CY7C1366C/CY7C1367C

9-Mbit (256 K × 36/512 K × 18) Pipelined DCD Sync SRAM

Features

- Supports bus operation up to 250 MHz
- Available speed grades are 250, 200, and 166 MHz
- Registered inputs and outputs for pipelined operation
  - Optimal for performance (double-cycle deselect)
    - Depth expansion without wait state
  - 3.3 V – 5% and + 10% core power supply (V_{DD})
- 2.5 V/3.3 V I/O power supply (V_{DDQ})
- Fast clock-to-output times
  - 2.8 ns (for 250 MHz device)
- Provide high performance 3-1-1-1 access rate
- User-selectable burst counter supporting Intel® Pentium® interleaved or linear burst sequences
- Separate processor and controller address strobes
- Synchronous self-timed writes
- Asynchronous output enable
- Available in Pb-free 100-pin TQFP, Pb-free and non Pb-free 119-ball BGA package and 165-ball FPBGA package
- IEEE 1149.1 JTAG-compatible boundary scan
- “ZZ” sleep mode option

Functional Description

The CY7C1366C/CY7C1367C SRAM[1] integrates 256 K × 36 and 512 K × 18 SRAM cells with advanced synchronous peripheral circuitry and a two-bit counter for internal burst operation. All synchronous inputs are gated by registers controlled by a positive-edge-triggered clock input (CLK). The synchronous inputs include all addresses, all data inputs, address-pipelining chip enable (CE_1), depth-expansion chip enables (CE_2 and CE_3[2]), burst control inputs (ADSC, ADSP, and ADV), write enables (BW_X, and BWE), and global write (GW). Asynchronous inputs include the output enable (OE) and the ZZ pin.

Addresses and chip enables are registered at rising edge of clock when either address strobe processor (ADSP) or address strobe controller (ADSC) are active. Subsequent burst addresses can be internally generated as controlled by the advance pin (ADV).

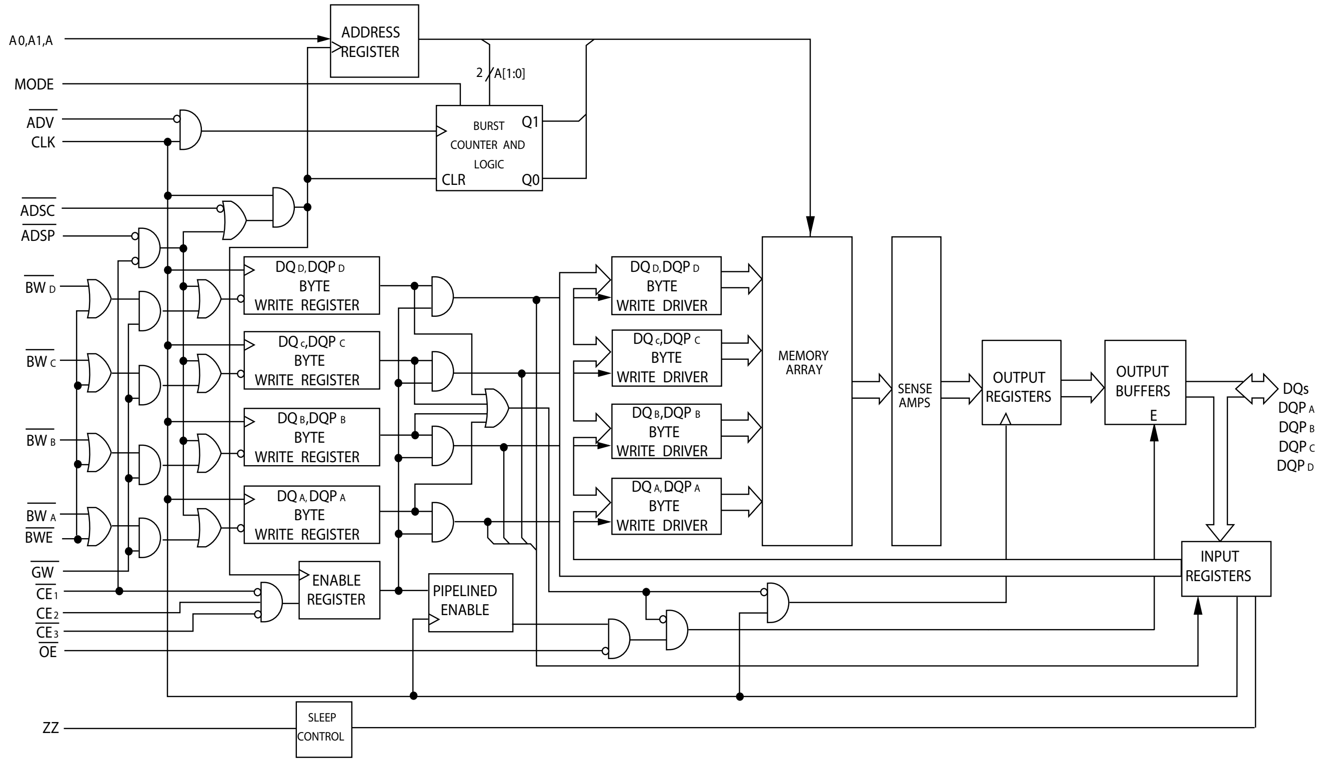
Address, data inputs, and write controls are registered on-chip to initiate a self-timed write cycle.This part supports byte write operations (see Pin Definitions on page 7 and Truth Table for Read/Write on page 10 for further details). Write cycles can be one to four bytes wide as controlled by the byte write control inputs. GW active LOW causes all bytes to be written. This device incorporates an additional pipelined enable register which delays turning off the output buffers an additional cycle when a deselect is executed. This feature enables depth expansion without penalizing system performance.

The CY7C1366C/CY7C1367C operates from a +3.3 V core power supply while all outputs operate with a +3.3 V or a +2.5 V supply. All inputs and outputs are JEDEC-standard JESD8-5-compatible.

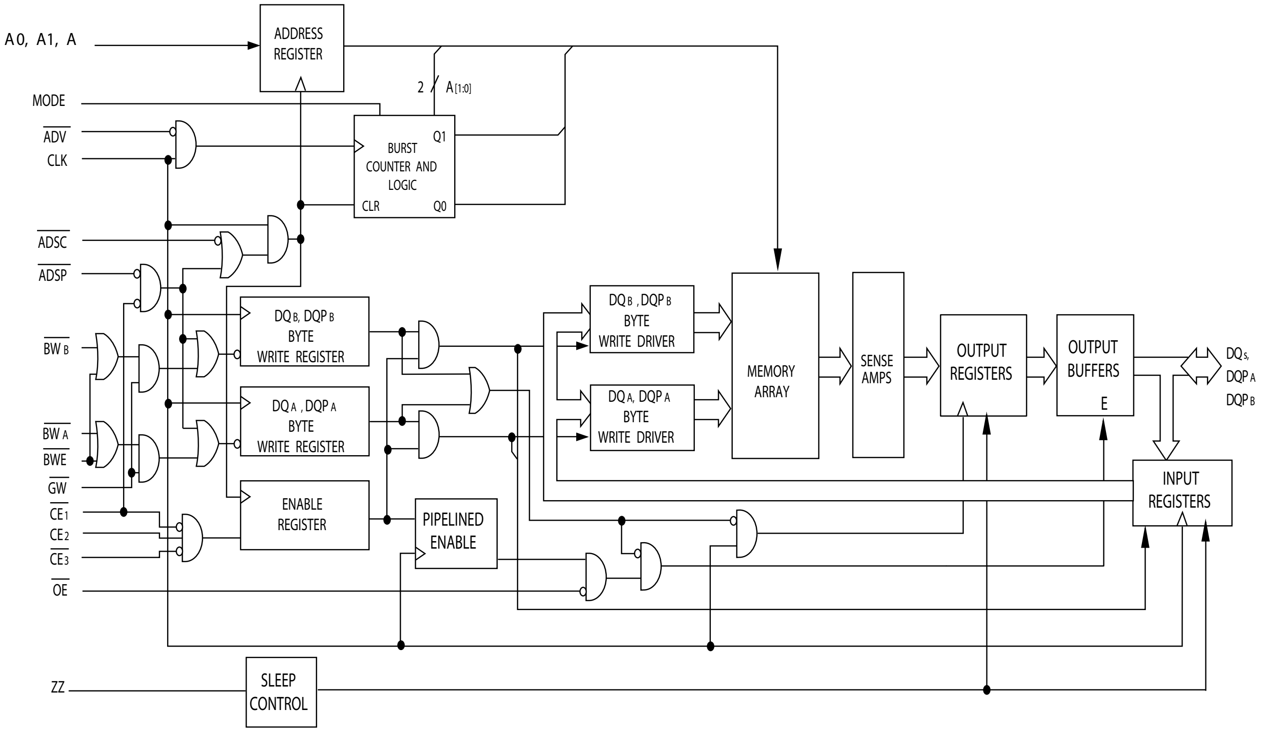
Notes

1. For best-practices recommendations, refer to the Cypress application note *System Design Guidelines* on www.cypress.com.
2. CE_3 is for TQFP and 165-ball FBGA package only. 119-ball BGA is offered only in 2 Chip Enable

Logic Block Diagram – CY7C1366C (256 K × 36)



Logic Block Diagram – CY7C1367C (512 K × 18)



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Selection Guide

Description	250 MHz	200 MHz	166 MHz	Unit
Maximum access time	2.8	3.0	3.5	ns
Maximum operating current	250	220	180	mA
Maximum CMOS standby current	40	40	40	mA

Pin Configurations

Figure 1. 100-pin TQFP (3 Chip Enables)

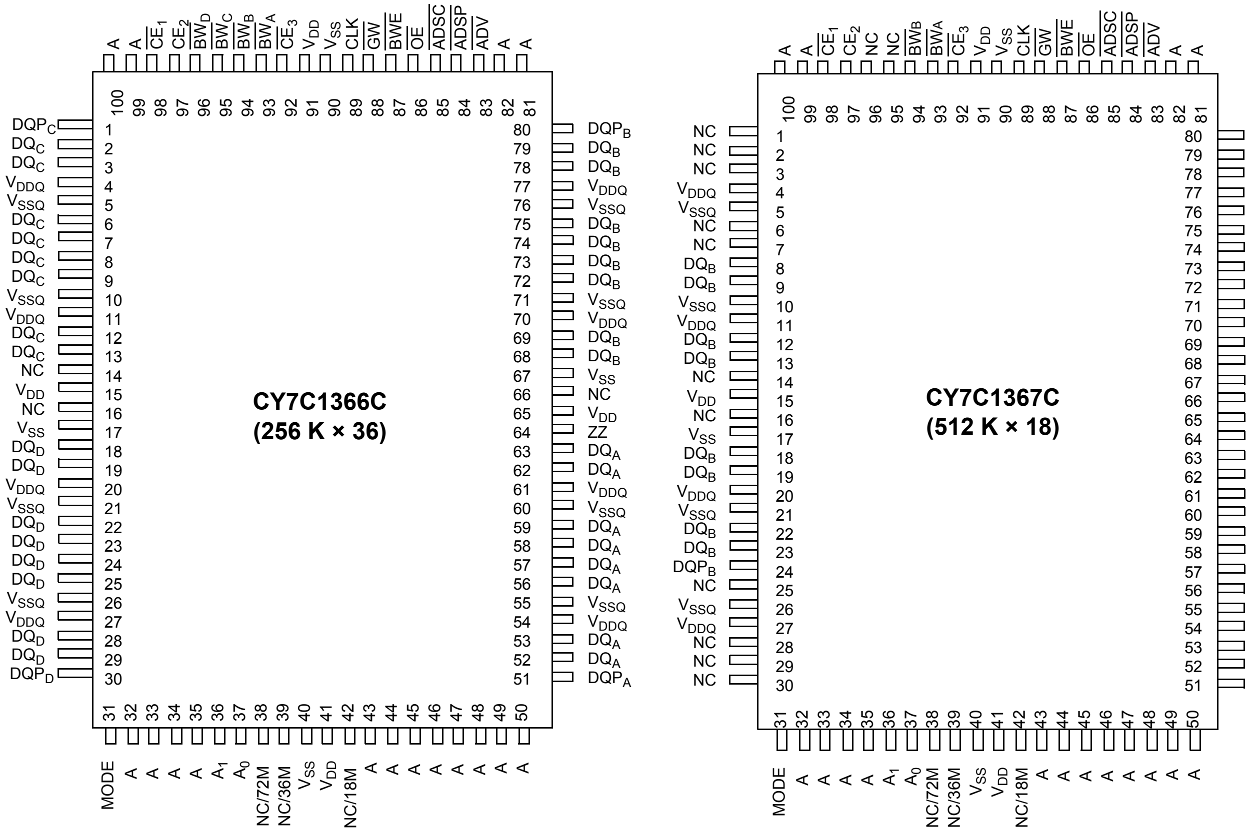


Figure 2. 119-ball BGA (2 Chip Enable with JTAG)

