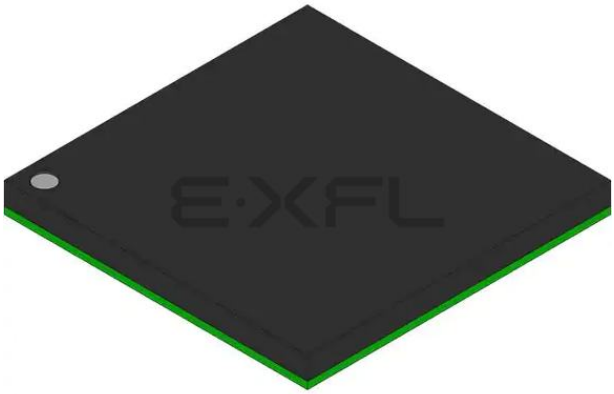


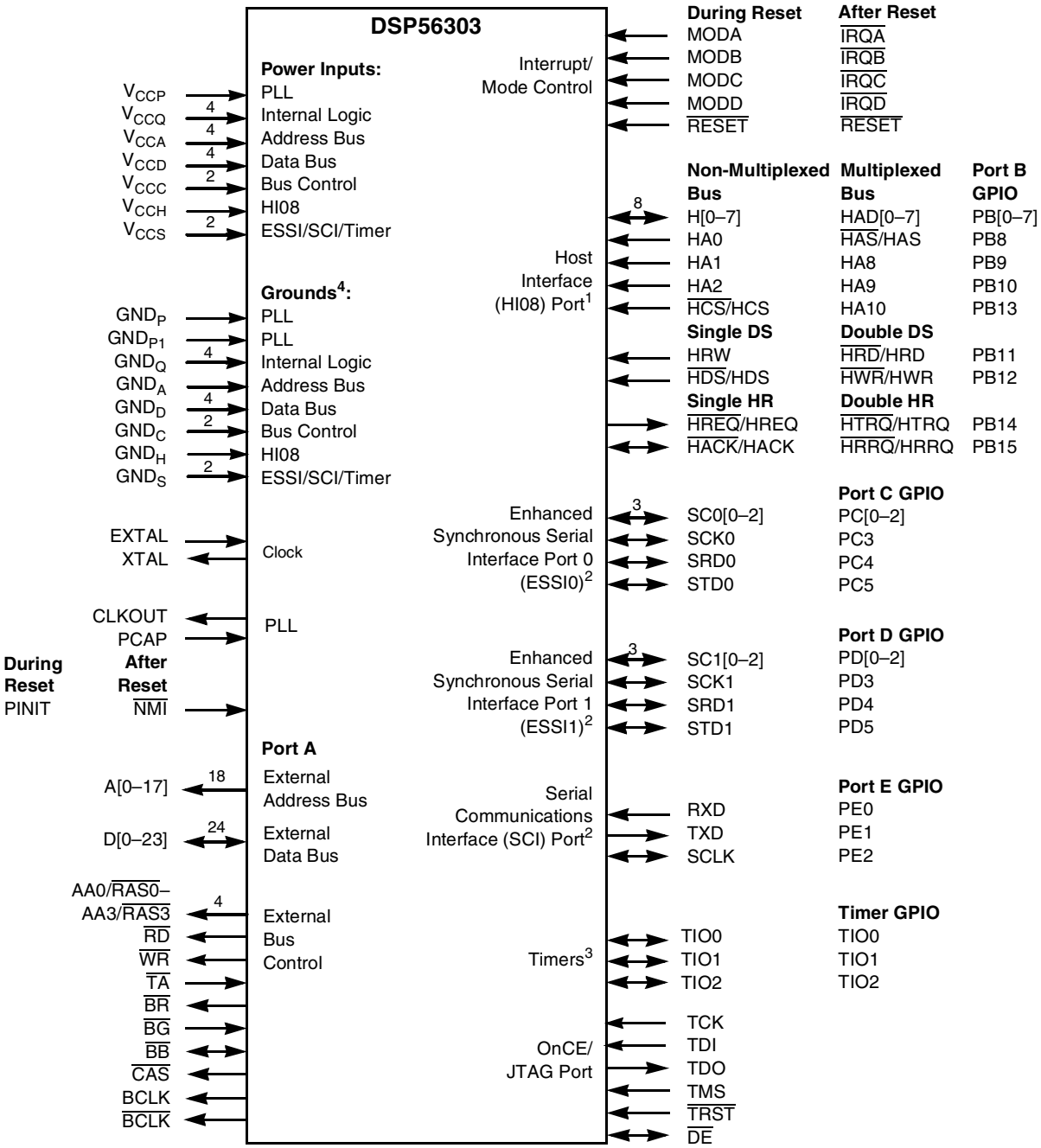
Welcome to E-XFL.COM

Understanding Embedded - DSP (Digital Signal Processors)

Embedded - DSP (Digital Signal Processors) are specialized microprocessors designed to perform complex mathematical computations on digital signals in real-time. Unlike general-purpose processors, DSPs are optimized for high-speed numeric processing tasks, making them ideal for applications that require efficient and precise manipulation of digital data. These processors are fundamental in converting and processing signals in various forms, including audio, video, and communication signals, ensuring that data is accurately interpreted and utilized in embedded systems.

Applications of Embedded - DSP (Digital Signal Processors)

Details	
Product Status	Active
Type	DSP
Interface	Host Interface, SSI, SCI
Clock Rate	100MHz
Non-Volatile Memory	ROM (576B)
On-Chip RAM	24kB
Voltage - I/O	3.30V
Voltage - Core	3.30V
Operating Temperature	-40°C ~ 100°C
Mounting Type	Surface Mount
Package / Case	196-LBGA
Supplier Device Package	196-PBGA (15x15)
Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=dsp56303vf100



Notes:

1. The HI08 port supports a non-multiplexed or a multiplexed bus, single or double Data Strobe (DS), and single or double Host Request (HR) configurations. Since each of these modes is configured independently, any combination of these modes is possible. These HI08 signals can also be configured alternatively as GPIO signals (PB[0–15]). Signals with dual designations (for example, HAS/HAS) have configurable polarity.
2. The ESSI0, ESSI1, and SCI signals are multiplexed with the Port C GPIO signals (PC[0–5]), Port D GPIO signals (PD[0–5]), and Port E GPIO signals (PE[0–2]), respectively.
3. TIO[0–2] can be configured as GPIO signals.
4. Ground connections shown in this figure are for the TQFP package. In the MAP-BGA package, in addition to the GND_P and GND_{P1} connections, there are 64 GND connections to a common internal package ground plane.

Figure 1-1. Signals Identified by Functional Group

1.3 Clock

Table 1-4. Clock Signals

Signal Name	Type	State During Reset	Signal Description
EXTAL	Input	Input	**External Clock/Crystal Input**—Interfaces the internal crystal oscillator input to an external crystal or an external clock.
XTAL	Output	Chip-driven	**Crystal Output**—Connects the internal crystal oscillator output to an external crystal. If an external clock is used, leave XTAL unconnected.

