



**512K x 36, 1M x 18
2.5V Synchronous ZBT™ SRAMs
2.5V I/O, Burst Counter
Pipelined Outputs**

**Advance
Information
IDT71T75612
IDT71T75812**

Features

- ◆ 512K x 36, 1M x 18 memory configurations
- ◆ Supports high performance system speed - 200 MHz (3.0ns Clock-to-Data Access)
- ◆ ZBT™ Feature - No dead cycles between write and read cycles
- ◆ Internally synchronized output buffer enable eliminates the need to control $\overline{OE}$
- ◆ Single R/W (READ/WRITE) control pin
- ◆ Positive clock-edge triggered address, data, and control signal registers for fully pipelined applications
- ◆ 4-word burst capability (interleaved or linear)
- ◆ Individual byte write ($\overline{BW}_1$ - $\overline{BW}_4$) control (May tie active)
- ◆ Three chip enables for simple depth expansion
- ◆ 2.5V power supply ($\pm 5\%$)
- ◆ 2.5V I/O Supply (V_{DDQ})
- ◆ Power down controlled by ZZ input
- ◆ Packaged in a JEDEC standard 100-pin plastic thin quad flatpack (TQFP), 119 ball grid array (BGA)

Description

The IDT71T75612/812 are 2.5V high-speed 18,874,368-bit (18 Megabit) synchronous SRAMs. They are designed to eliminate dead bus cycles when turning the bus around between reads and writes, or writes and reads. Thus, they have been given the name ZBT™, or Zero Bus Turnaround.

Address and control signals are applied to the SRAM during one clock cycle, and two cycles later the associated data cycle occurs, be it read or write.

The IDT71T75612/812 contain data I/O, address and control signal registers. Output enable is the only asynchronous signal and can be used to disable the outputs at any given time.

A Clock Enable $\overline{CEN}$ pin allows operation of the IDT71T75612/812 to be suspended as long as necessary. All synchronous inputs are ignored when ($\overline{CEN}$) is high and the internal device registers will hold their previous values.

There are three chip enable pins ($\overline{CE}_1$, $\overline{CE}_2$, $\overline{CE}_2$) that allow the user to deselect the device when desired. If any one of these three is not asserted when $\overline{ADV}/\overline{LD}$ is low, no new memory operation can be initiated. However, any pending data transfers (reads or writes) will be completed.

Pin Description Summary

A0-A19	Address Inputs	Input	Synchronous
$\overline{CE}_1$, $\overline{CE}_2$, $\overline{CE}_2$	Chip Enables	Input	Synchronous
$\overline{OE}$	Output Enable	Input	Asynchronous
R/W	Read/Write Signal	Input	Synchronous
$\overline{CEN}$	Clock Enable	Input	Synchronous
$\overline{BW}_1$, $\overline{BW}_2$, $\overline{BW}_3$, $\overline{BW}_4$	Individual Byte Write Selects	Input	Synchronous
CLK	Clock	Input	N/A
$\overline{ADV}/\overline{LD}$	Advance burst address / Load new address	Input	Synchronous
$\overline{LBO}$	Linear / Interleaved Burst Order	Input	Static
TMS	Test Mode Select	Input	N/A
TDI	Test Data Input	Input	N/A
TCK	Test Clock	Input	N/A
TDO	Test Data Input	Output	N/A
ZZ	Sleep Mode	Input	Synchronous
I/O0-I/O31, I/OP1-I/OP4	Data Input / Output	I/O	Synchronous
VDD, VDDQ	Core Power, I/O Power	Supply	Static
VSS	Ground	Supply	Static

5318 tbl 01

Description (cont.)

The data bus will tri-state two cycles after the chip is deselected or a write is initiated.

The IDT71T75612/812 have an on-chip burst counter. In the burst mode, the IDT71T75612/812 can provide four cycles of data for a single address presented to the SRAM. The order of the burst sequence is defined by the $\overline{\text{LBO}}$ input pin. The $\overline{\text{LBO}}$ pin selects between linear and interleaved burst sequence. The $\text{ADV}/\overline{\text{LD}}$ signal is used to load a new

external address ($\text{ADV}/\overline{\text{LD}} = \text{LOW}$) or increment the internal burst counter ($\text{ADV}/\overline{\text{LD}} = \text{HIGH}$).

The IDT71T75612/812 SRAMs utilize IDT's latest high-performance 2.5V CMOS process, and are packaged in a JEDEC Standard 14mm x 20mm 100pin thin plastic quad flatpack (TQFP) as well as a 119 ball grid array (BGA).

Pin Definitions⁽¹⁾

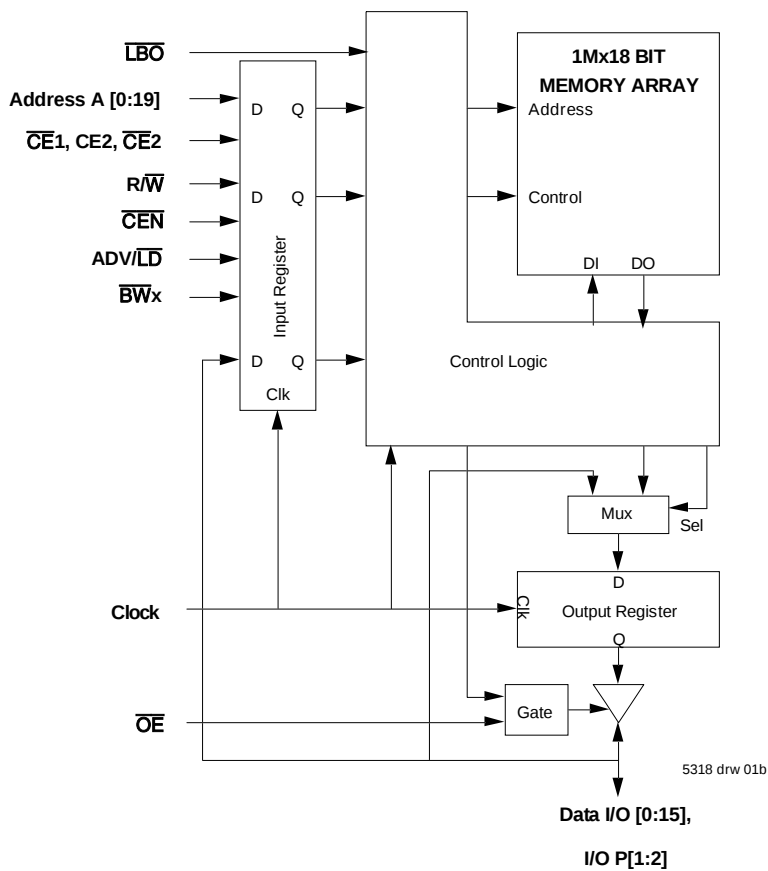
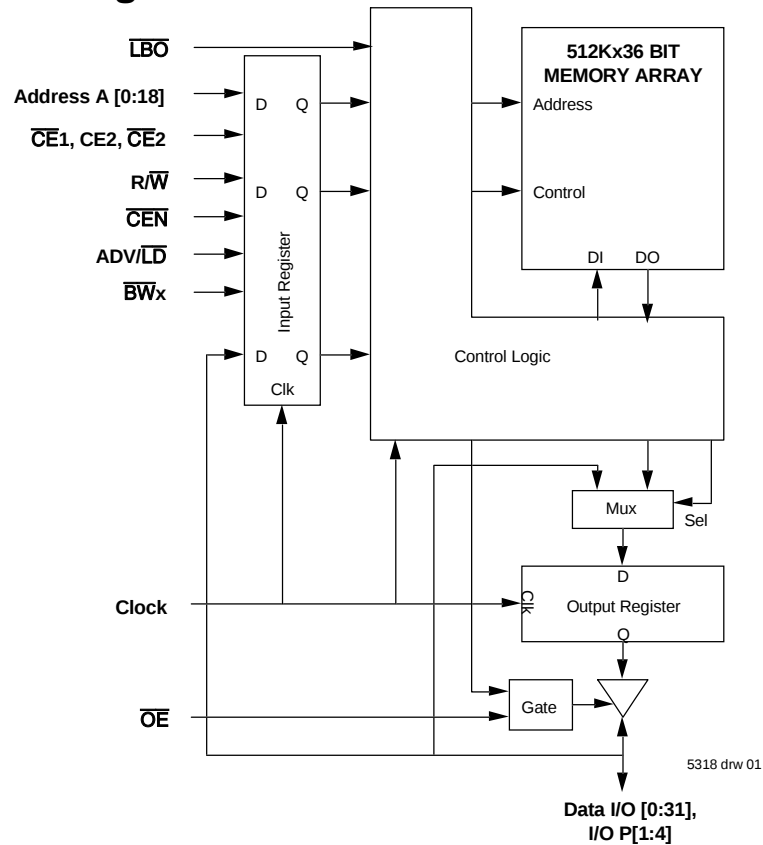
Symbol	Pin Function	I/O	Active	Description
A0-A19	Address Inputs	I	N/A	Synchronous Address inputs. The address register is triggered by a combination of the rising edge of CLK, $\text{ADV}/\overline{\text{LD}}$ low, $\overline{\text{CEN}}$ low, and true chip enables.
$\text{ADV}/\overline{\text{LD}}$	Advance / Load	I	N/A	$\text{ADV}/\overline{\text{LD}}$ is a synchronous input that is used to load the internal registers with new address and control when it is sampled low at the rising edge of clock with the chip selected. When $\text{ADV}/\overline{\text{LD}}$ is low with the chip deselected, any burst in progress is terminated. When $\text{ADV}/\overline{\text{LD}}$ is sampled high then the internal burst counter is advanced for any burst that was in progress. The external addresses are ignored when $\text{ADV}/\overline{\text{LD}}$ is sampled high.
$\text{R}/\overline{\text{W}}$	Read / Write	I	N/A	$\text{R}/\overline{\text{W}}$ signal is a synchronous input that identifies whether the current load cycle initiated is a Read or Write access to the memory array. The data bus activity for the current cycle takes place two clock cycles later.
$\overline{\text{CEN}}$	Clock Enable	I	LOW	Synchronous Clock Enable Input. When $\overline{\text{CEN}}$ is sampled high, all other synchronous inputs, including clock are ignored and outputs remain unchanged. The effect of $\overline{\text{CEN}}$ sampled high on the device outputs is as if the low to high clock transition did not occur. For normal operation, $\overline{\text{CEN}}$ must be sampled low at rising edge of clock.
$\overline{\text{BW}}_1\text{--}\overline{\text{BW}}_4$	Individual Byte Write Enables	I	LOW	Synchronous byte write enables. Each 9-bit byte has its own active low byte write enable. On load write cycles (when $\text{R}/\overline{\text{W}}$ and $\text{ADV}/\overline{\text{LD}}$ are sampled low) the appropriate byte write signal ($\overline{\text{BW}}_1\text{--}\overline{\text{BW}}_4$) must be valid. The byte write signal must also be valid on each cycle of a burst write. Byte Write signals are ignored when $\text{R}/\overline{\text{W}}$ is sampled high. The appropriate byte(s) of data are written into the device two cycles later. $\overline{\text{BW}}_1\text{--}\overline{\text{BW}}_4$ can all be tied low if always doing write to the entire 36-bit word.
$\overline{\text{CE}}_1, \overline{\text{CE}}_2$	Chip Enables	I	LOW	Synchronous active low chip enable. $\overline{\text{CE}}_1$ and $\overline{\text{CE}}_2$ are used with CE_2 to enable the IDT71T75612/812 ($\overline{\text{CE}}_1$ or $\overline{\text{CE}}_2$ sampled high or CE_2 sampled low) and $\text{ADV}/\overline{\text{LD}}$ low at the rising edge of clock, initiates a deselect cycle. The ZBT™ has a two cycle deselect, i.e., the data bus will tri-state two clock cycles after deselect is initiated.
CE_2	Chip Enable	I	HIGH	Synchronous active high chip enable. CE_2 is used with $\overline{\text{CE}}_1$ and $\overline{\text{CE}}_2$ to enable the chip. CE_2 has inverted polarity but otherwise identical to $\overline{\text{CE}}_1$ and $\overline{\text{CE}}_2$.
CLK	Clock	I	N/A	This is the clock input to the IDT71T75612/812. Except for $\overline{\text{OE}}$, all timing references for the device are made with respect to the rising edge of CLK.
$\text{I/O}_0\text{--}\text{I/O}_{31}$ $\text{I/O}_{\text{P}1}\text{--}\text{I/O}_{\text{P}4}$	Data Input/Output	I/O	N/A	Synchronous data input/output (I/O) pins. Both the data input path and data output path are registered and triggered by the rising edge of CLK.
$\overline{\text{LBO}}$	Linear Burst Order	I	LOW	Burst order selection input. When $\overline{\text{LBO}}$ is high the Interleaved burst sequence is selected. When $\overline{\text{LBO}}$ is low the Linear burst sequence is selected. $\overline{\text{LBO}}$ is a static input and it must not change during device operation.
$\overline{\text{OE}}$	Output Enable	I	LOW	Asynchronous output enable. $\overline{\text{OE}}$ must be low to read data from the 71T75612/812. When $\overline{\text{OE}}$ is high the I/O pins are in a high-impedance state. $\overline{\text{OE}}$ does not need to be actively controlled for read and write cycles. In normal operation, $\overline{\text{OE}}$ can be tied low.
TMS	Test Mode Select	I	N/A	Gives input command for TAP controller. Sampled on rising edge of TDK.
TDI	Test Data Input	I	N/A	Serial input of registers placed between TDI and TDO. Sampled on rising edge of TCK.
TCK	Test Clock	I	N/A	Clock input of TAP controller. Each TAP event is clocked. Test inputs are captured on rising edge of TCK, while test outputs are driven from the falling edge of TCK.
TDO	Test Data Output	O	N/A	Serial outout of registers placed between TDI and TDO. This outout is active depending on the state of the TAP controller.
ZZ	Sleep Mode	I	HIGH	Synchronous sleep mode input. ZZ HIGH will gate the CLK internally and power down the IDT71T75612/812 to its lowest power consumption level. Data retention is guaranteed in Sleep Mode.
V _{DD}	Power Supply	N/A	N/A	2.5V core power supply.
V _{DDQ}	Power Supply	N/A	N/A	2.5V I/O Supply.
V _{SS}	Ground	N/A	N/A	Ground.

