

**165-Bump BGA**  
**Commercial Temp**  
**Industrial Temp**

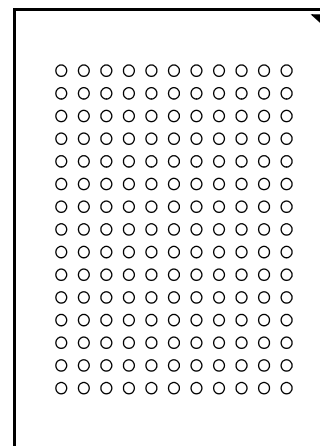


## 144Mb SigmaCIO DDR-II Burst of 2 SRAM

**333 MHz–167 MHz**  
**1.8 V V<sub>DD</sub>**  
**1.8 V and 1.5 V I/O**

### Features

- Simultaneous Read and Write SigmaCIO™ Interface
- Common I/O bus
- JEDEC-standard pinout and package
- Double Data Rate interface
- Byte Write (x36 and x18) and Nybble Write (x8) function
- Burst of 2 Read and Write
- 1.8 V +100/–100 mV core power supply
- 1.5 V or 1.8 V HSTL Interface
- Pipelined read operation with self-timed Late Write
- Fully coherent read and write pipelines
- ZQ pin for programmable output drive strength
- IEEE 1149.1 JTAG-compliant Boundary Scan
- Pin-compatible with present 9Mb, 18Mb, 36Mb and 72Mb devices
- 165-bump, 15 mm x 17 mm, 1 mm bump pitch BGA package
- RoHS-compliant 165-bump BGA package available



**Bottom View**  
**165-Bump, 15 mm x 17 mm BGA**  
**1 mm Bump Pitch, 11 x 15 Bump Array**

### SigmaCIO™ Family Overview

The GS81302T08/09/18/36E are built in compliance with the SigmaCIO DDR-II SRAM pinout standard for Common I/O synchronous SRAMs. They are 150,994,944-bit (144Mb) SRAMs. The GS81302T08/09/18/36E SigmaCIO SRAMs are just one element in a family of low power, low voltage HSTL I/O SRAMs designed to operate at the speeds needed to implement economical high performance networking systems.

clock inputs, not differential inputs. If the C clocks are tied high, the K clocks are routed internally to fire the output registers instead.

### Clocking and Addressing Schemes

The GS81302T08/09/18/36E SigmaCIO DDR-II SRAMs are synchronous devices. They employ two input register clock inputs, K and  $\bar{K}$ . K and  $\bar{K}$  are independent single-ended clock inputs, not differential inputs to a single differential clock input buffer. The device also allows the user to manipulate the output register clock inputs quasi independently with the C and C clock inputs. C and  $\bar{C}$  are also independent single-ended

Common I/O x36 and x18 SigmaCIO DDR-II B2 RAMs always transfer data in two packets. When a new address is loaded, A0 presets an internal 1 bit address counter. The counter increments by 1 (toggles) for each beat of a burst of two data transfer.

Common I/O x8 and x9 SigmaCIO DDR-II B2 RAMs always transfer data in two packets. When a new address is loaded, the LSB is internally set to 0 for the first read or write transfer, and incremented by 1 for the next transfer. Because the LSB is tied off internally, the address field of a x8/x9 SigmaCIO DDR-II B4 RAM is always one address pin less than the advertised index depth (e.g., the 16M x 8 has a 8M addressable index).

### Parameter Synopsis

	<b>-333</b>	<b>-300</b>	<b>-267</b>	<b>-250</b>	<b>-200</b>	<b>-167</b>
tKHKH	3.0 ns	3.3 ns	3.75 ns	4.0 ns	5.0 ns	6.0 ns
tKHQV	0.45 ns	0.45 ns	0.45 ns	0.45 ns	0.45 ns	0.5 ns

**4M x 36 SigmaCIO DDR-II SRAM—Top View**

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{\text{CQ}}$	SA	SA	$\text{R}/\overline{\text{W}}$	$\overline{\text{BW2}}$	$\overline{\text{K}}$	$\overline{\text{BW1}}$	$\overline{\text{LD}}$	SA	SA	CQ
B	NC	DQ27	DQ18	SA	$\overline{\text{BW3}}$	K	$\overline{\text{BW0}}$	SA	NC/SA (288Mb)	NC	DQ8
C	NC	NC	DQ28	$V_{\text{SS}}$	SA	SA0	SA	$V_{\text{SS}}$	NC	DQ17	DQ7
D	NC	DQ29	DQ19	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	NC	NC	DQ16
E	NC	NC	DQ20	$V_{\text{DDQ}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{DDQ}}$	NC	DQ15	DQ6
F	NC	DQ30	DQ21	$V_{\text{DDQ}}$	$V_{\text{DD}}$	$V_{\text{SS}}$	$V_{\text{DD}}$	$V_{\text{DDQ}}$	NC	NC	DQ5
G	NC	DQ31	DQ22	$V_{\text{DDQ}}$	$V_{\text{DD}}$	$V_{\text{SS}}$	$V_{\text{DD}}$	$V_{\text{DDQ}}$	NC	NC	DQ14
H	$\overline{\text{Doff}}$	$V_{\text{REF}}$	$V_{\text{DDQ}}$	$V_{\text{DDQ}}$	$V_{\text{DD}}$	$V_{\text{SS}}$	$V_{\text{DD}}$	$V_{\text{DDQ}}$	$V_{\text{DDQ}}$	$V_{\text{REF}}$	ZQ
J	NC	NC	DQ32	$V_{\text{DDQ}}$	$V_{\text{DD}}$	$V_{\text{SS}}$	$V_{\text{DD}}$	$V_{\text{DDQ}}$	NC	DQ13	DQ4
K	NC	NC	DQ23	$V_{\text{DDQ}}$	$V_{\text{DD}}$	$V_{\text{SS}}$	$V_{\text{DD}}$	$V_{\text{DDQ}}$	NC	DQ12	DQ3
L	NC	DQ33	DQ24	$V_{\text{DDQ}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{DDQ}}$	NC	NC	DQ2
M	NC	NC	DQ34	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	$V_{\text{SS}}$	NC	DQ11	DQ1
N	NC	DQ35	DQ25	$V_{\text{SS}}$	SA	SA	SA	$V_{\text{SS}}$	NC	NC	DQ10
P	NC	NC	DQ26	SA	SA	C	SA	SA	NC	DQ9	DQ0
R	TDO	TCK	SA	SA	SA	$\overline{\text{C}}$	SA	SA	SA	TMS	TDI

11 x 15 Bump BGA—13 x 15 mm<sup>2</sup> Body—1 mm Bump Pitch

**Notes:**

1.  $\overline{\text{BW0}}$  controls writes to DQ0:DQ8;  $\overline{\text{BW1}}$  controls writes to DQ9:DQ17;  $\overline{\text{BW2}}$  controls writes to DQ18:DQ26;  $\overline{\text{BW3}}$  controls writes to DQ27:DQ35
2. MCL = Must Connect Low

**8M x 18 SigmaCIO DDR-II SRAM—Top View**

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{\text{CQ}}$	SA	SA	$\overline{\text{R/W}}$	$\overline{\text{BW1}}$	$\overline{\text{K}}$	SA	$\overline{\text{LD}}$	SA	SA	CQ
B	NC	DQ9	NC	SA	NC/SA (288Mb)	K	$\overline{\text{BW0}}$	SA	NC	NC	DQ8
C	NC	NC	NC	$V_{SS}$	SA	SA0	SA	$V_{SS}$	NC	DQ7	NC
D	NC	NC	DQ10	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	NC	NC
E	NC	NC	DQ11	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ6
F	NC	DQ12	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	DQ5
G	NC	NC	DQ13	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
H	$\overline{\text{Doff}}$	$V_{REF}$	$V_{DDQ}$	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	$V_{DDQ}$	$V_{REF}$	ZQ
J	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	DQ4	NC
K	NC	NC	DQ14	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	DQ3
L	NC	DQ15	NC	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ2
M	NC	NC	NC	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	DQ1	NC
N	NC	NC	DQ16	$V_{SS}$	SA	SA	SA	$V_{SS}$	NC	NC	NC
P	NC	NC	DQ17	SA	SA	C	SA	SA	NC	NC	DQ0
R	TDO	TCK	SA	SA	SA	$\overline{\text{C}}$	SA	SA	SA	TMS	TDI

11 x 15 Bump BGA—13 x 15 mm<sup>2</sup> Body—1 mm Bump Pitch

**Notes:**

1.  $\overline{\text{BW0}}$  controls writes to DQ0:DQ8;  $\overline{\text{BW1}}$  controls writes to DQ9:DQ17
2. MCL = Must Connect Low

**16M x 9 SigmaCIO DDR-II SRAM—Top View**

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{\text{CQ}}$	SA	SA	$\overline{\text{R/W}}$	NC	$\overline{\text{K}}$	SA	$\overline{\text{LD}}$	SA	SA	CQ
B	NC	NC	NC	SA	NC/SA (288Mb)	K	$\overline{\text{BW}}$	SA	NC	NC	DQ4
C	NC	NC	NC	$V_{SS}$	SA	SA	SA	$V_{SS}$	NC	NC	NC
D	NC	NC	NC	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	NC	NC
E	NC	NC	DQ5	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ3
F	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
G	NC	NC	DQ6	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
H	$\overline{\text{Doff}}$	$V_{REF}$	$V_{DDQ}$	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	$V_{DDQ}$	$V_{REF}$	ZQ
J	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	DQ2	NC
K	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
L	NC	DQ7	NC	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ1
M	NC	NC	NC	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	NC	NC
N	NC	NC	NC	$V_{SS}$	SA	SA	SA	$V_{SS}$	NC	NC	NC
P	NC	NC	DQ8	SA	SA	C	SA	SA	NC	NC	DQ0
R	TDO	TCK	SA	SA	SA	$\overline{\text{C}}$	SA	SA	SA	TMS	TDI

11 x 15 Bump BGA—13 x 15 mm<sup>2</sup> Body—1 mm Bump Pitch

**Notes:**

1. Unlike the x36 and x18 versions of this device, the x8 and x9 versions do not give the user access to A0. SA0 is set to 0 at the beginning of each access.
2. MCL = Must Connect Low

**16M x 8 SigmaCIO DDR-II SRAM—Top View**

	1	2	3	4	5	6	7	8	9	10	11
A	$\overline{\text{CQ}}$	SA	SA	$\overline{\text{R/W}}$	$\overline{\text{NW1}}$	$\overline{\text{K}}$	SA	$\overline{\text{LD}}$	SA	SA	CQ
B	NC	NC	NC	SA	NC/SA (288Mb)	K	$\overline{\text{NW0}}$	SA	NC	NC	DQ3
C	NC	NC	NC	$V_{SS}$	SA	SA	SA	$V_{SS}$	NC	NC	NC
D	NC	NC	NC	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	NC	NC
E	NC	NC	DQ4	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ2
F	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
G	NC	NC	DQ5	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
H	$\overline{\text{Doff}}$	$V_{REF}$	$V_{DDQ}$	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	$V_{DDQ}$	$V_{REF}$	ZQ
J	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	DQ1	NC
K	NC	NC	NC	$V_{DDQ}$	$V_{DD}$	$V_{SS}$	$V_{DD}$	$V_{DDQ}$	NC	NC	NC
L	NC	DQ6	NC	$V_{DDQ}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{DDQ}$	NC	NC	DQ0
M	NC	NC	NC	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	$V_{SS}$	NC	NC	NC
N	NC	NC	NC	$V_{SS}$	SA	SA	SA	$V_{SS}$	NC	NC	NC
P	NC	NC	DQ7	SA	SA	C	SA	SA	NC	NC	NC
R	TDO	TCK	SA	SA	SA	$\overline{\text{C}}$	SA	SA	SA	TMS	TDI

11 x 15 Bump BGA—13 x 15 mm<sup>2</sup> Body—1 mm Bump Pitch

**Notes:**

1. Unlike the x36 and x18 versions of this device, the x8 and x9 versions do not give the user access to A0. SA0 is set to 0 at the beginning of each access.
2.  $\overline{\text{NW0}}$  controls writes to DQ0:DQ3;  $\overline{\text{NW1}}$  controls writes to DQ4:DQ7
3. MCL = Must Connect Low

### Pin Description Table

Symbol	Description	Type	Comments
SA	Synchronous Address Inputs	Input	—
NC	No Connect	—	—
R	Synchronous Read	Input	Active High
$\overline{W}$	Synchronous Write	Input	Active Low
$\overline{BW0-BW3}$	Synchronous Byte Writes	Input	Active Low x18/x36 only
$\overline{NW0-NW1}$	Nybble Write Control Pin	Input	Active Low x8 only
$\overline{LD}$	Synchronous Load Pin	Input	Active Low
K	Input Clock	Input	Active High
$\overline{K}$	Input Clock	Input	Active Low
C	Output Clock	Input	Active High
$\overline{C}$	Output Clock	Input	Active Low
TMS	Test Mode Select	Input	—
TDI	Test Data Input	Input	—
TCK	Test Clock Input	Input	—
TDO	Test Data Output	Output	—
V <sub>REF</sub>	HSTL Input Reference Voltage	Input	—
ZQ	Output Impedance Matching Input	Input	—
MCL	Must Connect Low	—	—
DQ	Data I/O	Input/Output	Three State
$\overline{Doff}$	Disable DLL when low	Input	Active Low
CQ	Output Echo Clock	Output	—
$\overline{CQ}$	Output Echo Clock	Output	—
V <sub>DD</sub>	Power Supply	Supply	1.8 V Nominal
V <sub>DDQ</sub>	Isolated Output Buffer Supply	Supply	1.5 V Nominal
V <sub>SS</sub>	Power Supply: Ground	Supply	—

**Notes:**

1. NC = Not Connected to die or any other pin
2. When ZQ pin is directly connected to V<sub>DD</sub>, output impedance is set to minimum value and it cannot be connected to ground or left unconnected.