CY7C1366C (256 K × 36)

	1	2	3	4	5	6	7
A	V_{DDQ}	A	A	$\overline{\mathrm{ADSP}}$	A	A	V_{DDQ}
B	NC/288M	CE_2	A	$\overline{\mathrm{ADSC}}$	A	A	NC/576M
C	NC/144M	A	A	V_{DD}	A	A	NC/1G
D	DQ_C	DQP_C	V_{SS}	NC	V_{SS}	DQP_B	DQ_B
E	DQ_C	DQ_C	V_{SS}	$\overline{\mathrm{CE}}_1$	V_{SS}	DQ_B	DQ_B
F	V_{DDQ}	DQ_C	V_{SS}	$\overline{\mathrm{OE}}$	V_{SS}	DQ_B	V_{DDQ}
G	DQ_C	DQ_C	$\overline{\mathrm{BW}}_C$	$\overline{\mathrm{ADV}}$	$\overline{\mathrm{BW}}_B$	DQ_B	DQ_B
H	DQ_C	DQ_C	V_{SS}	$\overline{\mathrm{GW}}$	V_{SS}	DQ_B	DQ_B
J	V_{DDQ}	V_{DD}	NC	V_{DD}	NC	V_{DD}	V_{DDQ}
K	DQ_D	DQ_D	V_{SS}	CLK	V_{SS}	DQ_A	DQ_A
L	DQ_D	DQ_D	$\overline{\mathrm{BW}}_D$	NC	$\overline{\mathrm{BW}}_A$	DQ_A	DQ_A
M	V_{DDQ}	DQ_D	V_{SS}	$\overline{\mathrm{BWE}}$	V_{SS}	DQ_A	V_{DDQ}
N	DQ_D	DQ_D	V_{SS}	A1	V_{SS}	DQ_A	DQ_A
P	DQ_D	DQP_D	V_{SS}	A0	V_{SS}	DQP_A	DQ_A
R	NC	A	MODE	V_{DD}	NC	A	NC
T	NC	NC/72M	A	A	A	NC/36M	ZZ
U	V_{DDQ}	TMS	TDI	TCK	TDO	NC	V_{DDQ}

CY7C1367C (512 K × 18)

	1	2	3	4	5	6	7
A	V_{DDQ}	A	A	$\overline{\mathrm{ADSP}}$	A	A	V_{DDQ}
B	NC/288M	CE_2	A	$\overline{\mathrm{ADSC}}$	A	A	NC/576M
C	NC/144M	A	A	V_{DD}	A	A	NC/1G
D	DQ_B	NC	V_{SS}	NC	V_{SS}	DQP_A	NC
E	NC	DQ_B	V_{SS}	$\overline{\mathrm{CE}}_1$	V_{SS}	NC	DQ_A
F	V_{DDQ}	NC	V_{SS}	$\overline{\mathrm{OE}}$	V_{SS}	DQ_A	V_{DDQ}
G	NC	DQ_B	$\overline{\mathrm{BW}}_B$	$\overline{\mathrm{ADV}}$	V_{SS}	NC	DQ_A
H	DQ_B	NC	V_{SS}	$\overline{\mathrm{GW}}$	V_{SS}	DQ_A	NC
J	V_{DDQ}	V_{DD}	NC	V_{DD}	NC	V_{DD}	V_{DDQ}
K	NC	DQ_B	V_{SS}	CLK	V_{SS}	NC	DQ_A
L	DQ_B	NC	V_{SS}	NC	$\overline{\mathrm{BW}}_A$	DQ_A	NC
M	V_{DDQ}	DQ_B	V_{SS}	$\overline{\mathrm{BWE}}$	V_{SS}	NC	V_{DDQ}
N	DQ_B	NC	V_{SS}	A1	V_{SS}	DQ_A	NC
P	NC	DQP_B	V_{SS}	A0	V_{SS}	NC	DQ_A
R	NC	A	MODE	V_{DD}	NC	A	NC
T	NC/72M	A	A	NC/36M	A	A	ZZ
U	V_{DDQ}	TMS	TDI	TCK	TDO	NC	V_{DDQ}

Figure 3. 165-ball FBGA (3 Chip Enable)

CY7C1366C (256 K × 36)

	1	2	3	4	5	6	7	8	9	10	11
A	NC/288M	A	$\overline{\text{CE}}_1$	$\overline{\text{BW}}_C$	$\overline{\text{BW}}_B$	$\overline{\text{CE}}_3$	$\overline{\text{BWE}}$	$\overline{\text{ADSC}}$	$\overline{\text{ADV}}$	A	NC
B	NC/144M	A	CE_2	$\overline{\text{BW}}_D$	$\overline{\text{BW}}_A$	CLK	$\overline{\text{GW}}$	$\overline{\text{OE}}$	$\overline{\text{ADSP}}$	A	NC/576M
C	DQP_C	NC	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC/ 1G	DQP_B
D	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
E	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
F	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
G	DQ_C	DQ_C	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_B	DQ_B
H	NC	V_{SS}	NC	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	NC	NC	ZZ
J	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
K	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
L	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
M	DQ_D	DQ_D	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	DQ_A
N	DQP_D	NC	V_{DDQ}	V_{SS}	NC	NC/18M	NC	V_{SS}	V_{DDQ}	NC	DQP_A
P	NC	NC/72M	A	A	TDI	A1	TDO	A	A	A	A
R	MODE	NC/36M	A	A	TMS	A0	TCK	A	A	A	A

CY7C1367C (512 K × 18)

	1	2	3	4	5	6	7	8	9	10	11
A	NC/288M	A	$\overline{\text{CE}}_1$	$\overline{\text{BW}}_B$	NC	$\overline{\text{CE}}_3$	$\overline{\text{BWE}}$	$\overline{\text{ADSC}}$	$\overline{\text{ADV}}$	A	A
B	NC/144M	A	CE_2	NC	$\overline{\text{BW}}_A$	CLK	$\overline{\text{GW}}$	$\overline{\text{OE}}$	$\overline{\text{ADSP}}$	A	NC/576M
C	NC	NC	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC/1G	DQP_A
D	NC	DQ_B	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQ_A
E	NC	DQ_B	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQ_A
F	NC	DQ_B	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQ_A
G	NC	DQ_B	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQ_A
H	NC	V_{SS}	NC	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	NC	NC	ZZ
J	DQ_B	NC	V_{DDQ}	V_{DD}	‘V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	NC
K	DQ_B	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	NC
L	DQ_B	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	NC
M	DQ_B	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQ_A	NC
N	DQP_B	NC	V_{DDQ}	V_{SS}	NC	NC/18M	NC	V_{SS}	V_{DDQ}	NC	NC
P	NC	NC/72M	A	A	TDI	A1	TDO	A	A	A	A
R	MODE	NC/36M	A	A	TMS	A0	TCK	A	A	A	A

Pin Definitions

Name	I/O	Description
A_0, A_1, A	Input-synchronous	**Address inputs used to select one of the address locations**. Sampled at the rising edge of the CLK if $\overline{\text{ADSP}}$ or $\overline{\text{ADSC}}$ is active LOW, and $\overline{\text{CE}}_1$, CE_2, and $\overline{\text{CE}}_3$[3] are sampled active. A1: A0 are fed to the two-bit counter.
$\overline{\text{BW}}_A$,$\overline{\text{BW}}_B$ $\overline{\text{BW}}_C$,$\overline{\text{BW}}_D$	Input-synchronous	**Byte write select inputs, active LOW**. Qualified with $\overline{\text{BWE}}$ to conduct byte writes to the SRAM. Sampled on the rising edge of CLK.
$\overline{\text{GW}}$	Input-synchronous	**Global write enable input, active LOW**. When asserted LOW on the rising edge of CLK, a global write is conducted (All bytes are written, regardless of the values on BW_X and $\overline{\text{BWE}}$).
$\overline{\text{BWE}}$	Input-synchronous	**Byte write enable input, active LOW**. Sampled on the rising edge of CLK. This signal must be asserted LOW to conduct a byte write.
CLK	Input-clock	**Clock input**. Used to capture all synchronous inputs to the device. Also used to increment the burst counter when $\overline{\text{ADV}}$ is asserted LOW, during a burst operation.
$\overline{\text{CE}}_1$	Input-synchronous	**Chip enable 1 input, active LOW**. Sampled on the rising edge of CLK. Used in conjunction with CE_2 and $\overline{\text{CE}}_3$[3] to select/deselect the device. $\overline{\text{ADSP}}$ is ignored if $\overline{\text{CE}}_1$ is HIGH. $\overline{\text{CE}}_1$ is sampled only when a new external address is loaded.
CE_2	Input-synchronous	**Chip enable 2 input, active HIGH**. Sampled on the rising edge of CLK. Used in conjunction with $\overline{\text{CE}}_1$ and $\overline{\text{CE}}_3$[3] to select/deselect the device. CE_2 is sampled only when a new external address is loaded.
$\overline{\text{CE}}_3$[3]	Input-synchronous	**Chip enable 3 input, active LOW**. Sampled on the rising edge of CLK. Used in conjunction with $\overline{\text{CE}}_1$ and CE_2 to select/deselect the device. Not connected for BGA. Where referenced, $\overline{\text{CE}}_3$[3] is assumed active throughout this document for BGA. $\overline{\text{CE}}_3$ is sampled only when a new external address is loaded.
$\overline{\text{OE}}$	Input-asynchronous	**Output enable, asynchronous input, active LOW**. Controls the direction of the I/O pins. When LOW, the I/O pins behave as outputs. When deasserted HIGH, DQ pins are tristated, and act as input data pins. $\overline{\text{OE}}$ is masked during the first clock of a read cycle when emerging from a deselected state.
$\overline{\text{ADV}}$	Input-synchronous	**Advance input signal, sampled on the rising edge of CLK, active LOW**. When asserted, it automatically increments the address in a burst cycle.
$\overline{\text{ADSP}}$	Input-synchronous	**Address strobe from processor, sampled on the rising edge of CLK, active LOW**. When asserted LOW, addresses presented to the device are captured in the address registers. A1: A0 are also loaded into the burst counter. When $\overline{\text{ADSP}}$ and $\overline{\text{ADSC}}$ are both asserted, only $\overline{\text{ADSP}}$ is recognized. $\overline{\text{ASDP}}$ is ignored when $\overline{\text{CE}}_1$ is deasserted HIGH.
$\overline{\text{ADSC}}$	Input-synchronous	**Address strobe from controller, sampled on the rising edge of CLK, active LOW**. When asserted LOW, addresses presented to the device are captured in the address registers. A1: A0 are also loaded into the burst counter. When $\overline{\text{ADSP}}$ and $\overline{\text{ADSC}}$ are both asserted, only $\overline{\text{ADSP}}$ is recognized.
ZZ	Input-asynchronous	**ZZ “sleep” input, active HIGH**. When asserted HIGH places the device in a non-time-critical “sleep” condition with data integrity preserved. For normal operation, this pin has to be LOW or left floating. ZZ pin has an internal pull-down.
DQs, DQPs	I/O-synchronous	**Bidirectional data I/O lines**. As inputs, they feed into an on-chip data register that is triggered by the rising edge of CLK. As outputs, they deliver the data contained in the memory location specified by the addresses presented during the previous clock rise of the read cycle. The direction of the pins is controlled by $\overline{\text{OE}}$. When $\overline{\text{OE}}$ is asserted LOW, the pins behave as outputs. When HIGH, DQs and DQP_X are placed in a tristate condition.
V_{DD}	Power supply	**Power supply inputs to the core of the device**.
V_{SS}	Ground	**Ground for the core of the device**.
V_{SSQ}	I/O ground	**Ground for the I/O circuitry**.

Note

[3] $\overline{\text{CE}}_3$ is for TQFP and 165-ball FBGA package only. 119-ball BGA is offered only in 2 Chip Enable

Pin Definitions *(continued)*

Name	I/O	Description
V_{DDQ}	I/O power supply	**Power supply for the I/O circuitry**.
MODE	Input- static	**Selects burst order**. When tied to GND selects linear burst sequence. When tied to V_{DD} or left floating selects interleaved burst sequence. This is a strap pin and should remain static during device operation. Mode pin has an internal pull-up.
TDO	JTAG serial output synchronous	**Serial data-out to the JTAG circuit**. Delivers data on the negative edge of TCK. If the JTAG feature is not being used, this pin should be disconnected. This pin is not available on TQFP packages.
TDI	JTAG serial input synchronous	**Serial data-in to the JTAG circuit**. Sampled on the rising edge of TCK. If the JTAG feature is not being used, this pin can be disconnected or connected to V_{DD}. This pin is not available on TQFP packages.
TMS	JTAG serial input synchronous	**Serial data-in to the JTAG circuit**. Sampled on the rising edge of TCK. If the JTAG feature is not being used, this pin can be disconnected or connected to V_{DD}. This pin is not available on TQFP packages.
TCK	JTAG- clock	**Clock input to the JTAG circuitry**. If the JTAG feature is not being used, this pin must be connected to V_{SS}. This pin is not available on TQFP packages.
NC	–	**No connects**. Not internally connected to the die.18M, 36M, 72M, 144M, 288M, 576M, and 1G are address expansion pins and are not internally connected to the die.