1.4 PLL

Table 1-5. Phase-Locked Loop Signals

Signal Name	Type	State During Reset	Signal Description
CLKOUT	Output	Chip-driven	**Clock Output—**Provides an output clock synchronized to the internal core clock phase. If the PLL is enabled and both the multiplication and division factors equal one, then CLKOUT is also synchronized to EXTAL. If the PLL is disabled, the CLKOUT frequency is half the frequency of EXTAL.
PCAP	Input	Input	**PLL Capacitor**—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 can be tied to V_{CC}, GND, or left floating.
PINIT $\overline{\text{NMI}}$	Input Input	Input	**PLL Initial**—During assertion of $\overline{\text{RESET}}$, the value of PINIT is written into the PLL enable (PEN) bit of the PLL control (PCTL) register, determining whether the PLL is enabled or disabled. **Nonmaskable Interrupt**—After $\overline{\text{RESET}}$ deassertion and during normal instruction processing, this Schmitt-trigger input is the negative-edge-triggered NMI request internally synchronized to CLKOUT. **Note**: PINIT/$\overline{\text{NMI}}$ can tolerate 5 V.

1.5 External Memory Expansion Port (Port A)

Note: When the DSP56303 enters a low-power standby mode (stop or wait), it releases bus mastership and tri-states the relevant Port A signals: A[0–17], D[0–23], AA0/$\overline{\text{RAS0}}$–AA3/$\overline{\text{RAS3}}$, $\overline{\text{RD}}$, $\overline{\text{WR}}$, $\overline{\text{BB}}$, $\overline{\text{CAS}}$.

1.5.1 External Address Bus

Table 1-6. External Address Bus Signals

Signal Name	Type	State During Reset, Stop, or Wait	Signal Description
A[0–17]	Output	Tri-stated	**Address Bus**—When the DSP is the bus master, A[0–17] are active-high outputs that specify the address for external program and data memory accesses. Otherwise, the signals are tri-stated. To minimize power dissipation, A[0–17] do not change state when external memory spaces are not being accessed.

1.5.2 External Data Bus

Table 1-7. External Data Bus Signals

Signal Name	Type	State During Reset	State During Stop or Wait	Signal Description
D[0–23]	Input/ Output	Ignored Input	Last state: *Input*: Ignored *Output*: Tri-stated	**Data Bus**—When the DSP is the bus master, D[0–23] are active-high, bidirectional input/outputs that provide the bidirectional data bus for external program and data memory accesses. Otherwise, D[0–23] are tri-stated.

1.5.3 External Bus Control

Table 1-8. External Bus Control Signals

Signal Name	Type	State During Reset, Stop, or Wait	Signal Description
AA[0–3]	Output	Tri-stated	**Address Attribute**—When defined as AA, these signals can be used as chip selects or additional address lines. The default use defines a priority scheme under which only one AA signal can be asserted at a time. Setting the AA priority disable (APD) bit (Bit 14) of the Operating Mode Register, the priority mechanism is disabled and the lines can be used together as four external lines that can be decoded externally into 16 chip select signals.
$\overline{\text{RAS}}$[0–3]	Output		**Row Address Strobe**—When defined as $\overline{\text{RAS}}$, these signals can be used as $\overline{\text{RAS}}$ for DRAM interface. These signals are tri-statable outputs with programmable polarity.
$\overline{\text{RD}}$	Output	Tri-stated	**Read Enable**—When the DSP is the bus master, $\overline{\text{RD}}$ is an active-low output that is asserted to read external memory on the data bus (D[0–23]). Otherwise, $\overline{\text{RD}}$ is tri-stated.
$\overline{\text{WR}}$	Output	Tri-stated	**Write Enable**—When the DSP is the bus master, $\overline{\text{WR}}$ is an active-low output that is asserted to write external memory on the data bus (D[0–23]). Otherwise, the signals are tri-stated.
$\overline{\text{TA}}$	Input	Ignored Input	**Transfer Acknowledge**—If the DSP56303 is the bus master and there is no external bus activity, or the DSP56303 is not the bus master, 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) can be added to the wait states inserted by the bus control register (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 CLKOUT. The number of wait states is determined by the $\overline{\text{TA}}$ input or by the BCR, whichever is longer. The BCR can be used to set the minimum number of wait states in external bus cycles. 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. $\overline{\text{TA}}$ functionality cannot be used during DRAM type accesses; otherwise improper operation may result.
$\overline{\text{BR}}$	Output	Reset: Output (deasserted) State during Stop/Wait depends on BRH bit setting: • BRH = 0: Output, deasserted • BRH = 1: Maintains last state (that is, if asserted, remains asserted)	**Bus Request**—Asserted when the DSP requests bus mastership. $\overline{\text{BR}}$ is deasserted when the DSP no longer needs the bus. $\overline{\text{BR}}$ may be asserted or deasserted independently of whether the DSP56303 is a bus master or a bus slave. Bus “parking” allows $\overline{\text{BR}}$ to be deasserted even though the DSP56303 is the bus master. (See the description of bus “parking” in the $\overline{\text{BB}}$ signal description.) The bus request hold (BRH) bit in the BCR allows $\overline{\text{BR}}$ to be asserted under software control even though the DSP does not need the bus. $\overline{\text{BR}}$ is typically sent to an external bus arbitrator that controls the priority, parking, and tenure of each master on the same external bus. $\overline{\text{BR}}$ is affected only by DSP requests for the external bus, never for the internal bus. During hardware reset, $\overline{\text{BR}}$ is deasserted and the arbitration is reset to the bus slave state.

Table 1-12. Enhanced Synchronous Serial Interface 0 (Continued)

Signal Name	Type	State During Reset[1,2]	Signal Description
STD0	Output	Ignored Input	**Serial Transmit Data**—Transmits data from the Serial Transmit Shift Register. STD0 is an output when data is transmitted.
PC5	Input or Output		**Port C 5**—The default configuration following reset is GPIO input PC5. When configured as PC5, signal direction is controlled through the Port C Direction Register. The signal can be configured as an ESSI signal STD0 through the Port C Control Register.

Notes:
1. In the Stop state, the signal maintains the last state as follows:
   - If the last state is input, the signal is an ignored input.
   - If the last state is output, the signal is tri-stated.
2. The Wait processing state does not affect the signal state.
3. All inputs are 5 V tolerant.

1.9 Enhanced Synchronous Serial Interface 1 (ESSI1)

Table 1-13. Enhanced Serial Synchronous Interface 1

Signal Name	Type	State During Reset[1,2]	Signal Description
SC10	Input or Output	Ignored Input	**Serial Control 0**—For asynchronous mode, this signal is used for the receive clock I/O (Schmitt-trigger input). For synchronous mode, this signal is used either for transmitter 1 output or for serial I/O flag 0.
PD0	Input or Output		**Port D 0**—The default configuration following reset is GPIO input PD0. When configured as PD0, signal direction is controlled through the Port D Direction Register. The signal can be configured as an ESSI signal SC10 through the Port D Control Register.
SC11	Input/Output	Ignored Input	**Serial Control 1**—For asynchronous mode, this signal is the receiver frame sync I/O. For synchronous mode, this signal is used either for Transmitter 2 output or for Serial I/O Flag 1.
PD1	Input or Output		**Port D 1**—The default configuration following reset is GPIO input PD1. When configured as PD1, signal direction is controlled through the Port D Direction Register. The signal can be configured as an ESSI signal SC11 through the Port D Control Register.
SC12	Input/Output	Ignored Input	**Serial Control Signal 2**—The frame sync for both the transmitter and receiver in synchronous mode and for the transmitter only in asynchronous mode. When configured as an output, this signal is the internally generated frame sync signal. When configured as an input, this signal receives an external frame sync signal for the transmitter (and the receiver in synchronous operation).
PD2	Input or Output		**Port D 2**—The default configuration following reset is GPIO input PD2. When configured as PD2, signal direction is controlled through the Port D Direction Register. The signal can be configured as an ESSI signal SC12 through the Port D Control Register.