## Background

Common I/O SRAMs, from a system architecture point of view, are attractive in read dominated or block transfer applications. Therefore, the SigmaCIO DDR-II SRAM interface and truth table are optimized for burst reads and writes. Common I/O SRAMs are unpopular in applications where alternating reads and writes are needed because bus turnaround delays can cut high speed Common I/O SRAM data bandwidth in half.

## Burst Operations

Read and write operations are "burst" operations. In every case where a read or write command is accepted by the SRAM, it will respond by issuing or accepting two beats of data, executing a data transfer on subsequent rising edges of K and K#, as illustrated in the timing diagrams. It is not possible to stop a burst once it starts. Two beats of data are always transferred. This means that it is possible to load new addresses every K clock cycle. Addresses can be loaded less often, if intervening deselect cycles are inserted.

## Deselect Cycles

Chip Deselect commands are pipelined to the same degree as read commands. This means that if a deselect command is applied to the SRAM on the next cycle after a read command captured by the SRAM, the device will complete the two beat read data transfer and then execute the deselect command, returning the output drivers to high-Z. A high on the LD# pin prevents the RAM from loading read or write command inputs and puts the RAM into deselect mode as soon as it completes all outstanding burst transfer operations.

## SigmaCIO DDR-II B2 SRAM Read Cycles

The SRAM executes pipelined reads. The status of the Address, LD# and R/W# pins are evaluated on the rising edge of K. The read command (LD# low and R/W# high) is clocked into the SRAM by a rising edge of K. After the next rising edge of K, the SRAM produces data out in response to the next rising edge of C# (or the next rising edge of K#, if C and C# are tied high). The second beat of data is transferred on the next rising edge of C, for a total of two transfers per address load.

## SigmaCIO DDR-II B2 SRAM Write Cycles

The status of the Address, LD# and R/W# pins are evaluated on the rising edge of K. The SRAM executes "late write" data transfers. Data in is due at the device inputs on the rising edge of K following the rising edge of K clock used to clock in the write command (LD# and R/W# low) and the write address. To complete the remaining beat of the burst of two write transfer, the SRAM captures data in on the next rising edge of K#, for a total of two transfers per address load.

### Power-Up Sequence for SigmaQuad-II SRAMs

SigmaQuad-II SRAMs must be powered-up in a specific sequence in order to avoid undefined operations.

#### Power-Up Sequence

1. Power-up and maintain  $\overline{\text{Doff}}$  at low state.
  - 1a. Apply  $V_{DD}$ .
  - 1b. Apply  $V_{DDQ}$ .
  - 1c. Apply  $V_{REF}$  (may also be applied at the same time as  $V_{DDQ}$ ).
2. After power is achieved and clocks ( $K$ ,  $\overline{K}$ ,  $C$ ,  $\overline{C}$ ) are stabilized, change  $\overline{\text{Doff}}$  to high.
3. An additional 1024 clock cycles are required to lock the DLL after it has been enabled.

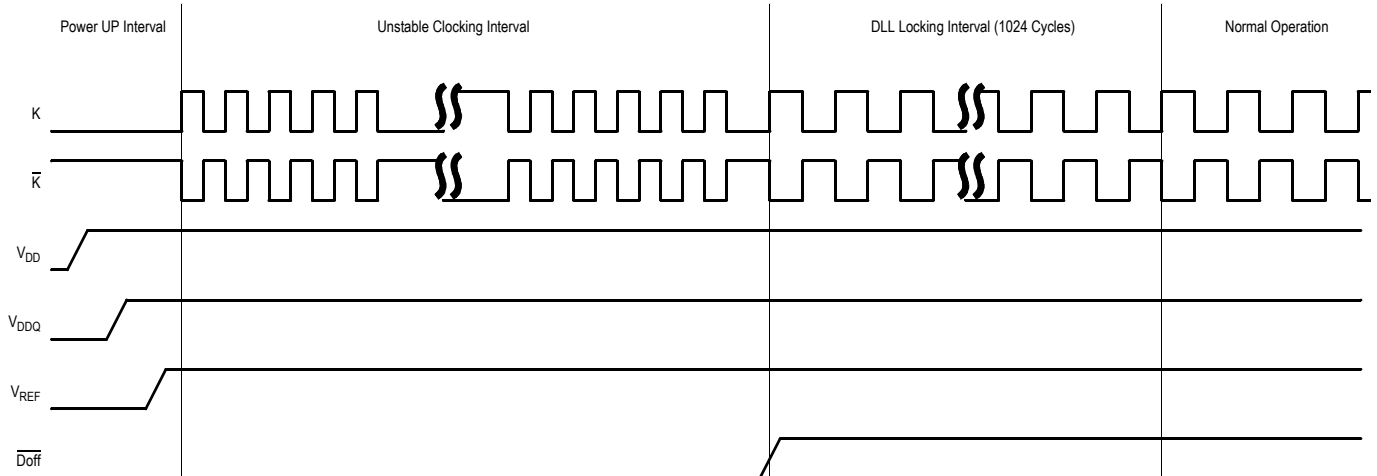
#### Note:

The DLL may be reset by driving the  $\overline{\text{Doff}}$  pin low or by stopping the K clocks for at least 30 ns. 1024 cycles of clean K clocks are always required to re-lock the DLL after reset.

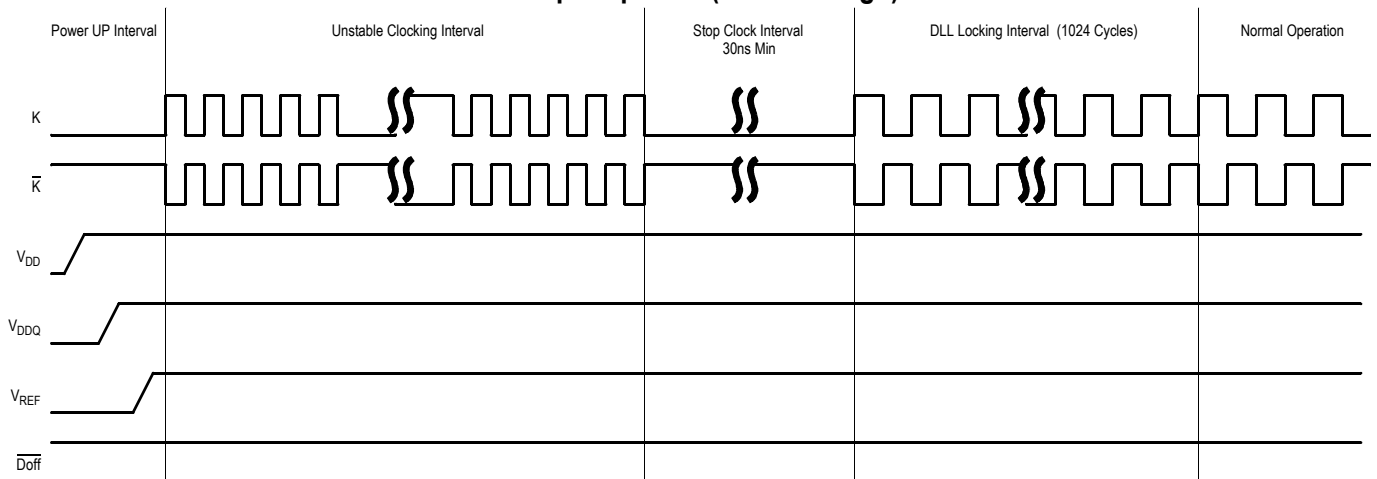
#### DLL Constraints

- The DLL synchronizes to either K or C clock. These clocks should have low phase jitter ( $t_{KCVar}$ ).
- The DLL cannot operate at a frequency lower than that specified by the  $t_{KHKH}$  maximum specification for the desired operating clock frequency.
- If the incoming clock is not stabilized when DLL is enabled, the DLL may lock on the wrong frequency and cause undefined errors or failures during the initial stage.

#### Power-Up Sequence ( $\overline{\text{Doff}}$ controlled)



#### Power-Up Sequence ( $\overline{\text{Doff}}$ tied High)



#### Note:

If the frequency is changed, DLL reset is required. After reset, a minimum of 1024 cycles is required for DLL lock.



## Special Functions

### Byte Write and Nybble Write Control

Byte Write Enable pins are sampled at the same time that Data In is sampled. A high on the Byte Write Enable pin associated with a particular byte (e.g.,  $\overline{BW0}$  controls D0–D8 inputs) will inhibit the storage of that particular byte, leaving whatever data may be stored at the current address at that byte location undisturbed. Any or all of the Byte Write Enable pins may be driven high or low during the data in sample times in a write sequence.

Each write enable command and write address loaded into the RAM provides the base address for a 2 beat data transfer. The x18 version of the RAM, for example, may write 36 bits in association with each address loaded. Any 9-bit byte may be masked in any write sequence.

Nybble Write (4-bit) write control is implemented on the 8-bit-wide version of the device. For the x8 version of the device, “Nybble Write Enable” and “ $\overline{NBx}$ ” may be substituted in all the discussion above.

### Example x18 RAM Write Sequence using Byte Write Enables

Data In Sample Time	$\overline{BW0}$	$\overline{BW1}$	D0–D8	D9–D17
Beat 1	0	1	Data In	Don't Care
Beat 2	1	0	Don't Care	Data In

