# 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/$\overline{W}$ (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 (±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 ($\overline{CE}_1$, $CE_2$, $\overline{CE}_2$) that allow the user to deselect the device when desired. If any one of these three is not asserted when 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

| | | | |
|---|---|---|---|
| $A_0$-$A_{19}$ | Address Inputs | Input | Synchronous |
| $\overline{CE}_1$, $CE_2$, $\overline{CE}_2$ | Chip Enables | Input | Synchronous |
| $\overline{OE}$ | Output Enable | Input | Asynchronous |
| R/$\overline{W}$ | 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 |
| 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 |
| $I/O_0$-$I/O_{31}$, $I/O_{P1}$-$I/O_{P4}$ | Data Input / Output | I/O | Synchronous |
| $V_{DD}$, $V_{DDQ}$ | Core Power, I/O Power | Supply | Static |
| $V_{SS}$ | Ground | Supply | Static |

5318 tbl 01

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## 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 $\overline{LBO}$ input pin. The $\overline{LBO}$ pin selects between linear and interleaved burst sequence. The ADV/$\overline{LD}$ signal is used to load a new external address (ADV/$\overline{LD}$ = LOW) or increment the internal burst counter (ADV/$\overline{LD}$ = 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)

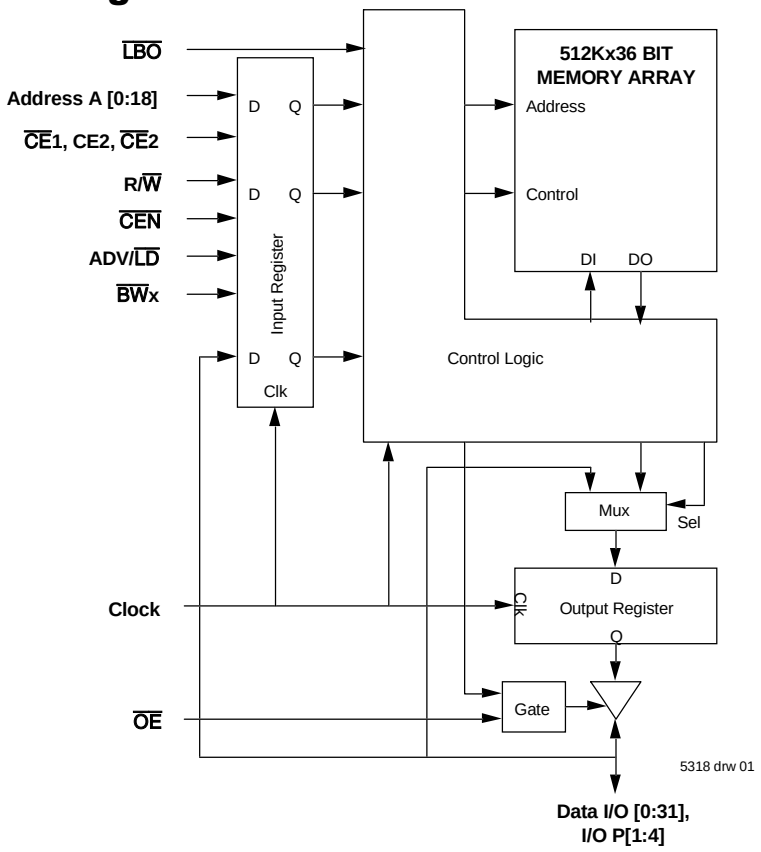
| Symbol | Pin Function | I/O | Active | Description |
|---|---|---|---|---|
| $A_0$-$A_{19}$ | Address Inputs | I | N/A | Synchronous Address inputs. The address register is triggered by a combination of the rising edge of CLK, ADV/$\overline{LD}$ low, $\overline{CEN}$ low, and true chip enables. |
| ADV/$\overline{LD}$ | Advance / Load | I | N/A | ADV/$\overline{LD}$ 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 ADV/$\overline{LD}$ is low with the chip deselected, any burst in progress is terminated. When ADV/$\overline{LD}$ is sampled high then the internal burst counter is advanced for any burst that was in progress. The external addresses are ignored when ADV/$\overline{LD}$ is sampled high. |
| R/$\overline{W}$ | Read / Write | I | N/A | R/$\overline{W}$ 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. |
| $\overline{CEN}$ | Clock Enable | I | LOW | Synchronous Clock Enable Input. When $\overline{CEN}$ is sampled high, all other synchronous inputs, including clock are ignored and outputs remain unchanged. The effect of $\overline{CEN}$ sampled high on the device outputs is as if the low to high clock transition did not occur. For normal operation, $\overline{CEN}$ must be sampled low at rising edge of clock. |
| $\overline{BW_1}$-$\overline{BW_4}$ | 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 R/$\overline{W}$ and ADV/$\overline{LD}$ are sampled low) the appropriate byte write signal ($\overline{BW_1}$-$\overline{BW_4}$) must be valid. The byte write signal must also be valid on each cycle of a burst write. Byte Write signals are ignored when R/$\overline{W}$ is sampled high. The appropriate byte(s) of data are written into the device two cycles later. $\overline{BW_1}$-$\overline{BW_4}$ can all be tied low if always doing write to the entire 36-bit word. |
| $\overline{CE_1}$, $\overline{CE_2}$ | Chip Enables | I | LOW | Synchronous active low chip enable. $\overline{CE_1}$ and $\overline{CE_2}$ are used with $CE_2$ to enable the IDT71T75612/812 ($\overline{CE_1}$ or $\overline{CE_2}$ sampled high or $CE_2$ sampled low) and ADV/$\overline{LD}$ 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 $\overline{CE_1}$ and $\overline{CE_2}$ to enable the chip. $CE_2$ has inverted polarity but otherwise identical to $\overline{CE_1}$ and $\overline{CE_2}$. |
| CLK | Clock | I | N/A | This is the clock input to the IDT71T75612/812. Except for $\overline{OE}$, all timing references for the device are made with respect to the rising edge of CLK. |
| $I/O_0$-$I/O_{31}$ $I/O_{P1}$-$I/O_{P4}$ | 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. |
| $\overline{LBO}$ | Linear Burst Order | I | LOW | Burst order selection input. When $\overline{LBO}$ is high the Interleaved burst sequence is selected. When $\overline{LBO}$ is low the Linear burst sequence is selected. $\overline{LBO}$ is a static input and it must not change during device operation. |
| $\overline{OE}$ | Output Enable | I | LOW | Asynchronous output enable. $\overline{OE}$ must be low to read data from the 71T75612/812. When $\overline{OE}$ is high the I/O pins are in a high-impedance state. $\overline{OE}$ does not need to be actively controlled for read and write cycles. In normal operation, $\overline{OE}$ 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. |

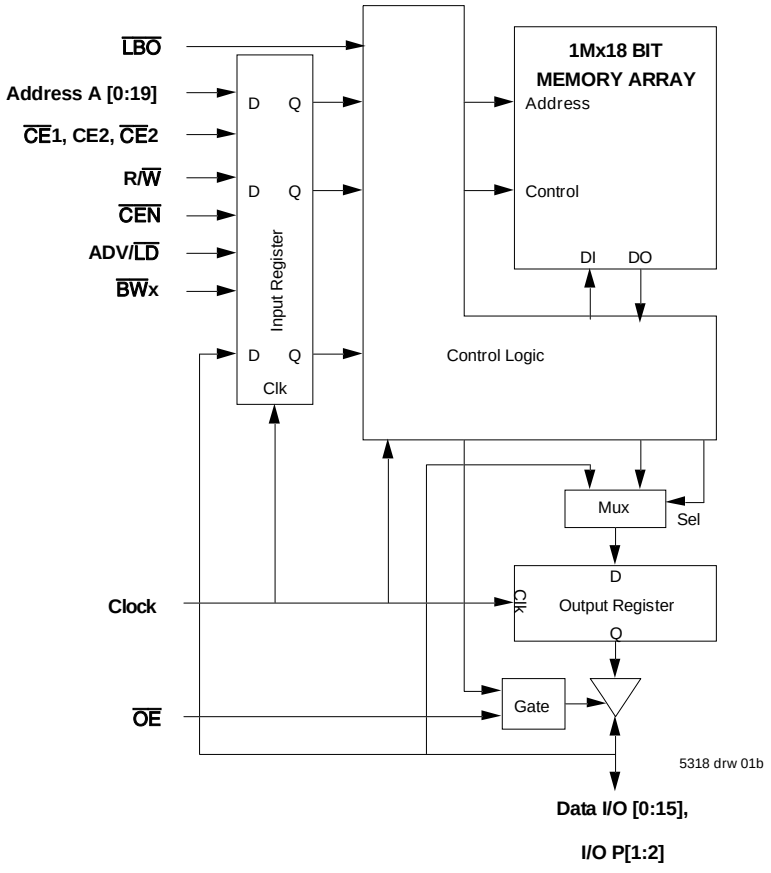
5318 tbl 02

**NOTE:**

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

# 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:**
1. $V_{IL}$ (min.) = –0.8V for pulse width less than $t_{CYC}$/2, once per cycle.