NOTE:

1. All synchronous inputs must meet specified setup and hold times with respect to CLK.

5318 tbl 02

Functional Block Diagram



Recommended DC Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V _{DD}	Core Supply Voltage	2.375	2.5	2.625	V
V _{DDQ}	I/O Supply Voltage	2.375	2.5	2.625	V
V _{SS}	Ground	0	0	0	V
V _{IH}	Input High Voltage - Inputs	1.7	—	V _{DD} + 0.3	V
V _{IH}	Input High Voltage - I/O	1.7	—	V _{DDQ} + 0.3	V
V _{IL}	Input Low Voltage	-0.3 ⁽¹⁾	—	0.7	V

5318 tbl 03

NOTE:

- V_{IL} (min.) = -0.8V for pulse width less than tcyc/2, once per cycle.

Recommended Operating Temperature and Supply Voltage

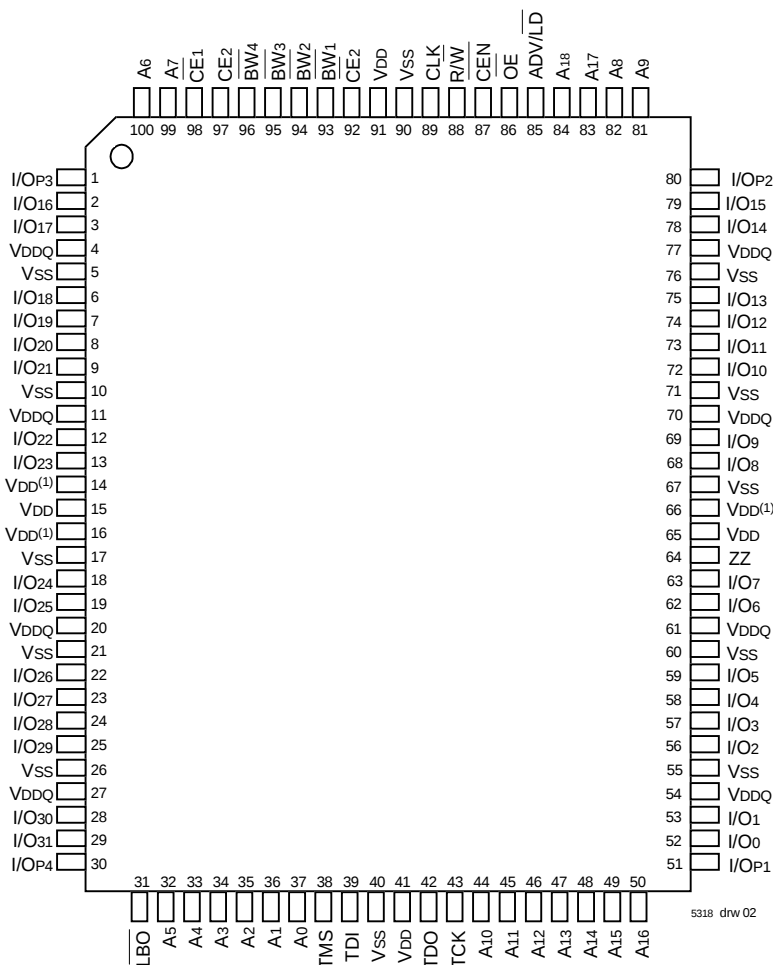
Grade	Temperature ⁽¹⁾	V _{SS}	V _{DD}	V _{DDQ}
Commercial	0°C to +70°C	0V	2.5V±5%	2.5V±5%

5318 tbl 05

NOTE:

- T_A is the "instant on" case temperature.

Pin Configuration — 512K x 36



5318 drw 02

Top View 100 TQFP

NOTES:

- Pins 14, 16, and 66 do not have to be connected directly to V_{DD} as long as the input voltage is ≥ V_{IH}.

Pin Configuration — 512K X 36, 119 BGA^(1,2)**Top View**

	1	2	3	4	5	6	7
A	VDDQ	A6	A4	A18	A8	A16	VDDQ
B	NC	CE2	A3	ADV/LD	A9	$\overline{CE}_2$	NC
C	NC	A7	A2	VDD	A12	A15	NC
D	I/O16	I/OP3	VSS	NC	VSS	I/OP2	I/O15
E	I/O17	I/O18	VSS	$\overline{CE}_1$	VSS	I/O13	I/O14
F	VDDQ	I/O19	VSS	$\overline{OE}$	VSS	I/O12	VDDQ
G	I/O20	I/O21	$\overline{BW}_3$	A17	$\overline{BW}_2$	I/O11	I/O10
H	I/O22	I/O23	VSS	R/W	VSS	I/O9	I/O8
J	VDDQ	VDD	VDD ⁽¹⁾	VDD	VDD ⁽¹⁾	VDD	VDDQ
K	I/O24	I/O26	VSS	CLK	VSS	I/O6	I/O7
L	I/O25	I/O27	$\overline{BW}_4$	NC	$\overline{BW}_1$	I/O4	I/O5
M	VDDQ	I/O28	VSS	$\overline{CEN}$	VSS	I/O3	VDDQ
N	I/O29	I/O30	VSS	A1	VSS	I/O2	I/O1
P	I/O31	I/OP4	VSS	A0	VSS	I/O0	I/OP1
R	NC	A5	$\overline{LB}_0$	VDD	VDD ⁽¹⁾	A13	NC
T	NC	NC	A10	A11	A14	NC	ZZ
U	VDDQ	TMS	TDI	TCK	TDO	$\overline{TRST}^{(2)}$	VDDQ

5318 tbl 25

Pin Configuration — 1M X 18, 119 BGA^(1,2)**Top View**

	1	2	3	4	5	6	7
A	VDDQ	A6	A4	A19	A8	A16	VDDQ
B	NC	CE2	A3	ADV/LD	A9	$\overline{CE}_2$	NC
C	NC	A7	A2	VDD	A13	A17	NC
D	I/O8	NC	VSS	NC	VSS	I/O7	NC
E	NC	I/O9	VSS	$\overline{CE}_1$	VSS	NC	I/O6
F	VDDQ	NC	VSS	$\overline{OE}$	VSS	I/O5	VDDQ
G	NC	I/O10	$\overline{BW}_2$	A18	VSS	NC	I/O4
H	I/O11	NC	VSS	R/W	VSS	I/O3	NC
J	VDDQ	VDD	VDD ⁽¹⁾	VDD	VDD ⁽¹⁾	VDD	VDDQ
K	NC	I/O12	VSS	CLK	VSS	NC	I/O2
L	I/O13	NC	VSS	NC	$\overline{BW}_1$	I/O1	NC
M	VDDQ	I/O14	VSS	$\overline{CEN}$	VSS	NC	VDDQ
N	I/O15	NC	VSS	A1	VSS	I/O0	NC
P	NC	I/OP2	VSS	A0	VSS	NC	I/OP1
R	NC	A5	$\overline{LB}_0$	VDD	VDD ⁽¹⁾	A12	NC
T	NC	A10	A15	NC	A14	A11	ZZ
U	VDDQ	TMS	TDI	TCK	TDO	$\overline{TRST}^{(2)}$	VDDQ

5318 tbl 25a

NOTES:

- J3, R5, and J5 do not have to be directly connected to VDD as long as the input voltage is $\geq V_{IH}$.
- U6 will be pulled internally to VDD if not actively driven. To disable the TAP controller without interfering with normal operation, $\overline{TRST}$ should be tied low and TCK, TDI, and TMS should be pulled through a resistor to 2.5V. TDO should be left unconnected.