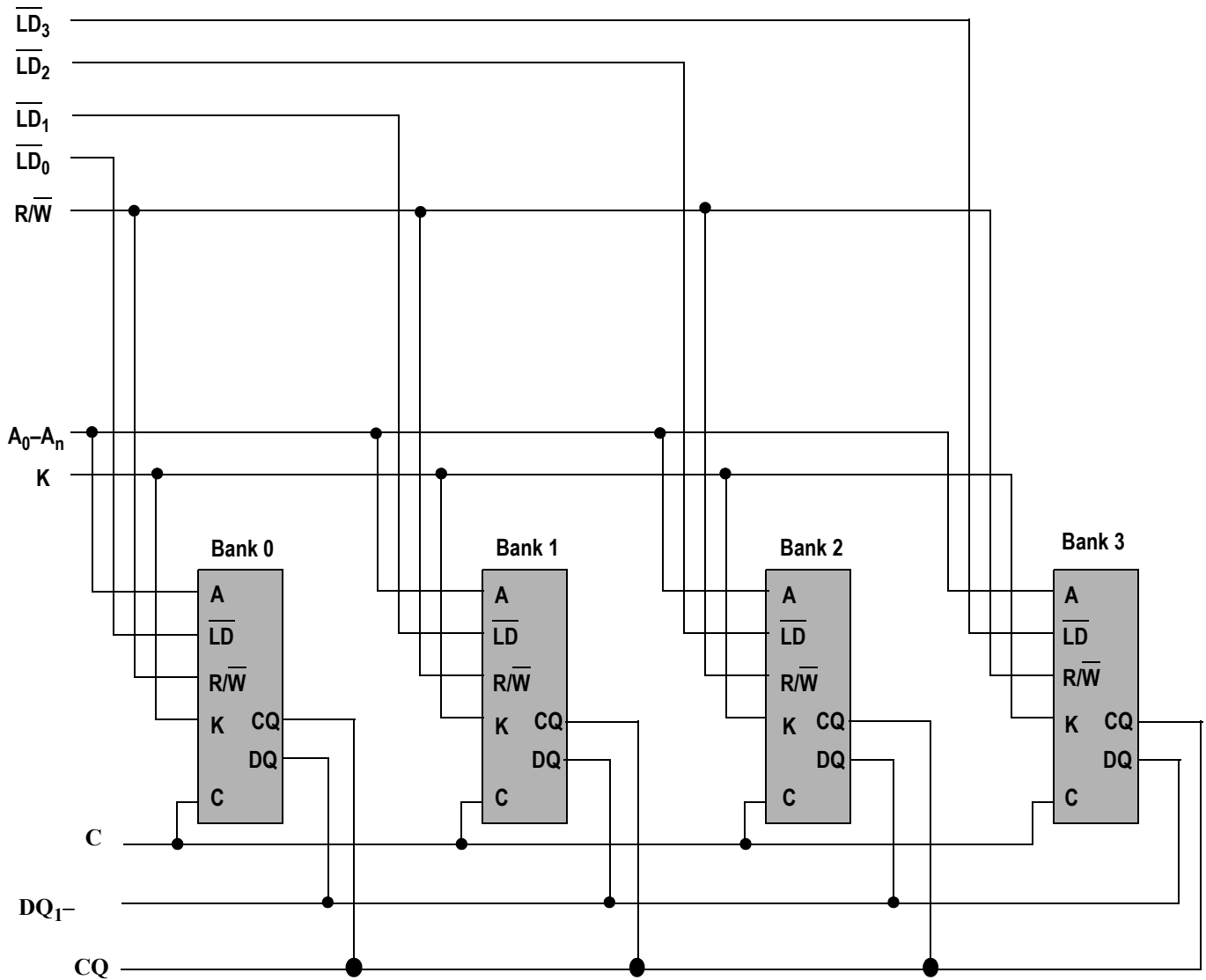
### Resulting Write Operation

Byte 1 D0–D8	Byte 2 D9–D17	Byte 3 D0–D8	Byte 4 D9–D17
Written	Unchanged	Unchanged	Written
Beat 1		Beat 2	

### Output Register Control

SigmaCIO DDR-II SRAMs offer two mechanisms for controlling the output data registers. Typically, control is handled by the Output Register Clock inputs, C and  $\overline{C}$ . The Output Register Clock inputs can be used to make small phase adjustments in the firing of the output registers by allowing the user to delay driving data out as much as a few nanoseconds beyond the next rising edges of the K and  $\overline{K}$  clocks. If the C and  $\overline{C}$  clock inputs are tied high, the RAM reverts to K and  $\overline{K}$  control of the outputs, allowing the RAM to function as a conventional pipelined read SRAM.

### Example Four Bank Depth Expansion Schematic



**Note:**  
For simplicity  $\overline{Bw_n}$  (or  $\overline{Nw_n}$ ),  $\overline{K}$ , and  $\overline{C}$  are not shown.

#### **FLXDrive-II Output Driver Impedance Control**

HSTL I/O SigmaCIO DDR-II SRAMs are supplied with programmable impedance output drivers. The ZQ pin must be connected to  $V_{SS}$  via an external resistor,  $R_Q$ , to allow the SRAM to monitor and adjust its output driver impedance. The value of  $R_Q$  must be 5X the value of the desired RAM output impedance at mid-rail. The allowable range of  $R_Q$  to guarantee impedance matching continuously is between  $175\Omega$  and  $350\Omega$ . Periodic readjustment of the output driver impedance is necessary as the impedance is affected by drifts in supply voltage and temperature. The SRAM's output impedance circuitry compensates for drifts in supply voltage and temperature. A clock cycle counter periodically triggers an impedance evaluation, resets and counts again. Each impedance evaluation may move the output driver impedance level one step at a time towards the optimum level. The output driver is implemented with discrete binary weighted impedance steps. Updates of pull-down drive impedance occur whenever a driver is producing a "1" or is High-Z. Pull-up drive impedance is updated when a driver is producing a "0" or is High-Z.

### Common I/O SigmaCIO DDR-II B2 SRAM Truth Table

$K_n$	$\overline{LD}$	$R/\overline{W}$	DQ		Operation
			A + 0	A + 1	
↑	1	X	Hi-Z	Hi-Z	Deselect
↑	0	0	$D@K_{n+1}$	$D@K_{n+1}$	Write
↑	0	1	$Q@K_{n+1}$ or $\overline{C}_{n+1}$	$Q@K_{n+2}$ or $C_{n+2}$	Read

Note: Q is controlled by K clocks if C clocks are not used.

### B2 Byte Write Clock Truth Table

$\overline{BW}$	$\overline{BW}$	Current Operation	D	D
$K \uparrow$ ( $t_{n+1}$ )	$K \uparrow$ ( $t_{n+2}$ )	$K \uparrow$ ( $t_n$ )	$K \uparrow$ ( $t_{n+1}$ )	$K \uparrow$ ( $t_{n+2}$ )
T	T	Write Dx stored if $\overline{BW}_n = 0$ in both data transfers	D1	D2
T	F	Write Dx stored if $\overline{BW}_n = 0$ in 1st data transfer only	D1	X
F	T	Write Dx stored if $\overline{BW}_n = 0$ in 2nd data transfer only	X	D2
F	F	Write Abort No Dx stored in either data transfer	X	X

**Notes:**

1. "1" = input "high"; "0" = input "low"; "X" = input "don't care"; "T" = input "true"; "F" = input "false".
2. If one or more  $\overline{BW}_n = 0$ , then  $\overline{BW} = "T"$ , else  $\overline{BW} = "F"$ .

\*Assuming stable conditions, the RAM can achieve optimum impedance within 1024 cycles.

### B2 Nybble Write Clock Truth Table

$\overline{NW}$	$\overline{NW}$	Current Operation	D	D
$K \uparrow$ ( $t_{n+1}$ )	$K \uparrow$ ( $t_{n+2}$ )	$K \uparrow$ ( $t_n$ )	$K \uparrow$ ( $t_{n+1}$ )	$K \uparrow$ ( $t_{n+2}$ )
T	T	Write Dx stored if $\overline{NWn} = 0$ in both data transfers	D1	D2
T	F	Write Dx stored if $\overline{NWn} = 0$ in 1st data transfer only	D1	X
F	T	Write Dx stored if $\overline{NWn} = 0$ in 2nd data transfer only	X	D2
F	F	Write Abort No Dx stored in either data transfer	X	X

**Notes:**

1. "1" = input "high"; "0" = input "low"; "X" = input "don't care"; "T" = input "true"; "F" = input "false".
2. If one or more  $\overline{NWn} = 0$ , then  $\overline{NW} = "T"$ , else  $\overline{NW} = "F"$ .

### x36 Byte Write Enable ( $\overline{BWn}$ ) Truth Table

$\overline{BW0}$	$\overline{BW1}$	$\overline{BW2}$	$\overline{BW3}$	D0–D8	D9–D17	D18–D26	D27–D35
1	1	1	1	Don't Care	Don't Care	Don't Care	Don't Care
0	1	1	1	Data In	Don't Care	Don't Care	Don't Care
1	0	1	1	Don't Care	Data In	Don't Care	Don't Care
0	0	1	1	Data In	Data In	Don't Care	Don't Care
1	1	0	1	Don't Care	Don't Care	Data In	Don't Care
0	1	0	1	Data In	Don't Care	Data In	Don't Care
1	0	0	1	Don't Care	Data In	Data In	Don't Care
0	0	0	1	Data In	Data In	Data In	Don't Care
1	1	1	0	Don't Care	Don't Care	Don't Care	Data In
0	1	1	0	Data In	Don't Care	Don't Care	Data In
1	0	1	0	Don't Care	Data In	Don't Care	Data In
0	0	1	0	Data In	Data In	Don't Care	Data In
1	1	0	0	Don't Care	Don't Care	Data In	Data In
0	1	0	0	Data In	Don't Care	Data In	Data In
1	0	0	0	Don't Care	Data In	Data In	Data In
0	0	0	0	Data In	Data In	Data In	Data In

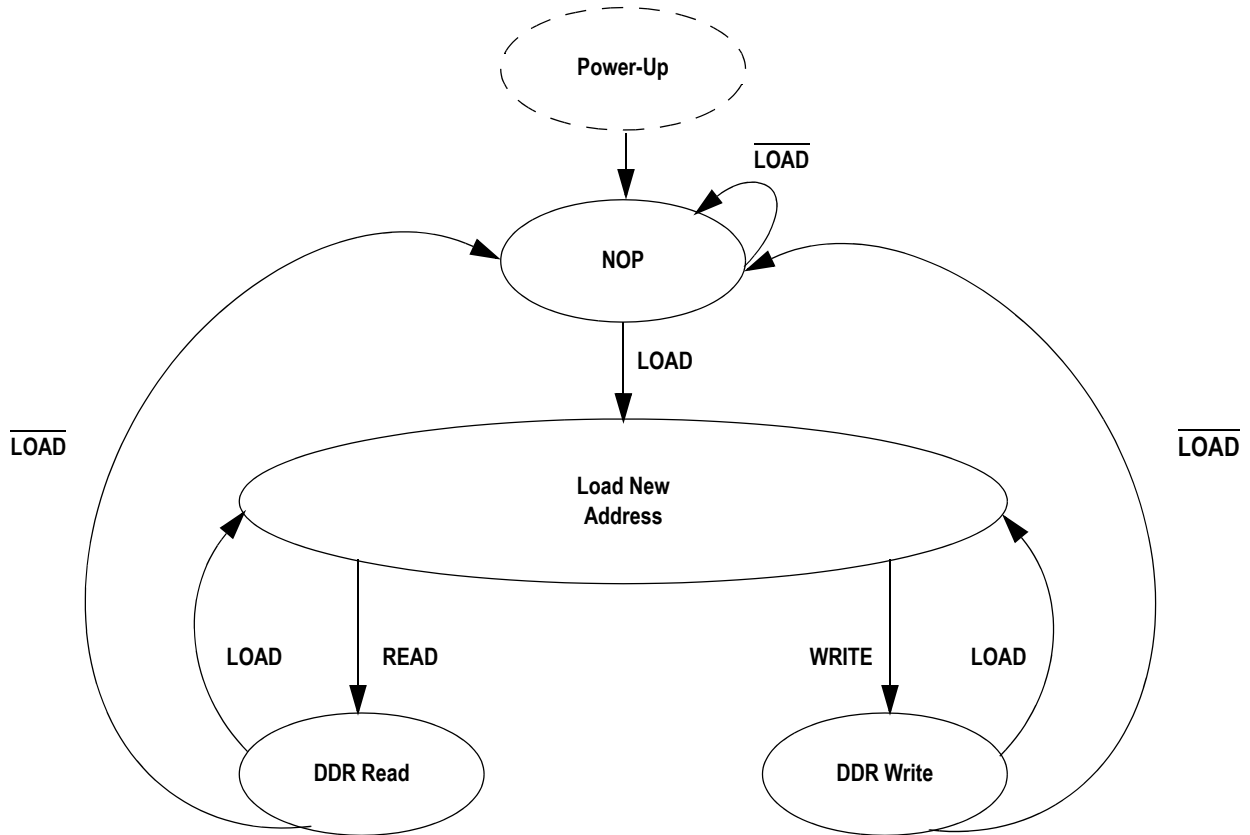
### x18 Byte Write Enable ( $\overline{BWn}$ ) Truth Table

$\overline{BW0}$	$\overline{BW1}$	D0–D8	D9–D17
1	1	Don't Care	Don't Care
0	1	Data In	Don't Care
1	0	Don't Care	Data In
0	0	Data In	Data In

### x8 Nybble Write Enable ( $\overline{NWn}$ ) Truth Table

$\overline{NW0}$	$\overline{NW1}$	D0–D3	D4–D7
1	1	Don't Care	Don't Care
0	1	Data In	Don't Care
1	0	Don't Care	Data In
0	0	Data In	Data In

**B2 State Diagram**



**Notes:**

1. The internal address burst counter is a 1 bit counter (i.e., when first address is A0, next internal burst address is A0+1).
2. "READ" refers to read active status with  $\overline{R/W} = \text{High}$ , "WRITE" refers to write inactive status with  $\overline{R/W} = \text{Low}$ .
3. "LOAD" refers to read new address active status with  $\overline{LD} = \text{Low}$ , "LOAD" refers to read new address inactive status with  $\overline{LD} = \text{High}$ .