1.10 Serial Communication Interface (SCI)

The SCI provides a full duplex port for serial communication with other DSPs, microprocessors, or peripherals such as modems.

Table 1-14. Serial Communication Interface

Signal Name	Type	State During Reset[1,2]	Signal Description
RXD	Input	Ignored Input	**Serial Receive Data**—Receives byte-oriented serial data and transfers it to the SCI Receive Shift Register.
PE0	Input or Output		**Port E 0**—The default configuration following reset is GPIO input PE0. When configured as PE0, signal direction is controlled through the Port E Direction Register. The signal can be configured as an SCI signal RXD through the Port E Control Register.
TXD	Output	Ignored Input	**Serial Transmit Data**—Transmits data from the SCI Transmit Data Register.
PE1	Input or Output		**Port E 1**—The default configuration following reset is GPIO input PE1. When configured as PE1, signal direction is controlled through the Port E Direction Register. The signal can be configured as an SCI signal TXD through the Port E Control Register.
SCLK	Input/Output	Ignored Input	**Serial Clock**—Provides the input or output clock used by the transmitter and/or the receiver.
PE2	Input or Output		**Port E 2**—The default configuration following reset is GPIO input PE2. When configured as PE2, signal direction is controlled through the Port E Direction Register. The signal can be configured as an SCI signal SCLK through the Port E Control Register.

Notes:
1. In the Stop state, the signal maintains the last state as follows:
   - If the last state is input, the signal is an ignored input.
   - If the last state is output, the signal is tri-stated.
2. The Wait processing state does not affect the signal state.
3. All inputs are 5 V tolerant.

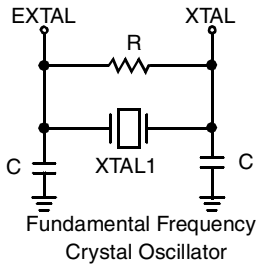
Table 2-4. Internal Clocks, CLKOUT (Continued)

Characteristics	Symbol	Expression[1, 2]		
		Min	Typ	Max
Internal clock and CLKOUT cycle time with PLL disabled	T_C	—	2 × ET_C	—
Instruction cycle time	I_{CYC}	—	T_C	—

Notes: 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.

2.5.2 External Clock Operation

The DSP56303 system clock is derived from the on-chip oscillator or is externally supplied. To use the on-chip oscillator, connect a crystal and associated resistor/capacitor components to EXTAL and XTAL; examples are shown in **Figure 2-1**.



Note: Make sure that in the PCTL Register:
- XTLD (bit 16) = 0
- If f_{OSC} > 200 kHz, XTLR (bit 15) = 0

Suggested Component Values:

f_{OSC} = 4 MHz
R = 680 kΩ±10%
C = 56 pF ±20%

f_{OSC} = 20 MHz
R = 680 kΩ±10%
C = 22 pF ±20%

Calculations were done for a 4/20 MHz crystal with the following parameters:
- C_L of 30/20 pF,
- C_0 of 7/6 pF,
- series resistance of 100/20 Ω, and
- drive level of 2 mW.

Figure 2-1. Crystal Oscillator Circuits

If an externally-supplied square wave voltage source is used, disable the internal oscillator circuit during bootup by setting XTLD (PCTL Register bit 16 = 1—see the *DSP56303 User's Manual*). The external square wave source connects to EXTAL; XTAL is not physically connected to the board or socket. **Figure 2-2** shows the relationship between the EXTAL input and the internal clock and CLKOUT.

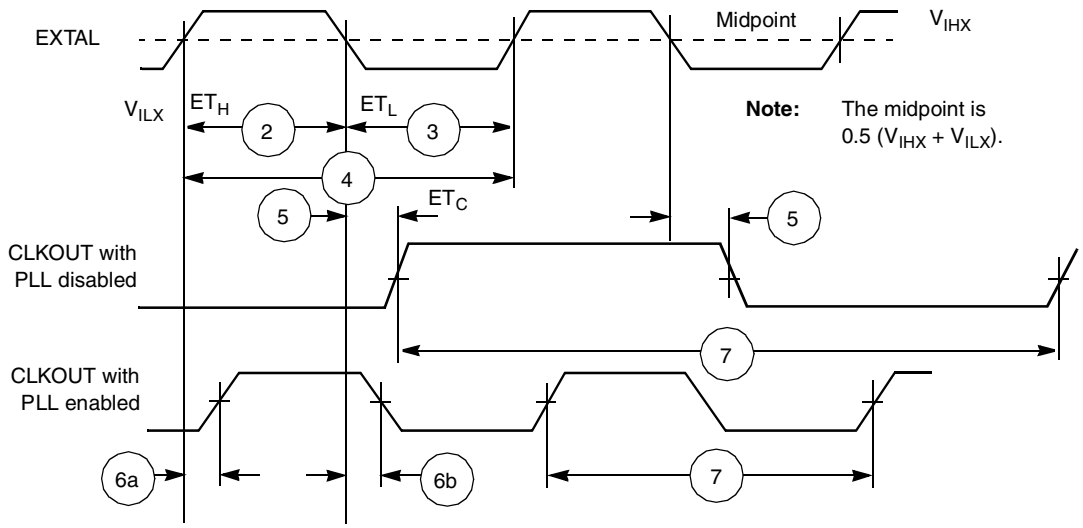


Figure 2-2. External Clock Timing

Table 2-9. DRAM Page Mode Timings, Three Wait States[1,2,3]

No.	Characteristics	Symbol	Expression[4]	100 MHz		Unit
				Min	Max	
131	Page mode cycle time for two consecutive accesses of the same direction		$4 \times T_C$	40.0	—	ns
	Page mode cycle time for mixed (read and write) accesses	t_{PC}	$3.5 \times T_C$	35.0	—	ns
132	$\overline{CAS}$ assertion to data valid (read)	t_{CAC}	$2 \times T_C - 5.7$	—	14.3	ns
133	Column address valid to data valid (read)	t_{AA}	$3 \times T_C - 5.7$	—	24.3	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, 01—not applicable • BRW[1–0] = 10 • BRW[1–0] = 11	t_{CRP}	 — $4.75 \times T_C - 6.0$ $6.75 \times T_C - 6.0$	 — 41.5 61.5	 — — —	 — ns 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}	$0.5 \times T_C - 4.5$	0.5	—	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
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}	$2.5 \times T_C - 5.7$	—	19.3	ns
154	$\overline{RD}$ deassertion to data not valid[6]	t_{GZ}		0.0	—	ns
155	$\overline{WR}$ assertion to data active		$0.75 \times T_C - 1.5$	6.0	—	ns
156	$\overline{WR}$ deassertion to data high impedance		$0.25 \times T_C$	—	2.5	ns

Notes:
1. The number of wait states for Page mode access is specified in the DRAM Control Register.
2. The refresh period is specified in the DRAM Control Register.
3. The asynchronous delays specified in the expressions are valid for the DSP56303.
4. All the timings are calculated for the worst case. Some of the timings are better for specific cases (for example, t_{PC} equals $4 \times T_C$ for read-after-read or write-after-write sequences). An expression is used to compute the number listed as the minimum or maximum value listed, as appropriate.
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 always occurs after $\overline{CAS}$ deassertion; therefore, the restricted timing is t_{OFF} and not t_{GZ}.