Synchronous Truth Table⁽¹⁾

$\overline{\text{CEN}}$	R/ $\overline{\text{W}}$	Chip ⁽⁵⁾ Enable	ADV/ $\overline{\text{LD}}$	$\overline{\text{BW}}_x$	ADDRESS USED	PREVIOUS CYCLE	CURRENT CYCLE	I/O (2 cycles later)
L	L	Select	L	Valid	External	X	LOAD WRITE	D ⁽⁷⁾
L	H	Select	L	X	External	X	LOAD READ	Q ⁽⁷⁾
L	X	X	H	Valid	Internal	LOAD WRITE / BURST WRITE	BURST WRITE (Advance burst counter) ⁽²⁾	D ⁽⁷⁾
L	X	X	H	X	Internal	LOAD READ / BURST READ	BURST READ (Advance burst counter) ⁽²⁾	Q ⁽⁷⁾
L	X	Deselect	L	X	X	X	DESELECT or STOP ⁽³⁾	HiZ
L	X	X	H	X	X	DESELECT / NOOP	NOOP	HiZ
H	X	X	X	X	X	X	SUSPEND ⁽⁴⁾	Previous Value

5318 tbl 08

NOTES:

1. L = V_{IL} , H = V_{IH} , X = Don't Care.
2. When ADV/ $\overline{\text{LD}}$ signal is sampled high, the internal burst counter is incremented. The R/ $\overline{\text{W}}$ signal is ignored when the counter is advanced. Therefore the nature of the burst cycle (Read or Write) is determined by the status of the R/ $\overline{\text{W}}$ signal when the first address is loaded at the beginning of the burst cycle.
3. Deselect cycle is initiated when either ($\overline{\text{CE}}_1$, or $\overline{\text{CE}}_2$ is sampled high or CE2 is sampled low) and ADV/ $\overline{\text{LD}}$ is sampled low at rising edge of clock. The data bus will tri-state two cycles after deselect is initiated.
4. When $\overline{\text{CEN}}$ is sampled high at the rising edge of clock, that clock edge is blocked from propagating through the part. The state of all the internal registers and the I/Os remains unchanged.
5. To select the chip requires $\overline{\text{CE}}_1 = \text{L}$, $\overline{\text{CE}}_2 = \text{L}$, CE2 = H on these chip enables. Chip is deselected if any one of the chip enables is false.
6. Device Outputs are ensured to be in High-Z after the first rising edge of clock upon power-up.
7. Q - Data read from the device, D - data written to the device.

Partial Truth Table for Writes⁽¹⁾

OPERATION	R/ $\overline{\text{W}}$	$\overline{\text{BW}}_1$	$\overline{\text{BW}}_2$	$\overline{\text{BW}}_3^{(3)}$	$\overline{\text{BW}}_4^{(3)}$
READ	H	X	X	X	X
WRITE ALL BYTES	L	L	L	L	L
WRITE BYTE 1 (I/O[0:7], I/OP1) ⁽²⁾	L	L	H	H	H
WRITE BYTE 2 (I/O[8:15], I/OP2) ⁽²⁾	L	H	L	H	H
WRITE BYTE 3 (I/O[16:23], I/OP3) ^(2,3)	L	H	H	L	H
WRITE BYTE 4 (I/O[24:31], I/OP4) ^(2,3)	L	H	H	H	L
NO WRITE	L	H	H	H	H

5318 tbl 09

NOTES:

1. L = V_{IL} , H = V_{IH} , X = Don't Care.
2. Multiple bytes may be selected during the same cycle.
3. N/A for X18 configuration.

Interleaved Burst Sequence Table ($\overline{\text{LBO}}=\text{VDD}$)

	Sequence 1		Sequence 2		Sequence 3		Sequence 4	
	A1	A0	A1	A0	A1	A0	A1	A0
First Address	0	0	0	1	1	0	1	1
Second Address	0	1	0	0	1	1	1	0
Third Address	1	0	1	1	0	0	0	1
Fourth Address ⁽¹⁾	1	1	1	0	0	1	0	0

5318 tbl 10

NOTE:

1. Upon completion of the Burst sequence the counter wraps around to its initial state and continues counting.

Linear Burst Sequence Table ($\overline{\text{LBO}}=\text{Vss}$)

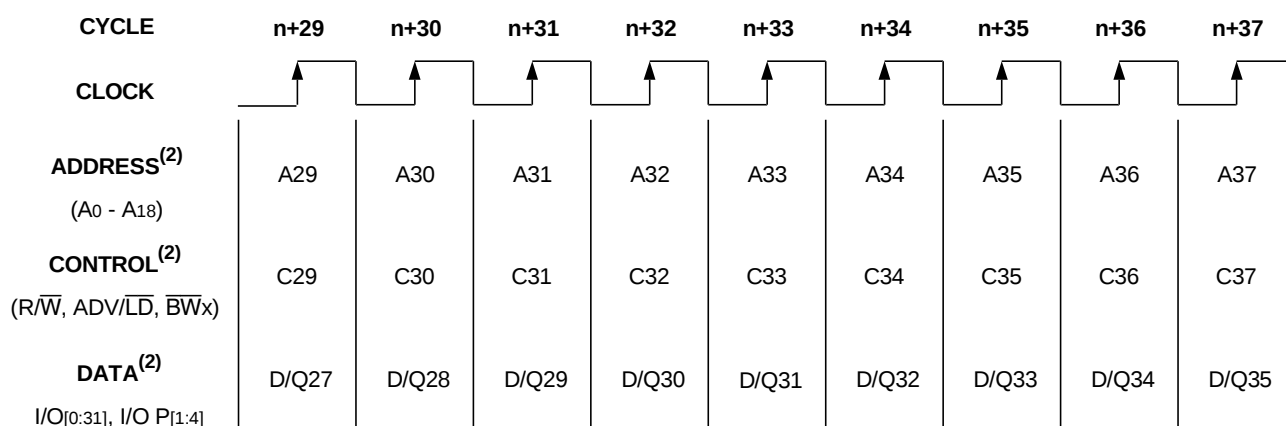
	Sequence 1		Sequence 2		Sequence 3		Sequence 4	
	A1	A0	A1	A0	A1	A0	A1	A0
First Address	0	0	0	1	1	0	1	1
Second Address	0	1	1	0	1	1	0	0
Third Address	1	0	1	1	0	0	0	1
Fourth Address ⁽¹⁾	1	1	0	0	0	1	1	0

5318 tbl 11

NOTE:

1. Upon completion of the Burst sequence the counter wraps around to its initial state and continues counting.

Functional Timing Diagram⁽¹⁾



5318 drw 03

NOTES:

1. This assumes $\overline{\text{CEN}}$, $\overline{\text{CE}}_1$, $\overline{\text{CE}}_2$, $\overline{\text{CE}}_3$ are all true.
2. All Address, Control and Data_In are only required to meet set-up and hold time with respect to the rising edge of clock. Data_Out is valid after a clock-to-data delay from the rising edge of clock.

Device Operation - Showing Mixed Load, Burst, Deselect and NOOP Cycles⁽²⁾

Cycle	Address	R/W	ADV/LD	$\overline{CE}^{(1)}$	$\overline{CEN}$	$\overline{BWx}$	$\overline{OE}$	I/O	Comments
n	A ₀	H	L	L	L	X	X	X	Load read
n+1	X	X	H	X	L	X	X	X	Burst read
n+2	A ₁	H	L	L	L	X	L	Q ₀	Load read
n+3	X	X	L	H	L	X	L	Q ₀₊₁	Deselect or STOP
n+4	X	X	H	X	L	X	L	Q ₁	NOOP
n+5	A ₂	H	L	L	L	X	X	Z	Load read
n+6	X	X	H	X	L	X	X	Z	Burst read
n+7	X	X	L	H	L	X	L	Q ₂	Deselect or STOP
n+8	A ₃	L	L	L	L	L	L	Q ₂₊₁	Load write
n+9	X	X	H	X	L	L	X	Z	Burst write
n+10	A ₄	L	L	L	L	L	X	D ₃	Load write
n+11	X	X	L	H	L	X	X	D ₃₊₁	Deselect or STOP
n+12	X	X	H	X	L	X	X	D ₄	NOOP
n+13	A ₅	L	L	L	L	L	X	Z	Load write
n+14	A ₆	H	L	L	L	X	X	Z	Load read
n+15	A ₇	L	L	L	L	L	X	D ₅	Load write
n+16	X	X	H	X	L	L	L	Q ₆	Burst write
n+17	A ₈	H	L	L	L	X	X	D ₇	Load read
n+18	X	X	H	X	L	X	X	D ₇₊₁	Burst read
n+19	A ₉	L	L	L	L	L	L	Q ₈	Load write

5318 tbl 12

NOTES:

- $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.
- H = High; L = Low; X = Don't Care; Z = High Impedance.

Read Operation⁽¹⁾

Cycle	Address	R/W	ADV/LD	$\overline{CE}^{(2)}$	$\overline{CEN}$	$\overline{BWx}$	$\overline{OE}$	I/O	Comments
n	A ₀	H	L	L	L	X	X	X	Address and Control meet setup
n+1	X	X	X	X	L	X	X	X	Clock Setup Valid
n+2	X	X	X	X	X	X	L	Q ₀	Contents of Address A ₀ Read Out

5318 tbl 13

NOTES:

- H = High; L = Low; X = Don't Care; Z = High Impedance.
- $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Burst Read Operation⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	$\overline{BWx}$	$\overline{OE}$	I/O	Comments
n	A ₀	H	L	L	L	X	X	X	Address and Control meet setup
n+1	X	X	H	X	L	X	X	X	Clock Setup Valid, Advance Counter
n+2	X	X	H	X	L	X	L	Q ₀	Address A ₀ Read Out, Inc. Count
n+3	X	X	H	X	L	X	L	Q ₀₊₁	Address A ₀₊₁ Read Out, Inc. Count
n+4	X	X	H	X	L	X	L	Q ₀₊₂	Address A ₀₊₂ Read Out, Inc. Count
n+5	A ₁	H	L	L	L	X	L	Q ₀₊₃	Address A ₀₊₃ Read Out, Load A ₁
n+6	X	X	H	X	L	X	L	Q ₀	Address A ₀ Read Out, Inc. Count
n+7	X	X	H	X	L	X	L	Q ₁	Address A ₁ Read Out, Inc. Count
n+8	A ₂	H	L	L	L	X	L	Q ₁₊₁	Address A ₁₊₁ Read Out, Load A ₂

5318 tbl 14

NOTES:

- H = High; L = Low; X = Don't Care; Z = High Impedance.
- $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Write Operation⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	$\overline{BWx}$	$\overline{OE}$	I/O	Comments
n	A ₀	L	L	L	L	L	X	X	Address and Control meet setup
n+1	X	X	X	X	L	X	X	X	Clock Setup Valid
n+2	X	X	X	X	L	X	X	D ₀	Write to Address A ₀

5318 tbl 15

NOTES:

- H = High; L = Low; X = Don't Care; Z = High Impedance.
- $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Burst Write Operation⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	$\overline{BWx}$	$\overline{OE}$	I/O	Comments
n	A ₀	L	L	L	L	L	X	X	Address and Control meet setup
n+1	X	X	H	X	L	L	X	X	Clock Setup Valid, Inc. Count
n+2	X	X	H	X	L	L	X	D ₀	Address A ₀ Write, Inc. Count
n+3	X	X	H	X	L	L	X	D ₀₊₁	Address A ₀₊₁ Write, Inc. Count
n+4	X	X	H	X	L	L	X	D ₀₊₂	Address A ₀₊₂ Write, Inc. Count
n+5	A ₁	L	L	L	L	L	X	D ₀₊₃	Address A ₀₊₃ Write, Load A ₁
n+6	X	X	H	X	L	L	X	D ₀	Address A ₀ Write, Inc. Count
n+7	X	X	H	X	L	L	X	D ₁	Address A ₁ Write, Inc. Count
n+8	A ₂	L	L	L	L	L	X	D ₁₊₁	Address A ₁₊₁ Write, Load A ₂

5318 tbl 16

NOTES:

- H = High; L = Low; X = Don't Care; ? = Don't Know; Z = High Impedance.
- $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Read Operation with Clock Enable Used⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	BWx	$\overline{OE}$	I/O	Comments
n	A ₀	H	L	L	L	X	X	X	Address and Control meet setup
n+1	X	X	X	X	H	X	X	X	Clock n+1 Ignored
n+2	A ₁	H	L	L	L	X	X	X	Clock Valid
n+3	X	X	X	X	H	X	L	Q ₀	Clock Ignored. Data Q ₀ is on the bus.
n+4	X	X	X	X	H	X	L	Q ₀	Clock Ignored. Data Q ₀ is on the bus.
n+5	A ₂	H	L	L	L	X	L	Q ₀	Address A ₀ Read out (bus trans.)
n+6	A ₃	H	L	L	L	X	L	Q ₁	Address A ₁ Read out (bus trans.)
n+7	A ₄	H	L	L	L	X	L	Q ₂	Address A ₂ Read out (bus trans.)

5318 tbl 17

NOTES:

1. H = High; L = Low; X = Don't Care; Z = High Impedance.
2. $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Write Operation with Clock Enable Used⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	BWx	$\overline{OE}$	I/O	Comments
n	A ₀	L	L	L	L	L	X	X	Address and Control meet setup.
n+1	X	X	X	X	H	X	X	X	Clock n+1 Ignored.
n+2	A ₁	L	L	L	L	L	X	X	Clock Valid.
n+3	X	X	X	X	H	X	X	X	Clock Ignored.
n+4	X	X	X	X	H	X	X	X	Clock Ignored.
n+5	A ₂	L	L	L	L	L	X	D ₀	Write Data D ₀
n+6	A ₃	L	L	L	L	L	X	D ₁	Write Data D ₁
n+7	A ₄	L	L	L	L	L	X	D ₂	Write Data D ₂

5313 tbl 18

NOTES:

1. H = High; L = Low; X = Don't Care; Z = High Impedance.
2. $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

Read Operation with Chip Enable Used⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	BW _x	$\overline{OE}$	I/O ⁽³⁾	Comments
n	X	X	L	H	L	X	X	?	Deselected.
n+1	X	X	L	H	L	X	X	?	Deselected.
n+2	A ₀	H	L	L	L	X	X	Z	Address and Control meet setup.
n+3	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+4	A ₁	H	L	L	L	X	L	Q ₀	Address A ₀ Read out. Load A ₁ .
n+5	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+6	X	X	L	H	L	X	L	Q ₁	Address A ₁ Read out. Deselected.
n+7	A ₂	H	L	L	L	X	X	Z	Address and control meet setup.
n+8	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+9	X	X	L	H	L	X	L	Q ₂	Address A ₂ Read out. Deselected.

5318 tbl 19

NOTES:

1. H = High; L = Low; X = Don't Care; ? = Don't Know; Z = High Impedance.
2. $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.
3. Device Outputs are ensured to be in High-Z after the first rising edge of clock upon power-up.

Write Operation with Chip Enable Used⁽¹⁾

Cycle	Address	R/ $\overline{W}$	ADV/ $\overline{LD}$	$\overline{CE}^{(2)}$	$\overline{CEN}$	BW _x	$\overline{OE}$	I/O	Comments
n	X	X	L	H	L	X	X	?	Deselected.
n+1	X	X	L	H	L	X	X	?	Deselected.
n+2	A ₀	L	L	L	L	L	X	Z	Address and Control meet setup.
n+3	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+4	A ₁	L	L	L	L	L	X	D ₀	Address D ₀ Write in. Load A ₁ .
n+5	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+6	X	X	L	H	L	X	X	D ₁	Address D ₁ Write in. Deselected.
n+7	A ₂	L	L	L	L	L	X	Z	Address and control meet setup.
n+8	X	X	L	H	L	X	X	Z	Deselected or STOP.
n+9	X	X	L	H	L	X	X	D ₂	Address D ₂ Write in. Deselected.

5318 tbl 20

NOTES:

1. H = High; L = Low; X = Don't Care; ? = Don't Know; Z = High Impedance.
2. $\overline{CE} = L$ is defined as $\overline{CE}_1 = L$, $\overline{CE}_2 = L$ and $CE_2 = H$. $\overline{CE} = H$ is defined as $\overline{CE}_1 = H$, $\overline{CE}_2 = H$ or $CE_2 = L$.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range ($V_{DD} = 2.5V \pm 5\%$)

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
$ I_{LI} $	Input Leakage Current	$V_{DD} = \text{Max.}, V_{IN} = 0V \text{ to } V_{DD}$	—	5	μA
$ I_{L\bar{L}} $	$\bar{LBO}$ Input Leakage Current ⁽¹⁾	$V_{DD} = \text{Max.}, V_{IN} = 0V \text{ to } V_{DD}$	—	30	μA
$ I_{LO} $	Output Leakage Current	$V_{OUT} = 0V \text{ to } V_{DDQ}$, Device Deselected	—	5	μA
V_{OL}	Output Low Voltage	$I_{OL} = +6mA$, $V_{DD} = \text{Min.}$	—	0.4	V
V_{OH}	Output High Voltage	$I_{OH} = -6mA$, $V_{DD} = \text{Min.}$	2.0	—	V

5318 tbl 21

NOTE:

1. The $\bar{LBO}$ pin will be internally pulled to V_{DD} if it is not actively driven in the application, and the ZZ pin will be internally pulled to V_{SS} if not actively driven.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range⁽¹⁾ ($V_{DD} = 2.5V \pm 5\%$)

Symbol	Parameter	Test Conditions	200MHz	166MHz	Unit
I_{DD}	Operating Power Supply Current	Device Selected, Outputs Open, $ADV/\bar{LD} = X$, $V_{DD} = \text{Max.}$, $V_{IN} \geq V_{IH}$ or $\leq V_{IL}$, $f = f_{MAX}^{(2)}$	400	350	mA
I_{SB1}	CMOS Standby Power Supply Current	Device Deselected, Outputs Open, $V_{DD} = \text{Max.}$, $V_{IN} \geq V_{HD}$ or $\leq V_{LD}$, $f = 0^{(2,3)}$	40	40	mA
I_{SB2}	Clock Running Power Supply Current	Device Deselected, Outputs Open, $V_{DD} = \text{Max.}$, $V_{IN} \geq V_{HD}$ or $\leq V_{LD}$, $f = f_{MAX}^{(2,3)}$	130	120	mA
I_{SB3}	Idle Power Supply Current	Device Selected, Outputs Open, $\bar{CEN} \geq V_{IH}$, $V_{DD} = \text{Max.}$, $V_{IN} \geq V_{HD}$ or $\leq V_{LD}$, $f = f_{MAX}^{(2,3)}$	40	40	mA
I_{ZZ}	Full Sleep Mode Supply Current	Device Selected, Outputs Open, $\bar{CEN} \leq V_{IH}$, $V_{DD} = \text{Max.}$, $V_{IN} \geq V_{HD}$ or $\leq V_{LD}$, $f = f_{MAX}^{(2,3)}$, $ZZ_{IN} \geq V_{HD}$	40	40	mA

5318 tbl 22

NOTES:

1. All values are maximum guaranteed values.
2. At $f = f_{MAX}$, inputs are cycling at the maximum frequency of read cycles of $1/t_{CYC}$; $f=0$ means no input lines are changing.
3. For I/Os $V_{HD} = V_{DDQ} - 0.2V$, $V_{LD} = 0.2V$. For other inputs $V_{HD} = V_{DD} - 0.2V$, $V_{LD} = 0.2V$.

AC Test Load

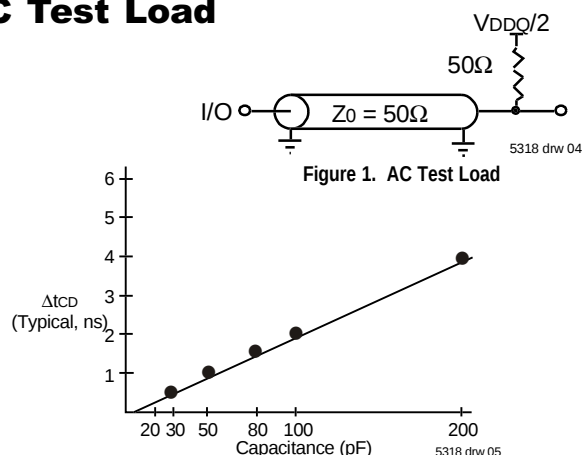


Figure 2. Lumped Capacitive Load, Typical Derating

AC Test Conditions

Input Pulse Levels	0 to 2.5V
Input Rise/Fall Times	2ns
Input Timing Reference Levels	$(V_{DDQ}/2)$
Output Timing Reference Levels	$(V_{DDQ}/2)$
AC Test Load	See Figure 1

5318 tbl 23

AC Electrical Characteristics (V_{DD} = 2.5V +/-5%, T_A = 0 to 70°C)