### Absolute Maximum Ratings

(All voltages reference to  $V_{SS}$ )

Symbol	Description	Value	Unit
$V_{DD}$	Voltage on $V_{DD}$ Pins	-0.5 to 2.9	V
$V_{DDQ}$	Voltage in $V_{DDQ}$ Pins	-0.5 to $V_{DD}$	V
$V_{REF}$	Voltage in $V_{REF}$ Pins	-0.5 to $V_{DDQ}$	V
$V_{I/O}$	Voltage on I/O Pins	-0.5 to $V_{DDQ} + 0.5$ ( $\leq 2.9$ V max.)	V
$V_{IN}$	Voltage on Other Input Pins	-0.5 to $V_{DDQ} + 0.5$ ( $\leq 2.9$ V max.)	V
$I_{IN}$	Input Current on Any Pin	+/-100	mA dc
$I_{OUT}$	Output Current on Any I/O Pin	+/-100	mA dc
$T_J$	Maximum Junction Temperature	125	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature	-55 to 125	$^{\circ}\text{C}$

**Note:**

Permanent damage to the device may occur if the Absolute Maximum Ratings are exceeded. Operation should be restricted to Recommended Operating Conditions. Exposure to conditions exceeding the Recommended Operating Conditions, for an extended period of time, may affect reliability of this component.

### Recommended Operating Conditions

#### Power Supplies

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	$V_{DD}$	1.7	1.8	1.9	V
I/O Supply Voltage	$V_{DDQ}$	1.4	—	1.9	V
Reference Voltage	$V_{REF}$	0.68	—	0.95	V

**Notes:**

- Unless otherwise noted, all performance specifications quoted are evaluated for worst case at both  $1.4\text{ V} \leq V_{DDQ} \leq 1.6\text{ V}$  (i.e., 1.5 V I/O) and  $1.7\text{ V} \leq V_{DDQ} \leq 1.9\text{ V}$  (i.e., 1.8 V I/O) and quoted at whichever condition is worst case.
- The power supplies need to be powered up simultaneously or in the following sequence:  $V_{DD}$ ,  $V_{DDQ}$ ,  $V_{REF}$ , followed by signal inputs. The power down sequence must be the reverse.  $V_{DDQ}$  must not exceed  $V_{DD}$ .

#### Operating Temperature

Parameter	Symbol	Min.	Typ.	Max.	Unit
Ambient Temperature (Commercial Range Versions)	$T_A$	0	25	70	$^{\circ}\text{C}$
Ambient Temperature (Industrial Range Versions)	$T_A$	-40	25	85	$^{\circ}\text{C}$



### HSTL I/O DC Input Characteristics

Parameter	Symbol	Min	Max	Units	Notes
DC Input Logic High	$V_{IH} (dc)$	$V_{REF} + 0.10$	$V_{DD} + 0.3 V$	V	1
DC Input Logic Low	$V_{IL} (dc)$	$-0.3 V$	$V_{REF} - 0.10$	V	1

**Notes:**

- Compatible with both 1.8 V and 1.5 V I/O drivers
- These are DC test criteria. DC design criteria is  $V_{REF} \pm 50$  mV. The AC  $V_{IH}/V_{IL}$  levels are defined separately for measuring timing parameters.
- $V_{IL} (Min) DC = -0.3 V$ ,  $V_{IL} (Min) AC = -1.5 V$  (pulse width  $\leq 3$  ns).
- $V_{IH} (Max) DC = V_{DDQ} + 0.3 V$ ,  $V_{IH} (Max) AC = V_{DDQ} + 0.85 V$  (pulse width  $\leq 3$  ns).

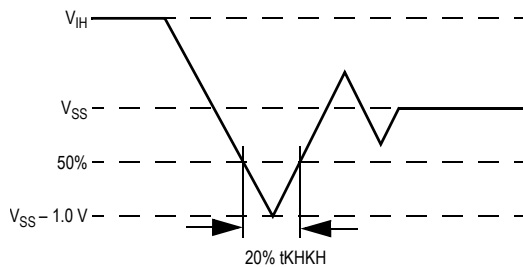
### HSTL I/O AC Input Characteristics

Parameter	Symbol	Min	Max	Units	Notes
AC Input Logic High	$V_{IH} (ac)$	$V_{REF} + 0.20$	—	V	3,4
AC Input Logic Low	$V_{IL} (ac)$	—	$V_{REF} - 0.20$	V	3,4
$V_{REF}$ Peak to Peak AC Voltage	$V_{REF} (ac)$	—	5% $V_{REF} (DC)$	V	1

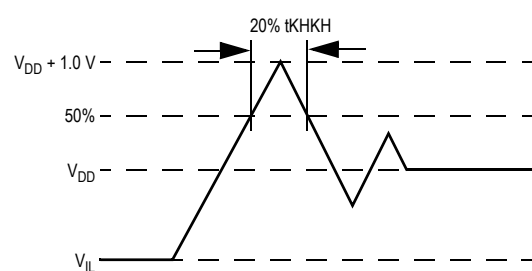
**Notes:**

- The peak to peak AC component superimposed on  $V_{REF}$  may not exceed 5% of the DC component of  $V_{REF}$ .
- To guarantee AC characteristics,  $V_{IH}, V_{IL}, Trise,$  and  $Tfall$  of inputs and clocks must be within 10% of each other.
- For devices supplied with HSTL I/O input buffers. Compatible with both 1.8 V and 1.5 V I/O drivers.

#### Undershoot Measurement and Timing



#### Overshoot Measurement and Timing



### Capacitance

( $T_A = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ ,  $V_{DD} = 3.3\text{ V}$ )

Parameter	Symbol	Test conditions	Typ.	Max.	Unit
Input Capacitance	$C_{IN}$	$V_{IN} = 0\text{ V}$	4	5	pF
Output Capacitance	$C_{OUT}$	$V_{OUT} = 0\text{ V}$	6	7	pF
Clock Capacitance	$C_{CLK}$	—	5	6	pF

**Note:**

This parameter is sample tested.

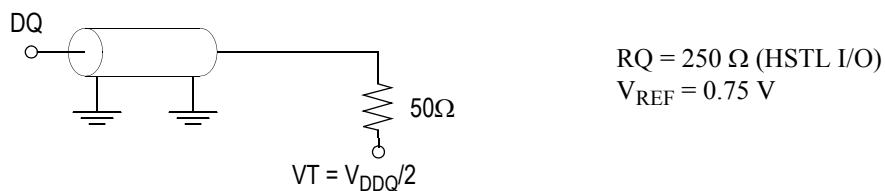
### AC Test Conditions

Parameter	Conditions
Input high level	$V_{DDQ}$
Input low level	0 V
Max. input slew rate	2 V/ns
Input reference level	$V_{DDQ}/2$
Output reference level	$V_{DDQ}/2$

**Note:**

Test conditions as specified with output loading as shown unless otherwise noted.

### AC Test Load Diagram



### Input and Output Leakage Characteristics

Parameter	Symbol	Test Conditions	Min.	Max	Notes
Input Leakage Current (except mode pins)	$I_{IL}$	$V_{IN} = 0\text{ to }V_{DD}$	-2 $\mu\text{A}$	2 $\mu\text{A}$	
$\overline{\text{Doff}}$	$I_{INDOFF}$	$V_{DD} \geq V_{IN} \geq V_{IL}$ $0\text{ V} \leq V_{IN} \leq V_{IL}$	-100 $\mu\text{A}$ -2 $\mu\text{A}$	2 $\mu\text{A}$ 2 $\mu\text{A}$	
Output Leakage Current	$I_{OL}$	Output Disable, $V_{OUT} = 0\text{ to }V_{DDQ}$	-2 $\mu\text{A}$	2 $\mu\text{A}$	

### Programmable Impedance HSTL Output Driver DC Electrical Characteristics

Parameter	Symbol	Min.	Max.	Units	Notes
Output High Voltage	$V_{OH1}$	$V_{DDQ}/2$	$V_{DDQ}$	V	1, 3
Output Low Voltage	$V_{OL1}$	$V_{SS}$	$V_{DDQ}/2$	V	2, 3
Output High Voltage	$V_{OH2}$	$V_{DDQ} - 0.2$	$V_{DDQ}$	V	4, 5
Output Low Voltage	$V_{OL2}$	$V_{SS}$	0.2	V	4, 6

**Notes:**

- $I_{OH} = (V_{DDQ}/2) / (RQ/5) \pm 15\%$  @  $V_{OH} = V_{DDQ}/2$  (for:  $175\Omega \leq RQ \leq 350\Omega$ ).
- $I_{OL} = (V_{DDQ}/2) / (RQ/5) \pm 15\%$  @  $V_{OL} = V_{DDQ}/2$  (for:  $175\Omega \leq RQ \leq 350\Omega$ ).
- Parameter tested with  $RQ = 250\Omega$  and  $V_{DDQ} = 1.5\text{ V}$  or  $1.8\text{ V}$
- $0\Omega \leq RQ \leq \infty\Omega$
- $I_{OH} = -1.0\text{ mA}$
- $I_{OL} = 1.0\text{ mA}$

### Operating Currents

Parameter	Symbol	Test Conditions	-333		-300		-267		-250		-200		-167		Notes
			0 to 70°C	-40 to 85°C	0 to 70°C	-40 to 85°C	0 to 70°C	-40 to 85°C	0 to 70°C	-40 to 85°C	0 to 70°C	-40 to 85°C	0 to 70°C	-40 to 85°C	
Operating Current (x36): DDR	$I_{DD}$	$V_{DD} = \text{Max}, I_{OUT} = 0\text{ mA}$ Cycle Time $\geq t_{KHKH}\text{ Min}$	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	2, 3
Operating Current (x18): DDR	$I_{DD}$	$V_{DD} = \text{Max}, I_{OUT} = 0\text{ mA}$ Cycle Time $\geq t_{KHKH}\text{ Min}$	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	2, 3
Operating Current (x9): DDR	$I_{DD}$	$V_{DD} = \text{Max}, I_{OUT} = 0\text{ mA}$ Cycle Time $\geq t_{KHKH}\text{ Min}$	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	2, 3
Operating Current (x8): DDR	$I_{DD}$	$V_{DD} = \text{Max}, I_{OUT} = 0\text{ mA}$ Cycle Time $\geq t_{KHKH}\text{ Min}$	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	2, 3
Standby Current (NOP): DDR	$I_{SB1}$	Device deselected, $I_{OUT} = 0\text{ mA}, f = \text{Max},$ All Inputs $\leq 0.2\text{ V}$ or $\geq V_{DD} - 0.2\text{ V}$	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	2, 4

**Notes:**

- Power measured with output pins floating.
- Minimum cycle,  $I_{OUT} = 0\text{ mA}$
- Operating current is calculated with 50% read cycles and 50% write cycles.
- Standby Current is only after all pending read and write burst operations are completed.

