49.1	—	ns
170	$\overline{\text{CAS}}$ deassertion pulse width	t_{CP}	$2.75 \times T_C - 4.0$	37.7	—	30.4	—	ns
171	Row address valid to $\overline{\text{RAS}}$ assertion	t_{ASR}	$3.25 \times T_C - 4.0$	45.2	—	36.6	—	ns
172	$\overline{\text{RAS}}$ assertion to row address not valid	t_{RAH}	$1.75 \times T_C - 4.0$	22.5	—	17.9	—	ns
173	Column address valid to $\overline{\text{CAS}}$ assertion	t_{ASC}	$0.75 \times T_C - 4.0$	7.4	—	5.4	—	ns
174	$\overline{\text{CAS}}$ assertion to column address not valid	t_{CAH}	$3.25 \times T_C - 4.0$	45.2	—	36.6	—	ns
175	$\overline{\text{RAS}}$ assertion to column address not valid	t_{AR}	$5.75 \times T_C - 4.0$	83.1	—	67.9	—	ns
176	Column address valid to $\overline{\text{RAS}}$ deassertion	t_{RAL}	$4 \times T_C - 4.0$	56.6	—	46.0	—	ns
177	$\overline{\text{WR}}$ deassertion to $\overline{\text{CAS}}$ assertion	t_{RCS}	$2 \times T_C - 3.8$	26.5	—	21.2	—	ns
178	$\overline{\text{CAS}}$ deassertion to $\overline{\text{WR}}^5$ assertion	t_{RCH}	$1.25 \times T_C - 3.7$	15.2	—	11.9	—	ns
179	$\overline{\text{RAS}}$ deassertion to $\overline{\text{WR}}^5$ assertion	t_{RRH}	$0.25 \times T_C - 3.7$	0.1	—	—	—	ns
			$0.25 \times T_C - 3.0$	—	—	0.1	—	ns
180	$\overline{\text{CAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCH}	$3 \times T_C - 4.2$	41.3	—	33.3	—	ns
181	$\overline{\text{RAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCR}	$5.5 \times T_C - 4.2$	79.1	—	64.6	—	ns
182	$\overline{\text{WR}}$ assertion pulse width	t_{WP}	$8.5 \times T_C - 4.5$	124.3	—	101.8	—	ns
183	$\overline{\text{WR}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RWL}	$8.75 \times T_C - 4.3$	128.3	—	105.1	—	ns
184	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CWL}	$7.75 \times T_C - 4.3$	113.1	—	92.6	—	ns
185	Data valid to $\overline{\text{CAS}}$ assertion (write)	t_{DS}	$4.75 \times T_C - 4.0$	68.0	—	55.4	—	ns

Table 3-14 DRAM Out-of-Page and Refresh Timings, Eight Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression ⁴	66 MHz		80 MHz		Unit
				Min	Max	Min	Max	
186	$\overline{\text{CAS}}$ assertion to data not valid (write)	t_{DH}	$3.25 \times T_{\text{C}} - 4.0$	45.2	—	36.6	—	ns
187	$\overline{\text{RAS}}$ assertion to data not valid (write)	t_{DHR}	$5.75 \times T_{\text{C}} - 4.0$	83.1	—	67.9	—	ns
188	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{WCS}	$5.5 \times T_{\text{C}} - 4.3$	79.0	—	64.5	—	ns
189	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ assertion (refresh)	t_{CSR}	$1.5 \times T_{\text{C}} - 4.0$	18.7	—	14.8	—	ns
190	$\overline{\text{RAS}}$ deassertion to $\overline{\text{CAS}}$ assertion (refresh)	t_{RPC}	$1.75 \times T_{\text{C}} - 4.0$	22.5	—	17.9	—	ns
191	$\overline{\text{RD}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{ROH}	$8.5 \times T_{\text{C}} - 4.0$	124.8	—	102.3	—	ns
192	$\overline{\text{RD}}$ assertion to data valid	t_{GA}	$7.5 \times T_{\text{C}} - 7.5$	—	106.1	—	—	ns
			$7.5 \times T_{\text{C}} - 6.5$	—	—	—	87.3	ns
193	$\overline{\text{RD}}$ deassertion to data not valid ³	t_{GZ}	0.0	0.0	—	0.0	—	ns
194	$\overline{\text{WR}}$ assertion to data active		$0.75 \times T_{\text{C}} - 0.3$	11.1	—	9.1	—	ns
195	$\overline{\text{WR}}$ deassertion to data high impedance		$0.25 \times T_{\text{C}}$	—	3.8	—	3.1	ns

¹ The number of wait states for out-of-page access is specified in the DCR.

² The refresh period is specified in the DCR.

³ $\overline{\text{RD}}$ deassertion will always occur after $\overline{\text{CAS}}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

⁴ The asynchronous delays specified in the expressions are valid for DSP56364.

⁵ Either t_{RCH} or t_{RRH} must be satisfied for read cycles.

Table 3-15 DRAM Out-of-Page and Refresh Timings, Eleven Wait States^{1, 2}

No.	Characteristics ³	Symbol	Expression ⁴	Min	Max	Unit
157	Random read or write cycle time	t_{RC}	$12 \times T_{\text{C}}$	120.0	—	ns
158	$\overline{\text{RAS}}$ assertion to data valid (read)	t_{RAC}	$6.25 \times T_{\text{C}} - 7.0$	—	55.5	ns
159	$\overline{\text{CAS}}$ assertion to data valid (read)	t_{CAC}	$3.75 \times T_{\text{C}} - 7.0$	—	30.5	ns
160	Column address valid to data valid (read)	t_{AA}	$4.5 \times T_{\text{C}} - 7.0$	—	38.0	ns
161	$\overline{\text{CAS}}$ deassertion to data not valid (read hold time)	t_{OFF}		0.0	—	ns
162	$\overline{\text{RAS}}$ deassertion to $\overline{\text{RAS}}$ assertion	t_{RP}	$4.25 \times T_{\text{C}} - 4.0$	38.5	—	ns
163	$\overline{\text{RAS}}$ assertion pulse width	t_{RAS}	$7.75 \times T_{\text{C}} - 4.0$	73.5	—	ns

Table 3-15 DRAM Out-of-Page and Refresh Timings, Eleven Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression ⁴	Min	Max	Unit
164	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RSH}	$5.25 \times T_C - 4.0$	48.5	—	ns
165	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CSH}	$6.25 \times T_C - 4.0$	58.5	—	ns
166	$\overline{\text{CAS}}$ assertion pulse width	t_{CAS}	$3.75 \times T_C - 4.0$	33.5	—	ns
167	$\overline{\text{RAS}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{RCD}	$2.5 \times T_C \pm 4.0$	21.0	29.0	ns
168	$\overline{\text{RAS}}$ assertion to column address valid	t_{RAD}	$1.75 \times T_C \pm 4.0$	13.5	21.5	ns
169	$\overline{\text{CAS}}$ deassertion to $\overline{\text{RAS}}$ assertion	t_{CRP}	$5.75 \times T_C - 4.0$	53.5	—	ns
170	$\overline{\text{CAS}}$ deassertion pulse width	t_{CP}	$4.25 \times T_C - 4.0$	38.5	—	ns
171	Row address valid to $\overline{\text{RAS}}$ assertion	t_{ASR}	$4.25 \times T_C - 4.0$	38.5	—	ns
172	$\overline{\text{RAS}}$ assertion to row address not valid	t_{RAH}	$1.75 \times T_C - 4.0$	13.5	—	ns
173	Column address valid to $\overline{\text{CAS}}$ assertion	t_{ASC}	$0.75 \times T_C - 4.0$	3.5	—	ns
174	$\overline{\text{CAS}}$ assertion to column address not valid	t_{CAH}	$5.25 \times T_C - 4.0$	48.5	—	ns
175	$\overline{\text{RAS}}$ assertion to column address not valid	t_{AR}	$7.75 \times T_C - 4.0$	73.5	—	ns
176	Column address valid to $\overline{\text{RAS}}$ deassertion	t_{RAL}	$6 \times T_C - 4.0$	56.0	—	ns
177	$\overline{\text{WR}}$ deassertion to $\overline{\text{CAS}}$ assertion	t_{RCS}	$3.0 \times T_C - 4.0$	26.0	—	ns
178	$\overline{\text{CAS}}$ deassertion to $\overline{\text{WR}}^5$ assertion	t_{RCH}	$1.75 \times T_C - 4.0$	13.5	—	ns
179	$\overline{\text{RAS}}$ deassertion to $\overline{\text{WR}}^5$ assertion	t_{RRH}	$0.25 \times T_C - 2.0$	0.5	—	ns
180	$\overline{\text{CAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCH}	$5 \times T_C - 4.2$	45.8	—	ns
181	$\overline{\text{RAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCR}	$7.5 \times T_C - 4.2$	70.8	—	ns
182	$\overline{\text{WR}}$ assertion pulse width	t_{WP}	$11.5 \times T_C - 4.5$	110.5	—	ns
183	$\overline{\text{WR}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RWL}	$11.75 \times T_C - 4.3$	113.2	—	ns
184	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CWL}	$10.25 \times T_C - 4.3$	103.2	—	ns
185	Data valid to $\overline{\text{CAS}}$ assertion (write)	t_{DS}	$5.75 \times T_C - 4.0$	53.5	—	ns
186	$\overline{\text{CAS}}$ assertion to data not valid (write)	t_{DH}	$5.25 \times T_C - 4.0$	48.5	—	ns
187	$\overline{\text{RAS}}$ assertion to data not valid (write)	t_{DHR}	$7.75 \times T_C - 4.0$	73.5	—	ns
188	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{WCS}	$6.5 \times T_C - 4.3$	60.7	—	ns
189	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ assertion (refresh)	t_{CSR}	$1.5 \times T_C - 4.0$	11.0	—	ns
190	$\overline{\text{RAS}}$ deassertion to $\overline{\text{CAS}}$ assertion (refresh)	t_{RPC}	$2.75 \times T_C - 4.0$	23.5	—	ns

Table 3-15 DRAM Out-of-Page and Refresh Timings, Eleven Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression ⁴	Min	Max	Unit
191	$\overline{RD}$ assertion to $\overline{RAS}$ deassertion	t_{ROH}	$11.5 \times T_C - 4.0$	111.0	—	ns
192	$\overline{RD}$ assertion to data valid	t_{GA}	$10 \times T_C - 7.0$	—	93.0	ns
193	$\overline{RD}$ deassertion to data not valid ³	t_{GZ}		0.0	—	ns
194	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 0.3$	7.2	—	ns
195	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	2.5	ns

¹ The number of wait states for out-of-page access is specified in the DCR.

² The refresh period is specified in the DCR.

³ $\overline{RD}$ deassertion will always occur after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .

⁴ The asynchronous delays specified in the expressions are valid for DSP56364.

⁵ Either t_{RCH} or t_{RRH} must be satisfied for read cycles.

Table 3-16 DRAM Out-of-Page and Refresh Timings, Fifteen Wait States^{1, 2}

No.	Characteristics ³	Symbol	Expression	Min	Max	Unit
157	Random read or write cycle time	t_{RC}	$16 \times T_C$	160.0	—	ns
158	$\overline{RAS}$ assertion to data valid (read)	t_{RAC}	$8.25 \times T_C - 5.7$	—	76.8	ns
159	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$4.75 \times T_C - 5.7$	—	41.8	ns
160	Column address valid to data valid (read)	t_{AA}	$5.5 \times T_C - 5.7$	—	49.3	ns
161	$\overline{CAS}$ deassertion to data not valid (read hold time)	t_{OFF}	0.0	0.0	—	ns
162	$\overline{RAS}$ deassertion to $\overline{RAS}$ assertion	t_{RP}	$6.25 \times T_C - 4.0$	58.5	—	ns
163	$\overline{RAS}$ assertion pulse width	t_{RAS}	$9.75 \times T_C - 4.0$	93.5	—	ns
164	$\overline{CAS}$ assertion to $\overline{RAS}$ deassertion	t_{RSH}	$6.25 \times T_C - 4.0$	58.5	—	ns
165	$\overline{RAS}$ assertion to $\overline{CAS}$ deassertion	t_{CSH}	$8.25 \times T_C - 4.0$	78.5	—	ns
166	$\overline{CAS}$ assertion pulse width	t_{CAS}	$4.75 \times T_C - 4.0$	43.5	—	ns
167	$\overline{RAS}$ assertion to $\overline{CAS}$ assertion	t_{RCD}	$3.5 \times T_C \pm 2$	33.0	37.0	ns
168	$\overline{RAS}$ assertion to column address valid	t_{RAD}	$2.75 \times T_C \pm 2$	25.5	29.5	ns
169	$\overline{CAS}$ deassertion to $\overline{RAS}$ assertion	t_{CRP}	$7.75 \times T_C - 4.0$	73.5	—	ns
170	$\overline{CAS}$ deassertion pulse width	t_{CP}	$6.25 \times T_C - 4.0$	58.5	—	ns
171	Row address valid to $\overline{RAS}$ assertion	t_{ASR}	$6.25 \times T_C - 4.0$	58.5	—	ns
172	$\overline{RAS}$ assertion to row address not valid	t_{RAH}	$2.75 \times T_C - 4.0$	23.5	—	ns

Table 3-16 DRAM Out-of-Page and Refresh Timings, Fifteen Wait States^{1, 2} (continued)

No.	Characteristics ³	Symbol	Expression	Min	Max	Unit
173	Column address valid to $\overline{\text{CAS}}$ assertion	t_{ASC}	$0.75 \times T_C - 4.0$	3.5	—	ns
174	$\overline{\text{CAS}}$ assertion to column address not valid	t_{CAH}	$6.25 \times T_C - 4.0$	58.5	—	ns
175	$\overline{\text{RAS}}$ assertion to column address not valid	t_{AR}	$9.75 \times T_C - 4.0$	93.5	—	ns
176	Column address valid to $\overline{\text{RAS}}$ deassertion	t_{RAL}	$7 \times T_C - 4.0$	66.0	—	ns
177	$\overline{\text{WR}}$ deassertion to $\overline{\text{CAS}}$ assertion	t_{RCS}	$5 \times T_C - 3.8$	46.2	—	ns
178	$\overline{\text{CAS}}$ deassertion to $\overline{\text{WR}}$ ⁴ assertion	t_{RCH}	$1.75 \times T_C - 3.7$	13.8	—	ns
179	$\overline{\text{RAS}}$ deassertion to $\overline{\text{WR}}$ ⁴ assertion	t_{RRH}	$0.25 \times T_C - 2.0$	0.5	—	ns
180	$\overline{\text{CAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCH}	$6 \times T_C - 4.2$	55.8	—	ns
181	$\overline{\text{RAS}}$ assertion to $\overline{\text{WR}}$ deassertion	t_{WCR}	$9.5 \times T_C - 4.2$	90.8	—	ns
182	$\overline{\text{WR}}$ assertion pulse width	t_{WP}	$15.5 \times T_C - 4.5$	150.5	—	ns
183	$\overline{\text{WR}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{RWL}	$15.75 \times T_C - 4.3$	153.2	—	ns
184	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ deassertion	t_{CWL}	$14.25 \times T_C - 4.3$	138.2	—	ns
185	Data valid to $\overline{\text{CAS}}$ assertion (write)	t_{DS}	$8.75 \times T_C - 4.0$	83.5	—	ns
186	$\overline{\text{CAS}}$ assertion to data not valid (write)	t_{DH}	$6.25 \times T_C - 4.0$	58.5	—	ns
187	$\overline{\text{RAS}}$ assertion to data not valid (write)	t_{DHR}	$9.75 \times T_C - 4.0$	93.5	—	ns
188	$\overline{\text{WR}}$ assertion to $\overline{\text{CAS}}$ assertion	t_{WCS}	$9.5 \times T_C - 4.3$	90.7	—	ns
189	$\overline{\text{CAS}}$ assertion to $\overline{\text{RAS}}$ assertion (refresh)	t_{CSR}	$1.5 \times T_C - 4.0$	11.0	—	ns
190	$\overline{\text{RAS}}$ deassertion to $\overline{\text{CAS}}$ assertion (refresh)	t_{RPC}	$4.75 \times T_C - 4.0$	43.5	—	ns
191	$\overline{\text{RD}}$ assertion to $\overline{\text{RAS}}$ deassertion	t_{ROH}	$15.5 \times T_C - 4.0$	151.0	—	ns
192	$\overline{\text{RD}}$ assertion to data valid	t_{GA}	$14 \times T_C - 5.7$	—	134.3	ns
193	$\overline{\text{RD}}$ deassertion to data not valid ³	t_{GZ}		0.0	—	ns
194	$\overline{\text{WR}}$ assertion to data active		$0.75 \times T_C - 0.3$	7.2	—	ns
195	$\overline{\text{WR}}$ deassertion to data high impedance		$0.25 \times T_C$	—	2.5	ns

¹ The number of wait states for out-of-page access is specified in the DCR.² The refresh period is specified in the DCR.³ $\overline{\text{RD}}$ deassertion will always occur after $\overline{\text{CAS}}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ} .⁴ Either t_{RCH} or t_{RRH} must be satisfied for read cycles.

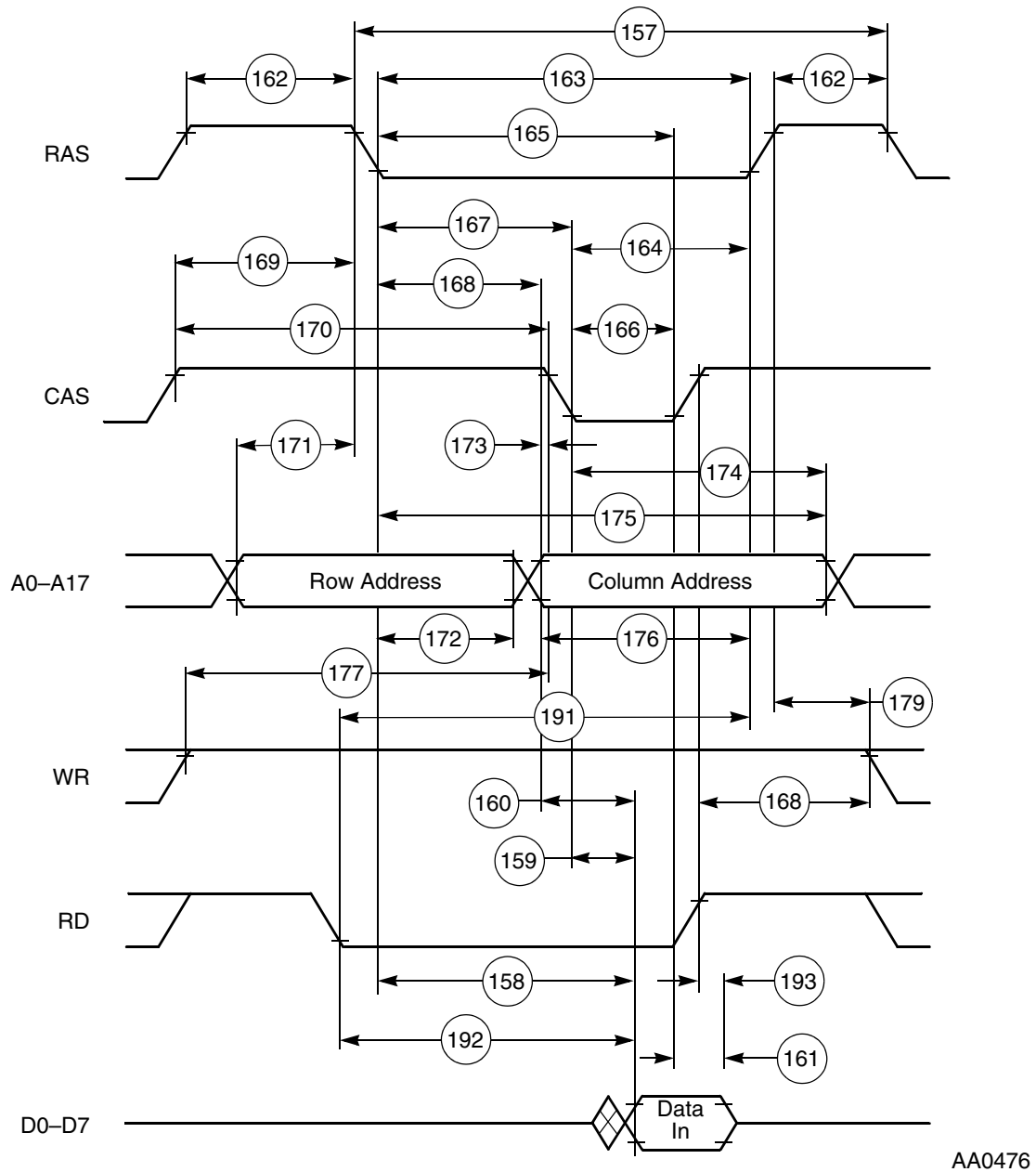
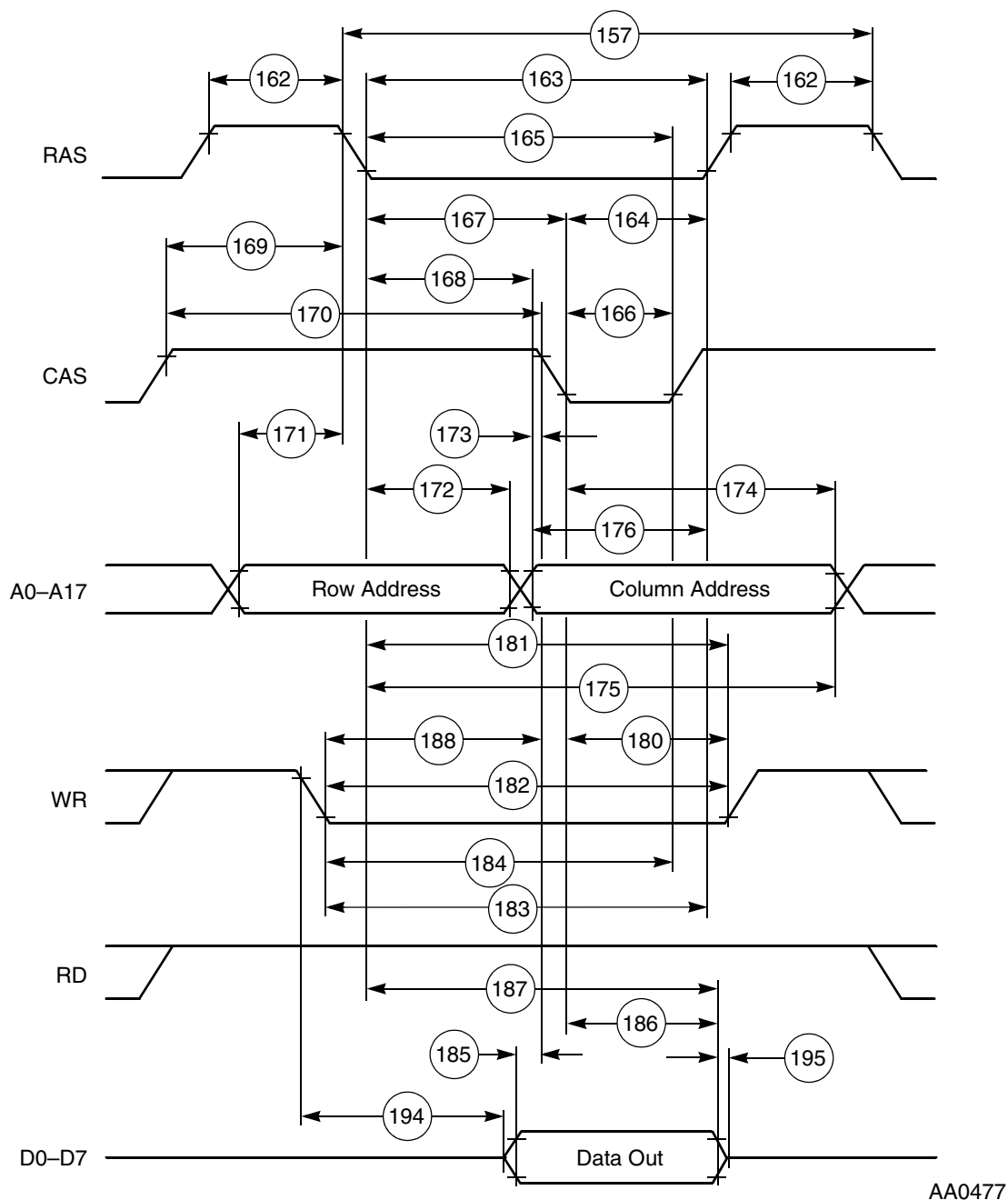


Figure 3-15 DRAM Out-of-Page Read Access



AA0477

Figure 3-16 DRAM Out-of-Page Write Access

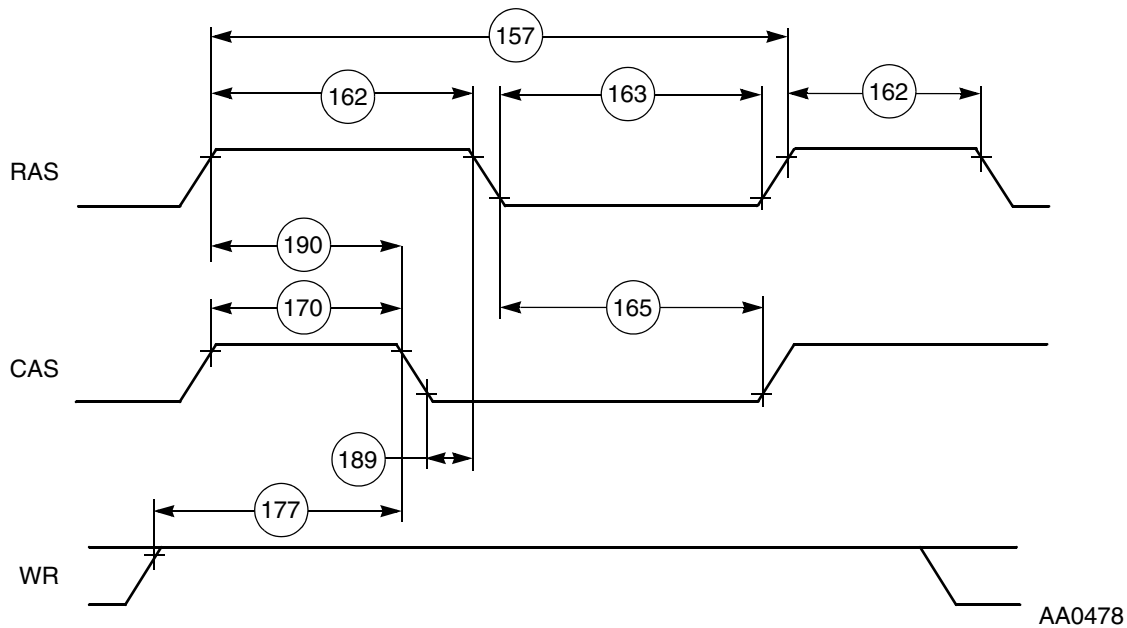


Figure 3-17 DRAM Refresh Access

3.11 Serial Host Interface SPI Protocol Timing

Table 3-17 Serial Host Interface SPI Protocol Timing

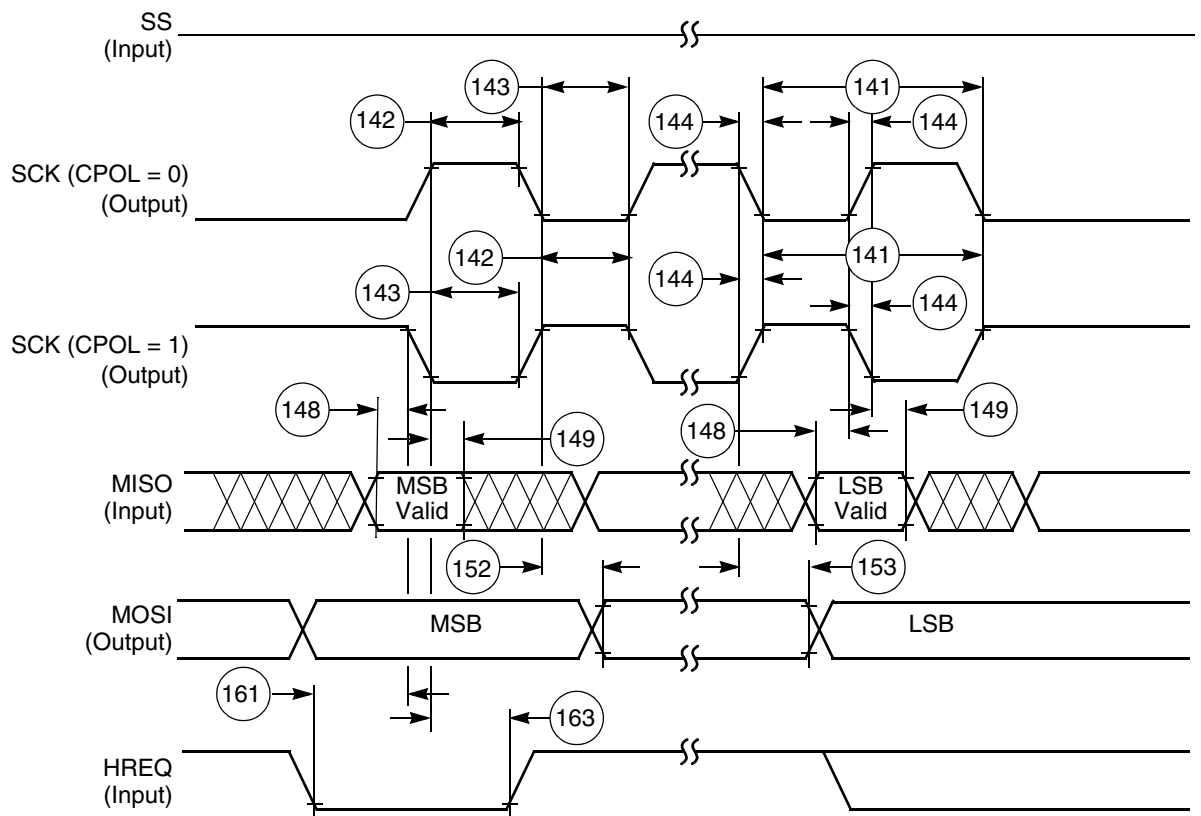
No.	Characteristics	Mode	Filter Mode	Expression	Min	Max	Unit
140	Tolerable spike width on clock or data in	—	Bypassed	—	—	0	ns
			Narrow	—	—	50	ns
			Wide	—	—	100	ns
141	Minimum serial clock cycle = $t_{SPICC}(\text{min})$	Master	Bypassed	$6 \times T_C + 46$	106	—	ns
			Narrow	$6 \times T_C + 152$	212	—	ns
			Wide	$6 \times T_C + 223$	283	—	ns
142	Serial clock high period	Master	Bypassed	$0.5 \times t_{SPICC} - 10$	43	—	ns
			Narrow	$0.5 \times t_{SPICC} - 10$	96	—	ns
			Wide	$0.5 \times t_{SPICC} - 10$	131	—	ns
		Slave	Bypassed	$2.5 \times T_C + 12$	37	—	ns
			Narrow	$2.5 \times T_C + 102$	127	—	ns
			Wide	$2.5 \times T_C + 189$	214	—	ns

