

## FullFlex™ Synchronous SDR Dual-Port SRAM

### Features

- True dual-ported memory allows simultaneous access to the shared array from each port
- Synchronous pipelined operation with Single Data Rate (SDR) operation on each port
  - SDR interface at 250 MHz
  - Up to 36-Gb/s bandwidth (250 MHz \* 72 bit \* 2 ports)
- Selectable pipelined or flow-through mode
- 1.5V or 1.8V core power supply
- Commercial and Industrial temperature
- IEEE 1149.1 JTAG boundary scan
- Available in 484-ball PBGA Packages and 256-ball FBGA packages
- FullFlex72 family
  - 36-Mbit: 512K x 72 (CYD36S72V18)
  - 18-Mbit: 256K x 72 (CYD18S72V18)
  - 9-Mbit: 128K x 72 (CYD09S72V18)
  - 4-Mbit: 64K x 72 (CYD04S72V18)
- FullFlex36 family
  - 36-Mbit: 1M x 36 (CYD36S36V18)
  - 18-Mbit: 512K x 36 (CYD18S36V18)
  - 9-Mbit: 256K x 36 (CYD09S36V18)
  - 4-Mbit: 128K x 36 (CYD04S36V18)
- FullFlex18 family
  - 36-Mbit: 2M x 18 (CYD36S18V18)
  - 18-Mbit: 1M x 18 (CYD18S18V18)
  - 9-Mbit: 512K x 18 (CYD09S18V18)
  - 4-Mbit: 256K x 18 (CYD04S18V18)
- Built-in deterministic access control to manage address collisions
  - Deterministic flag output upon collision detection
  - Collision detection on back-to-back clock cycles
  - First Busy Address readback
- Advanced features for improved high-speed data transfer and flexibility
  - Variable Impedance Matching (VIM)
  - Echo clocks

- Selectable LVTTTL (3.3V), Extended HSTL (1.4V–1.9V), 1.8V LVCMOS, or 2.5V LVCMOS I/O on each port
- Burst counters for sequential memory access
- Mailbox with interrupt flags for message passing
- Dual Chip Enables for easy depth expansion

### Functional Description

The FullFlex™ Dual-Port SRAM families consist of 4-Mbit, 9-Mbit, 18-Mbit, and 36-Mbit synchronous, true dual-port static RAMs that are high-speed, low-power 1.8V/1.5V CMOS. Two ports are provided, allowing the array to be accessed simultaneously. Simultaneous access to a location triggers deterministic access control. For FullFlex72 these ports can operate independently with 72-bit bus widths and each port can be independently configured for two pipelined stages. Each port can also be configured to operate in pipelined or flow-through mode.

Advanced features include built-in deterministic access control to manage address collisions during simultaneous access to the same memory location, Variable Impedance Matching (VIM) to improve data transmission by matching the output driver impedance to the line impedance, and echo clocks to improve data transfer.

To reduce the static power consumption, chip enables can be used to power down the internal circuitry. The number of cycles of latency before a change in CE0 or CE1 will enable or disable the databus matches the number of cycles of read latency selected for the device. In order for a valid write or read to occur, both chip enable inputs on a port must be active.

Each port contains an optional burst counter on the input address register. After externally loading the counter with the initial address, the counter will increment the address internally.

Additional features of this device include a mask register and a mirror register to control counter increments and wrap-around. The counter-interrupt (CNTINT) flags notify the host that the counter will reach maximum count value on the next clock cycle. The host can read the burst-counter internal address, mask register address, and busy address on the address lines. The host can also load the counter with the address stored in the mirror register by utilizing the retransmit functionality. Mailbox interrupt flags can be used for message passing, and JTAG boundary scan and asynchronous Master Reset (MRST) are also available. The logic block diagram in Figure 1 displays these features.

The FullFlex72 is offered in a 484-ball plastic BGA package. The FullFlex36 and FullFlex18 are offered in both 484-ball and 256-ball fine pitch BGA packages.