### AC Electrical Characteristics

Parameter	Symbol	-333		-300		-267		-250		-200		-167		Units	Notes
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
<b>Clock</b>															
K, $\bar{K}$ Clock Cycle Time C, C Clock Cycle Time	$t_{KHKH}$ $t_{CHCH}$	3.0	4.5	3.3	4.5	3.75	4.5	4.0	8.4	5.0	8.4	6.0	8.4	ns	
tTKC Variable	$t_{KCVar}$	—	0.2	—	0.2	—	0.2	—	0.2	—	0.2	—	0.2	ns	5
K, $\bar{K}$ Clock High Pulse Width C, C Clock High Pulse Width	$t_{KHKL}$ $t_{CHCL}$	1.2	—	1.32	—	1.6	—	1.6	—	2.0	—	2.4	—	ns	
K, $\bar{K}$ Clock Low Pulse Width C, C Clock Low Pulse Width	$t_{KLKH}$ $t_{CLCH}$	1.2	—	1.32	—	1.6	—	1.6	—	2.0	—	2.4	—	ns	
K to $\bar{K}$ High C to C High	$t_{KH\bar{K}H}$ $t_{CH\bar{C}H}$	1.35	—	1.49	—	1.8	—	1.8	—	2.2	—	2.7	—	ns	
$\bar{K}$ to K High C to C High	$t_{\bar{K}KH}$ $t_{\bar{C}CH}$	1.35	—	1.49	—	1.8	—	1.8	—	2.2	—	2.7	—	ns	
K, $\bar{K}$ Clock High to C, $\bar{C}$ Clock High	$t_{KHCH}$	0	0.8	0	0.8	0	1.8	0	1.8	0	2.3	0	2.8	ns	
DLL Lock Time	$t_{KCLock}$	1024	—	1024	—	1024	—	1024	—	1024	—	1024	—	cycle	6
K Static to DLL reset	$t_{KCRReset}$	30	—	30	—	30	—	30	—	30	—	30	—	ns	
<b>Output Times</b>															
K, $\bar{K}$ Clock High to Data Output Valid C, C Clock High to Data Output Valid	$t_{KHQV}$ $t_{CHQV}$	—	0.45	—	0.45	—	0.45	—	0.45	—	0.45	—	0.5	ns	3
K, $\bar{K}$ Clock High to Data Output Hold C, C Clock High to Data Output Hold	$t_{KHQX}$ $t_{CHQX}$	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.5	—	ns	3
K, $\bar{K}$ Clock High to Echo Clock Valid C, C Clock High to Echo Clock Valid	$t_{KHCV}$ $t_{CHCV}$	—	0.45	—	0.45	—	0.45	—	0.45	—	0.45	—	0.5	ns	
K, $\bar{K}$ Clock High to Echo Clock Hold C, C Clock High to Echo Clock Hold	$t_{KHCVX}$ $t_{CHCVX}$	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.5	—	ns	
CQ, $\bar{C}Q$ High Output Valid	$t_{CQHCV}$	—	0.25	—	0.27	—	0.30	—	0.30	—	0.35	—	0.40	ns	7
CQ, $\bar{C}Q$ High Output Hold	$t_{CQHCVX}$	-0.25	—	-0.27	—	-0.30	—	-0.30	—	-0.35	—	-0.40	—	ns	7
CQ Phase Distortion	$t_{CQH\bar{C}QH}$ $t_{\bar{C}QHCV}$	1.10	—	1.24	—	1.55	—	1.55	—	1.95	—	2.45	—	ns	
K Clock High to Data Output High-Z C Clock High to Data Output High-Z	$t_{KHQZ}$ $t_{CHQZ}$	—	0.45	—	0.45	—	0.45	—	0.45	—	0.45	—	0.5	ns	3
K Clock High to Data Output Low-Z C Clock High to Data Output Low-Z	$t_{KHQX1}$ $t_{CHQX1}$	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.45	—	-0.5	—	ns	3
<b>Setup Times</b>															
Address Input Setup Time	$t_{AVKH}$	0.4	—	0.4	—	0.5	—	0.5	—	0.6	—	0.7	—	ns	
Control Input Setup Time	$t_{IVKH}$	0.4	—	0.4	—	0.5	—	0.5	—	0.6	—	0.7	—	ns	2
Data Input Setup Time	$t_{DVKH}$	0.28	—	0.3	—	0.35	—	0.35	—	0.4	—	0.5	—	ns	

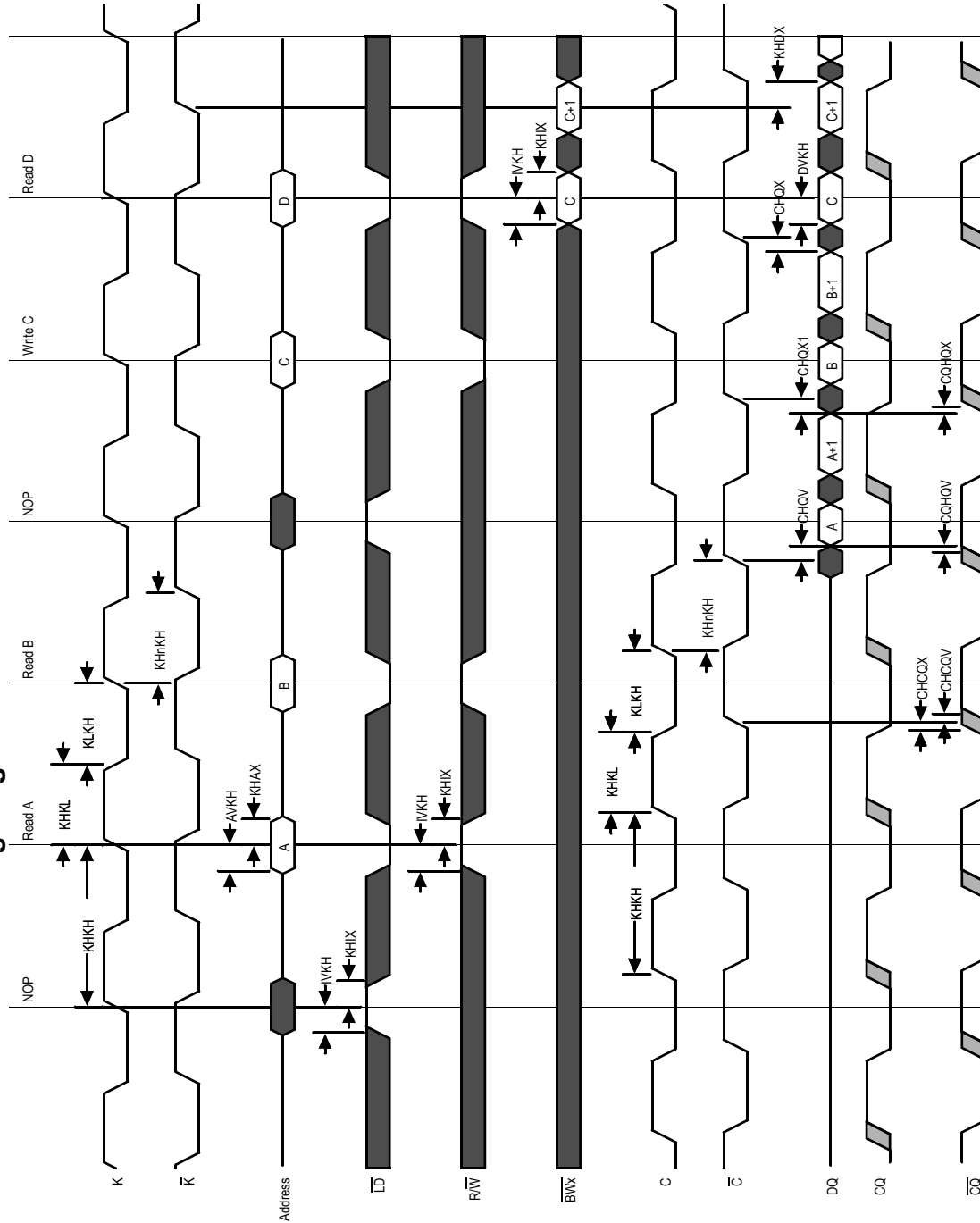
### AC Electrical Characteristics (Continued)

Parameter	Symbol	-333		-300		-267		-250		-200		-167		Units	Notes
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
<b>Hold Times</b>															
Address Input Hold Time	$t_{KHAX}$	0.4	—	0.4	—	0.5	—	0.5	—	0.6	—	0.7	—	ns	
Control Input Hold Time	$t_{KHIX}$	0.4	—	0.4	—	0.5	—	0.5	—	0.6	—	0.7	—	ns	
Data Input Hold Time	$t_{KHDX}$	0.28	—	0.3	—	0.35	—	0.35	—	0.4	—	0.5	—	ns	

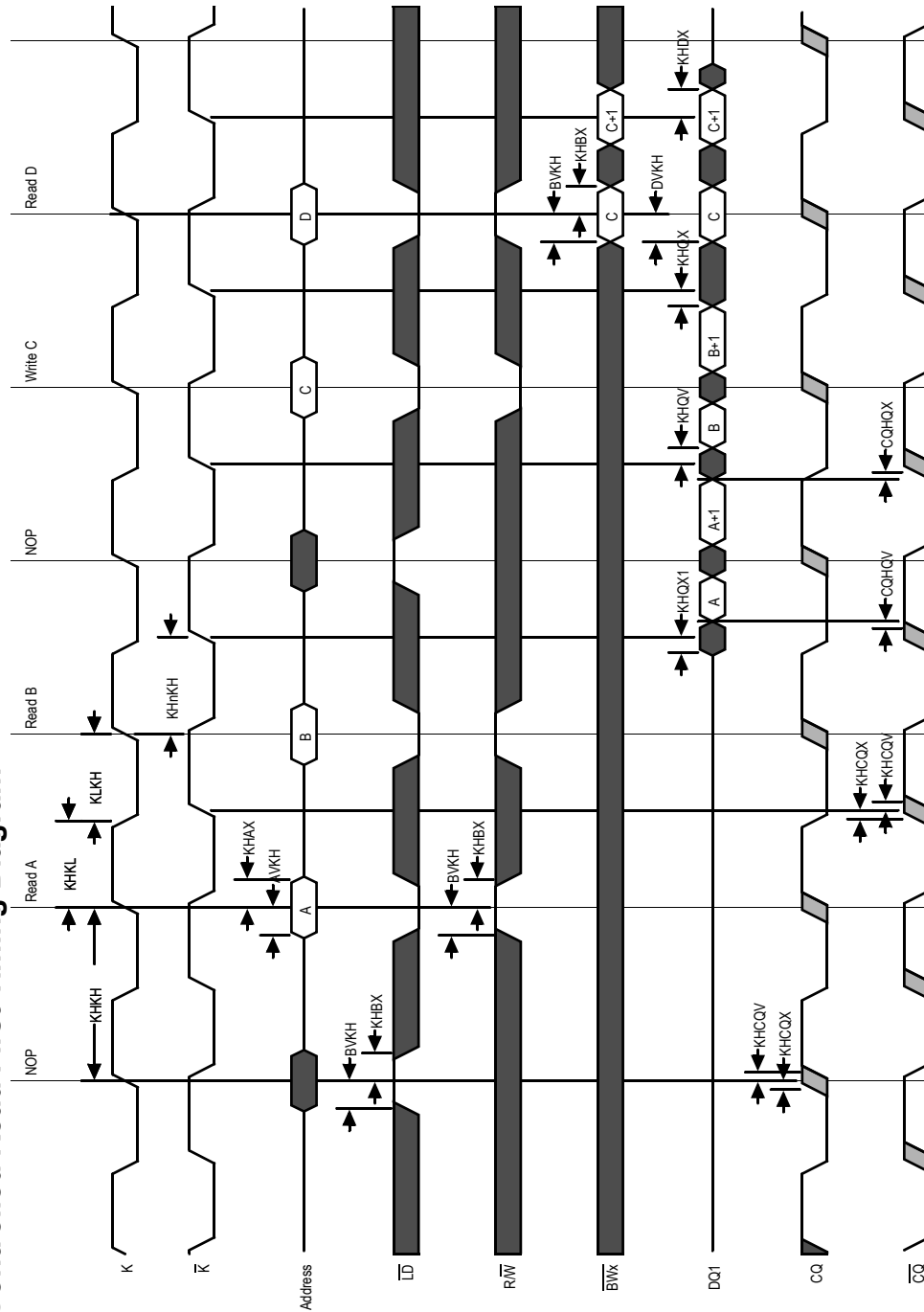
**Notes:**

1. All Address inputs must meet the specified setup and hold times for all latching clock edges.
2. Control singles are  $\overline{R}$ ,  $\overline{W}$ ,  $\overline{BW0}$ ,  $\overline{BW1}$ , and ( $\overline{NW0}$ ,  $\overline{NW1}$  for x8) and ( $\overline{BW2}$ ,  $\overline{BW3}$  for x36).
3. If  $\overline{C}$ ,  $\overline{C}$  are tied high,  $\overline{K}$ ,  $\overline{K}$  become the references for  $\overline{C}$ ,  $\overline{C}$  timing parameters
4. To avoid bus contention, at a given voltage and temperature  $t_{CHQX1}$  is bigger than  $t_{CHQZ}$ . The specs as shown do not imply bus contention because  $t_{CHQX1}$  is a MIN parameter that is worst case at totally different test conditions (0°C, 1.9 V) than  $t_{CHQZ}$ , which is a MAX parameter (worst case at 70°C, 1.7 V). It is not possible for two SRAMs on the same board to be at such different voltages and temperatures.
5. Clock phase jitter is the variance from clock rising edge to the next expected clock rising edge.
6.  $V_{DD}$  slew rate must be less than 0.1 V DC per 50 ns for DLL lock retention. DLL lock time begins once  $V_{DD}$  and input clock are stable.
7. Echo clock is very tightly controlled to data valid/data hold. By design, there is a  $\pm 0.1$  ns variation from echo clock to data. The datasheet parameters reflect tester guard bands and test setup variations.