Table 3-17 Serial Host Interface SPI Protocol Timing (continued)

No.	Characteristics	Mode	Filter Mode	Expression	Min	Max	Unit
143	Serial clock low period	Master	Bypassed	$0.5 \times t_{\text{SPICC}} - 10$	43	—	ns
			Narrow	$0.5 \times t_{\text{SPICC}} - 10$	96	—	ns
			Wide	$0.5 \times t_{\text{SPICC}} - 10$	131	—	ns
		Slave	Bypassed	$2.5 \times T_C + 12$	37	—	ns
			Narrow	$2.5 \times T_C + 102$	127	—	ns
			Wide	$2.5 \times T_C + 189$	214	—	ns
144	Serial clock rise/fall time	Master	—	—	—	10	ns
		Slave	—	—	—	2000	ns
146	$\overline{\text{SS}}$ assertion to first SCK edge CPHA = 0	Slave	Bypassed	$3.5 \times T_C + 15$	50	—	ns
			Narrow	0	0	—	ns
			Wide	0	0	—	ns
	CPHA = 1	Slave	Bypassed	10	10	—	ns
			Narrow	0	0	—	ns
			Wide	0	0	—	ns
147	Last SCK edge to $\overline{\text{SS}}$ not asserted	Slave	Bypassed	12	12	—	ns
			Narrow	102	102	—	ns
			Wide	189	189	—	ns
148	Data input valid to SCK edge (data input set-up time)	Master/ Slave	Bypassed	0	0	—	ns
			Narrow	$\text{MAX}\{(20 - T_C), 0\}$	10	—	ns
			Wide	$\text{MAX}\{(40 - T_C), 0\}$	30	—	ns
149	SCK last sampling edge to data input not valid	Master/ Slave	Bypassed	$2.5 \times T_C + 10$	35	—	ns
			Narrow	$2.5 \times T_C + 30$	55	—	ns
			Wide	$2.5 \times T_C + 50$	75	—	ns
150	$\overline{\text{SS}}$ assertion to data out active	Slave	—	2	2	—	ns
151	$\overline{\text{SS}}$ deassertion to data high impedance	Slave	—	9	—	9	ns

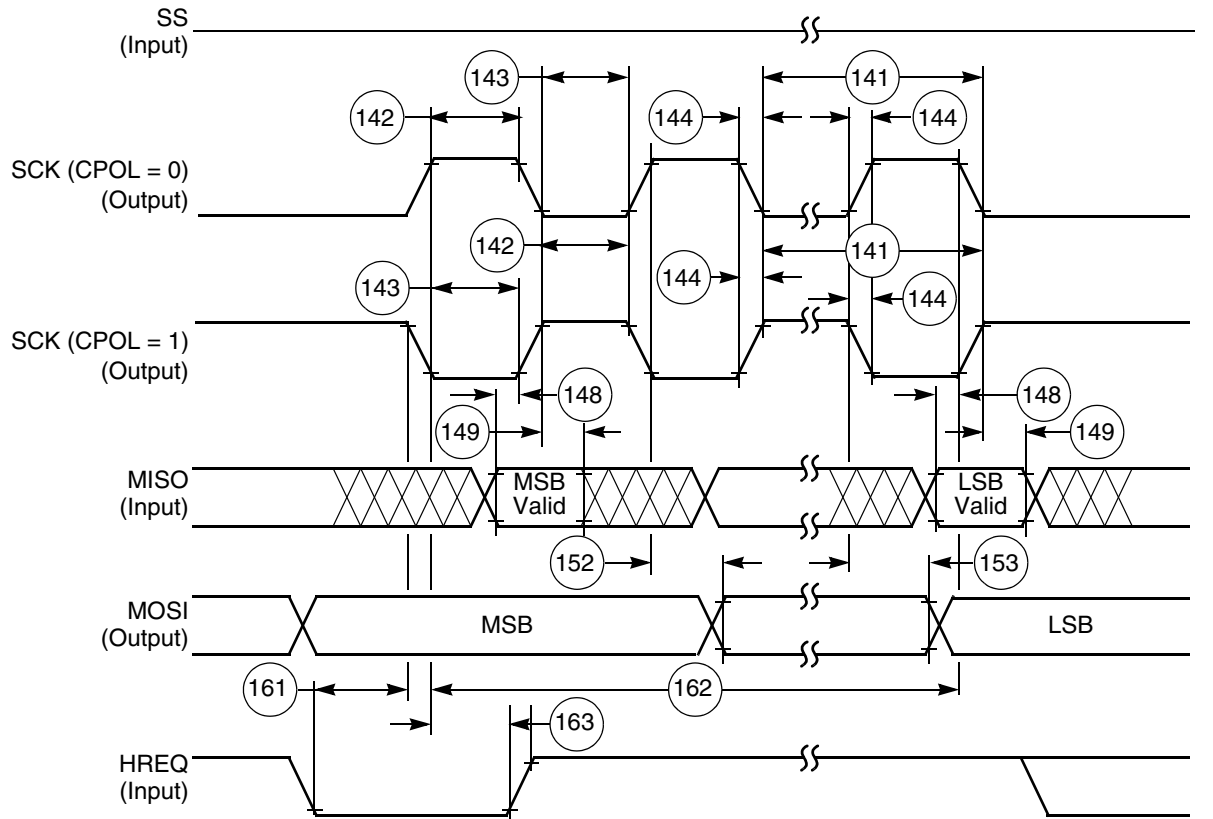
Table 3-17 Serial Host Interface SPI Protocol Timing (continued)

No.	Characteristics	Mode	Filter Mode	Expression	Min	Max	Unit
152	SCK edge to data out valid (data out delay time)	Master/ Slave	Bypassed	$2 \times T_C + 33$	—	53	ns
			Narrow	$2 \times T_C + 123$	—	143	ns
			Wide	$2 \times T_C + 210$	—	230	ns
153	SCK edge to data out not valid (data out hold time)	Master/ Slave	Bypassed	$T_C + 5$	15	—	ns
			Narrow	$T_C + 55$	65	—	ns
			Wide	$T_C + 106$	116	—	ns
154	$\overline{SS}$ assertion to data out valid (CPHA = 0)	Slave	—	$T_C + 33$	—	43	ns
157	First SCK sampling edge to $\overline{HREQ}$ output deassertion	Slave	Bypassed	$2.5 \times T_C + 30$	—	55	ns
			Narrow	$2.5 \times T_C + 120$	—	145	ns
			Wide	$2.5 \times T_C + 217$	—	242	ns
158	Last SCK sampling edge to $\overline{HREQ}$ output not deasserted (CPHA = 1)	Slave	Bypassed	$2.5 \times T_C + 30$	55	—	ns
			Narrow	$2.5 \times T_C + 80$	105	—	ns
			Wide	$2.5 \times T_C + 136$	161	—	ns
159	$\overline{SS}$ deassertion to $\overline{HREQ}$ output not deasserted (CPHA = 0)	Slave	—	$2.5 \times T_C + 30$	55	—	ns
160	$\overline{SS}$ deassertion pulse width (CPHA = 0)	Slave	—	$T_C + 6$	16	—	ns
161	$\overline{HREQ}$ in assertion to first SCK edge	Master	Bypassed	$0.5 \times t_{SPICC} + 2.5 \times T_C + 43$	121	—	ns
			Narrow	$0.5 \times t_{SPICC} + 2.5 \times T_C + 43$	174	—	ns
			Wide	$0.5 \times t_{SPICC} + 2.5 \times T_C + 43$	209	—	ns
162	$\overline{HREQ}$ in deassertion to last SCK sampling edge ($\overline{HREQ}$ in set-up time) (CPHA = 1)	Master	—	0	0	—	ns
163	First SCK edge to $\overline{HREQ}$ in not asserted ($\overline{HREQ}$ in hold time)	Master	—	0	0	—	ns
Note: Periodically sampled, not 100% tested							



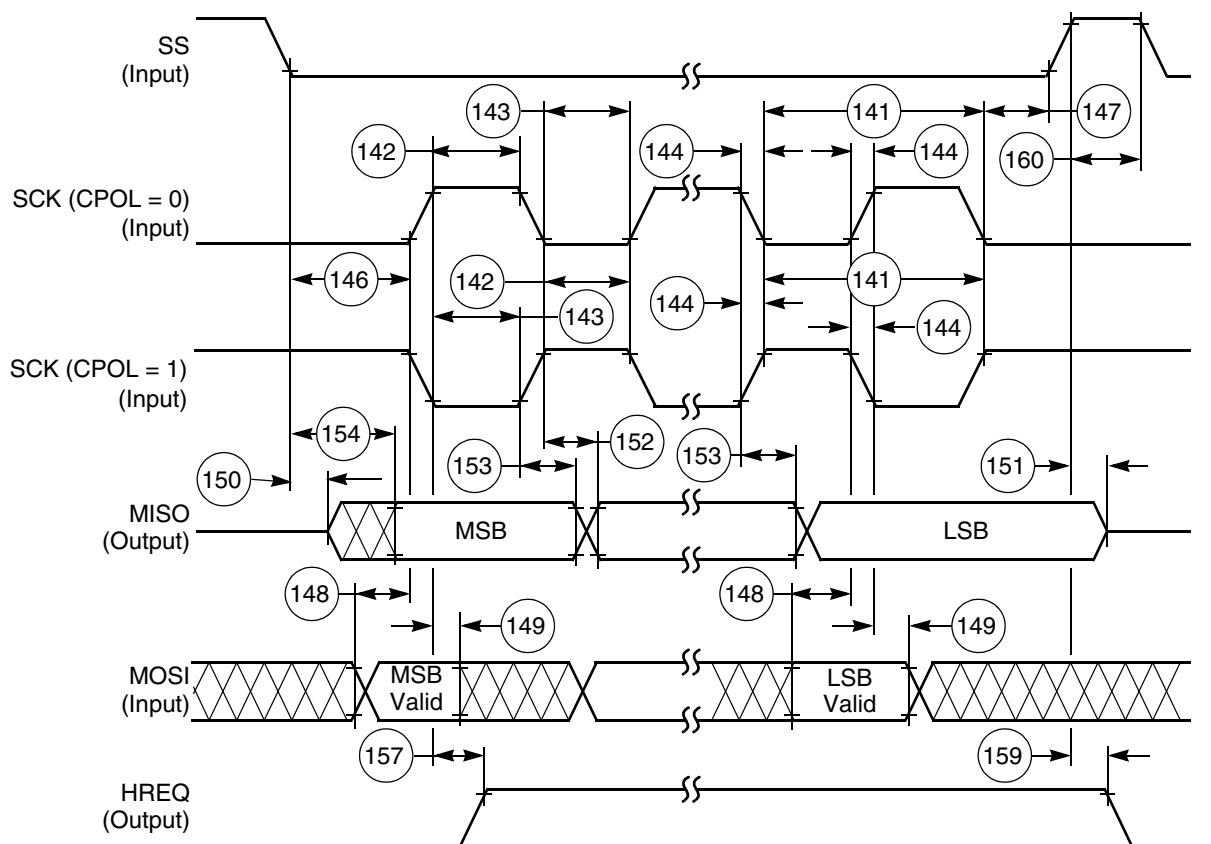
AA0271

Figure 3-18 SPI Master Timing (CPHA = 0)



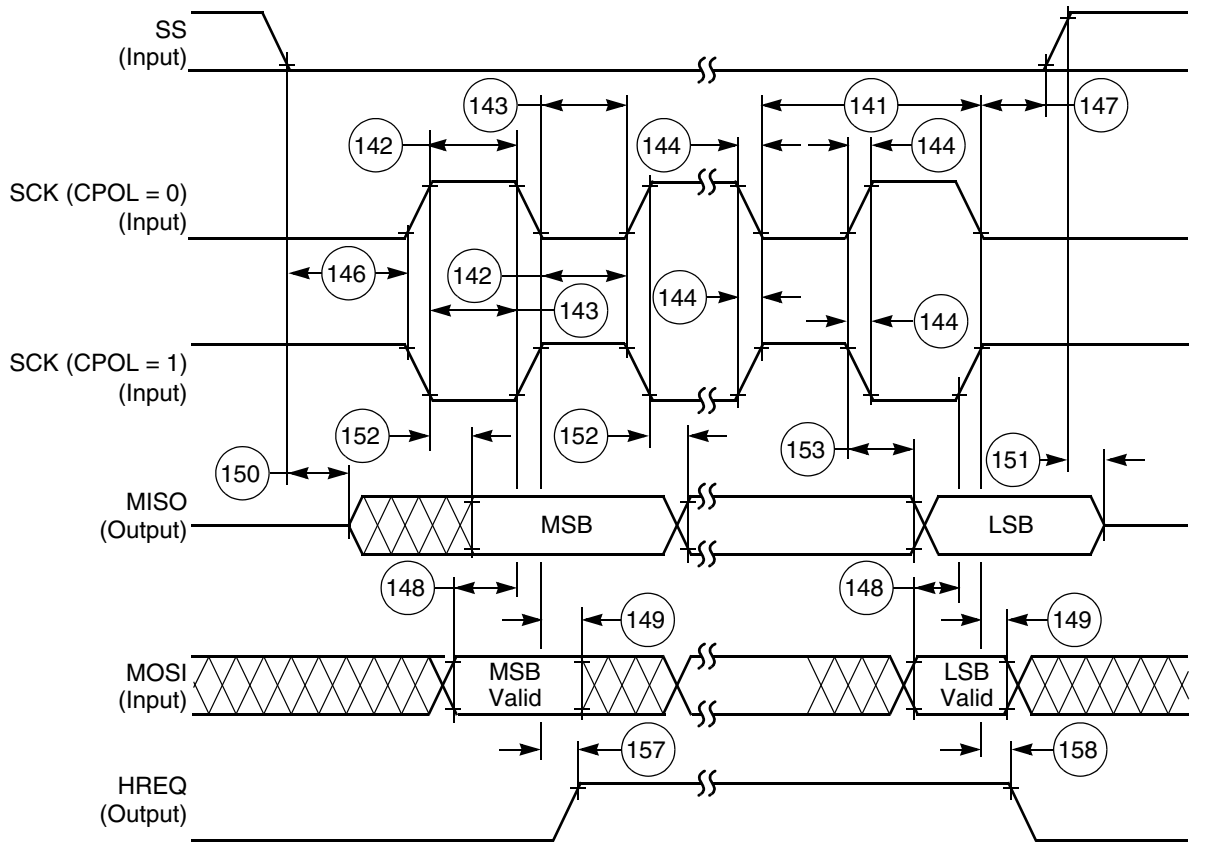
AA0272

Figure 3-19 SPI Master Timing (CPHA = 1)



AA0273

Figure 3-20 SPI Slave Timing (CPHA = 0)



AA0274

Figure 3-21 SPI Slave Timing (CPHA = 1)

3.12 Serial Host Interface (SHI) I²C Protocol Timing

Table 3-18 SHI I²C Protocol Timing

Standard I ² C ¹							
No.	Characteristics	Symbol/ Expression	Standard-Mode		Fast-Mode		Unit
			Min	Max	Min	Max	
	Tolerable spike width on SCL or SDA	—					
	• Filters bypassed		—	0	—	0	ns
	• Narrow filters enabled		—	50	—	50	ns
	• Wide filters enabled		—	100	—	100	ns
171	SCL clock frequency	F _{SCL}	—	100	—	400	kHz
172	Bus free time	T _{BUF}	4.7	—	1.3	—	μs
173	Start condition set-up time	T _{SU;STA}	4.7	—	0.6	—	μs
174	Start condition hold time	T _{HD;STA}	4.0	—	0.6	—	μs
175	SCL low period	T _{LOW}	4.7	—	1.3	—	μs
176	SCL high period	T _{HIGH}	4.0	—	1.3	—	μs
177	SCL and SDA rise time	T _R	—	1000	20 + 0.1 × C _b	300	ns
178	SCL and SDA fall time	T _F	—	300	20 + 0.1 × C _b	300	ns
179	Data set-up time	T _{SU;DAT}	250	—	100	—	ns
180	Data hold time	T _{HD;DAT}	0.0	—	0.0	0.9	μs
181	Stop condition set-up time	T _{SU;STO}	4.0	—	0.6	—	μs
182	Capacitive load for each line	C _b	—	400	—	400	pF
183	DSP clock frequency	F _{DSP}					
	• Filters bypassed		10.6	—	28.5	—	MHz
	• Narrow filters enabled		11.8	—	39.7	—	MHz
	• Wide filters enabled		13.1	—	61.0	—	MHz
184	$\overline{\text{HREQ}}$ in deassertion to last SCL edge ($\overline{\text{HREQ}}$ in set-up time)	t _{SU;RQI}	0.0	—	0.0	—	ns

Table 3-18 SHI I²C Protocol Timing (continued)

Standard I ² C ¹							
No.	Characteristics	Symbol/ Expression	Standard-Mode		Fast-Mode		Unit
			Min	Max	Min	Max	
186	First SCL sampling edge to $\overline{\text{HREQ}}$ output deassertion	$T_{\text{NG;RQO}}$					ns
	• Filters bypassed	$2 \times T_C + 30$	—	50	—	50	ns
	• Narrow filters enabled	$2 \times T_C + 120$	—	140	—	140	ns
	• Wide filters enabled	$2 \times T_C + 208$	—	228	—	228	ns
187	Last SCL edge to HREQ output not deasserted	$T_{\text{AS;RQO}}$					ns
	• Filters bypassed	$2 \times T_C + 30$	50	—	50	—	ns
	• Narrow filters enabled	$2 \times T_C + 80$	100	—	100	—	ns
	• Wide filters enabled	$2 \times T_C + 135$	155	—	155	—	ns
188	HREQ in assertion to first SCL edge	$T_{\text{AS;RQI}}$					ns
	• Filters bypassed	$0.5 \times T_{\text{I}^2\text{CCP}} - 0.5 \times T_C - 21$	4327	—	927	—	ns
	• Narrow filters enabled		4282	—	882	—	ns
	• Wide filters enabled		4238	—	838	—	ns

¹ $R_P(\text{min}) = 1.5 \text{ k}\Omega$

3.12.1 Programming the Serial Clock

The programmed serial clock cycle, $T_{\text{I}^2\text{CCP}}$, is specified by the value of the HDM[5:0] and HRS bits of the HCKR (SHI clock control register).

The expression for $T_{\text{I}^2\text{CCP}}$ is

$$T_{\text{I}^2\text{CCP}} = [T_C \times 2 \times (\text{HDM}[7:0] + 1) \times (7 \times (1 - \text{HRS}) + 1)]$$

where

HRS is the prescaler rate select bit. When HRS is cleared, the fixed divide-by-eight prescaler is operational. When HRS is set, the prescaler is bypassed.

HDM[7:0] are the divider modulus select bits.

A divide ratio from 1 to 64 (HDM[5:0] = 0 to \$3F) may be selected.

Serial Host Interface (SHI) I²C Protocol Timing

In I²C mode, the user may select a value for the programmed serial clock cycle from

$$6 \times T_C (\text{if HDMS}[5:0] = \$02 \text{ and HRS} = 1)$$

to

$$4096 \times T_C (\text{if HDMS}[7:0] = \$FF \text{ and HRS} = 0)$$

The programmed serial clock cycle ($T_{I^2C_{CCP}}$), SCL rise time (T_R), and the filters selected should be chosen in order to achieve the desired SCL frequency, as shown in Table 3-19.

Table 3-19 SCL Serial Clock Cycle Generated as Master

Filters bypassed	$T_{I^2C_{CCP}} + 2.5 \times T_C + 45\text{ns} + T_R$
Narrow filters enabled	$T_{I^2C_{CCP}} + 2.5 \times T_C + 135\text{ns} + T_R$
Wide filters enabled	$T_{I^2C_{CCP}} + 2.5 \times T_C + 223\text{ns} + T_R$

EXAMPLE:

For DSP clock frequency of 100 MHz (i.e. $T_C = 10\text{ns}$), operating in a standard-mode I²C environment ($F_{SCL} = 100\text{ KHz}$ (i.e. $T_{SCL} = 10\mu\text{s}$), $T_R = 1000\text{ns}$), with filters bypassed

$$T_{I^2C_{CCP}} = 10\mu\text{s} - 2.5 \times 10\text{ns} - 45\text{ns} - 1000\text{ns} = 893\text{ns}$$

Choosing HRS = 0 gives

$$\text{HDM}[7:0] = (8930\text{ns}) / (2 \times 10\text{ns} \times 8) - 1 = 55.8$$

Thus the HDM[7:0] value should be programmed to \$38 (=56).

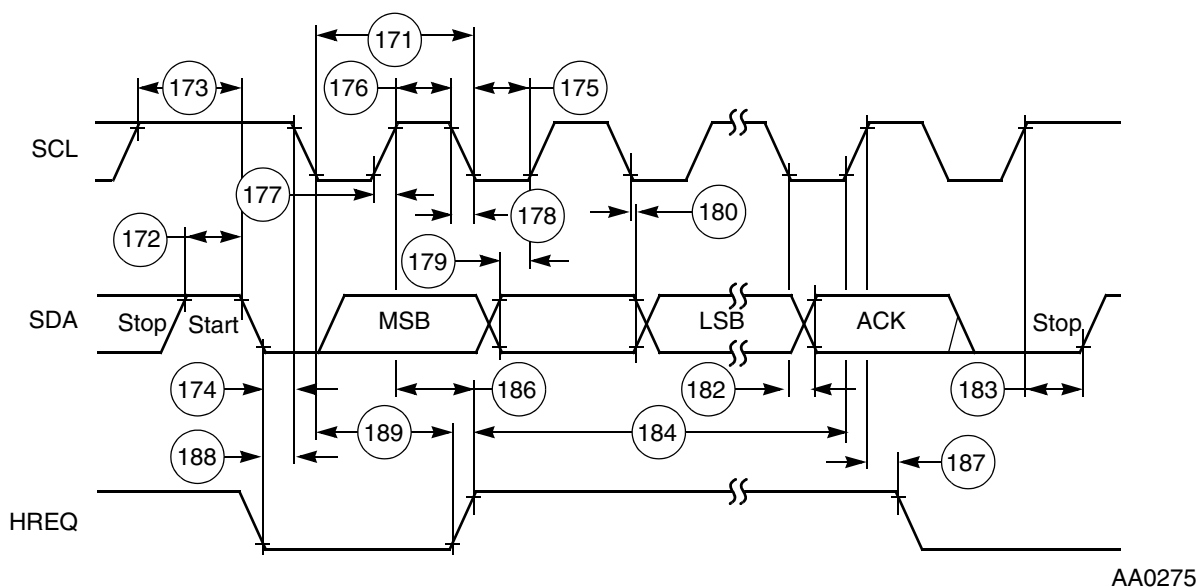


Figure 3-22 I²C Timing

3.13 Enhanced Serial Audio Interface Timing

Table 3-20 Enhanced Serial Audio Interface Timing

No.	Characteristics ^{1, 2, 3}	Symbol	Expression	Min	Max	Condition ⁴	Unit
430	Clock cycle ⁵	t_{SSICC}	$4 \times T_C$ $3 \times T_C$ TXC:max[3*tc; t454]	40.0 30.0 40.0	— — —	i ck x ck x ck	ns
431	Clock high period • For internal clock • For external clock	—	$2 \times T_C - 10.0$ $1.5 \times T_C$	10.0 15.0	— —		ns
432	Clock low period • For internal clock • For external clock	—	$2 \times T_C - 10.0$ $1.5 \times T_C$	10.0 15.0	— —		ns
433	RXC rising edge to FSR out (bl) high	—	—	— —	37.0 22.0	x ck i ck a	ns
434	RXC rising edge to FSR out (bl) low	—	—	— —	37.0 22.0	x ck i ck a	ns
435	RXC rising edge to FSR out (wr) high ⁶	—	—	— —	39.0 24.0	x ck i ck a	ns
436	RXC rising edge to FSR out (wr) low ⁶	—	—	— —	39.0 24.0	x ck i ck a	ns
437	RXC rising edge to FSR out (wl) high	—	—	— —	36.0 21.0	x ck i ck a	ns
438	RXC rising edge to FSR out (wl) low	—	—	— —	37.0 22.0	x ck i ck a	ns
439	Data in setup time before RXC (SCK in synchronous mode) falling edge	—	—	0.0 19.0	— —	x ck i ck	ns
440	Data in hold time after RXC falling edge	—	—	5.0 3.0	— —	x ck i ck	ns
441	FSR input (bl, wr) high before RXC falling edge ⁶	—	—	23.0 1.0	— —	x ck i ck a	ns
442	FSR input (wl) high before RXC falling edge	—	—	1.0 23.0	— —	x ck i ck a	ns

Table 3-20 Enhanced Serial Audio Interface Timing (continued)

No.	Characteristics ^{1, 2, 3}	Symbol	Expression	Min	Max	Condition ⁴	Unit
443	FSR input hold time after RXC falling edge	—	—	3.0 0.0	— —	x ck i ck a	ns
444	Flags input setup before RXC falling edge	—	—	0.0 19.0	— —	x ck i ck s	ns
445	Flags input hold time after RXC falling edge	—	—	6.0 0.0	— —	x ck i ck s	ns
446	TXC rising edge to FST out (bl) high	—	—	— —	29.0 15.0	x ck i ck	ns
447	TXC rising edge to FST out (bl) low	—	—	— —	31.0 17.0	x ck i ck	ns
448	TXC rising edge to FST out (wr) high ⁶	—	—	— —	31.0 17.0	x ck i ck	ns
449	TXC rising edge to FST out (wr) low ⁶	—	—	— —	33.0 19.0	x ck i ck	ns
450	TXC rising edge to FST out (wl) high	—	—	— —	30.0 16.0	x ck i ck	ns
451	TXC rising edge to FST out (wl) low	—	—	— —	31.0 17.0	x ck i ck	ns
452	TXC rising edge to data out enable from high impedance	—	—	— —	31.0 17.0	x ck i ck	ns
453	TXC rising edge to transmitter #0 drive enable assertion	—	—	— —	34.0 20.0	x ck i ck	ns
454	TXC rising edge to data out valid	—	$23 + 0.5 \times T_C$ 21.0	— —	28.0 21.0	x ck i ck	ns
455	TXC rising edge to data out high impedance ⁷	—	—	— —	31.0 16.0	x ck i ck	ns
456	TXC rising edge to transmitter #0 drive enable deassertion ⁷	—	—	— —	34.0 20.0	x ck i ck	ns
457	FST input (bl, wr) setup time before TXC falling edge ⁶	—	—	2.0 21.0	— —	x ck i ck	ns
458	FST input (wl) to data out enable from high impedance	—	—	—	27.0	—	ns

Table 3-20 Enhanced Serial Audio Interface Timing (continued)

No.	Characteristics ^{1, 2, 3}	Symbol	Expression	Min	Max	Condition ⁴	Unit
459	FST input (wl) to transmitter #0 drive enable assertion	—	—	—	31.0	—	ns
460	FST input (wl) setup time before TXC falling edge	—	—	2.0 21.0	— —	x ck i ck	ns
461	FST input hold time after TXC falling edge	—	—	4.0 0.0	— —	x ck i ck	ns
462	Flag output valid after TXC rising edge	—	—	— —	32.0 18.0	x ck i ck	ns
463	HCKR/HCKT clock cycle	—	—	40.0	—		ns
464	HCKT input rising edge to TXC output	—	—	—	27.5		ns
465	HCKR input rising edge to RXC output	—	—	—	27.5		ns

¹ $V_{CC} = 3.16 \text{ V} \pm 0.16 \text{ V}$; $T_J = 0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50 \text{ pF}$.