Functional Overview

All synchronous inputs pass through input registers controlled by the rising edge of the clock. All data outputs pass through output registers controlled by the rising edge of the clock.

The CY7C1366C/CY7C1367C supports secondary cache in systems using either a linear or interleaved burst sequence. The interleaved burst order supports Pentium and i486™ processors. The linear burst sequence is suited for processors that use a linear burst sequence. The burst order is user selectable, and is determined by sampling the MODE input. Accesses can be initiated with either the processor address strobe ($\overline{ADSP}$) or the controller address strobe ($\overline{ADSC}$). Address advancement through the burst sequence is controlled by the $\overline{ADV}$ input. A two-bit on-chip wraparound burst counter captures the first address in a burst sequence and automatically increments the address for the rest of the burst access.

Byte write operations are qualified with the byte write enable ($\overline{BWE}$) and byte write select ($\overline{BW_X}$) inputs. A global write enable ($\overline{GW}$) overrides all byte write inputs and writes data to all four bytes. All writes are simplified with on-chip synchronous self-timed write circuitry.

Synchronous chip selects $\overline{CE_1}$, CE_2, $\overline{CE_3}$[4] and an asynchronous output enable ($\overline{OE}$) provide for easy bank selection and output tristate control. $\overline{ADSP}$ is ignored if $\overline{CE_1}$ is HIGH.

Single Read Accesses

This access is initiated when the following conditions are satisfied at clock rise: (1) $\overline{ADSP}$ or $\overline{ADSC}$ is asserted LOW, (2) chip selects are all asserted active, and (3) the write signals ($\overline{GW}$, $\overline{BWE}$) are all deasserted HIGH. $\overline{ADSP}$ is ignored if $\overline{CE_1}$ is HIGH. The address presented to the address inputs is stored into the address advancement logic and the address register while being presented to the memory core. The corresponding data is allowed to propagate to the input of the output registers. At the rising edge of the next clock the data is allowed to propagate through the output register and on the data bus within t_{co} if $\overline{OE}$ is active LOW. The only exception occurs when the SRAM is emerging from a deselected state to a selected state, its outputs are always tristated during the first cycle of the access. After the first cycle of the access, the outputs are controlled by the $\overline{OE}$ signal. Consecutive single read cycles are supported.

The CY7C1366C/CY7C1367C is a double-cycle deselect part. Once the SRAM is deselected at clock rise by the chip select and either $\overline{ADSP}$ or $\overline{ADSC}$ signals, its output will tristate immediately after the next clock rise.

Note

[4] $\overline{CE_3}$ is for TQFP and 165-ball FBGA package only. 119-ball BGA is offered only in 2 Chip Enable

Single Write Accesses Initiated by ADSP

This access is initiated when both of the following conditions are satisfied at clock rise: (1) ADSP is asserted LOW, and (2) chip select is asserted active. The address presented is loaded into the address register and the address advancement logic while being delivered to the memory core. The write signals (GW, BWE, and BW_X) and ADV inputs are ignored during this first cycle.

ADSP triggered write accesses require two clock cycles to complete. If GW is asserted LOW on the second clock rise, the data presented to the DQ_x inputs is written into the corresponding address location in the memory core. If GW is HIGH, then the write operation is controlled by BWE and BW_X signals. The CY7C1366C/CY7C1367C provides byte write capability that is described in the Write Cycle Description table. Asserting the byte write enable input (BWE) with the selected byte write input will selectively write to only the desired bytes. Bytes not selected during a byte write operation remain unaltered. A synchronous self-timed write mechanism is provided to simplify the write operations.

Because the CY7C1366C/CY7C1367C is a common I/O device, the output enable (OE) must be deasserted HIGH before presenting data to the DQ inputs. Doing so tristates the output drivers. As a safety precaution, DQ are automatically tristated whenever a write cycle is detected, regardless of the state of OE.

Single Write Accesses Initiated by ADSC

ADSC write accesses are initiated when the following conditions are satisfied: (1) ADSC is asserted LOW, (2) ADSP is deasserted HIGH, (3) chip select is asserted active, and (4) the appropriate combination of the write inputs (GW, BWE, and BW_X) are asserted active to conduct a write to the desired byte(s). ADSC triggered write accesses require a single clock cycle to complete. The address presented is loaded into the address register and the address advancement logic while being delivered to the memory core. The ADV input is ignored during this cycle. If a global write is conducted, the data presented to the DQ_X is written into the corresponding address location in the memory core. If a byte write is conducted, only the selected bytes are written. Bytes not selected during a byte write operation remain unaltered. A synchronous self-timed write mechanism is provided to simplify the write operations.

Because the CY7C1366C/CY7C1367C is a common I/O device, the output enable (OE) must be deasserted HIGH before presenting data to the DQ_X inputs. Doing so tristates the output drivers. As a safety precaution, DQ_X are automatically tristated whenever a write cycle is detected, regardless of the state of OE.

Burst Sequences

The CY7C1366C/CY7C1367C provides a two-bit wraparound counter, fed by $A_{[1:0]}$, that implements either an interleaved or linear burst sequence. The interleaved burst sequence is designed specifically to support Intel Pentium applications. The linear burst sequence is designed to support processors that follow a linear burst sequence. The burst sequence is user selectable through the MODE input. Both read and write burst operations are supported.

Asserting ADV LOW at clock rise automatically increments the burst counter to the next address in the burst sequence. Both read and write burst operations are supported.

Sleep Mode

The ZZ input pin is an asynchronous input. Asserting ZZ places the SRAM in a power conservation 'sleep' mode. Two clock cycles are required to enter into or exit from this 'sleep' mode. While in this mode, data integrity is guaranteed. Accesses pending when entering the 'sleep' mode are not considered valid nor is the completion of the operation guaranteed. The device must be deselected prior to entering the 'sleep' mode. CEs, ADSP, and ADSC must remain inactive for the duration of t_{ZZREC} after the ZZ input returns LOW.

Table 1. Interleaved Burst Address Table (MODE = Floating or V_{DD})

First Address A1: A0	Second Address A1: A0	Third Address A1: A0	Fourth Address A1: A0
00	01	10	11
01	00	11	10
10	11	00	01
11	10	01	00

Table 2. Linear Burst Address Table (MODE = GND)

First Address A1: A0	Second Address A1: A0	Third Address A1: A0	Fourth Address A1: A0
00	01	10	11
01	10	11	00
10	11	00	01
11	00	01	10

Table 3. ZZ Mode Electrical Characteristics

Parameter	Description	Test Conditions	Min	Max	Unit
I_{DDZZ}	Sleep mode standby current	ZZ $\geq V_{DD} - 0.2$ V	–	50	mA
t_{ZZS}	Device operation to ZZ	ZZ $\geq V_{DD} - 0.2$ V	–	$2t_{CYC}$	ns
t_{ZZREC}	ZZ recovery time	ZZ ≤ 0.2 V	$2t_{CYC}$	–	ns
t_{ZZI}	ZZ active to sleep current	This parameter is sampled	–	$2t_{CYC}$	ns
t_{RZZI}	ZZ inactive to exit sleep current	This parameter is sampled	0	–	ns

Partial Truth Table for Read/Write

The Partial Truth Table for Read/Write follows.[5, 6]

Function (CY7C1366C)	$\overline{\text{GW}}$	$\overline{\text{BWE}}$	$\overline{\text{BW}}_D$	$\overline{\text{BW}}_C$	$\overline{\text{BW}}_B$	$\overline{\text{BW}}_A$
Read	H	H	X	X	X	X
Read	H	L	H	H	H	H
Write byte A – (DQ_A and DQP_A)	H	L	H	H	H	L
Write byte B – (DQ_B and DQP_B)	H	L	H	H	L	H
Write bytes B, A	H	L	H	H	L	L
Write byte C – (DQ_C and DQP_C)	H	L	H	L	H	H
Write bytes C, A	H	L	H	L	H	L
Write bytes C, B	H	L	H	L	L	H
Write bytes C, B, A	H	L	H	L	L	L
Write byte D – (DQ_D and DQP_D)	H	L	L	H	H	H
Write bytes D, A	H	L	L	H	H	L
Write bytes D, B	H	L	L	H	L	H
Write bytes D, B, A	H	L	L	H	L	L
Write bytes D, C	H	L	L	L	H	H
Write bytes D, C, A	H	L	L	L	H	L
Write bytes D, C, B	H	L	L	L	L	H
Write all bytes	H	L	L	L	L	L
Write all bytes	L	X	X	X	X	X

Truth Table for Read/Write

The Truth Table for Read/Write follows.[5, 6]

Function (CY7C1367C)	$\overline{\text{GW}}$	$\overline{\text{BW}}_E$	$\overline{\text{BW}}_B$	$\overline{\text{BW}}_A$
Read	H	H	X	X
Read	H	L	H	H
Write byte A – (DQ_A and DQP_A)	H	L	H	L
Write byte B – (DQ_B and DQP_B)	H	L	L	H
Write all bytes	H	L	L	L
Write all bytes	L	X	X	X

Notes

[5] All voltages referenced to V_{SS} (GND).

[6] This part has a voltage regulator internally; t_{POWER} is the time that the power needs to be supplied above V_{DD}(minimum) initially before a read or write operation can be initiated.

IEEE 1149.1 Serial Boundary Scan (JTAG)

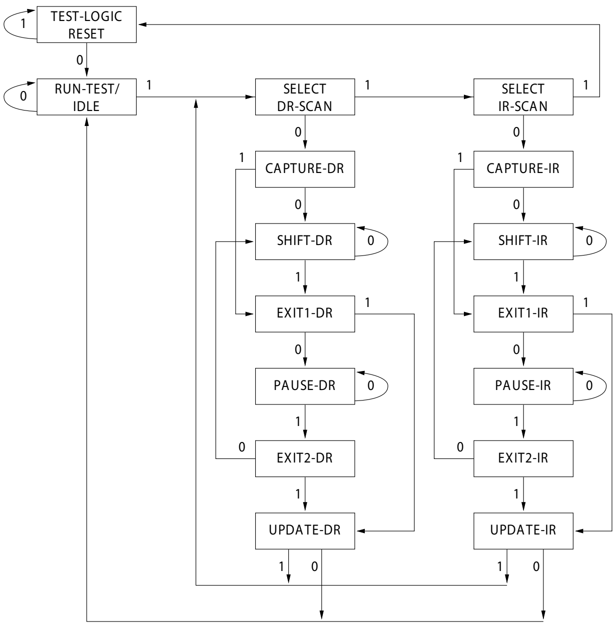
The CY7C1366C/CY7C1367C incorporates a serial boundary scan test access port (TAP) in the BGA package only. The TQFP package does not offer this functionality. This part operates in accordance with IEEE Standard 1149.1-1900, but does not have the set of functions required for full 1149.1 compliance. These functions from the IEEE specification are excluded because their inclusion places an added delay in the critical speed path of the SRAM. Note that the TAP controller functions in a manner that does not conflict with the operation of other devices using 1149.1 fully compliant TAPs. The TAP operates using JEDEC-standard 3.3 V or 2.5 V I/O logic levels.

The CY7C1366C/CY7C1367C contains a TAP controller, instruction register, boundary scan register, bypass register, and ID register.

Disabling the JTAG Feature

It is possible to operate the SRAM without using the JTAG feature. To disable the TAP controller, TCK must be tied LOW (V_{SS}) to prevent clocking of the device. TDI and TMS are internally pulled up and may be unconnected. They may alternately be connected to V_{DD} through a pull-up resistor. TDO should be left unconnected. Upon power-up, the device comes up in a reset state which does not interfere with the operation of the device.

TAP Controller State Diagram



The 0/1 next to each state represents the value of TMS at the rising edge of TCK.

Test Access Port (TAP)

Test Clock (TCK)

The test clock is used only with the TAP controller. All inputs are captured on the rising edge of TCK. All outputs are driven from the falling edge of TCK.

Test Mode Select (TMS)

The TMS input is used to give commands to the TAP controller and is sampled on the rising edge of TCK. It is allowable to leave this ball unconnected if the TAP is not used. The ball is pulled up internally, resulting in a logic HIGH level.