2.5.5.3 Synchronous Timings

Table 2-13. External Bus Synchronous Timings[1,2]

No.	Characteristics	Expression[3,4,5]	100 MHz		Unit
			Min	Max	
198	CLKOUT high to address, and AA valid[6]	$0.25 \times T_C + 4.0$	—	6.5	ns
199	CLKOUT high to address, and AA invalid[6]	$0.25 \times T_C$	2.5	—	ns
200	$\overline{TA}$ valid to CLKOUT high (set-up time)		4.0	—	ns
201	CLKOUT high to $\overline{TA}$ invalid (hold time)		0.0	—	ns
202	CLKOUT high to data out active	$0.25 \times T_C$	2.5	—	ns
203	CLKOUT high to data out valid	$0.25 \times T_C + 4.0$	—	6.5	ns
204	CLKOUT high to data out invalid	$0.25 \times T_C$	2.5	—	ns
205	CLKOUT high to data out high impedance	$0.25 \times T_C$	—	2.5	ns
206	Data in valid to CLKOUT high (set-up)		4.0	—	ns
207	CLKOUT high to data in invalid (hold)		0.0	—	ns
208	CLKOUT high to $\overline{RD}$ assertion	maximum: $0.75 \times T_C + 2.5$	6.7	10.0	ns
209	CLKOUT high to $\overline{RD}$ deassertion		0.0	4.0	ns
210	CLKOUT high to $\overline{WR}$ assertion[2]	maximum: $0.5 \times T_C + 4.3$ for WS = 1 or WS ≥ 4 for 2 ≤WS ≤3	5.0 0.0	9.3 4.3	ns ns
211	CLKOUT high to $\overline{WR}$ deassertion		0.0	3.8	ns

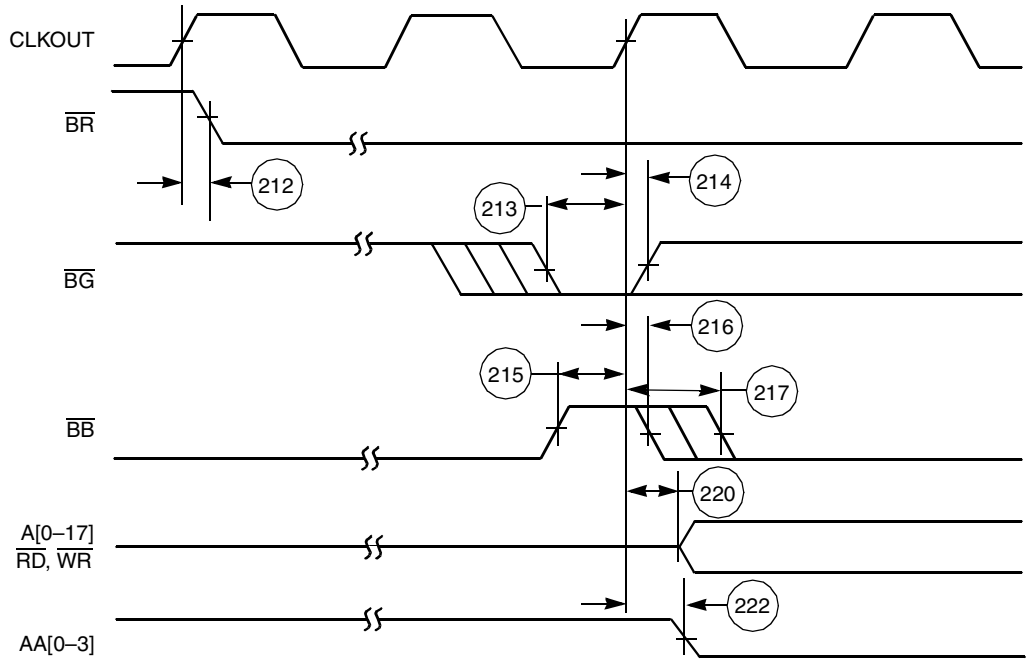
Notes:
1. Use external bus synchronous timings only for reference to the clock and *not* for relative timings.
2. Synchronous Bus Arbitration is not recommended. Use Asynchronous mode whenever possible.
3. WS is the number of wait states specified in the BCR.
4. If WS > 1, $\overline{WR}$ assertion refers to the next rising edge of CLKOUT.
5. Use the expression to compute the maximum or minimum value listed, as appropriate. For timing 210, the minimum is an absolute value.
6. T198 and T199 are valid for Address Trace mode if the ATE bit in the Operating Mode Register is set. when this mode is enabled, use the status of $\overline{BR}$ (See T212) to determine whether the access referenced by A[0–17] is internal or external.

2.5.5.4 Arbitration Timings

Table 2-14. Arbitration Bus Timings[1]

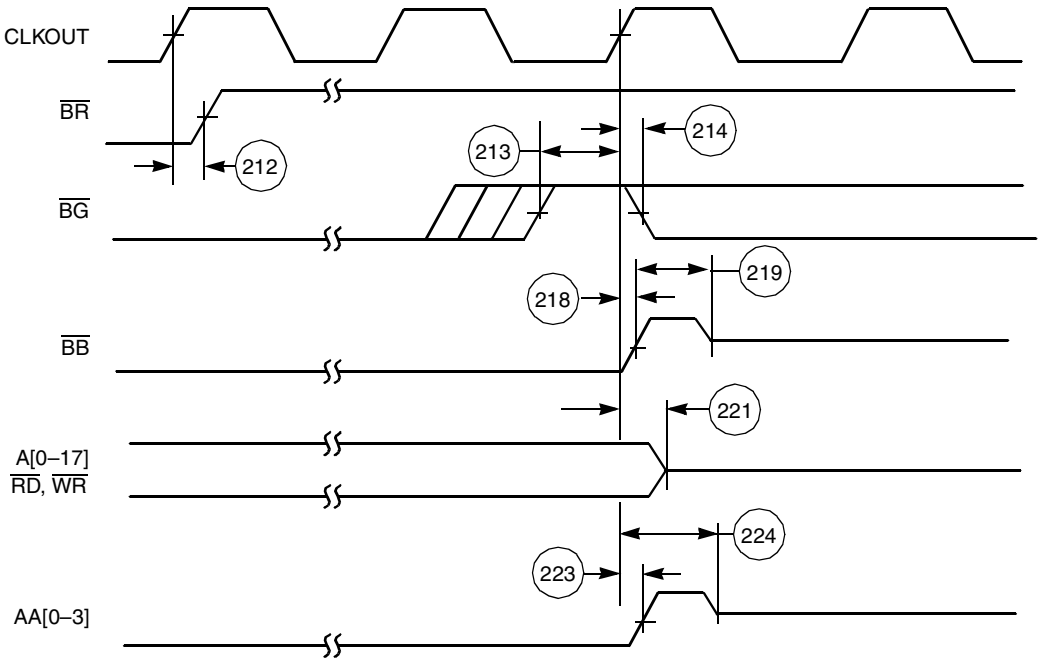
No.	Characteristics	Expression[2]	100 MHz		Unit
			Min	Max	
212	CLKOUT high to $\overline{BR}$ assertion/deassertion[3]		0.0	4.0	ns
213	$\overline{BG}$ asserted/deasserted to CLKOUT high (setup)		4.0	—	ns
214	CLKOUT high to $\overline{BG}$ deasserted/asserted (hold)		0.0	—	ns
215	$\overline{BB}$ deassertion to CLKOUT high (input set-up)		4.0	—	ns
216	CLKOUT high to $\overline{BB}$ assertion (input hold)		0.0	—	ns
217	CLKOUT high to $\overline{BB}$ assertion (output)		0.0	4.0	ns
218	CLKOUT high to $\overline{BB}$ deassertion (output)		0.0	4.0	ns
219	$\overline{BB}$ high to $\overline{BB}$ high impedance (output)		—	4.5	ns
220	CLKOUT high to address and controls active	$0.25 \times T_C$	2.5	—	ns
221	CLKOUT high to address and controls high impedance	$0.75 \times T_C$	—	7.5	ns
222	CLKOUT high to AA active	$0.25 \times T_C$	2.5	—	ns
223	CLKOUT high to AA deassertion	maximum: $0.25 \times T_C + 4.0$	2.0	6.5	ns
224	CLKOUT high to AA high impedance	$0.75 \times T_C$	—	7.5	ns