² i ck = internal clock

x ck = external clock

i ck a = internal clock, asynchronous mode (asynchronous implies that TXC and RXC are two different clocks)

i ck s = internal clock, synchronous mode (synchronous implies that TXC and RXC are the same clock)

³ bl = bit length

wl = word length

wr = word length relative

⁴ TXC (SCKT pin) = transmit clock

RXC (SCKR pin) = receive clock

FST (FST pin) = transmit frame sync

FSR (FSR pin) = receive frame sync

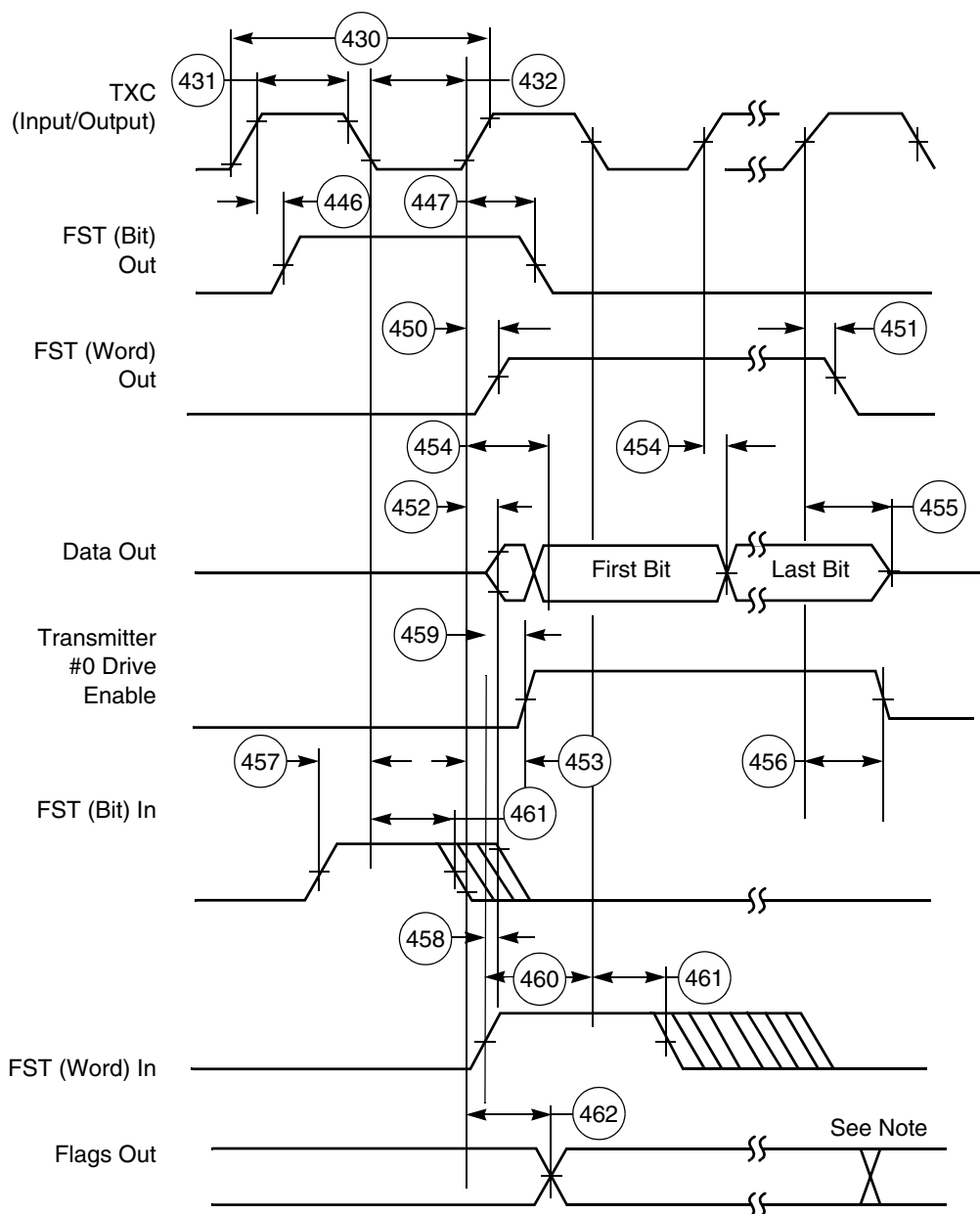
HCKT (HCKT pin) = transmit high speed clock

HCKR (HCKR pin) = receive high speed clock

⁵ For the internal clock, the external clock cycle is defined by I_{cyc} and the ESAI control register.

⁶ The word-relative frame sync signal waveform relative to the clock operates in the same manner as the bit-length frame sync signal waveform, but spreads from one serial clock before first bit clock (same as bit length frame sync signal), until the one before last bit clock of the first word in frame.

⁷ Periodically sampled and not 100% tested



Note: In network mode, output flag transitions can occur at the start of each time slot within the frame. In normal mode, the output flag state is asserted for the entire frame period.

AA0490

Figure 3-23 ESAI Transmitter Timing

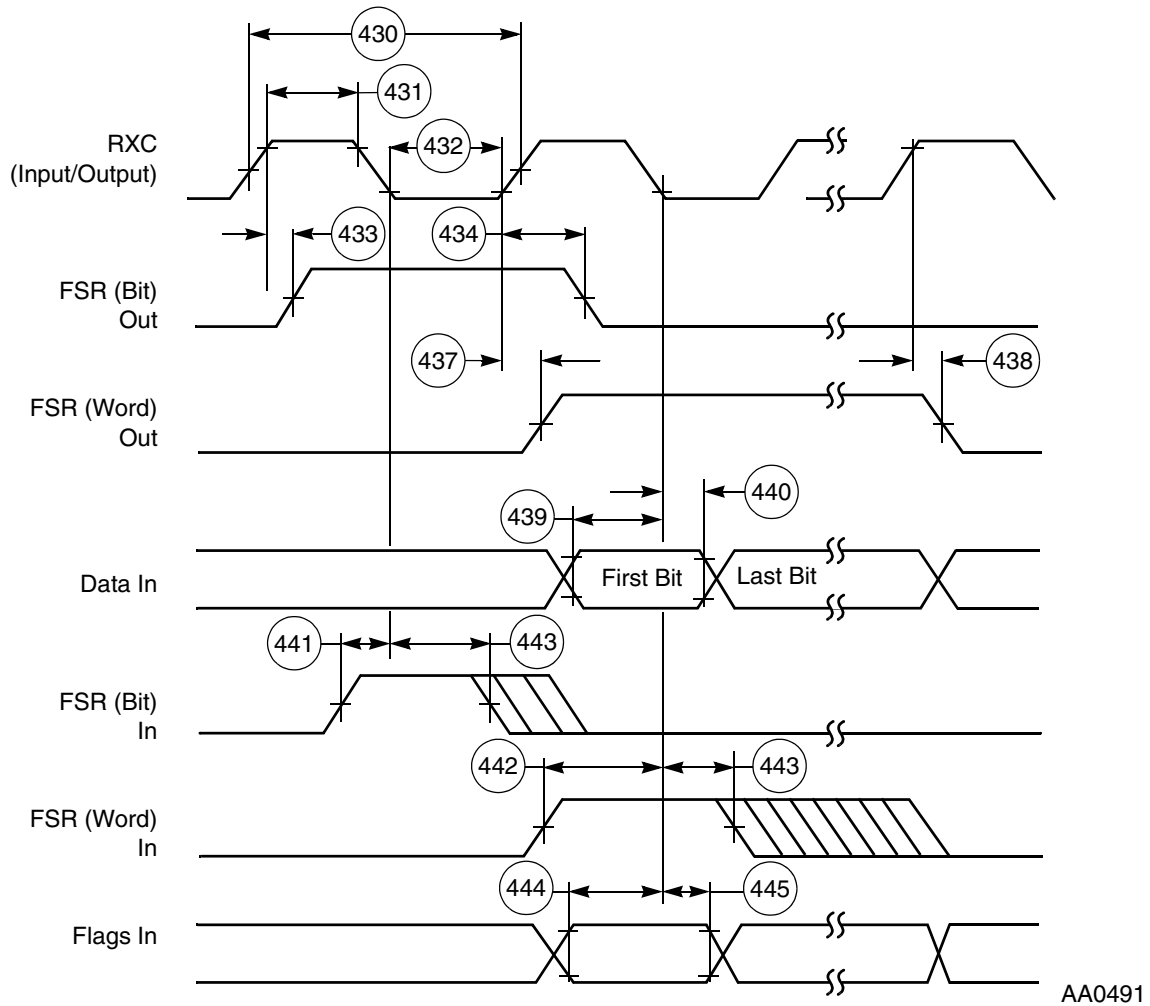


Figure 3-24 ESAI Receiver Timing

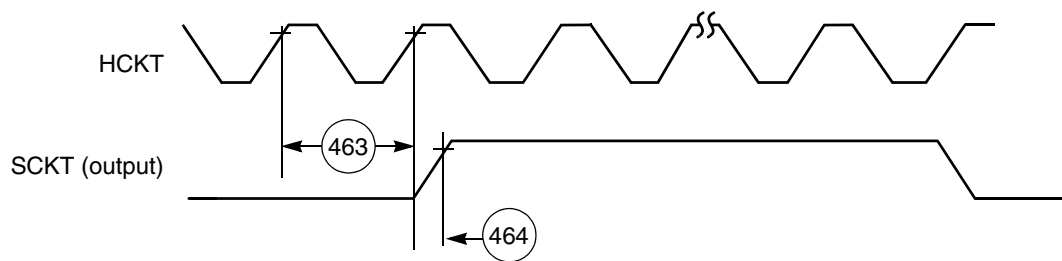


Figure 3-25 ESAI HCKT Timing

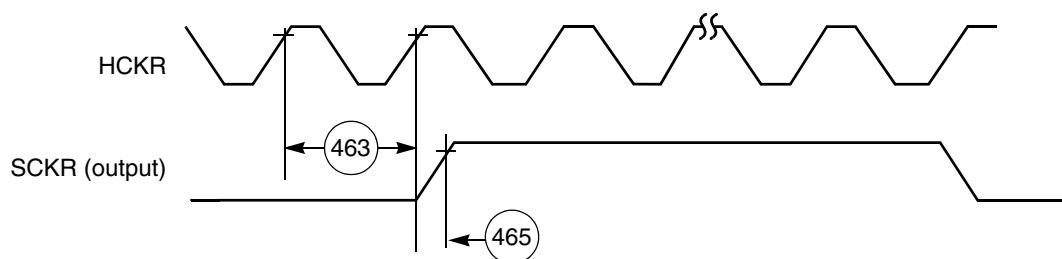


Figure 3-26 ESAL HCKR Timing

3.14 GPIO Timing

Table 3-21 GPIO Timing

No.	Characteristics ¹	Expression	Min	Max	Unit
490 ²	EXTAL edge to GPIO out valid (GPIO out delay time)		—	32.8	ns
491	EXTAL edge to GPIO out not valid (GPIO out hold time)		4.8	—	ns
492	GPIO In valid to EXTAL edge (GPIO in set-up time)		10.2	—	ns
493	EXTAL edge to GPIO in not valid (GPIO in hold time)		1.8	—	ns
494 ²	Fetch to EXTAL edge before GPIO change	$6.75 \times T_C - 1.8$	65.7	—	ns
495	GPIO out rise time	—	—	13	ns
496	GPIO out fall time	—	—	13	ns

¹ $V_{CC} = 3.3 \text{ V} \pm 0.16 \text{ V}$; $T_J = 0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50 \text{ pF}$

² Valid only when PLL enabled with multiplication factor equal to one.

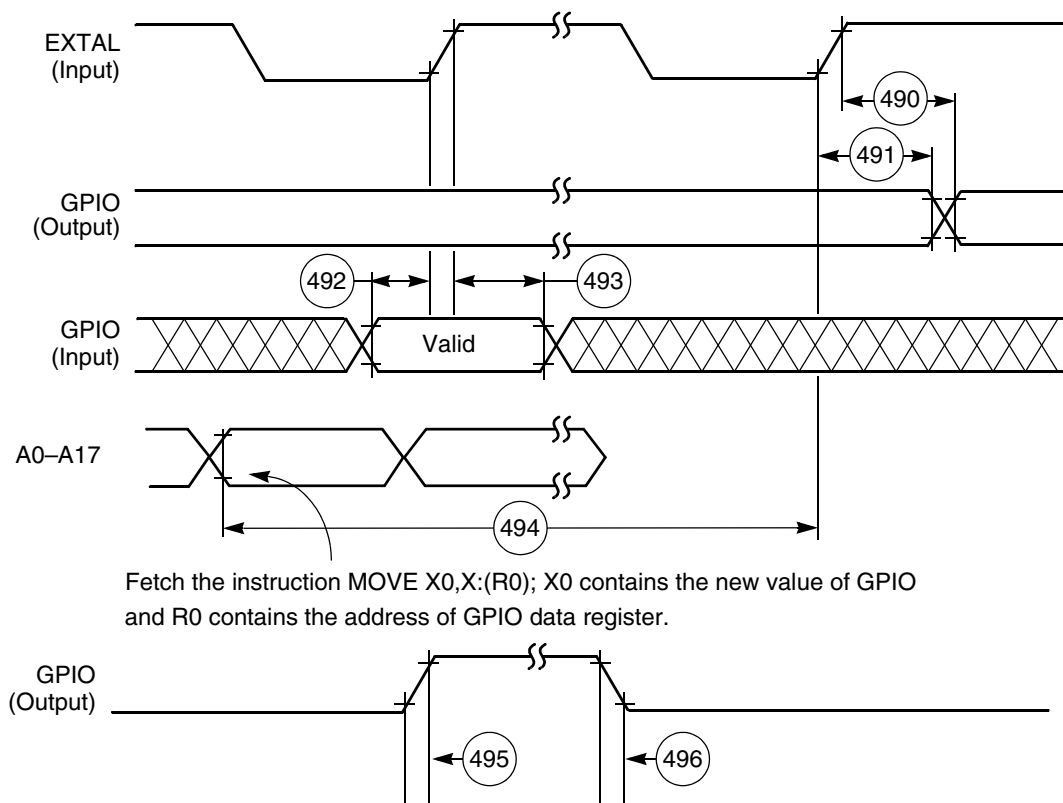


Figure 3-27 GPIO Timing

3.15 JTAG Timing

Table 3-22 JTAG Timing^{1, 2}

No.	Characteristics	All Frequencies		Unit
		Min	Max	
500	TCK frequency of operation ($1/(T_C \times 3)$; maximum 22 MHz)	0.0	22.0	MHz
501	TCK cycle time in Crystal mode	45.0	—	ns
502	TCK clock pulse width measured at 1.5 V	20.0	—	ns
503	TCK rise and fall times	0.0	3.0	ns
504	Boundary scan input data setup time	5.0	—	ns
505	Boundary scan input data hold time	24.0	—	ns
506	TCK low to output data valid	0.0	40.0	ns
507	TCK low to output high impedance	0.0	40.0	ns
508	TMS, TDI data setup time	5.0	—	ns

Table 3-22 JTAG Timing^{1, 2} (continued)

No.	Characteristics	All Frequencies		Unit
		Min	Max	
509	TMS, TDI data hold time	25.0	—	ns
510	TCK low to TDO data valid	0.0	44.0	ns
511	TCK low to TDO high impedance	0.0	44.0	ns

¹ $V_{CC} = 3.3\text{ V} \pm 0.16\text{ V}$; $T_J = 0^\circ\text{C}$ to $+105^\circ\text{C}$, $C_L = 50\text{ pF}$

² All timings apply to OnCE module data transfers because it uses the JTAG port as an interface.

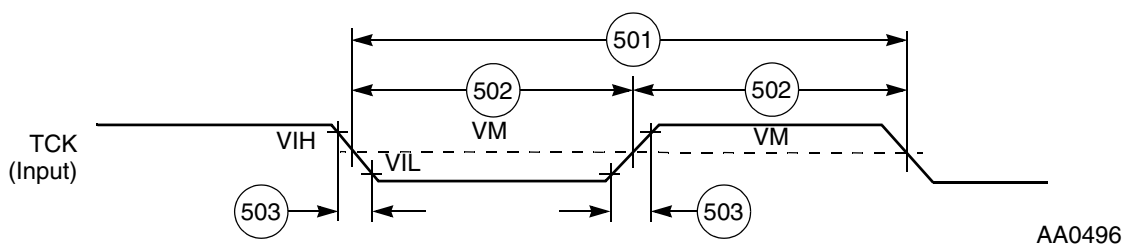


Figure 3-28 Test Clock Input Timing Diagram

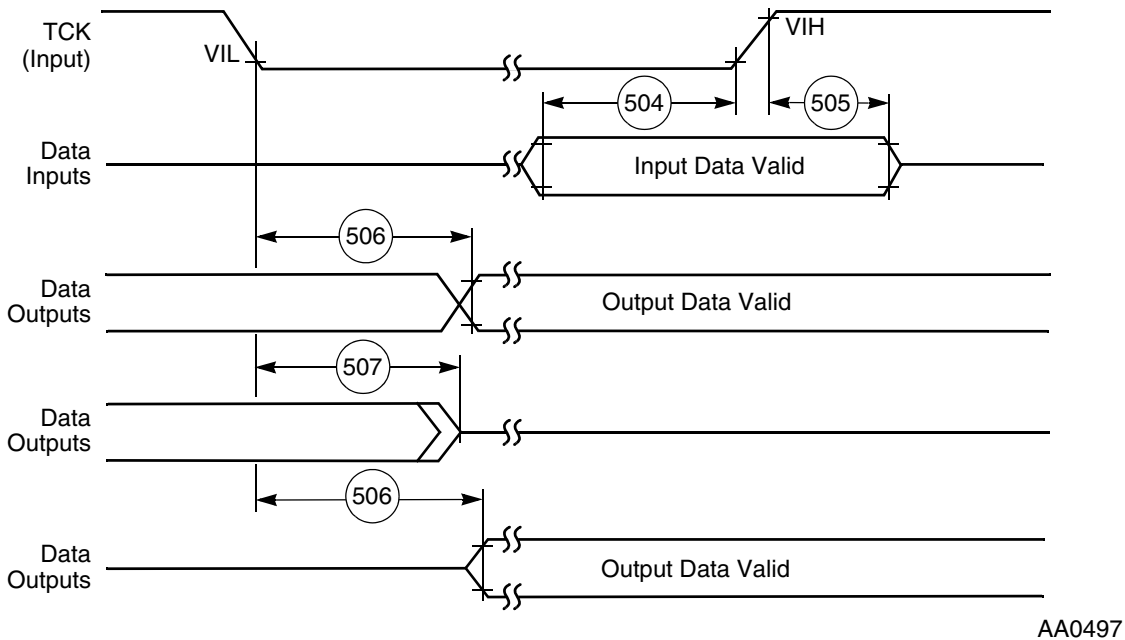
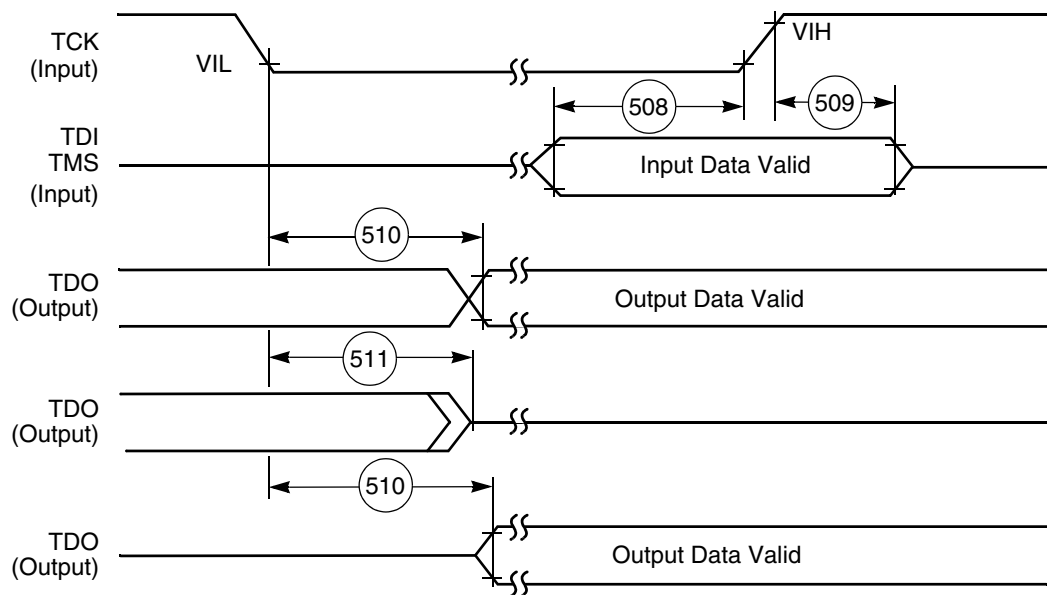


Figure 3-29 Boundary Scan (JTAG) Timing Diagram



AA0498

Figure 3-30 Test Access Port Timing Diagram

NOTES

4 Packaging

4.1 Pin-Out and Package Information

This section provides information about the available package for this product, including diagrams of the package pinouts and tables describing how the signals described in [Section 2, "Signal/Connection Descriptions"](#) are allocated for the package. The DSP56364 is available in a 100-pin TQFP package. [Table 4-1](#) and [Table 4-2](#) show the pin/name assignments for the packages.

4.1.1 TQFP Package Description

Top view of the 100-pin TQFP package is shown in [Figure 4-1](#) with its pin-outs. The 100-pin TQFP package mechanical drawing is shown in [Figure 4-2](#).

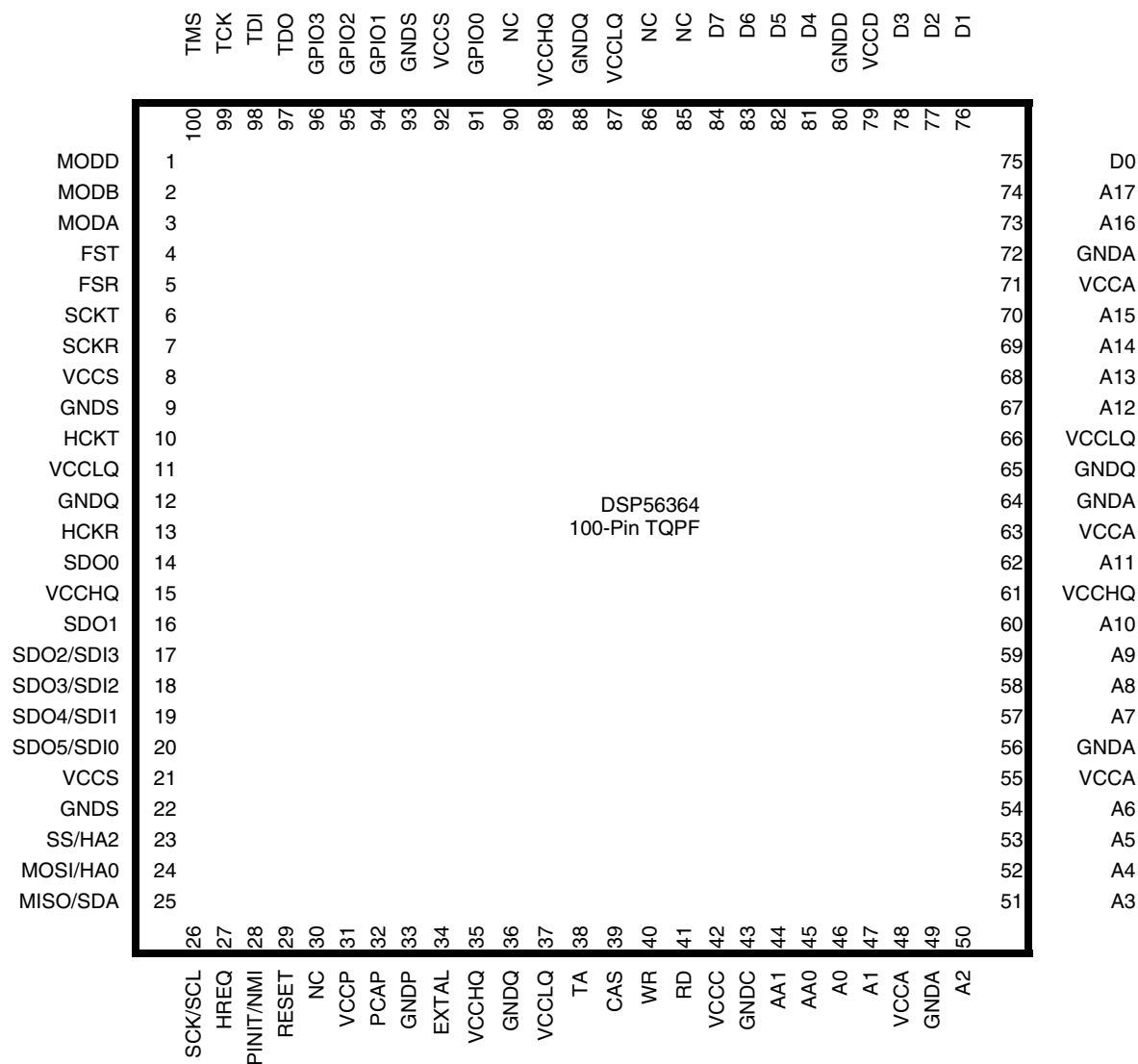


Figure 4-1 DSP56364 100-Pin Thin Quad Flat Pack (TQFP), Top View

Table 4-1 DSP56364 100-Pin TQFP Signal Identification by Pin Number

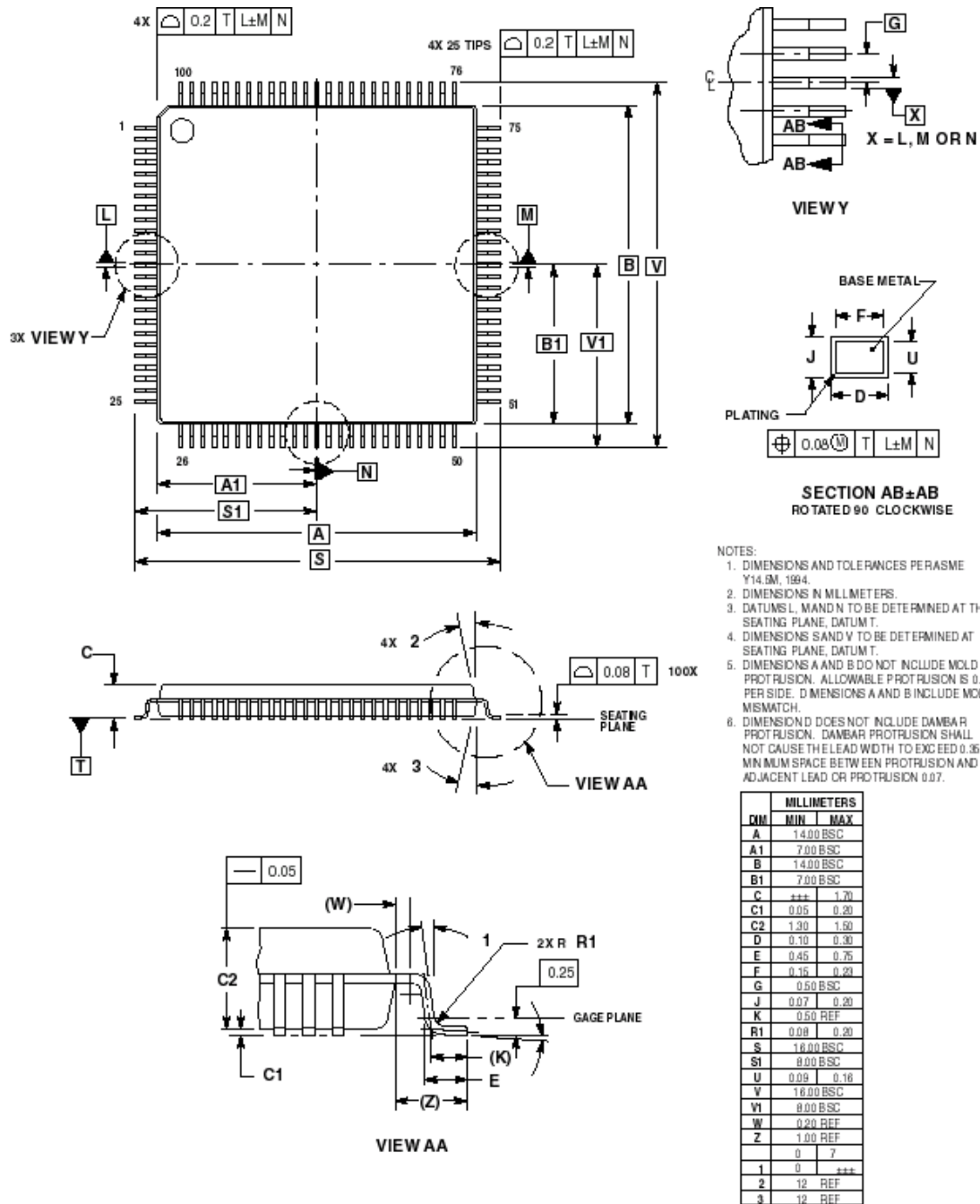
Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name
1	MODD/ $\overline{\text{IRQD}}$	26	SCK/SCL	51	A3	76	D1
2	MODB/ $\overline{\text{IRQB}}$	27	$\overline{\text{HREQ}}$	52	A4	77	D2
3	MODA/ $\overline{\text{IRQA}}$	28	PINIT/ $\overline{\text{NMI}}$	53	A5	78	D3
4	FST	29	RESET	54	A6	79	VCCD
5	FSR	30	No Connect	55	VCCA	80	GNDD
6	SCKT	31	VCCP	56	GNDA	81	D4
7	SCKR	32	PCAP	57	A7	82	D5
8	VCCS	33	GNDP	58	A8	83	D6
9	GNDS	34	EXTAL	59	A9	84	D7
10	HCKT	35	VCCHQ	60	A10	85	No Connect
11	VCCLQ	36	GNDQ	61	VCCHQ	86	No Connect
12	GNDQ	37	VCCLQ	62	A11	87	VCCLQ
13	HCKR	38	TA	63	VCCA	88	GNDQ
14	SDO0	39	$\overline{\text{CAS}}$	64	GNDA	89	VCCHQ
15	VCCHQ	40	WR	65	GNDQ	90	No Connect
16	SDO1	41	RD	66	VCCLQ	91	GPIO0
17	SDO2/SDI3	42	VCCC	67	A12	92	VCCS
18	SDO3/SDI2	43	GNDC	68	A13	93	GNDS
19	SDO4/SDI1	44	AA1/ $\overline{\text{RAS1}}$	69	A14	94	GPIO1
20	SDO5/SDI0	45	AA0/ $\overline{\text{RAS0}}$	70	A15	95	GPIO2
21	VCCS	46	A0	71	VCCA	96	GPIO3
22	GNDS	47	A1	72	GNDA	97	TDO
23	$\overline{\text{SS}}$ /HA2	48	VCCA	73	A16	98	TDI
24	MOSI/HA0	49	GNDA	74	A17	99	TCK
25	MISO/SDA	50	A2	75	D0	100	TMS

Note: Signal names are based on configured functionality. Most pins supply a single signal. Some pins provide a signal with dual functionality, such as the MODx/ $\overline{\text{IRQx}}$ pins that select an operating mode after $\overline{\text{RESET}}$ is deasserted, but act as interrupt lines during operation.