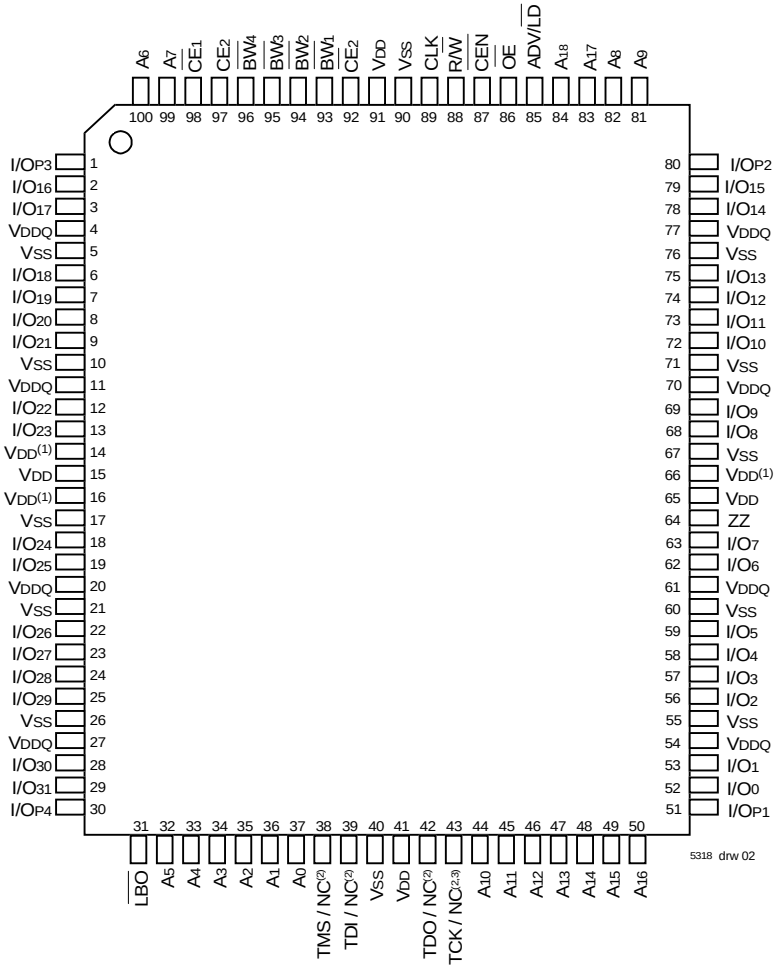
## Recommended Operating Temperature and Supply Voltage

| 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:**
1. $T_A$ is the "instant on" case temperature.

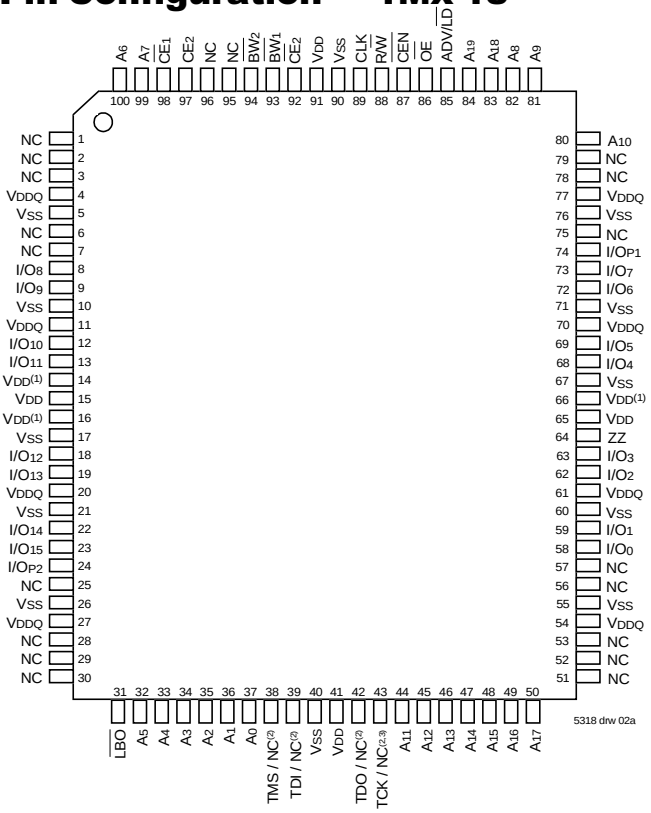
## Pin Configuration — 512K x 36




**Top View**
**100 TQFP**

**NOTES:**
1. Pins 14, 16, and 66 do not have to be connected directly to $V_{DD}$ as long as the input voltage is ≥ $V_{IH}$.
2. Pins 38, 39 and 43 will be pulled internally to $V_{DD}$ if not actively driven. To disable the TAP controller without interfering with normal operation, several settings are possible. Pins 38, 39 and 43 could be tied to $V_{DD}$ or $V_{SS}$ and pin 42 should be left unconnected. Or all JTAG inputs (TMS, TDI and TCK) pins 38, 39 and 43 could be left unconnected "NC" and the JTAG circuit will remain disabled from power up.
3. Pin 43 is reserved for the 36M address. JTAG is not offered in the 100-pin TQFP package for the 36M ZBT device.

## Pin Configuration — 1Mx 18




**Top View**
**100 TQFP**

**NOTES:**
1. Pins 14, 16, and 66 do not have to be connected directly to $V_{DD}$ as long as the input voltage is $\geq V_{IH}$.
2. Pins 38, 39 and 43 will be pulled internally to $V_{DD}$ if not actively driven. To disable the TAP controller without interfering with normal operation, several settings are possible. Pins 38, 39 and 43 could be tied to $V_{DD}$ or $V_{SS}$ and pin 42 should be left unconnected. Or all JTAG inputs (TMS, TDI and TCK) pins 38, 39 and 43 could be left unconnected "NC" and the JTAG circuit will remain disabled from power up.
3. Pin 43 is reserved for the 36M address. JTAG is not offered in the 100-pin TQFP package for the 36M ZBT device.

## Absolute Maximum Ratings(1)

| Symbol | Rating | Commercial | Unit |
|---|---|---|---|
| $V_{TERM}$(2) | Terminal Voltage with Respect to GND | -0.5 to +3.6 | V |
| $V_{TERM}$(3,6) | Terminal Voltage with Respect to GND | -0.5 to $V_{DD}$ | V |
| $V_{TERM}$(4,6) | Terminal Voltage with Respect to GND | -0.5 to $V_{DD}$ +0.5 | V |
| $V_{TERM}$(5,6) | Terminal Voltage with Respect to GND | -0.5 to $V_{DDQ}$ +0.5 | V |
| $T_A$(7) | Operating Temperature | 0 to +70 | °C |
| $T_{BIAS}$ | Temperature Under Bias | -55 to +125 | °C |
| $T_{STG}$ | Storage Temperature | -55 to +125 | °C |
| $P_T$ | Power Dissipation | 2.0 | W |
| $I_{OUT}$ | DC Output Current | 50 | mA |

5318 tbl 06

**NOTES:**
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. $V_{DD}$ terminals only.
3. $V_{DDQ}$ terminals only.
4. Input terminals only.
5. I/O terminals only.
6. This is a steady-state DC parameter that applies after the power supply has reached its nominal operating value. Power sequencing is not necessary; however, the voltage on any input or I/O pin cannot exceed $V_{DDQ}$ during power supply ramp up.
7. $T_A$ is the "instant on" case temperature.