Notes:
1. Synchronous bus arbitration is not recommended. Use Asynchronous mode whenever possible.
2. An expression is used to compute the maximum or minimum value listed, as appropriate. For timing 223, the minimum is an absolute value.
3. T212 is valid for Address Trace mode when the ATE bit in the Operating Mode Register is set. $\overline{BR}$ is deasserted for internal accesses and asserted for external accesses.



Note: Address lines A[0–17] hold their state after a read or write operation. AA[0–3] do not hold their state after a read or write operation.

Figure 2-23. Bus Acquisition Timings



Note: Address lines A[0–17] hold their state after a read or write operation. AA[0–3] do not hold their state after a read or write operation.

Figure 2-24. Bus Release Timings Case 1 (BRT Bit in Operating Mode Register Cleared)

2.5.6 Host Interface Timing

Table 2-16. Host Interface Timings[1,2,12]

No.	Characteristic[10]	Expression	100 MHz		Unit
			Min	Max	
317	Read data strobe assertion width[5] $\overline{HACK}$ assertion width	$T_C + 9.9$	19.9	—	ns
318	Read data strobe deassertion width[5] $\overline{HACK}$ deassertion width		9.9	—	ns
319	Read data strobe deassertion width[5] after "Last Data Register" reads[8,11], or between two consecutive CVR, ICR, or ISR reads[3] $\overline{HACK}$ deassertion width after "Last Data Register" reads[8,11]	$2.5 \times T_C + 6.6$	31.6	—	ns
320	Write data strobe assertion width[6]		13.2	—	ns
321	Write data strobe deassertion width[8] $\overline{HACK}$ write deassertion width • after ICR, CVR and "Last Data Register" writes • after IVR writes, or after TXH:TXM:TXL writes (with HLEND= 0), or after TXL:TXM:TXH writes (with HLEND = 1)	$2.5 \times T_C + 6.6$	31.8 16.5	— —	ns ns
322	$\overline{HAS}$ assertion width		9.9	—	ns
323	$\overline{HAS}$ deassertion to data strobe assertion[4]		0.0	—	ns
324	Host data input setup time before write data strobe deassertion[6]		9.9	—	ns
325	Host data input hold time after write data strobe deassertion[6]		3.3	—	ns
326	Read data strobe assertion to output data active from high impedance[5] $\overline{HACK}$ assertion to output data active from high impedance		3.3	—	ns
327	Read data strobe assertion to output data valid[5] $\overline{HACK}$ assertion to output data valid		—	24.5	ns
328	Read data strobe deassertion to output data high impedance[5] $\overline{HACK}$ deassertion to output data high impedance		—	9.9	ns
329	Output data hold time after read data strobe deassertion[5] Output data hold time after $\overline{HACK}$ deassertion		3.3	—	ns
330	$\overline{HCS}$ assertion to read data strobe deassertion[5]	$T_C + 9.9$	19.9	—	ns
331	$\overline{HCS}$ assertion to write data strobe deassertion[6]		9.9	—	ns
332	$\overline{HCS}$ assertion to output data valid		—	19.3	ns
333	$\overline{HCS}$ hold time after data strobe deassertion[4]		0.0	—	ns
334	Address (HAD[0–7]) setup time before $\overline{HAS}$ deassertion (HMUX=1)		4.6	—	ns
335	Address (HAD[0–7]) hold time after $\overline{HAS}$ deassertion (HMUX=1)		3.3	—	ns
336	HA[8–10] (HMUX=1), HA[0–2] (HMUX=0), HR/$\overline{W}$ setup time before data strobe assertion[4] • Read • Write		 0 4.6	 — —	 ns ns
337	HA[8–10] (HMUX=1), HA[0–2] (HMUX=0), HR/$\overline{W}$ hold time after data strobe deassertion[4]		3.3	—	ns
338	Delay from read data strobe deassertion to host request assertion for "Last Data Register" read[5, 7, 8]	$T_C + 5.3$	15.3	—	ns
339	Delay from write data strobe deassertion to host request assertion for "Last Data Register" write[6, 7, 8]	$1.5 \times T_C + 5.3$	20.3	—	ns

