PRELIMINARY

CY7C1303CV25
CY7C1306CV25

18-Mbit Burst of 2 Pipelined SRAM with QDR™ Architecture

Features

- Separate independent read and write data ports
  - Supports concurrent transactions
- 167 MHz clock for high bandwidth
  - 2.5 ns Clock-to-Valid access time
- 2-word burst on all accesses
- Double Data Rate (DDR) interfaces on both read and write ports (data transferred at 333 MHz) at 167 MHz
- Two input clocks (K and $\overline{K}$) for precise DDR timing
  - SRAM uses rising edges only
- Two input clocks for output data (C and $\overline{C}$) to minimize clock skew and flight time mismatches
- Single multiplexed address input bus latches address inputs for both read and write ports
- Separate port selects for depth expansion
- Synchronous internally self-timed writes
- 2.5V core power supply with HSTL inputs and outputs
- Available in 165-Ball FBGA package (13 x 15 x 1.4 mm)
- Variable drive HSTL output buffers
- Expanded HSTL output voltage (1.4V–1.9V)
- JTAG interface
- Variable Impedance HSTL

Configurations

CY7C1303CV25 – 1M x 18
CY7C1306CV25 – 512K x 36

Functional Description

The CY7C1303CV25 and CY7C1306CV25 are 2.5V Synchronous Pipelined SRAMs, equipped with QDR™ architecture. QDR architecture consists of two separate ports: the read port and the write port to access the memory array. The read port has data outputs to support read operations and the write port has data inputs to support write operations. QDR architecture has separate data inputs and data outputs to completely eliminate the need to “turn-around” the data bus required with common I/O devices. Access to each port is accomplished through a common address bus. The read address is latched on the rising edge of the K clock and the write address is latched on the rising edge of the $\overline{K}$ clock. Accesses to the QDR read and write ports are completely independent of one another. All accesses are initiated synchronously on the rising edge of the positive input clock (K). To maximize data throughput, both read and write ports are provided with DDR interfaces. Therefore, data can be transferred into the device on every rising edge of both input clocks (K and $\overline{K}$) and out of the device on every rising edge of the output clock (C and $\overline{C}$, or K and $\overline{K}$ when in single clock mode) thereby maximizing performance while simplifying system design. Each address location is associated with two 18-bit words (CY7C1303CV25), or 36-bit words (CY7C1306CV25) that burst sequentially into or out of the device.

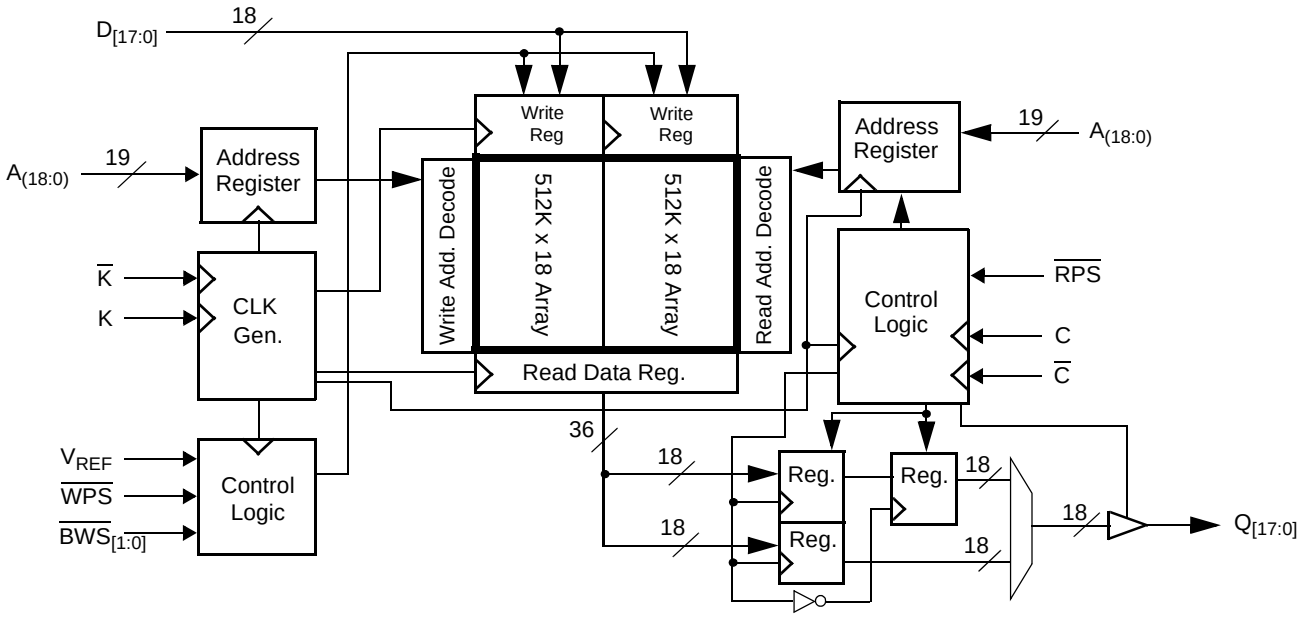
Depth expansion is accomplished with port selects, which enables each port to operate independently.

All synchronous inputs pass through input registers controlled by the K or $\overline{K}$ input clocks. All data outputs pass through output registers controlled by the C or $\overline{C}$ (or K/$\overline{K}$ in a single clock domain) input clocks. Writes are conducted with on-chip synchronous self-timed write circuitry.

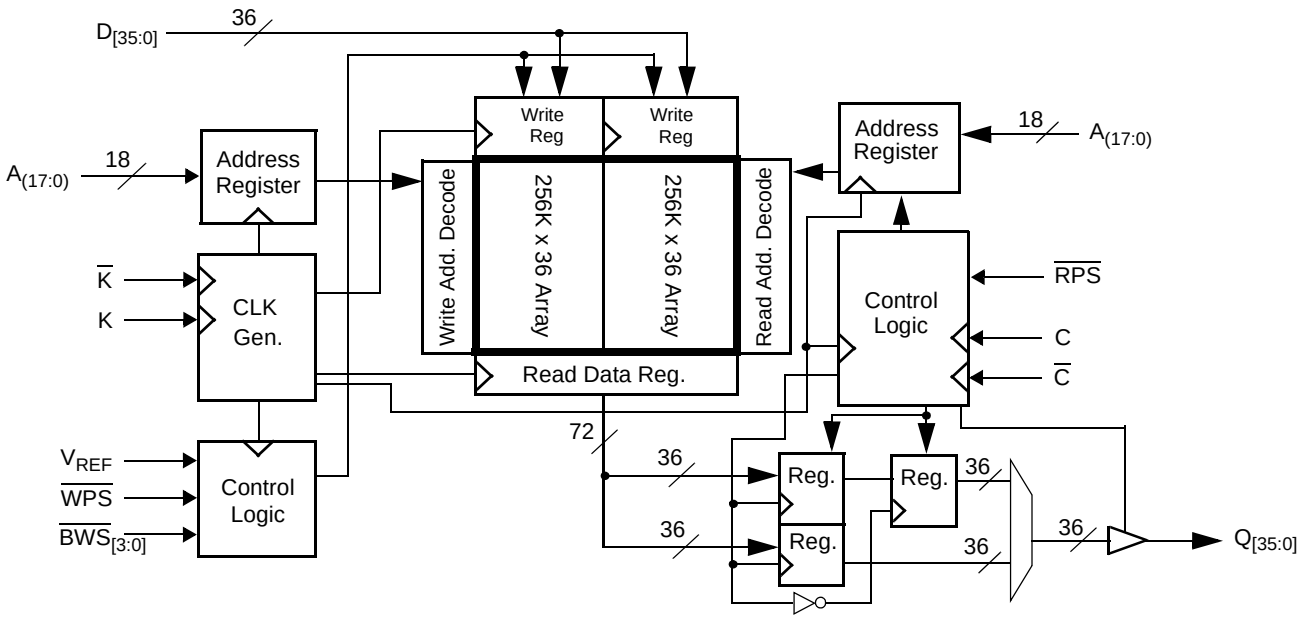
Selection Guide

Description	167 MHz	Unit
Maximum Operating Frequency	167	MHz
Maximum Operating Current	500	mA

Logic Block Diagram (CY7C1303CV25)



Logic Block Diagram (CY7C1306CV25)



Pin Configuration

The pin configurations for CY7C1303CV25 and CY7C1306CV25 follow.