## 100-Pin TQFP Capacitance
**($T_A$ = +25°C, f = 1.0MHz)**

| Symbol | Parameter(1) | Conditions | Max. | Unit |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 3dV | 5 | pF |
| $C_{I/O}$ | I/O Capacitance | $V_{OUT}$ = 3dV | 7 | pF |

5318 tbl 07

## 119 BGA Capacitance
**($T_A$ = +25°C, f = 1.0MHz)**

| Symbol | Parameter(1) | Conditions | Max. | Unit |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 3dV | 7 | pF |
| $C_{I/O}$ | I/O Capacitance | $V_{OUT}$ = 3dV | 7 | pF |

5318 tbl 07a

## 165 fBGA Capacitance
**($T_A$ = +25°C, f = 1.0MHz)**

| Symbol | Parameter(1) | Conditions | Max. | Unit |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 3dV | TDB | pF |
| $C_{I/O}$ | I/O Capacitance | $V_{OUT}$ = 3dV | TDB | pF |

5318 tbl 07b

**NOTE:**
1. This parameter is guaranteed by device characterization, but not production tested.

# Pin Configuration — 512K X 36, 119 BGA[1,2]

## Top View

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A | $V_{DDQ}$ | $A_6$ | $A_4$ | $A_{18}$ | $A_8$ | $A_{16}$ | $V_{DDQ}$ |
| B | NC | $CE_2$ | $A_3$ | ADV/$\overline{LD}$ | $A_9$ | $\overline{CE}_2$ | NC |
| C | NC | $A_7$ | $A_2$ | $V_{DD}$ | $A_{12}$ | $A_{15}$ | NC |
| D | $I/O_{16}$ | $I/O_{P3}$ | $V_{SS}$ | NC | $V_{SS}$ | $I/O_{P2}$ | $I/O_{15}$ |
| E | $I/O_{17}$ | $I/O_{18}$ | $V_{SS}$ | $\overline{CE}_1$ | $V_{SS}$ | $I/O_{13}$ | $I/O_{14}$ |
| F | $V_{DDQ}$ | $I/O_{19}$ | $V_{SS}$ | $\overline{OE}$ | $V_{SS}$ | $I/O_{12}$ | $V_{DDQ}$ |
| G | $I/O_{20}$ | $I/O_{21}$ | $\overline{BW}_3$ | $A_{17}$ | $\overline{BW}_2$ | $I/O_{11}$ | $I/O_{10}$ |
| H | $I/O_{22}$ | $I/O_{23}$ | $V_{SS}$ | R/$\overline{W}$ | $V_{SS}$ | $I/O_9$ | $I/O_8$ |
| J | $V_{DDQ}$ | $V_{DD}$ | $V_{DD}$[1] | $V_{DD}$ | $V_{DD}$[1] | $V_{DD}$ | $V_{DDQ}$ |
| K | $I/O_{24}$ | $I/O_{26}$ | $V_{SS}$ | CLK | $V_{SS}$ | $I/O_6$ | $I/O_7$ |
| L | $I/O_{25}$ | $I/O_{27}$ | $\overline{BW}_4$ | NC | $\overline{BW}_1$ | $I/O_4$ | $I/O_5$ |
| M | $V_{DDQ}$ | $I/O_{28}$ | $V_{SS}$ | $\overline{CEN}$ | $V_{SS}$ | $I/O_3$ | $V_{DDQ}$ |
| N | $I/O_{29}$ | $I/O_{30}$ | $V_{SS}$ | $A_1$ | $V_{SS}$ | $I/O_2$ | $I/O_1$ |
| P | $I/O_{31}$ | $I/O_{P4}$ | $V_{SS}$ | $A_0$ | $V_{SS}$ | $I/O_0$ | $I/O_{P1}$ |
| R | NC | $A_5$ | $\overline{LBO}$ | $V_{DD}$ | $V_{DD}$[1] | $A_{13}$ | NC |
| T | NC | NC | $A_{10}$ | $A_{11}$ | $A_{14}$ | NC[3] | ZZ |
| U | $V_{DDQ}$ | NC/TMS[2] | NC/TDI[2] | NC/TCK[2] | NC/TDO[2] | NC/$\overline{TRST}$[2] | $V_{DDQ}$ |

5318 tbl 25

# Pin Configuration — 1M X 18, 119 BGA[1,2]

## Top View

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A | $V_{DDQ}$ | $A_6$ | $A_4$ | $A_{19}$ | $A_8$ | $A_{16}$ | $V_{DDQ}$ |
| B | NC | $CE_2$ | $A_3$ | ADV/$\overline{LD}$ | $A_9$ | $\overline{CE}_2$ | NC |
| C | NC | $A_7$ | $A_2$ | $V_{DD}$ | $A_{13}$ | $A_{17}$ | NC |
| D | $I/O_8$ | NC | $V_{SS}$ | NC | $V_{SS}$ | $I/O_7$ | NC |
| E | NC | $I/O_9$ | $V_{SS}$ | $\overline{CE}_1$ | $V_{SS}$ | NC | $I/O_6$ |
| F | $V_{DDQ}$ | NC | $V_{SS}$ | $\overline{OE}$ | $V_{SS}$ | $I/O_5$ | $V_{DDQ}$ |
| G | NC | $I/O_{10}$ | $\overline{BW}_2$ | $A_{18}$ | $V_{SS}$ | NC | $I/O_4$ |
| H | $I/O_{11}$ | NC | $V_{SS}$ | R/$\overline{W}$ | $V_{SS}$ | $I/O_3$ | NC |
| J | $V_{DDQ}$ | $V_{DD}$ | $V_{DD}$[1] | $V_{DD}$ | $V_{DD}$[1] | $V_{DD}$ | $V_{DDQ}$ |
| K | NC | $I/O_{12}$ | $V_{SS}$ | CLK | $V_{SS}$ | NC | $I/O_2$ |
| L | I/O13 | NC | $V_{SS}$ | NC | $\overline{BW}$1 | I/O1 | NC |
| M | $V_{DDQ}$ | $I/O_{14}$ | $V_{SS}$ | $\overline{CEN}$ | $V_{SS}$ | NC | $V_{DDQ}$ |
| N | $I/O_{15}$ | NC | $V_{SS}$ | $A_1$ | $V_{SS}$ | $I/O_0$ | NC |
| P | NC | $I/O_{P2}$ | $V_{SS}$ | $A_0$ | $V_{SS}$ | NC | $I/O_{P1}$ |
| R | NC | $A_5$ | $\overline{LBO}$ | $V_{DD}$ | $V_{DD}$[1] | $A_{12}$ | NC |
| T | NC | $A_{10}$ | $A_{15}$ | NC[3] | $A_{14}$ | $A_{11}$ | ZZ |
| U | $V_{DDQ}$ | NC/TMS[2] | NC/TDI[2] | NC/TCK[2] | NC/TDO[2] | NC/$\overline{TRST}$[2] | $V_{DDQ}$ |

5318 tbl 25a

**NOTES:**

1. J3, R5, and J5 do not have to be directly connected to $V_{DD}$ as long as the input voltage is ≥ $V_{IH}$.
2. U2, U3, U4 and U6 will be pulled internally to $V_{DD}$ if not actively driven. To disable the TAP controller without interfering with normal operation, several settings are possible. U2, U3, U4 and U6 could be tied to VDD or VSS and U5 should be left unconnected. Or all JTAG inputs(TMS, TDI, and TCK and $\overline{TRST}$) U2, U3, U4 and U6 could be left unconnected "NC" and the JTAG circuit will remain disabled from power up.
3. The 36M address will be ball T6 (for the 512K x 36 device) and ball T4 (for the 1M x 18 device.)

## Synchronous Truth Table(1)

| $\overline{CEN}$ | R/$\overline{W}$ | Chip(5) Enable | ADV/$\overline{LD}$ | $\overline{BW}$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/$\overline{LD}$ signal is sampled high, the internal burst counter is incremented. The R/$\overline{W}$ 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/$\overline{W}$ signal when the first address is loaded at the beginning of the burst cycle.
3. Deselect cycle is initiated when either ($\overline{CE}_1$, or $\overline{CE}_2$ is sampled high or $CE_2$ is sampled low) and ADV/$\overline{LD}$ is sampled low at rising edge of clock. The data bus will tri-state two cycles after deselect is initiated.
4. When $\overline{CEN}$ is sampled high at the rising edge of clock, that clock edge is blocked from propogating through the part. The state of all the internal registers and the I/Os remains unchanged.
5. To select the chip requires $\overline{CE}_1$ = L, $\overline{CE}_2$ = L, $CE_2$ = 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/$\overline{W}$ | $\overline{BW}_1$ | $\overline{BW}_2$ | $\overline{BW}_3$(3) | $\overline{BW}_4$(3) |
|---|---|---|---|---|---|
| READ | H | X | X | X | X |
| WRITE ALL BYTES | L | L | L | L | L |
| WRITE BYTE 1 (I/O[0:7], $I/O_{P1}$)(2) | L | L | H | H | H |
| WRITE BYTE 2 (I/O[8:15], $I/O_{P2}$)(2) | L | H | L | H | H |
| WRITE BYTE 3 (I/O[16:23], $I/O_{P3}$)(2,3) | L | H | H | L | H |
| WRITE BYTE 4 (I/O[24:31], $I/O_{P4}$)(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 ($\overline{LBO}$=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.