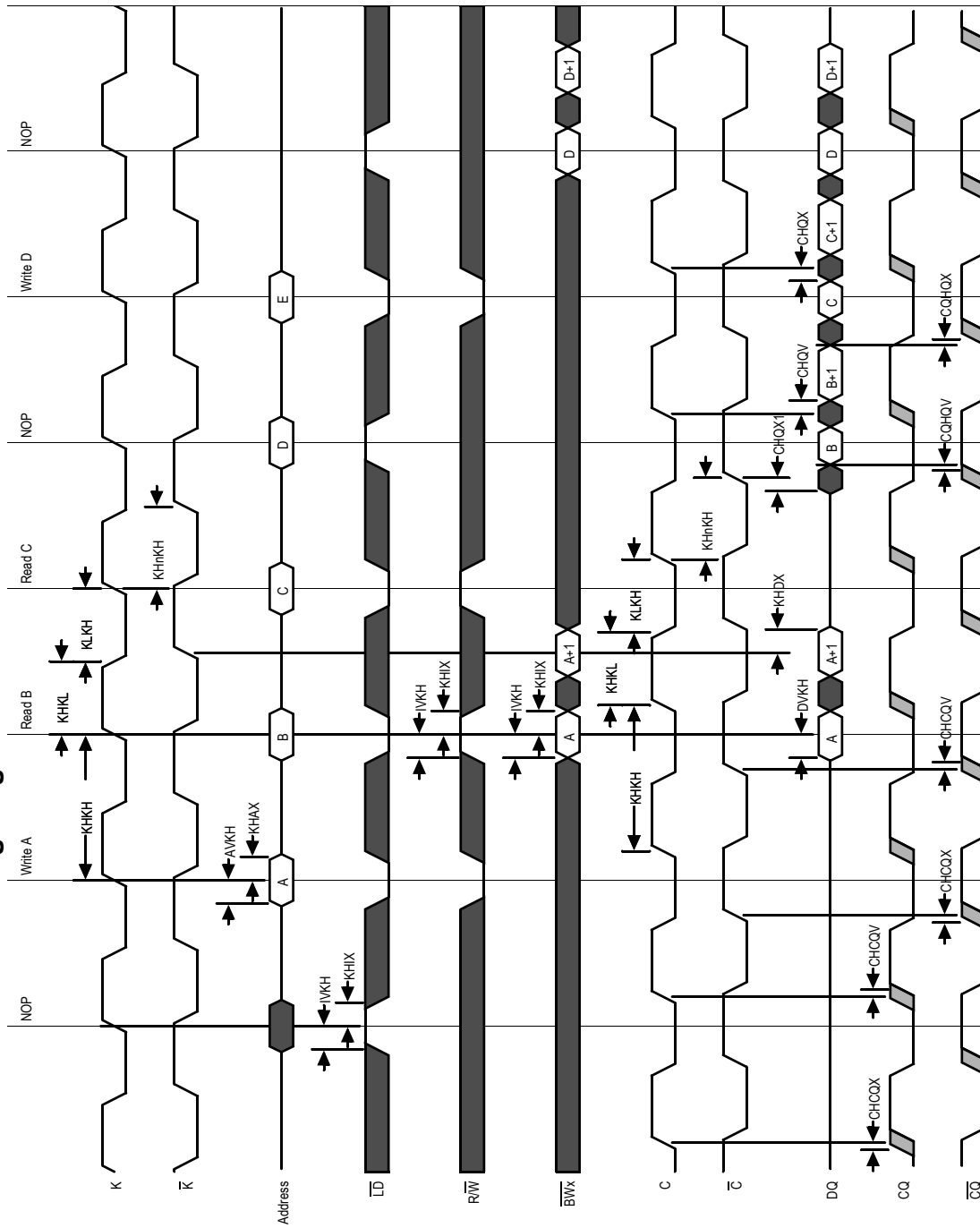
### C and $\bar{C}$ Controlled Read First Timing Diagram



### K and $\bar{K}$ Controlled Read First Timing Diagram

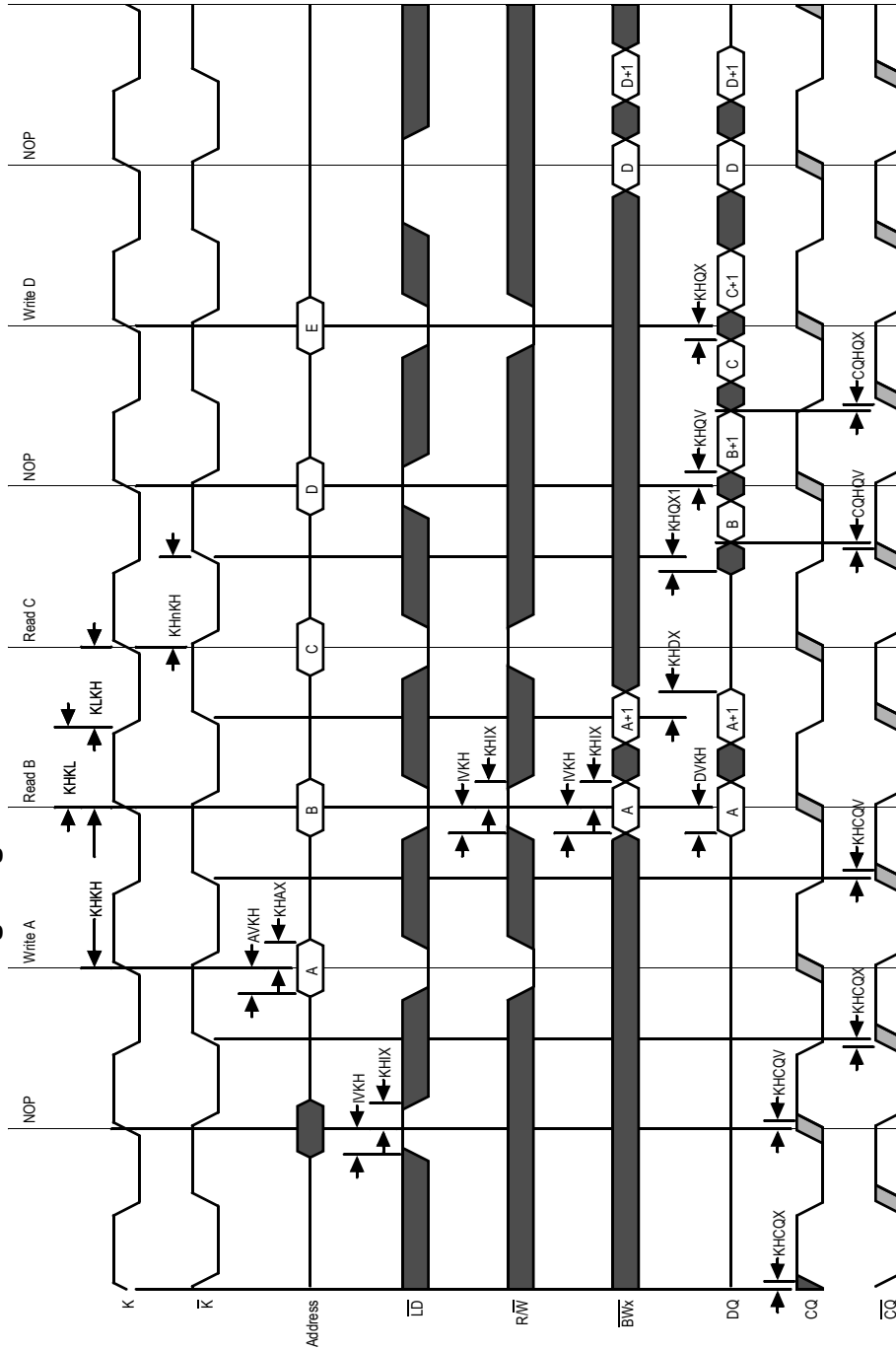


**C and  $\bar{C}$  Controlled Write First Timing Diagram**





### K and $\bar{K}$ Controlled Write First Timing Diagram



## JTAG Port Operation

### Overview

The JTAG Port on this RAM operates in a manner that is compliant with IEEE Standard 1149.1-1990, a serial boundary scan interface standard (commonly referred to as JTAG). The JTAG Port input interface levels scale with  $V_{DD}$ . The JTAG output drivers are powered by  $V_{DDQ}$ .

### Disabling the JTAG Port

It is possible to use this device without utilizing the JTAG port. The port is reset at power-up and will remain inactive unless clocked. TCK, TDI, and TMS are designed with internal pull-up circuits. To assure normal operation of the RAM with the JTAG Port unused, TCK, TDI, and TMS may be left floating or tied to either  $V_{DD}$  or  $V_{SS}$ . TDO should be left unconnected.

## JTAG Pin Descriptions

Pin	Pin Name	I/O	Description
TCK	Test Clock	In	Clocks all TAP events. All inputs are captured on the rising edge of TCK and all outputs propagate from the falling edge of TCK.
TMS	Test Mode Select	In	The TMS input is sampled on the rising edge of TCK. This is the command input for the TAP controller state machine. An undriven TMS input will produce the same result as a logic one input level.
TDI	Test Data In	In	The TDI input is sampled on the rising edge of TCK. This is the input side of the serial registers placed between TDI and TDO. The register placed between TDI and TDO is determined by the state of the TAP Controller state machine and the instruction that is currently loaded in the TAP Instruction Register (refer to the TAP Controller State Diagram). An undriven TDI pin will produce the same result as a logic one input level.
TDO	Test Data Out	Out	Output that is active depending on the state of the TAP state machine. Output changes in response to the falling edge of TCK. This is the output side of the serial registers placed between TDI and TDO.

### Note:

This device does not have a TRST (TAP Reset) pin. TRST is optional in IEEE 1149.1. The Test-Logic-Reset state is entered while TMS is held high for five rising edges of TCK. The TAP Controller is also reset automatically at power-up.

## JTAG Port Registers

### Overview

The various JTAG registers, referred to as Test Access Port or TAP Registers, are selected (one at a time) via the sequences of 1s and 0s applied to TMS as TCK is strobed. Each of the TAP Registers is a serial shift register that captures serial input data on the rising edge of TCK and pushes serial data out on the next falling edge of TCK. When a register is selected, it is placed between the TDI and TDO pins.

### Instruction Register

The Instruction Register holds the instructions that are executed by the TAP controller when it is moved into the Run, Test/Idle, or the various data register states. Instructions are 3 bits long. The Instruction Register can be loaded when it is placed between the TDI and TDO pins. The Instruction Register is automatically preloaded with the IDCODE instruction at power-up or whenever the controller is placed in Test-Logic-Reset state.

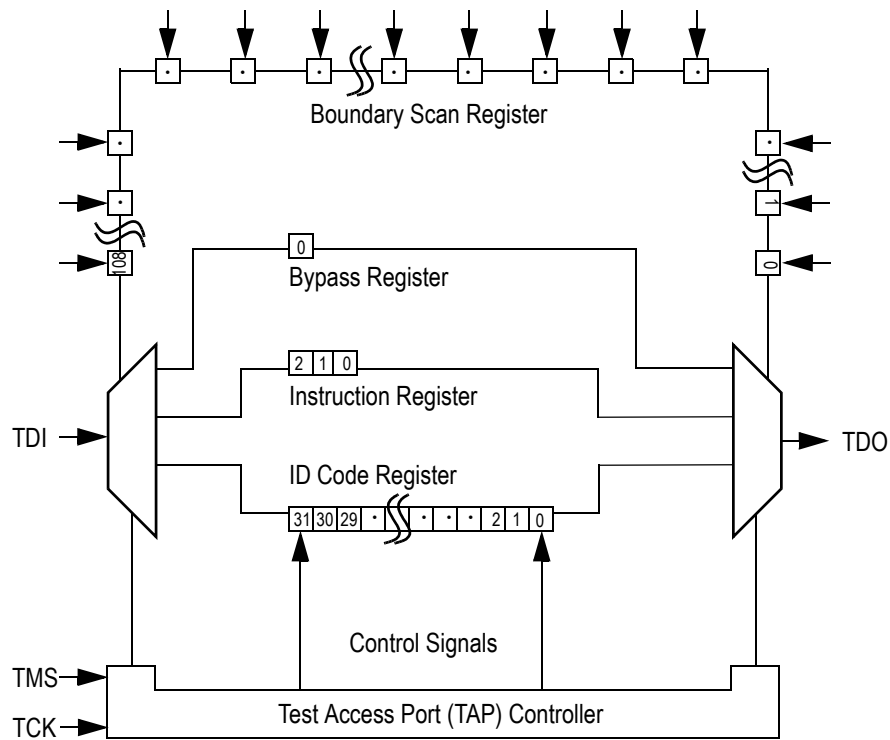
### Bypass Register

The Bypass Register is a single bit register that can be placed between TDI and TDO. It allows serial test data to be passed through the RAM's JTAG Port to another device in the scan chain with as little delay as possible.