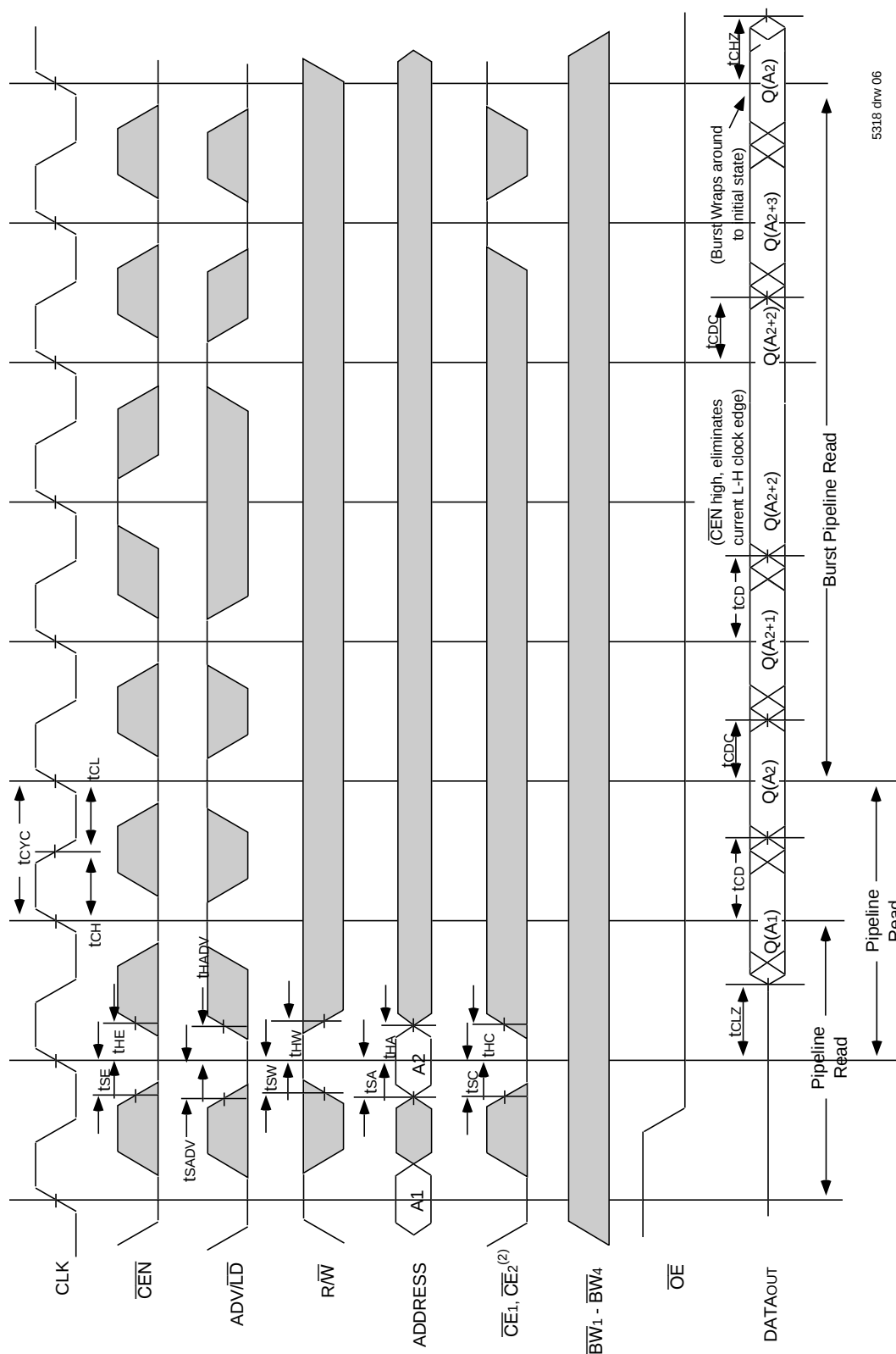
Symbol	Parameter	200MHz		166MHz		Unit
		Min.	Max.	Min.	Max.	
t _{CYC}	Clock Cycle Time	5	—	6	—	ns
t _F ⁽¹⁾	Clock Frequency	—	200	—	166	MHz
t _{CH} ⁽²⁾	Clock High Pulse Width	1.8	—	1.8	—	ns
t _{CL} ⁽²⁾	Clock Low Pulse Width	1.8	—	1.8	—	ns
Output Parameters						
t _{CD}	Clock High to Valid Data	—	3.0	—	3.5	ns
t _{ODC}	Clock High to Data Change	1	—	1	—	ns
t _{OLZ} ^(3,4,5)	Clock High to Output Active	1	—	1	—	ns
t _{CHZ} ^(3,4,5)	Clock High to Data High-Z	1	3	1	3	ns
t _{OE}	Output Enable Access Time	—	3.0	—	3.5	ns
t _{OLZ} ^(3,4)	Output Enable Low to Data Active	0	—	0	—	ns
t _{OHZ} ^(3,4)	Output Enable High to Data High-Z	—	3.5	—	3.5	ns
Set Up Times						
t _{SE}	Clock Enable Setup Time	1.5	—	1.5	—	ns
t _{SA}	Address Setup Time	1.5	—	1.5	—	ns
t _{SD}	Data In Setup Time	1.5	—	1.5	—	ns
t _{SW}	Read/Write (R/W) Setup Time	1.5	—	1.5	—	ns
t _{SADV}	Advance/Load (ADV/LD) Setup Time	1.5	—	1.5	—	ns
t _{SC}	Chip Enable/Select Setup Time	1.5	—	1.5	—	ns
t _{SB}	Byte Write Enable (BWx) Setup Time	1.5	—	1.5	—	ns
Hold Times						
t _{HE}	Clock Enable Hold Time	0.5	—	0.5	—	ns
t _{HA}	Address Hold Time	0.5	—	0.5	—	ns
t _{HD}	Data In Hold Time	0.5	—	0.5	—	ns
t _{HW}	Read/Write (R/W) Hold Time	0.5	—	0.5	—	ns
t _{HADV}	Advance/Load (ADV/LD) Hold Time	0.5	—	0.5	—	ns
t _{HC}	Chip Enable/Select Hold Time	0.5	—	0.5	—	ns
t _{HB}	Byte Write Enable (BWx) Hold Time	0.5	—	0.5	—	ns

5318 tbl 24

NOTES:

- t_F = 1/t_{CYC}.
- Measured as HIGH above 0.6V_{DDQ} and LOW below 0.4V_{DDQ}.
- Transition is measured ±200mV from steady-state.
- These parameters are guaranteed with the AC load (Figure 1) by device characterization. They are not production tested.
- To avoid bus contention, the output buffers are designed such that t_{CHZ} (device turn-off) is faster than t_{CLZ} (device turn-on) at a given temperature and voltage. The specs as shown do not imply bus contention because t_{CLZ} is a Min. parameter that is worse case at totally different test conditions (0 deg. C, 2.625V) than t_{CHZ}, which is a Max. parameter (worse case at 70 deg. C, 2.375V).

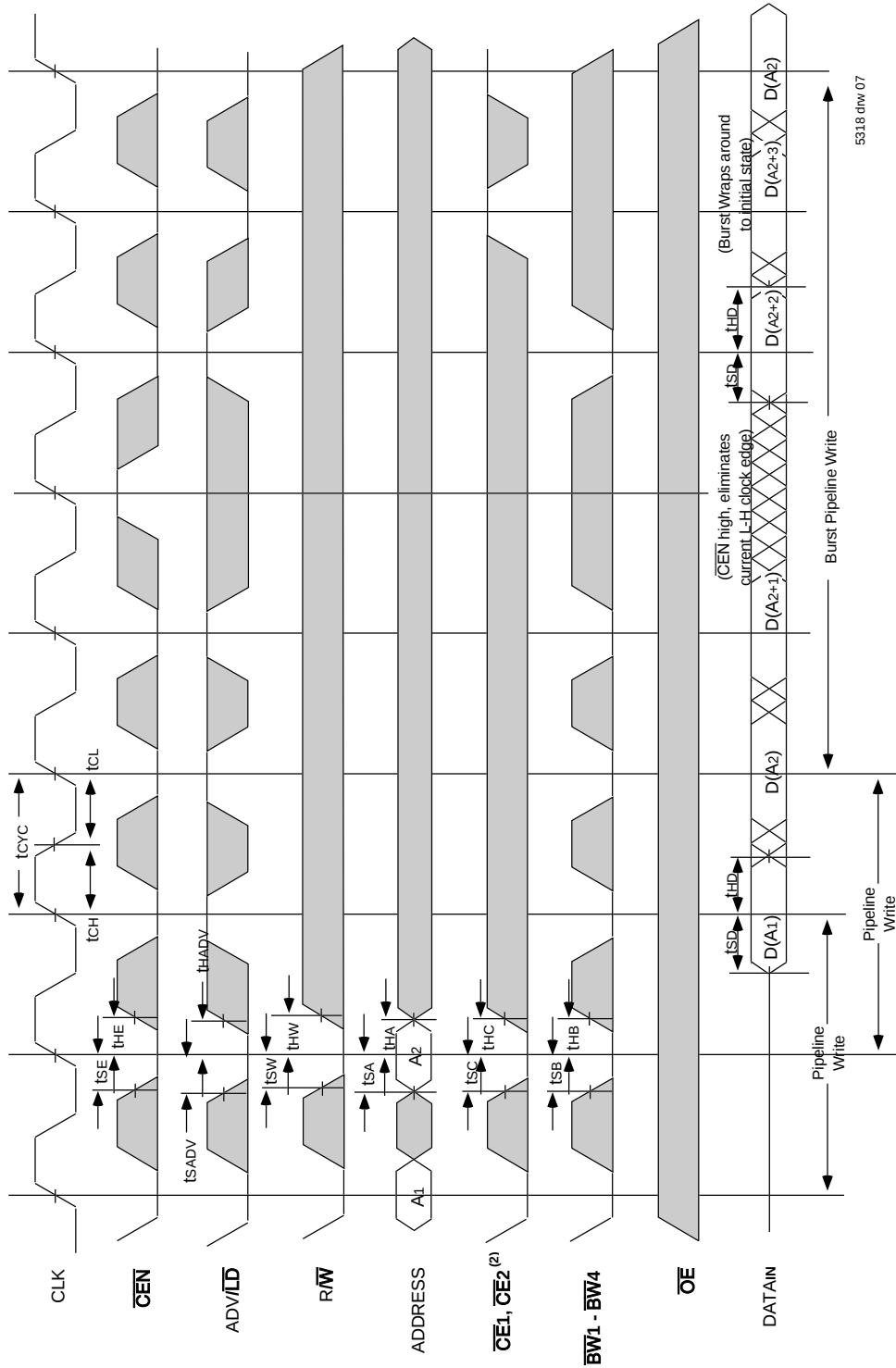
Timing Waveform of Read Cycle^(1,2,3,4)



NOTES:

1. $Q(A1)$ represents the first output from the external address $A1$. $Q(A2)$ represents the first output from the external address $A2$; $Q(A2+1)$ represents the next output data in the burst sequence of the base address $A2$, etc. where address bits $A0$ and $A1$ are advancing for the four word burst in the sequence defined by the state of the LBO input.
2. $\overline{CE2}$ timing transitions are identical but inverted to the $\overline{CE1}$ and $\overline{CE2}$ signals. For example, when $\overline{CE1}$ and $\overline{CE2}$ are LOW on this waveform, $\overline{CE1}$ is HIGH.
3. Burst ends when new address and control are loaded into the SRAM by sampling $\overline{ADV/LD}$ LOW.
4. $R/\overline{W}$ is don't care when the SRAM is bursting ($\overline{ADV/LD}$ sampled HIGH). The nature of the burst access (Read or Write) is fixed by the state of the $R/\overline{W}$ signal when new address and control are loaded into the SRAM.