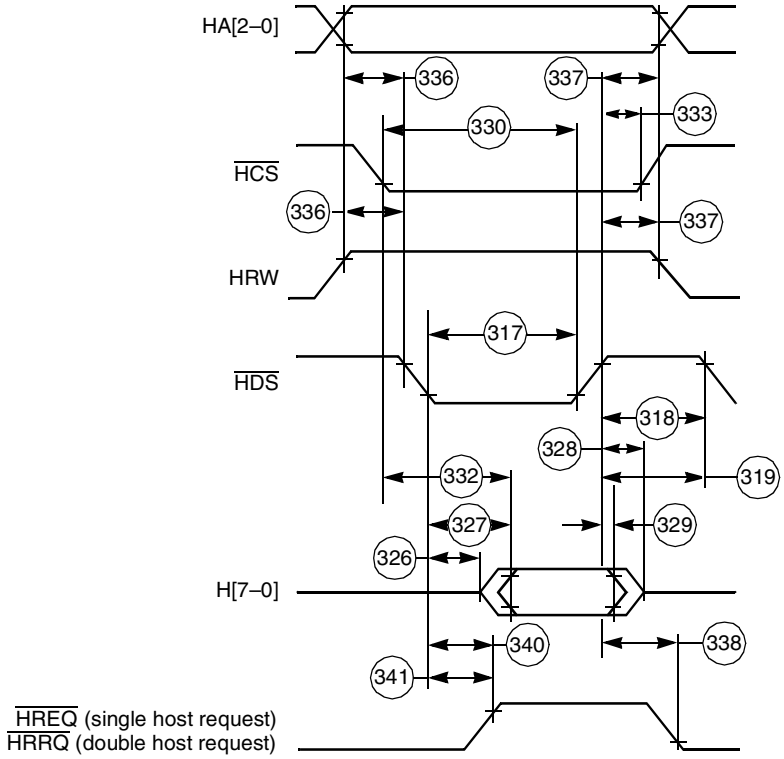


Figure 2-28. Read Timing Diagram, Non-Multiplexed Bus, Single Data Strobe

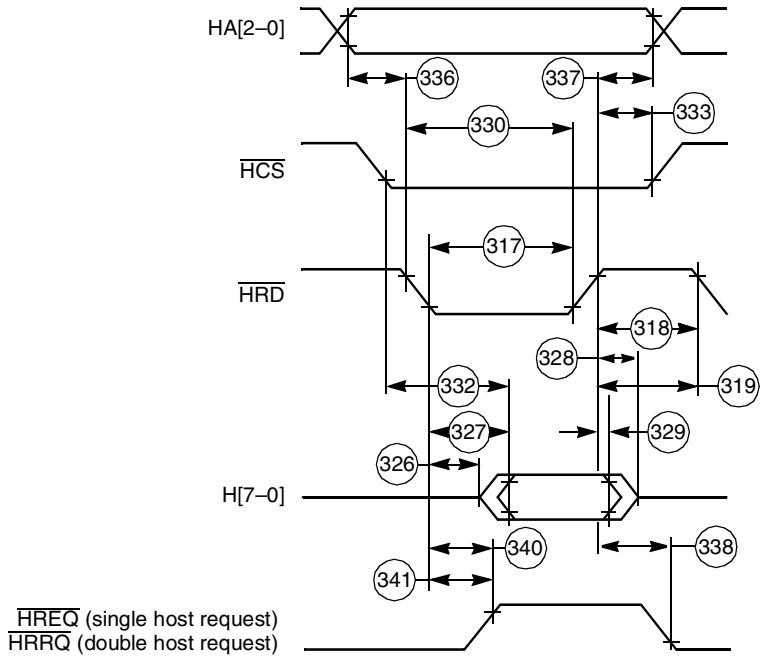


Figure 2-29. Read Timing Diagram, Non-Multiplexed Bus, Double Data Strobe

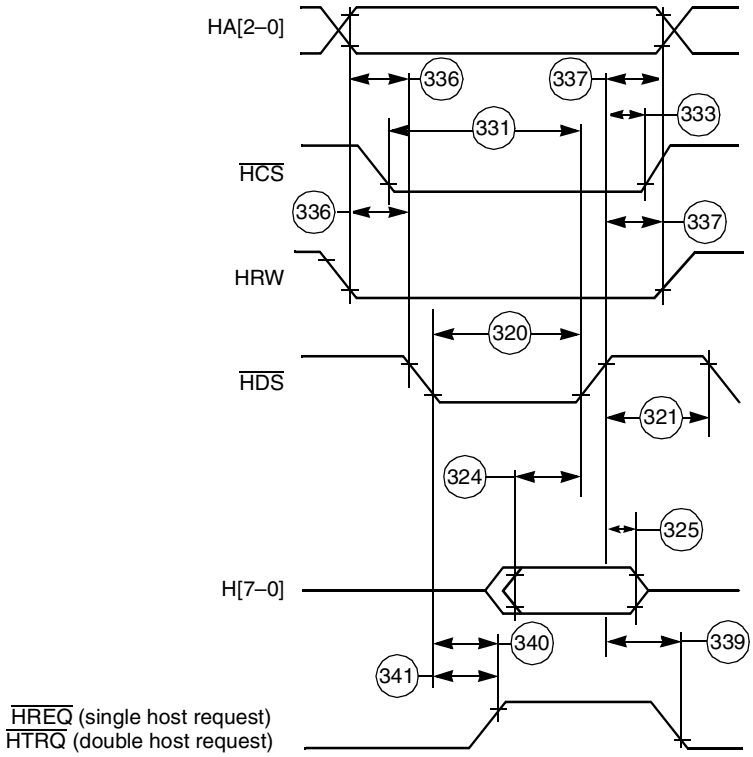


Figure 2-30. Write Timing Diagram, Non-Multiplexed Bus, Single Data Strobe

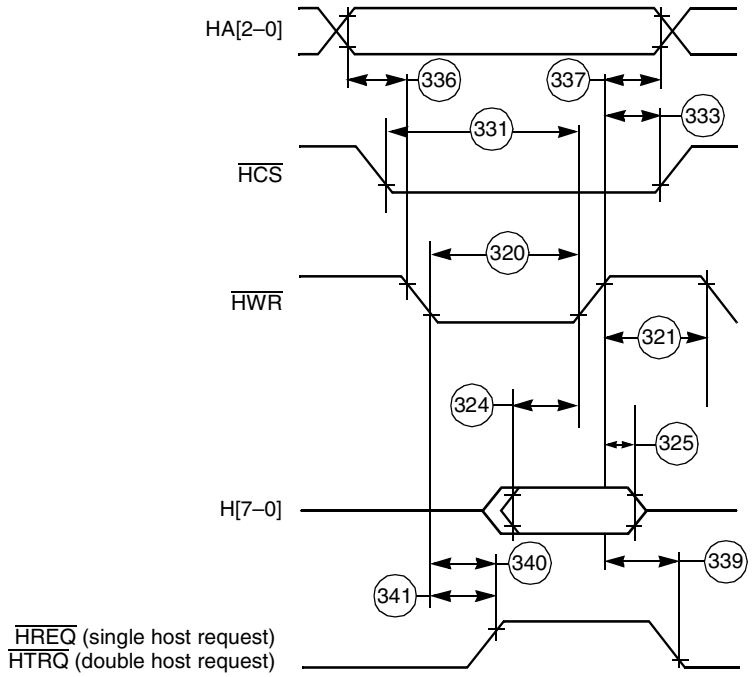


Figure 2-31. Write Timing Diagram, Non-Multiplexed Bus, Double Data Strobe

2.5.9 Timer Timing

Table 2-19. Timer Timing[1]

No.	Characteristics	Expression[2]	100 MHz		Unit
			Min	Max	
480	TIO Low	$2 \times T_C + 2.0$	22.0	—	ns
481	TIO High	$2 \times T_C + 2.0$	22.0	—	ns
482	Timer set-up time from TIO (Input) assertion to CLKOUT rising edge		9.0	10.0	ns
483	Synchronous timer delay time from CLKOUT rising edge to the external memory access address out valid caused by first interrupt instruction execution	$10.25 \times T_C + 1.0$	103.5	—	ns
484	CLKOUT rising edge to TIO (Output) assertion • Minimum • Maximum	 $0.5 \times T_C + 0.5$ $0.5 \times T_C + 19.8$	 5.5 —	 — 24.8	 ns ns
485	CLKOUT rising edge to TIO (Output) deassertion • Minimum • Maximum	 $0.5 \times T_C + 0.5$ $0.5 \times T_C + 19.8$	 5.5 —	 — 24.8	 ns ns

Notes: 1. V_{CC} = 3.3 V ± 0.3 V; T_J = -40°C to +100 °C, C_L = 50 pF.
2. An expression is used to compute the number listed as the minimum or maximum value as appropriate.