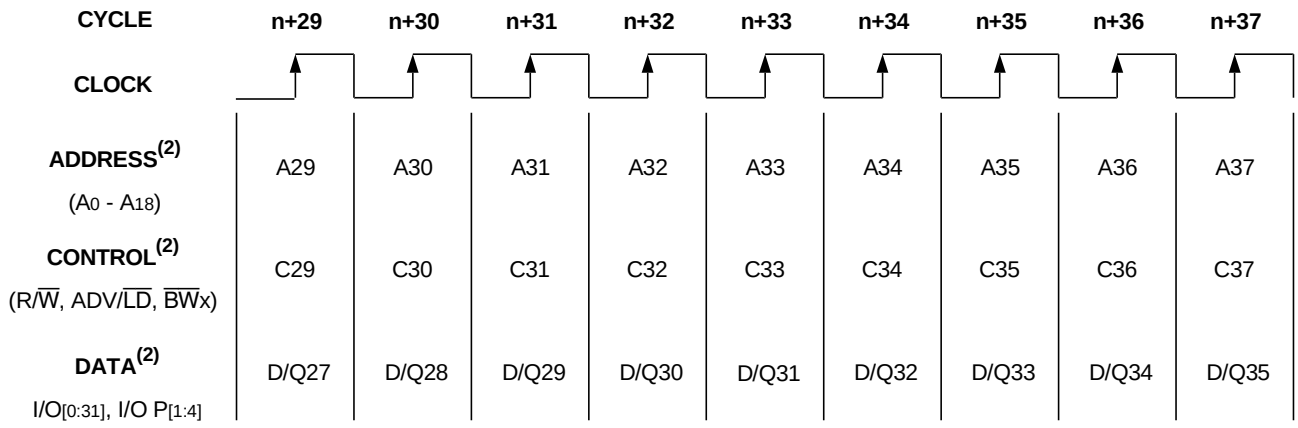
## Linear Burst Sequence Table ($\overline{LBO}$=Vss)

| | 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 $\overline{CEN}$, $\overline{CE}_1$, $CE_2$, $\overline{CE}_2$ 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/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(1) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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:**
1. $\overline{CE}$ = 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.
2. H = High; L = Low; X = Don't Care; Z = High Impedance.

## Read Operation(1)

| Cycle | Address | R/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(2) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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:**
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.

## Burst Read Operation(1)

| Cycle | Address | R/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(2) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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:**
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(1)

| Cycle | Address | R/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(2) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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:**
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.

## Burst Write Operation(1)

| Cycle | Address | R/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(2) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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:**
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.

## Read Operation with Clock Enable Used(1)

| Cycle | Address | R/$\overline{W}$ | ADV/$\overline{LD}$ | $\overline{CE}$(2) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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) | $\overline{CEN}$ | $\overline{BW}$x | $\overline{OE}$ | 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) | $\overline{CEN}$ | $\overline{BW}$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) | $\overline{CEN}$ | $\overline{BW}$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±5%)

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

5318 tbl 21

**NOTE:**
1. The $\overline{LBO}$ 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±5%)

| Symbol | Parameter | Test Conditions | 200MHz | 166MHz | Unit |
|---|---|---|---|---|---|
| $I_{DD}$ | Operating Power Supply Current | Device Selected, Outputs Open, ADV/$\overline{LD}$ = X, $V_{DD}$ = 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, $V_{DD}$ = 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, $V_{DD}$ = Max., $V_{IN} \geq V_{HD}$ or < $V_{LD}$, f = $f_{MAX}$(2,3) | 130 | 120 | mA |
| $I_{SB3}$ | Idle Power Supply Current | Device Selected, Outputs Open, $\overline{CEN} \geq V_{IH}$, $V_{DD}$ = 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, $\overline{CEN} \leq V_{IH}$, $V_{DD}$ = 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

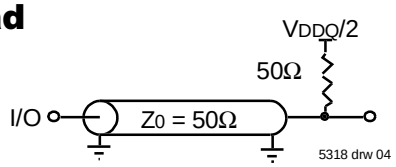



**Figure 1. AC Test Load**

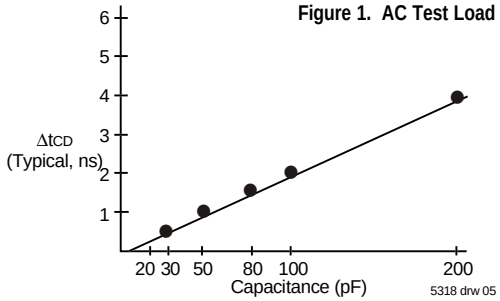



**Figure 2. Lumped Capacitive Load, Typical Derating**

## 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

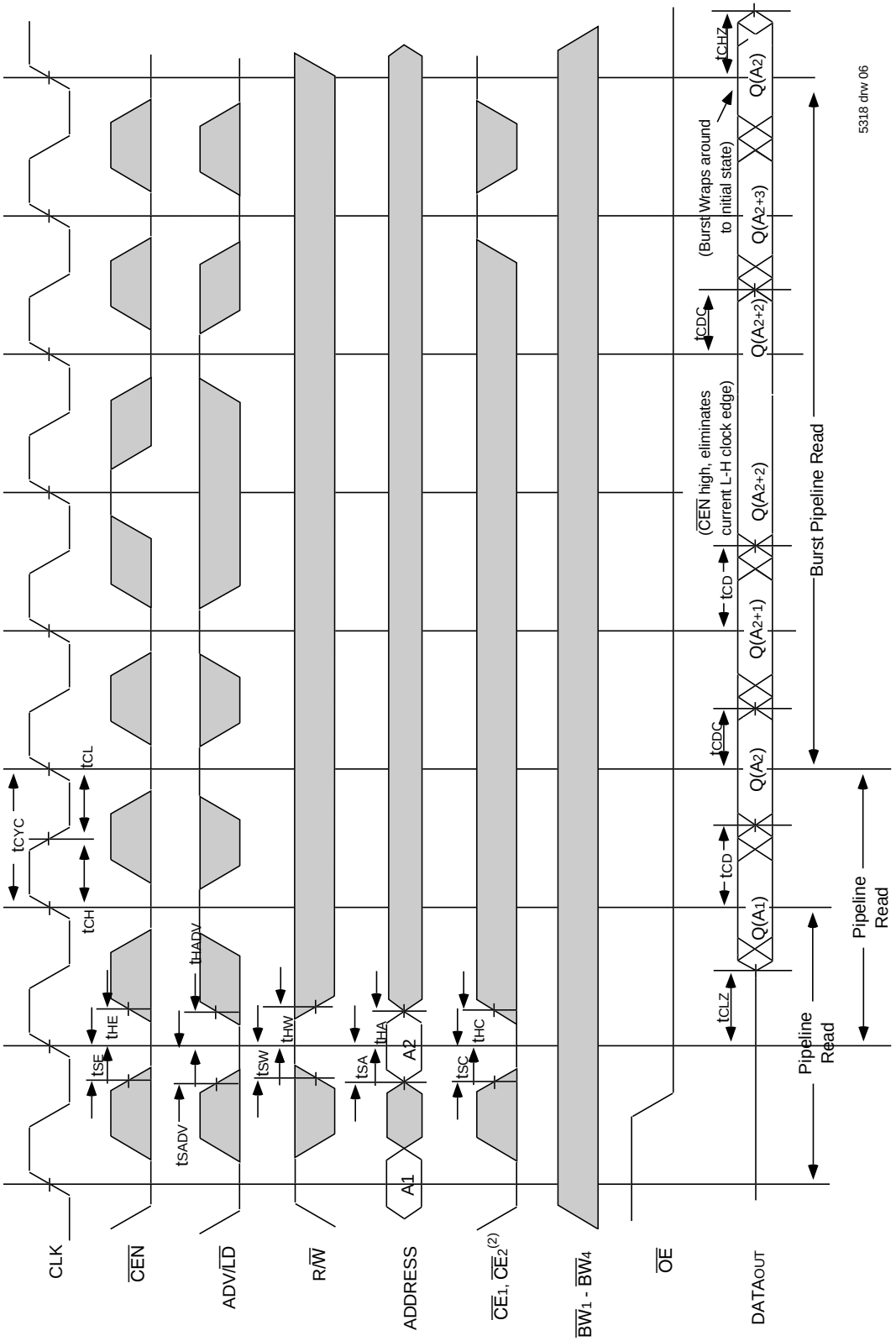
## AC Electrical Characteristics ($V_{DD}$ = 2.5V +/-5%, $T_A$ = 0 to 70°C)

| Symbol | Parameter | 200MHz | | 166MHz | | Unit |
|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | |
| | | | | | | |
| $t_{CYC}$ | Clock Cycle Time | 5 | — | 6 | — | ns |
| $t_F$[1] | Clock Frequence | — | 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 |
| $t_{CDC}$ | Clock High to Data Change | 1 | — | 1 | — | ns |
| $t_{CLZ}$[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/$\overline{W}$) Setup Time | 1.5 | — | 1.5 | — | ns |
| $t_{SADV}$ | Advance/Load (ADV/$\overline{LD}$) Setup Time | 1.5 | — | 1.5 | — | ns |
| $t_{SC}$ | Chip Enable/Select Setup Time | 1.5 | — | 1.5 | — | ns |
| $t_{SB}$ | Byte Write Enable ($\overline{BW}$x) 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/$\overline{W}$) Hold Time | 0.5 | — | 0.5 | — | ns |
| $t_{HADV}$ | Advance/Load (ADV/$\overline{LD}$) Hold Time | 0.5 | — | 0.5 | — | ns |
| $t_{HC}$ | Chip Enable/Select Hold Time | 0.5 | — | 0.5 | — | ns |
| $t_{HB}$ | Byte Write Enable ($\overline{BW}$x) Hold Time | 0.5 | — | 0.5 | — | ns |