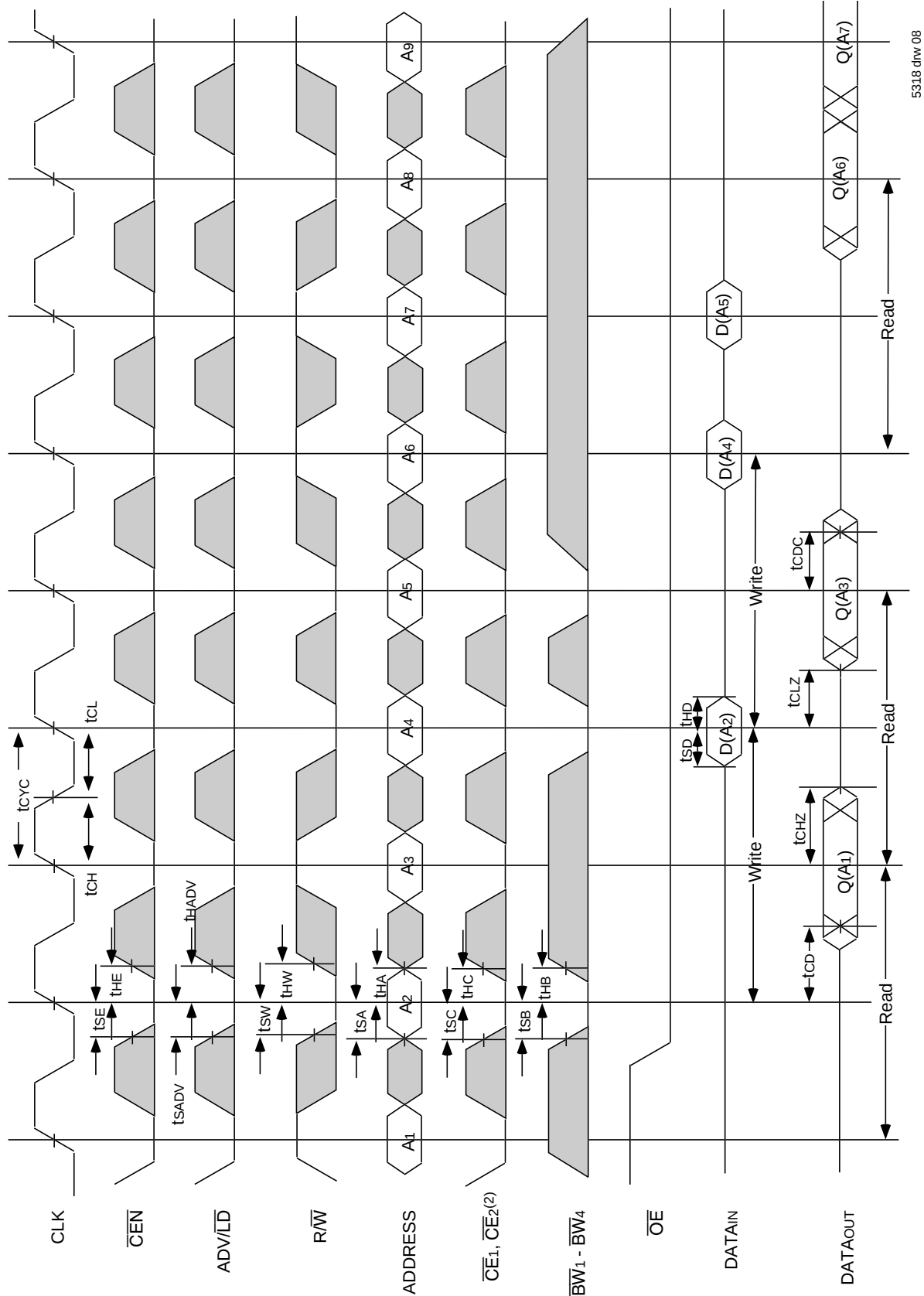
Timing Waveform of Write Cycles^(1,2,3,4,5)



NOTES:

1. D (A₁) represents the first input to the external address A₁. D (A₂) represents the first input to the external address A₂; D (A₂₊₁) represents the next input data in the burst sequence of the base address A₂, etc. where address bits A₀ and A₁ are advancing for the four word burst in the sequence defined by the state of the LBO input.
2. CE₂ timing transitions are identical but inverted to the $\overline{CE1}$ and $\overline{CE2}$ signals. For example, when $\overline{CE1}$ and $\overline{CE2}$ are LOW on this waveform, CE₂ is HIGH.
3. Burst ends when new address and control are loaded into the SRAM by sampling ADV/LD LOW.
4. RW is don't care when the SRAM is bursting (ADV/LD sampled HIGH). The nature of the burst access (Read or Write) is fixed by the state of the $\overline{RW}$ signal when new address and control are loaded into the SRAM.
5. Individual Byte Write signals ($\overline{BWx}$) must be valid on all write and burst-write cycles. A write cycle is initiated when $\overline{RW}$ signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

Timing Waveform of Combined Read and Write Cycles^(1,2,3)

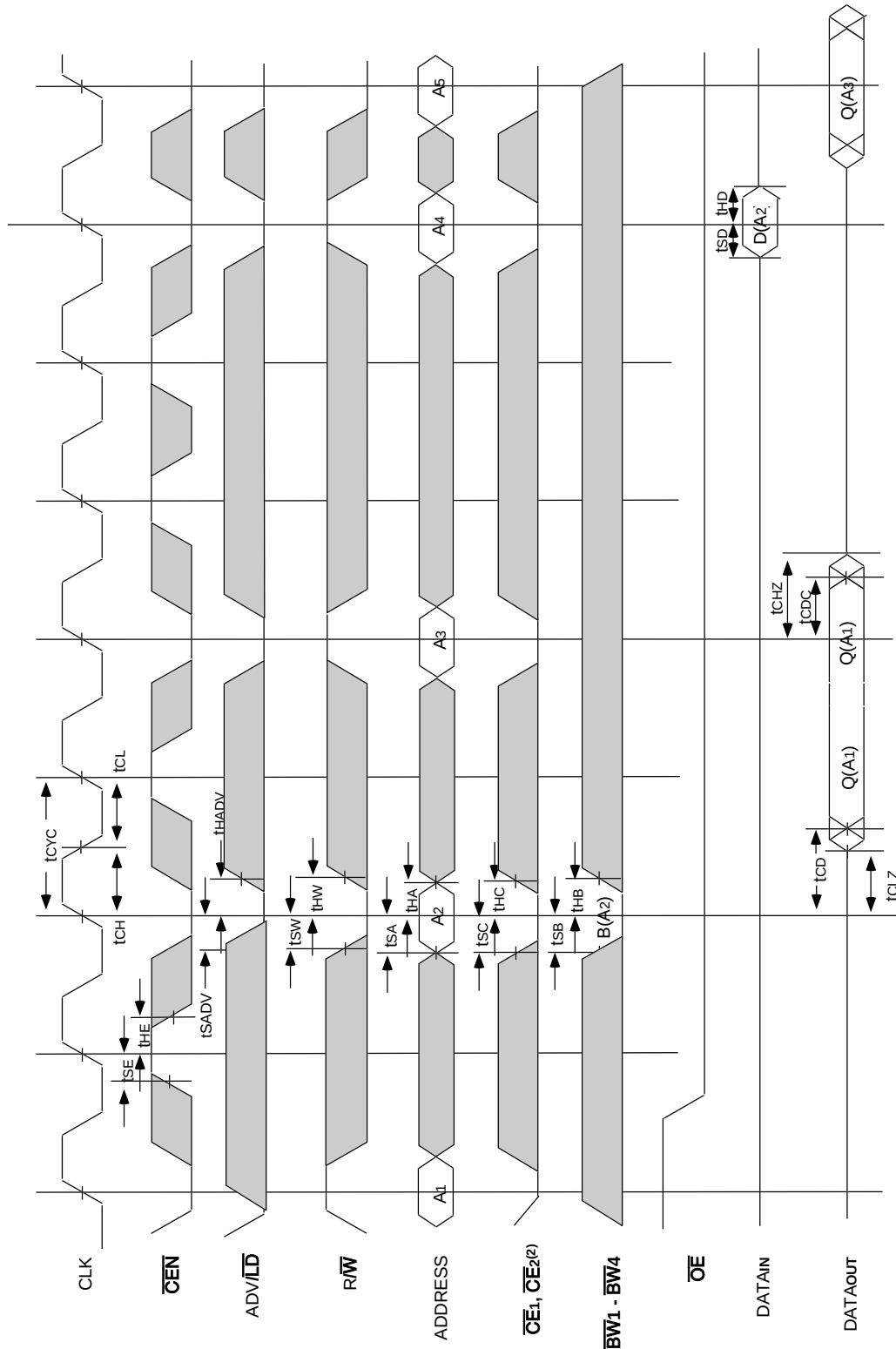


5318 dhw 08

NOTES:

1. Q (A1) represents the first output from the external address A1. D (A2) represents the input data to the SRAM corresponding to address A2.
2. CE2 timing transitions are identical but inverted to the $\overline{CE1}$ and $\overline{CE2}$ signals. For example, when $\overline{CE1}$ and $\overline{CE2}$ are LOW on this waveform, $\overline{CE2}$ is HIGH.
3. Individual Byte Write signals (BWx) must be valid on all write and burst-write cycles. A write cycle is initiated when R/W signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

Timing Waveform of $\overline{\text{CEN}}$ Operation^(1,2,3,4)