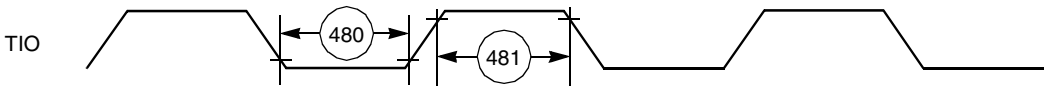


Figure 2-40. TIO Timer Event Input Restrictions

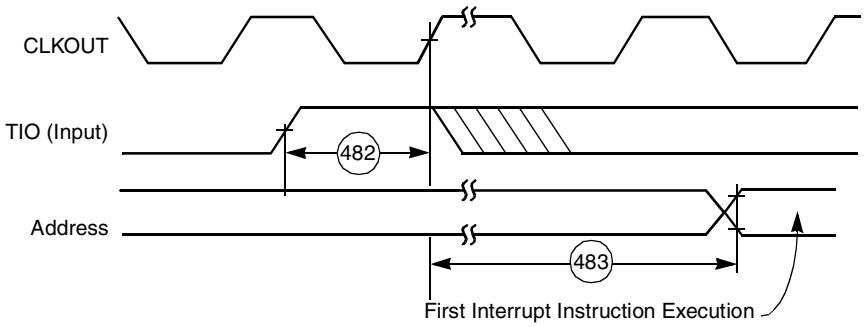


Figure 2-41. Timer Interrupt Generation

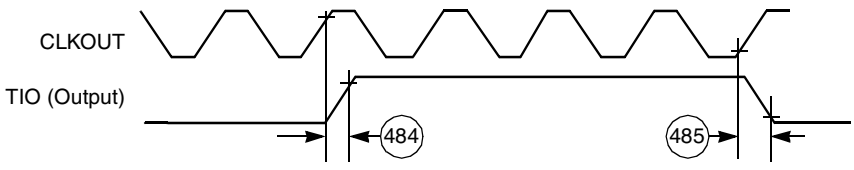


Figure 2-42. External Pulse Generation

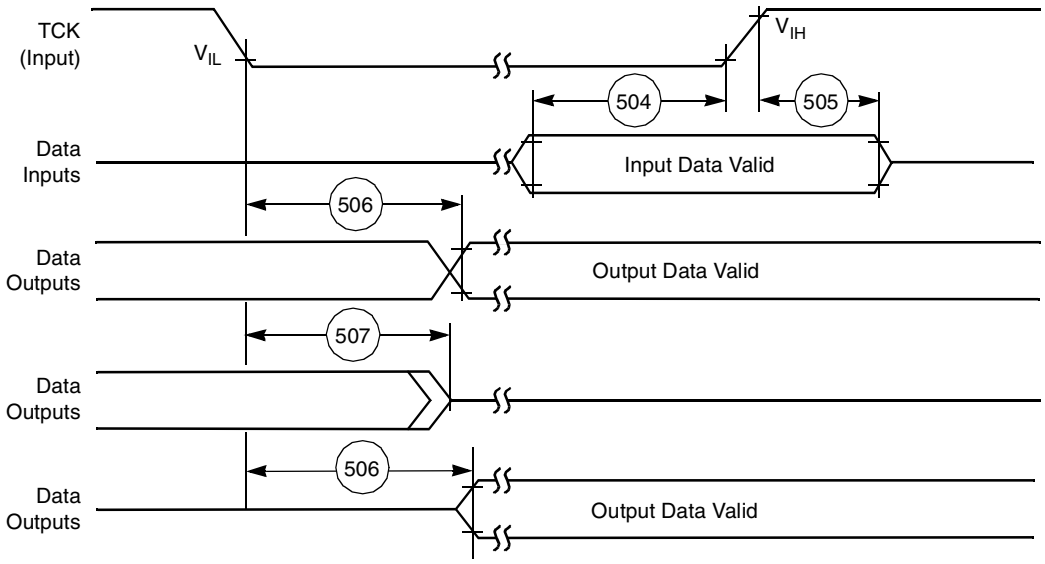


Figure 2-45. Boundary Scan (JTAG) Timing Diagram

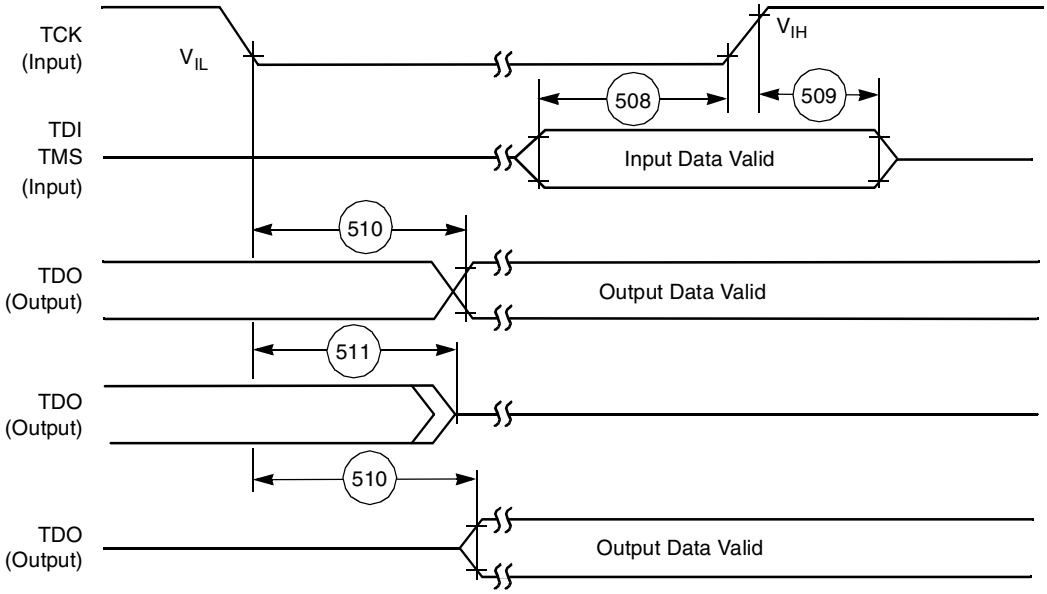


Figure 2-46. Test Access Port Timing Diagram

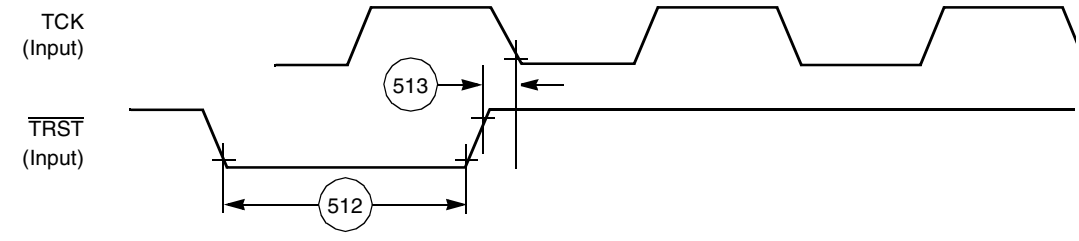


Figure 2-47. $\overline{\text{TRST}}$ Timing Diagram

Table 3-4. DSP56303 MAP-BGA Signal Identification by Name (Continued)

Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.
HRW	J2	PB14	K2	PE2	G2
$\overline{\text{HTRQ}}$/HTRQ	K2	PB15	J1	PINIT	D1
$\overline{\text{HWR}}$/HWR	J3	PB2	N4	$\overline{\text{RAS0}}$	N13
$\overline{\text{IRQA}}$	C4	PB3	P3	$\overline{\text{RAS1}}$	P12
$\overline{\text{IRQB}}$	A5	PB4	N3	$\overline{\text{RAS2}}$	P7
$\overline{\text{IRQC}}$	C5	PB5	P2	$\overline{\text{RAS3}}$	N7
$\overline{\text{IRQD}}$	B5	PB6	N1	$\overline{\text{RD}}$	M12
MODA	C4	PB7	N2	$\overline{\text{RESET}}$	N5
MODB	A5	PB8	M3	RXD	F1
MODC	C5	PB9	M1	SC00	F3
MODD	B5	PC0	F3	SC01	D2
NC	A1	PC1	D2	SC02	C1
NC	A14	PC2	C1	SC10	F2
NC	B14	PC3	H3	SC11	A2
NC	H1	PC4	E3	SC12	B2
NC	M7	PC5	E1	SCK0	H3
NC	P1	PCAP	P5	SCK1	G1
NC	P14	PD0	F2	SCLK	G2
NMI	D1	PD1	A2	SRD0	E3
PB0	M5	PD2	B2	SRD1	B1
PB1	P4	PD3	G1	STD0	E1
PB10	M2	PD4	B1	STD1	C2
PB11	J2	PD5	C2	$\overline{\text{TA}}$	P10
PB12	J3	PE0	F1	TCK	C3
PB13	L1	PE1	G3	TDI	B3

- To define a value approximately equal to a junction-to-board thermal resistance, the thermal resistance is measured from the junction to the point at which the leads attach to the case.
- If the temperature of the package case (T_T) is determined by a thermocouple, thermal resistance is computed from the value obtained by the equation $(T_J - T_T)/P_D$.

As noted earlier, 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 to determine the junction temperature from a case thermocouple reading in forced convection environments. In natural convection, the use of the junction-to-case thermal resistance to estimate junction temperature from a thermocouple reading on the case of the package will yield an estimate of a junction temperature slightly higher 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 the surface temperature of the package is used. 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.

4.2 Electrical Design Considerations

CAUTION

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

Use the following list of recommendations to ensure 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 µF 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 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 $\overline{\text{IRQA}}$, $\overline{\text{IRQB}}$, $\overline{\text{IRQC}}$, $\overline{\text{IRQD}}$, $\overline{\text{TA}}$, and $\overline{\text{BG}}$ pins. Maximum PCB trace lengths on the order of 6 inches are recommended.

```
        dc      $6C6657
        dc      $C2A544
        dc      $A3662D
        dc      $A4E762
        dc      $84F0F3
        dc      $E6F1B0
        dc      $B3829
        dc      $8BF7AE
        dc      $63A94F
        dc      $EF78DC
        dc      $242DE5
        dc      $A3E0BA
        dc      $EBAB6B
        dc      $8726C8
        dc      $CA361
        dc      $2F6E86
        dc      $A57347
        dc      $4BE774
        dc      $8F349D
        dc      $A1ED12
        dc      $4BFCE3
        dc      $EA26E0
        dc      $CD7D99
        dc      $4BA85E
        dc      $27A43F
        dc      $A8B10C
        dc      $D3A55
        dc      $25EC6A
        dc      $2A255B
        dc      $A5F1F8
        dc      $2426D1
        dc      $AE6536
        dc      $CBBC37
        dc      $6235A4
        dc      $37F0D
        dc      $63BEC2
        dc      $A5E4D3
        dc      $8CE810
        dc      $3FF09
        dc      $60E50E
        dc      $CFFB2F
        dc      $40753C
        dc      $8262C5
        dc      $CA641A
        dc      $EB3B4B
        dc      $2DA928
        dc      $AB6641
        dc      $28A7E6
        dc      $4E2127
        dc      $482FD4
        dc      $7257D
        dc      $E53C72
        dc      $1A8C3
        dc      $E27540
XDAT_END

YDAT_START
;       org     y:0
        dc      $5B6DA
        dc      $C3F70B
```

```
M_DI EQU 12                          ; Data Input
M_DO EQU 13                          ; Data Output
M_PCE EQU  15                        ; Prescaled Clock Enable
M_TOF EQU 20                         ; Timer Overflow Flag
M_TCF EQU 21                         ; Timer Compare Flag

;       Timer Prescaler Register Bit Flags

M_PS EQU  $600000                    ; Prescaler Source Mask
M_PS0 EQU  21
M_PS1 EQU  22

;      Timer Control Bits
M_TC0 EQU 4                          ; Timer Control 0
M_TC1 EQU 5                          ; Timer Control 1
M_TC2 EQU 6                          ; Timer Control 2
M_TC3 EQU 7                          ; Timer Control 3


;------------------------------------------------------------------------
;
;       EQUATES for Direct Memory Access (DMA)
;
;------------------------------------------------------------------------

;       Register Addresses Of DMA
M_DSTR EQU FFFFF4                    ; DMA Status Register
M_DOR0 EQU $FFFFF3                   ; DMA Offset Register 0
M_DOR1 EQU $FFFFF2                   ; DMA Offset Register 1
M_DOR2 EQU $FFFFF1                   ; DMA Offset Register 2
M_DOR3 EQU $FFFFF0                   ; DMA Offset Register 3


;       Register Addresses Of DMA0

M_DSR0 EQU $FFFFEF                   ; DMA0 Source Address Register
M_DDR0 EQU $FFFFEE                   ; DMA0 Destination Address Register
M_DCO0 EQU $FFFFED                   ; DMA0 Counter
M_DCR0 EQU $FFFFEC                   ; DMA0 Control Register

;       Register Addresses Of DMA1

M_DSR1 EQU $FFFFEB                   ; DMA1 Source Address Register
M_DDR1 EQU $FFFFEA                   ; DMA1 Destination Address Register
M_DCO1 EQU $FFFFE9                   ; DMA1 Counter
M_DCR1 EQU $FFFFE8                   ; DMA1 Control Register

;       Register Addresses Of DMA2

M_DSR2 EQU $FFFFE7                   ; DMA2 Source Address Register
M_DDR2 EQU $FFFFE6                   ; DMA2 Destination Address Register
M_DCO2 EQU $FFFFE5                   ; DMA2 Counter
M_DCR2 EQU $FFFFE4                   ; DMA2 Control Register

;       Register Addresses Of DMA4

M_DSR3 EQU $FFFFE3                   ; DMA3 Source Address Register
M_DDR3 EQU $FFFFE2                   ; DMA3 Destination Address Register
M_DCO3 EQU $FFFFE1                   ; DMA3 Counter
M_DCR3 EQU $FFFFE0                   ; DMA3 Control Register
```

Ordering Information

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

Part	Supply Voltage	Package Type	Pin Count	Core Frequency (MHz)	Solder Spheres	Order Number
DSP56303	3.3 V	Thin Quad Flat Pack (TQFP)	144	100	Lead-free	DSP56303AG100
					Lead-bearing	DSP56303PV100
		Molded Array Process-Ball Grid Array (MAP-BGA)	196	100	Lead-free	DSP56303VL100
					Lead-bearing	DSP56303VF100

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 München, 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
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Document Order No.: DSP56303
Rev. 11
2/2005