165-Ball FBGA (13 x 15 x 1.4 mm) Pinout

CY7C1303CV25 (1M x 18)

	1	2	3	4	5	6	7	8	9	10	11
A	NC	GND/144M	NC/36M	$\overline{WPS}$	$\overline{BWS_1}$	$\overline{K}$	NC	$\overline{RPS}$	A	GND/72M	NC
B	NC	Q9	D9	A	NC	K	$\overline{BWS_0}$	A	NC	NC	Q8
C	NC	NC	D10	V_{SS}	A	A	A	V_{SS}	NC	Q7	D8
D	NC	D11	Q10	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC	D7
E	NC	NC	Q11	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	D6	Q6
F	NC	Q12	D12	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	Q5
G	NC	D13	Q13	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	NC	D5
H	NC	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	NC	NC	D14	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	Q4	D4
K	NC	NC	Q14	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	NC	D3	Q3
L	NC	Q15	D15	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	NC	Q2
M	NC	NC	D16	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	Q1	D2
N	NC	D17	Q16	V_{SS}	A	A	A	V_{SS}	NC	NC	D1
P	NC	NC	Q17	A	A	C	A	A	NC	D0	Q0
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

CY7C1306CV25 (512K x 36)

	1	2	3	4	5	6	7	8	9	10	11
A	NC	GND/288M	NC/72M	$\overline{WPS}$	$\overline{BWS_2}$	$\overline{K}$	$\overline{BWS_1}$	$\overline{RPS}$	NC/36M	GND/144M	NC
B	Q27	Q18	D18	A	$\overline{BWS_3}$	K	$\overline{BWS_0}$	A	D17	Q17	Q8
C	D27	Q28	D19	V_{SS}	A	A	A	V_{SS}	D16	Q7	D8
D	D28	D20	Q19	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	Q16	D15	D7
E	Q29	D29	Q20	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	Q15	D6	Q6
F	Q30	Q21	D21	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	D14	Q14	Q5
G	D30	D22	Q22	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	Q13	D13	D5
H	NC	V_{REF}	V_{DDQ}	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	V_{DDQ}	V_{REF}	ZQ
J	D31	Q31	D23	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	D12	Q4	D4
K	Q32	D32	Q23	V_{DDQ}	V_{DD}	V_{SS}	V_{DD}	V_{DDQ}	Q12	D3	Q3
L	Q33	Q24	D24	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	D11	Q11	Q2
M	D33	Q34	D25	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	D10	Q1	D2
N	D34	D26	Q25	V_{SS}	A	A	A	V_{SS}	Q10	D9	D1
P	Q35	D35	Q26	A	A	C	A	A	Q9	D0	Q0
R	TDO	TCK	A	A	A	$\overline{C}$	A	A	A	TMS	TDI

Pin Definitions

Pin Name	I/O	Pin Description
$D_{[x:0]}$	Input-Synchronous	**Data Input Signals.** Sampled on the rising edge of K and $\overline{K}$ clocks during valid write operations. CY7C1303CV25 - $D_{[17:0]}$ CY7C1306CV25 - $D_{[35:0]}$
$\overline{WPS}$	Input-Synchronous	**Write Port Select** – **Active LOW**. Sampled on the rising edge of the K clock. When asserted active, a write operation is initiated. Deasserting deselects the write port. Deselecting the write port ignores $D_{[x:0]}$.
$\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$, $\overline{BWS_3}$	Input-Synchronous	**Byte Write Select 0, 1, 2 and 3** – **Active LOW**. Sampled on the rising edge of the K and $\overline{K}$ clocks during write operations. Used to select which byte is written into the device during the current portion of the write operations. CY7C1303CV25 – $\overline{BWS_0}$ controls $D_{[8:0]}$, $\overline{BWS_1}$ controls $D_{[17:9]}$. CY7C1306CV25 – $\overline{BWS_0}$ controls $D_{[8:0]}$, $\overline{BWS_1}$ controls $D_{[17:9]}$, $\overline{BWS_2}$ controls $D_{[26:18]}$ and $\overline{BWS_3}$ controls $D_{[35:27]}$. Bytes not written remain unaltered. Deselecting a Byte Write Select ignores the corresponding byte of data and it is not written into the device.
A	Input-Synchronous	**Address Inputs.** Sampled on the rising edge of the K clock during active Read operations and on the rising edge of $\overline{K}$ for Write operations. These address inputs are multiplexed for both read and write operations. Internally, the device is organized as 1M x 18 (2 arrays each of 512K x 18) for CY7C1303CV25 and 512K x 36 (2 arrays each of 256K x 36) for CY7C1306CV25. Therefore, only 19 address inputs are needed to access the entire memory array of CY7C1303CV25 and 18 address inputs for CY7C1306CV25. These inputs are ignored when the appropriate port is deselected.
$Q_{[x:0]}$	Outputs-Synchronous	**Data Output Signals**. These pins drive out the requested data during a read operation. Valid data is driven out on the rising edge of both the C and $\overline{C}$ clocks during read operations, or K and $\overline{K}$ when in single clock mode. When the read port is deselected, $Q_{[x:0]}$ are automatically tri-stated. CY7C1303CV25 – $Q_{[17:0]}$ CY7C1306CV25 – $Q_{[35:0]}$
$\overline{RPS}$	Input-Synchronous	**Read Port Select** – **Active LOW**. Sampled on the rising edge of positive input clock (K). When active, a read operation is initiated. Deasserting deselects the read port. When deselected, the pending access is allowed to complete and the output drivers are automatically tri-stated following the next rising edge of the C clock. Each read access consists of a burst of two sequential transfers.
C	Input Clock	**Positive Input Clock for Output Data**. C is used in conjunction with $\overline{C}$ to clock out the read data from the device. C and $\overline{C}$ can be used together to deskew the flight times of various devices on the board back to the controller. See Application Example on page 7 for further details.
$\overline{C}$	Input Clock	**Negative Input Clock for Output Data**. $\overline{C}$ is used in conjunction with C to clock out the read data from the device. C and $\overline{C}$ can be used together to deskew the flight times of various devices on the board back to the controller. See Application Example on page 7 for further details.
K	Input Clock	**Positive Input Clock Input**. The rising edge of K is used to capture synchronous inputs to the device and to drive out data through $Q_{[x:0]}$ when in single clock mode. All accesses are initiated on the rising edge of K.
$\overline{K}$	Input Clock	**Negative Input Clock Input**. $\overline{K}$ is used to capture synchronous inputs being presented to the device and to drive out data through $Q_{[x:0]}$ when in single clock mode.
ZQ	Input	**Output Impedance Matching Input**. This input is used to tune the device outputs to the system data bus impedance. $Q_{[x:0]}$ output impedance are set to 0.2 x RQ, where RQ is a resistor connected between ZQ and ground. Alternatively, this pin can be connected directly to V_{DDQ}, which enables the minimum impedance mode. This pin cannot be connected directly to GND or left unconnected.

Pin Definitions (continued)

Pin Name	I/O	Pin Description
TDO	Output	**TDO for JTAG**.
TCK	Input	**TCK Pin for JTAG**.
TDI	Input	**TDI Pin for JTAG**.
TMS	Input	**TMS Pin for JTAG**.
NC	N/A	**Not Connected to the Die**. Can be tied to any voltage level.
NC/36M	N/A	**Not Connected to the Die**. Can be tied to any voltage level.
GND/72M	Input	**Address expansion for 72M.** This pin must be tied to GND on CY7C1303CV25.
NC/72M	N/A	**Address expansion for 72M.** This pin can be tied to any voltage level on CY7C1306CV25.
GND/144M	Input	**Address expansion for 144M.** This pin must be tied to GND on CY7C1303CV25/CY7C1306CV25.
GND/288M	Input	**Address expansion for 288M.** This pin must be tied to GND on CY7C1306CV25.
V_{REF}	Input-Reference	**Reference Voltage Input**. Static input used to set the reference level for HSTL inputs, Outputs, and AC measurement points.
V_{DD}	Power Supply	**Power Supply Inputs to the Core of the Device**.
V_{SS}	Ground	**Ground for the Device**.
V_{DDQ}	Power Supply	**Power Supply Inputs for the Outputs of the Device**.