Table 4-2 DSP56364 100-Pin TQFP Signal Identification by Name

Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.
A0	46	D4	81	HCKR	13	SDO4/SDI1	19
A1	47	D5	82	HCKT	10	TA	38
A10	60	D6	83	$\overline{\text{HREQ}}$	27	TCK	99
A11	62	D7	84	MISO/SDA	25	TDI	98
A12	67	EXTAL	34	MODA/ $\overline{\text{IRQA}}$	3	TD0	97
A13	68	FSR	5	MODB/ $\overline{\text{IRQB}}$	2	TMS	100
A14	69	FST	4	MODD/ $\overline{\text{IRQD}}$	1	VCCA	48
A15	70	GNDA	49	MOSI/HA0	24	VCCA	55
A16	73	GNDA	56	No Connect	30	VCCA	63
A17	74	GNDA	64	No Connect	85	VCCA	71
A2	50	GNDA	72	No Connect	86	VCCC	42
A3	51	GNDC	43	No Connect	90	VCCD	79
A4	52	GNDD	80	PCAP	32	VCCHQ	15
A5	53	GNDP	33	PINIT/ $\overline{\text{NMI}}$	28	VCCHQ	35
A6	54	GNDQ	12	$\overline{\text{RD}}$	41	VCCHQ	61
A7	57	GNDQ	36	$\overline{\text{RESET}}$	29	VCCHQ	89
A8	58	GNDQ	65	SCK/SCL	26	VCCLQ	11
A9	59	GNDQ	88	SCKR	7	VCCLQ	37
AA0	45	GNDS	9	SCKT	6	VCCLQ	66
AA1	44	GNDS	22	SDO0	14	VCCLQ	87
$\overline{\text{CAS}}$	39	GNDS	93	SDO1	16	VCCP	31
D0	75	GPIO0	91	SDO5/SDI0	20	VCCS	8
D1	76	GPIO1	94	$\overline{\text{SS}}/\text{HA2}$	23	VCCS	21
D2	77	GPIO2	95	SDO2/SDI3	17	VCCS	92
D3	78	GPIO3	96	SDO3/SDI2	18	$\overline{\text{WR}}$	40

4.1.2 TQFP Package Mechanical Drawing



CASE 983±02
ISSUE E

DATE 01/30/96

Figure 4-2 DSP56364 100-pin TQFP Package

5 Design Considerations

5.1 Thermal Design Considerations

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

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

Where: T_A = ambient temperature °C
 $R_{\theta JA}$ = package junction-to-ambient thermal resistance °C/W
 P_D = power dissipation in package W

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

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$$

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 a 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 $R_{\theta JA}$ 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 ways for determining the junction-to-case thermal resistance in plastic packages.

- To minimize temperature variation across the surface, the thermal resistance is measured 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.

- To define a value approximately equal to a junction-to-board thermal resistance, the thermal resistance is measured from the junction to where the leads are attached to the case.
- If the temperature of the package case (T_T) is determined by a thermocouple, the thermal resistance is computed using the value obtained by the equation:

$$(T_J - T_T)/P_D$$

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 temperature. 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.

5.2 Electrical Design Considerations

CAUTION

This device contains circuitry protecting against damage due to high static voltage or electrical fields. However, normal precautions should be taken to avoid exceeding maximum voltage ratings. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). The suggested value for a pull-up or pull-down resistor is 10 k ohm.

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

- Provide a low-impedance path from the board power supply to each V_{CC} pin on the DSP and from the board ground to each GND pin.
- Use at least six 0.01–0.1 μ F bypass capacitors positioned as close as possible to the four sides of the package to connect the V_{CC} power source to GND.
- Ensure that capacitor leads and associated printed circuit traces that connect to the chip V_{CC} and GND pins are less than 1.2 cm (0.5 inch) per capacitor lead.
- Use at least a four-layer PCB with two inner layers for V_{CC} and GND.
- Because the DSP output signals have fast rise and fall times, PCB trace lengths should be minimal. This recommendation particularly applies to the address and data buses as well as the $\overline{IRQA}$, $\overline{IRQB}$, $\overline{IRQD}$, and $\overline{TA}$ pins. Maximum PCB trace lengths on the order of 15 cm (6 inches) are recommended.
- 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_{CC} and GND circuits.

- All inputs must be terminated (i.e., not allowed to float) using CMOS levels, except for the three pins with internal pull-up resistors (TMS, TDI, TCK).
- Take special care to minimize noise levels on the V_{CCP} and GND_P pins.
- If multiple DSP56364 devices are on the same board, check for cross-talk or excessive spikes on the supplies due to synchronous operation of the devices.
- RESET must be asserted when the chip is powered up. A stable EXTAL signal must be supplied before deassertion of RESET.
- At power-up, ensure that the voltage difference between the 5 V tolerant pins and the chip V_{CC} never exceeds 3.95 V.

5.3 Power Consumption Considerations

Power dissipation is a key issue in portable DSP applications. Some of the factors which affect current consumption are described in this section. Most of the current consumed by CMOS devices is alternating current (ac), which is charging and discharging the capacitances of the pins and internal nodes.

Current consumption is described by the following formula:

$$I = C \times V \times f$$

where

C	= node/pin capacitance
V	= voltage swing
f	= frequency of node/pin toggle

Example 1. Current Consumption

For a Port A address pin loaded with 50 pF capacitance, operating at 3.3 V, and with a 100 MHz clock, toggling at its maximum possible rate (50 MHz), the current consumption is

$$I = 50 \times 10^{-12} \times 3.3 \times 50 \times 10^6 = 8.25 \text{ mA}$$

The maximum internal current ($I_{CC1\text{max}}$) value reflects the typical possible switching of the internal buses on best-case operation conditions, which is not necessarily a real application case. The typical internal current ($I_{CC1\text{typ}}$) value reflects the average switching of the internal buses on typical operating conditions.

For applications that require very low current consumption, do the following:

- Set the EBD bit when not accessing external memory.
- Minimize external memory accesses and use internal memory accesses.
- Minimize the number of pins that are switching.
- Minimize the capacitive load on the pins.
- Connect the unused inputs to pull-up or pull-down resistors.
- Disable unused peripherals.

One way to evaluate power consumption is to use a current per MIPS measurement methodology to minimize specific board effects (i.e., to compensate for measured board current not caused by the DSP).

A benchmark power consumption test algorithm is listed in [Appendix A, "IBIS Model"](#). Use the test algorithm, specific test current measurements, and the following equation to derive the current per MIPS value.

$$I/\text{MIPS} = I/\text{MHz} = (I_{\text{typF2}} - I_{\text{typF1}})/(F2 - F1)$$

where:

- I_{typF2} = current at F2
- I_{typF1} = current at F1
- F2 = high frequency (any specified operating frequency)
- F1 = low frequency (any specified operating frequency lower than F2)

NOTE

F1 should be significantly less than F2. For example, F2 could be 66 MHz and F1 could be 33 MHz. The degree of difference between F1 and F2 determines the amount of precision with which the current rating can be determined for an application.

5.4 PLL Performance Issues

The following explanations should be considered as general observations on expected PLL behavior. There is no testing that verifies these exact numbers. These observations were measured on a limited number of parts and were not verified over the entire temperature and voltage ranges.

5.4.1 Input (EXTAL) Jitter Requirements

The allowed jitter on the frequency of EXTAL is 0.5%. If the rate of change of the frequency of EXTAL is slow (i.e., it does not jump between the minimum and maximum values in one cycle) or the frequency of the jitter is fast (i.e., it does not stay at an extreme value for a long time), then the allowed jitter can be 2%. The phase and frequency jitter performance results are only valid if the input jitter is less than the prescribed values.

6 Ordering Information

Consult a Freescale Semiconductor sales office or authorized distributor to determine product availability and to place an order.

Table 6-1 Ordering Information^{1, 2}

Part	Supply Voltage	Package Type	Pin Count	Frequency (MHz)	Order Number
DSP56364	3.3 V	Thin quad flat pack (TQFP)	100	100	XCB56364FU100
		Quad flat pack (QFP)	112	100	XCB56364PV100

¹ The DSP56364 can include factory-programmed ROM. The listed 'B' ROM code is a generic unused ROM available to any customer. Variations will be supported for Dolby digital (AC-3), DTS, MPEG2, and other features. These products are only available to authorized licensees of those technologies. Please consult the web site at www.freescale.com/dsp for current availability.

² Future products in the DSP56364 family may include other ROM-based options. For additional information on future part development, or to request customer-specific ROM-based support, call your local Freescale Semiconductor sales office or authorized distributor.



NOTES

Appendix A IBIS Model

```

IBIS Model
[IBIS Ver]          3.2
[File name]         56364_e.ibs
[File Rev]          e
[Date]              Feb 13, 2002
[Component]         56364
[Manufacturer]      Freescale SEMI CONDUCTOR Ltd.
[Package]
| variable          typ          min          max
R_pkg               45.0m        22.0m        75.0m
L_pkg               2.5nH         1.1nH         4.3nH
C_pkg               1.3pF         1.2pF         1.4pF
[Pin]              signal_name    model_name    R_pin        L_pin        C_pin
1                   irqd_          ipad5v_io
2                   irqb_          ipad5v_io
3                   irqa_          ipad5v_io
4                   fst           ipad5v_io
5                   fsr           ipad5v_io
6                   sckt          ipad5v_io
7                   sckr          ipad5v_io
8                   vccs          power
9                   gn timer          gnd
10                  hckt          ipad5v_io
11                  vcclq         power
12                  gndq          gnd
13                  hckr          ipad5v_io
14                  sdo0          ipad5v_io
15                  vcchq         power
16                  sdo1          ipad5v_io
17                  sdo2/sdi3      ipad5v_io
18                  sdo3/sdi2      ipad5v_io
19                  sdo4/sdi1      ipad5v_io
20                  sdo5/sdi0      ipad5v_io
21                  vccs          power
22                  gn timer          gnd
23                  ss_/ha2        ipad5v_io
24                  mosi/ha0        ipad5v_io
25                  miso/sda        ipad5i_io
26                  sck/scl         ipad5i_io
27                  hreq_          ipad5i_io
28                  pinit/nmi_      ipad5v_io
29                  reset_         ipad5v_io
31                  vccp          power
32                  pcap          power
33                  gndp          gnd
34                  extal          ipadex_i
35                  vcchq         power

```

36	gndq	gnd
37	vcclq	power
38	ta_	ipadn_io
39	cas_	ipadm_3st
40	wr_	ipadn_io
41	rd_	ipadn_io
42	vccc	power
43	gndc	gnd
44	aa1/ras1_	ipado_3st
45	aa0/ras0_	ipado_3st
46	a0	ipada_3st
47	a1	ipada_3st
48	vcca	power
49	gnda	gnd
50	a2	ipada_3st
51	a3	ipada_3st
52	a4	ipada_3st
53	a5	ipada_3st
54	a6	ipada_3st
55	vcca	power
56	gnda	gnd
57	a7	ipada_3st
58	a8	ipada_3st
59	a9	ipada_3st
60	a10	ipada_3st
61	vcchq	power
62	a11	ipada_3st
63	vcca	power
64	gnda	gnd
65	gndq	gnd
66	vcclq	power
67	a12	power
68	a13	ipada_3st
69	a14	ipada_3st
70	a15	ipada_3st
71	vcca	power
72	gnda	gnd
73	a16	ipada_3st
74	a17	ipada_3st
75	d0	ipadd_io
76	d1	ipadd_io
77	d2	ipadd_io
78	d3	ipadd_io
79	vccd	power
80	gndd	gnd
81	d4	ipadd_io
82	d5	ipadd_io
83	d6	ipadd_io
84	d7	ipadd_io
87	vcclq	power
88	gndq	gnd
89	vcchq	power
91	gpio0	ipad5v_io
92	vccs	power
93	gn ds	gnd

```

94          gpio1          ipad5v_io
95          gpio2          ipad5v_io
96          gpio3          ipad5v_io
97          tdo            ipad5f_io
98          tdi            ipad5f_io
99          tck            ipad5f_io
100         tms            ipad5f_io

[Model]          ipad5f_io          | ""
Model_type       I/O
Vinl = 0.8
Vinh = 2
| variable       typ          min          max
C_comp           1.96p        1.87p        2.06p
| variable       typ          min          max
[Temperature Range] 40.0        0.0        120.0
| variable       typ          min          max
[Voltage Range]   3.30V        3.00V        3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
| Voltage        I (typ)        I (min)        I (max)
|
-3.30V          -142.303u   -76.239u   -215.182u
-3.20V          -149.700u   -80.226u   -226.432u
-3.10V          -157.861u   -84.616u   -238.866u
-3.00V          -166.908u   -89.472u   -252.678u
-2.90V          -176.992u   -94.869u   -268.107u
-2.80V          -188.295u  -100.900u  -285.446u
-2.70V          -201.049u  -107.679u  -305.068u
-2.60V          -215.545u  -115.349u  -327.446u
-2.50V          -232.155u  -124.094u  -353.191u
-2.40V          -251.367u  -134.145u  -383.107u
-2.30V          -273.825u  -145.808u  -418.273u
-2.20V          -300.403u  -159.488u  -460.167u
-2.10V          -332.314u  -175.737u  -510.874u
-2.00V          -371.286u  -195.318u  -573.418u
-1.90V          -419.868u  -219.325u  -652.360u
-1.80V          -481.968u  -249.369u  -754.892u
-1.70V          -563.882u  -287.925u  -893.013u
-1.60V          -676.382u  -338.973u   -1.088m
-1.50V          -839.410u  -409.300u   -1.383m
-1.40V           -1.094m  -511.367u   -1.873m
-1.30V           -1.537m  -670.350u   -2.819m
-1.20V           -2.451m  -943.845u   -5.162m
-1.10V           -4.857m   -1.486m  -12.214m
-1.00V           -10.606m   -2.746m  -20.764m
-0.90V           -14.267m   -5.259m  -21.749m
-0.80V           -13.851m   -7.108m  -20.142m
-0.70V           -12.481m   -7.168m  -18.211m
-0.60V           -10.883m   -6.348m  -15.981m
-0.50V            -9.156m   -5.339m  -13.503m
-0.40V            -7.378m   -4.288m  -10.922m
-0.30V            -5.572m   -3.224m   -8.282m
-0.20V            -3.741m   -2.154m   -5.584m

```

-0.10V	-1.885m	-1.080m	-2.825m
0.00V	1.898p	1.419p	1.871p
0.10V	1.857m	1.057m	2.800m
0.20V	3.630m	2.064m	5.482m
0.30V	5.323m	3.023m	8.052m
0.40V	6.936m	3.935m	10.508m
0.50V	8.467m	4.798m	12.849m
0.60V	9.915m	5.611m	15.073m
0.70V	11.275m	6.371m	17.176m
0.80V	12.546m	7.078m	19.155m
0.90V	13.723m	7.726m	21.011m
1.00V	36.925m	20.745m	56.704m
1.10V	39.391m	22.074m	60.708m
1.20V	41.612m	23.244m	64.383m
1.30V	43.585m	24.247m	67.726m
1.40V	45.305m	25.079m	70.735m
1.50V	46.773m	25.741m	73.414m
1.60V	47.997m	26.251m	75.766m
1.70V	48.985m	26.633m	77.783m
1.80V	49.733m	26.905m	79.441m
1.90V	50.257m	27.092m	80.724m
2.00V	50.612m	27.223m	81.651m
2.10V	50.858m	27.321m	82.294m
2.20V	51.040m	27.399m	82.744m
2.30V	51.182m	27.465m	83.074m
2.40V	51.302m	27.522m	83.332m
2.50V	51.405m	27.572m	83.543m
2.60V	51.497m	27.618m	83.724m
2.70V	51.581m	27.657m	83.884m
2.80V	51.658m	27.674m	84.030m
2.90V	51.727m	27.587m	84.165m
3.00V	51.757m	27.577m	84.290m
3.10V	51.229m	28.700m	84.409m
3.20V	49.190m	30.042m	84.515m
3.30V	49.441m	31.171m	84.491m
3.40V	51.034m	32.199m	81.077m
3.50V	54.363m	33.153m	79.736m
3.60V	57.165m	34.039m	80.276m
3.70V	58.834m	34.872m	82.430m
3.80V	60.328m	35.686m	85.482m
3.90V	61.725m	36.495m	91.743m
4.00V	63.035m	37.291m	94.219m
4.10V	64.319m	38.051m	96.276m
4.20V	65.598m	38.755m	98.249m
4.30V	66.836m	39.394m	100.059m
4.40V	67.999m	39.962m	101.849m
4.50V	69.069m	40.453m	103.628m
4.60V	70.046m	40.840m	105.345m
4.70V	70.938m	41.065m	106.956m
4.80V	71.751m	40.952m	108.448m
4.90V	72.476m	40.067m	109.826m
5.00V	73.089m	39.395m	111.106m
5.10V	73.531m	39.313m	112.297m
5.20V	73.651m	39.358m	113.400m
5.30V	72.901m	39.410m	114.401m

5.40V	71.005m	39.460m	115.267m
5.50V	70.389m	39.508m	115.917m
5.60V	70.321m	39.552m	116.139m
5.70V	70.361m	39.595m	114.582m
5.80V	70.422m	39.634m	111.344m
5.90V	70.489m	39.672m	110.612m
6.00V	70.557m	39.708m	110.449m
6.10V	70.624m	39.743m	110.455m
6.20V	70.690m	39.777m	110.515m
6.30V	70.753m	39.812m	110.595m
6.40V	70.817m	39.848m	110.686m
6.50V	70.881m	39.886m	110.783m
6.60V	70.949m	39.929m	110.885m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	75.797u	7.914u	161.477u
-3.20V	90.464u	17.699u	181.779u
-3.10V	105.160u	27.445u	202.314u
-3.00V	119.836u	37.119u	223.007u
-2.90V	134.451u	46.694u	243.785u
-2.80V	148.966u	56.144u	264.581u
-2.70V	163.342u	65.447u	285.332u
-2.60V	177.543u	74.582u	305.982u
-2.50V	191.536u	83.527u	326.474u
-2.40V	205.285u	92.262u	346.757u
-2.30V	218.754u	100.766u	366.776u
-2.20V	231.907u	109.016u	386.478u
-2.10V	244.706u	116.988u	405.807u
-2.00V	257.106u	124.659u	424.699u
-1.90V	269.061u	131.998u	443.089u
-1.80V	280.519u	138.978u	460.899u
-1.70V	291.423u	145.565u	478.046u
-1.60V	301.710u	151.723u	494.457u
-1.50V	311.348u	157.417u	521.406u
-1.40V	729.899u	162.626u	1.612m
-1.30V	10.510m	445.517u	14.832m
-1.20V	9.629m	6.444m	13.576m
-1.10V	8.670m	5.833m	12.231m
-1.00V	7.693m	5.190m	10.854m
-0.90V	6.732m	4.551m	9.483m
-0.80V	5.825m	3.942m	8.169m
-0.70V	5.004m	3.382m	6.971m
-0.60V	4.261m	2.869m	5.921m
-0.50V	3.549m	2.381m	4.953m
-0.40V	2.841m	1.902m	3.978m
-0.30V	2.135m	1.426m	2.987m
-0.20V	1.437m	951.489u	2.003m
-0.10V	722.340u	478.341u	1.005m
-0.00V	22.329p	3.311p	24.081p
0.10V	-708.556u	-465.927u	-990.647u
0.20V	-1.377m	-903.637u	-1.943m
0.30V	-2.007m	-1.319m	-2.832m

0.40V	-2.614m	-1.710m	-3.702m
0.50V	-3.192m	-2.079m	-4.537m
0.60V	-3.738m	-2.423m	-5.336m
0.70V	-4.253m	-2.742m	-6.096m
0.80V	-4.736m	-3.037m	-6.817m
0.90V	-5.185m	-3.305m	-7.499m
1.00V	-5.600m	-3.547m	-8.139m
1.10V	-5.980m	-3.762m	-8.737m
1.20V	-6.324m	-3.948m	-9.292m
1.30V	-6.631m	-17.709m	-9.802m
1.40V	-29.730m	-18.279m	-10.265m
1.50V	-30.749m	-18.747m	-45.983m
1.60V	-31.630m	-19.131m	-47.620m
1.70V	-32.393m	-19.454m	-49.086m
1.80V	-33.055m	-19.730m	-50.392m
1.90V	-33.632m	-19.973m	-51.551m
2.00V	-34.135m	-20.188m	-52.571m
2.10V	-34.575m	-20.381m	-53.463m
2.20V	-34.960m	-20.556m	-54.240m
2.30V	-35.302m	-20.715m	-54.917m
2.40V	-35.608m	-20.861m	-55.510m
2.50V	-35.884m	-20.997m	-56.035m
2.60V	-36.137m	-21.123m	-56.505m
2.70V	-36.370m	-21.241m	-56.932m
2.80V	-36.586m	-21.352m	-57.322m
2.90V	-36.788m	-21.457m	-57.683m
3.00V	-36.978m	-21.556m	-58.019m
3.10V	-37.157m	-21.650m	-58.334m
3.20V	-37.327m	-21.741m	-58.631m
3.30V	-37.489m	-21.827m	-58.913m
3.40V	-37.643m	-21.909m	-59.181m
3.50V	-37.791m	-21.989m	-59.436m
3.60V	-37.933m	-22.067m	-59.681m
3.70V	-38.070m	-22.143m	-59.916m
3.80V	-38.202m	-22.216m	-60.142m
3.90V	-38.332m	-22.284m	-60.361m
4.00V	-38.460m	-22.352m	-60.573m
4.10V	-38.590m	-22.420m	-60.780m
4.20V	-38.714m	-22.490m	-60.986m
4.30V	-38.828m	-22.561m	-61.194m
4.40V	-38.949m	-22.635m	-61.406m
4.50V	-39.076m	-22.713m	-61.623m
4.60V	-39.211m	-22.798m	-61.819m
4.70V	-39.357m	-22.892m	-62.024m
4.80V	-39.516m	-22.997m	-62.254m
4.90V	-39.693m	-23.116m	-62.506m
5.00V	-39.893m	-23.253m	-62.785m
5.10V	-40.121m	-23.411m	-63.098m
5.20V	-40.384m	-23.595m	-63.453m
5.30V	-40.689m	-23.801m	-63.860m
5.40V	-41.043m	-24.032m	-64.330m
5.50V	-41.444m	-24.288m	-64.874m
5.60V	-41.886m	-24.570m	-65.505m
5.70V	-42.370m	-24.880m	-66.214m
5.80V	-42.899m	-25.217m	-66.983m

5.90V	-43.473m	-25.585m	-67.815m
6.00V	-44.095m	-25.983m	-68.711m
6.10V	-44.769m	-26.415m	-69.678m
6.20V	-45.498m	-26.884m	-70.721m
6.30V	-46.287m	-27.390m	-71.848m
6.40V	-47.140m	-27.929m	-73.065m
6.50V	-48.049m	-28.487m	-74.374m
6.60V	-48.990m	-29.080m	-75.748m
[GND_clamp]			
Voltage	I (typ)	I (min)	I (max)
-3.30V	-1.875	-1.074	-2.155
-3.20V	-1.793	-1.029	-2.059
-3.10V	-1.711	-983.765m	-1.963
-2.90V	-1.548	-893.931m	-1.771
-2.80V	-1.466	-849.071m	-1.675
-2.70V	-1.385	-804.256m	-1.579
-2.60V	-1.303	-759.489m	-1.483
-2.50V	-1.221	-714.777m	-1.388
-2.40V	-1.140	-670.127m	-1.292
-2.30V	-1.059	-625.548m	-1.197
-2.20V	-977.735m	-581.048m	-1.102
-2.10V	-896.773m	-536.642m	-1.007
-1.90V	-735.446m	-448.177m	-817.634m
-1.80V	-655.171m	-404.164m	-723.409m
-1.70V	-575.242m	-360.342m	-629.587m
-1.60V	-495.760m	-316.758m	-536.295m
-1.50V	-416.878m	-273.482m	-443.730m
-1.40V	-338.839m	-230.618m	-352.222m
-1.30V	-262.067m	-188.327m	-262.384m
-1.20V	-187.395m	-146.891m	-175.533m
-1.10V	-116.756m	-106.839m	-95.231m
-0.90V	-16.024m	-37.029m	-6.612m
-0.80V	-2.254m	-14.319m	-2.370m
-0.70V	-476.015u	-2.883m	-845.181u
-0.60V	-85.877u	-295.354u	-147.930u
-0.50V	-8.033u	-33.637u	-9.999u
-0.40V	-432.304n	-3.576u	-310.975n
-0.30V	-20.874n	-340.944n	-8.593n
-0.20V	-964.564p	-30.895n	-258.649p
-0.10V	-72.583p	-2.560n	-43.910p
0.00V	-33.685p	-210.508p	-34.610p
0.10V	-27.665p	-30.628p	-29.748p
0.20V	-22.754p	13.546p	-25.110p
0.30V	-18.303p	48.356p	-20.906p
0.40V	-14.129p	81.869p	-16.971p
0.50V	-9.979p	114.849p	-13.050p
0.60V	-5.833p	147.499p	-9.130p
0.70V	-1.689p	179.924p	-5.210p
0.80V	2.454p	212.188p	-1.291p
0.90V	6.596p	244.335p	2.628p
1.10V	14.877p	308.388p	10.466p
1.20V	19.017p	340.335p	14.384p

1.30V	23.157p	372.250p	18.302p
1.40V	27.297p	404.143p	22.221p
1.50V	31.436p	436.027p	26.139p
1.60V	35.576p	467.910p	30.057p
1.70V	39.715p	499.805p	33.974p
1.80V	43.855p	531.722p	37.892p
1.90V	47.995p	563.675p	41.810p
2.10V	56.277p	627.761p	49.646p
2.20V	60.418p	659.933p	53.564p
2.30V	64.561p	692.106p	57.482p
2.40V	68.706p	723.142p	61.400p
2.50V	72.847p	751.973p	65.319p
2.60V	76.869p	780.264p	69.237p
2.70V	80.074p	808.442p	73.156p
2.80V	82.499p	835.513p	77.065p
2.90V	84.837p	860.391p	80.794p
3.10V	89.018p	1.265n	86.195p
3.20V	89.573p	1.305n	88.344p
3.30V	103.108p	1.593n	90.478p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-33.685p	-340.944n	-20.906p
3.40V	-72.583p	-3.576u	-25.110p
3.50V	-964.564p	-33.637u	-29.748p
3.60V	-20.874n	-295.354u	-34.610p
3.70V	-432.304n	-2.883m	-43.910p
3.80V	-8.033u	-14.319m	-258.649p
3.90V	-85.877u	-37.029m	-8.593n
4.10V	-2.254m	-106.839m	-9.999u
4.20V	-16.024m	-146.891m	-147.930u
4.30V	-55.636m	-188.327m	-845.181u
4.40V	-116.756m	-230.618m	-2.370m
4.50V	-187.395m	-273.482m	-6.612m
4.60V	-262.067m	-316.758m	-33.199m
4.70V	-338.839m	-360.342m	-95.231m
4.80V	-416.878m	-404.164m	-175.533m
4.90V	-495.760m	-448.177m	-262.384m
5.10V	-655.171m	-536.642m	-443.730m
5.20V	-735.446m	-581.048m	-536.295m
5.30V	-815.997m	-625.548m	-629.587m
5.40V	-896.773m	-670.127m	-723.409m
5.50V	-977.735m	-714.777m	-817.634m
5.60V	-1.059	-759.489m	-912.174m
5.70V	-1.140	-804.256m	-1.007
5.80V	-1.221	-849.071m	-1.102
5.90V	-1.303	-893.931m	-1.197
6.10V	-1.466	-983.765m	-1.388
6.20V	-1.548	-1.029	-1.483
6.30V	-1.630	-1.074	-1.579
6.40V	-1.711	-1.119	-1.675
6.50V	-1.793	-1.164	-1.771
6.60V	-1.875	-1.209	-1.867

```

|
[Ramp]
|Voltage          I (typ)          I (min)          I (max)
|
dV/dt_f      2.04/136.004p 1.86/237.542p 2.23/85.504p
|
dV/dt_r      2.05/194.744p 1.86/343.805p 2.23/118.850p
R_load=10000ohms
| R_load was connected to ground for Ramp_up test and power for Ramp_dn test
|
|End model
[Model]          ipad5i_io          | ""
Model_type      I/O
Vinl = 0.8
Vinh = 2
| variable          typ          min          max
C_comp          4.44p          3.89p          4.56p
| variable          typ          min          max
[Temperature Range] 40.0          0.0          120.0
| variable          typ          min          max
[Voltage Range]    3.30V          3.00V          3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
|Voltage          I (typ)          I (min)          I (max)
|
-3.30V          -142.303u -76.239u -215.182u
-3.20V          -149.700u -80.226u -226.432u
-3.10V          -157.861u -84.616u -238.866u
-3.00V          -166.908u -89.472u -252.678u
-2.90V          -176.992u -94.869u -268.107u
-2.80V          -188.295u -100.900u -285.446u
-2.70V          -201.049u -107.679u -305.068u
-2.60V          -215.545u -115.349u -327.446u
-2.50V          -232.155u -124.094u -353.191u
-2.40V          -251.367u -134.145u -383.107u
-2.30V          -273.825u -145.808u -418.273u
-2.20V          -300.403u -159.488u -460.167u
-2.10V          -332.314u -175.737u -510.874u
-2.00V          -371.286u -195.318u -573.418u
-1.90V          -419.868u -219.325u -652.360u
-1.80V          -481.968u -249.369u -754.892u
-1.70V          -563.882u -287.925u -893.013u
-1.60V          -676.382u -338.973u -1.088m
-1.50V          -839.410u -409.300u -1.383m
-1.40V          -1.094m -511.367u -1.873m
-1.30V          -1.537m -670.350u -2.819m
-1.20V          -2.451m -943.845u -5.162m
-1.10V          -4.857m -1.486m -12.214m
-1.00V          -10.606m -2.746m -20.764m
-0.90V          -14.267m -5.259m -21.749m
-0.80V          -13.851m -7.108m -20.142m
-0.70V          -12.481m -7.168m -18.211m
-0.60V          -10.883m -6.348m -15.981m
-0.50V          -9.156m -5.339m -13.503m