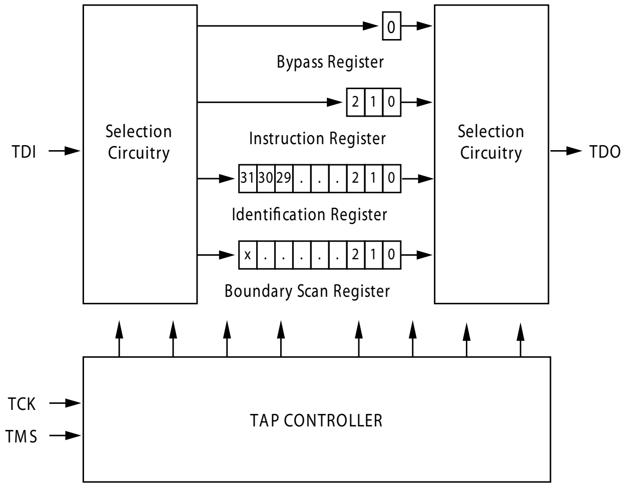
Test Data-In (TDI)

The TDI ball is used to serially input information into the registers and can be connected to the input of any of the registers. The register between TDI and TDO is chosen by the instruction that is loaded into the TAP instruction register. TDI is internally pulled up and can be unconnected if the TAP is unused in an application. TDI is connected to the most significant bit (MSB) of any register. (See TAP Controller Block Diagram.)

Test Data-Out (TDO)

The TDO output ball is used to serially clock data-out from the registers. The output is active depending upon the current state of the TAP state machine. The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register. (See TAP Controller State Diagram.)

TAP Controller Block Diagram



Performing a TAP Reset

A RESET is performed by forcing TMS HIGH (V_{DD}) for five rising edges of TCK. This RESET does not affect the operation of the SRAM and may be performed while the SRAM is operating.

At power up, the TAP is reset internally to ensure that TDO comes up in a high Z state.

TAP Registers

Registers are connected between the TDI and TDO balls and enable data to be scanned into and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction register. Data is serially loaded into the TDI ball on the rising edge of TCK. Data is output on the TDO ball on the falling edge of TCK.

Instruction Register

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the TDI and TDO balls as shown in the "TAP Controller Block Diagram" on page 11. Upon power-up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state as described in the previous section.

When the TAP controller is in the Capture-IR state, the two least significant bits are loaded with a binary "01" pattern to enable fault isolation of the board-level serial test data path.

Bypass Register

To save time when serially shifting data through registers, it is sometimes advantageous to skip certain chips. The bypass register is a single-bit register that can be placed between the TDI and TDO balls. This enables data to be shifted through the SRAM with minimal delay. The bypass register is set LOW (V_{SS}) when the BYPASS instruction is executed.

Boundary Scan Register

The boundary scan register is connected to all the input and bidirectional balls on the SRAM.

The boundary scan register is loaded with the contents of the RAM I/O ring when the TAP controller is in the Capture-DR state and is then placed between the TDI and TDO balls when the controller is moved to the Shift-DR state. The EXTEST, SAMPLE/PRELOAD and SAMPLE Z instructions can be used to capture the contents of the I/O ring.

The "119-ball BGA Boundary Scan Order" on page 17 and "165-ball FBGA Boundary Scan Order" on page 18 show the order in which the bits are connected. Each bit corresponds to one of the bumps on the SRAM package. The MSB of the register is connected to TDI and the LSB is connected to TDO.

Identification (ID) Register

The ID register is loaded with a vendor-specific, 32-bit code during the Capture-DR state when the IDCODE command is loaded in the instruction register. The IDCODE is hardwired into the SRAM and can be shifted out when the TAP controller is in the Shift-DR state. The ID register has a vendor code and other information described in "Identification Register Definitions" on page 15.

TAP Instruction Set

Overview

Eight different instructions are possible with the three-bit instruction register. All combinations are listed in "Identification Codes" on page 16. Three of these instructions are listed as RESERVED and should not be used. The other five instructions are described in detail in this section.

The TAP controller used in this SRAM is not fully compliant to the 1149.1 convention because some of the mandatory 1149.1 instructions are not fully implemented.

The TAP controller cannot be used to load address data or control signals into the SRAM and cannot preload the I/O buffers. The SRAM does not implement the 1149.1 commands EXTEST or INTEST or the PRELOAD portion of SAMPLE/PRELOAD; rather, it performs a capture of the I/O ring when these instructions are executed.

Instructions are loaded into the TAP controller during the Shift-IR state when the instruction register is placed between TDI and TDO. During this state, instructions are shifted through the instruction register through the TDI and TDO balls. To execute the instruction once it is shifted in, the TAP controller needs to be moved into the Update-IR state.

EXTEST

EXTEST is a mandatory 1149.1 instruction which is to be executed whenever the instruction register is loaded with all 0s. EXTEST is not implemented in this SRAM TAP controller, and therefore this device is not compliant to 1149.1. The TAP controller does recognize an all-0 instruction.

When an EXTEST instruction is loaded into the instruction register, the SRAM responds as if a SAMPLE/PRELOAD instruction has been loaded. There is one difference between the two instructions. Unlike the SAMPLE/PRELOAD instruction, EXTEST places the SRAM outputs in a high Z state.

IDCODE

The IDCODE instruction causes a vendor-specific, 32-bit code to be loaded into the instruction register. It also places the instruction register between the TDI and TDO balls and allows the IDCODE to be shifted out of the device when the TAP controller enters the Shift-DR state.

The IDCODE instruction is loaded into the instruction register upon power up or whenever the TAP controller is given a test logic reset state.

SAMPLE Z

The SAMPLE Z instruction causes the boundary scan register to be connected between the TDI and TDO balls when the TAP controller is in a Shift-DR state. It also places all SRAM outputs into a high Z state.

SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. When the SAMPLE/PRELOAD instructions are loaded into the instruction register and the TAP controller is in the Capture-DR state, a snapshot of data on the inputs and output pins is captured in the boundary scan register.

The user must be aware that the TAP controller clock can only operate at a frequency up to 20 MHz, while the SRAM clock operates more than an order of magnitude faster. Because there is a large difference in the clock frequencies, it is possible that during the Capture-DR state, an input or output undergoes a transition. The TAP may then try to capture a signal while in transition (metastable state). This does not harm the device, but there is no guarantee as to the value that is captured. Repeatable results may not be possible.

To guarantee that the boundary scan register captures the correct value of a signal, the SRAM signal must be stabilized long enough to meet the TAP controller’s capture setup plus hold times (t_{CS} and t_{CH}). The SRAM clock input might not be captured correctly if there is no way in a design to stop (or slow) the clock during a SAMPLE/PRELOAD instruction. If this is an issue, it is still possible to capture all other signals and simply ignore the value of the CK and CK# captured in the boundary scan register.

Once the data is captured, it is possible to shift out the data by putting the TAP into the Shift-DR state. This places the boundary scan register between the TDI and TDO pins.

PRELOAD enables an initial data pattern to be placed at the latched parallel outputs of the boundary scan register cells prior to the selection of another boundary scan test operation.

The shifting of data for the SAMPLE and PRELOAD phases can occur concurrently when required - that is, while data captured is shifted out, the preloaded data can be shifted in.

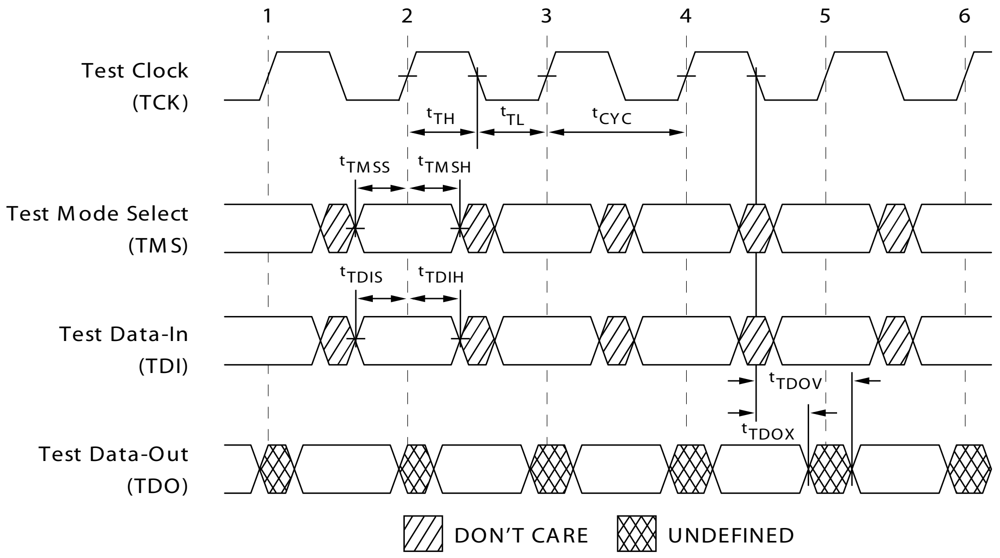
BYPASS

When the BYPASS instruction is loaded in the instruction register and the TAP is placed in a Shift-DR state, the bypass register is placed between the TDI and TDO balls. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

Reserved

These instructions are not implemented but are reserved for future use. Do not use these instructions.

TAP Timing



TAP AC Switching Characteristics

Over the Operating Range[7, 8]

Parameter	Description	Min	Max	Unit
Clock				
t_{TCYC}	TCK clock cycle time	50	–	ns
t_{TF}	TCK clock frequency	–	20	MHz
t_{TH}	TCK clock HIGH time	20	–	ns
t_{TL}	TCK clock LOW time	20	–	ns
Output Times				
t_{TDOV}	TCK clock LOW to TDO valid	–	10	ns
t_{TDOX}	TCK clock LOW to TDO invalid	0	–	ns
Setup Times				
t_{TMSS}	TMS setup to TCK clock rise	5	–	ns
t_{TDIS}	TDI setup to TCK clock rise	5	–	ns
t_{CS}	Capture setup to TCK rise	5	–	ns
Hold Times				
t_{TMSH}	TMS hold after TCK clock rise	5	–	ns
t_{TDIH}	TDI hold after clock rise	5	–	ns
t_{CH}	Capture hold after clock rise	5	–	ns

Notes

[7] t_{CS} and t_{CH} refer to the setup and hold time requirements of latching data from the boundary scan register.

[8] Test conditions are specified using the load in TAP AC test Conditions. t_R/t_F = 1 ns.

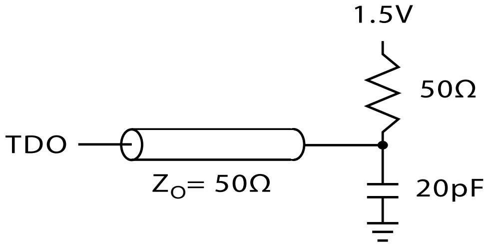
3.3 V TAP AC Test Conditions

Input pulse levels .... V_{SS} to 3.3 V
Input rise and fall times.. 1 ns
Input timing reference levels.. 1.5 V
Output reference levels .... 1.5 V
Test load termination supply voltage .... 1.5 V

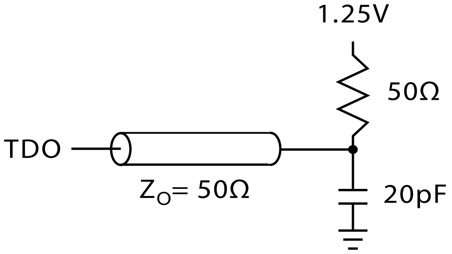
2.5 V TAP AC Test Conditions

Input pulse levels .... V_{SS} to 2.5 V
Input rise and fall time .... 1 ns
Input timing reference levels....................................... 1.25 V
Output reference levels .... 1.25 V
Test load termination supply voltage .... 1.25 V

3.3 V TAP AC Output Load Equivalent



2.5 V TAP AC Output Load Equivalent



TAP DC Electrical Characteristics and Operating Conditions

(0 °C < T_A < +70 °C; V_{DD} = 3.3 V ± 0.165 V unless otherwise noted)[9]

Parameter	Description	Conditions		Min	Max	Unit
V_{OH1}	Output HIGH voltage	I_{OH} = –4.0 mA	V_{DDQ} = 3.3 V	2.4	–	V
		I_{OH} = –1.0 mA	V_{DDQ} = 2.5 V	2.0	–	V
V_{OH2}	Output HIGH voltage	I_{OH} = –100 µA	V_{DDQ} = 3.3 V	2.9	–	V
			V_{DDQ} = 2.5 V	2.1	–	V
V_{OL1}	Output LOW voltage	I_{OL} = 8.0 mA	V_{DDQ} = 3.3 V	–	0.4	V
		I_{OL} = 8.0 mA	V_{DDQ} = 2.5 V	–	0.4	V
V_{OL2}	Output LOW voltage	I_{OL} = 100 µA	V_{DDQ} = 3.3 V	–	0.2	V
			V_{DDQ} = 2.5 V	–	0.2	V
V_{IH}	Input HIGH voltage		V_{DDQ} = 3.3 V	2.0	V_{DD} + 0.3	V
			V_{DDQ} = 2.5 V	1.7	V_{DD} + 0.3	V
V_{IL}	Input LOW voltage		V_{DDQ} = 3.3 V	–0.5	0.7	V
			V_{DDQ} = 2.5 V	–0.3	0.7	V
I_X	Input load current	GND ≤ V_{IN} ≤ V_{DDQ}		–5	5	µA

Identification Register Definitions

Instruction Field	CY7C1366C (256 K × 36)	CY7C1367C (512 K × 18)	Description
Revision number (31:29)	000	000	Describes the version number.
Device depth (28:24)[10]	01011	01011	Reserved for Internal Use
Device width (23:18) 119-ball BGA	101110	101110	Defines memory type and architecture
Device width (23:18) 165-ball FBGA	000110	000110	Defines memory type and architecture
Cypress device ID (17:12)	100110	010110	Defines width and density
Cypress JEDEC ID code (11:1)	00000110100	00000110100	Allows unique identification of SRAM vendor.
ID register presence indicator (0)	1	1	Indicates the presence of an ID register.