Functional Overview

The CY7C1303CV25 and CY7C1306CV25 are synchronous pipelined Burst SRAMs equipped with a read port and a write port. The read port is dedicated to read operations and the write port is dedicated to write operations. Data flows into the SRAM through the write port and flows out through the read port. These devices multiplex the address inputs to minimize the number of address pins required. By having separate read and write ports, the QDR completely eliminates the need to “turn-around” the data bus and avoids any possible data contention, thereby simplifying system design. Each access consists of two 18-bit data transfers in the case of CY7C1303CV25, and two 36-bit data transfers in the case of CY7C1306CV25 in one clock cycle.

Accesses for both ports are initiated on the rising edge of the positive input clock (K). All synchronous input timing is referenced from the rising edge of the input clocks (K and $\overline{K}$) and all output timing is referenced to the rising edge of the output clocks (C and $\overline{C}$, or K and $\overline{K}$ when in single clock mode).

All synchronous data inputs ($D_{[x:0]}$) pass through input registers controlled by the input clocks (K and $\overline{K}$). All synchronous data outputs ($Q_{[x:0]}$) pass through output registers controlled by the rising edge of the output clocks (C and $\overline{C}$ or K and $\overline{K}$ when in single clock mode).

All synchronous control ($\overline{RPS}$, $\overline{WPS}$, $\overline{BWS}_{[x:0]}$) inputs pass through input registers controlled by the rising edge of the input clocks (K and $\overline{K}$).

CY7C1303CV25 is described in the following sections. The same basic descriptions apply to CY7C1306CV25.

Read Operations

The CY7C1303CV25 is organized internally as two arrays of 512K x 18. Accesses are completed in a burst of two sequential 18-bit data words. Read operations are initiated by asserting $\overline{RPS}$ active at the rising edge of the positive input clock (K). The address is latched on the rising edge of the K clock. The address presented to the address inputs is stored in the read address register. Following the next K clock rise the corresponding lowest order 18-bit word of data is driven onto the $Q_{[17:0]}$ using C as the output timing reference. On the subsequent rising edge of $\overline{C}$, the next 18-bit data word is driven onto the $Q_{[17:0]}$. The requested data is valid 2.5 ns from the rising edge of the output clock (C and $\overline{C}$ or K and $\overline{K}$ when in single clock mode).

Synchronous internal circuitry automatically tri-states the outputs following the next rising edge of the positive output clock (C). This allows a seamless transition between devices without the insertion of wait states in a depth expanded memory.

Write Operations

Write operations are initiated by asserting $\overline{WPS}$ active at the rising edge of the positive input clock (K). On the same K clock rise, the data presented to $D_{[17:0]}$ is latched and stored into the lower 18-bit write data register, provided $\overline{BWS}_{[1:0]}$ are both asserted active. On the subsequent rising edge of the negative input clock ($\overline{K}$), the address is latched and the information presented to $D_{[17:0]}$ is stored into the write data register, provided $\overline{BWS}_{[1:0]}$ are both asserted active. The 36 bits of data are then written into the memory array at the specified location. When deselected, the write port ignores all inputs after completion of pending write operations.

Byte Write Operations

Byte write operations are supported by the CY7C1303CV25. A write operation is initiated as described in the section Write Operations on page 6. The bytes that are written are determined by $\overline{BWS}_0$ and $\overline{BWS}_1$, which are sampled with each 18-bit data word. Asserting the appropriate Byte Write Select input during the data portion of a write latches the data being presented and writes it into the device. Deasserting the Byte Write Select input during the data portion of a write allows the data stored in the device for that byte to remain unaltered. This feature can be used to simplify read, modify, or write operations to a byte write operation.

Single Clock Mode

The CY7C1303CV25 can be used with a single clock that controls both the input and output registers. In this mode, the device recognizes only a single pair of input clocks (K and $\overline{K}$) that control both the input and output registers. This operation is identical to the operation if the device had zero skew between the K/$\overline{K}$ and C/$\overline{C}$ clocks. All timing parameters remain the same in this mode. To use this mode of operation, the user must tie C and $\overline{C}$ HIGH at power on. This function is a strap option and not alterable during device operation.

Concurrent Transactions

The read and write ports on the CY7C1303CV25 operate independently of one another. As each port latches the address inputs on different clock edges, the user can read or write to any location, regardless of the transaction on the other port. The user can start reads and writes in the same clock cycle. If the ports access the same location at the same time, the SRAM delivers the most recent information associated with the specified address location. This includes forwarding data from a write cycle that was initiated on the previous K clock rise.

Depth Expansion

The CY7C1303CV25 has a port select input for each port. This enables for easy depth expansion. Both port selects are sampled on the rising edge of the positive input clock only (K). Each port select input can deselect the specified port. Deselecting a port does not affect the other port. All pending transactions (read and write) are completed before the device is deselected.

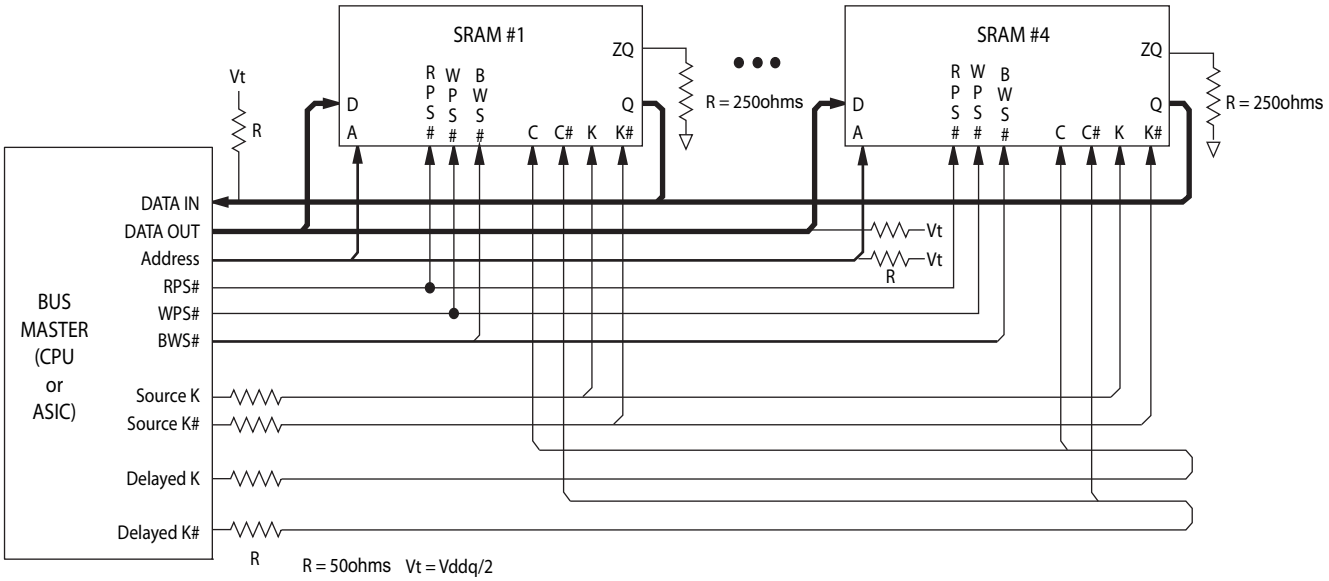
Programmable Impedance

An external resistor, RQ, must be connected between the ZQ pin on the SRAM and V_{SS} to allow the SRAM to adjust its output driver impedance. The value of RQ must be 5x the value of the intended line impedance driven by the SRAM. The allowable range of RQ to guarantee impedance matching with a tolerance of ±15% is between 175Ω and 350Ω, with V_{DDQ} = 1.5V. The output impedance is adjusted every 1024 cycles upon power up to account for drifts in supply voltage and temperature.

Application Example

Figure 1 shows four QDR-I used in an application.