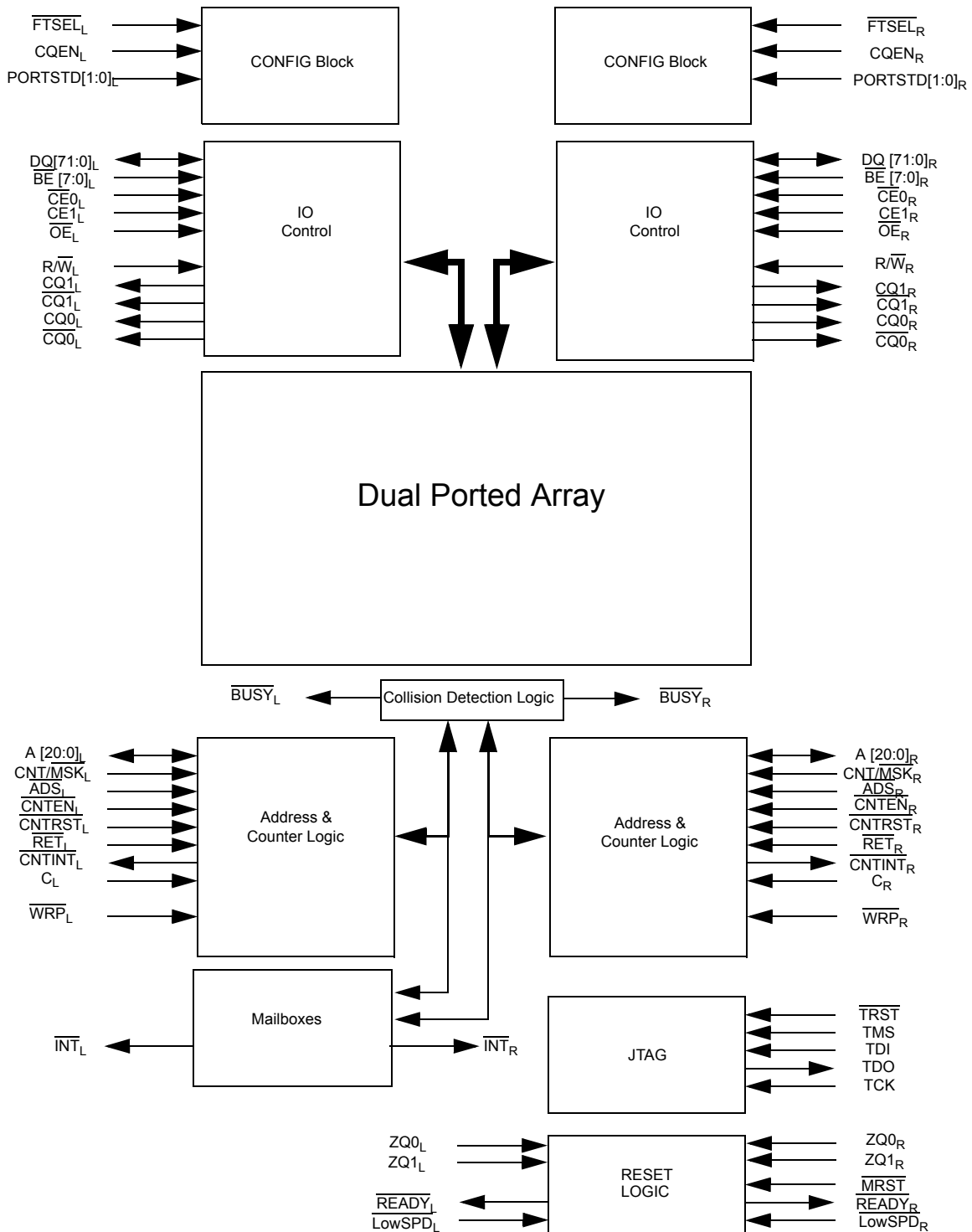


Figure 1. FullFlex72 18-Mbit (CYD18S72V18) Block Diagram<sup>[1, 2, 3]</sup>

Notes:

1. The CYD36S18V18 device has 21 address bits. The CYD36S36V18 and the CYD18S18V18 devices have 20 address bits. The CYD36S72V18, CYD18S36V18, and the CYD09S18V18 devices have 19 address bits. The CYD18S72V18, CYD09S36V18, and the CYD04S18V18 devices have 18 address bits. The CYD09S72V18 and the CYD04S36V18 devices have 17 address bits. The CYD04S72V18 has 16 address bits.
2. The FullFlex72 family of devices has 72 data lines. The FullFlex36 family of devices has 36 data lines. The FullFlex18 family of devices has 18 data lines.
3. The FullFlex72 family of devices has eight byte enables. The FullFlex36 family of devices has four byte enables. The FullFlex18 family of devices has two byte enables.