5318 tbl 24

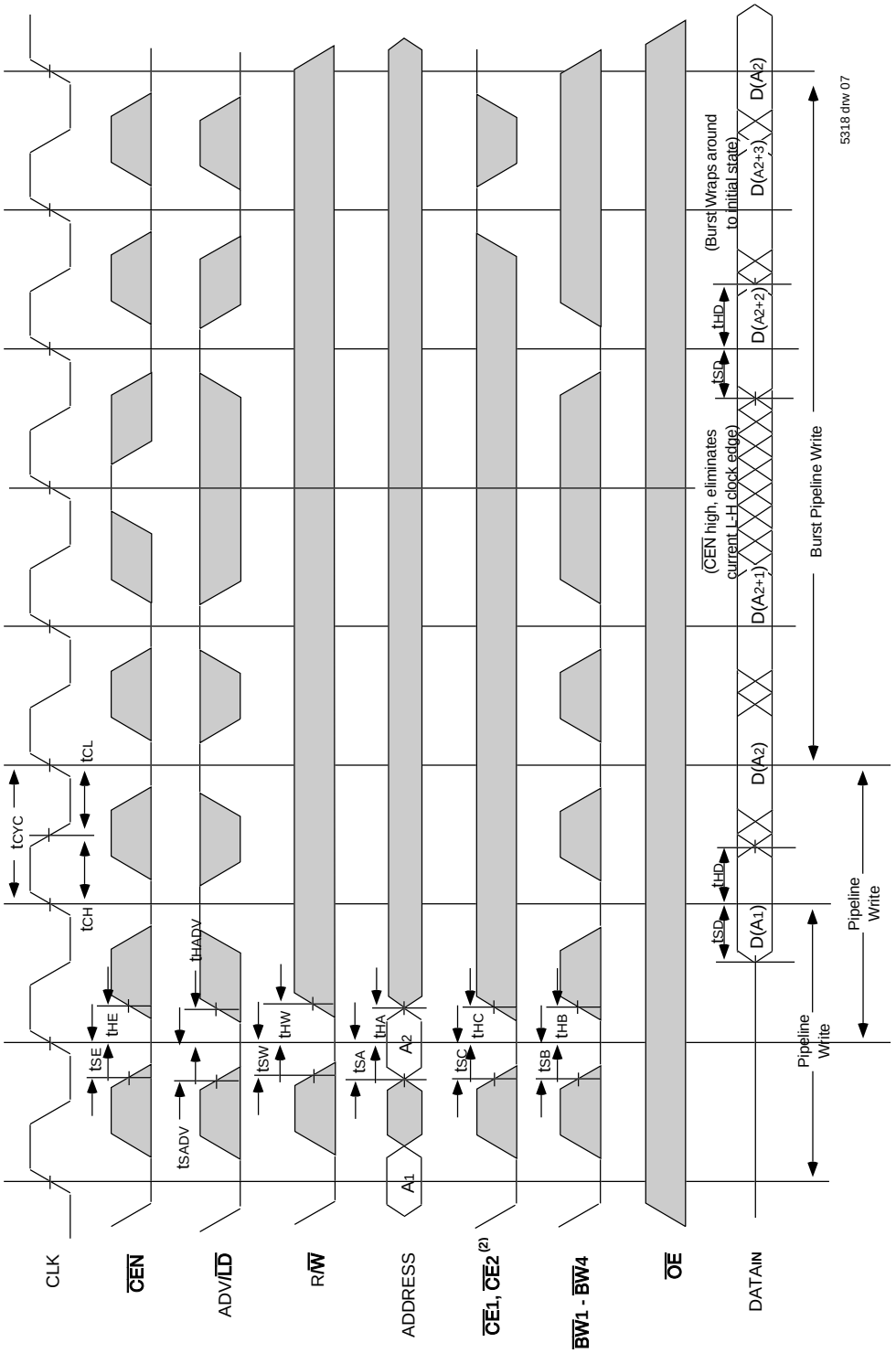
**NOTES:**
1. tF = 1/$t_{CYC}$.
2. Measured as HIGH above 0.6$V_{DDQ}$ and LOW below 0.4$V_{DDQ}$.
3. Transition is measured ±200mV from steady-state.
4. These parameters are guaranteed with the AC load (Figure 1) by device characterization. They are not production tested.
5. To avoid bus contention, 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. CE2 timing transitions are identical but inverted to the $\overline{CE}_1$ and $\overline{CE}_2$ signals. For example, when $\overline{CE}_1$ and $\overline{CE}_2$ are LOW on this waveform, CE2 is HIGH.
3. Burst ends when new address and control are loaded into the SRAM by sampling ADV/$\overline{LD}$ LOW.
4. R/$\overline{W}$ is don't care when the SRAM is bursting (ADV/$\overline{LD}$ 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.

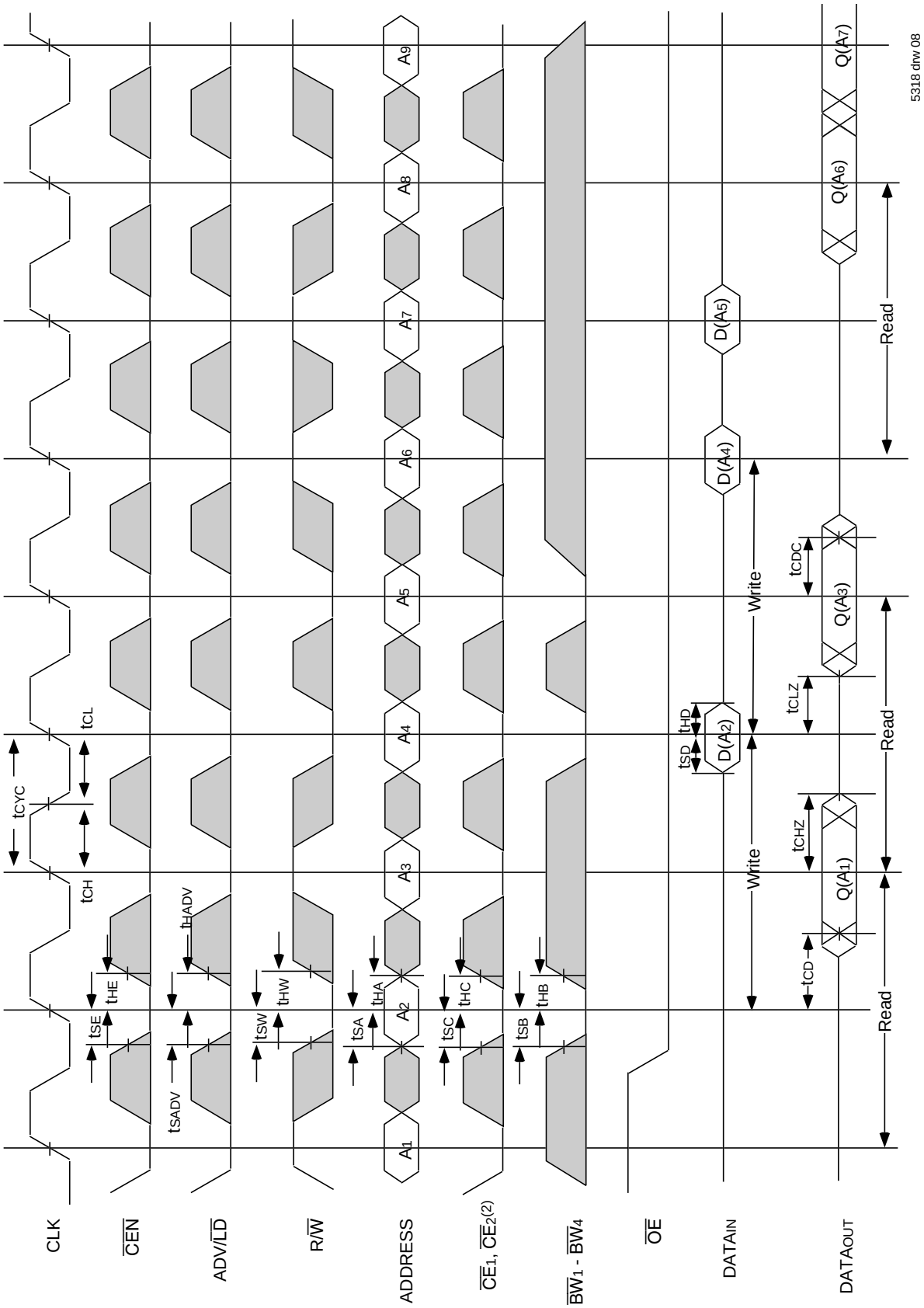
# Timing Waveform of Write Cycles(1,2,3,4,5)