Figure 1. Application Example



Truth Table

The truth table for CY7C1303CV25 and CY7C1306CV25 follows. [1, 2, 3, 4, 5, 6]

Operation	K	$\overline{RPS}$	$\overline{WPS}$	DQ	DQ
Write Cycle: Load address on the rising edge of $\overline{K}$; input write data on K and $\overline{K}$ rising edges.	L-H	X	L	D(A + 0) at K(t) ↑	D(A + 1) at $\overline{K}$(t) ↑
Read Cycle: Load address on the rising edge of K; wait one cycle; read data on C and $\overline{C}$ rising edges.	L-H	L	X	Q(A + 0) at C(t + 1) ↑	Q(A + 1) at $\overline{C}$(t + 1) ↑
NOP: No Operation	L-H	H	H	D = X Q = High-Z	D = X Q = High-Z
Standby: Clock Stopped	Stopped	X	X	Previous State	Previous State

Notes
1. X = "Don't Care," H = Logic HIGH, L = Logic LOW, ↑represents rising edge.
2. Device powers up deselected with the outputs in a tri-state condition.
3. "A" represents address location latched by the devices when transaction was initiated. A + 0, A + 1 represents the internal address sequence in the burst.
4. "t" represents the cycle at which a Read/Write operation is started. t + 1 is the first clock cycle succeeding the "t" clock cycle.
5. Data inputs are registered at K and $\overline{K}$ rising edges. Data outputs are delivered on C and $\overline{C}$ rising edges, except when in single clock mode.
6. It is recommended that K = $\overline{K}$ and C = $\overline{C}$ = HIGH when clock is stopped. This is not essential, but permits most rapid restart by overcoming transmission line charging symmetrically.

Write Cycle Descriptions

The write cycle description table for CY7C1303CV25 follows. [1, 7]

$\overline{BWS_0}$	$\overline{BWS_1}$	K	$\overline{K}$	Comments
L	L	L–H	–	During the data portion of a write sequence, both bytes ($D_{[17:0]}$) are written into the device.
L	L	–	L-H	During the data portion of a write sequence, both bytes ($D_{[17:0]}$) are written into the device.
L	H	L–H	–	During the data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device, $D_{[17:9]}$ remains unaltered.
L	H	–	L–H	During the data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device, $D_{[17:9]}$ remains unaltered.
H	L	L–H	–	During the data portion of a write sequence, only the upper byte ($D_{[17:9]}$) is written into the device, $D_{[8:0]}$ remains unaltered.
H	L	–	L–H	During the data portion of a write sequence, only the upper byte ($D_{[17:9]}$) is written into the device, $D_{[8:0]}$ remains unaltered.
H	H	L–H	–	No data is written into the devices during this portion of a write operation.
H	H	–	L–H	No data is written into the devices during this portion of a write operation.

Write Cycle Descriptions

The write cycle description table for CY7C1306CV25 follows. [1, 7]

$\overline{BWS_0}$	$\overline{BWS_1}$	$\overline{BWS_2}$	$\overline{BWS_3}$	K	$\overline{K}$	Comments
L	L	L	L	L–H	–	During the data portion of a write sequence, all four bytes ($D_{[35:0]}$) are written into the device.
L	L	L	L	–	L–H	During the data portion of a write sequence, all four bytes ($D_{[35:0]}$) are written into the device.
L	H	H	H	L–H	–	During the data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device. $D_{[35:9]}$ remains unaltered.
L	H	H	H	–	L–H	During the data portion of a write sequence, only the lower byte ($D_{[8:0]}$) is written into the device. $D_{[35:9]}$ remains unaltered.
H	L	H	H	L–H	–	During the data portion of a write sequence, only the byte ($D_{[17:9]}$) is written into the device. $D_{[8:0]}$ and $D_{[35:18]}$ remains unaltered.
H	L	H	H	–	L–H	During the data portion of a write sequence, only the byte ($D_{[17:9]}$) is written into the device. $D_{[8:0]}$ and $D_{[35:18]}$ remains unaltered.
H	H	L	H	L–H	–	During the data portion of a write sequence, only the byte ($D_{[26:18]}$) is written into the device. $D_{[17:0]}$ and $D_{[35:27]}$ remains unaltered.
H	H	L	H	–	L–H	During the data portion of a write sequence, only the byte ($D_{[26:18]}$) is written into the device. $D_{[17:0]}$ and $D_{[35:27]}$ remains unaltered.
H	H	H	L	L–H	–	During the data portion of a write sequence, only the byte ($D_{[35:27]}$) is written into the device. $D_{[26:0]}$ remains unaltered.
H	H	H	L	–	L–H	During the data portion of a write sequence, only the byte ($D_{[35:27]}$) is written into the device. $D_{[26:0]}$ remains unaltered.
H	H	H	H	L–H	–	No data is written into the device during this portion of a write operation.
H	H	H	H	–	L–H	No data is written into the device during this portion of a write operation.

Note

7. Is based on a write cycle that was initiated in accordance with the Write Cycle Descriptions table. $\overline{BWS_0}$, $\overline{BWS_1}$, $\overline{BWS_2}$, and $\overline{BWS_3}$ can be altered on different portions of a write cycle, as long as the setup and hold requirements are achieved.

IEEE 1149.1 Serial Boundary Scan (JTAG)

These SRAMs incorporate a serial boundary scan Test Access Port (TAP) in the FBGA package. This part is fully compliant with IEEE Standard #1149.1-1900. The TAP operates using JEDEC standard 2.5V I/O logic levels.

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 alternatively be connected to V_{DD} through a pull up resistor. TDO must be left unconnected. Upon power up, the device comes up in a reset state, which does not interfere with the operation of the device.

Test Access Port—Test Clock

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. This pin may be left unconnected if the TAP is not used. The pin is pulled up internally, resulting in a logic HIGH level.

Test Data-In (TDI)

The TDI pin 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. For information on loading the instruction register, see the TAP Controller State Diagram on page 11. 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) on any register.

Test Data-Out (TDO)

The TDO output pin is used to serially clock data out from the registers. The output is active, depending upon the current state of the TAP state machine (see Instruction Codes on page 14). The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register.

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 can 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 pins to scan the data in and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction registers. Data is serially loaded into the TDI pin on the rising edge of TCK. Data is output on the TDO pin 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 pins, as shown in TAP Controller Block Diagram on page 12. 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 allow the fault isolation of the board level serial test 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 TDI and TDO pins. This enables shifting of data 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 output pins on the SRAM. Several No Connect (NC) pins are also included in the scan register to reserve pins for higher density devices.

The boundary scan register is loaded with the contents of the RAM input and output ring when the TAP controller is in the Capture-DR state and is then placed between the TDI and TDO pins 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 input and output ring.

The Boundary Scan Order on page 15 shows 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 14.

TAP Instruction Set

Eight different instructions are possible with the three-bit instruction register. All combinations are listed in Instruction Codes on page 14. Three of these instructions are listed as RESERVED and must not be used. The other five instructions are described in this section in detail.

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 pins. To execute the instruction after it is shifted in, the TAP controller must be moved into the Update-IR state.

IDCODE

The IDCODE instruction loads a vendor-specific, 32-bit code into the instruction register. It also places the instruction register between the TDI and TDO pins and shifts the IDCODE out of the device when the TAP controller enters the Shift-DR state. The IDCODE instruction is loaded into the instruction register at power up or whenever the TAP controller is supplied a Test-Logic-Reset state.

SAMPLE Z

The SAMPLE Z instruction connects the boundary scan register between the TDI and TDO pins when the TAP controller is in a Shift-DR state. The SAMPLE Z command puts the output bus into a High-Z state until the next command is supplied during the Update IR 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 input 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 10 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 $\overline{CK}$ captured in the boundary scan register.

After 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 places an initial data pattern at the latched parallel outputs of the boundary scan register cells before 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 the 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 pins. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

EXTEST

The EXTEST instruction drives the preloaded data out through the system output pins. This instruction also connects the boundary scan register for serial access between the TDI and TDO in the Shift-DR controller state.

EXTEST OUTPUT BUS TRI-STATE

IEEE Standard 1149.1 mandates that the TAP controller be able to put the output bus into a tri-state mode.

The boundary scan register has a special bit located at bit #47. When this scan cell, called the “extest output bus tri-state,” is latched into the preload register during the Update-DR state in the TAP controller, it directly controls the state of the output (Q-bus) pins, when the EXTEST is entered as the current instruction. When HIGH, it enables the output buffers to drive the output bus. When LOW, this bit places the output bus into a High-Z condition.