**FullFlex72 SDR 484-ball BGA Pinout (Top View)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			
A	NC	DQ61 L	DQ59 L	DQ57 L	DQ54 L	DQ51 L	DQ48 L	DQ45 L	DQ42 L	DQ39 L	DQ36 L	DQ36 R	DQ39 R	DQ42 R	DQ45 R	DQ48 R	DQ51 R	DQ54 R	DQ57 R	DQ59 R	DQ61 R	NC			
B	DQ63 L	DQ62 L	DQ60 L	DQ58 L	DQ55 L	DQ52 L	DQ49 L	DQ46 L	DQ43 L	DQ40 L	DQ37 L	DQ37 R	DQ40 R	DQ43 R	DQ46 R	DQ49 R	DQ52 R	DQ55 R	DQ58 R	DQ60 R	DQ62 R	DQ63 R			
C	DQ65 L	DQ64 L	VSS	VSS	DQ56 L	DQ53 L	DQ50 L	DQ47 L	DQ44 L	DQ41 L	DQ38 L	DQ38 R	DQ41 R	DQ44 R	DQ47 R	DQ50 R	DQ53 R	DQ56 R	VSS	VSS	DQ64 R	DQ65 R			
D	DQ67 L	DQ66 L	VSS	VSS	VSS	CQ1L	CQ1L	VSS	LOW SPDL	PORT STD0 L	ZQ0L [4]	BUSY L	CNTI NTR	PORT STD1 L	NC	CQ1R	CQ1R	VSS	VSS	VSS	DQ66 R	DQ67 R			
E	DQ69 L	DQ68 L	VDDI OL	VSS	VSS	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VTTTL	VTTTL	VTTTL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	NC	VSS	VDDI OR	DQ68 R	DQ69 R		
F	DQ71 L	DQ70 L	CE1L	CE0L	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	CE0R	CE1R	DQ70 R	DQ71 R		
G	A0L	A1L	RET <sub>L</sub>	BE4 <sub>L</sub>	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	VDDI OR	BE4 <sub>R</sub>	RETR	A1R	A0R		
H	A2L	A3L	WRP <sub>L</sub>	BE5 <sub>L</sub>	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	BE5 <sub>R</sub>	WRP <sub>R</sub>	A3R	A2R		
J	A4L	A5L	READ <sub>YL</sub>	BE6 <sub>L</sub>	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	BE6 <sub>R</sub>	READ <sub>YR</sub>	A5R	A4R		
K	A6L	A7L	ZQ1L [4]	BE7 <sub>L</sub>	VTTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VDDI OR	VDDI OR	BE7 <sub>R</sub>	ZQ1R [4]	A7R	A6R		
L	A8L	A9L	CL	OE <sub>L</sub>	VTTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTTL	VTTTL	OE <sub>R</sub>	CR	A9R	A8R		
M	A10L	A11L	VSS	BE3 <sub>L</sub>	VTTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTTL	VTTTL	BE3 <sub>R</sub>	VSS	A11R	A10R		
N	A12L	A13L	ADSL	BE2 <sub>L</sub>	VDDI OL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTTL	VTTTL	BE2 <sub>R</sub>	ADSR	A13R	A12R		
P	A14L	A15L	CNT/ MSKL	BE1 <sub>L</sub>	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	BE1 <sub>R</sub>	CNT/ MSKR	A15R	A14R		
R	A16L [7]	A17L [6]	CNT/ ENL	BE0 <sub>L</sub>	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	BE0 <sub>R</sub>	CNT/ ENR	A17R [6]	A16R [7]		
T	A18L [5]	NC	CNT/ STL	INTL	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	INTR	CNT/ STR	NC	A18R [5]		
U	DQ35 L	DQ34 L	R/W <sub>L</sub>	CQE NL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	CQE NR	R/W <sub>R</sub>	DQ34 R	DQ35 R	
V	DQ33 L	DQ32 L	FTSE LL	VDDI OL	NC	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VTTTL	VTTTL	VTTTL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	TRST	VDDI OR	FTSE LR	DQ32 R	DQ33 R
W	DQ31 L	DQ30 L	VSS	MRST	VSS	CQ0L	CQ0L	NC	PORT STD1 R	CNTI NTR	BUSY R	ZQ0R [4]	PORT STD0 R	LOW SPDR	VSS	CQ0R	CQ0R	VSS	TDI	TDO	DQ30 R	DQ31 R			
Y	DQ29 L	DQ28 L	VSS	VSS	DQ20 L	DQ17 L	DQ14 L	DQ11 L	DQ8L	DQ5L	DQ2L	DQ2R	DQ5R	DQ8R	DQ11 R	DQ14 R	DQ17 R	DQ20 R	TMS	TCK	DQ28 R	DQ29 R			
AA	DQ27 L	DQ26 L	DQ24 L	DQ22 L	DQ19 L	DQ16 L	DQ13 L	DQ10 L	DQ7L	DQ4L	DQ1L	DQ1R	DQ4R	DQ7R	DQ10 R	DQ13 R	DQ16 R	DQ19 R	DQ22 R	DQ24 R	DQ26 R	DQ27 R			
AB	NC	DQ25 L	DQ23 L	DQ21 L	DQ18 L	DQ15 L	DQ12 L	DQ9L	DQ6L	DQ3L	DQ0L	DQ0R	DQ3R	DQ6R	DQ9R	DQ12 R	DQ15 R	DQ18 R	DQ21 R	DQ23 R	DQ25 R	NC			

**Notes:**

- 4. Leaving this pin NC disables VIM.
- 5. Leave this ball unconnected for CYD18S72V18, CYD09S72V18 and CYD04S72V18.
- 6. Leave this ball unconnected for CYD09S72V18 and CYD04S72V18.
- 7. Leave this ball unconnected for CYD04S72V18.