Notes

[9] All voltages referenced to V_{SS} (GND).

[10] Bit #24 is “1” in the Register Definitions for both 2.5 V and 3.3 V versions of this device.

Scan Register Sizes

Register Name	Bit Size (× 36)	Bit Size (× 18)
Instruction	3	3
Bypass	1	1
ID	32	32
Boundary scan order (119-ball BGA package)	71	71
Boundary scan order (165-ball FBGA package)	71	71

Identification Codes

Instruction	Code	Description
EXTEST	000	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM outputs to high Z state.
IDCODE	001	Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operations.
SAMPLE Z	010	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a high Z state.
RESERVED	011	Do Not Use: This instruction is reserved for future use.
SAMPLE/PRELOAD	100	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Does not affect SRAM operation.
RESERVED	101	Do Not Use: This instruction is reserved for future use.
RESERVED	110	Do Not Use: This instruction is reserved for future use.
BYPASS	111	Places the bypass register between TDI and TDO. This operation does not affect SRAM operations.

119-ball BGA Boundary Scan Order

CY7C1366C (256 K × 36)					
Bit #	**Ball ID**	**Signal Name**	**Bit #**	**Ball ID**	**Signal Name**
1	K4	CLK	37	P4	A0
2	H4	$\overline{GW}$	38	N4	A1
3	M4	$\overline{BWE}$	39	R6	A
4	F4	$\overline{OE}$	40	T5	A
5	B4	$\overline{ADSC}$	41	T3	A
6	A4	$\overline{ADSP}$	42	R2	A
7	G4	$\overline{ADV}$	43	R3	MODE
8	C3	A	44	P2	DQP_D
9	B3	A	45	P1	DQ_D
10	D6	DQP_B	46	L2	DQ_D
11	H7	DQ_B	47	K1	DQ_D
12	G6	DQ_B	48	N2	DQ_D
13	E6	DQ_B	49	N1	DQ_D
14	D7	DQ_B	50	M2	DQ_D
15	E7	DQ_B	51	L1	DQ_D
16	F6	DQ_B	52	K2	DQ_D
17	G7	DQ_B	53	Internal	Internal
18	H6	DQ_B	54	H1	DQ_C
19	T7	ZZ	55	G2	DQ_C
20	K7	DQ_A	56	E2	DQ_C
21	L6	DQ_A	57	D1	DQ_C
22	N6	DQ_A	58	H2	DQ_C
23	P7	DQ_A	59	G1	DQ_C
24	N7	DQ_A	60	F2	DQ_C
25	M6	DQ_A	61	E1	DQ_C
26	L7	DQ_A	62	D2	DQP_C
27	K6	DQ_A	63	C2	A
28	P6	DQP_A	64	A2	A
29	T4	A	65	E4	$\overline{CE}_1$
30	A3	A	66	B2	CE_2
31	C5	A	67	L3	$\overline{BWD}$
32	B5	A	68	G3	$\overline{BW}_C$
33	A5	A	69	G5	$\overline{BW}_B$
34	C6	A	70	L5	$\overline{BW}_A$
35	A6	A	71	Internal	Internal
36	B6	A			

CY7C1367C (512 K × 18)					
Bit #	**Ball ID**	**Signal Name**	**Bit #**	**Ball ID**	**Signal Name**
1	K4	CLK	37	P4	A0
2	H4	$\overline{GW}$	38	N4	A1
3	M4	$\overline{BWE}$	39	R6	A
4	F4	$\overline{OE}$	40	T5	A
5	B4	$\overline{ADSC}$	41	T3	A
6	A4	$\overline{ADSP}$	42	R2	A
7	G4	$\overline{ADV}$	43	R3	MODE
8	C3	A	44	Internal	Internal
9	B3	A	45	Internal	Internal
10	T2	A	46	Internal	Internal
11	Internal	Internal	47	Internal	Internal
12	Internal	Internal	48	P2	DQP_B
13	Internal	Internal	49	N1	DQ_B
14	D6	DQP_A	50	M2	DQ_B
15	E7	DQ_A	51	L1	DQ_B
16	F6	DQ_A	52	K2	DQ_B
17	G7	DQ_A	53	Internal	Internal
18	H6	DQ_A	54	H1	DQ_B
19	T7	ZZ	55	G2	DQ_B
20	K7	DQ_A	56	E2	DQ_B
21	L6	DQ_A	57	D1	DQ_B
22	N6	DQ_A	58	Internal	Internal
23	P7	DQ_A	59	Internal	Internal
24	Internal	Internal	60	Internal	Internal
25	Internal	Internal	61	Internal	Internal
26	Internal	Internal	62	Internal	Internal
27	Internal	Internal	63	C2	A
28	Internal	Internal	64	A2	A
29	T6	A	65	E4	$\overline{CE}_1$
30	A3	A	66	B2	CE_2
31	C5	A	67	Internal	Internal
32	B5	A	68	Internal	Internal
33	A5	A	69	G3	$\overline{BW}_B$
34	C6	A	70	L5	$\overline{BW}_A$
35	A6	A	71	Internal	Internal
36	B6	A			

165-ball FBGA Boundary Scan Order

CY7C1366C (256 K × 36)					
Bit #	**Ball ID**	**Signal Name**	**Bit #**	**Ball ID**	**Signal Name**
1	B6	CLK	37	R6	A0
2	B7	$\overline{\text{GW}}$	38	P6	A1
3	A7	$\overline{\text{BWE}}$	39	R4	A
4	B8	$\overline{\text{OE}}$	40	P4	A
5	A8	$\overline{\text{ADSC}}$	41	R3	A
6	B9	$\overline{\text{ADSP}}$	42	P3	A
7	A9	$\overline{\text{ADV}}$	43	R1	MODE
8	B10	A	44	N1	DQP_D
9	A10	A	45	L2	DQ_D
10	C11	DQP_B	46	K2	DQ_D
11	E10	DQ_B	47	J2	DQ_D
12	F10	DQ_B	48	M2	DQ_D
13	G10	DQ_B	49	M1	DQ_D
14	D10	DQ_B	50	L1	DQ_D
15	D11	DQ_B	51	K1	DQ_D
16	E11	DQ_B	52	J1	DQ_D
17	F11	DQ_B	53	Internal	Internal
18	G11	DQ_B	54	G2	DQ_C
19	H11	ZZ	55	F2	DQ_C
20	J10	DQ_A	56	E2	DQ_C
21	K10	DQ_A	57	D2	DQ_C
22	L10	DQ_A	58	G1	DQ_C
23	M10	DQ_A	59	F1	DQ_C
24	J11	DQ_A	60	E1	DQ_C
25	K11	DQ_A	61	D1	DQ_C
26	L11	DQ_A	62	C1	DQP_C
27	M11	DQ_A	63	B2	A
28	N11	DQP_A	64	A2	A
29	R11	A	65	A3	CE_1
30	R10	A	66	B3	CE_2
31	P10	A	67	B4	BW_D
32	R9	A	68	A4	$\overline{BW}_C$
33	P9	A	69	A5	$\overline{BW}_B$
34	R8	A	70	B5	$\overline{BW}_A$
35	P8	A	71	A6	$\overline{CE}_3$
36	P11	A			

CY7C1367C (512 K × 18)					
Bit #	**Ball ID**	**Signal Name**	**Bit #**	**Ball ID**	**Signal Name**
1	B6	CLK	37	R6	A0
2	B7	$\overline{\text{GW}}$	38	P6	A1
3	A7	$\overline{\text{BWE}}$	39	R4	A
4	B8	$\overline{\text{OE}}$	40	P4	A
5	A8	$\overline{\text{ADSC}}$	41	R3	A
6	B9	$\overline{\text{ADSP}}$	42	P3	A
7	A9	$\overline{\text{ADV}}$	43	R1	MODE
8	B10	A	44	Internal	Internal
9	A10	A	45	Internal	Internal
10	A11	A	46	Internal	Internal
11	Internal	Internal	47	Internal	Internal
12	Internal	Internal	48	N1	DQP_B
13	Internal	Internal	49	M1	DQ_B
14	C11	DQP_A	50	L1	DQ_B
15	D11	DQ_A	51	K1	DQ_B
16	E11	DQ_A	52	J1	DQ_B
17	F11	DQ_A	53	Internal	Internal
18	G11	DQ_A	54	G2	DQ_B
19	H11	ZZ	55	F2	DQ_B
20	J10	DQ_A	56	E2	DQ_B
21	K10	DQ_A	57	D2	DQ_B
22	L10	DQ_A	58	Internal	Internal
23	M10	DQ_A	59	Internal	Internal
24	Internal	Internal	60	Internal	Internal
25	Internal	Internal	61	Internal	Internal
26	Internal	Internal	62	Internal	Internal
27	Internal	Internal	63	B2	A
28	Internal	Internal	64	A2	A
29	R11	A	65	A3	CE_1
30	R10	A	66	B3	CE_2
31	P10	A	67	Internal	Internal
32	R9	A	68	Internal	Internal
33	P9	A	69	A4	$\overline{BW}_B$
34	R8	A	70	B5	$\overline{BW}_A$
35	P8	A	71	A6	$\overline{CE}_3$
36	P11	A			

Maximum Ratings

Exceeding maximum ratings may impair the useful life of the device. These user guidelines are not tested.

Storage temperature .... –65 °C to +150 °C

Ambient temperature with power applied .... –55 °C to +125 °C

Supply voltage on V_{DD} relative to GND ....–0.5 V to +4.6 V

Supply voltage on V_{DDQ} relative to GND....... –0.5 V to $+V_{DD}$

DC voltage applied to outputs in tri-state ....–0.5 V to V_{DDQ} + 0.5 V

DC input voltage ....–0.5 V to V_{DD} + 0.5 V

Current into outputs (LOW) .... 20 mA

Static discharge voltage... > 2001 V (per MIL-STD-883, method 3015)

Latch-up current .... > 200 mA

Operating Range

Range	Ambient Temperature	V_{DD}	V_{DDQ}
Commercial	0 °C to +70 °C	3.3 V – 5% / + 10%	2.5 V – 5% to V_{DD}
Industrial	–40 °C to +85 °C		

Neutron Soft Error Immunity

Parameter	Description	Test Conditions	Typ	Max*	Unit
LSBU	Logical single-bit upsets	25 °C	361	394	FIT/ Mb
LMBU	Logical multi-bit upsets	25 °C	0	0.01	FIT/ Mb
SEL	Single event latch-up	85 °C	0	0.1	FIT/ Dev

* *No LMBU or SEL events occurred during testing*; this column represents a statistical χ^2, 95% confidence limit calculation. For more details refer to Application Note AN54908 "Accelerated Neutron SER Testing and Calculation of Terrestrial Failure Rates"

Electrical Characteristics

Over the Operating Range[11, 12]

Parameter	Description	Test Conditions	Min	Max	Unit
V_{DD}	Power supply voltage		3.135	3.6	V
V_{DDQ}	I/O supply voltage	for 3.3 V I/O	3.135	V_{DD}	V
		for 2.5 V I/O	2.375	2.625	V
V_{OH}	Output HIGH voltage	for 3.3 V I/O, I_{OH} = –4.0 mA	2.4	–	V
		for 2.5 V I/O, I_{OH} = –1.0 mA	2.0	–	V
V_{OL}	Output LOW voltage	for 3.3 V I/O, I_{OL}= 8.0 mA	–	0.4	V
		for 2.5 V I/O, I_{OL}= 1.0 mA	–	0.4	V
V_{IH}	Input HIGH voltage[11]	for 3.3 V I/O	2.0	V_{DD} + 0.3V	V
		for 2.5 V I/O	1.7	V_{DD} + 0.3V	V
V_{IL}	Input LOW voltage[11]	for 3.3 V I/O	–0.3	0.8	V
		for 2.5 V I/O	–0.3	0.7	V
I_X	Input leakage current except ZZ and MODE	$GND \le V_I \le V_{DDQ}$	–5	5	µA
	Input current of MODE	Input = V_{SS}	–30	–	µA
		Input = V_{DD}	–	5	µA
	Input current of ZZ	Input = V_{SS}	–5	–	µA
		Input = V_{DD}	–	30	µA
I_{OZ}	Output leakage current	$GND \le V_I \le V_{DDQ},$ output disabled	–5	5	µA

Notes

[11] Overshoot: $V_{IH}(AC) < V_{DD}$ + 1.5 V (Pulse width less than $t_{CYC}/2$), undershoot: $V_{IL}(AC) > -2$ V (Pulse width less than $t_{CYC}/2$).