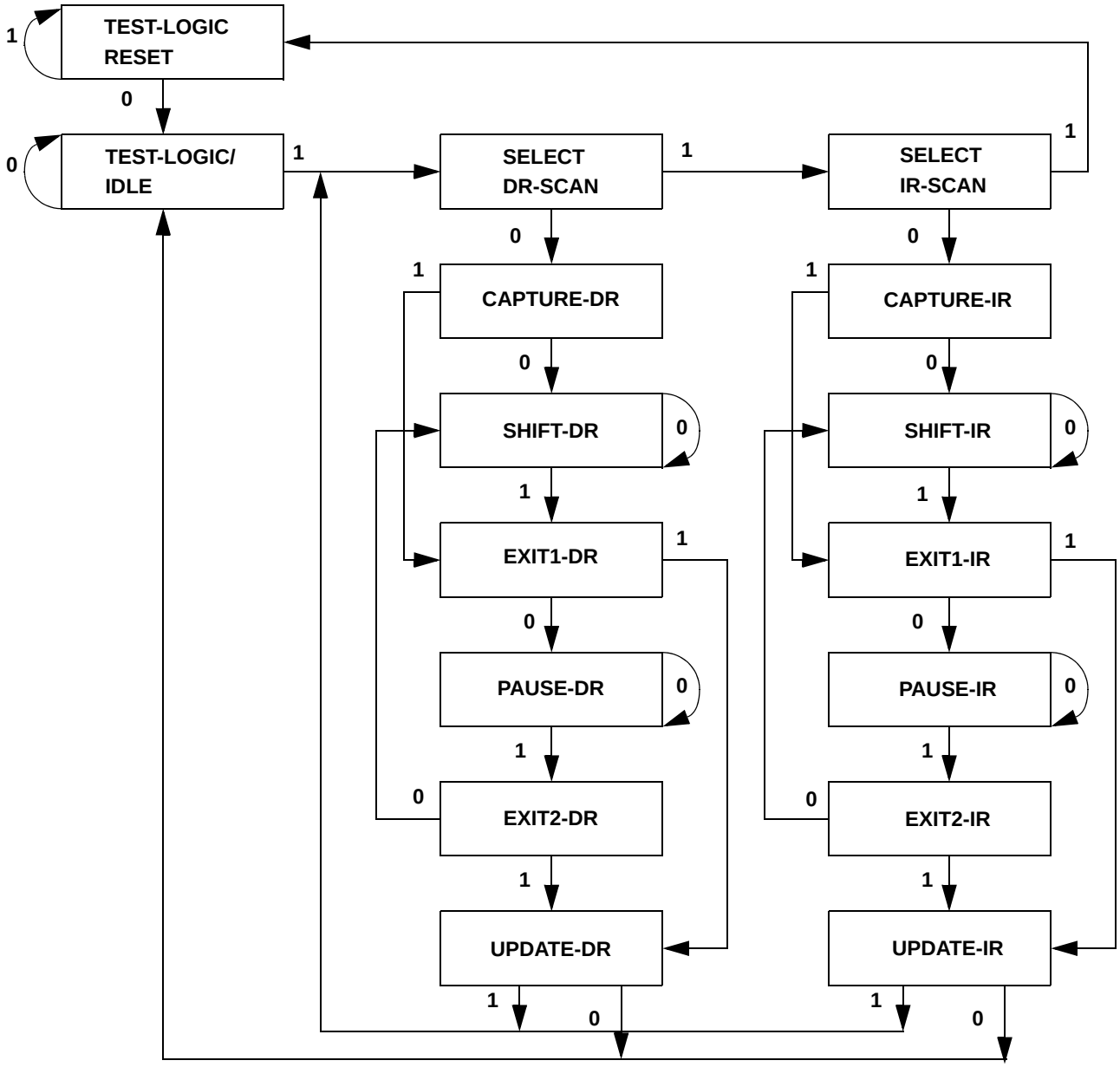
This bit can be set by entering the SAMPLE/PRELOAD or EXTEST command, and then shifting the desired bit into that cell, during the Shift-DR state. During Update-DR, the value loaded into that shift-register cell latches into the preload register. When the EXTEST instruction is entered, this bit directly controls the output Q-bus pins. Note that this bit is pre-set HIGH to enable the output when the device is powered up, and also when the TAP controller is in the Test-Logic-Reset state.

Reserved

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

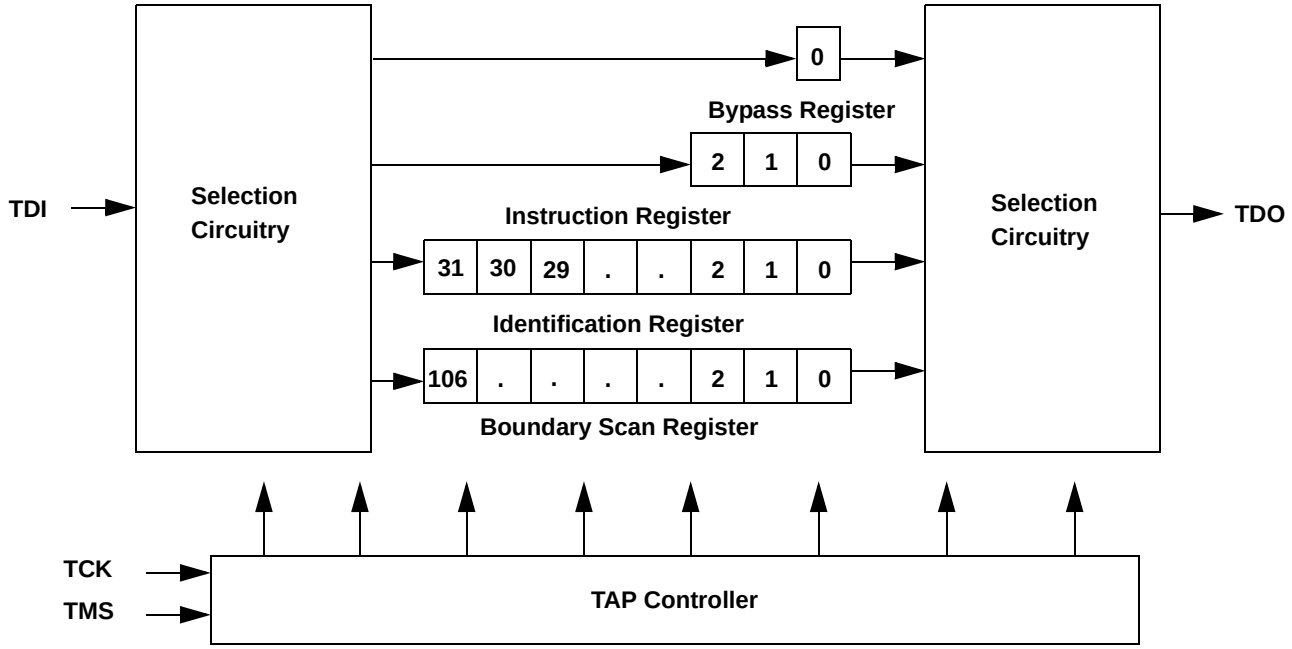
TAP Controller State Diagram

The state diagram for the TAP controller follows. [8]



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

TAP Controller Block Diagram



TAP Electrical Characteristics

Over the Operating Range [9, 10, 11]

Parameter	Description	Test Conditions	Min	Max	Unit
V_{OH1}	Output HIGH Voltage	I_{OH} = –2.0 mA	1.7		V
V_{OH2}	Output HIGH Voltage	I_{OH} = –100 µA	2.1		V
V_{OL1}	Output LOW Voltage	I_{OL} = 2.0 mA		0.7	V
V_{OL2}	Output LOW Voltage	I_{OL} = 100 µA		0.2	V
V_{IH}	Input HIGH Voltage		1.7	V_{DD} + 0.3	V
V_{IL}	Input LOW Voltage		–0.3	0.7	V
I_X	Input and Output Load Current	$GND \le V_I \le V_{DD}$	–5	5	µA

Notes

9. These characteristics pertain to the TAP inputs (TMS, TCK, TDI and TDO). Parallel load levels are specified in the Electrical Characteristics table.
10. Overshoot: $V_{IH}(AC) < V_{DDQ} + 0.85V$ (Pulse width less than $t_{CYC}/2$), Undershoot: $V_{IL}(AC) > -1.5V$ (Pulse width less than $t_{CYC}/2$).
11. All Voltage referenced to Ground.