**FullFlex36 SDR 484-ball BGA Pinout (Top View)<sup>[8]</sup>**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			
A	NC	NC	NC	NC	NC	DQ33 L	DQ30 L	DQ27 L	DQ24 L	DQ21 L	DQ18 L	DQ18 R	DQ21 R	DQ24 R	DQ27 R	DQ30 R	DQ33 R	NC	NC	NC	NC	NC			
B	NC	NC	NC	NC	NC	DQ34 L	DQ31 L	DQ28 L	DQ25 L	DQ22 L	DQ19 L	DQ19 R	DQ22 R	DQ25 R	DQ28 R	DQ31 R	DQ34 R	NC	NC	NC	NC	NC			
C	NC	NC	VSS	VSS	NC	DQ35 L	DQ32 L	DQ29 L	DQ26 L	DQ23 L	DQ20 L	DQ20 R	DQ23 R	DQ26 R	DQ29 R	DQ32 R	DQ35 R	NC	VSS	VSS	NC	NC			
D	NC	NC	VSS	VSS	VSS	$\overline{\text{CQ1L}}$	CQ1L	VSS	$\overline{\text{LOW}}\text{SPDL}$	PORT STD0 L	ZQ0L <sup>[4]</sup>	BUSY L	$\overline{\text{CNT}}\text{NTR}$	PORT STD1 L	NC	CQ1R	$\overline{\text{CQ1R}}$	VSS	VSS	VSS	NC	NC			
E	NC	NC	VDDI OL	VSS	VSS	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VTTL	VTTL	VTTL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	NC	VSS	VDDI OR	NC	NC		
F	NC	NC	CE1L	$\overline{\text{CE0L}}$	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OR	$\overline{\text{CE0R}}$	CE1R	NC	NC		
G	A0L	A1L	$\overline{\text{RETL}}$	$\overline{\text{BE2L}}$	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{BE2R}}$	$\overline{\text{RETR}}$	A1R	A0R		
H	A2L	A3L	$\overline{\text{WRP}}\text{L}$	$\overline{\text{BE3L}}$	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{BE3R}}$	$\overline{\text{WRP}}\text{R}$	A3R	A2R		
J	A4L	A5L	$\overline{\text{REAYL}}$	NC	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	NC	$\overline{\text{REAYR}}$	A5R	A4R			
K	A6L	A7L	ZQ1L <sup>[4]</sup>	NC	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VDDI OR	NC	ZQ1R <sup>[4]</sup>	A7R	A6R			
L	A8L	A9L	CL	$\overline{\text{OEL}}$	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	$\overline{\text{OER}}$	CR	A9R	A8R			
M	A10L	A11L	VSS	NC	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	NC	VSS	A11R	A10R			
N	A12L	A13L	$\overline{\text{ADSL}}$	NC	VDDI OL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	NC	$\overline{\text{ADSR}}$	A13R	A12R			
P	A14L	A15L	$\overline{\text{CNT}}\text{MSKL}$	$\overline{\text{BE1L}}$	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{BE1R}}$	$\overline{\text{CNT}}\text{MSKR}$	A15R	A14R		
R	A16L	A17L	$\overline{\text{CNT}}\text{ENL}$	$\overline{\text{BE0L}}$	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{BE0R}}$	$\overline{\text{CNT}}\text{ENR}$	A17R	A16R		
T	A18L	A19L	$\overline{\text{CNT}}\text{RSTL}$	$\overline{\text{INTL}}$	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{INTR}}$	$\overline{\text{CNT}}\text{RSTR}$	A19R	A18R		
U	NC	NC	$\overline{\text{RWL}}$	CQE NL	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OR	CQE NR	$\overline{\text{RWR}}$	NC	NC	
V	NC	NC	$\overline{\text{FTSEL}}$	VDDI OL	NC	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VTTL	VTTL	VTTL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	$\overline{\text{TRST}}$	VDDI OR	$\overline{\text{FTSELR}}$	NC	NC
W	NC	NC	VSS	$\overline{\text{MRST}}$	VSS	$\overline{\text{CQ0L}}$	CQ0L	NC	PORT STD1 R	$\overline{\text{CNT}}\text{NTR}$	BUSY R	ZQ0R <sup>[4]</sup>	PORT STD0 R	$\overline{\text{LOW}}\text{SPDR}$	VSS	CQ0R	$\overline{\text{CQ0R}}$	VSS	TDI	TDO	NC	NC			
Y	NC	NC	VSS	VSS	NC	DQ17 L	DQ14 L	DQ11 L	DQ8L	DQ5L	DQ2L	DQ2R	DQ5R	DQ8R	DQ11 R	DQ14 R	DQ17 R	NC	TMS	TCK	NC	NC			
AA	NC	NC	NC	NC	NC	DQ16 L	DQ13 L	DQ10 L	DQ7L	DQ4L	DQ1L	DQ1R	DQ4R	DQ7R	DQ10 R	DQ13 R	DQ16 R	NC	NC	NC	NC	NC			
AB	NC	NC	NC	NC	NC	DQ15 L	DQ12 L	DQ9L	DQ6L	DQ3L	DQ0L	DQ0R	DQ3R	DQ6R	DQ9R	DQ12 R	DQ15 R	NC	NC	NC	NC	NC			