**NOTES:**

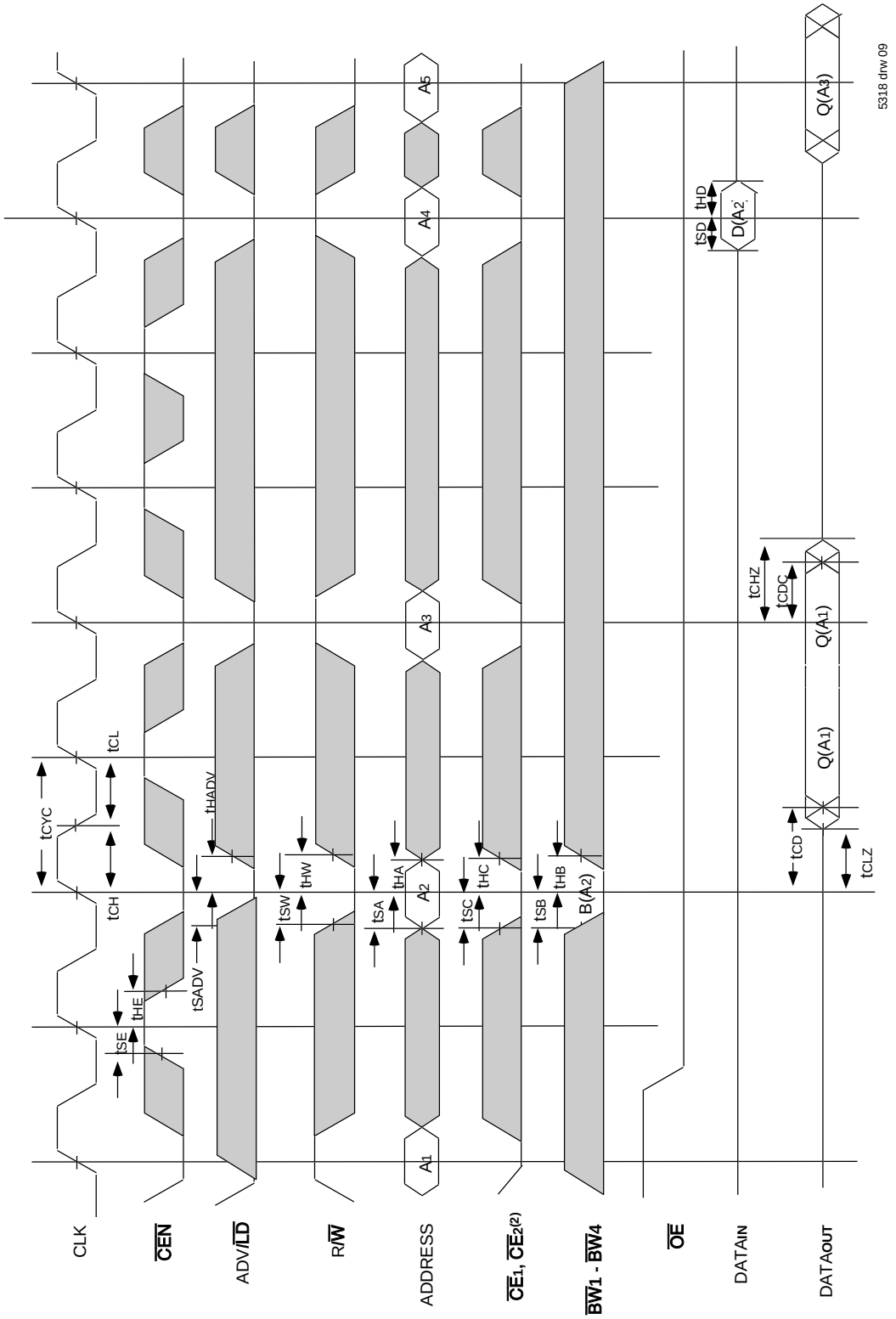
1. D (A1) represents the first input to the external address A1. D (A2) represents the first input to the external address A2; D (A2+1) represents the next input data in the burst sequence of the base address A2, etc. where address bits A0 and A1 are advancing for the four word burst in the sequence defined by the state of the LBO input.
2. CE2 timing transitions are identical but inverted to the CE1 and CE2 signals. For example, when CE1 and 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. R/W 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 R/W signal when new address and control are loaded into the SRAM.
5. 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 Combined Read and Write Cycles(1.2.3)



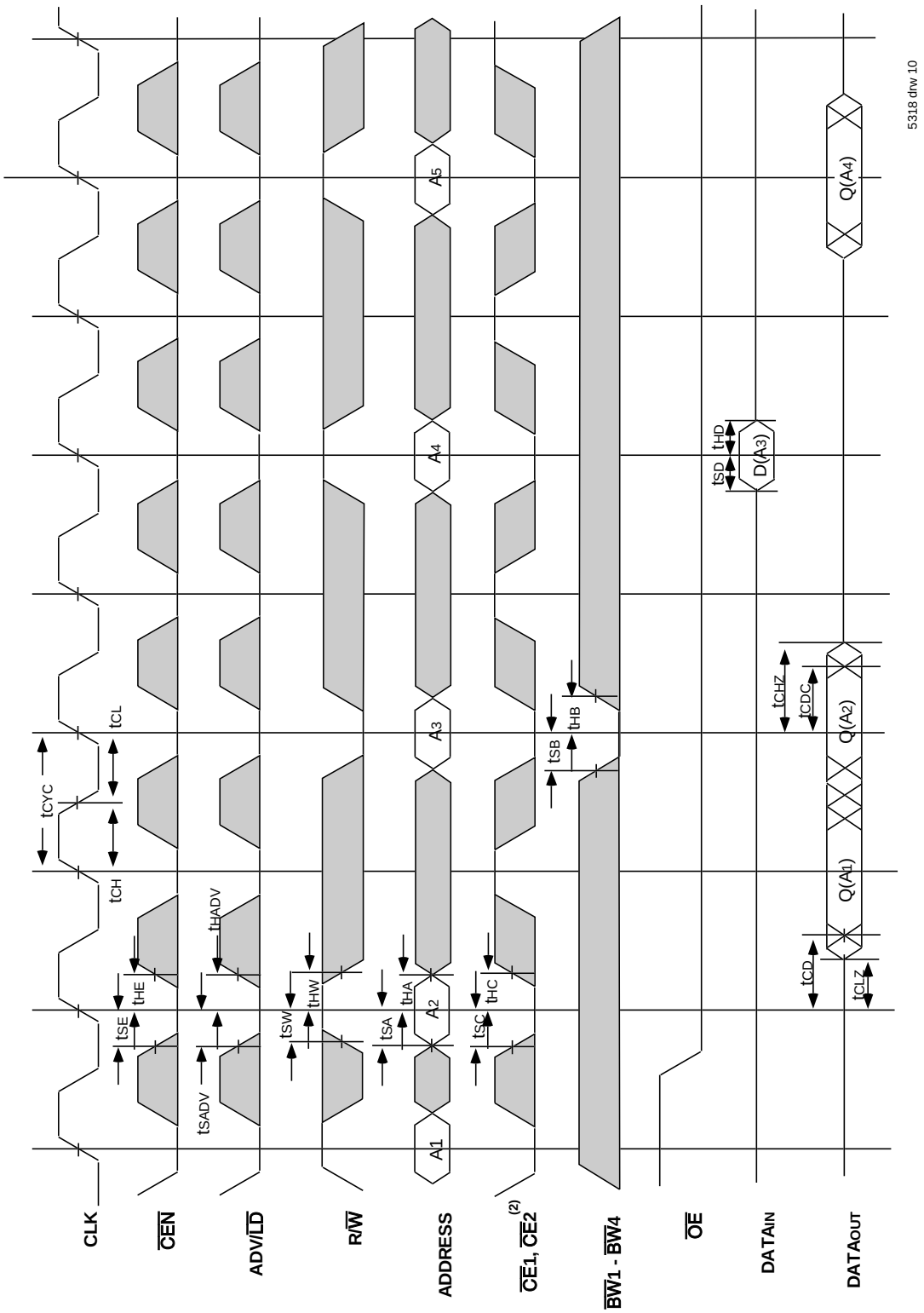

**NOTES:**
1. Q (A1) represents the first output from the external address A1. D (A2) represents the input data to the SRAM corresponding to address A2.
2. CE2 timing transitions are identical but inverted to the $\overline{CE}_1$ and $\overline{CE}_2$ signals. For example, when $\overline{CE}_1$ and $\overline{CE}_2$ are LOW on this waveform, CE2 is HIGH.
3. Individual Byte Write signals ($\overline{BW}x$) must be valid on all write and burst-write cycles. A write cycle is initiated when $R/\overline{W}$ signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

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




**NOTES:**
1. Q ($A_1$) represents the first output from the external address $A_1$. D ($A_2$) represents the input data to the SRAM corresponding to address $A_2$.
2. $CE_2$ timing transitions are identical but inverted to the $\overline{CE}_1$ and $\overline{CE}_2$ signals. For example, when $\overline{CE}_1$ and $\overline{CE}_2$ are LOW on this waveform, $CE_2$ is HIGH.
3. $\overline{CEN}$ when sampled high on the rising edge of clock will block that L-H transition of the clock from propogating 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 ($\overline{BWx}$) must be valid on all write and burst-write cycles. A write cycle is initiated when $R/\overline{W}$ signal is sampled LOW. The byte write information comes in two cycles before the actual data is presented to the SRAM.