TAP AC Switching Characteristics

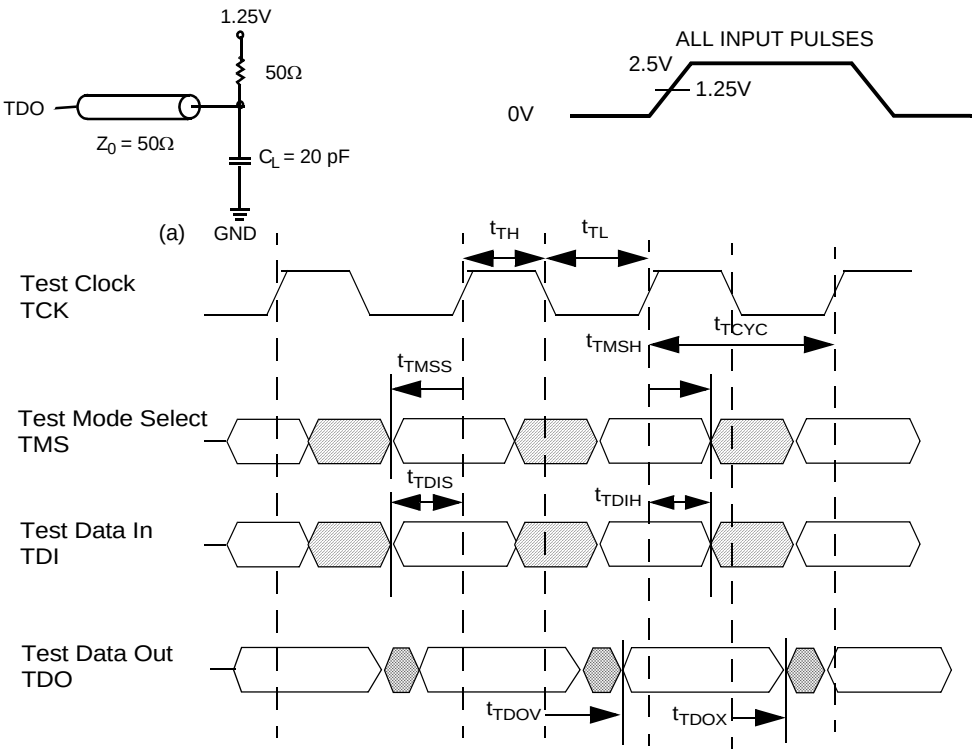
Over the Operating Range [12, 13]

Parameter	Description	Min	Max	Unit
t_{TCYC}	TCK Clock Cycle Time	50		ns
t_{TF}	TCK Clock Frequency		20	MHz
t_{TH}	TCK Clock HIGH	20		ns
t_{TL}	TCK Clock LOW	20		ns
Setup Times				
t_{TMSS}	TMS Setup to TCK Clock Rise	10		ns
t_{TDIS}	TDI Setup to TCK Clock Rise	10		ns
t_{CS}	Capture Setup to TCK Rise	10		ns
Hold Times				
t_{TMSH}	TMS Hold after TCK Clock Rise	10		ns
t_{TDIH}	TDI Hold after Clock Rise	10		ns
t_{CH}	Capture Hold after Clock Rise	10		ns
Output Times				
t_{TDOV}	TCK Clock LOW to TDO Valid		20	ns
t_{TDOX}	TCK Clock LOW to TDO Invalid	0		ns

TAP Timing and Test Conditions

Figure 2 shows the TAP timing and test conditions. [13]

Figure 2. TAP Timing and Test Conditions



Notes

12. t_{CS} and t_{CH} refer to the setup and hold time requirements of latching data from the boundary scan register.
13. Test conditions are specified using the load in TAP AC Test Conditions. t_R/t_F = 1 ns.

Identification Register Definitions

Instruction Field	Value		Description
	CY7C1303CV25	CY7C1306CV25	
Revision Number (31:29)	000	000	Version number.
Cypress Device ID (28:12)	01011011010010101	01011011010100101	Defines the type of SRAM.
Cypress JEDEC ID (11:1)	00000110100	00000110100	Allows unique identification of SRAM vendor.
ID Register Presence (0)	1	1	Indicates the presence of an ID register.

Scan Register Sizes

Register Name	Bit Size
Instruction	3
Bypass	1
ID	32
Boundary Scan	107

Instruction Codes

Instruction	Code	Description
EXTEST	000	Captures the input and output ring contents.
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 operation.
SAMPLE Z	010	Captures the input and output 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 the input and output ring contents. Places the boundary scan register between TDI and TDO. Does not affect the 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 operation.

Boundary Scan Order

Bit #	Bump ID	Bit #	Bump ID	Bit #	Bump ID	Bit #	Bump ID
0	6R	27	11H	54	7B	81	3G
1	6P	28	10G	55	6B	82	2G
2	6N	29	9G	56	6A	83	1J
3	7P	30	11F	57	5B	84	2J
4	7N	31	11G	58	5A	85	3K
5	7R	32	9F	59	4A	86	3J
6	8R	33	10F	60	5C	87	2K
7	8P	34	11E	61	4B	88	1K
8	9R	35	10E	62	3A	89	2L
9	11P	36	10D	63	1H	90	3L
10	10P	37	9E	64	1A	91	1M
11	10N	38	10C	65	2B	92	1L
12	9P	39	11D	66	3B	93	3N
13	10M	40	9C	67	1C	94	3M
14	11N	41	9D	68	1B	95	1N
15	9M	42	11B	69	3D	96	2M
16	9N	43	11C	70	3C	97	3P
17	11L	44	9B	71	1D	98	2N
18	11M	45	10B	72	2C	99	2P
19	9L	46	11A	73	3E	100	1P
20	10L	47	Internal	74	2D	101	3R
21	11K	48	9A	75	2E	102	4R
22	10K	49	8B	76	1E	103	4P
23	9J	50	7C	77	2F	104	5P
24	9K	51	6C	78	3F	105	5N
25	10J	52	8A	79	1G	106	5R
26	11J	53	7A	80	1F		

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 ..... –0.5V to +3.6V

Supply Voltage on V_{DDQ} Relative to GND ..... –0.5V to +V_{DD}

DC Applied to Outputs in High-Z ..... –0.5V to V_{DDQ} + 0.5V

DC Input Voltage [10] ..... –0.5V to V_{DD} + 0.5V

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

Static Discharge Voltage (MIL-STD-883, M. 3015).. > 2001V

Latch-up Current ..... > 200 mA

Operating Range

Range	Ambient Temperature (T_A)	V_{DD} [14]	V_{DDQ} [14]
Commercial	0°C to +70°C	2.5 ± 0.1V	1.4V to 1.9V
Industrial	–40°C to +85°C		

Electrical Characteristics

DC Electrical Characteristics

Over the Operating Range [11]

Parameter	Description	Test Conditions	Min	Typ	Max	Unit
V_{DD}	Power Supply Voltage		2.4	2.5	2.6	V
V_{DDQ}	I/O Supply Voltage		1.4	1.5	1.9	V
V_{OH}	Output HIGH Voltage	Note 15	$V_{DDQ}/2 – 0.12$		$V_{DDQ}/2 + 0.12$	V
V_{OL}	Output LOW Voltage	Note 16	$V_{DDQ}/2 – 0.12$		$V_{DDQ}/2 + 0.12$	V
$V_{OH(LOW)}$	Output HIGH Voltage	I_{OH} = –0.1 mA, Nominal Impedance	$V_{DDQ} – 0.2$		V_{DDQ}	V
$V_{OL(LOW)}$	Output LOW Voltage	I_{OL} = 0.1 mA, Nominal Impedance	V_{SS}		0.2	V
V_{IH}	Input HIGH Voltage [10]		$V_{REF} + 0.1$		$V_{DDQ} + 0.3$	V
V_{IL}	Input LOW Voltage [10, 17]		–0.3		$V_{REF} – 0.1$	V
V_{REF}	Input Reference Voltage [18]	Typical Value = 0.75V	0.68	0.75	0.95	V
I_X	Input Leakage Current	$GND \le V_I \le V_{DDQ}$	–5		5	µA
I_{OZ}	Output Leakage Current	$GND \le V_I \le V_{DDQ}$, Output Disabled	–5		5	µA
I_{DD} [19]	V_{DD} Operating Supply	V_{DD} = Max, I_{OUT} = 0 mA, f = $f_{MAX} = 1/t_{CYC}$			500	mA
I_{SB1}	Automatic Power Down Current	Max V_{DD}, Both Ports Deselected, $V_{IN} \ge V_{IH}$ or $V_{IN} \le V_{IL}$ f = $f_{MAX} = 1/t_{CYC}$, Inputs Static			240	mA

AC Electrical Characteristics

Over the Operating Range

Parameter	Description	Test Conditions	Min	Typ	Max	Unit
V_{IH}	Input HIGH Voltage		$V_{REF} + 0.2$	–	–	V
V_{IL}	Input LOW Voltage		–	–	$V_{REF} – 0.2$	V

Notes

14. Power up: Assumes a linear ramp from 0V to V_{DD}(min) within 200 ms. During this time $V_{IH} < V_{DD}$ and $V_{DDQ} \le V_{DD}$.
15. Output are impedance controlled. $I_{OH} = –(V_{DDQ}/2)/(RQ/5)$ for values of 175 ohms <= RQ <= 350 ohms.
16. Output are impedance controlled. $I_{OL} = (V_{DDQ}/2)/(RQ/5)$ for values of 175 ohms <= RQ <= 350 ohms.
17. This spec is for all inputs except C and $\overline{C}$ Clock. For C and $\overline{C}$ Clock, V_{IL}(Max.) = $V_{REF} – 0.2V$
18. V_{REF} (min) = 0.68V or 0.46V_{DDQ}, whichever is larger, V_{REF} (max) = 0.95V or 0.54V_{DDQ}, whichever is smaller.
19. The operation current is calculated with 50% read cycle and 50% write cycle.