**Note:**

8. Use this pinout only for device CYD36S36V18 of the FullFlex36 family.

**FullFlex18 SDR 484-ball BGA Pinout (Top View)<sup>[9]</sup>**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
A	NC	NC	NC	NC	NC	NC	NC	NC	DQ15 L	DQ12 L	DQ9L	DQ9R	DQ12 R	DQ15 R	NC	NC	NC	NC	NC	NC	NC	NC	
B	NC	NC	NC	NC	NC	NC	NC	NC	DQ16 L	DQ13 L	DQ10 L	DQ10 R	DQ13 R	DQ16 R	NC	NC	NC	NC	NC	NC	NC	NC	
C	NC	NC	VSS	VSS	NC	NC	NC	NC	DQ17 L	DQ14 L	DQ11 L	DQ11 R	DQ14 R	DQ17 R	NC	NC	NC	NC	VSS	VSS	NC	NC	
D	NC	NC	VSS	VSS	VSS	CQ1L	CQ1L	VSS	LOW SPDL	PORT STD0 L	ZQ0L <sup>[4]</sup>	BUSY L	CNT NTL	PORT STD1 L	NC	CQ1R	CQ1R	VSS	VSS	VSS	NC	NC	
E	NC	NC	VDDI OL	VSS	VSS	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VTTL	VTTL	VTTL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	NC	VSS	VDDI OR	NC
F	NC	NC	CE1L	CE0L	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	CE0R	CE1R	NC	NC
G	A0L	A1L	RETL	BE1L	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	VDDI OR	BE1R	RETR	A1R	A0R
H	A2L	A3L	WRP L	NC	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	NC	WRP R	A3R	A2R	
J	A4L	A5L	READ YL	NC	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	NC	READ YR	A5R	A4R	
K	A6L	A7L	ZQ1L <sup>[4]</sup>	NC	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VDDI OR	NC	ZQ1R <sup>[4]</sup>	A7R	A6R	
L	A8L	A9L	CL	OEL	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	OER	CR	A9R	A8R	
M	A10L	A11L	VSS	NC	VTTL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	NC	VSS	A11R	A10R	
N	A12L	A13L	ADSL	NC	VDDI OL	VCO RE	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VCO RE	VTTL	NC	ADSR	A13R	A12R	
P	A14L	A15L	CNT/ MSKL	NC	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	NC	CNT/ MSKR	A15R	A14R	
R	A16L	A17L	CNT NL	BE0L	VDDI OL	VDDI OL	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VDDI OR	VDDI OR	BE0R	CNT NR	A17R	A16R	
T	A18L	A19L	CNT STL	INTL	VDDI OL	VDDI OL	VREF L	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VREF R	VDDI OR	VDDI OR	INTR	CNT STR	A19R	A18R	
U	A20L	NC	R/WL	CQENL	VDDI OL	VDDI OL	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VCO RE	VCO RE	VCO RE	VCO RE	VDDI OL	VDDI OL	VDDI OL	VDDI OR	VDDI OR	CQENR	R/WR	NC	A20R
V	NC	NC	FISE LL	VDDI OL	NC	VDDI OR	VDDI OR	VDDI OR	VDDI OR	VTTL	VTTL	VTTL	VDDI OL	VDDI OL	VDDI OL	VDDI OL	VDDI OR	VDDI OR	TRST	VDDI OR	FISE LR	NC	NC
W	NC	NC	VSS	MRST	VSS	CQ0L	CQ0L	NC	PORT STD1 R	CNT NTR	BUSY R	ZQ0R <sup>[4]</sup>	PORT STD0 R	LOW SPDR	VSS	CQ0R	CQ0R	VSS	TDI	TDO	NC	NC	
Y	NC	NC	VSS	VSS	NC	NC	NC	NC	DQ8L	DQ5L	DQ2L	DQ2R	DQ5R	DQ8R	NC	NC	NC	NC	NC	TMS	TCK	NC	NC
AA	NC	NC	NC	NC	NC	NC	NC	NC	DQ7L	DQ4L	DQ1L	DQ1R	DQ4R	DQ7R	NC	NC	NC	NC	NC	NC	NC	NC	NC
AB	NC	NC	NC	NC	NC	NC	NC	NC	DQ6L	DQ3L	DQ0L	DQ0R	DQ3R	DQ6R	NC	NC	NC	NC	NC	NC	NC	NC	NC

**Note:**  
9. Use this pinout only for device CYD36S18V18 of the FullFlex18 family.

**FullFlex36 SDR 256-Ball BGA (Top View)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	DQ32L	DQ30L	DQ28L	DQ26L	DQ24L	DQ22L	DQ20L	DQ18L	DQ18R	DQ20R	DQ22R	DQ24R	DQ26R	DQ28R	DQ30R	DQ32R
B	DQ33L	DQ31L	DQ29L	DQ27L	DQ25L	DQ23L	DQ21L	DQ19L	DQ19R	DQ21R	DQ23R	DQ25R	DQ27R	DQ29R	DQ31R	DQ33R
C	DQ34L	DQ35L	$\overline{\text{RET}}\text{L}$	$\overline{\text{INT}}\text{L}$	CQ1L	$\overline{\text{CQ}}\text{1L}$	NC	$\overline{\text{TR}}\text{ST}$	$\overline{\text{MR}}\text{ST}$	ZQ0R <sup>[4]</sup>	$\overline{\text{CQ}}\text{1R}$	CQ1R	$\overline{\text{IN}}\text{TR}$	$\overline{\text{RE}}\text{TR}$	DQ35R	DQ34R
D	A0L	A1L	$\overline{\text{WR}}\text{PL}$	VREFL	$\overline{\text{FT}}\text{SELL}$	$\overline{\text{LOW}}\text{SPDL}$	VSS	VTTL	VTTL	VSS	$\overline{\text{LOW}}\text{SPDR}$	$\overline{\text{FT}}\text{SELR}$	VREFR	$\overline{\text{WR}}\text{PR}$	A1R	A0R
E	A2L	A3L	$\overline{\text{CE}}\text{0L}$	CE1L	VDDIOL	VDDIOL	VDDIOL	VCORE	VCORE	VDDIOR	VDDIOR	VDDIOR	CE1R	$\overline{\text{CE}}\text{0R}$	A3R	A2R
F	A4L	A5L	$\overline{\text{CNT}}\text{INTL}$	$\overline{\text{BE}}\text{3L}$	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{3R}$	$\overline{\text{CNT}}\text{INTR}$	A5R	A4R
G	A6L	A7L	$\overline{\text{BUS}}\text{YL}$	$\overline{\text{BE}}\text{2L}$	ZQ0L <sup>[4]</sup>	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{2R}$	$\overline{\text{BUS}}\text{YR}$	A7R	A6R
H	A8L	A9L	CL	VTTL	VCORE	VSS	VSS	VSS	VSS	VSS	VSS	VCORE	VTTL	CR	A9R	A8R
J	A10L	A11L	VSS	PORTST D1L	VCORE	VSS	VSS	VSS	VSS	VSS	VSS	VCORE	PORTST D1R	VSS	A11R	A10R
K	A12L	A13L	$\overline{\text{OE}}\text{L}$	$\overline{\text{BE}}\text{1L}$	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{1R}$	$\overline{\text{OE}}\text{R}$	A13R	A12R
L	A14L	A15L	$\overline{\text{ADS}}\text{L}$	$\overline{\text{BE}}\text{0L}$	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{0R}$	$\overline{\text{ADS}}\text{R}$	A15R	A14R
M	A16L	A17L <sup>[11]</sup>	$\text{R}/\overline{\text{W}}\text{L}$	CQENL	VDDIOL	VDDIOL	VDDIOL	VCORE	VCORE	VDDIOR	VDDIOR	VDDIOR	CQENR	$\text{R}/\overline{\text{W}}\text{R}$	A17R <sup>[11]</sup>	A16R
N	A18L <sup>[10]</sup>	NC	$\overline{\text{CNT}}\text{MSKL}$	VREFL	PORTST D0L	$\overline{\text{READY}}\text{L}$	ZQ1L <sup>[4]</sup>	VTTL	VTTL	ZQ1R <sup>[4]</sup>	$\overline{\text{READY}}\text{R}$	PORTST D0R	VREFR	$\overline{\text{CNT}}\text{MSKR}$	NC	A18R <sup>[10]</sup>
P	DQ16L	DQ17L	$\overline{\text{CNT}}\text{ENL}$	$\overline{\text{CNT}}\text{RSTL}$	CQ0L	$\overline{\text{CQ}}\text{0L}$	TCK	TMS	TDO	TDI	$\overline{\text{CQ}}\text{0R}$	CQ0R	$\overline{\text{CNT}}\text{RSTR}$	$\overline{\text{CNT}}\text{ENR}$	DQ17R	DQ16R
R	DQ15L	DQ13L	DQ11L	DQ9L	DQ7L	DQ5L	DQ3L	DQ1L	DQ1R	DQ3R	DQ5R	DQ7R	DQ9R	DQ11R	DQ13R	DQ15R
T	DQ14L	DQ12L	DQ10L	DQ8L	DQ6L	DQ4L	DQ2L	DQ0L	DQ0R	DQ2R	DQ4R	DQ6R	DQ8R	DQ10R	DQ12R	DQ14R