### Boundary Scan Register

The Boundary Scan Register is a collection of flip flops that can be preset by the logic level found on the RAM's input or I/O pins. The flip flops are then daisy chained together so the levels found can be shifted serially out of the JTAG Port's TDO pin. The Boundary Scan Register also includes a number of place holder flip flops (always set to a logic 1). The relationship between the device pins and the bits in the Boundary Scan Register is described in the Scan Order Table following. The Boundary Scan Register, under the control of the TAP Controller, is loaded with the contents of the RAMs I/O ring when the controller is in Capture-DR state and then is placed between the TDI and TDO pins when the controller is moved to Shift-DR state. SAMPLE-Z, SAMPLE/PRELOAD and EXTEST instructions can be used to activate the Boundary Scan Register.

### JTAG TAP Block Diagram



### Identification (ID) Register

The ID Register is a 32-bit register that is loaded with a device and vendor specific 32-bit code when the controller is put in Capture-DR state with the IDCODE command loaded in the Instruction Register. The code is loaded from a 32-bit on-chip ROM. It describes various attributes of the RAM as indicated below. The register is then placed between the TDI and TDO pins when the controller is moved into Shift-DR state. Bit 0 in the register is the LSB and the first to reach TDO when shifting begins.

### ID Register Contents

	<b>Not Used</b>																		<b>GSI Technology JEDEC Vendor ID Code</b>						<b>Presence Register</b>							
<b>Bit #</b>	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	0	0	1	1	0	1	1	0	0	1	1

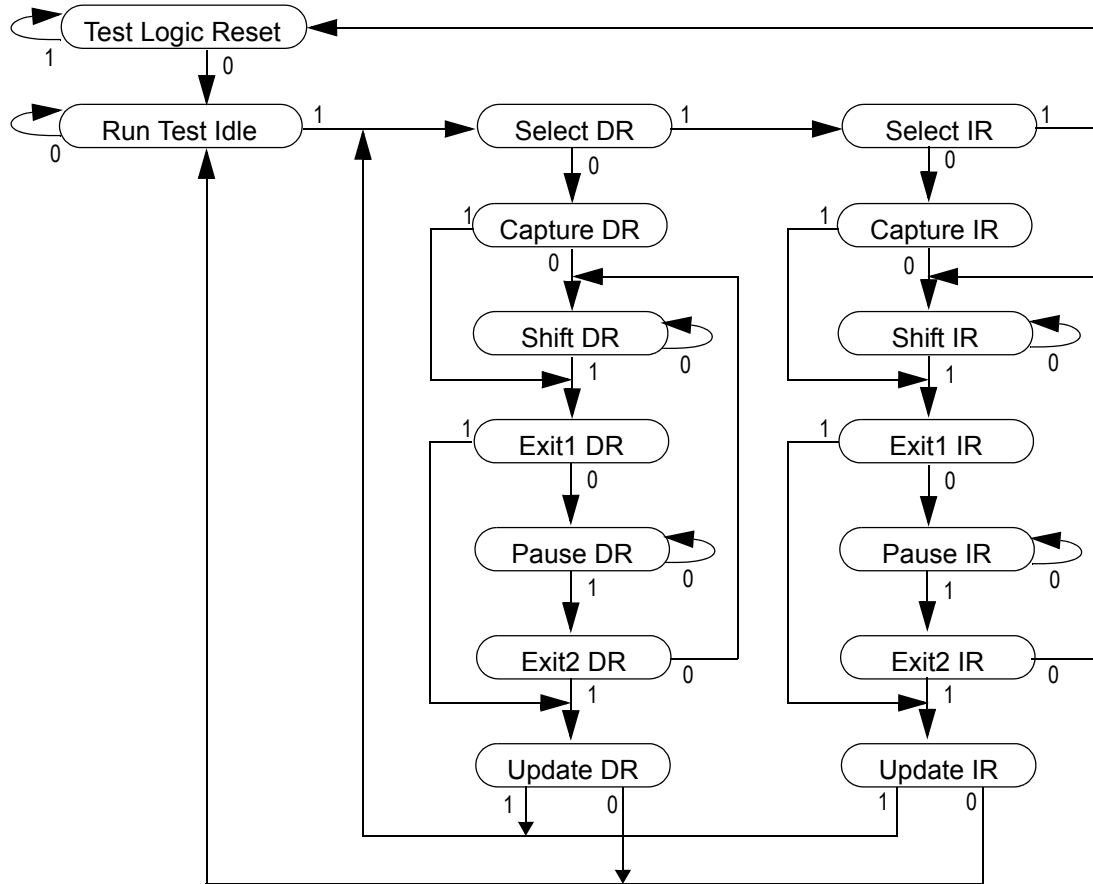
### Tap Controller Instruction Set

#### Overview

There are two classes of instructions defined in the Standard 1149.1-1990; the standard (Public) instructions, and device specific (Private) instructions. Some Public instructions are mandatory for 1149.1 compliance. Optional Public instructions must be implemented in prescribed ways. The TAP on this device may be used to monitor all input and I/O pads, and can be used to load address, data or control signals into the RAM or to preload the I/O buffers.

When the TAP controller is placed in Capture-IR state the two least significant bits of the instruction register are loaded with 01. When the controller is moved to the Shift-IR state the Instruction Register is placed between TDI and TDO. In this state the desired instruction is serially loaded through the TDI input (while the previous contents are shifted out at TDO). For all instructions, the TAP executes newly loaded instructions only when the controller is moved to Update-IR state. The TAP instruction set for this device is listed in the following table.

### JTAG Tap Controller State Diagram



#### Instruction Descriptions

##### **BYPASS**

When the BYPASS instruction is loaded in the Instruction Register the Bypass Register is placed between TDI and TDO. This occurs when the TAP controller is moved to the Shift-DR state. This allows the board level scan path to be shortened to facilitate testing of other devices in the scan path.

##### **SAMPLE/PRELOAD**

SAMPLE/PRELOAD is a Standard 1149.1 mandatory public instruction. When the SAMPLE / PRELOAD instruction is loaded in the Instruction Register, moving the TAP controller into the Capture-DR state loads the data in the RAMs input and I/O buffers into the Boundary Scan Register. Boundary Scan Register locations are not associated with an input or I/O pin, and are loaded with the default state identified in the Boundary Scan Chain table at the end of this section of the datasheet. Because the RAM clock is independent from the TAP Clock (TCK) it is possible for the TAP to attempt to capture the I/O ring contents while the input buffers are in transition (i.e. in a metastable state). Although allowing the TAP to sample metastable inputs will not harm the device, repeatable results cannot be expected. RAM input signals must be stabilized for long enough to meet the TAPs input data capture set-up plus hold time (tTS plus tTH). The RAMs clock inputs need not be paused for any other TAP operation except capturing the I/O ring contents into the Boundary Scan Register. Moving the controller to Shift-DR state then places the boundary scan register between the TDI and TDO pins.

##### **EXTEST**

EXTEST is an IEEE 1149.1 mandatory public instruction. It is to be executed whenever the instruction register is loaded with all logic 0s. The EXTEST command does not block or override the RAM's input pins; therefore, the RAM's internal state is still determined by its input pins.

Typically, the Boundary Scan Register is loaded with the desired pattern of data with the SAMPLE/PRELOAD command. Then the EXTEST command is used to output the Boundary Scan Register's contents, in parallel, on the RAM's data output drivers on the falling edge of TCK when the controller is in the Update-IR state.

Alternately, the Boundary Scan Register may be loaded in parallel using the EXTEST command. When the EXTEST instruction is selected, the state of all the RAM's input and I/O pins, as well as the default values at Scan Register locations not associated with a pin, are transferred in parallel into the Boundary Scan Register on the rising edge of TCK in the Capture-DR state, the RAM's output pins drive out the value of the Boundary Scan Register location with which each output pin is associated.

#### **IDCODE**

The IDCODE instruction causes the ID ROM to be loaded into the ID register when the controller is in Capture-DR mode and places the ID register between the TDI and TDO pins in Shift-DR mode. The IDCODE instruction is the default instruction loaded in at power up and any time the controller is placed in the Test-Logic-Reset state.

#### **SAMPLE-Z**

If the SAMPLE-Z instruction is loaded in the instruction register, all RAM outputs are forced to an inactive drive state (high-Z) and the Boundary Scan Register is connected between TDI and TDO when the TAP controller is moved to the Shift-DR state.

#### **RFU**

These instructions are Reserved for Future Use. In this device they replicate the BYPASS instruction.

### **JTAG TAP Instruction Set Summary**

<b>Instruction</b>	<b>Code</b>	<b>Description</b>	<b>Notes</b>
EXTEST	000	Places the Boundary Scan Register between TDI and TDO.	1
IDCODE	001	Preloads ID Register and places it between TDI and TDO.	1, 2
SAMPLE-Z	010	Captures I/O ring contents. Places the Boundary Scan Register between TDI and TDO. Forces all RAM output drivers to High-Z except CQ.	1
RFU	011	Do not use this instruction; Reserved for Future Use. Replicates BYPASS instruction. Places Bypass Register between TDI and TDO.	1
SAMPLE/ PRELOAD	100	Captures I/O ring contents. Places the Boundary Scan Register between TDI and TDO.	1
GSI	101	GSI private instruction.	1
RFU	110	Do not use this instruction; Reserved for Future Use. Replicates BYPASS instruction. Places Bypass Register between TDI and TDO.	1
BYPASS	111	Places Bypass Register between TDI and TDO.	1

#### **Notes:**

1. Instruction codes expressed in binary, MSB on left, LSB on right.
2. Default instruction automatically loaded at power-up and in test-logic-reset state.

### JTAG Port Recommended Operating Conditions and DC Characteristics

Parameter	Symbol	Min.	Max.	Unit	Notes
Test Port Input Low Voltage	$V_{ILJ}$	-0.3	$0.3 * V_{DD}$	V	1
Test Port Input High Voltage	$V_{IHJ}$	$0.6 * V_{DD}$	$V_{DD} + 0.3$	V	1
TMS, TCK and TDI Input Leakage Current	$I_{INHJ}$	-300	1	uA	2
TMS, TCK and TDI Input Leakage Current	$I_{INLJ}$	-1	100	uA	3
TDO Output Leakage Current	$I_{OLJ}$	-1	1	uA	4
Test Port Output High Voltage	$V_{OHJ}$	$V_{DD} - 200$ mV	—	V	5, 6
Test Port Output Low Voltage	$V_{OLJ}$	—	0.4	V	5, 7
Test Port Output CMOS High	$V_{OHJC}$	$V_{DD} - 100$ mV	—	V	5, 8
Test Port Output CMOS Low	$V_{OLJC}$	—	100 mV	V	5, 9

**Notes:**

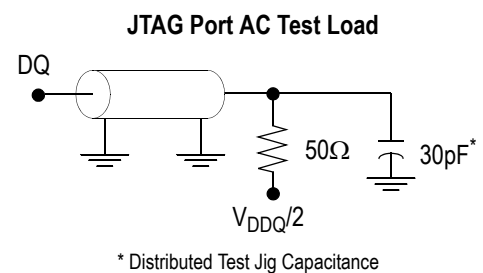
- Input Under/overshoot voltage must be  $-1\text{ V} < V_i < V_{DDn} + 1\text{ V}$  not to exceed 2.9 V maximum, with a pulse width not to exceed 20% tTKC.
- $V_{ILJ} \leq V_{IN} \leq V_{DDn}$
- $0\text{ V} \leq V_{IN} \leq V_{ILJn}$
- Output Disable,  $V_{OUT} = 0$  to  $V_{DDn}$
- The TDO output driver is served by the  $V_{DD}$  supply.
- $I_{OHJ} = -2\text{ mA}$
- $I_{OLJ} = +2\text{ mA}$
- $I_{OHJC} = -100\text{ uA}$
- $I_{OLJC} = +100\text{ uA}$

### JTAG Port AC Test Conditions

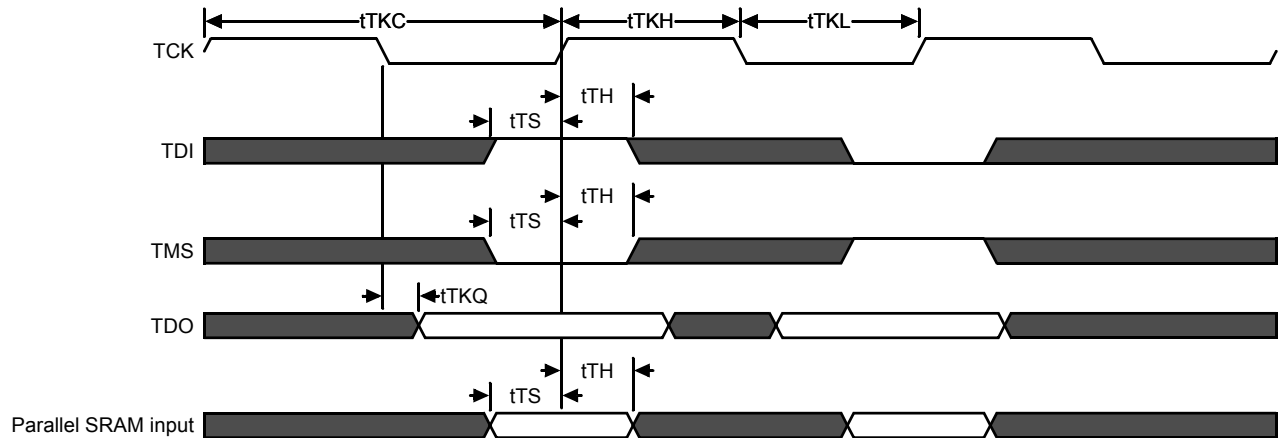
Parameter	Conditions
Input high level	$V_{DD} - 0.2\text{ V}$
Input low level	0.2 V
Input slew rate	1 V/ns
Input reference level	$V_{DDQ}/2$
Output reference level	$V_{DDQ}/2$

**Notes:**

- Include scope and jig capacitance.
- Test conditions as shown unless otherwise noted.