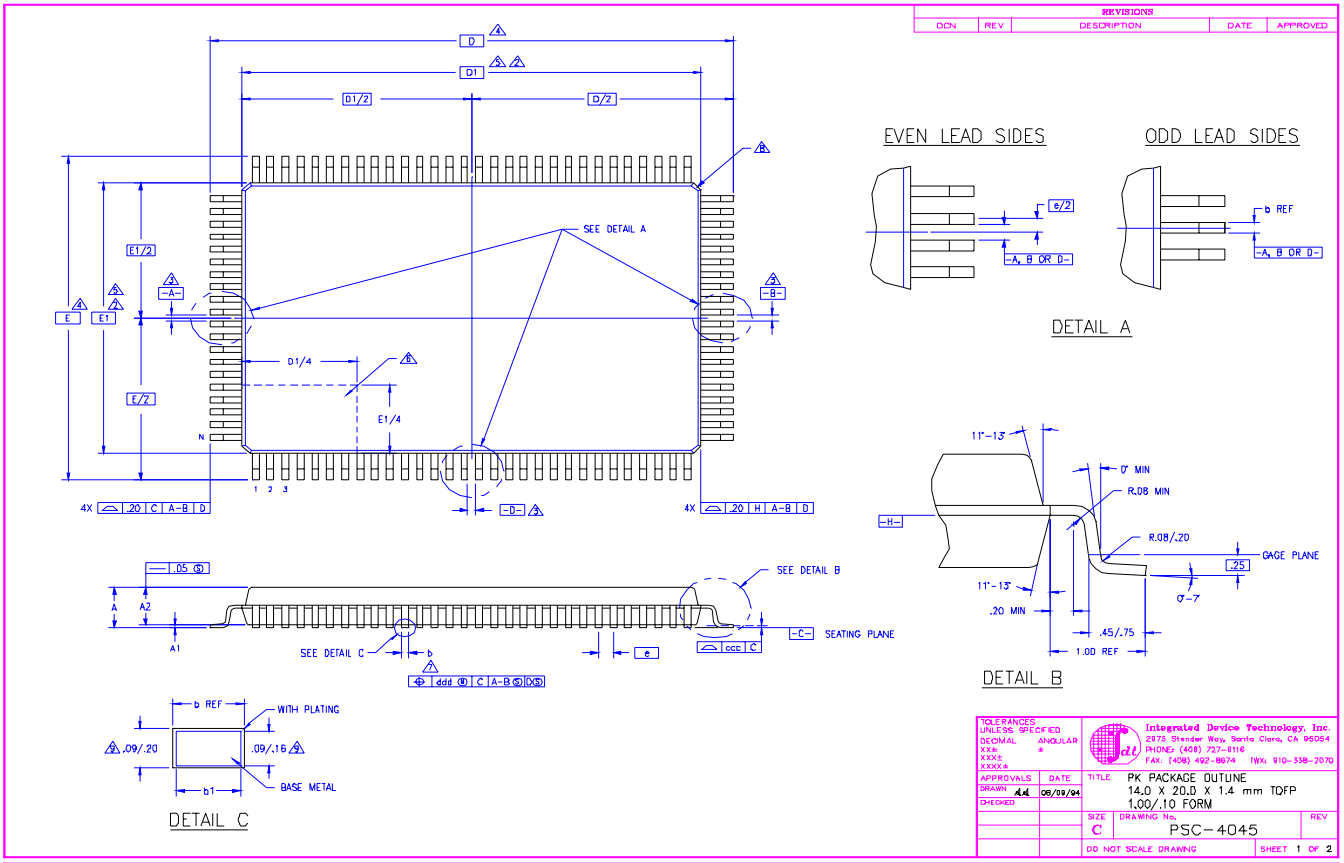
# Timing Waveform of $\overline{CS}$ Operation(1,2,3,4)




**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. $CE_2$ timing transitions are identical but inverted to the $\overline{CE}_1$ and $\overline{CE}_2$ signals. For example, when $\overline{CE}_1$ and $\overline{CE}_2$ are LOW on this waveform, $CE_2$ is HIGH.
3. $\overline{CEN}$ when sampled high on the rising edge of clock will block that L-H transition of the clock from propogating 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 ($\overline{BW}x$) must be valid on all write and burst-write cycles. A write cycle is initiated when R/$\overline{W}$ 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

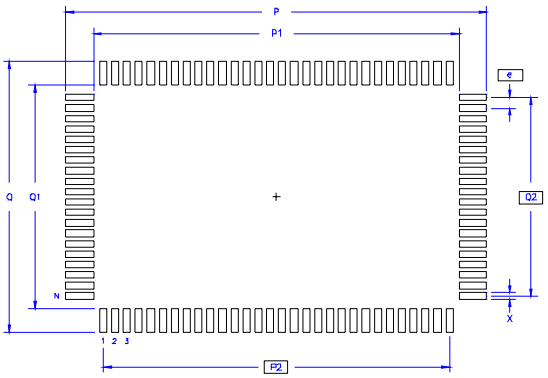



| SYMBOL | JEDEC VARIATION DJ MIN | DJ NOM | DJ MAX | NOTE |
|---|---|---|---|---|
| A | – | – | 1.60 | |
| A1 | .05 | .10 | .15 | |
| A2 | 1.35 | 1.40 | 1.45 | |
| D | | 22.00 BSC | | 4 |
| D1 | | 20.00 BSC | | 5,2 |
| E | | 16.00 BSC | | 4 |
| E1 | | 14.00 BSC | | 5,2 |
| N | | 100 | | |
| ND | | 30 | | |
| NE | | 20 | | |
| e | | .65 BSC | | |
| b | .22 | .32 | .38 | 7 |
| b1 | .22 | .30 | .33 | |
| ccc | – | – | .10 | |
| ddd | – | – | .13 | |

NOTES:

1. ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M–1982
2. TOP PACKAGE MAY BE SMALLER THAN BOTTOM PACKAGE BY .15 mm
3. DATUMS -A-B- AND -D- TO BE DETERMINED AT DATUM PLANE -H-
4. DIMENSIONS D AND E ARE TO BE DETERMINED AT SEATING PLANE -C-
5. 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
6. DETAILS OF PIN 1 IDENTIFIER IS OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED
7. 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.
8. EXACT SHAPE OF EACH CORNER IS OPTIONAL
9. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .10 AND .25 mm FROM THE LEAD TIP
10. ALL DIMENSIONS ARE IN MILLIMETERS
11. THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MO–136, VARIATION DJ AND BX

LAND PATTERN DIMENSIONS

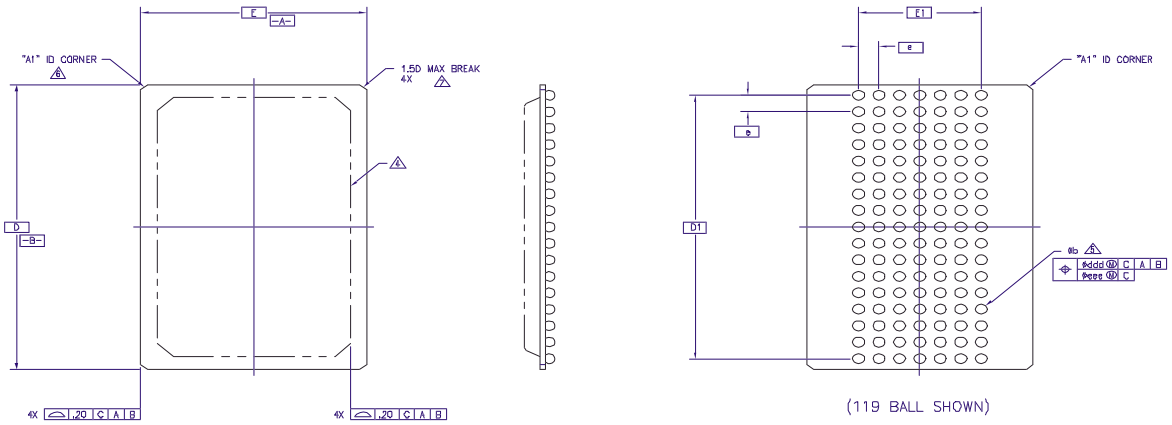



| | MIN | MAX |
|---|---|---|
| P | 22.80 | 23.00 |
| P1 | 19.80 | 20.00 |
| P2 | 18.85 BSC | |
| Q | 16.80 | 17.00 |
| Q1 | 13.80 | 14.00 |
| Q2 | 12.35 BSC | |
| X | .30 | .50 |
| e | .65 BSC | |
| N | 100 | |