Capacitance

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

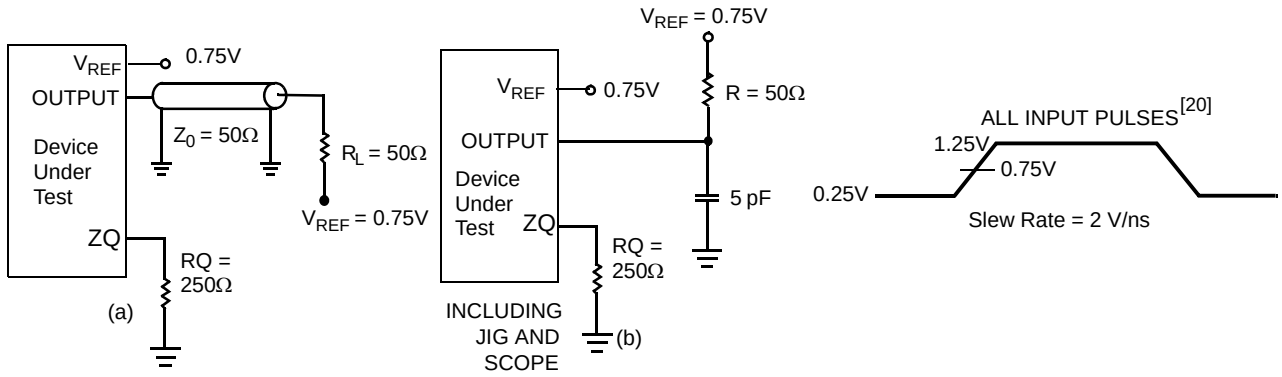
Parameter	Description	Test Conditions	Max	Unit
C_{IN}	Input Capacitance	T_A = 25°C, f = 1 MHz, V_{DD} = 2.5V, V_{DDQ} = 1.5V	5	pF
C_{CLK}	Clock Input Capacitance		6	pF
C_O	Output Capacitance		7	pF

Thermal Resistance

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

Parameter	Description	Test Conditions	165 FBGA Package	Unit
Θ_{JA}	Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51.	16.7	°C/W
Θ_{JC}	Thermal Resistance (Junction to Case)		6.5	°C/W

Figure 3. AC Test Loads and Waveforms



Note

20. Unless otherwise noted, test conditions are based on signal transition time of 2V/ns, timing reference levels of 0.75V, V_{REF} = 0.75V, RQ = 250Ω, V_{DDQ} = 1.5V, input pulse levels of 0.25V to 1.25V, and output loading of the specified I_{OL}/I_{OH} and load capacitance shown in (a) of AC Test Loads and Waveforms.

Switching Characteristics

Over the Operating Range [20]

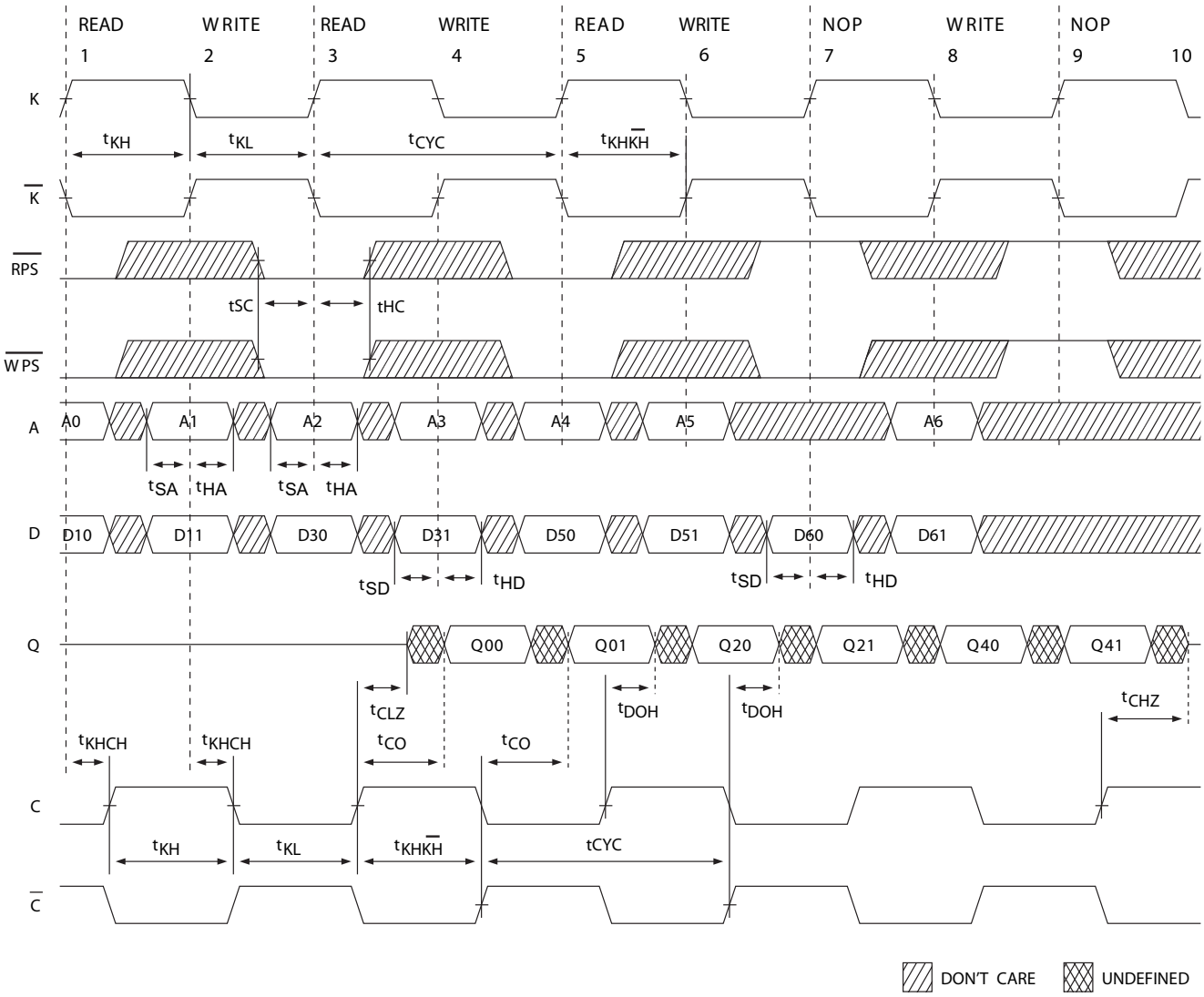
Cypress Parameter	Consortium Parameter	Description	167 MHz		Unit
			Min	Max	
t_{POWER}		V_{DD}(Typical) to the First Access Read or Write [21]	10		µs
Cycle Time					
t_{CYC}	t_{KHKH}	K Clock and C Clock Cycle Time	6.0		ns
t_{KH}	t_{KHKL}	Input Clock (K/$\overline{K}$ and C/$\overline{C}$) HIGH	2.4	–	ns
t_{KL}	t_{KLKH}	Input Clock (K/$\overline{K}$ and C/$\overline{C}$) LOW	2.4	–	ns
$t_{KH\overline{K}H}$	$t_{KH\overline{K}H}$	K Clock Rise to $\overline{K}$ Clock Rise and C to $\overline{C}$ Rise (rising edge to rising edge)	2.7	3.3	ns
t_{KHCH}	t_{KHCH}	K/$\overline{K}$ Clock Rise to C/$\overline{C}$ Clock Rise (rising edge to rising edge)	0	2.0	ns
Setup Times					
t_{SA}	t_{SA}	Address Setup to Clock (K/$\overline{K}$) Rise	0.7	–	ns
t_{SC}	t_{SC}	Control Setup to Clock (K/$\overline{K}$) Rise ($\overline{RPS}$, $\overline{WPS}$, $\overline{BWS_0}$, $\overline{BWS_1}$)	0.7	–	ns
t_{SD}	t_{SD}	$D_{[X:0]}$ Setup to Clock (K/$\overline{K}$) Rise	0.7	–	ns
Hold Times					
t_{HA}	t_{HA}	Address Hold after Clock (K/$\overline{K}$) Rise	0.7	–	ns
t_{HC}	t_{HC}	Control Hold after Clock (K/$\overline{K}$) Rise ($\overline{RPS}$, $\overline{WPS}$, $\overline{BWS_0}$, $\overline{BWS_1}$)	0.7	–	ns
t_{HD}	t_{HD}	$D_{[X:0]}$ Hold after Clock (K/$\overline{K}$) Rise	0.7	–	ns
Output Times					
t_{CO}	t_{CHQV}	C/$\overline{C}$ Clock Rise (or K/$\overline{K}$ in Single Clock Mode) to Data Valid	–	2.5	ns
t_{DOH}	t_{CHQX}	Data Output Hold after Output C/$\overline{C}$ Clock Rise (Active to Active)	1.2	–	ns
t_{CHZ}	t_{CHZ}	Clock (C/$\overline{C}$) Rise to High-Z (Active to High-Z) [22, 23]	–	2.5	ns
t_{CLZ}	t_{CLZ}	Clock (C/$\overline{C}$) Rise to Low-Z [22, 23]	1.2	–	ns