### JTAG Port Timing Diagram

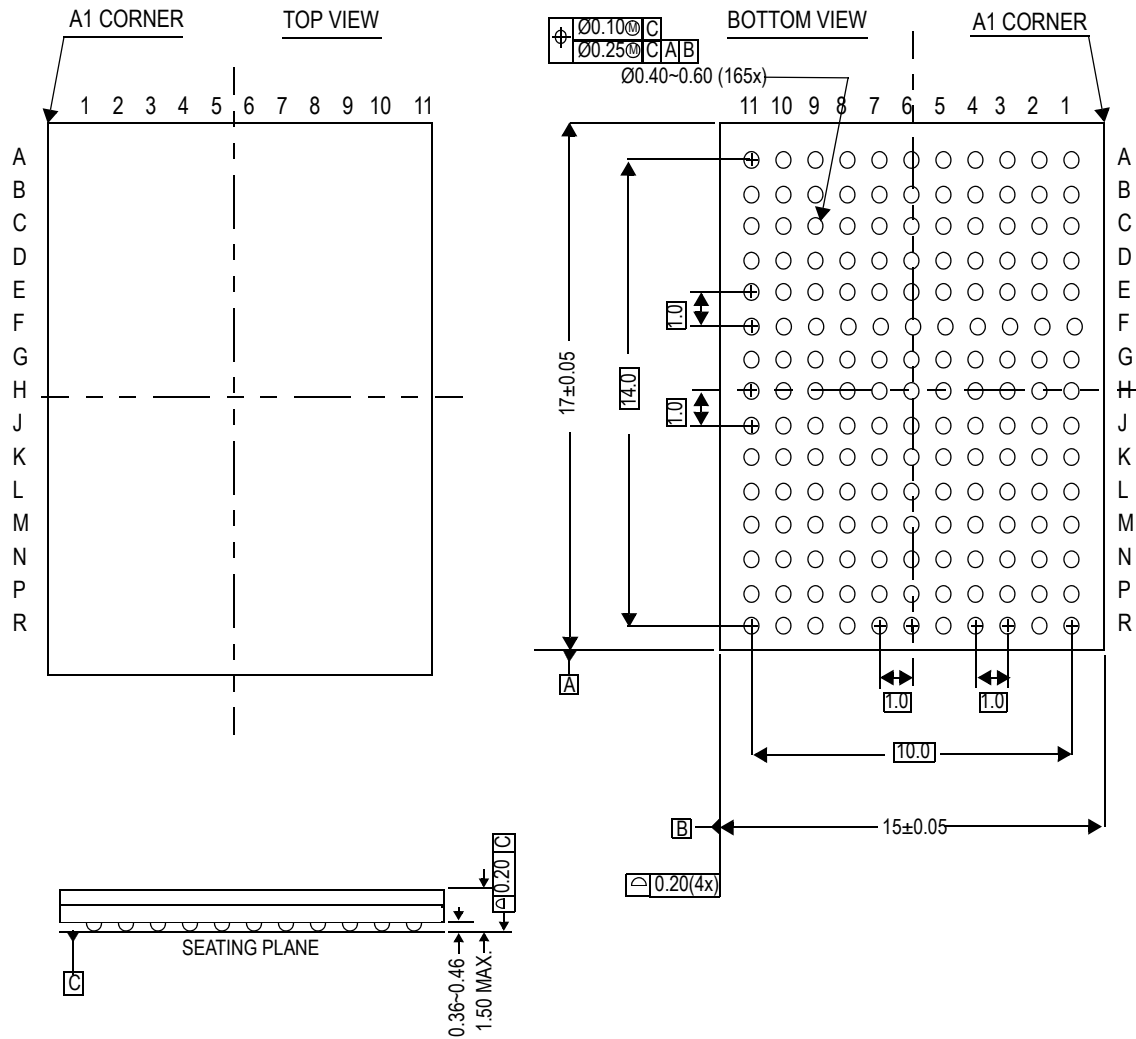


### JTAG Port AC Electrical Characteristics

Parameter	Symbol	Min	Max	Unit
TCK Cycle Time	$t_{TKC}$	50	—	ns
TCK Low to TDO Valid	$t_{TKQ}$	—	20	ns
TCK High Pulse Width	$t_{TKH}$	20	—	ns
TCK Low Pulse Width	$t_{TKL}$	20	—	ns
TDI & TMS Set Up Time	$t_{TS}$	10	—	ns
TDI & TMS Hold Time	$t_{TH}$	10	—	ns



**Package Dimensions—165-Bump FPBGA (Package E)**



**Ordering Information—GSI SigmaCIO DDR-II SRAM**

Org	Part Number1	Type	Package	Speed (MHz)	TA <sup>2</sup>
16M x 8	GS81302T08E-333	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	C
16M x 8	GS81302T08E-300	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	C
16M x 8	GS81302T08E-250	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	C
16M x 8	GS81302T08E-200	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	C

**Notes:**

- For Tape and Reel add the character "T" to the end of the part number. Example: GS8130x36E-300T.
- TA = C = Commercial Temperature Range. TA = I = Industrial Temperature Range.

**Ordering Information—GSI SigmaCIO DDR-II SRAM**

Org	Part Number1	Type	Package	Speed (MHz)	TA <sup>2</sup>
16M x 8	GS81302T08E-167	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	C
16M x 8	GS81302T08E-333I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	I
16M x 8	GS81302T08E-300I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	I
16M x 8	GS81302T08E-250I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	I
16M x 8	GS81302T08E-200I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	I
16M x 8	GS81302T08E-167I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	I
16M x 9	GS81302T09E-333	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	C
16M x 9	GS81302T09E-300	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	C
16M x 9	GS81302T09E-250	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	C
16M x 9	GS81302T09E-200	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	C
16M x 9	GS81302T09E-167	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	C
16M x 9	GS81302T09E-333I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	I
16M x 9	GS81302T09E-300I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	I
16M x 9	GS81302T09E-250I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	I
16M x 9	GS81302T09E-200I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	I
16M x 9	GS81302T09E-167I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	I
8M x 18	GS81302T18E-333	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	C
8M x 18	GS81302T18E-300	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	C
8M x 18	GS81302T18E-267	SigmaCIO DDR-II B2 SRAM	165-bump BGA	267	C
8M x 18	GS81302T18E-250	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	C
8M x 18	GS81302T18E-200	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	C
8M x 18	GS81302T18E-167	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	C
8M x 18	GS81302T18E-333I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	I
8M x 18	GS81302T18E-300I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	I
8M x 18	GS81302T18E-267I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	267	I
8M x 18	GS81302T18E-250I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	I
8M x 18	GS81302T18E-200I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	I
8M x 18	GS81302T18E-167I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	I
4M x 36	GS81302T36E-333	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	C
4M x 36	GS81302T36E-300	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	C
4M x 36	GS81302T36E-250	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	C

**Notes:**

1. For Tape and Reel add the character "T" to the end of the part number. Example: GS8130x36E-300T.
2. TA = C = Commercial Temperature Range. TA = I = Industrial Temperature Range.

**Ordering Information—GSI SigmaCIO DDR-II SRAM**

Org	Part Number <sup>1</sup>	Type	Package	Speed (MHz)	TA <sup>2</sup>
4M x 36	GS81302T36E-200	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	C
4M x 36	GS81302T36E-167	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	C
4M x 36	GS81302T36E-333I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	333	I
4M x 36	GS81302T36E-300I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	300	I
4M x 36	GS81302T36E-250I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	250	I
4M x 36	GS81302T36E-200I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	200	I
4M x 36	GS81302T36E-167I	SigmaCIO DDR-II B2 SRAM	165-bump BGA	167	I
16M x 8	GS81302T08GE-333	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	C
16M x 8	GS81302T08GE-300	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	C
16M x 8	GS81302T08GE-250	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	C
16M x 8	GS81302T08GE-200	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	C
16M x 8	GS81302T08GE-167	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	C
16M x 8	GS81302T08GE-333I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	I
16M x 8	GS81302T08GE-300I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	I
16M x 8	GS81302T08GE-250I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	I
16M x 8	GS81302T08GE-200I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	I
16M x 8	GS81302T08GE-167I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	I
16M x 9	GS81302T09GE-333	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	C
16M x 9	GS81302T09GE-300	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	C
16M x 9	GS81302T09GE-250	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	C
16M x 9	GS81302T09GE-200	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	C
16M x 9	GS81302T09GE-167	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	C
16M x 9	GS81302T09GE-333I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	I
16M x 9	GS81302T09GE-300I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	I
16M x 9	GS81302T09GE-250I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	I
16M x 9	GS81302T09GE-200I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	I
16M x 9	GS81302T09GE-167I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	I
8M x 18	GS81302T18GE-333	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	C
8M x 18	GS81302T18GE-300	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	C
8M x 18	GS81302T18GE-267	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	267	C
8M x 18	GS81302T18GE-250	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	C

**Notes:**

- For Tape and Reel add the character "T" to the end of the part number. Example: GS8130x36E-300T.
- TA = C = Commercial Temperature Range. TA = I = Industrial Temperature Range.

**Ordering Information—GSI SigmaCIO DDR-II SRAM**

Org	Part Number1	Type	Package	Speed (MHz)	TA <sup>2</sup>
8M x 18	GS81302T18GE-200	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	C
8M x 18	GS81302T18GE-167	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	C
8M x 18	GS81302T18GE-333I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	I
8M x 18	GS81302T18GE-300I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	I
8M x 18	GS81302T18GE-267I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	267	I
8M x 18	GS81302T18GE-250I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	I
8M x 18	GS81302T18GE-200I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	I
8M x 18	GS81302T18GE-167I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	I
4M x 36	GS81302T36GE-333	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	C
4M x 36	GS81302T36GE-300	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	C
4M x 36	GS81302T36GE-250	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	C
4M x 36	GS81302T36GE-200	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	C
4M x 36	GS81302T36GE-167	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	C
4M x 36	GS81302T36GE-333I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	333	I
4M x 36	GS81302T36GE-300I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	300	I
4M x 36	GS81302T36GE-250I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	250	I
4M x 36	GS81302T36GE-200I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	200	I
4M x 36	GS81302T36GE-167I	SigmaCIO DDR-II B2 SRAM	RoHS-compliant 165-bump BGA	167	I

**Notes:**

1. For Tape and Reel add the character "T" to the end of the part number. Example: GS8130x36E-300T.
2. TA = C = Commercial Temperature Range. TA = I = Industrial Temperature Range.

### Revision History

Rev. Code: Old; New	Types of Changes Format or Content	Revisions
GS81302Txx_r1	Format	• Creation of new datasheet
GS81302Txx_r1.00a	Content	• Corrected Ordering Information Table