```

-0.40V	-7.378m	-4.288m	-10.922m
-0.30V	-5.572m	-3.224m	-8.282m
-0.20V	-3.741m	-2.154m	-5.584m
-0.10V	-1.885m	-1.080m	-2.825m
0.00V	1.898p	1.419p	1.871p
0.10V	1.857m	1.057m	2.800m
0.20V	3.630m	2.064m	5.482m
0.30V	5.323m	3.023m	8.052m
0.40V	6.936m	3.935m	10.508m
0.50V	8.467m	4.798m	12.849m
0.60V	9.915m	5.611m	15.073m
0.70V	11.275m	6.371m	17.176m
0.80V	12.546m	7.078m	19.155m
0.90V	13.723m	7.726m	21.011m
1.00V	36.925m	20.745m	56.704m
1.10V	39.391m	22.074m	60.708m
1.20V	41.612m	23.244m	64.383m
1.30V	43.585m	24.247m	67.726m
1.40V	45.305m	25.079m	70.735m
1.50V	46.773m	25.741m	73.414m
1.60V	47.997m	26.251m	75.766m
1.70V	48.985m	26.633m	77.783m
1.80V	49.733m	26.905m	79.441m
1.90V	50.257m	27.092m	80.724m
2.00V	50.612m	27.223m	81.651m
2.10V	50.858m	27.321m	82.294m
2.20V	51.040m	27.399m	82.744m
2.30V	51.182m	27.465m	83.074m
2.40V	51.302m	27.522m	83.332m
2.50V	51.405m	27.572m	83.543m
2.60V	51.497m	27.618m	83.724m
2.70V	51.581m	27.658m	83.884m
2.80V	51.658m	27.683m	84.030m
2.90V	51.729m	27.643m	84.165m
3.00V	51.781m	27.704m	84.290m
3.10V	51.640m	28.793m	84.409m
3.20V	50.282m	30.065m	84.519m
3.30V	50.273m	31.174m	84.574m
3.40V	51.871m	32.200m	83.365m
3.50V	55.121m	33.153m	80.948m
3.60V	57.228m	34.039m	81.423m
3.70V	58.838m	34.872m	83.424m
3.80V	60.328m	35.687m	87.158m
3.90V	61.725m	36.498m	91.951m
4.00V	63.035m	37.296m	94.228m
4.10V	64.321m	38.059m	96.276m
4.20V	65.602m	38.767m	98.249m
4.30V	66.844m	39.409m	100.060m
4.40V	68.012m	39.982m	101.853m
4.50V	69.088m	40.478m	103.638m
4.60V	70.072m	40.871m	105.361m
4.70V	70.973m	41.102m	106.982m
4.80V	71.794m	40.996m	108.484m
4.90V	72.529m	40.118m	109.875m
5.00V	73.152m	39.453m	111.168m

5.10V	73.605m	39.379m	112.374m
5.20V	73.737m	39.432m	113.492m
5.30V	72.999m	39.492m	114.510m
5.40V	71.115m	39.551m	115.392m
5.50V	70.512m	39.608m	116.061m
5.60V	70.457m	39.661m	116.301m
5.70V	70.511m	39.713m	114.763m
5.80V	70.586m	39.762m	111.545m
5.90V	70.667m	39.809m	110.833m
6.00V	70.749m	39.855m	110.689m
6.10V	70.831m	39.899m	110.716m
6.20V	70.911m	39.944m	110.796m
6.30V	70.989m	39.988m	110.897m
6.40V	71.068m	40.034m	111.009m
6.50V	71.148m	40.083m	111.127m
6.60V	71.230m	40.136m	111.250m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	357.190u	184.381u	591.381u
-3.20V	356.622u	184.121u	590.188u
-3.10V	356.193u	183.920u	589.287u
-3.00V	355.875u	183.765u	588.617u
-2.90V	355.641u	183.645u	588.129u
-2.80V	355.468u	183.550u	587.779u
-2.70V	355.340u	183.472u	587.528u
-2.60V	355.242u	183.405u	587.349u
-2.50V	355.163u	183.345u	587.218u
-2.40V	355.097u	183.288u	587.118u
-2.30V	355.036u	183.233u	587.036u
-2.20V	354.978u	183.177u	586.964u
-2.10V	354.920u	183.119u	586.896u
-2.00V	354.860u	183.060u	586.829u
-1.90V	354.799u	182.997u	586.762u
-1.80V	354.734u	182.931u	586.692u
-1.70V	354.666u	182.862u	586.621u
-1.60V	354.595u	182.788u	586.574u
-1.50V	354.559u	182.711u	597.934u
-1.40V	764.198u	182.650u	1.674m
-1.30V	10.536m	460.815u	14.880m
-1.20V	9.648m	6.455m	13.612m
-1.10V	8.683m	5.841m	12.257m
-1.00V	7.701m	5.195m	10.870m
-0.90V	6.737m	4.554m	9.492m
-0.80V	5.827m	3.944m	8.173m
-0.70V	5.004m	3.383m	6.972m
-0.60V	4.262m	2.870m	5.921m
-0.50V	3.549m	2.382m	4.953m
-0.40V	2.841m	1.902m	3.978m
-0.30V	2.134m	1.426m	2.985m
-0.20V	1.434m	951.249u	2.002m
-0.10V	721.882u	477.946u	1.005m
-0.00V	23.094p	36.805p	24.891p

0.10V	-708.040u	-465.659u	-990.277u
0.20V	-1.374m	-903.549u	-1.941m
0.30V	-2.007m	-1.319m	-2.832m
0.40V	-2.614m	-1.710m	-3.702m
0.50V	-3.192m	-2.079m	-4.537m
0.60V	-3.738m	-2.423m	-5.336m
0.70V	-4.253m	-2.742m	-6.096m
0.80V	-4.736m	-3.037m	-6.817m
0.90V	-5.185m	-3.305m	-7.499m
1.00V	-5.600m	-3.547m	-8.139m
1.10V	-5.980m	-3.762m	-8.737m
1.20V	-6.324m	-3.948m	-9.292m
1.30V	-6.631m	-17.709m	-9.802m
1.40V	-29.730m	-18.279m	-10.265m
1.50V	-30.749m	-18.747m	-45.983m
1.60V	-31.630m	-19.131m	-47.620m
1.70V	-32.393m	-19.454m	-49.086m
1.80V	-33.055m	-19.730m	-50.392m
1.90V	-33.632m	-19.973m	-51.551m
2.00V	-34.135m	-20.188m	-52.571m
2.10V	-34.575m	-20.381m	-53.463m
2.20V	-34.960m	-20.556m	-54.240m
2.30V	-35.302m	-20.715m	-54.917m
2.40V	-35.608m	-20.861m	-55.510m
2.50V	-35.884m	-20.997m	-56.035m
2.60V	-36.137m	-21.123m	-56.505m
2.70V	-36.370m	-21.241m	-56.932m
2.80V	-36.586m	-21.352m	-57.322m
2.90V	-36.788m	-21.457m	-57.683m
3.00V	-36.978m	-21.556m	-58.019m
3.10V	-37.157m	-21.650m	-58.334m
3.20V	-37.327m	-21.741m	-58.631m
3.30V	-37.489m	-21.827m	-58.913m
3.40V	-37.643m	-21.909m	-59.181m
3.50V	-37.791m	-21.989m	-59.436m
3.60V	-37.933m	-22.067m	-59.681m
3.70V	-38.070m	-22.143m	-59.916m
3.80V	-38.202m	-22.216m	-60.142m
3.90V	-38.332m	-22.284m	-60.361m
4.00V	-38.460m	-22.352m	-60.573m
4.10V	-38.590m	-22.420m	-60.780m
4.20V	-38.714m	-22.490m	-60.986m
4.30V	-38.828m	-22.561m	-61.194m
4.40V	-38.949m	-22.635m	-61.406m
4.50V	-39.076m	-22.713m	-61.623m
4.60V	-39.211m	-22.798m	-61.819m
4.70V	-39.357m	-22.892m	-62.024m
4.80V	-39.516m	-22.997m	-62.254m
4.90V	-39.693m	-23.116m	-62.506m
5.00V	-39.893m	-23.253m	-62.785m
5.10V	-40.121m	-23.411m	-63.098m
5.20V	-40.384m	-23.595m	-63.453m
5.30V	-40.689m	-23.801m	-63.860m
5.40V	-41.043m	-24.032m	-64.330m
5.50V	-41.444m	-24.288m	-64.874m

5.60V	-41.886m	-24.570m	-65.505m
5.70V	-42.370m	-24.880m	-66.214m
5.80V	-42.899m	-25.217m	-66.983m
5.90V	-43.473m	-25.585m	-67.815m
6.00V	-44.095m	-25.983m	-68.711m
6.10V	-44.769m	-26.415m	-69.678m
6.20V	-45.498m	-26.884m	-70.721m
6.30V	-46.287m	-27.390m	-71.848m
6.40V	-47.140m	-27.929m	-73.065m
6.50V	-48.049m	-28.487m	-74.374m
6.60V	-48.990m	-29.080m	-75.748m

|
[GND_clamp]

Voltage	I (typ)	I (min)	I (max)
-3.30V	-1.875	-1.074	-2.155
-3.20V	-1.793	-1.029	-2.059
-3.10V	-1.711	-983.769m	-1.963
-2.90V	-1.548	-893.934m	-1.771
-2.80V	-1.466	-849.075m	-1.675
-2.70V	-1.385	-804.259m	-1.579
-2.60V	-1.303	-759.493m	-1.483
-2.50V	-1.221	-714.781m	-1.388
-2.40V	-1.140	-670.131m	-1.292
-2.30V	-1.059	-625.551m	-1.197
-2.20V	-977.740m	-581.052m	-1.102
-2.10V	-896.779m	-536.646m	-1.007
-1.90V	-735.452m	-448.180m	-817.639m
-1.80V	-655.177m	-404.167m	-723.415m
-1.70V	-575.247m	-360.345m	-629.593m
-1.60V	-495.766m	-316.761m	-536.300m
-1.50V	-416.883m	-273.485m	-443.735m
-1.40V	-338.844m	-230.621m	-352.227m
-1.30V	-262.072m	-188.330m	-262.388m
-1.20V	-187.399m	-146.893m	-175.537m
-1.10V	-116.760m	-106.842m	-95.235m
-0.90V	-16.027m	-37.031m	-6.614m
-0.80V	-2.255m	-14.321m	-2.370m
-0.70V	-476.049u	-2.884m	-845.183u
-0.60V	-85.878u	-295.501u	-147.930u
-0.50V	-8.033u	-33.646u	-9.999u
-0.40V	-432.308n	-3.576u	-310.979n
-0.30V	-20.878n	-340.971n	-8.597n
-0.20V	-968.068p	-30.900n	-262.449p
-0.10V	-75.987p	-2.564n	-47.610p
0.00V	-36.990p	-214.009p	-38.210p
0.10V	-30.869p	-34.018p	-33.249p
0.20V	-25.858p	10.263p	-28.510p
0.30V	-21.307p	45.181p	-24.206p
0.40V	-17.033p	78.801p	-20.171p
0.50V	-12.783p	111.888p	-16.150p
0.60V	-8.537p	144.645p	-12.130p
0.70V	-4.293p	177.177p	-8.110p
0.80V	-49.635f	209.548p	-4.091p

0.90V	4.192p	241.802p	-71.907f
1.10V	12.674p	306.070p	7.965p
1.20V	16.914p	338.124p	11.984p
1.30V	21.154p	370.146p	16.002p
1.40V	25.393p	402.147p	20.020p
1.50V	29.633p	434.138p	24.038p
1.60V	-31.788p	466.129p	28.056p
1.70V	38.112p	498.131p	-33.622p
1.80V	42.352p	530.156p	36.092p
1.90V	46.592p	562.217p	40.110p
2.10V	55.074p	626.519p	48.146p
2.20V	59.316p	658.799p	52.164p
2.30V	63.559p	691.080p	56.182p
2.40V	67.803p	722.224p	60.200p
2.50V	72.044p	751.129p	64.219p
2.60V	76.162p	779.443p	68.237p
2.70V	79.409p	807.731p	72.256p
2.80V	81.838p	835.534p	76.265p
2.90V	84.178p	864.770p	80.080p
3.10V	88.733p	1.234n	85.501p
3.20V	90.025p	1.247n	87.652p
3.30V	96.129p	1.274n	89.793p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-36.990p	-340.971n	-24.206p
3.40V	-75.987p	-3.576u	-28.510p
3.50V	-968.068p	-33.646u	-33.249p
3.60V	-20.878n	-295.501u	-38.210p
3.70V	-432.308n	-2.884m	-47.610p
3.80V	-8.033u	-14.321m	-262.449p
3.90V	-85.878u	-37.031m	-8.597n
4.10V	-2.255m	-106.842m	-9.999u
4.20V	-16.027m	-146.893m	-147.930u
4.30V	-55.640m	-188.330m	-845.183u
4.40V	-116.760m	-230.621m	-2.370m
4.50V	-187.399m	-273.485m	-6.614m
4.60V	-262.072m	-316.761m	-33.203m
4.70V	-338.844m	-360.345m	-95.235m
4.80V	-416.883m	-404.167m	-175.537m
4.90V	-495.766m	-448.180m	-262.388m
5.10V	-655.177m	-536.646m	-443.735m
5.20V	-735.452m	-581.052m	-536.300m
5.30V	-816.003m	-625.551m	-629.593m
5.40V	-896.779m	-670.131m	-723.415m
5.50V	-977.740m	-714.781m	-817.639m
5.60V	-1.059	-759.493m	-912.179m
5.70V	-1.140	-804.259m	-1.007
5.80V	-1.221	-849.075m	-1.102
5.90V	-1.303	-893.934m	-1.197
6.10V	-1.466	-983.769m	-1.388
6.20V	-1.548	-1.029	-1.483
6.30V	-1.630	-1.074	-1.579

6.40V	-1.711	-1.119	-1.675
6.50V	-1.793	-1.164	-1.771
6.60V	-1.875	-1.209	-1.867

```

|
[Ramp]
|Voltage          I (typ)          I (min)          I (max)
|
dV/dt_f      2.01/129.093p 1.83/223.594p 2.20/79.668p
|
dV/dt_r      2.02/200.492p 1.83/352.515p 2.20/122.321p
R_load=10000ohms
| R_load was connected to ground for Ramp_up test and power for Ramp_dn test
|
|End model
[Model]          ipad5v_io          | ""
Model_type      I/O
Vinl = 0.8
Vinh = 2
| variable      typ          min          max
C_comp          1.96p      1.87p      2.06p
| variable      typ          min          max
[Temperature Range] 40.0      0.0      120.0
| variable      typ          min          max
[Voltage Range]   3.30V      3.00V      3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
|Voltage          I (typ)          I (min)          I (max)
|
-3.30V          -142.303u  -76.239u  -215.182u
-3.20V          -149.700u  -80.226u  -226.432u
-3.10V          -157.861u  -84.616u  -238.866u
-3.00V          -166.908u  -89.472u  -252.678u
-2.90V          -176.992u  -94.869u  -268.107u
-2.80V          -188.295u -100.900u  -285.446u
-2.70V          -201.049u -107.679u  -305.068u
-2.60V          -215.545u -115.349u  -327.446u
-2.50V          -232.155u -124.094u  -353.191u
-2.40V          -251.367u -134.145u  -383.107u
-2.30V          -273.825u -145.808u  -418.273u
-2.20V          -300.403u -159.488u  -460.167u
-2.10V          -332.314u -175.737u  -510.874u
-2.00V          -371.286u -195.318u  -573.418u
-1.90V          -419.868u -219.325u  -652.360u
-1.80V          -481.968u -249.369u  -754.892u
-1.70V          -563.882u -287.925u  -893.013u
-1.60V          -676.382u -338.973u  -1.088m
-1.50V          -839.410u -409.300u  -1.383m
-1.40V          -1.094m  -511.367u  -1.873m
-1.30V          -1.537m  -670.350u  -2.819m
-1.20V          -2.451m  -943.845u  -5.162m
-1.10V          -4.857m   -1.486m  -12.214m
-1.00V          -10.606m   -2.746m  -20.764m
-0.90V          -14.267m   -5.259m  -21.749m
-0.80V          -13.851m   -7.108m  -20.142m

```

-0.70V	-12.481m	-7.168m	-18.211m
-0.60V	-10.883m	-6.348m	-15.981m
-0.50V	-9.156m	-5.339m	-13.503m
-0.40V	-7.378m	-4.288m	-10.922m
-0.30V	-5.572m	-3.224m	-8.282m
-0.20V	-3.741m	-2.154m	-5.584m
-0.10V	-1.885m	-1.080m	-2.825m
0.00V	1.898p	1.419p	1.871p
0.10V	1.857m	1.057m	2.800m
0.20V	3.630m	2.064m	5.482m
0.30V	5.323m	3.023m	8.052m
0.40V	6.936m	3.935m	10.508m
0.50V	8.467m	4.798m	12.849m
0.60V	9.915m	5.611m	15.073m
0.70V	11.275m	6.371m	17.176m
0.80V	12.546m	7.078m	19.155m
0.90V	13.723m	7.726m	21.011m
1.00V	36.925m	20.745m	56.704m
1.10V	39.391m	22.074m	60.708m
1.20V	41.612m	23.244m	64.383m
1.30V	43.585m	24.247m	67.726m
1.40V	45.305m	25.079m	70.735m
1.50V	46.773m	25.741m	73.414m
1.60V	47.997m	26.251m	75.766m
1.70V	48.985m	26.633m	77.783m
1.80V	49.733m	26.905m	79.441m
1.90V	50.257m	27.092m	80.724m
2.00V	50.612m	27.223m	81.651m
2.10V	50.858m	27.321m	82.294m
2.20V	51.040m	27.399m	82.744m
2.30V	51.182m	27.465m	83.074m
2.40V	51.302m	27.522m	83.332m
2.50V	51.405m	27.572m	83.543m
2.60V	51.497m	27.618m	83.724m
2.70V	51.581m	27.657m	83.884m
2.80V	51.658m	27.674m	84.030m
2.90V	51.727m	27.587m	84.165m
3.00V	51.757m	27.577m	84.290m
3.10V	51.229m	28.700m	84.409m
3.20V	49.190m	30.042m	84.515m
3.30V	49.441m	31.171m	84.491m
3.40V	51.034m	32.199m	81.077m
3.50V	54.363m	33.153m	79.736m
3.60V	57.165m	34.039m	80.276m
3.70V	58.834m	34.872m	82.430m
3.80V	60.328m	35.686m	85.482m
3.90V	61.725m	36.495m	91.743m
4.00V	63.035m	37.291m	94.219m
4.10V	64.319m	38.051m	96.276m
4.20V	65.598m	38.755m	98.249m
4.30V	66.836m	39.394m	100.059m
4.40V	67.999m	39.962m	101.849m
4.50V	69.069m	40.453m	103.628m
4.60V	70.046m	40.840m	105.345m
4.70V	70.938m	41.065m	106.956m

4.80V	71.751m	40.952m	108.448m
4.90V	72.476m	40.067m	109.826m
5.00V	73.089m	39.395m	111.106m
5.10V	73.531m	39.313m	112.297m
5.20V	73.651m	39.358m	113.400m
5.30V	72.901m	39.410m	114.401m
5.40V	71.005m	39.460m	115.267m
5.50V	70.389m	39.508m	115.917m
5.60V	70.321m	39.552m	116.139m
5.70V	70.361m	39.595m	114.582m
5.80V	70.422m	39.634m	111.344m
5.90V	70.489m	39.672m	110.612m
6.00V	70.557m	39.708m	110.449m
6.10V	70.624m	39.743m	110.455m
6.20V	70.690m	39.777m	110.515m
6.30V	70.753m	39.812m	110.595m
6.40V	70.817m	39.848m	110.686m
6.50V	70.881m	39.886m	110.783m
6.60V	70.949m	39.929m	110.885m

[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	75.797u	7.914u	161.477u
-3.20V	90.464u	17.699u	181.779u
-3.10V	105.160u	27.445u	202.314u
-3.00V	119.836u	37.119u	223.007u
-2.90V	134.451u	46.694u	243.785u
-2.80V	148.966u	56.144u	264.581u
-2.70V	163.342u	65.447u	285.332u
-2.60V	177.543u	74.582u	305.982u
-2.50V	191.536u	83.527u	326.474u
-2.40V	205.285u	92.262u	346.757u
-2.30V	218.754u	100.766u	366.776u
-2.20V	231.907u	109.016u	386.478u
-2.10V	244.706u	116.988u	405.807u
-2.00V	257.106u	124.659u	424.699u
-1.90V	269.061u	131.998u	443.089u
-1.80V	280.519u	138.978u	460.899u
-1.70V	291.423u	145.565u	478.046u
-1.60V	301.710u	151.723u	494.457u
-1.50V	311.348u	157.417u	521.406u
-1.40V	729.899u	162.626u	1.612m
-1.30V	10.510m	445.517u	14.832m
-1.20V	9.629m	6.444m	13.576m
-1.10V	8.670m	5.833m	12.231m
-1.00V	7.693m	5.190m	10.854m
-0.90V	6.732m	4.551m	9.483m
-0.80V	5.825m	3.942m	8.169m
-0.70V	5.004m	3.382m	6.971m
-0.60V	4.261m	2.869m	5.921m
-0.50V	3.549m	2.381m	4.953m

-0.40V	2.841m	1.902m	3.978m
-0.30V	2.135m	1.426m	2.987m
-0.20V	1.437m	951.489u	2.003m
-0.10V	722.340u	478.341u	1.005m
-0.00V	22.329p	36.936p	24.081p
0.10V	-708.556u	-465.927u	-990.647u
0.20V	-1.377m	-903.637u	-1.943m
0.30V	-2.007m	-1.319m	-2.832m
0.40V	-2.614m	-1.710m	-3.702m
0.50V	-3.192m	-2.079m	-4.537m
0.60V	-3.738m	-2.423m	-5.336m
0.70V	-4.253m	-2.742m	-6.096m
0.80V	-4.736m	-3.037m	-6.817m
0.90V	-5.185m	-3.305m	-7.499m
1.00V	-5.600m	-3.547m	-8.139m
1.10V	-5.980m	-3.762m	-8.737m
1.20V	-6.324m	-3.948m	-9.292m
1.30V	-6.631m	-17.709m	-9.802m
1.40V	-29.730m	-18.279m	-10.265m
1.50V	-30.749m	-18.747m	-45.983m
1.60V	-31.630m	-19.131m	-47.620m
1.70V	-32.393m	-19.454m	-49.086m
1.80V	-33.055m	-19.730m	-50.392m
1.90V	-33.632m	-19.973m	-51.551m
2.00V	-34.135m	-20.188m	-52.571m
2.10V	-34.575m	-20.381m	-53.463m
2.20V	-34.960m	-20.556m	-54.240m
2.30V	-35.302m	-20.715m	-54.917m
2.40V	-35.608m	-20.861m	-55.510m
2.50V	-35.884m	-20.997m	-56.035m
2.60V	-36.137m	-21.123m	-56.505m
2.70V	-36.370m	-21.241m	-56.932m
2.80V	-36.586m	-21.352m	-57.322m
2.90V	-36.788m	-21.457m	-57.683m
3.00V	-36.978m	-21.556m	-58.019m
3.10V	-37.157m	-21.650m	-58.334m
3.20V	-37.327m	-21.741m	-58.631m
3.30V	-37.489m	-21.827m	-58.913m
3.40V	-37.643m	-21.909m	-59.181m
3.50V	-37.791m	-21.989m	-59.436m
3.60V	-37.933m	-22.067m	-59.681m
3.70V	-38.070m	-22.143m	-59.916m
3.80V	-38.202m	-22.216m	-60.142m
3.90V	-38.332m	-22.284m	-60.361m
4.00V	-38.460m	-22.352m	-60.573m
4.10V	-38.590m	-22.420m	-60.780m
4.20V	-38.714m	-22.490m	-60.986m
4.30V	-38.828m	-22.561m	-61.194m
4.40V	-38.949m	-22.635m	-61.406m
4.50V	-39.076m	-22.713m	-61.623m
4.60V	-39.211m	-22.798m	-61.819m
4.70V	-39.357m	-22.892m	-62.024m
4.80V	-39.516m	-22.997m	-62.254m
4.90V	-39.693m	-23.116m	-62.506m
5.00V	-39.893m	-23.253m	-62.785m

5.10V	-40.121m	-23.411m	-63.098m
5.20V	-40.384m	-23.595m	-63.453m
5.30V	-40.689m	-23.801m	-63.860m
5.40V	-41.043m	-24.032m	-64.330m
5.50V	-41.444m	-24.288m	-64.874m
5.60V	-41.886m	-24.570m	-65.505m
5.70V	-42.370m	-24.880m	-66.214m
5.80V	-42.899m	-25.217m	-66.983m
5.90V	-43.473m	-25.585m	-67.815m
6.00V	-44.095m	-25.983m	-68.711m
6.10V	-44.769m	-26.415m	-69.678m
6.20V	-45.498m	-26.884m	-70.721m
6.30V	-46.287m	-27.390m	-71.848m
6.40V	-47.140m	-27.929m	-73.065m
6.50V	-48.049m	-28.487m	-74.374m
6.60V	-48.990m	-29.080m	-75.748m

|
[GND_clamp]
|

Voltage	I (typ)	I (min)	I (max)
-3.30V	-1.875	-1.074	-2.155
-3.20V	-1.793	-1.029	-2.059
-3.10V	-1.711	-983.765m	-1.963
-2.90V	-1.548	-893.931m	-1.771
-2.80V	-1.466	-849.071m	-1.675
-2.70V	-1.385	-804.256m	-1.579
-2.60V	-1.303	-759.489m	-1.483
-2.50V	-1.221	-714.777m	-1.388
-2.40V	-1.140	-670.127m	-1.292
-2.30V	-1.059	-625.548m	-1.197
-2.20V	-977.735m	-581.048m	-1.102
-2.10V	-896.773m	-536.642m	-1.007
-1.90V	-735.446m	-448.177m	-817.634m
-1.80V	-655.171m	-404.164m	-723.409m
-1.70V	-575.242m	-360.342m	-629.587m
-1.60V	-495.760m	-316.758m	-536.295m
-1.50V	-416.878m	-273.482m	-443.730m
-1.40V	-338.839m	-230.618m	-352.222m
-1.30V	-262.067m	-188.327m	-262.384m
-1.20V	-187.395m	-146.891m	-175.533m
-1.10V	-116.756m	-106.839m	-95.231m
-0.90V	-16.024m	-37.029m	-6.612m
-0.80V	-2.254m	-14.319m	-2.370m
-0.70V	-476.015u	-2.883m	-845.181u
-0.60V	-85.877u	-295.354u	-147.930u
-0.50V	-8.033u	-33.637u	-9.999u
-0.40V	-432.304n	-3.576u	-310.975n
-0.30V	-20.874n	-340.944n	-8.593n
-0.20V	-964.564p	-30.895n	-258.649p
-0.10V	-72.583p	-2.560n	-43.910p
0.00V	-33.685p	-210.508p	-34.610p
0.10V	-27.665p	-30.628p	-29.748p
0.20V	-22.754p	13.546p	-25.110p
0.30V	-18.303p	48.356p	-20.906p

0.40V	-14.129p	81.869p	-16.971p
0.50V	-9.979p	114.849p	-13.050p
0.60V	-5.833p	147.499p	-9.130p
0.70V	-1.689p	179.924p	-5.210p
0.80V	2.454p	212.188p	-1.291p
0.90V	6.596p	244.335p	2.628p
1.10V	14.877p	308.388p	10.466p
1.20V	19.017p	340.335p	14.384p
1.30V	23.157p	372.250p	18.302p
1.40V	27.297p	404.143p	22.221p
1.50V	31.436p	436.027p	26.139p
1.60V	35.576p	467.910p	30.057p
1.70V	39.715p	499.805p	33.974p
1.80V	43.855p	531.722p	37.892p
1.90V	47.995p	563.675p	41.810p
2.10V	56.277p	627.761p	49.646p
2.20V	60.418p	659.933p	53.564p
2.30V	64.561p	692.106p	57.482p
2.40V	68.706p	723.142p	61.400p
2.50V	72.847p	751.973p	65.319p
2.60V	76.869p	780.264p	69.237p
2.70V	80.074p	808.442p	73.156p
2.80V	82.499p	835.513p	77.065p
2.90V	84.837p	860.391p	80.794p
3.10V	89.018p	1.265n	86.195p
3.20V	89.573p	1.305n	88.344p
3.30V	103.108p	1.593n	90.478p

|
[POWER_clamp]