Notes

21. This part has a voltage regulator that steps down the voltage internally; t_{POWER} is the time that the power is supplied above V_{DD} minimum initially before a read or write operation is initiated.
22. t_{CHZ}, t_{CLZ}, are specified with a load capacitance of 5 pF as in part (b) of AC Test Loads and Waveforms. Transition is measured ± 100 mV from steady state voltage.
23. At any voltage and temperature t_{CHZ} is less than t_{CLZ} and t_{CHZ} less than t_{CO}.

Switching Waveforms

Figure 4. Switching Waveforms[24, 25, 26]



Notes

24. Q00 refers to output from address A0. Q01 refers to output from the next internal burst address following A0, that is, A0+1.
25. Outputs are disabled (High-Z) one clock cycle after a NOP.
26. In this example, if address A0 = A1, then data Q00 = D10 and Q01 = D11. Write data is forwarded immediately as read results. This note applies to the whole diagram.

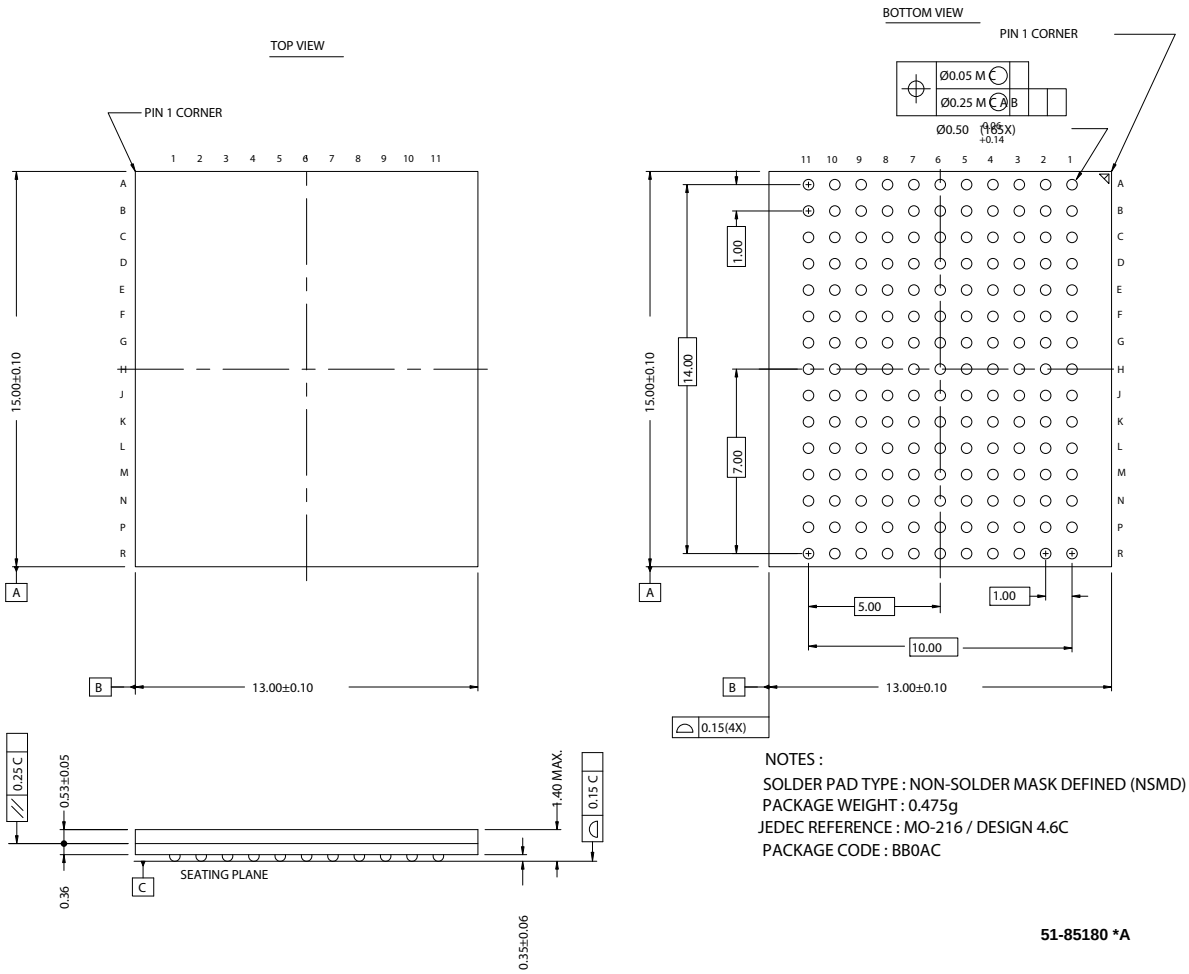
Ordering Information

Not all of the speed, package and temperature ranges are available. Please contact your local sales representative or visit www.cypress.com for actual products offered.

Speed (MHz)	Ordering Code	Package Diagram	Package Type	Operating Range
167	CY7C1303CV25-167BZC	51-85180	165-Ball Fine Pitch Ball Grid Array (13 x 15 x 1.4 mm)	Commercial
	CY7C1306CV25-167BZC			
	CY7C1303CV25-167BZXC	51-85180	165-Ball Fine Pitch Ball Grid Array (13 x 15 x 1.4 mm) Pb-Free	
	CY7C1306CV25-167BZXC			
	CY7C1303CV25-167BZI	51-85180	165-Ball Fine Pitch Ball Grid Array (13 x 15 x 1.4 mm)	Industrial
	CY7C1306CV25-167BZI			
	CY7C1303CV25-167BZXI	51-85180	165-Ball Fine Pitch Ball Grid Array (13 x 15 x 1.4 mm) Pb-Free	
	CY7C1306CV25-167BZXI			

Package Diagram

Figure 5. 165-Ball FBGA (13 x 15 x 1.4 mm)



Document History Page

Document Title: CY7C1303CV25/CY7C1306CV25, 18-Mbit Burst of 2 Pipelined SRAM with QDR™ Architecture Document Number: 001-44701				
Rev.	**ECN No.**	**Submission Date**	**Orig. of Change**	**Description of Change**
**	2192568	See ECN	VKN/PYRS	New datasheet
*A	2507779	See ECN	VKN/PYRS	Corrected JTAG ID code
*B	2746930	07/31/09	NJY	Post to external web site

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