**Notes:**

- 10. Leave this ball unconnected for CYD09S36V18 and CYD04S36V18.
- 11. Leave this ball unconnected for CYD04S36V18.

**FullFlex18 SDR 256-Ball BGA (Top View)**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	NC	NC	NC	DQ17L	DQ16L	DQ13L	DQ12L	DQ9L	DQ9R	DQ12R	DQ13R	DQ16R	DQ17R	NC	NC	NC
B	NC	NC	NC	NC	DQ15L	DQ14L	DQ11L	DQ10L	DQ10R	DQ11R	DQ14R	DQ15R	NC	NC	NC	NC
C	NC	NC	$\overline{\text{RET}}\text{L}$	$\overline{\text{INT}}\text{L}$	CQ1L	$\overline{\text{CQ}}\text{1L}$	NC	$\overline{\text{TR}}\text{ST}$	$\overline{\text{MR}}\text{ST}$	ZQ0R <sup>[4]</sup>	$\overline{\text{CQ}}\text{1R}$	CQ1R	$\overline{\text{IN}}\text{TR}$	$\overline{\text{RE}}\text{TR}$	NC	NC
D	A0L	A1L	$\overline{\text{WR}}\text{PL}$	VREFL	$\overline{\text{FT}}\text{SELL}$	$\overline{\text{LOW}}\text{SPDL}$	VSS	VTTL	VTTL	VSS	$\overline{\text{LOW}}\text{SPDR}$	$\overline{\text{FT}}\text{SELR}$	VREFR	$\overline{\text{WR}}\text{PR}$	A1R	A0R
E	A2L	A3L	$\overline{\text{CE}}\text{0L}$	CE1L	VDDIOL	VDDIOL	VDDIOL	VCORE	VCORE	VDDIOR	VDDIOR	VDDIOR	CE1R	$\overline{\text{CE}}\text{0R}$	A3R	A2R
F	A4L	A5L	$\overline{\text{CNT}}\text{INTL}$	NC	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	NC	$\overline{\text{CNT}}\text{INTR}$	A5R	A4R
G	A6L	A7L	$\overline{\text{BUS}}\text{YL}$	NC	ZQ0L <sup>[4]</sup>	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	NC	$\overline{\text{BUS}}\text{YR}$	A7R	A6R
H	A8L	A9L	CL	VTTL	VCORE	VSS	VSS	VSS	VSS	VSS	VSS	VCORE	VTTL	CR	A9R	A8R
J	A10L	A11L	VSS	PORTST D1L	VCORE	VSS	VSS	VSS	VSS	VSS	VSS	VCORE	PORTST D1R	VSS	A11R	A10R
K	A12L	A13L	$\overline{\text{OE}}\text{L}$	$\overline{\text{BE}}\text{1L}$	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{1R}$	$\overline{\text{OE}}\text{R}$	A13R	A12R
L	A14L	A15L	$\overline{\text{ADS}}\text{L}$	$\overline{\text{BE}}\text{0L}$	VDDIOL	VSS	VSS	VSS	VSS	VSS	VSS	VDDIOR	$\overline{\text{BE}}\text{0R}$	$\overline{\text{ADS}}\text{R}$	A15R	A14R
M	A16L	A17L	$\overline{\text{R}}\text{WL}$	CQENL	VDDIOL	VDDIOL	VDDIOL	VCORE	VCORE	VDDIOR	VDDIOR	VDDIOR	CQENR	$\overline{\text{R}}\text{WR}$	A17R	A16R
N	A18L <sup>[13]</sup>	A19L <sup>[12]</sup>	$\overline{\text{CNT}}\text{MSKL}$	VREFL	PORTST D0L	$\overline{\text{RE}}\text{ADYL}$	ZQ1L <sup>[4]</sup>	VTTL	VTTL	ZQ1R <sup>[4]</sup>	$\overline{\text{RE}}\text{ADYR}$	PORTST D0R	VREFR	$\overline{\text{CNT}}\text{MSKR}$	A19R <sup>[12]</sup>	A18R <sup>[13]</sup>
P	NC	NC	$\overline{\text{CNT}}\text{ENL}$	$\overline{\text{CNT}}\text{RSTL}$	CQ0L	$\overline{\text{CQ}}\text{0L}$	TCK	TMS	TDO	TDI	$\overline{\text{CQ}}\text{0R}$	CQ0R	$\overline{\text{CNT}}\text{RSTR}$	$\overline{\text{CNT}}\text{ENR}$	NC	NC
R	NC	NC	NC	NC	DQ6L	DQ5L	DQ2L	DQ1L	DQ1R	DQ2R	DQ5R	DQ6R	NC	NC	NC	NC
T	NC	NC	NC	DQ8L	DQ7L	DQ4L	DQ3L	DQ0L	DQ0R	DQ3R	DQ4R	DQ7R	DQ8R	NC	NC	NC