Voltage	I (typ)	I (min)	I (max)
3.30V	-33.685p	-340.944n	-20.906p
3.40V	-72.583p	-3.576u	-25.110p
3.50V	-964.564p	-33.637u	-29.748p
3.60V	-20.874n	-295.354u	-34.610p
3.70V	-432.304n	-2.883m	-43.910p
3.80V	-8.033u	-14.319m	-258.649p
3.90V	-85.877u	-37.029m	-8.593n
4.10V	-2.254m	-106.839m	-9.999u
4.20V	-16.024m	-146.891m	-147.930u
4.30V	-55.636m	-188.327m	-845.181u
4.40V	-116.756m	-230.618m	-2.370m
4.50V	-187.395m	-273.482m	-6.612m
4.60V	-262.067m	-316.758m	-33.199m
4.70V	-338.839m	-360.342m	-95.231m
4.80V	-416.878m	-404.164m	-175.533m
4.90V	-495.760m	-448.177m	-262.384m
5.10V	-655.171m	-536.642m	-443.730m
5.20V	-735.446m	-581.048m	-536.295m
5.30V	-815.997m	-625.548m	-629.587m
5.40V	-896.773m	-670.127m	-723.409m
5.50V	-977.735m	-714.777m	-817.634m
5.60V	-1.059	-759.489m	-912.174m
5.70V	-1.140	-804.256m	-1.007

5.80V	-1.221	-849.071m	-1.102
5.90V	-1.303	-893.931m	-1.197
6.10V	-1.466	-983.765m	-1.388
6.20V	-1.548	-1.029	-1.483
6.30V	-1.630	-1.074	-1.579
6.40V	-1.711	-1.119	-1.675
6.50V	-1.793	-1.164	-1.771
6.60V	-1.875	-1.209	-1.867

|

[Ramp]

Voltage	I (typ)	I (min)	I (max)
---------	---------	---------	---------

|

dV/dt_f 2.04/134.002p 1.86/235.405p 2.23/85.874p

|

dV/dt_r 2.05/194.838p 1.86/341.412p 2.23/118.822p

R_load=10000ohms

| R_load was connected to ground for Ramp_up test and power for Ramp_dn test

|

|End model

[Model] ipada_3st | ""

Model_type	3-state		
variable	typ	min	max
C_comp	2.32p	2.17p	2.48p
variable	typ	min	max
[Temperature Range]	40.0	0.0	120.0
variable	typ	min	max
[Voltage Range]	3.30V	3.00V	3.60V

|

[Pulldown]

| pulldown in the table = pulldown subtract gnd_clamp

Voltage	I (typ)	I (min)	I (max)
---------	---------	---------	---------

|

-3.30V	-157.134u	-99.256u	-219.000u
-3.20V	-165.037u	-104.127u	-230.250u
-3.10V	-173.749u	-109.479u	-242.685u
-3.00V	-183.400u	-115.386u	-256.500u
-2.90V	-194.148u	-121.936u	-271.934u
-2.80V	-206.189u	-129.240u	-289.286u
-2.70V	-219.766u	-137.431u	-308.933u
-2.60V	-235.190u	-146.680u	-331.355u
-2.50V	-252.856u	-157.199u	-357.176u
-2.40V	-273.283u	-169.265u	-387.219u
-2.30V	-297.162u	-183.236u	-422.595u
-2.20V	-325.427u	-199.590u	-464.837u
-2.10V	-359.384u	-218.976u	-516.117u
-2.00V	-400.901u	-242.299u	-579.623u
-1.90V	-452.750u	-270.851u	-660.217u
-1.80V	-519.217u	-306.549u	-765.681u
-1.70V	-607.277u	-352.346u	-909.270u
-1.60V	-729.045u	-413.024u	-1.115m
-1.50V	-907.407u	-496.811u	-1.434m
-1.40V	-1.191m	-619.011u	-1.987m
-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m

-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.871e-18	18.541e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	64.562m	22.817m
1.50V	117.094m	66.208m	23.575m
1.60V	119.708m	67.513m	184.138m
1.70V	121.667m	68.498m	187.874m
1.80V	123.055m	69.206m	190.647m
1.90V	124.020m	69.710m	192.621m
2.00V	124.711m	70.083m	194.017m
2.10V	125.232m	70.374m	195.034m
2.20V	125.650m	70.612m	195.815m
2.30V	126.000m	70.814m	196.447m
2.40V	126.305m	70.992m	196.983m
2.50V	126.577m	71.151m	197.453m
2.60V	126.823m	71.296m	197.876m
2.70V	127.050m	71.428m	198.263m
2.80V	127.260m	71.551m	198.622m
2.90V	127.457m	71.666m	198.958m
3.00V	127.643m	71.774m	199.275m
3.10V	127.818m	71.876m	199.576m
3.20V	127.986m	71.973m	199.863m
3.30V	128.147m	72.066m	200.138m
3.40V	128.304m	72.156m	200.405m
3.50V	128.458m	72.245m	200.667m
3.60V	128.614m	72.335m	200.928m
3.70V	128.776m	72.428m	201.194m
3.80V	128.948m	72.527m	201.472m
3.90V	129.140m	72.638m	201.774m
4.00V	129.361m	72.764m	202.113m
4.10V	129.621m	72.914m	202.503m
4.20V	129.934m	73.093m	202.966m
4.30V	130.316m	73.311m	203.524m
4.40V	130.784m	73.579m	204.203m

4.50V	131.358m	73.906m	205.033m
4.60V	132.060m	74.304m	206.045m
4.70V	132.912m	74.787m	207.276m
4.80V	133.939m	75.368m	208.763m
4.90V	135.166m	76.060m	210.544m
5.00V	136.619m	76.878m	212.659m
5.10V	138.324m	77.836m	215.149m
5.20V	140.308m	78.948m	218.056m
5.30V	142.597m	80.230m	221.419m
5.40V	145.217m	81.694m	225.277m
5.50V	148.192m	83.355m	229.669m
5.60V	151.545m	85.224m	234.630m
5.70V	155.300m	87.316m	240.194m
5.80V	159.478m	89.640m	246.393m
5.90V	164.097m	92.208m	253.255m
6.00V	169.177m	95.029m	260.806m
6.10V	174.734m	98.112m	269.070m
6.20V	180.781m	101.465m	278.065m
6.30V	187.333m	105.096m	287.810m
6.40V	194.400m	109.009m	298.319m
6.50V	201.993m	113.211m	309.602m
6.60V	210.118m	117.705m	321.670m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u
-2.00V	303.830u	217.155u	404.033u
-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u
-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m
-1.30V	960.395u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m
-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m

-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-65.539m	-13.798m
1.40V	-110.103m	-67.611m	-154.438m
1.50V	-113.807m	-69.311m	-170.370m
1.60V	-117.010m	-70.713m	-176.323m
1.70V	-119.783m	-71.893m	-181.647m
1.80V	-122.195m	-72.910m	-186.387m
1.90V	-124.297m	-73.804m	-190.581m
2.00V	-126.131m	-74.599m	-194.261m
2.10V	-127.733m	-75.311m	-197.468m
2.20V	-129.139m	-75.954m	-200.255m
2.30V	-130.384m	-76.540m	-202.683m
2.40V	-131.498m	-77.077m	-204.814m
2.50V	-132.504m	-77.575m	-206.704m
2.60V	-133.423m	-78.037m	-208.399m
2.70V	-134.270m	-78.470m	-209.937m
2.80V	-135.057m	-78.877m	-211.346m
2.90V	-135.792m	-79.261m	-212.650m
3.00V	-136.483m	-79.625m	-213.864m
3.10V	-137.136m	-79.971m	-215.004m
3.20V	-137.756m	-80.302m	-216.079m
3.30V	-138.345m	-80.617m	-217.098m
3.40V	-138.908m	-80.920m	-218.067m
3.50V	-139.447m	-81.210m	-218.993m
3.60V	-139.964m	-81.490m	-219.880m
3.70V	-140.462m	-81.761m	-220.732m
3.80V	-140.943m	-82.022m	-221.552m
3.90V	-141.408m	-82.277m	-222.344m
4.00V	-141.860m	-82.525m	-223.112m
4.10V	-142.300m	-82.769m	-223.858m
4.20V	-142.733m	-83.010m	-224.586m
4.30V	-143.159m	-83.250m	-225.300m
4.40V	-143.585m	-83.493m	-226.006m
4.50V	-144.013m	-83.740m	-226.709m
4.60V	-144.449m	-83.996m	-227.417m
4.70V	-144.899m	-84.265m	-228.137m
4.80V	-145.370m	-84.551m	-228.879m
4.90V	-145.871m	-84.861m	-229.656m

5.00V	-146.411m	-85.200m	-230.481m
5.10V	-147.001m	-85.575m	-231.368m
5.20V	-147.652m	-85.993m	-232.336m
5.30V	-148.379m	-86.464m	-233.404m
5.40V	-149.195m	-86.995m	-234.592m
5.50V	-150.115m	-87.597m	-235.924m
5.60V	-151.157m	-88.280m	-237.426m
5.70V	-152.339m	-89.054m	-239.124m
5.80V	-153.678m	-89.930m	-241.046m
5.90V	-155.194m	-90.921m	-243.223m
6.00V	-156.907m	-92.038m	-245.685m
6.10V	-158.839m	-93.294m	-248.465m
6.20V	-161.011m	-94.701m	-251.595m
6.30V	-163.444m	-96.273m	-255.109m
6.40V	-166.160m	-98.023m	-259.041m
6.50V	-169.182m	-99.963m	-263.425m
6.60V	-172.531m	-102.106m	-268.293m

|
[GND_clamp]
|

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.637	-1.514	-3.063
-3.20V	-2.521	-1.451	-2.926
-3.10V	-2.406	-1.387	-2.789
-2.90V	-2.174	-1.259	-2.515
-2.80V	-2.059	-1.195	-2.378
-2.70V	-1.943	-1.132	-2.242
-2.60V	-1.828	-1.068	-2.105
-2.50V	-1.713	-1.004	-1.969
-2.40V	-1.598	-941.073m	-1.833
-2.30V	-1.483	-877.750m	-1.697
-2.20V	-1.368	-814.544m	-1.561
-2.10V	-1.254	-751.475m	-1.425
-1.90V	-1.026	-625.847m	-1.155
-1.80V	-912.311m	-563.357m	-1.021
-1.70V	-799.377m	-501.149m	-886.904m
-1.60V	-687.103m	-439.297m	-753.859m
-1.50V	-575.715m	-377.904m	-621.897m
-1.40V	-465.583m	-317.129m	-491.519m
-1.30V	-357.354m	-257.221m	-363.667m
-1.20V	-252.314m	-198.614m	-240.395m
-1.10V	-153.494m	-142.138m	-127.373m
-0.90V	-19.457m	-45.305m	-11.215m
-0.80V	-3.535m	-16.226m	-4.650m
-0.70V	-877.640u	-3.288m	-1.613m
-0.60V	-156.838u	-397.909u	-271.662u
-0.50V	-14.514u	-53.601u	-18.044u
-0.40V	-780.351n	-6.086u	-560.308n
-0.30V	-37.668n	-598.098n	-15.437n
-0.20V	-1.699n	-55.739n	-411.332p
-0.10V	-92.071p	-5.410n	-29.683p
0.00V	-27.709p	-1.212n	-18.939p
0.10V	-22.802p	-890.771p	-16.163p
0.20V	-19.598p	-810.054p	-13.516p

0.30V	-16.468p	-745.765p	-10.874p
0.40V	-13.353p	-683.799p	-8.234p
0.50V	-10.247p	-622.802p	-5.595p
0.60V	-7.147p	-562.404p	-2.956p
0.70V	-4.050p	-502.414p	-318.962f
0.80V	-955.896f	-442.712p	2.318p
0.90V	2.136p	-383.217p	4.954p
1.10V	8.315p	-264.634p	10.227p
1.20V	11.404p	-205.467p	12.862p
1.30V	14.492p	-146.346p	15.498p
1.40V	17.579p	-87.245p	18.133p
1.50V	20.666p	-28.141p	20.768p
1.60V	23.754p	30.987p	23.404p
1.70V	26.841p	90.164p	26.039p
1.80V	29.929p	149.414p	28.674p
1.90V	33.018p	208.769p	31.310p
2.10V	39.198p	327.949p	36.581p
2.20V	42.291p	387.873p	39.216p
2.30V	45.385p	448.012p	41.852p
2.40V	48.483p	507.296p	44.489p
2.50V	51.583p	563.856p	47.125p
2.60V	54.673p	619.785p	49.762p
2.70V	57.468p	676.156p	52.401p
2.80V	59.647p	733.868p	55.040p
2.90V	61.717p	807.258p	57.675p
3.10V	65.859p	5.906n	61.928p
3.20V	68.003p	59.801n	63.585p
3.30V	72.601p	620.266n	65.236p

|
[POWER_clamp]

Voltage	I (typ)	I (min)	I (max)
3.30V	-27.709p	-598.098n	-10.874p
3.40V	-92.071p	-6.086u	-13.516p
3.50V	-1.699n	-53.601u	-16.163p
3.60V	-37.668n	-397.909u	-18.939p
3.70V	-780.351n	-3.288m	-29.683p
3.80V	-14.514u	-16.226m	-411.332p
3.90V	-156.838u	-45.305m	-15.437n
4.10V	-3.535m	-142.138m	-18.044u
4.20V	-19.457m	-198.614m	-271.662u
4.30V	-69.631m	-257.221m	-1.613m
4.40V	-153.494m	-317.129m	-4.650m
4.50V	-252.314m	-377.904m	-11.215m
4.60V	-357.354m	-439.297m	-43.562m
4.70V	-465.583m	-501.149m	-127.373m
4.80V	-575.715m	-563.357m	-240.395m
4.90V	-687.103m	-625.847m	-363.667m
5.10V	-912.311m	-751.475m	-621.897m
5.20V	-1.026	-814.544m	-753.859m
5.30V	-1.140	-877.750m	-886.904m
5.40V	-1.254	-941.073m	-1.021
5.50V	-1.368	-1.004	-1.155
5.60V	-1.483	-1.068	-1.290

5.70V	-1.598	-1.132	-1.425
5.80V	-1.713	-1.195	-1.561
5.90V	-1.828	-1.259	-1.697
6.10V	-2.059	-1.387	-1.969
6.20V	-2.174	-1.451	-2.105
6.30V	-2.290	-1.514	-2.242
6.40V	-2.406	-1.578	-2.378
6.50V	-2.521	-1.642	-2.515
6.60V	-2.637	-1.706	-2.652

```

|
[Ramp]
|Voltage      I (typ)      I (min)      I (max)
|
dV/dt_f      1.99/110.010p 1.81/184.463p 2.17/69.974p
|
dV/dt_r      2.04/120.172p 1.85/212.126p 2.21/73.179p
R_load=10000ohms
| R_load was connected to ground for Ramp_up test and power for Ramp_dn test
|
|End model
[Model]      ipadd_io      | ""
Model_type   I/O
Vinl = 0.8
Vinh = 2
| variable      typ      min      max
C_comp        2.34p      2.21p      2.52p
| variable      typ      min      max
[Temperature Range] 40.0      0.0      120.0
| variable      typ      min      max
[Voltage Range]   3.30V      3.00V      3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
|Voltage      I (typ)      I (min)      I (max)
|
-3.30V      -157.134u -99.256u -219.000u
-3.20V      -165.037u -104.127u -230.250u
-3.10V      -173.749u -109.479u -242.685u
-3.00V      -183.400u -115.386u -256.500u
-2.90V      -194.148u -121.936u -271.934u
-2.80V      -206.189u -129.240u -289.286u
-2.70V      -219.766u -137.431u -308.933u
-2.60V      -235.190u -146.680u -331.355u
-2.50V      -252.856u -157.199u -357.176u
-2.40V      -273.283u -169.265u -387.219u
-2.30V      -297.162u -183.236u -422.595u
-2.20V      -325.427u -199.590u -464.837u
-2.10V      -359.384u -218.976u -516.117u
-2.00V      -400.901u -242.299u -579.623u
-1.90V      -452.750u -270.851u -660.217u
-1.80V      -519.217u -306.549u -765.681u
-1.70V      -607.277u -352.346u -909.270u
-1.60V      -729.045u -413.024u -1.115m
-1.50V      -907.407u -496.811u -1.434m
-1.40V      -1.191m -619.011u -1.987m

```

-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m
-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.871e-18	18.540e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	64.562m	22.817m
1.50V	117.094m	66.208m	23.575m
1.60V	119.708m	67.513m	184.138m
1.70V	121.667m	68.498m	187.874m
1.80V	123.055m	69.206m	190.647m
1.90V	124.020m	69.710m	192.621m
2.00V	124.711m	70.083m	194.017m
2.10V	125.232m	70.374m	195.034m
2.20V	125.650m	70.612m	195.815m
2.30V	126.000m	70.814m	196.447m
2.40V	126.305m	70.992m	196.983m
2.50V	126.577m	71.151m	197.453m
2.60V	126.823m	71.296m	197.876m
2.70V	127.050m	71.428m	198.263m
2.80V	127.260m	71.551m	198.622m
2.90V	127.457m	71.666m	198.958m
3.00V	127.643m	71.774m	199.275m
3.10V	127.818m	71.876m	199.576m
3.20V	127.986m	71.973m	199.863m
3.30V	128.147m	72.066m	200.138m
3.40V	128.304m	72.156m	200.405m
3.50V	128.458m	72.245m	200.667m
3.60V	128.614m	72.335m	200.928m
3.70V	128.776m	72.428m	201.194m
3.80V	128.948m	72.527m	201.472m
3.90V	129.140m	72.638m	201.774m
4.00V	129.361m	72.764m	202.113m
4.10V	129.621m	72.914m	202.503m

4.20V	129.934m	73.093m	202.966m
4.30V	130.316m	73.311m	203.524m
4.40V	130.784m	73.579m	204.203m
4.50V	131.358m	73.906m	205.033m
4.60V	132.060m	74.304m	206.045m
4.70V	132.912m	74.787m	207.276m
4.80V	133.939m	75.368m	208.763m
4.90V	135.166m	76.060m	210.544m
5.00V	136.619m	76.878m	212.659m
5.10V	138.324m	77.836m	215.149m
5.20V	140.308m	78.948m	218.056m
5.30V	142.597m	80.230m	221.419m
5.40V	145.217m	81.694m	225.277m
5.50V	148.192m	83.355m	229.669m
5.60V	151.545m	85.224m	234.630m
5.70V	155.300m	87.316m	240.194m
5.80V	159.478m	89.640m	246.393m
5.90V	164.097m	92.208m	253.255m
6.00V	169.177m	95.029m	260.806m
6.10V	174.734m	98.112m	269.070m
6.20V	180.781m	101.465m	278.065m
6.30V	187.333m	105.096m	287.810m
6.40V	194.400m	109.009m	298.319m
6.50V	201.993m	113.211m	309.602m
6.60V	210.118m	117.705m	321.670m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u
-2.00V	303.830u	217.155u	404.033u
-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u
-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m
-1.30V	960.395u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m

-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m
-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-65.539m	-13.798m
1.40V	-110.103m	-67.611m	-154.438m
1.50V	-113.807m	-69.311m	-170.370m
1.60V	-117.010m	-70.713m	-176.323m
1.70V	-119.783m	-71.893m	-181.647m
1.80V	-122.195m	-72.910m	-186.387m
1.90V	-124.297m	-73.804m	-190.581m
2.00V	-126.131m	-74.599m	-194.261m
2.10V	-127.733m	-75.311m	-197.468m
2.20V	-129.139m	-75.954m	-200.255m
2.30V	-130.384m	-76.540m	-202.683m
2.40V	-131.498m	-77.077m	-204.814m
2.50V	-132.504m	-77.575m	-206.704m
2.60V	-133.423m	-78.037m	-208.399m
2.70V	-134.270m	-78.470m	-209.937m
2.80V	-135.057m	-78.877m	-211.346m
2.90V	-135.792m	-79.261m	-212.650m
3.00V	-136.483m	-79.625m	-213.864m
3.10V	-137.136m	-79.971m	-215.004m
3.20V	-137.756m	-80.302m	-216.079m
3.30V	-138.345m	-80.617m	-217.098m
3.40V	-138.908m	-80.920m	-218.067m
3.50V	-139.447m	-81.210m	-218.993m
3.60V	-139.964m	-81.490m	-219.880m
3.70V	-140.462m	-81.761m	-220.732m
3.80V	-140.943m	-82.022m	-221.552m
3.90V	-141.408m	-82.277m	-222.344m
4.00V	-141.860m	-82.525m	-223.112m
4.10V	-142.300m	-82.769m	-223.858m
4.20V	-142.733m	-83.010m	-224.586m
4.30V	-143.159m	-83.250m	-225.300m
4.40V	-143.585m	-83.493m	-226.006m
4.50V	-144.013m	-83.740m	-226.709m
4.60V	-144.449m	-83.996m	-227.417m

4.70V	-144.899m	-84.265m	-228.137m
4.80V	-145.370m	-84.551m	-228.879m
4.90V	-145.871m	-84.861m	-229.656m
5.00V	-146.411m	-85.200m	-230.481m
5.10V	-147.001m	-85.575m	-231.368m
5.20V	-147.652m	-85.993m	-232.336m
5.30V	-148.379m	-86.464m	-233.404m
5.40V	-149.195m	-86.995m	-234.592m
5.50V	-150.115m	-87.597m	-235.924m
5.60V	-151.157m	-88.280m	-237.426m
5.70V	-152.339m	-89.054m	-239.124m
5.80V	-153.678m	-89.930m	-241.046m
5.90V	-155.194m	-90.921m	-243.223m
6.00V	-156.907m	-92.038m	-245.685m
6.10V	-158.839m	-93.294m	-248.465m
6.20V	-161.011m	-94.701m	-251.595m
6.30V	-163.444m	-96.273m	-255.109m
6.40V	-166.160m	-98.023m	-259.041m
6.50V	-169.182m	-99.963m	-263.425m
6.60V	-172.531m	-102.106m	-268.293m

|
[GND_clamp]

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.637	-1.514	-3.063
-3.20V	-2.521	-1.451	-2.926
-3.10V	-2.406	-1.387	-2.789
-2.90V	-2.174	-1.259	-2.515
-2.80V	-2.059	-1.195	-2.378
-2.70V	-1.943	-1.132	-2.242
-2.60V	-1.828	-1.068	-2.105
-2.50V	-1.713	-1.004	-1.969
-2.40V	-1.598	-941.073m	-1.833
-2.30V	-1.483	-877.750m	-1.697
-2.20V	-1.368	-814.544m	-1.561
-2.10V	-1.254	-751.475m	-1.425
-1.90V	-1.026	-625.847m	-1.155
-1.80V	-912.311m	-563.357m	-1.021
-1.70V	-799.377m	-501.149m	-886.904m
-1.60V	-687.103m	-439.297m	-753.859m
-1.50V	-575.715m	-377.904m	-621.897m
-1.40V	-465.583m	-317.129m	-491.519m
-1.30V	-357.354m	-257.221m	-363.667m
-1.20V	-252.314m	-198.614m	-240.395m
-1.10V	-153.494m	-142.138m	-127.373m
-0.90V	-19.457m	-45.305m	-11.215m
-0.80V	-3.535m	-16.226m	-4.650m
-0.70V	-877.640u	-3.288m	-1.613m
-0.60V	-156.838u	-397.909u	-271.662u
-0.50V	-14.514u	-53.601u	-18.044u
-0.40V	-780.351n	-6.086u	-560.308n
-0.30V	-37.668n	-598.098n	-15.437n
-0.20V	-1.699n	-55.739n	-411.332p
-0.10V	-92.071p	-5.410n	-29.683p

0.00V	-27.709p	-1.212n	-18.939p
0.10V	-22.802p	-890.771p	-16.163p
0.20V	-19.598p	-810.054p	-13.516p
0.30V	-16.468p	-745.765p	-10.874p
0.40V	-13.353p	-683.799p	-8.234p
0.50V	-10.247p	-622.802p	-5.595p
0.60V	-7.147p	-562.404p	-2.956p
0.70V	-4.050p	-502.414p	-318.962f
0.80V	-955.896f	-442.712p	2.318p
0.90V	2.136p	-383.217p	4.954p
1.10V	8.315p	-264.634p	10.227p
1.20V	11.404p	-205.467p	12.862p
1.30V	14.492p	-146.346p	15.498p
1.40V	17.579p	-87.245p	18.133p
1.50V	20.666p	-28.141p	20.768p
1.60V	23.754p	30.987p	23.404p
1.70V	26.841p	90.164p	26.039p
1.80V	29.929p	149.414p	28.674p
1.90V	33.018p	208.769p	31.310p
2.10V	39.198p	327.949p	36.581p
2.20V	42.291p	387.873p	39.216p
2.30V	45.385p	448.012p	41.852p
2.40V	48.483p	507.296p	44.489p
2.50V	51.583p	563.856p	47.125p
2.60V	54.673p	619.785p	49.762p
2.70V	57.468p	676.156p	52.401p
2.80V	59.647p	733.868p	55.040p
2.90V	61.717p	807.258p	57.675p
3.10V	65.859p	5.906n	61.928p
3.20V	68.003p	59.801n	63.585p
3.30V	72.601p	620.266n	65.236p

|
[POWER_clamp]

Voltage	I (typ)	I (min)	I (max)
3.30V	-27.709p	-598.098n	-10.874p
3.40V	-92.071p	-6.086u	-13.516p
3.50V	-1.699n	-53.601u	-16.163p
3.60V	-37.668n	-397.909u	-18.939p
3.70V	-780.351n	-3.288m	-29.683p
3.80V	-14.514u	-16.226m	-411.332p
3.90V	-156.838u	-45.305m	-15.437n
4.10V	-3.535m	-142.138m	-18.044u
4.20V	-19.457m	-198.614m	-271.662u
4.30V	-69.631m	-257.221m	-1.613m
4.40V	-153.494m	-317.129m	-4.650m
4.50V	-252.314m	-377.904m	-11.215m
4.60V	-357.354m	-439.297m	-43.562m
4.70V	-465.583m	-501.149m	-127.373m
4.80V	-575.715m	-563.357m	-240.395m
4.90V	-687.103m	-625.847m	-363.667m
5.10V	-912.311m	-751.475m	-621.897m
5.20V	-1.026	-814.544m	-753.859m
5.30V	-1.140	-877.750m	-886.904m

5.40V	-1.254	-941.073m	-1.021
5.50V	-1.368	-1.004	-1.155
5.60V	-1.483	-1.068	-1.290
5.70V	-1.598	-1.132	-1.425
5.80V	-1.713	-1.195	-1.561
5.90V	-1.828	-1.259	-1.697
6.10V	-2.059	-1.387	-1.969
6.20V	-2.174	-1.451	-2.105
6.30V	-2.290	-1.514	-2.242
6.40V	-2.406	-1.578	-2.378
6.50V	-2.521	-1.642	-2.515
6.60V	-2.637	-1.706	-2.652

|

[Ramp]

Voltage	I (typ)	I (min)	I (max)
dV/dt_f	1.99/104.603p	1.81/183.924p	2.18/69.643p
dV/dt_r	2.04/123.810p	1.85/215.062p	2.20/73.602p

R_load=10000ohms

| R_load was connected to ground for Ramp_up test and power for Ramp_dn test

|

|End model

[Model] ipadex_i | ""

Model_type Input

Vinl = 0.8

Vinh = 2

variable	typ	min	max
C_comp	2.92p	2.78p	2.96p

variable	typ	min	max
[Temperature Range]	40.0	0.0	120.0

variable	typ	min	max
[Voltage Range]	3.30V	3.00V	3.60V

|

[GND_clamp]

|

Voltage	I (typ)	I (min)	I (max)
-3.30V	-831.819m	-473.616m	-909.150m
-3.20V	-796.528m	-454.528m	-869.534m
-3.10V	-761.255m	-435.451m	-829.938m
-2.90V	-690.773m	-397.335m	-750.811m
-2.80V	-655.569m	-378.299m	-711.286m
-2.70V	-620.391m	-359.279m	-671.789m
-2.60V	-585.244m	-340.277m	-632.324m
-2.50V	-550.131m	-321.295m	-592.895m
-2.40V	-515.057m	-302.336m	-553.507m
-2.30V	-480.027m	-283.402m	-514.167m
-2.20V	-445.047m	-264.496m	-474.880m
-2.10V	-410.126m	-245.624m	-435.657m
-1.90V	-340.501m	-207.998m	-357.451m
-1.80V	-305.826m	-189.259m	-318.503m
-1.70V	-271.273m	-170.582m	-279.692m
-1.60V	-236.871m	-151.981m	-241.057m
-1.50V	-202.665m	-133.474m	-202.657m