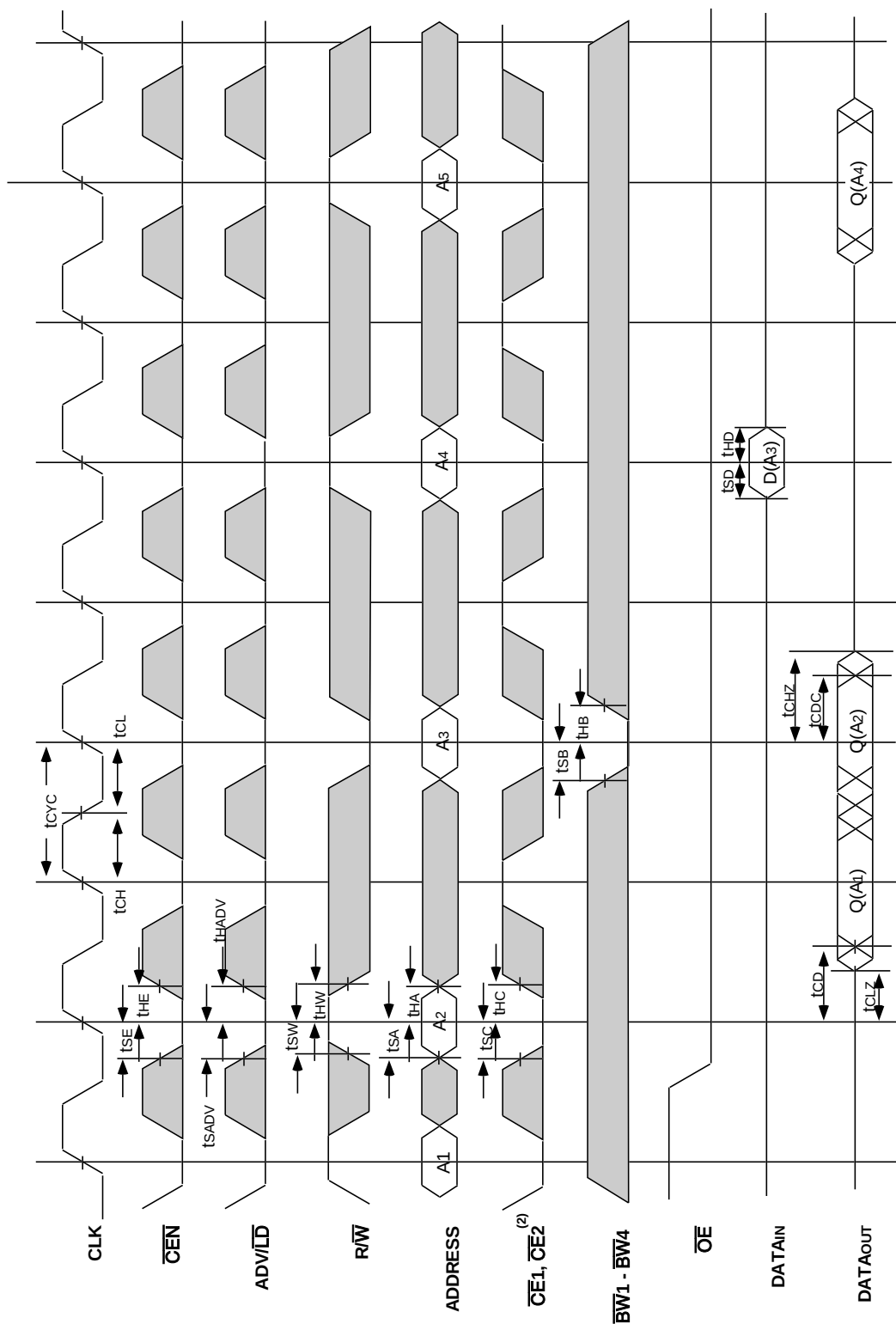


5318 drw 09

NOTES:

1. Q (A1) represents the first output from the external address A1. D (A2) represents the input data to the SRAM corresponding to address A2.
2. $\overline{\text{CE1}}$ timing transitions are identical but inverted to the $\overline{\text{CE1}}$ and $\overline{\text{CE2}}$ signals. For example, when $\overline{\text{CE1}}$ and $\overline{\text{CE2}}$ are LOW on this waveform, $\overline{\text{CE2}}$ is HIGH.
3. $\overline{\text{CEN}}$ when sampled high on the rising edge of clock will block that L-H transition of the clock from propagating into the SRAM. The part will behave as if the L-H clock transition did not occur. All internal registers in the SRAM will retain their previous state.
4. Individual Byte Write signals ($\overline{\text{BWx}}$) must be valid on all write and burst-write cycles. A write cycle is initiated when $\overline{\text{R/W}}$ signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

Timing Waveform of $\overline{\text{CS}}$ Operation^(1,2,3,4)

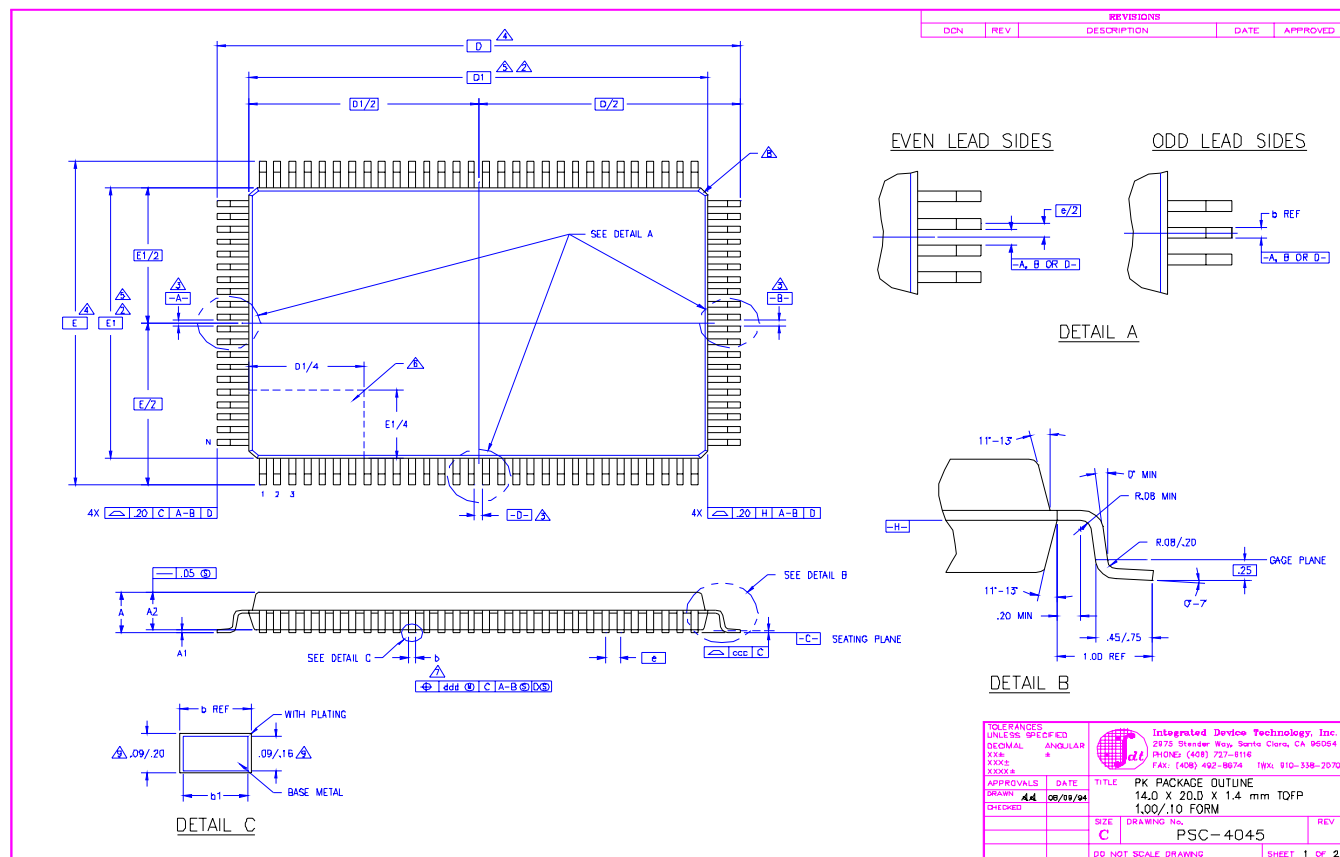


5318 dnr 10

NOTES:

1. Q(A1) represents the first output from the external address A1 . D(A3) represents the input data to the SRAM corresponding to address A3 .
2. $\overline{\text{CE2}}$ timing transitions are identical but inverted to the $\overline{\text{CE1}}$ and $\overline{\text{CE2}}$ signals. For example, when $\overline{\text{CE1}}$ and $\overline{\text{CE2}}$ are LOW on this waveform, $\overline{\text{CE2}}$ is HIGH.
3. $\overline{\text{CEN}}$ when sampled high on the rising edge of clock will block that L-H transition of the clock from propagating into the SRAM. The part will behave as if the L-H clock transition did not occur. All internal registers in the SRAM will retain their previous state.
4. Individual Byte Write signals ($\overline{\text{BWx}}$) must be valid on all write and burst-write cycles. A write cycle is initiated when $\overline{\text{R/W}}$ signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

100-Pin Thin Quad Flatpack (TQFP) Package Diagram Outline

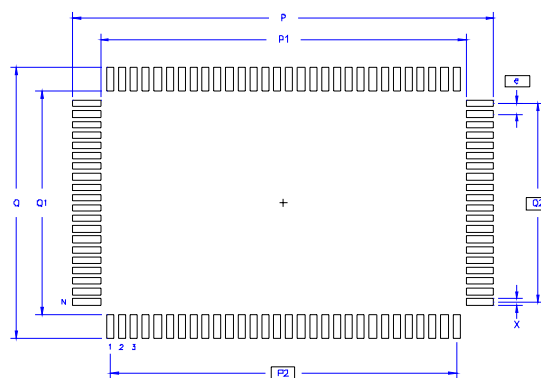


SYMBOL	JEDEC VARIATION			NOMINAL
	MIN	NOM	MAX	
A	—	—	1.60	
A1	.05	.10	.15	
A2	1.35	1.40	1.45	
D	22.00 BSC			4
D1	20.00 BSC			5.2
E	16.00 BSC			4
E1	14.00 BSC			5.2
N	100			
ND	30			
NE	20			
e	.65 BSC			
b	.22	.32	.38	7
b1	.22	.30	.33	
ccc	—	—	.10	
ddd	—	—	.13	

NOTES:

- ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M-1982
- TOP PACKAGE MAY BE SMALLER THAN BOTTOM PACKAGE BY .15 mm
- DATUMS **[A-B]** AND **[D-D]** TO BE DETERMINED AT DATUM PLANE **[H-H]**
- DIMENSIONS D AND E ARE TO BE DETERMINED AT SEATING PLANE **[C-C]**
- DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION IS .25 mm PER SIDE. D1 AND E1 ARE MAXIMUM BODY SIZE DIMENSIONS INCLUDING MOLD MISMATCH
- DETAILS OF PIN 1 IDENTIFIER IS OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED
- DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS .08 mm IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT.
- EXACT SHAPE OF EACH CORNER IS OPTIONAL
- THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .10 AND .25 mm FROM THE LEAD TIP
- ALL DIMENSIONS ARE IN MILLIMETERS
- THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION WD-136, VARIATION DJ AND BX

LAND PATTERN DIMENSIONS



	MIN	MAX
P	22.80	23.00
P1	19.80	20.00
P2	18.85	BSC
Q	16.80	17.00
Q1	13.80	14.00
Q2	12.35	BSC
X	.30	.50
e	.65	BSC
N		100

TOLERANCES UNLESS SPECIFIED		APPROVALS	DATE	TITLE
DECIMAL	ANGULAR			
.XXX	.5	DRAWN: Ad	08/09/94	PK PACKAGE OUTLINE
.XXX	.5			
		CHECKED:		14.0 X 20.0 X 1.4 mm TQFP
				1.00/.10 FORM
				SIZE: C
				DRAWING No. PSC-4045
				DO NOT SCALE DRAWING

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2975 Stoner Way, Santa Clara, CA 95054
PHONE: (408) 727-8116
FAX: (408) 442-8674 TWK: 910-338-2070