**Notes:**

- 12. Leave this ball unconnected for CYD09S18V18 and CYD04S18V18.
- 13. Leave this ball unconnected for CYD04S18V18.

**Table 1. Selection Guide**

	-250	-200	-167	Unit
$f_{MAX}^{[15]}$	250	200	167	MHz
Max. Access Time (Clock to Data)	2.64	3.3	4.0	ns
Typical Operating Current $I_{CC}$	930 <sup>[14]</sup>	800 <sup>[14]</sup>	700 <sup>[14]</sup>	mA
Typical Standby Current for $I_{SB3}$ (Both Ports CMOS Level)	210 <sup>[14]</sup>	210 <sup>[14]</sup>	210 <sup>[14]</sup>	mA

**Pin Definitions**

Left Port	Right Port	Description
A[20:0] <sub>L</sub>	A[20:0] <sub>R</sub>	<b>Address Inputs.</b> <sup>[1]</sup>
DQ[71:0] <sub>L</sub>	DQ[71:0] <sub>R</sub>	<b>Data Bus Input/Output.</b> <sup>[2]</sup>
$\overline{BE}$ [7:0] <sub>L</sub>	$\overline{BE}$ [7:0] <sub>R</sub>	<b>Byte Select Inputs.</b> <sup>[3]</sup> Asserting these signals enables Read and Write operations to the corresponding bytes of the memory array.
$\overline{BUSY}$ <sub>L</sub>	$\overline{BUSY}$ <sub>R</sub>	<b>Port Busy Output.</b> When there is an address match and both chip enables are active for both ports, an external $\overline{BUSY}$ signal is asserted on the fifth clock cycles from when the collision occurs.
$C_L$	$C_R$	<b>Clock Signal.</b> Maximum clock input rate is $f_{MAX}$ .
$\overline{CE0}$ <sub>L</sub>	$\overline{CE0}$ <sub>R</sub>	<b>Active LOW Chip Enable Input.</b>
$\overline{CE1}$ <sub>L</sub>	$\overline{CE1}$ <sub>R</sub>	<b>Active HIGH Chip Enable Input.</b>
$\overline{CQEN}$ <sub>L</sub>	$\overline{CQEN}$ <sub>R</sub>	<b>Echo Clock Enable Input.</b> Assert HIGH to enable echo clocking on respective port.
$\overline{CQ0}$ <sub>L</sub>	$\overline{CQ0}$ <sub>R</sub>	<b>Echo Clock Signal Output for DQ[35:0] for FullFlex72 devices.</b> Echo Clock Signal Output for DQ[17:0] for FullFlex36 devices. Echo Clock Signal Output for DQ[8:0] for FullFlex18 devices.
$\overline{CQ0}$ <sub>L</sub>	$\overline{CQ0}$ <sub>R</sub>	<b>Inverted Echo Clock Signal Output for DQ[35:0] for FullFlex72 devices.</b> Inverted Echo Clock Signal Output for DQ[17:0] for FullFlex36 devices. Inverted Echo Clock Signal Output for DQ[8:0] for FullFlex18 devices.
$\overline{CQ1}$ <sub>L</sub>	$\overline{CQ1}$ <sub>R</sub>	<b>Echo Clock Signal Output for DQ[71:36] for FullFlex72 devices.</b> Echo Clock Signal Output for DQ[35:18] for FullFlex36 devices. Echo Clock Signal Output for DQ[17:9] for FullFlex18 devices.
$\overline{CQ1}$ <sub>L</sub>	$\overline{CQ1}$ <sub>R</sub>	<b>Inverted Echo Clock Signal Output for DQ[71:36] for FullFlex72 devices.</b> Inverted Echo Clock Signal Output for DQ[35:18] for FullFlex36 devices. Inverted Echo Clock Signal Output for DQ[17:9] for FullFlex18 devices.
ZQ[1:0] <sub>L</sub>	ZQ[1:0] <sub>R</sub>	<b>VIM Output Impedance Matching Input.</b> To use, connect a calibrating resistor between ZQ and ground. The resistor must be five times larger than the intended line impedance driven by the dual-port. Assert HIGH or leave NC to disable Variable Impedance Matching.
$\overline{OE}$ <sub>L</sub>	$\overline{OE}$ <sub>R</sub>	<b>Output Enable Input.</b> This asynchronous signal must be asserted LOW to enable the DQ data pins during Read operations.
$\overline{INT}$ <sub>L</sub>	$\overline{INT}$ <sub>R</sub>	<b>Mailbox Interrupt Flag Output.</b> The mailbox permits communications between ports. The upper two memory locations can be used for message passing. $\overline{INT}_L$ is asserted LOW when the right port writes to the mailbox location of the left port, and vice versa. An interrupt to a port is deasserted HIGH when it reads the contents of its mailbox.
$\overline{LowSPD}$ <sub>L</sub>	$\overline{LowSPD}$ <sub>R</sub>	<b>Port Low Speed Select Input.</b> Assert this pin LOW to disable the DLL. For operation at less than 100 MHz, assert this pin LOW.
PORTSTD[1:0] <sub>L</sub> <sup>[16]</sup>	PORTSTD[1:0] <sub>R</sub> <sup>[16]</sup>	<b>Port Clock/Address/Control/Data/Echo Clock/I/O Standard Select Input.</b> Assert these pins LOW/LOW for LVTTTL, LOW/HIGH for HSTL, HIGH/LOW for 2.5V LVCMOS, and HIGH/HIGH for 1.8V LVCMOS, respectively. These pins must be driven by VTTTL referenced levels.