[12] $T_{Power\text{-}up}$: Assumes a linear ramp from 0V to V_{DD}(min) within 200 ms. During this time $V_{IH} < V_{DD}$ and $V_{DDQ} \le V_{DD}$.

Electrical Characteristics *(continued)*

Over the Operating Range[11, 12]

Parameter	Description	Test Conditions		Min	Max	Unit
I_{DD}	V_{DD} operating supply current	V_{DD} = Max, I_{OUT} = 0 mA, $f = f_{MAX} = 1/t_{CYC}$	4 ns cycle, 250 MHz	–	250	mA
			5 ns cycle, 200 MHz	–	220	mA
			6 ns cycle, 166 MHz	–	180	mA
I_{SB1}	Automatic CE power-down current—TTL inputs	V_{DD} = Max, device deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$ $f = f_{MAX} = 1/t_{CYC}$	4 ns cycle, 250 MHz	–	130	mA
			5 ns cycle, 200 MHz	–	120	mA
			6 ns cycle, 166 MHz	–	110	mA
I_{SB2}	Automatic CE power-down current—CMOS inputs	V_{DD} = Max, device deselected, $V_{IN} \leq 0.3$ V or $V_{IN} \geq V_{DDQ} - 0.3$ V, f = 0	All speeds	–	40	mA
I_{SB3}	Automatic CE power-down current—CMOS inputs	V_{DD} = Max, device deselected, or $V_{IN} \leq 0.3$ V or $V_{IN} \geq V_{DDQ} - 0.3$ V $f = f_{MAX} = 1/t_{CYC}$	4 ns cycle, 250 MHz	–	120	mA
			5 ns cycle, 200 MHz	–	110	mA
			6 ns cycle, 166 MHz	–	100	mA
I_{SB4}	Automatic CE power-down current—TTL inputs	V_{DD} = Max, device deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$, f = 0	All speeds	–	40	mA

Capacitance[13]

Parameter	Description	Test Conditions	100 TQFP Max	119 BGA Max	165 FBGA Max	Unit
C_{IN}	Input capacitance	T_A = 25 °C, f = 1 MHz, V_{DD} = 3.3 V V_{DDQ} = 2.5 V	5	5	5	pF
C_{CLK}	Clock input capacitance		5	5	5	pF
$C_{I/O}$	Input/output capacitance		5	7	7	pF

Thermal Resistance[13]

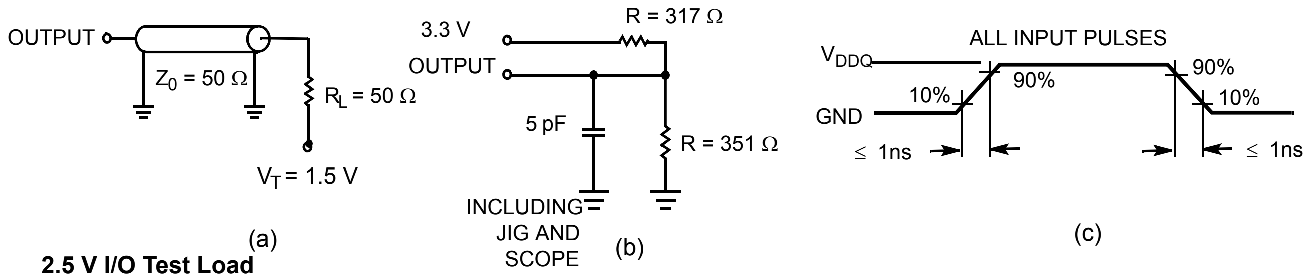
Parameter	Description	Test Conditions	100 TQFP Package	119 BGA Package	165 FBGA Package	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	29.41	34.1	16.8	°C/W
Θ_{JC}	Thermal resistance (junction to case)		6.31	14.0	3.0	°C/W

Note

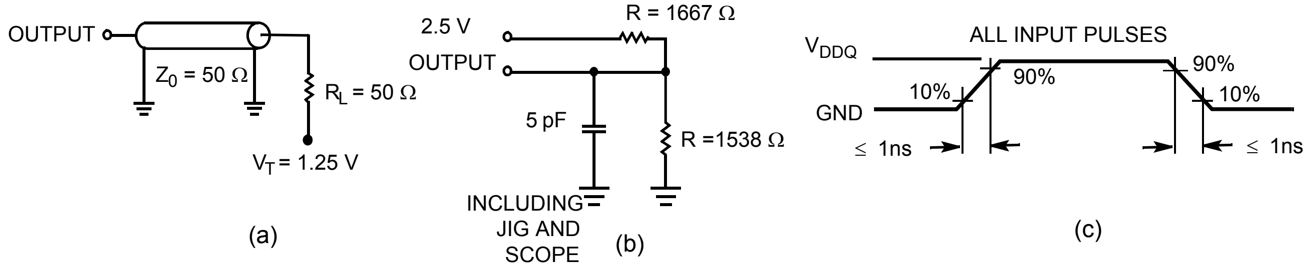
13. Tested initially and after any design or process change that may affect these parameters

Figure 4. AC Test Loads and Waveforms

3.3 V I/O Test Load



2.5 V I/O Test Load



Switching Characteristics

Over the Operating Range[14, 15]

Parameter	Description	–250		–200		166 MHz		Unit
		Min	Max	Min	Max	Min	Max	
t_{POWER}	V_{DD}(Typical) to the first access[16]	1	–	1	–	1	–	ms
Clock								
t_{CYC}	Clock cycle time	4.0	–	5.0	–	6.0	–	ns
t_{CH}	Clock HIGH	1.8	–	2.0	–	2.4	–	ns
t_{CL}	Clock LOW	1.8	–	2.0	–	2.4	–	ns
Output Times								
t_{CO}	Data output valid after CLK rise	–	2.8	–	3.0	–	3.5	ns
t_{DOH}	Data output hold after CLK rise	1.25	–	1.25	–	1.25	–	ns
t_{CLZ}	Clock to low Z[17, 18, 19]	1.25	–	1.25	–	1.25	–	ns
t_{CHZ}	Clock to high Z[17, 18, 19]	1.25	2.8	1.25	3.0	1.25	3.5	ns
t_{OEV}	$\overline{OE}$ LOW to output valid	–	2.8	–	3.0	–	3.5	ns
t_{OELZ}	$\overline{OE}$ LOW to output low Z[17, 18, 19]	0	–	0	–	0	–	ns
t_{OEHZ}	$\overline{OE}$ HIGH to output high Z[17, 18, 19]	–	2.8	–	3.0	–	3.5	ns
Setup Times								
t_{AS}	Address setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
t_{ADS}	$\overline{ADSC}$, $\overline{ADSP}$ setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
t_{ADVS}	$\overline{ADV}$ setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
t_{WES}	$\overline{GW}$, $\overline{BWE}$, $\overline{BW_X}$ setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
t_{DS}	Data input setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
t_{CES}	Chip enable setup before CLK rise	1.4	–	1.5	–	1.5	–	ns
Hold Times								
t_{AH}	Address hold after CLK rise	0.4	–	0.5	–	0.5	–	ns
t_{ADH}	$\overline{ADSP}$, $\overline{ADSC}$ hold after CLK rise	0.4	–	0.5	–	0.5	–	ns
t_{ADVH}	$\overline{ADV}$ hold after CLK rise	0.4	–	0.5	–	0.5	–	ns
t_{WEH}	$\overline{GW}$, $\overline{BWE}$, $\overline{BW_X}$ hold after CLK rise	0.4	–	0.5	–	0.5	–	ns
t_{DH}	Data input hold after CLK rise	0.4	–	0.5	–	0.5	–	ns
t_{CEH}	Chip enable hold after CLK rise	0.4	–	0.5	–	0.5	–	ns

Notes:

[14] Timing reference level is 1.5 V when V_{DDQ} = 3.3 V and is 1.25 V when V_{DDQ} = 2.5 V.

[15] Test conditions shown in (a) of AC Test Loads unless otherwise noted.

[16] This part has a voltage regulator internally; t_{POWER} is the time that the power needs to be supplied above V_{DD}(minimum) initially before a read or write operation can be initiated.

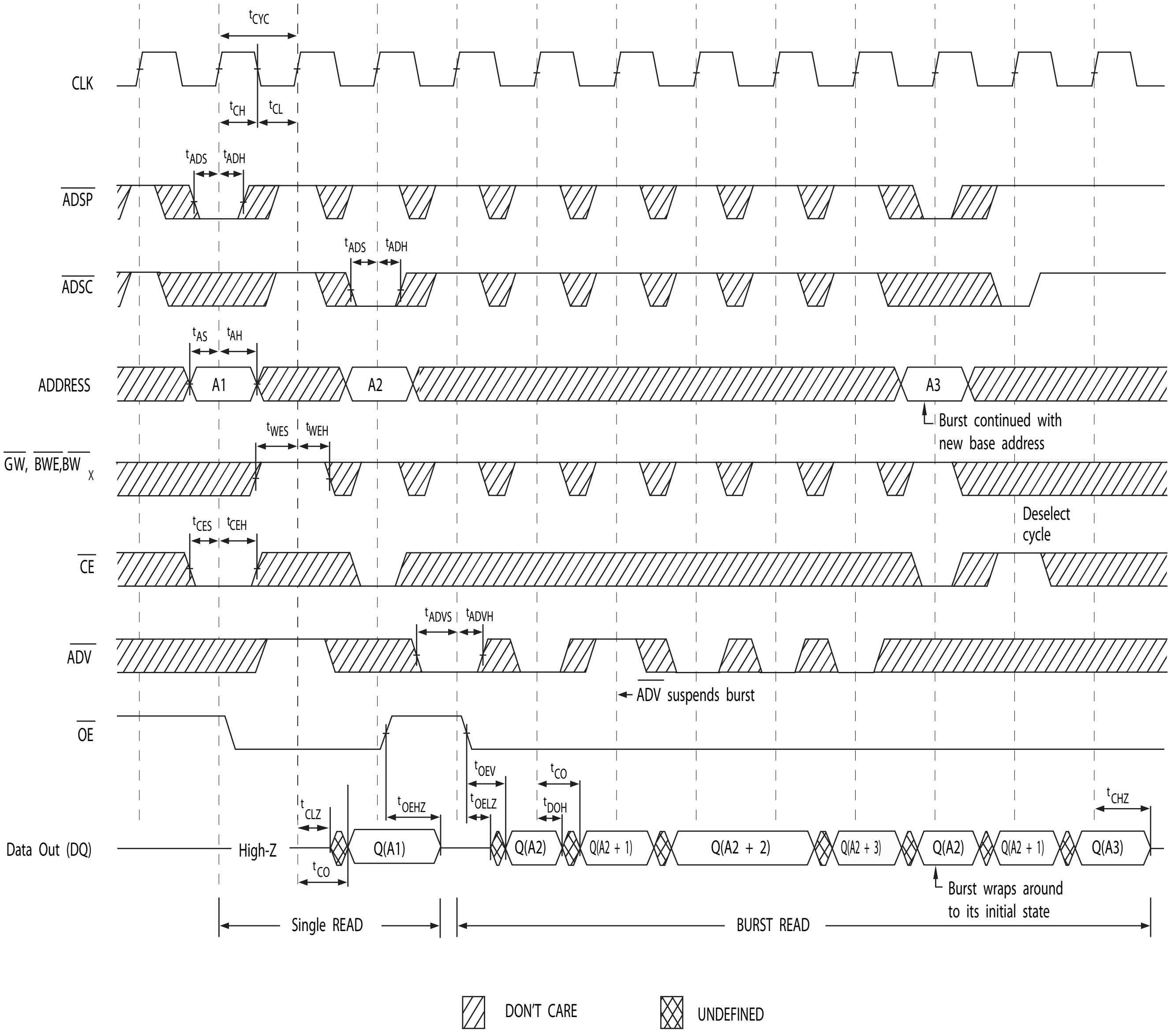
[17] t_{CHZ}, t_{CLZ},t_{OELZ}, and t_{OEHZ} are specified with AC test conditions shown in part (b) of AC Test Loads. Transition is measured ± 200 mV from steady-state voltage.