Integrated Device Technology, Inc.
2975 Stender Way, Santa Clara, CA 95054
PHONE: (408) 727-6116
FAX: (408) 492-8674 TWX: 910-338-2070
TITLE PK PACKAGE OUTLINE
14.0 X 20.0 X 1.4 mm TQFP
1.00/.10 FORM
SIZE C
DRAWING No. PSC-4045
REV
DO NOT SCALE DRAWING
SHEET 2 OF 2

# 119 Ball Grid Array (BGA) Package Diagram Outline

| REVISIONS | | | | |
|---|---|---|---|---|
| DCN | REV | DESCRIPTION | DATE | APPROVED |
| 60626 | 00 | INITIAL RELEASE | 10/15/97 | T. VU |
| | 01 | SWITCH E & D DIMENSIONS | 04/25/00 | |




TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX±
XXXX±

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PHONE: (408) 727-6116
FAX: (408) 492-8674 TWX: 910-338-2070

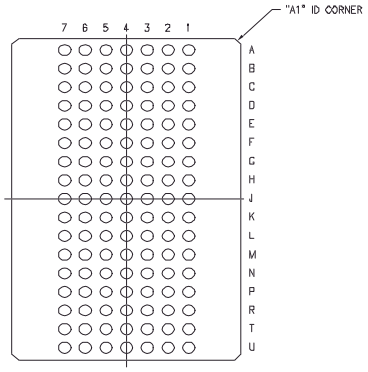
| APPROVALS | DATE |
|---|---|
| DRAWN JTB | 10/15/97 |
| CHECKED | |

TITLE BG PACKAGE OUTLINE
14.0 X 22.0 mm BODY
PBGA

| SIZE | DRAWING No. | REV |
|---|---|---|
| C | PSC-4063 | 01 |

DO NOT SCALE DRAWING SHEET 1 OF 2

| REVISIONS | | | | |
|---|---|---|---|---|
| DCN | REV | DESCRIPTION | DATE | APPROVED |
| 60626 | 00 | INITIAL RELEASE | 10/15/97 | T. VU |
| | 01 | SWITCH E & D DIMENSIONS | 04/25/00 | T. VU |
| | 02 | CHANGE PACKAGE THICKNESS | 08/05/00 | |




(119 BALL)

| SYMBOL | JEDEC VARIATION AA | | | NOTE |
|---|---|---|---|---|
| | MIN | NOM | MAX | |
| A | – | 2.15 | 2.36 | |
| A1 | .50 | .60 | .70 | |
| A2 | – | – | 1.20 | |
| D | 22.00 BSC | | | |
| D1 | 20.32 BSC | | | |
| E | 14.00 BSC | | | |
| E1 | 7.62 BSC | | | |
| MD | 17 | | | 3 |
| ME | 7 | | | 3 |
| N | 119 | | | 3 |
| e | 1.27 BSC | | | |
| b | .60 | .75 | .90 | 5 |
| c | .51 | .56 | .61 | |
| aaa | – | – | .15 | |
| bbb | – | – | .25 | |
| ccc | – | – | .35 | |
| ddd | – | – | .30 | |
| eee | – | – | .10 | |

NOTES:

1. ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M-1982.
2. SEATING PLANE AND PRIMARY DATUM -C- ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
3. "MD" IS THE BALL MATRIX SIZE IN THE "D" DIRECTION
   "ME" IS THE BALL MATRIX SIZE IN THE "E" DIRECTION
   "N" IS THE MAXIMUM ALLOWABLE NUMBER OF SOLDER BALLS
4. PACKAGE MAY EXTEND TO EDGE PERIPHERY AND MAY CONSIST OF MOLDING COMPOUND, EPOXY, METAL, CERAMIC OR OTHER MATERIAL
5. DIMENSION "b" IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO PRIMARY DATUM -C-
6. "A1" ID CORNER MUST BE IDENTIFIED. IDENTIFICATION MAY BE BY MEANS OF CHAMFER, METALLIZED OR INK MARK, INDENTATION OR OTHER FEATURE OF THE PACKAGE BODY. MARK MUST BE VISIBLE FROM TOP SURFACE
7. ACTUAL SHAPE OF THIS FEATURE IS OPTIONAL
8. ALL DIMENSIONS ARE IN MILLIMETERS
9. THIS DRAWING CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MS-028, VARIATION AA

TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX±
XXXX±

Integrated Device Technology, Inc.
2975 Stender Way, Santa Clara, CA 95054
PHONE: (408) 727-6116
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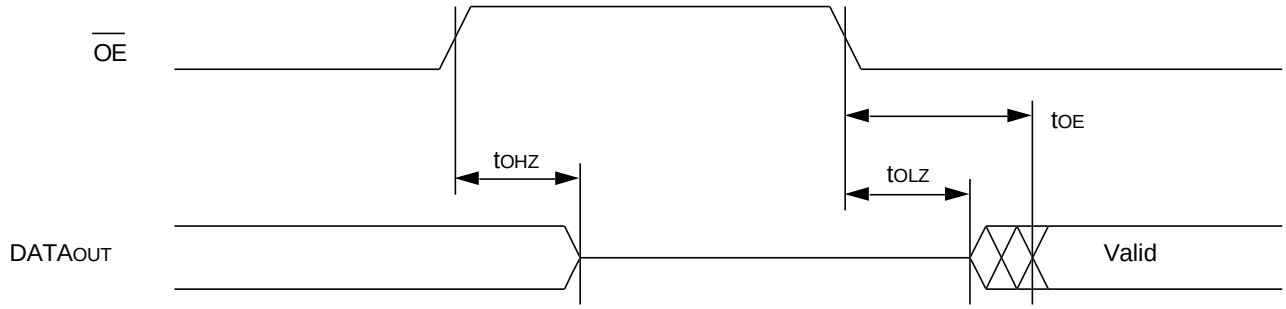
| APPROVALS | DATE |
|---|---|
| DRAWN JTB | 10/15/97 |
| CHECKED | |

TITLE BG PACKAGE OUTLINE
14.0 X 22.0 mm BODY
PBGA

| SIZE | DRAWING No. | REV |
|---|---|---|
| C | PSC-4063 | 02 |

DO NOT SCALE DRAWING SHEET 2 OF 2

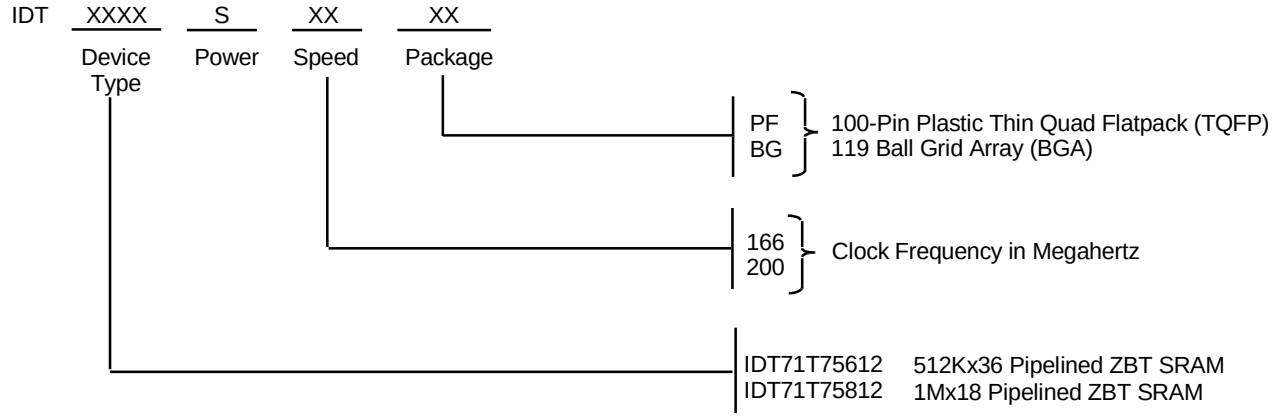
## Timing Waveform of $\overline{OE}$ Operation(1)




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

| Rev | Date | Pages | Description |
|---|---|---|---|
| 0 | 05/25/00 | | Created New Datasheet |
| 1 | 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 |
| 2 | 10/16/01 | p. 6 | Corrected 3.3V to 2.5V in Note 2 |
| 3 | 12/21/01 | p. 4-6 | Added clarification to JTAG pins, allow for NC. Added 36M address pin location |

*CORPORATE HEADQUARTERS*
2975 Stender Way
Santa Clara, CA 95054

*for SALES:*
800-345-7015 or 408-727-6116
fax: 408-492-8674
www.idt.com

*for Tech Support:*
sramhelp@idt.com
800-544-7726, x4033