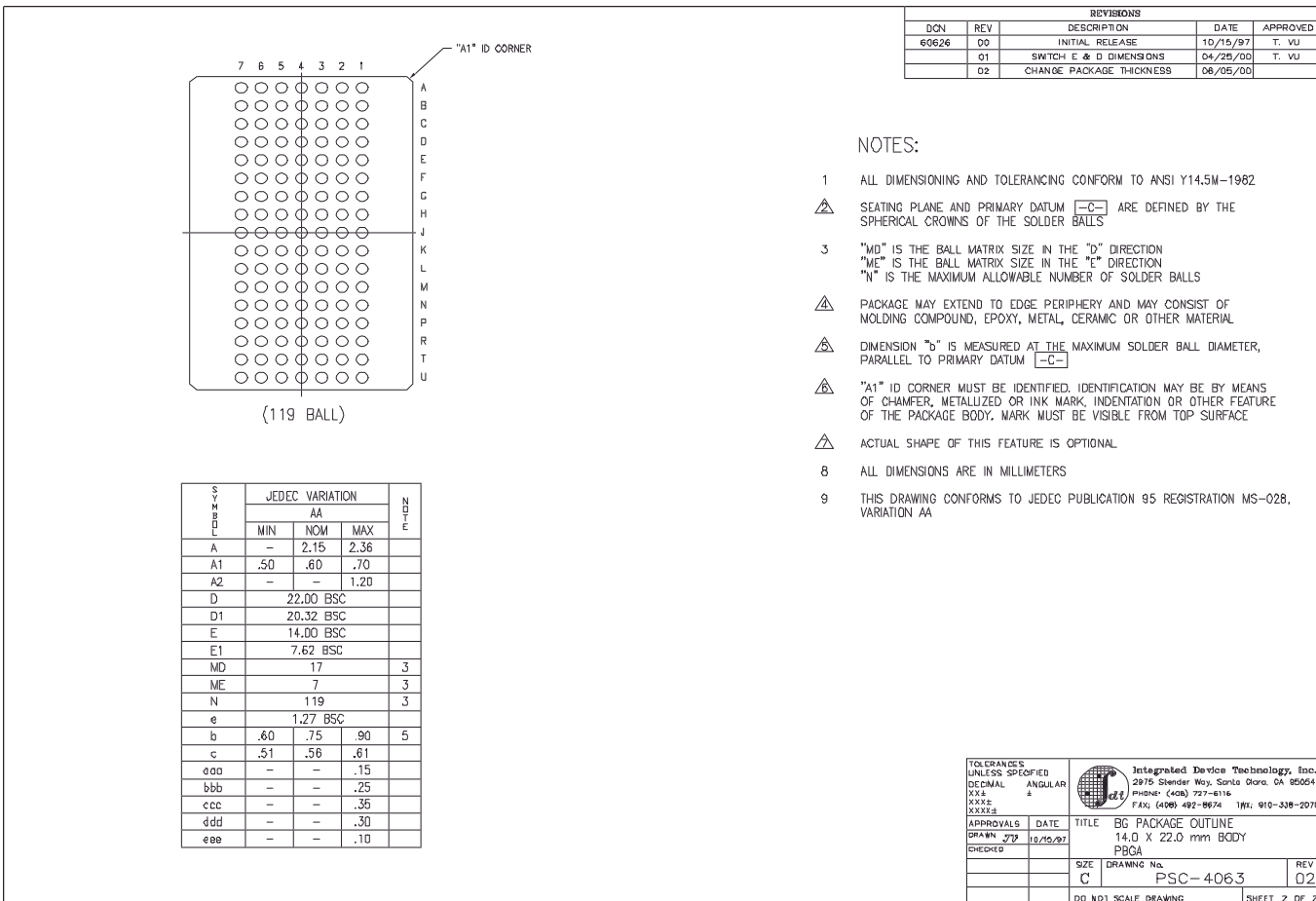
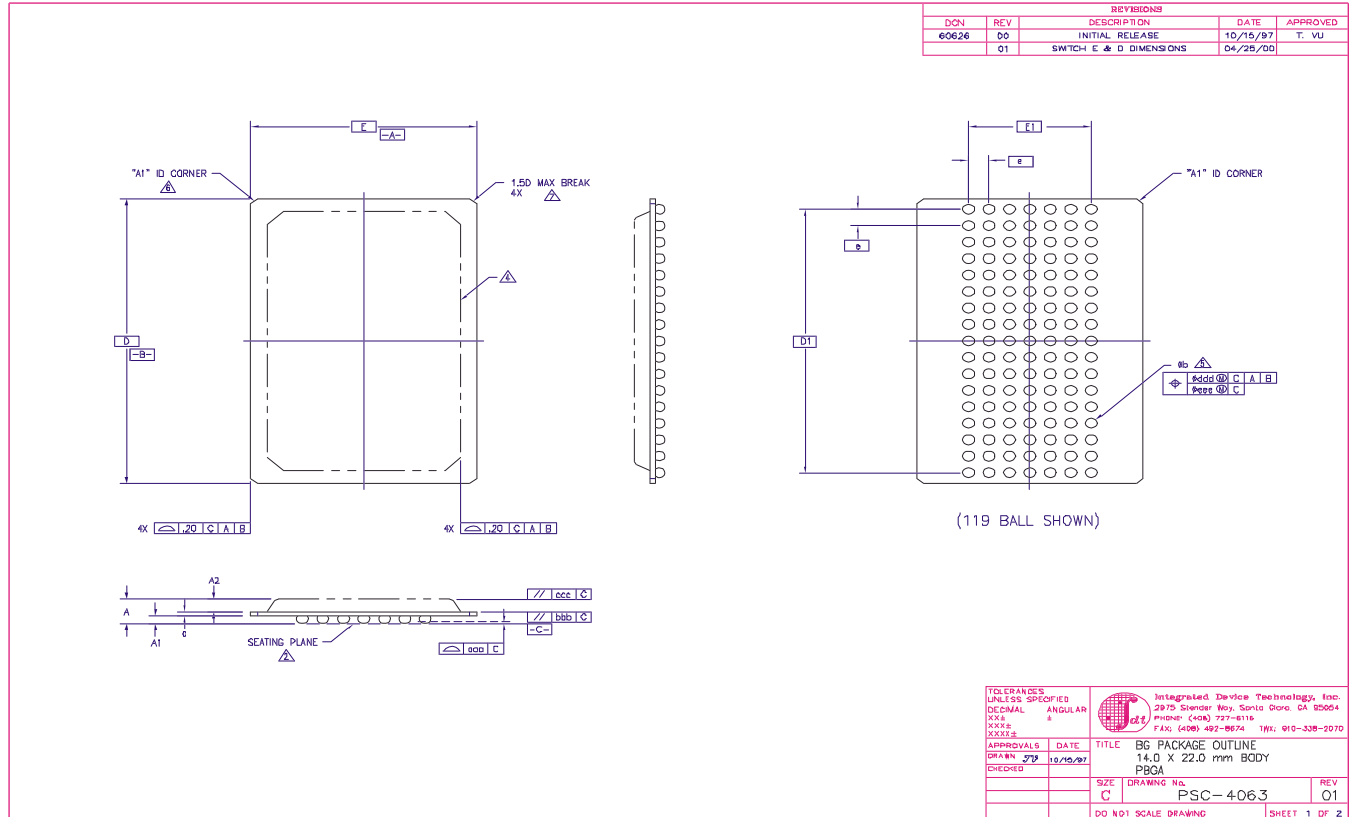
PK PACKAGE OUTLINE
14.0 X 20.0 X 1.4 mm TQFP
1.00/.10 FORM

SIZE: C
DRAWING No. PSC-4045

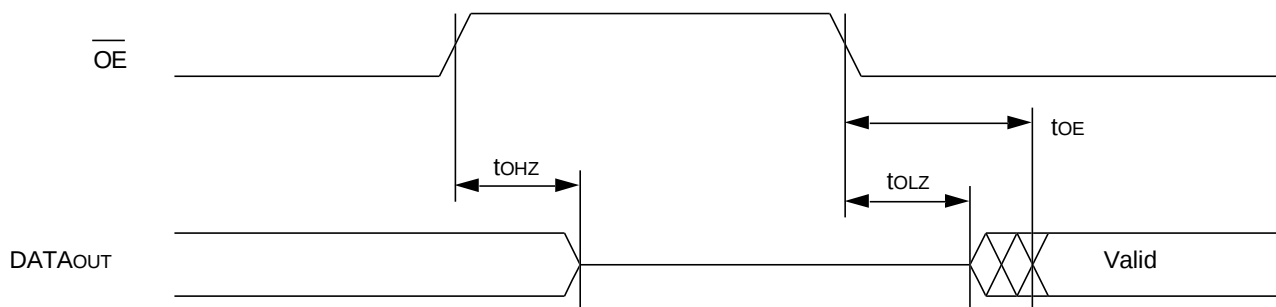
DO NOT SCALE DRAWING

SHEET 2 OF 2

119 Ball Grid Array (BGA) Package Diagram Outline



Timing Waveform of $\overline{OE}$ Operation⁽¹⁾

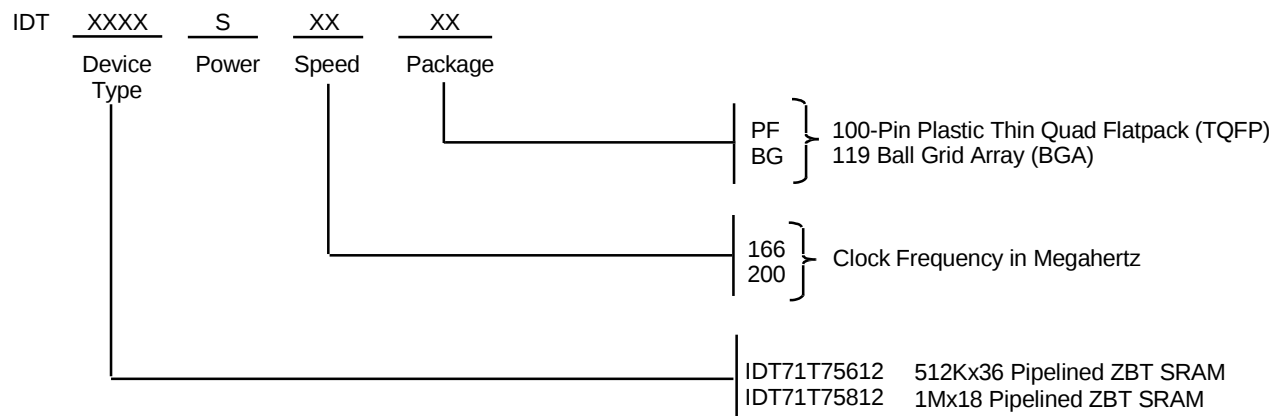


5318 drw 11

NOTE:

1. A read operation is assumed to be in progress.

Ordering Information



5318 drw 12

Advanced Datsheet:

"Advance Information" datasheets contain intial descriptions, subject to change, for products which are in development, including features and block diagrams.

Datasheet Document History

05/25/00		Created New Datasheet
08/24/01	p. 1,2,24	Removed reference of the BQ165 package
	p. 7	Removed page of the 165 BGA pin configuration
	p. 23	Removed page of the 165 BGA package diagram
10/16/01	p. 6	Corrected 3.3V to 2.5V in Note 2



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