[18] At any given voltage and temperature, t_{OEHZ} is less than t_{OELZ} and t_{CHZ} is less than t_{CLZ} to eliminate bus contention between SRAMs when sharing the same data bus. These specifications do not imply a bus contention condition, but reflect parameters guaranteed over worst case user conditions. Device is designed to achieve high Z prior to low Z under the same system conditions.

[19] This parameter is sampled and not 100% tested.

Switching Waveforms

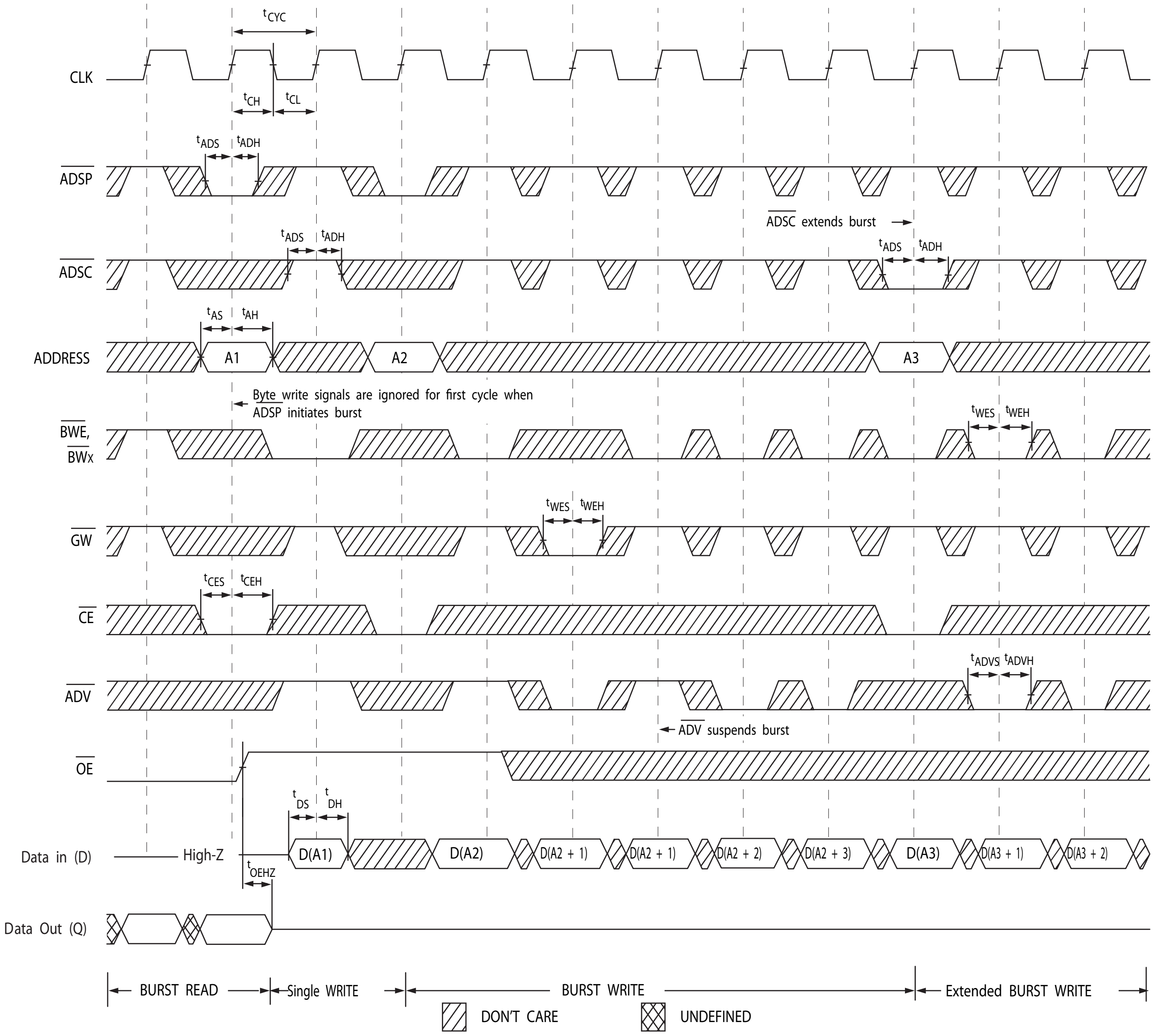
Figure 5. Read Cycle Timing[20]



Note

20. In this diagram, when $\overline{CE}$ is LOW: $\overline{CE}_1$ is LOW, CE_2 is HIGH and $\overline{CE}_3$ is LOW. When $\overline{CE}$ is HIGH: $\overline{CE}_1$ is HIGH or CE_2 is LOW or $\overline{CE}_3$ is HIGH.

Figure 6. Write Cycle Timing[21, 22]



Notes

21. In this diagram, when $\overline{CE}$ is LOW: $\overline{CE}_1$ is LOW, CE_2 is HIGH and $\overline{CE}_3$ is LOW. When $\overline{CE}$ is HIGH: $\overline{CE}_1$ is HIGH or CE_2 is LOW or $\overline{CE}_3$ is HIGH.
22. Full width write can be initiated by either $\overline{GW}$ LOW; or by $\overline{GW}$ HIGH, $\overline{BWE}$ LOW and $\overline{BW}_X$ LOW.

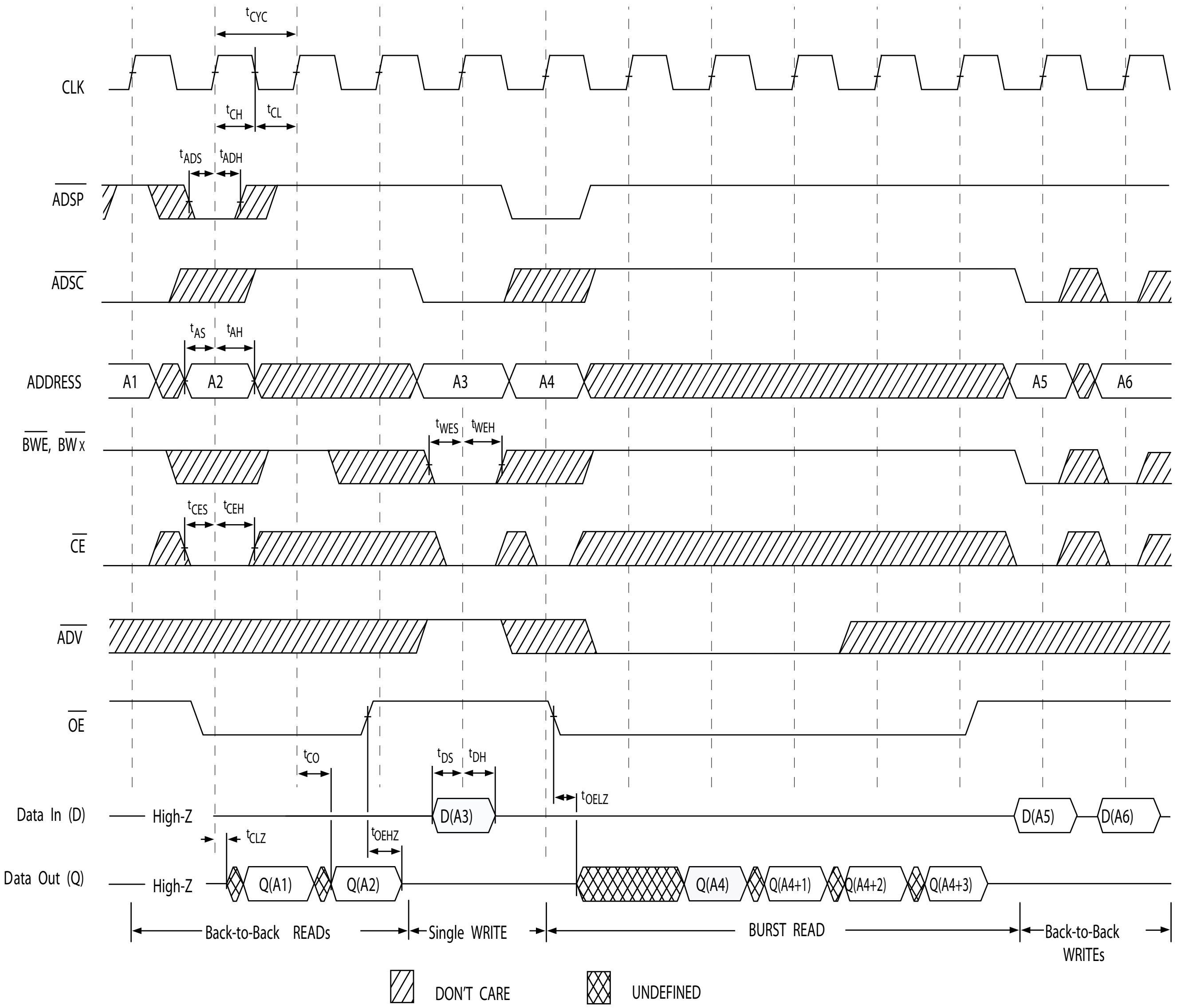


Figure 7. Read/Write Cycle Timing[23, 24, 25]

Notes

[23] In this diagram, when $\overline{CE}$ is LOW: $\overline{CE}_1$ is LOW, CE_2 is HIGH and $\overline{CE}_3$ is LOW. When $\overline{CE}$ is HIGH: $\overline{CE}_1$ is HIGH or CE_2 is LOW or $\overline{CE}_3$ is HIGH.

[24] The data bus (Q) remains in high Z following a WRITE cycle, unless a new read access is initiated by $\overline{ADSP}$ or $\overline{ADSC}$.

[25] $\overline{GW}$ is HIGH.

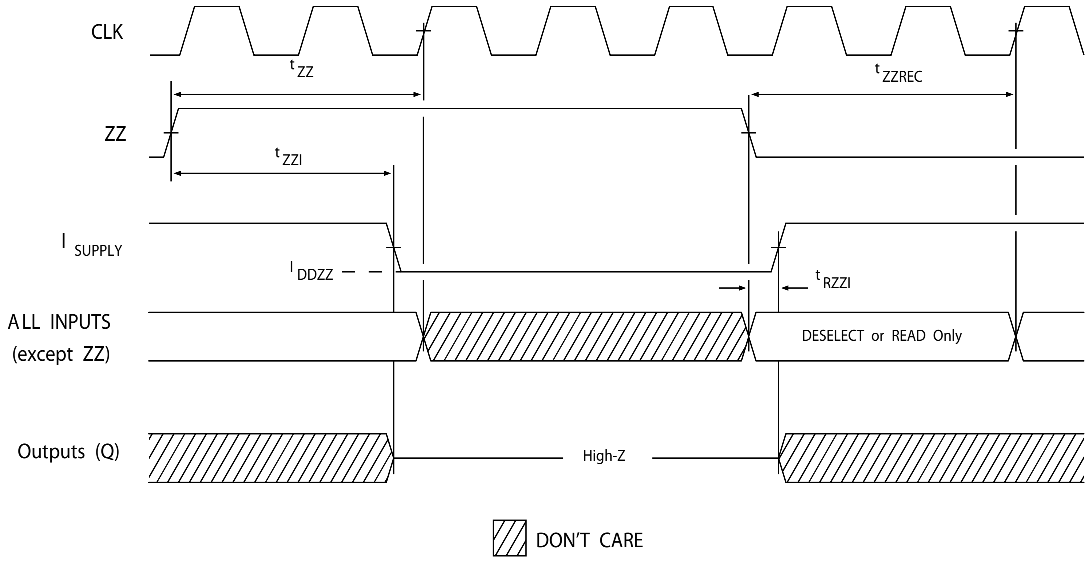


Figure 8. ZZ Mode Timing[26, 27]

Notes

26. Device must be deselected when entering ZZ mode. See Cycle Descriptions table for all possible signal conditions to deselect the device.
27. DQs are in high Z when exiting ZZ sleep mode.