-1.40V	-168.722m	-115.088m	-164.583m
-1.30V	-135.151m	-96.861m	-126.991m
-1.20V	-102.140m	-78.852m	-90.181m
-1.10V	-70.064m	-61.160m	-54.834m
-0.90V	-14.097m	-27.650m	-2.799m
-0.80V	-1.307m	-13.160m	-53.501u
-0.70V	-36.639u	-3.159m	-768.589n
-0.60V	-903.944n	-256.975u	-10.997n
-0.50V	-22.242n	-13.934u	-172.415p
-0.40V	-567.014p	-730.372n	-16.888p
-0.30V	-32.976p	-38.990n	-13.767p
-0.20V	-18.575p	-2.810n	-12.822p
-0.10V	-16.945p	-867.431p	-11.909p
0.00V	-15.630p	-713.428p	-10.996p
0.10V	-14.322p	-652.886p	-10.084p
0.20V	-13.014p	-597.227p	-9.171p
0.30V	-11.707p	-541.823p	-8.258p
0.40V	-10.399p	-486.432p	-7.345p
0.50V	-9.092p	-431.043p	-6.432p
0.60V	-7.784p	-375.653p	-5.520p
0.70V	-6.477p	-320.263p	-4.607p
0.80V	-5.169p	-264.873p	-3.694p
0.90V	-3.862p	-209.483p	-2.781p
1.10V	-1.246p	-98.704p	-955.508f
1.20V	61.165f	-43.314p	-42.711f
1.30V	1.369p	12.076p	870.085f
1.40V	2.676p	67.466p	1.783p
1.50V	3.984p	122.856p	2.696p
1.60V	5.291p	178.246p	3.609p
1.70V	6.599p	233.635p	4.521p
1.80V	7.906p	289.025p	5.434p
1.90V	9.214p	344.415p	6.347p
2.10V	11.829p	455.195p	8.173p
2.20V	13.137p	510.585p	9.085p
2.30V	14.444p	565.974p	9.998p
2.40V	15.752p	621.364p	10.911p
2.50V	17.059p	676.754p	11.824p
2.60V	18.367p	732.144p	12.736p
2.70V	19.674p	787.535p	13.649p
2.80V	20.982p	842.946p	14.562p
2.90V	22.290p	898.735p	15.475p
3.10V	24.905p	1.163n	17.301p
3.20V	26.212p	4.019n	18.213p
3.30V	27.520p	57.671n	19.126p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-15.630p	-38.990n	-8.258p
3.40V	-16.945p	-730.372n	-9.171p
3.50V	-18.575p	-13.934u	-10.084p
3.60V	-32.976p	-256.975u	-10.996p
3.70V	-567.014p	-3.159m	-11.909p
3.80V	-22.242n	-13.160m	-12.822p

```

3.90V      -903.944n -27.650m -13.767p
4.10V      -1.307m -61.160m -172.415p
4.20V      -14.097m -78.852m -10.997n
4.30V      -39.803m -96.861m -768.589n
4.40V      -70.064m -115.088m -53.501u
4.50V      -102.140m -133.474m -2.799m
4.60V      -135.151m -151.981m -22.990m
4.70V      -168.722m -170.582m -54.834m
4.80V      -202.665m -189.259m -90.181m
4.90V      -236.871m -207.998m -126.991m
5.10V      -305.826m -245.624m -202.657m
5.20V      -340.501m -264.496m -241.057m
5.30V      -375.273m -283.402m -279.692m
5.40V      -410.126m -302.336m -318.503m
5.50V      -445.047m -321.295m -357.451m
5.60V      -480.027m -340.277m -396.509m
5.70V      -515.057m -359.279m -435.657m
5.80V      -550.131m -378.299m -474.880m
5.90V      -585.244m -397.335m -514.167m
6.10V      -655.569m -435.451m -592.895m
6.20V      -690.773m -454.528m -632.324m
6.30V      -726.003m -473.616m -671.789m
6.40V      -761.255m -492.715m -711.286m
6.50V      -796.528m -511.823m -750.811m
6.60V      -831.819m -530.941m -790.363m
|
|End model
[Model]          ipadm_3st          | ""
Model_type      3-state
| variable      typ          min          max
C_comp          1.99p      1.86p      2.15p
| variable      typ          min          max
[Temperature Range] 40.0          0.0          120.0
| variable      typ          min          max
[Voltage Range]   3.30V      3.00V      3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
|Voltage      I(typ)      I(min)      I(max)
|
-3.30V      -157.134u -99.256u -219.000u
-3.20V      -165.037u -104.127u -230.250u
-3.10V      -173.749u -109.479u -242.685u
-3.00V      -183.400u -115.386u -256.500u
-2.90V      -194.148u -121.936u -271.934u
-2.80V      -206.189u -129.240u -289.286u
-2.70V      -219.766u -137.431u -308.933u
-2.60V      -235.190u -146.680u -331.355u
-2.50V      -252.856u -157.199u -357.176u
-2.40V      -273.283u -169.265u -387.219u
-2.30V      -297.162u -183.236u -422.595u
-2.20V      -325.427u -199.590u -464.837u
-2.10V      -359.384u -218.976u -516.117u
-2.00V      -400.901u -242.299u -579.623u
-1.90V      -452.750u -270.851u -660.217u

```

-1.80V	-519.217u	-306.549u	-765.681u
-1.70V	-607.277u	-352.346u	-909.270u
-1.60V	-729.045u	-413.024u	-1.115m
-1.50V	-907.407u	-496.811u	-1.434m
-1.40V	-1.191m	-619.011u	-1.987m
-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m
-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.755e-18	18.548e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	47.725m	22.817m
1.50V	86.564m	48.943m	23.575m
1.60V	88.497m	49.908m	136.139m
1.70V	89.946m	50.637m	138.902m
1.80V	90.974m	51.160m	140.954m
1.90V	91.689m	51.534m	142.415m
2.00V	92.200m	51.810m	143.449m
2.10V	92.586m	52.024m	144.201m
2.20V	92.895m	52.201m	144.779m
2.30V	93.154m	52.351m	145.246m
2.40V	93.380m	52.482m	145.642m
2.50V	93.581m	52.600m	145.990m
2.60V	93.764m	52.706m	146.303m
2.70V	93.931m	52.804m	146.590m
2.80V	94.087m	52.895m	146.855m
2.90V	94.233m	52.980m	147.104m
3.00V	94.370m	53.060m	147.338m
3.10V	94.500m	53.135m	147.560m
3.20V	94.624m	53.207m	147.772m
3.30V	94.744m	53.276m	147.976m
3.40V	94.859m	53.343m	148.174m
3.50V	94.974m	53.408m	148.367m
3.60V	95.089m	53.475m	148.560m

3.70V	95.208m	53.543m	148.757m
3.80V	95.336m	53.617m	148.963m
3.90V	95.478m	53.699m	149.186m
4.00V	95.641m	53.792m	149.436m
4.10V	95.833m	53.902m	149.725m
4.20V	96.065m	54.035m	150.067m
4.30V	96.347m	54.196m	150.479m
4.40V	96.693m	54.394m	150.981m
4.50V	97.117m	54.635m	151.594m
4.60V	97.636m	54.930m	152.342m
4.70V	98.266m	55.287m	153.252m
4.80V	99.024m	55.716m	154.350m
4.90V	99.931m	56.227m	155.666m
5.00V	101.005m	56.831m	157.230m
5.10V	102.264m	57.539m	159.070m
5.20V	103.730m	58.361m	161.218m
5.30V	105.422m	59.308m	163.704m
5.40V	107.357m	60.391m	166.555m
5.50V	109.556m	61.618m	169.801m
5.60V	112.034m	63.000m	173.468m
5.70V	114.809m	64.545m	177.581m
5.80V	117.897m	66.263m	182.163m
5.90V	121.311m	68.160m	187.235m
6.00V	125.066m	70.245m	192.816m
6.10V	129.172m	72.524m	198.924m
6.20V	133.642m	75.002m	205.573m
6.30V	138.485m	77.685m	212.776m
6.40V	143.709m	80.578m	220.544m
6.50V	149.320m	83.683m	228.885m
6.60V	155.326m	87.004m	237.805m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u
-2.00V	303.830u	217.155u	404.033u
-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u
-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m

-1.30V	960.396u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m
-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m
-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-47.451m	-13.837m
1.40V	-79.705m	-48.954m	-118.519m
1.50V	-82.391m	-50.187m	-123.324m
1.60V	-84.713m	-51.203m	-127.640m
1.70V	-86.724m	-52.057m	-131.501m
1.80V	-88.472m	-52.794m	-134.939m
1.90V	-89.996m	-53.442m	-137.982m
2.00V	-91.327m	-54.017m	-140.655m
2.10V	-92.489m	-54.533m	-142.987m
2.20V	-93.511m	-54.999m	-145.014m
2.30V	-94.415m	-55.424m	-146.781m
2.40V	-95.224m	-55.814m	-148.333m
2.50V	-95.955m	-56.174m	-149.709m
2.60V	-96.623m	-56.510m	-150.943m
2.70V	-97.238m	-56.824m	-152.063m
2.80V	-97.809m	-57.119m	-153.088m
2.90V	-98.343m	-57.398m	-154.036m
3.00V	-98.846m	-57.662m	-154.920m
3.10V	-99.320m	-57.913m	-155.749m
3.20V	-99.770m	-58.152m	-156.531m
3.30V	-100.198m	-58.381m	-157.272m
3.40V	-100.607m	-58.601m	-157.977m
3.50V	-100.998m	-58.812m	-158.650m
3.60V	-101.374m	-59.015m	-159.295m
3.70V	-101.735m	-59.211m	-159.914m
3.80V	-102.084m	-59.401m	-160.510m
3.90V	-102.422m	-59.585m	-161.086m
4.00V	-102.750m	-59.766m	-161.644m
4.10V	-103.070m	-59.942m	-162.186m

4.20V	-103.384m	-60.117m	-162.715m
4.30V	-103.694m	-60.291m	-163.234m
4.40V	-104.002m	-60.467m	-163.747m
4.50V	-104.313m	-60.647m	-164.257m
4.60V	-104.629m	-60.832m	-164.770m
4.70V	-104.955m	-61.027m	-165.293m
4.80V	-105.296m	-61.234m	-165.831m
4.90V	-105.659m	-61.459m	-166.394m
5.00V	-106.050m	-61.704m	-166.991m
5.10V	-106.477m	-61.975m	-167.634m
5.20V	-106.949m	-62.278m	-168.334m
5.30V	-107.474m	-62.619m	-169.106m
5.40V	-108.064m	-63.003m	-169.965m
5.50V	-108.730m	-63.439m	-170.928m
5.60V	-109.483m	-63.932m	-172.012m
5.70V	-110.337m	-64.492m	-173.239m
5.80V	-111.305m	-65.126m	-174.627m
5.90V	-112.401m	-65.843m	-176.199m
6.00V	-113.640m	-66.651m	-177.978m
6.10V	-115.036m	-67.560m	-179.986m
6.20V	-116.606m	-68.578m	-182.247m
6.30V	-118.365m	-69.715m	-184.785m
6.40V	-120.329m	-70.981m	-187.626m
6.50V	-122.513m	-72.384m	-190.793m
6.60V	-124.935m	-73.935m	-194.311m

|
[GND_clamp]
|

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.165	-1.242	-2.500
-3.20V	-2.070	-1.190	-2.388
-3.10V	-1.975	-1.138	-2.277
-2.90V	-1.786	-1.033	-2.054
-2.80V	-1.691	-981.185m	-1.942
-2.70V	-1.597	-929.174m	-1.831
-2.60V	-1.503	-877.220m	-1.720
-2.50V	-1.408	-825.330m	-1.609
-2.40V	-1.314	-773.514m	-1.498
-2.30V	-1.220	-721.779m	-1.387
-2.20V	-1.126	-670.140m	-1.276
-2.10V	-1.032	-618.610m	-1.166
-1.90V	-845.771m	-515.958m	-945.908m
-1.80V	-752.887m	-464.892m	-836.403m
-1.70V	-660.410m	-414.052m	-727.373m
-1.60V	-568.461m	-363.494m	-618.970m
-1.50V	-477.221m	-313.301m	-511.430m
-1.40V	-386.980m	-263.597m	-405.149m
-1.30V	-298.248m	-214.579m	-300.867m
-1.20V	-212.028m	-166.582m	-200.187m
-1.10V	-130.668m	-120.248m	-107.496m
-0.90V	-17.375m	-40.029m	-8.803m
-0.80V	-2.837m	-14.886m	-3.451m
-0.70V	-656.331u	-3.014m	-1.195m
-0.60V	-116.521u	-336.317u	-201.636u

-0.50V	-10.789u	-41.964u	-13.420u
-0.40V	-580.051n	-4.632u	-416.799n
-0.30V	-27.994n	-450.005n	-11.484n
-0.20V	-1.269n	-41.862n	-311.158p
-0.10V	-74.463p	-4.218n	-27.092p
0.00V	-26.215p	-1.078n	-18.737p
0.10V	-22.114p	-826.325p	-16.303p
0.20V	-19.278p	-754.146p	-13.966p
0.30V	-16.497p	-694.188p	-11.632p
0.40V	-13.726p	-635.953p	-9.300p
0.50V	-10.963p	-578.437p	-6.968p
0.60V	-8.203p	-521.365p	-4.637p
0.70V	-5.446p	-464.595p	-2.307p
0.80V	-2.691p	-408.039p	22.980f
0.90V	62.079f	-351.636p	2.353p
1.10V	5.566p	-239.133p	7.011p
1.20V	8.316p	-182.975p	9.340p
1.30V	11.067p	-126.851p	11.669p
1.40V	13.817p	-70.743p	13.998p
1.50V	16.567p	-14.634p	16.327p
1.60V	19.317p	41.493p	18.656p
1.70V	22.067p	97.654p	20.985p
1.80V	24.817p	153.868p	23.313p
1.90V	27.568p	210.159p	25.642p
2.10V	33.072p	323.083p	30.300p
2.20V	35.825p	379.789p	32.629p
2.30V	38.581p	436.650p	34.958p
2.40V	41.339p	492.867p	37.288p
2.50V	44.098p	547.026p	39.618p
2.60V	46.849p	600.695p	41.948p
2.70V	49.356p	654.682p	44.279p
2.80V	51.378p	709.650p	46.611p
2.90V	53.315p	776.122p	48.939p
3.10V	57.193p	4.552n	52.772p
3.20V	59.183p	44.522n	54.319p
3.30V	62.959p	466.732n	55.861p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-26.215p	-450.005n	-11.632p
3.40V	-74.463p	-4.632u	-13.966p
3.50V	-1.269n	-41.964u	-16.303p
3.60V	-27.994n	-336.317u	-18.737p
3.70V	-580.051n	-3.014m	-27.092p
3.80V	-10.789u	-14.886m	-311.158p
3.90V	-116.521u	-40.029m	-11.484n
4.10V	-2.837m	-120.248m	-13.420u
4.20V	-17.375m	-166.582m	-201.636u
4.30V	-60.888m	-214.579m	-1.195m
4.40V	-130.668m	-263.597m	-3.451m
4.50V	-212.028m	-313.301m	-8.803m
4.60V	-298.248m	-363.494m	-37.420m
4.70V	-386.980m	-414.052m	-107.496m

```

4.80V      -477.221m -464.892m -200.187m
4.90V      -568.461m -515.958m -300.867m
5.10V      -752.887m -618.610m -511.430m
5.20V      -845.771m -670.140m -618.970m
5.30V      -938.979m -721.779m -727.373m
5.40V      -1.032   -773.514m -836.403m
5.50V      -1.126   -825.330m -945.908m
5.60V      -1.220   -877.220m   -1.056
5.70V      -1.314   -929.174m   -1.166
5.80V      -1.408   -981.185m   -1.276
5.90V      -1.503    -1.033    -1.387
6.10V      -1.691    -1.138    -1.609
6.20V      -1.786    -1.190    -1.720
6.30V      -1.881    -1.242    -1.831
6.40V      -1.975    -1.294    -1.942
6.50V      -2.070    -1.346    -2.054
6.60V      -2.165    -1.399    -2.165
|
[Ramp]
|Voltage      I (typ)      I (min)      I (max)
|
dV/dt_f      1.99/116.478p 1.81/206.384p 2.17/80.687p
|
dV/dt_r      2.02/147.722p 1.84/253.853p 2.19/93.030p
R_load=10000ohms
| R_load was connected to ground for Ramp_up test and power for Ramp_dn test
|
|End model
[Model]      ipadn_io      | ""
Model_type      I/O
Vinl = 0.8
Vinh = 2
| variable      typ      min      max
C_comp      2.03p      1.90p      2.18p
| variable      typ      min      max
[Temperature Range] 40.0      0.0      120.0
| variable      typ      min      max
[Voltage Range] 3.30V      3.00V      3.60V
|
[Pulldown]
| pulldown in the table = pulldown subtract gnd_clamp
|Voltage      I (typ)      I (min)      I (max)
|
-3.30V      -157.134u -99.256u -219.000u
-3.20V      -165.037u -104.127u -230.250u
-3.10V      -173.749u -109.479u -242.685u
-3.00V      -183.400u -115.386u -256.500u
-2.90V      -194.148u -121.936u -271.934u
-2.80V      -206.189u -129.240u -289.286u
-2.70V      -219.766u -137.431u -308.933u
-2.60V      -235.190u -146.680u -331.355u
-2.50V      -252.856u -157.199u -357.176u
-2.40V      -273.283u -169.265u -387.219u
-2.30V      -297.162u -183.236u -422.595u
-2.20V      -325.427u -199.590u -464.837u

```

-2.10V	-359.384u	-218.976u	-516.117u
-2.00V	-400.901u	-242.299u	-579.623u
-1.90V	-452.750u	-270.851u	-660.217u
-1.80V	-519.217u	-306.549u	-765.681u
-1.70V	-607.277u	-352.346u	-909.270u
-1.60V	-729.045u	-413.024u	-1.115m
-1.50V	-907.407u	-496.811u	-1.434m
-1.40V	-1.191m	-619.011u	-1.987m
-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m
-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.755e-18	18.548e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	47.725m	22.817m
1.50V	86.564m	48.943m	23.575m
1.60V	88.497m	49.908m	136.139m
1.70V	89.946m	50.637m	138.902m
1.80V	90.974m	51.160m	140.954m
1.90V	91.689m	51.534m	142.415m
2.00V	92.200m	51.810m	143.449m
2.10V	92.586m	52.024m	144.201m
2.20V	92.895m	52.201m	144.779m
2.30V	93.154m	52.351m	145.246m
2.40V	93.380m	52.482m	145.642m
2.50V	93.581m	52.600m	145.990m
2.60V	93.764m	52.706m	146.303m
2.70V	93.931m	52.804m	146.590m
2.80V	94.087m	52.895m	146.855m
2.90V	94.233m	52.980m	147.104m
3.00V	94.370m	53.060m	147.338m
3.10V	94.500m	53.135m	147.560m
3.20V	94.624m	53.207m	147.772m
3.30V	94.744m	53.276m	147.976m

3.40V	94.859m	53.343m	148.174m
3.50V	94.974m	53.408m	148.367m
3.60V	95.089m	53.475m	148.560m
3.70V	95.208m	53.543m	148.757m
3.80V	95.336m	53.617m	148.963m
3.90V	95.478m	53.699m	149.186m
4.00V	95.641m	53.792m	149.436m
4.10V	95.833m	53.902m	149.725m
4.20V	96.065m	54.035m	150.067m
4.30V	96.347m	54.196m	150.479m
4.40V	96.693m	54.394m	150.981m
4.50V	97.117m	54.635m	151.594m
4.60V	97.636m	54.930m	152.342m
4.70V	98.266m	55.287m	153.252m
4.80V	99.024m	55.716m	154.350m
4.90V	99.931m	56.227m	155.666m
5.00V	101.005m	56.831m	157.230m
5.10V	102.264m	57.539m	159.070m
5.20V	103.730m	58.361m	161.218m
5.30V	105.422m	59.308m	163.704m
5.40V	107.357m	60.391m	166.555m
5.50V	109.556m	61.618m	169.801m
5.60V	112.034m	63.000m	173.468m
5.70V	114.809m	64.545m	177.581m
5.80V	117.897m	66.263m	182.163m
5.90V	121.311m	68.160m	187.235m
6.00V	125.066m	70.245m	192.816m
6.10V	129.172m	72.524m	198.924m
6.20V	133.642m	75.002m	205.573m
6.30V	138.485m	77.685m	212.776m
6.40V	143.709m	80.578m	220.544m
6.50V	149.320m	83.683m	228.885m
6.60V	155.326m	87.004m	237.805m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u
-2.00V	303.830u	217.155u	404.033u
-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u

-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m
-1.30V	960.396u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m
-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m
-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-47.451m	-13.901m
1.40V	-79.705m	-48.954m	-118.519m
1.50V	-82.391m	-50.187m	-123.324m
1.60V	-84.713m	-51.203m	-127.640m
1.70V	-86.724m	-52.057m	-131.501m
1.80V	-88.472m	-52.794m	-134.939m
1.90V	-89.996m	-53.442m	-137.982m
2.00V	-91.327m	-54.017m	-140.655m
2.10V	-92.489m	-54.533m	-142.987m
2.20V	-93.511m	-54.999m	-145.014m
2.30V	-94.415m	-55.424m	-146.781m
2.40V	-95.224m	-55.814m	-148.333m
2.50V	-95.955m	-56.174m	-149.709m
2.60V	-96.623m	-56.510m	-150.943m
2.70V	-97.238m	-56.824m	-152.063m
2.80V	-97.809m	-57.119m	-153.088m
2.90V	-98.343m	-57.398m	-154.036m
3.00V	-98.846m	-57.662m	-154.920m
3.10V	-99.320m	-57.913m	-155.749m
3.20V	-99.770m	-58.152m	-156.531m
3.30V	-100.198m	-58.381m	-157.272m
3.40V	-100.607m	-58.601m	-157.977m
3.50V	-100.998m	-58.812m	-158.650m
3.60V	-101.374m	-59.015m	-159.295m
3.70V	-101.735m	-59.211m	-159.914m
3.80V	-102.084m	-59.401m	-160.510m

3.90V	-102.422m	-59.585m	-161.086m
4.00V	-102.750m	-59.766m	-161.644m
4.10V	-103.070m	-59.942m	-162.186m
4.20V	-103.384m	-60.117m	-162.715m
4.30V	-103.694m	-60.291m	-163.234m
4.40V	-104.002m	-60.467m	-163.747m
4.50V	-104.313m	-60.647m	-164.257m
4.60V	-104.629m	-60.832m	-164.770m
4.70V	-104.955m	-61.027m	-165.293m
4.80V	-105.296m	-61.234m	-165.831m
4.90V	-105.659m	-61.459m	-166.394m
5.00V	-106.050m	-61.704m	-166.991m
5.10V	-106.477m	-61.975m	-167.634m
5.20V	-106.949m	-62.278m	-168.334m
5.30V	-107.474m	-62.619m	-169.106m
5.40V	-108.064m	-63.003m	-169.965m
5.50V	-108.730m	-63.439m	-170.928m
5.60V	-109.483m	-63.932m	-172.012m
5.70V	-110.337m	-64.492m	-173.239m
5.80V	-111.305m	-65.126m	-174.627m
5.90V	-112.401m	-65.843m	-176.199m
6.00V	-113.640m	-66.651m	-177.978m
6.10V	-115.036m	-67.560m	-179.986m
6.20V	-116.606m	-68.578m	-182.247m
6.30V	-118.365m	-69.715m	-184.785m
6.40V	-120.329m	-70.981m	-187.626m
6.50V	-122.513m	-72.384m	-190.793m
6.60V	-124.935m	-73.935m	-194.311m

|
[GND_clamp]

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.165	-1.242	-2.500
-3.20V	-2.070	-1.190	-2.388
-3.10V	-1.975	-1.138	-2.277
-2.90V	-1.786	-1.033	-2.054
-2.80V	-1.691	-981.185m	-1.942
-2.70V	-1.597	-929.174m	-1.831
-2.60V	-1.503	-877.220m	-1.720
-2.50V	-1.408	-825.330m	-1.609
-2.40V	-1.314	-773.514m	-1.498
-2.30V	-1.220	-721.779m	-1.387
-2.20V	-1.126	-670.140m	-1.276
-2.10V	-1.032	-618.610m	-1.166
-1.90V	-845.771m	-515.958m	-945.908m
-1.80V	-752.887m	-464.892m	-836.403m
-1.70V	-660.410m	-414.052m	-727.373m
-1.60V	-568.461m	-363.494m	-618.970m
-1.50V	-477.221m	-313.301m	-511.430m
-1.40V	-386.980m	-263.597m	-405.149m
-1.30V	-298.248m	-214.579m	-300.867m
-1.20V	-212.028m	-166.582m	-200.187m
-1.10V	-130.668m	-120.248m	-107.496m
-0.90V	-17.375m	-40.029m	-8.803m

-0.80V	-2.837m	-14.886m	-3.451m
-0.70V	-656.331u	-3.014m	-1.195m
-0.60V	-116.521u	-336.317u	-201.636u
-0.50V	-10.789u	-41.964u	-13.420u
-0.40V	-580.051n	-4.632u	-416.799n
-0.30V	-27.994n	-450.005n	-11.484n
-0.20V	-1.269n	-41.862n	-311.158p
-0.10V	-74.463p	-4.218n	-27.092p
0.00V	-26.215p	-1.078n	-18.737p
0.10V	-22.114p	-826.325p	-16.303p
0.20V	-19.278p	-754.146p	-13.966p
0.30V	-16.497p	-694.188p	-11.632p
0.40V	-13.726p	-635.953p	-9.300p
0.50V	-10.963p	-578.437p	-6.968p
0.60V	-8.203p	-521.365p	-4.637p
0.70V	-5.446p	-464.595p	-2.307p
0.80V	-2.691p	-408.039p	22.980f
0.90V	62.079f	-351.636p	2.353p
1.10V	5.566p	-239.133p	7.011p
1.20V	8.316p	-182.975p	9.340p
1.30V	11.067p	-126.851p	11.669p
1.40V	13.817p	-70.743p	13.998p
1.50V	16.567p	-14.634p	16.327p
1.60V	19.317p	41.493p	18.656p
1.70V	22.067p	97.654p	20.985p
1.80V	24.817p	153.868p	23.313p
1.90V	27.568p	210.159p	25.642p
2.10V	33.072p	323.083p	30.300p
2.20V	35.825p	379.789p	32.629p
2.30V	38.581p	436.650p	34.958p
2.40V	41.339p	492.867p	37.288p
2.50V	44.098p	547.026p	39.618p
2.60V	46.849p	600.695p	41.948p
2.70V	49.356p	654.682p	44.279p
2.80V	51.378p	709.650p	46.611p
2.90V	53.315p	776.122p	48.939p
3.10V	57.193p	4.552n	52.772p
3.20V	59.183p	44.522n	54.319p
3.30V	62.959p	466.732n	55.861p

|
[POWER_clamp]

Voltage	I (typ)	I (min)	I (max)
3.30V	-26.215p	-450.005n	-11.632p
3.40V	-74.463p	-4.632u	-13.966p
3.50V	-1.269n	-41.964u	-16.303p
3.60V	-27.994n	-336.317u	-18.737p
3.70V	-580.051n	-3.014m	-27.092p
3.80V	-10.789u	-14.886m	-311.158p
3.90V	-116.521u	-40.029m	-11.484n
4.10V	-2.837m	-120.248m	-13.420u
4.20V	-17.375m	-166.582m	-201.636u
4.30V	-60.888m	-214.579m	-1.195m
4.40V	-130.668m	-263.597m	-3.451m

4.50V	-212.028m	-313.301m	-8.803m
4.60V	-298.248m	-363.494m	-37.420m
4.70V	-386.980m	-414.052m	-107.496m
4.80V	-477.221m	-464.892m	-200.187m
4.90V	-568.461m	-515.958m	-300.867m
5.10V	-752.887m	-618.610m	-511.430m
5.20V	-845.771m	-670.140m	-618.970m
5.30V	-938.979m	-721.779m	-727.373m
5.40V	-1.032	-773.514m	-836.403m
5.50V	-1.126	-825.330m	-945.908m
5.60V	-1.220	-877.220m	-1.056
5.70V	-1.314	-929.174m	-1.166
5.80V	-1.408	-981.185m	-1.276
5.90V	-1.503	-1.033	-1.387
6.10V	-1.691	-1.138	-1.609
6.20V	-1.786	-1.190	-1.720
6.30V	-1.881	-1.242	-1.831
6.40V	-1.975	-1.294	-1.942
6.50V	-2.070	-1.346	-2.054
6.60V	-2.165	-1.399	-2.165

|

[Ramp]

Voltage	I (typ)	I (min)	I (max)
---------	---------	---------	---------

|

dV/dt_f 2.00/112.556p 1.82/199.937p 2.17/74.356p

|

dV/dt_r 2.02/146.245p 1.84/252.851p 2.20/93.872p

R_load=10000ohms

| R_load was connected to ground for Ramp_up test and power for Ramp_dn test

|

|End model

[Model] ipadni_io | ""

Model_type I/O

Vinl = 0.8

Vinh = 2

variable	typ	min	max
----------	-----	-----	-----

C_comp 2.01p 1.89p 2.17p

variable	typ	min	max
----------	-----	-----	-----

[Temperature Range] 40.0 0.0 120.0

variable	typ	min	max
----------	-----	-----	-----

[Voltage Range] 3.30V 3.00V 3.60V

|

[Pulldown]

| pulldown in the table = pulldown subtract gnd_clamp

Voltage	I (typ)	I (min)	I (max)
---------	---------	---------	---------

|

-3.30V	-157.134u	-99.256u	-219.000u
-3.20V	-165.037u	-104.127u	-230.250u
-3.10V	-173.749u	-109.479u	-242.685u
-3.00V	-183.400u	-115.386u	-256.500u
-2.90V	-194.148u	-121.936u	-271.934u
-2.80V	-206.189u	-129.240u	-289.286u
-2.70V	-219.766u	-137.431u	-308.933u
-2.60V	-235.190u	-146.680u	-331.355u
-2.50V	-252.856u	-157.199u	-357.176u

-2.40V	-273.283u	-169.265u	-387.219u
-2.30V	-297.162u	-183.236u	-422.595u
-2.20V	-325.427u	-199.590u	-464.837u
-2.10V	-359.384u	-218.976u	-516.117u
-2.00V	-400.901u	-242.299u	-579.623u
-1.90V	-452.750u	-270.851u	-660.217u
-1.80V	-519.217u	-306.549u	-765.681u
-1.70V	-607.277u	-352.346u	-909.270u
-1.60V	-729.045u	-413.024u	-1.115m
-1.50V	-907.407u	-496.811u	-1.434m
-1.40V	-1.191m	-619.011u	-1.987m
-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m
-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.755e-18	18.548e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	47.725m	22.817m
1.50V	86.564m	48.943m	23.575m
1.60V	88.497m	49.908m	136.139m
1.70V	89.946m	50.637m	138.902m
1.80V	90.974m	51.160m	140.954m
1.90V	91.689m	51.534m	142.415m
2.00V	92.200m	51.810m	143.449m
2.10V	92.586m	52.024m	144.201m
2.20V	92.895m	52.201m	144.779m
2.30V	93.154m	52.351m	145.246m
2.40V	93.380m	52.482m	145.642m
2.50V	93.581m	52.600m	145.990m
2.60V	93.764m	52.706m	146.303m
2.70V	93.931m	52.804m	146.590m
2.80V	94.087m	52.895m	146.855m
2.90V	94.233m	52.980m	147.104m
3.00V	94.370m	53.060m	147.338m