Ordering Information

The table below contains only the parts that are currently available. If you don’t see what you are looking for, please contact your local sales representative. For more information, visit the Cypress website at www.cypress.com and refer to the product summary page at http://www.cypress.com/products

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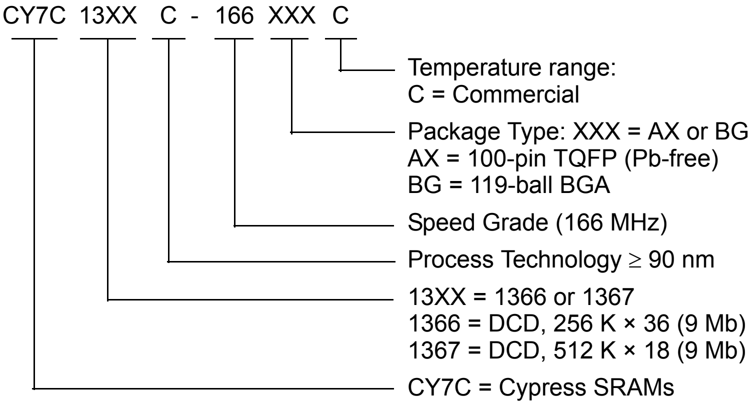
Speed (MHz)	Ordering Code	Package Diagram	Part and Package Type	Operating Range
166	CY7C1366C-166AXC	51-85050	100-pin Thin Quad Flat Pack (14 × 20 × 1.4 mm) Pb-free	Commercial
	CY7C1367C-166AXC			
	CY7C1366C-166BGC	51-85115	119-ball Ball Grid Array (14 × 22 × 2.4 mm)	

Ordering Code Definitions



Temperature range:
C = Commercial

Package Type: XXX = AX or BG
AX = 100-pin TQFP (Pb-free)
BG = 119-ball BGA

Speed Grade (166 MHz)

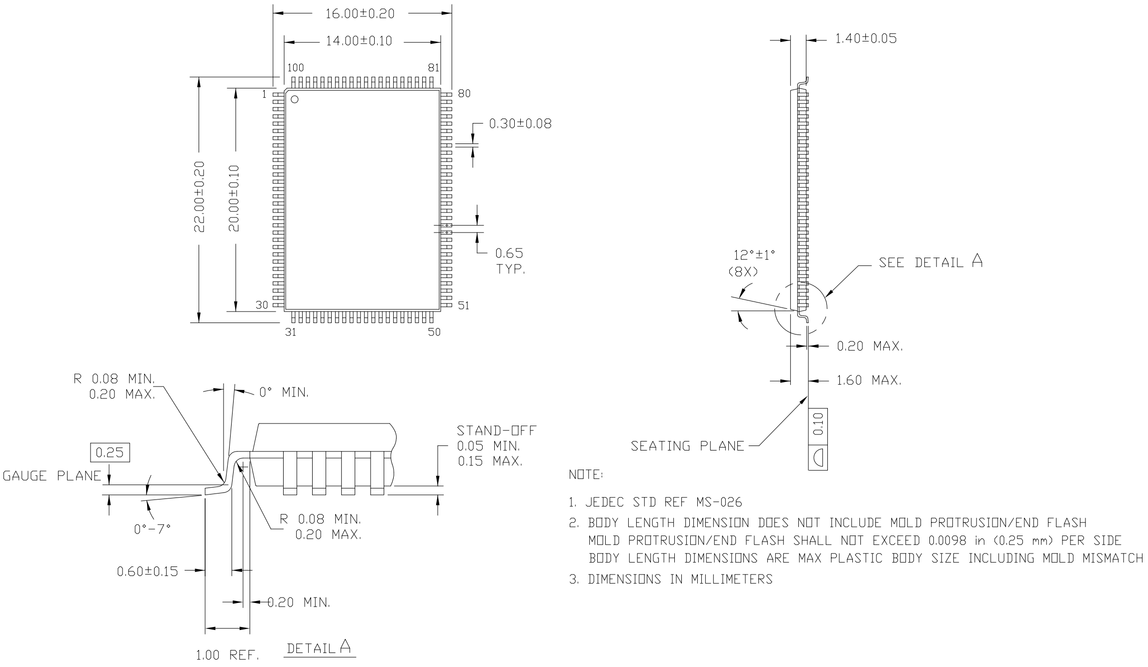
Process Technology ≥ 90 nm

13XX = 1366 or 1367
1366 = DCD, 256 K × 36 (9 Mb)
1367 = DCD, 512 K × 18 (9 Mb)

CY7C = Cypress SRAMs

Package Diagrams

Figure 9. 100-pin Thin Plastic Quad Flatpack (14 × 20 × 1.4 mm), 51-85050

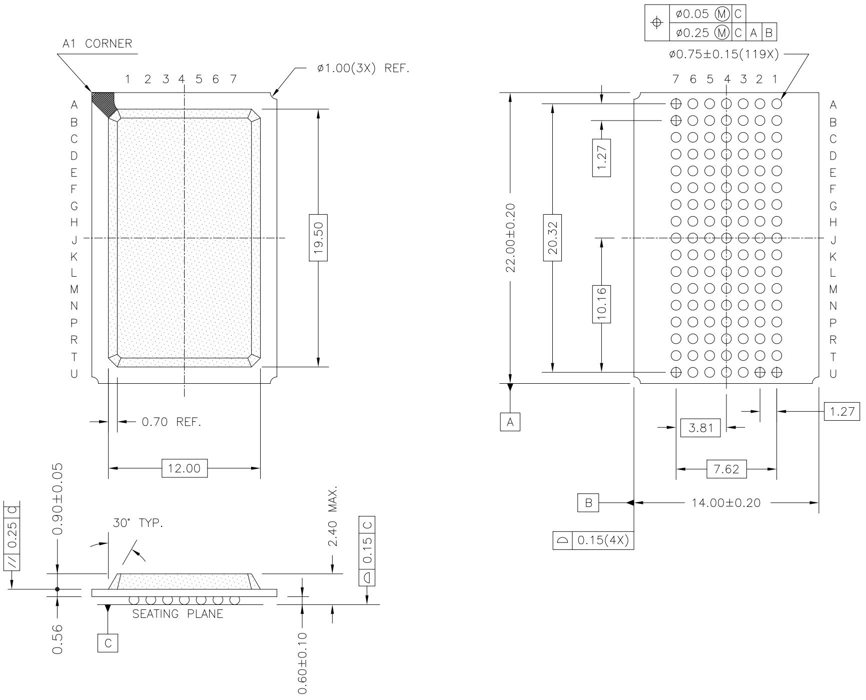


NOTE:

1. JEDEC STD REF MS-026
2. BODY LENGTH DIMENSION DOES NOT INCLUDE MOLD PROTRUSION/END FLASH
   MOLD PROTRUSION/END FLASH SHALL NOT EXCEED 0.0098 in (0.25 mm) PER SIDE
   BODY LENGTH DIMENSIONS ARE MAX PLASTIC BODY SIZE INCLUDING MOLD MISMATCH
3. DIMENSIONS IN MILLIMETERS

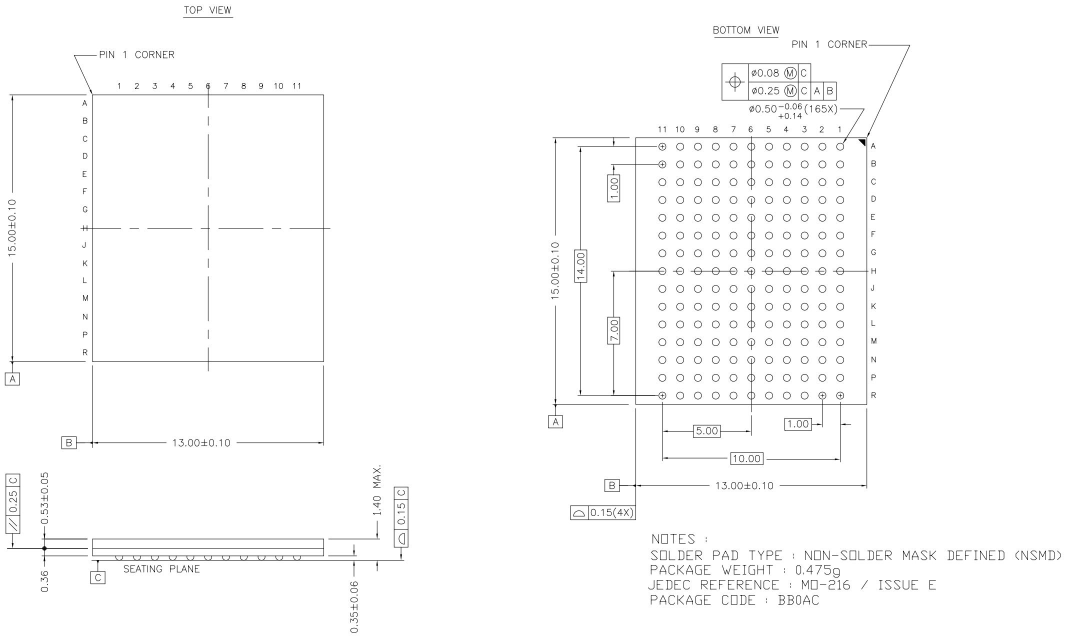
51-85050 *C

Figure 10. 119-ball BGA (14 × 22 × 2.4 mm), 51-85115



51-85115 *C

Figure 11. 165-ball FBGA (13 × 15 × 1.4 mm), 51-85180



51-85180 *C

Acronyms

Acronym	Description
BGA	ball grid array
CE	chip enable
CEN	clock enable
FPBGA	fine-pitch ball grid array
I/O	input/output
JTAG	Joint Test Action Group
OE	output enable
SRAM	static random access memory
TCK	test clock
TMS	test mode select
TDI	test data-in
TDO	test data-out
TQFP	thin quad flat pack
WE	write enable

Document Conventions

Units of Measure

Symbol	Unit of Measure
ns	nano seconds
V	Volts
µA	micro Amperes
mA	milli Amperes
ms	milli seconds
MHz	Mega Hertz
pF	pico Farad
W	Watts
°C	degree Celcius

Document History Page

Document Title: CY7C1366C/CY7C1367C 9-Mbit (256 K × 36/512 K × 18) Pipelined DCD Sync SRAM
Document Number: 38-05542

REV.	ECN NO.	Submission Date	Orig. of Change	Description of Change
**	241690	See ECN	RKF	New data sheet
*A	278969	See ECN	RKF	Changed Boundary Scan order to match the B rev of these devices
*B	332059	See ECN	PCI	Changed 225-MHz to 250 MHz Speed bins Changed t_{CYC} for 250 MHz from 4.4 ns to 4.0 ns Unshaded 200 and 166 MHz speed bins in the AC/DC Table and Selection Guide Address expansion pins/balls in the pinouts for all packages are modified as per JEDEC standard Added Address Expansion pins in the Pin Definitions Table Changed Device Width (23:18) for 119-BGA from 000110 to 101110 Added separate row for 165 -FBGA Device Width (23:18) Included ZZ Mode Electrical Characteristics table Modified V_{OL}, V_{OH} test conditions Changed I_{DDZZ} from 35 mA to 50 mA Changed I_{SB1} from 50 mA to 130, 120 and 110 mA for 250, 200 and 166 MHz Changed I_{SB3} from 50 mA to 120, 110 and 100 mA for 250, 200 and 166 MHz Changed Θ_{JA} and Θ_{JC} from 25 and 9 °C/W to 29.41 and 6.31 °C/W respectively for 100 TQFP Package Changed Θ_{JA} and Θ_{JC} from 25 and 6 °C/W to 34.1 and 14.0 °C/W respectively for 119 BGA Package Changed Θ_{JA} and Θ_{JC} from 27 and 6 °C/W to 16.8 and 3.0 °C/W respectively for 165 FBGA Package Added lead-free information for 100-pin TQFP, 119 BGA and 165 FBGA packages Updated Ordering Information Table
*C	377095	See ECN	PCI	Changed I_{SB2} from 30 to 40 mA Modified test condition in note# 8 from $V_{IH} \leq V_{DD}$ to $V_{IH} < V_{DD}$
*D	408298	See ECN	RXU	Changed address of Cypress Semiconductor Corporation on Page# 1 from “3901 North First Street” to “198 Champion Court” Converted from Preliminary to Final Modified “Input Load” to “Input Leakage Current except ZZ and MODE” in the Electrical Characteristics Table Replaced Package Name column with Package Diagram in the Ordering Information table Updated the ordering information
*E	501793	See ECN	VKN	Added the Maximum Rating for Supply Voltage on V_{DDQ} Relative to GND. Changed t_{TH}, t_{TL} from 25 ns to 20 ns and t_{TDOV} from 5 ns to 10 ns in TAP AC Switching Characteristics table. Updated the Ordering Information table.
*F	2756940	08/27/2009	VKN	Included Soft Error Immunity Data Modified Ordering Information table by including parts that are available and modified the disclaimer for the Ordering information.
*G	3046851	10/04/2010	NJY	Added Ordering Code Definitions. Updated Package Diagrams. Added Acronyms and Units of Measure. Minor edits and updated in new template.

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