3.10V	94.500m	53.135m	147.560m
3.20V	94.624m	53.207m	147.772m
3.30V	94.744m	53.276m	147.976m
3.40V	94.859m	53.343m	148.174m
3.50V	94.974m	53.408m	148.367m
3.60V	95.089m	53.475m	148.560m
3.70V	95.208m	53.543m	148.757m
3.80V	95.336m	53.617m	148.963m
3.90V	95.478m	53.699m	149.186m
4.00V	95.641m	53.792m	149.436m
4.10V	95.833m	53.902m	149.725m
4.20V	96.065m	54.035m	150.067m
4.30V	96.347m	54.196m	150.479m
4.40V	96.693m	54.394m	150.981m
4.50V	97.117m	54.635m	151.594m
4.60V	97.636m	54.930m	152.342m
4.70V	98.266m	55.287m	153.252m
4.80V	99.024m	55.716m	154.350m
4.90V	99.931m	56.227m	155.666m
5.00V	101.005m	56.831m	157.230m
5.10V	102.264m	57.539m	159.070m
5.20V	103.730m	58.361m	161.218m
5.30V	105.422m	59.308m	163.704m
5.40V	107.357m	60.391m	166.555m
5.50V	109.556m	61.618m	169.801m
5.60V	112.034m	63.000m	173.468m
5.70V	114.809m	64.545m	177.581m
5.80V	117.897m	66.263m	182.163m
5.90V	121.311m	68.160m	187.235m
6.00V	125.066m	70.245m	192.816m
6.10V	129.172m	72.524m	198.924m
6.20V	133.642m	75.002m	205.573m
6.30V	138.485m	77.685m	212.776m
6.40V	143.709m	80.578m	220.544m
6.50V	149.320m	83.683m	228.885m
6.60V	155.326m	87.004m	237.805m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u
-2.00V	303.830u	217.155u	404.033u

-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u
-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m
-1.30V	960.396u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m
-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m
-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-47.451m	-13.901m
1.40V	-79.705m	-48.954m	-118.519m
1.50V	-82.391m	-50.187m	-123.324m
1.60V	-84.713m	-51.203m	-127.640m
1.70V	-86.724m	-52.057m	-131.501m
1.80V	-88.472m	-52.794m	-134.939m
1.90V	-89.996m	-53.442m	-137.982m
2.00V	-91.327m	-54.017m	-140.655m
2.10V	-92.489m	-54.533m	-142.987m
2.20V	-93.511m	-54.999m	-145.014m
2.30V	-94.415m	-55.424m	-146.781m
2.40V	-95.224m	-55.814m	-148.333m
2.50V	-95.955m	-56.174m	-149.709m
2.60V	-96.623m	-56.510m	-150.943m
2.70V	-97.238m	-56.824m	-152.063m
2.80V	-97.809m	-57.119m	-153.088m
2.90V	-98.343m	-57.398m	-154.036m
3.00V	-98.846m	-57.662m	-154.920m
3.10V	-99.320m	-57.913m	-155.749m
3.20V	-99.770m	-58.152m	-156.531m
3.30V	-100.198m	-58.381m	-157.272m
3.40V	-100.607m	-58.601m	-157.977m
3.50V	-100.998m	-58.812m	-158.650m

3.60V	-101.374m	-59.015m	-159.295m
3.70V	-101.735m	-59.211m	-159.914m
3.80V	-102.084m	-59.401m	-160.510m
3.90V	-102.422m	-59.585m	-161.086m
4.00V	-102.750m	-59.766m	-161.644m
4.10V	-103.070m	-59.942m	-162.186m
4.20V	-103.384m	-60.117m	-162.715m
4.30V	-103.694m	-60.291m	-163.234m
4.40V	-104.002m	-60.467m	-163.747m
4.50V	-104.313m	-60.647m	-164.257m
4.60V	-104.629m	-60.832m	-164.770m
4.70V	-104.955m	-61.027m	-165.293m
4.80V	-105.296m	-61.234m	-165.831m
4.90V	-105.659m	-61.459m	-166.394m
5.00V	-106.050m	-61.704m	-166.991m
5.10V	-106.477m	-61.975m	-167.634m
5.20V	-106.949m	-62.278m	-168.334m
5.30V	-107.474m	-62.619m	-169.106m
5.40V	-108.064m	-63.003m	-169.965m
5.50V	-108.730m	-63.439m	-170.928m
5.60V	-109.483m	-63.932m	-172.012m
5.70V	-110.337m	-64.492m	-173.239m
5.80V	-111.305m	-65.126m	-174.627m
5.90V	-112.401m	-65.843m	-176.199m
6.00V	-113.640m	-66.651m	-177.978m
6.10V	-115.036m	-67.560m	-179.986m
6.20V	-116.606m	-68.578m	-182.247m
6.30V	-118.365m	-69.715m	-184.785m
6.40V	-120.329m	-70.981m	-187.626m
6.50V	-122.513m	-72.384m	-190.793m
6.60V	-124.935m	-73.935m	-194.311m

|
[GND_clamp]

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.165	-1.242	-2.500
-3.20V	-2.070	-1.190	-2.388
-3.10V	-1.975	-1.138	-2.277
-2.90V	-1.786	-1.033	-2.054
-2.80V	-1.691	-981.185m	-1.942
-2.70V	-1.597	-929.174m	-1.831
-2.60V	-1.503	-877.220m	-1.720
-2.50V	-1.408	-825.330m	-1.609
-2.40V	-1.314	-773.514m	-1.498
-2.30V	-1.220	-721.779m	-1.387
-2.20V	-1.126	-670.140m	-1.276
-2.10V	-1.032	-618.610m	-1.166
-1.90V	-845.771m	-515.958m	-945.908m
-1.80V	-752.887m	-464.892m	-836.403m
-1.70V	-660.410m	-414.052m	-727.373m
-1.60V	-568.461m	-363.494m	-618.970m
-1.50V	-477.221m	-313.301m	-511.430m
-1.40V	-386.980m	-263.597m	-405.149m
-1.30V	-298.248m	-214.579m	-300.867m

-1.20V	-212.028m	-166.582m	-200.187m
-1.10V	-130.668m	-120.248m	-107.496m
-0.90V	-17.375m	-40.029m	-8.803m
-0.80V	-2.837m	-14.886m	-3.451m
-0.70V	-656.331u	-3.014m	-1.195m
-0.60V	-116.521u	-336.317u	-201.636u
-0.50V	-10.789u	-41.964u	-13.420u
-0.40V	-580.051n	-4.632u	-416.799n
-0.30V	-27.994n	-450.005n	-11.484n
-0.20V	-1.269n	-41.862n	-311.158p
-0.10V	-74.463p	-4.218n	-27.092p
0.00V	-26.215p	-1.078n	-18.737p
0.10V	-22.114p	-826.325p	-16.303p
0.20V	-19.278p	-754.146p	-13.966p
0.30V	-16.497p	-694.188p	-11.632p
0.40V	-13.726p	-635.953p	-9.300p
0.50V	-10.963p	-578.437p	-6.968p
0.60V	-8.203p	-521.365p	-4.637p
0.70V	-5.446p	-464.595p	-2.307p
0.80V	-2.691p	-408.039p	22.980f
0.90V	62.079f	-351.636p	2.353p
1.10V	5.566p	-239.133p	7.011p
1.20V	8.316p	-182.975p	9.340p
1.30V	11.067p	-126.851p	11.669p
1.40V	13.817p	-70.743p	13.998p
1.50V	16.567p	-14.634p	16.327p
1.60V	19.317p	41.493p	18.656p
1.70V	22.067p	97.654p	20.985p
1.80V	24.817p	153.868p	23.313p
1.90V	27.568p	210.159p	25.642p
2.10V	33.072p	323.083p	30.300p
2.20V	35.825p	379.789p	32.629p
2.30V	38.581p	436.650p	34.958p
2.40V	41.339p	492.867p	37.288p
2.50V	44.098p	547.026p	39.618p
2.60V	46.849p	600.695p	41.948p
2.70V	49.356p	654.682p	44.279p
2.80V	51.378p	709.650p	46.611p
2.90V	53.315p	776.122p	48.939p
3.10V	57.193p	4.552n	52.772p
3.20V	59.183p	44.522n	54.319p
3.30V	62.959p	466.732n	55.861p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-26.215p	-450.005n	-11.632p
3.40V	-74.463p	-4.632u	-13.966p
3.50V	-1.269n	-41.964u	-16.303p
3.60V	-27.994n	-336.317u	-18.737p
3.70V	-580.051n	-3.014m	-27.092p
3.80V	-10.789u	-14.886m	-311.158p
3.90V	-116.521u	-40.029m	-11.484n
4.10V	-2.837m	-120.248m	-13.420u

4.20V	-17.375m	-166.582m	-201.636u
4.30V	-60.888m	-214.579m	-1.195m
4.40V	-130.668m	-263.597m	-3.451m
4.50V	-212.028m	-313.301m	-8.803m
4.60V	-298.248m	-363.494m	-37.420m
4.70V	-386.980m	-414.052m	-107.496m
4.80V	-477.221m	-464.892m	-200.187m
4.90V	-568.461m	-515.958m	-300.867m
5.10V	-752.887m	-618.610m	-511.430m
5.20V	-845.771m	-670.140m	-618.970m
5.30V	-938.979m	-721.779m	-727.373m
5.40V	-1.032	-773.514m	-836.403m
5.50V	-1.126	-825.330m	-945.908m
5.60V	-1.220	-877.220m	-1.056
5.70V	-1.314	-929.174m	-1.166
5.80V	-1.408	-981.185m	-1.276
5.90V	-1.503	-1.033	-1.387
6.10V	-1.691	-1.138	-1.609
6.20V	-1.786	-1.190	-1.720
6.30V	-1.881	-1.242	-1.831
6.40V	-1.975	-1.294	-1.942
6.50V	-2.070	-1.346	-2.054
6.60V	-2.165	-1.399	-2.165

|

[Ramp]

Voltage	I (typ)	I (min)	I (max)
dV/dt_f	2.00/113.266p	1.82/197.371p	2.17/74.028p
dV/dt_r	2.02/147.014p	1.84/251.849p	2.20/93.411p

R_load=10000ohms

| R_load was connected to ground for Ramp_up test and power for Ramp_dn test

|

|End model

[Model] ipado_3st | ""

Model_type 3-state

variable	typ	min	max
C_comp	1.99p	1.86p	2.15p
variable	typ	min	max
[Temperature Range]	40.0	0.0	120.0
variable	typ	min	max
[Voltage Range]	3.30V	3.00V	3.60V

|

[Pulldown]

| pulldown in the table = pulldown subtract gnd_clamp

Voltage	I (typ)	I (min)	I (max)
-3.30V	-157.134u	-99.256u	-219.000u
-3.20V	-165.037u	-104.127u	-230.250u
-3.10V	-173.749u	-109.479u	-242.685u
-3.00V	-183.400u	-115.386u	-256.500u
-2.90V	-194.148u	-121.936u	-271.934u
-2.80V	-206.189u	-129.240u	-289.286u
-2.70V	-219.766u	-137.431u	-308.933u
-2.60V	-235.190u	-146.680u	-331.355u

-2.50V	-252.856u	-157.199u	-357.176u
-2.40V	-273.283u	-169.265u	-387.219u
-2.30V	-297.162u	-183.236u	-422.595u
-2.20V	-325.427u	-199.590u	-464.837u
-2.10V	-359.384u	-218.976u	-516.117u
-2.00V	-400.901u	-242.299u	-579.623u
-1.90V	-452.750u	-270.851u	-660.217u
-1.80V	-519.217u	-306.549u	-765.681u
-1.70V	-607.277u	-352.346u	-909.270u
-1.60V	-729.045u	-413.024u	-1.115m
-1.50V	-907.407u	-496.811u	-1.434m
-1.40V	-1.191m	-619.011u	-1.987m
-1.30V	-1.699m	-811.079u	-3.133m
-1.20V	-2.799m	-1.146m	-6.243m
-1.10V	-5.689m	-1.822m	-12.974m
-1.00V	-10.416m	-3.302m	-17.948m
-0.90V	-12.342m	-5.449m	-17.964m
-0.80V	-11.672m	-6.479m	-16.692m
-0.70V	-10.528m	-6.146m	-15.152m
-0.60V	-9.204m	-5.387m	-13.338m
-0.50V	-7.770m	-4.535m	-11.313m
-0.40V	-6.286m	-3.652m	-9.190m
-0.30V	-4.766m	-2.754m	-6.999m
-0.20V	-3.214m	-1.846m	-4.740m
-0.10V	-1.627m	-928.990u	-2.410m
0.00V	32.755e-18	18.548e-18	-1.607f
0.10V	1.604m	910.814u	2.391m
0.20V	3.124m	1.775m	4.661m
0.30V	4.566m	2.595m	6.817m
0.40V	5.928m	3.372m	8.858m
0.50V	7.210m	4.105m	10.784m
0.60V	8.411m	4.792m	12.593m
0.70V	9.529m	5.432m	14.284m
0.80V	10.562m	6.023m	15.855m
0.90V	11.508m	6.563m	17.306m
1.00V	12.367m	7.051m	18.639m
1.10V	13.138m	7.486m	19.856m
1.20V	13.821m	7.865m	20.957m
1.30V	14.417m	8.189m	21.944m
1.40V	14.930m	47.725m	22.817m
1.50V	86.564m	48.943m	23.575m
1.60V	88.497m	49.908m	136.139m
1.70V	89.946m	50.637m	138.902m
1.80V	90.974m	51.160m	140.954m
1.90V	91.689m	51.534m	142.415m
2.00V	92.200m	51.810m	143.449m
2.10V	92.586m	52.024m	144.201m
2.20V	92.895m	52.201m	144.779m
2.30V	93.154m	52.351m	145.246m
2.40V	93.380m	52.482m	145.642m
2.50V	93.581m	52.600m	145.990m
2.60V	93.764m	52.706m	146.303m
2.70V	93.931m	52.804m	146.590m
2.80V	94.087m	52.895m	146.855m
2.90V	94.233m	52.980m	147.104m

3.00V	94.370m	53.060m	147.338m
3.10V	94.500m	53.135m	147.560m
3.20V	94.624m	53.207m	147.772m
3.30V	94.744m	53.276m	147.976m
3.40V	94.859m	53.343m	148.174m
3.50V	94.974m	53.408m	148.367m
3.60V	95.089m	53.475m	148.560m
3.70V	95.208m	53.543m	148.757m
3.80V	95.336m	53.617m	148.963m
3.90V	95.478m	53.699m	149.186m
4.00V	95.641m	53.792m	149.436m
4.10V	95.833m	53.902m	149.725m
4.20V	96.065m	54.035m	150.067m
4.30V	96.347m	54.196m	150.479m
4.40V	96.693m	54.394m	150.981m
4.50V	97.117m	54.635m	151.594m
4.60V	97.636m	54.930m	152.342m
4.70V	98.266m	55.287m	153.252m
4.80V	99.024m	55.716m	154.350m
4.90V	99.931m	56.227m	155.666m
5.00V	101.005m	56.831m	157.230m
5.10V	102.264m	57.539m	159.070m
5.20V	103.730m	58.361m	161.218m
5.30V	105.422m	59.308m	163.704m
5.40V	107.357m	60.391m	166.555m
5.50V	109.556m	61.618m	169.801m
5.60V	112.034m	63.000m	173.468m
5.70V	114.809m	64.545m	177.581m
5.80V	117.897m	66.263m	182.163m
5.90V	121.311m	68.160m	187.235m
6.00V	125.066m	70.245m	192.816m
6.10V	129.172m	72.524m	198.924m
6.20V	133.642m	75.002m	205.573m
6.30V	138.485m	77.685m	212.776m
6.40V	143.709m	80.578m	220.544m
6.50V	149.320m	83.683m	228.885m
6.60V	155.326m	87.004m	237.805m
[Pullup]			
pullup in the table = pullup subtract power_clamp			
Voltage	I (typ)	I (min)	I (max)
-3.30V	132.979u	100.794u	170.075u
-3.20V	138.984u	105.115u	178.000u
-3.10V	145.559u	109.825u	186.702u
-3.00V	152.789u	114.981u	196.300u
-2.90V	160.778u	120.648u	206.941u
-2.80V	169.651u	126.906u	218.803u
-2.70V	179.562u	133.852u	232.110u
-2.60V	190.706u	141.605u	247.141u
-2.50V	203.326u	150.317u	264.253u
-2.40V	217.736u	160.174u	283.910u
-2.30V	234.344u	171.418u	306.723u
-2.20V	253.692u	184.362u	333.513u
-2.10V	276.513u	199.421u	365.415u

-2.00V	303.830u	217.155u	404.033u
-1.90V	337.102u	238.340u	451.722u
-1.80V	378.494u	264.081u	512.067u
-1.70V	431.351u	296.004u	590.810u
-1.60V	501.113u	336.601u	697.730u
-1.50V	597.240u	389.880u	850.877u
-1.40V	737.641u	462.700u	1.087m
-1.30V	960.396u	567.748u	1.497m
-1.20V	1.361m	731.012u	2.348m
-1.10V	2.237m	1.013m	4.712m
-1.00V	4.644m	1.583m	10.148m
-0.90V	8.090m	2.907m	12.062m
-0.80V	8.032m	4.727m	11.029m
-0.70V	7.118m	4.754m	9.778m
-0.60V	6.128m	4.128m	8.443m
-0.50V	5.109m	3.441m	7.052m
-0.40V	4.082m	2.746m	5.644m
-0.30V	3.056m	2.053m	4.233m
-0.20V	2.033m	1.363m	2.821m
-0.10V	1.014m	678.856u	1.410m
-0.00V	58.687e-18	58.622e-18	117.504e-18
0.10V	-987.106u	-655.604u	-1.381m
0.20V	-1.928m	-1.274m	-2.709m
0.30V	-2.828m	-1.859m	-3.988m
0.40V	-3.685m	-2.412m	-5.216m
0.50V	-4.499m	-2.931m	-6.392m
0.60V	-5.269m	-3.416m	-7.516m
0.70V	-5.994m	-3.866m	-8.587m
0.80V	-6.673m	-4.280m	-9.602m
0.90V	-7.306m	-4.658m	-10.561m
1.00V	-7.890m	-4.999m	-11.461m
1.10V	-8.424m	-5.301m	-12.302m
1.20V	-8.907m	-5.563m	-13.081m
1.30V	-9.339m	-47.451m	-13.837m
1.40V	-79.705m	-48.954m	-118.519m
1.50V	-82.391m	-50.187m	-123.324m
1.60V	-84.713m	-51.203m	-127.640m
1.70V	-86.724m	-52.057m	-131.501m
1.80V	-88.472m	-52.794m	-134.939m
1.90V	-89.996m	-53.442m	-137.982m
2.00V	-91.327m	-54.017m	-140.655m
2.10V	-92.489m	-54.533m	-142.987m
2.20V	-93.511m	-54.999m	-145.014m
2.30V	-94.415m	-55.424m	-146.781m
2.40V	-95.224m	-55.814m	-148.333m
2.50V	-95.955m	-56.174m	-149.709m
2.60V	-96.623m	-56.510m	-150.943m
2.70V	-97.238m	-56.824m	-152.063m
2.80V	-97.809m	-57.119m	-153.088m
2.90V	-98.343m	-57.398m	-154.036m
3.00V	-98.846m	-57.662m	-154.920m
3.10V	-99.320m	-57.913m	-155.749m
3.20V	-99.770m	-58.152m	-156.531m
3.30V	-100.198m	-58.381m	-157.272m
3.40V	-100.607m	-58.601m	-157.977m

3.50V	-100.998m	-58.812m	-158.650m
3.60V	-101.374m	-59.015m	-159.295m
3.70V	-101.735m	-59.211m	-159.914m
3.80V	-102.084m	-59.401m	-160.510m
3.90V	-102.422m	-59.585m	-161.086m
4.00V	-102.750m	-59.766m	-161.644m
4.10V	-103.070m	-59.942m	-162.186m
4.20V	-103.384m	-60.117m	-162.715m
4.30V	-103.694m	-60.291m	-163.234m
4.40V	-104.002m	-60.467m	-163.747m
4.50V	-104.313m	-60.647m	-164.257m
4.60V	-104.629m	-60.832m	-164.770m
4.70V	-104.955m	-61.027m	-165.293m
4.80V	-105.296m	-61.234m	-165.831m
4.90V	-105.659m	-61.459m	-166.394m
5.00V	-106.050m	-61.704m	-166.991m
5.10V	-106.477m	-61.975m	-167.634m
5.20V	-106.949m	-62.278m	-168.334m
5.30V	-107.474m	-62.619m	-169.106m
5.40V	-108.064m	-63.003m	-169.965m
5.50V	-108.730m	-63.439m	-170.928m
5.60V	-109.483m	-63.932m	-172.012m
5.70V	-110.337m	-64.492m	-173.239m
5.80V	-111.305m	-65.126m	-174.627m
5.90V	-112.401m	-65.843m	-176.199m
6.00V	-113.640m	-66.651m	-177.978m
6.10V	-115.036m	-67.560m	-179.986m
6.20V	-116.606m	-68.578m	-182.247m
6.30V	-118.365m	-69.715m	-184.785m
6.40V	-120.329m	-70.981m	-187.626m
6.50V	-122.513m	-72.384m	-190.793m
6.60V	-124.935m	-73.935m	-194.311m

|
[GND_clamp]

Voltage	I (typ)	I (min)	I (max)
-3.30V	-2.165	-1.242	-2.500
-3.20V	-2.070	-1.190	-2.388
-3.10V	-1.975	-1.138	-2.277
-2.90V	-1.786	-1.033	-2.054
-2.80V	-1.691	-981.185m	-1.942
-2.70V	-1.597	-929.174m	-1.831
-2.60V	-1.503	-877.220m	-1.720
-2.50V	-1.408	-825.330m	-1.609
-2.40V	-1.314	-773.514m	-1.498
-2.30V	-1.220	-721.779m	-1.387
-2.20V	-1.126	-670.140m	-1.276
-2.10V	-1.032	-618.610m	-1.166
-1.90V	-845.771m	-515.958m	-945.908m
-1.80V	-752.887m	-464.892m	-836.403m
-1.70V	-660.410m	-414.052m	-727.373m
-1.60V	-568.461m	-363.494m	-618.970m
-1.50V	-477.221m	-313.301m	-511.430m
-1.40V	-386.980m	-263.597m	-405.149m

-1.30V	-298.248m	-214.579m	-300.867m
-1.20V	-212.028m	-166.582m	-200.187m
-1.10V	-130.668m	-120.248m	-107.496m
-0.90V	-17.375m	-40.029m	-8.803m
-0.80V	-2.837m	-14.886m	-3.451m
-0.70V	-656.331u	-3.014m	-1.195m
-0.60V	-116.521u	-336.317u	-201.636u
-0.50V	-10.789u	-41.964u	-13.420u
-0.40V	-580.051n	-4.632u	-416.799n
-0.30V	-27.994n	-450.005n	-11.484n
-0.20V	-1.269n	-41.862n	-311.158p
-0.10V	-74.463p	-4.218n	-27.092p
0.00V	-26.215p	-1.078n	-18.737p
0.10V	-22.114p	-826.325p	-16.303p
0.20V	-19.278p	-754.146p	-13.966p
0.30V	-16.497p	-694.188p	-11.632p
0.40V	-13.726p	-635.953p	-9.300p
0.50V	-10.963p	-578.437p	-6.968p
0.60V	-8.203p	-521.365p	-4.637p
0.70V	-5.446p	-464.595p	-2.307p
0.80V	-2.691p	-408.039p	22.980f
0.90V	62.079f	-351.636p	2.353p
1.10V	5.566p	-239.133p	7.011p
1.20V	8.316p	-182.975p	9.340p
1.30V	11.067p	-126.851p	11.669p
1.40V	13.817p	-70.743p	13.998p
1.50V	16.567p	-14.634p	16.327p
1.60V	19.317p	41.493p	18.656p
1.70V	22.067p	97.654p	20.985p
1.80V	24.817p	153.868p	23.313p
1.90V	27.568p	210.159p	25.642p
2.10V	33.072p	323.083p	30.300p
2.20V	35.825p	379.789p	32.629p
2.30V	38.581p	436.650p	34.958p
2.40V	41.339p	492.867p	37.288p
2.50V	44.098p	547.026p	39.618p
2.60V	46.849p	600.695p	41.948p
2.70V	49.356p	654.682p	44.279p
2.80V	51.378p	709.650p	46.611p
2.90V	53.315p	776.122p	48.939p
3.10V	57.193p	4.552n	52.772p
3.20V	59.183p	44.522n	54.319p
3.30V	62.959p	466.732n	55.861p

|
[POWER_clamp]
|

Voltage	I (typ)	I (min)	I (max)
3.30V	-26.215p	-450.005n	-11.632p
3.40V	-74.463p	-4.632u	-13.966p
3.50V	-1.269n	-41.964u	-16.303p
3.60V	-27.994n	-336.317u	-18.737p
3.70V	-580.051n	-3.014m	-27.092p
3.80V	-10.789u	-14.886m	-311.158p
3.90V	-116.521u	-40.029m	-11.484n

4.10V	-2.837m	-120.248m	-13.420u
4.20V	-17.375m	-166.582m	-201.636u
4.30V	-60.888m	-214.579m	-1.195m
4.40V	-130.668m	-263.597m	-3.451m
4.50V	-212.028m	-313.301m	-8.803m
4.60V	-298.248m	-363.494m	-37.420m
4.70V	-386.980m	-414.052m	-107.496m
4.80V	-477.221m	-464.892m	-200.187m
4.90V	-568.461m	-515.958m	-300.867m
5.10V	-752.887m	-618.610m	-511.430m
5.20V	-845.771m	-670.140m	-618.970m
5.30V	-938.979m	-721.779m	-727.373m
5.40V	-1.032	-773.514m	-836.403m
5.50V	-1.126	-825.330m	-945.908m
5.60V	-1.220	-877.220m	-1.056
5.70V	-1.314	-929.174m	-1.166
5.80V	-1.408	-981.185m	-1.276
5.90V	-1.503	-1.033	-1.387
6.10V	-1.691	-1.138	-1.609
6.20V	-1.786	-1.190	-1.720
6.30V	-1.881	-1.242	-1.831
6.40V	-1.975	-1.294	-1.942
6.50V	-2.070	-1.346	-2.054
6.60V	-2.165	-1.399	-2.165

|

[Ramp]

Voltage	I (typ)	I (min)	I (max)
dV/dt_f	1.99/130.331p	1.81/220.000p	2.17/83.712p
dV/dt_r	2.03/153.657p	1.84/260.814p	2.20/92.663p
R_load=10000ohms			
R_load was connected to ground for Ramp_up test and power for Ramp_dn test			
End model			
[End]			



NOTES

Index

A

ac electrical characteristics 4

B

Boundary Scan (JTAG Port) timing diagram 54

bus

external address 4

external data 4

C

Clock 4

clock

external 4

operation 6

clocks

internal 4

configuration 3

D

dc electrical characteristics 3

design considerations

electrical 3

PLL 4

power consumption 3

thermal 1

DRAM

out of page

wait states selection guide 27

out of page and refresh timings

11 wait states 31

15 wait states 33

4 wait states 27

8 wait states 29

Page mode

read accesses 26

wait states selection guide 17

write accesses 25

Page mode timings

1 wait state 17

2 wait states 20

3 wait states 22

4 wait states 23

refresh access 37

E

electrical design considerations 3

emory 3

Enhanced Serial Audio Interface 9

ESAI 9

receiver timing 51, 52

timings 47

transmitter timing 50

EXTAL jitter 4

external address bus 4

external bus control 4, 5

external clock operation 4

external data bus 4

external interrupt timing (negative edge-triggered)
11

external level-sensitive fast interrupt timing 10

external memory access (DMA Source) timing 12

External Memory Expansion Port 4, 12

F

functional signal groups 1

G

GPIO timing 52

Ground 3
PLL 3

I

internal clocks 4
interrupt and mode control 6
interrupt control 6
interrupt timing 7
 external level-sensitive fast 10
 external negative edge-triggered 11

J

Jitter 4
JTAG 12
JTAG Port
 timing 53, 54

M

maximum ratings 1, 2
Memory 3
Memory Configuration 3
mode control 6
Mode select timing 7

O

OnCE module 12
operating mode select timing 11

P

package
 TQFP description 1, 3
Peripheral modules 3
Phase Lock Loop 6
PLL 4, 6
 Characteristics 6
 performance issues 4
PLL design considerations 4
PLL performance issues 4
Port A 4
Port C 9
Power 2
power consumption design considerations 3

R

recovery from Stop state using IRQA 11, 12
RESET 6
Reset timing 7, 10

S

Serial Audio Interface (ESAI) 3
Serial Host Interface 7
Serial Host Interface (SHI) 3
SHI 7
signal groupings 1
signals 1
SRAM

read and write accesses 12
Stop state
 recovery from 11, 12
Stop timing 7
supply voltage 2

T

Test Access Port timing diagram 55
Test Clock (TCLK) input timing diagram 54
thermal characteristics 2
thermal design considerations 1
Timing
 Enhanced Serial Audio Interface (ESAI) 50
 General Purpose I/O (GPIO) Timing 47
 OnCE™ (On Chip Emulator) Timing 47
 Serial Host Interface (SHI) SPI Protocol Timing 37
 Serial Host Interface (SHI) Timing 37
timing
 interrupt 7
 mode select 7
 Reset 7
 Stop 7
TQFP
 pin list by number 3
 pin-out drawing (top) 1

How to Reach Us:

Home Page:

www.freescale.com

E-mail:

support@freescale.com

USA/Europe or Locations Not Listed:

Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:

Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:

Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:

Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-521-6274 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc. 2006, 2007. All rights reserved.

RoHS-compliant and/or Pb-free versions of Freescale products have the functionality and electrical characteristics of their non-RoHS-compliant and/or non-Pb-free counterparts. For further information, see <http://www.freescale.com> or contact your Freescale sales representative.

For information on Freescale's Environmental Products program, go to <http://www.freescale.com/epp>.