**Notes:**

14. For 18-Mbit x72 commercial configuration only, please refer to the electrical characteristics section for complete information.

15. SDR mode with two pipelined stages.

16. PORTSTD[1:0]<sub>L</sub> and PORTSTD[1:0]<sub>R</sub> have internal pull-down resistors.



**Pin Definitions** (continued)

Left Port	Right Port	Description
$\overline{R/W}_L$	$\overline{R/W}_R$	<b>Read/Write Enable Input.</b> Assert this pin LOW to Write to, or HIGH to Read from the dual-port memory array.
$\overline{READY}_L$	$\overline{READY}_R$	<b>Port DLL Ready Output.</b> This signal will be asserted LOW when the DLL and Variable Impedance Matching circuits have completed calibration. This is a wired OR capable output.
$\overline{CNT/MSK}_L$	$\overline{CNT/MSK}_R$	<b>Port Counter/Mask Select Input.</b> Counter control input.
$\overline{ADS}_L$	$\overline{ADS}_R$	<b>Port Counter Address Load Strobe Input.</b> Counter control input.
$\overline{CNTEN}_L$	$\overline{CNTEN}_R$	<b>Port Counter Enable Input.</b> Counter control input.
$\overline{CNTRST}_L$	$\overline{CNTRST}_R$	<b>Port Counter Reset Input.</b> Counter control input.
$\overline{CNTINT}_L$	$\overline{CNTINT}_R$	<b>Port Counter Interrupt Output.</b> This pin is asserted LOW one cycle before the unmasked portion of the counter is incremented to all "1s".
$\overline{WRP}_L$	$\overline{WRP}_R$	<b>Port Counter Wrap Input.</b> When the burst counter reaches the maximum count, on the next counter increment $\overline{WRP}$ can be set LOW to load the unmasked counter bits to 0 or set HIGH to load the counter with the value stored in the mirror register.
$\overline{RET}_L$	$\overline{RET}_R$	<b>Port Counter Retransmit Input.</b> Assert this pin LOW to reload the initial address for repeated access to the same segment of memory.
$\overline{VREF}_L$	$\overline{VREF}_R$	<b>Port External HSTL I/O Reference Input.</b> This pin is left NC when HSTL is not used.
$\overline{VDDIO}_L$	$\overline{VDDIO}_R$	<b>Port Data I/O Power Supply.</b>
$\overline{FTSEL}_L$	$\overline{FTSEL}_R$	<b>Port Flow-through Mode Select Input.</b> Assert this pin LOW to select Flow-through mode. Assert this pin HIGH to select Pipelined mode.
$\overline{MRST}$		<b>Master Reset Input.</b> $\overline{MRST}$ is an asynchronous input signal and affects both ports. Asserting $\overline{MRST}$ LOW performs all of the reset functions as described in the text. A $\overline{MRST}$ operation is required at power-up. This pin must be driven by a $\overline{VDDIO}_L$ referenced signal.
TMS		<b>JTAG Test Mode Select Input.</b> It controls the advance of JTAG TAP state machine. State machine transitions occur on the rising edge of TCK. Operation for LVTTTL or 2.5V LVCMOS.
TDI		<b>JTAG Test Data Input.</b> Data on the TDI input will be shifted serially into selected registers. Operation for LVTTTL or 2.5V LVCMOS.
$\overline{TRST}$		<b>JTAG Reset Input.</b> Operation for LVTTTL or 2.5V LVCMOS.
TCK		<b>JTAG Test Clock Input.</b> Operation for LVTTTL or 2.5V LVCMOS.
TDO		<b>JTAG Test Data Output.</b> TDO transitions occur on the falling edge of TCK. TDO is normally three-stated except when captured data is shifted out of the JTAG TAP. Operation for LVTTTL or 2.5V LVCMOS.
VSS		<b>Ground Inputs.</b>
VCORE		<b>Device Core Power Supply.</b>
VTTTL		<b>LVTTTL Power Supply.</b>

**Selectable I/O Standard**

The FullFlex device families also offer the option of choosing one of four port standards for the device. Each port can independently select standards from single-ended HSTL class I, single-ended LVTTTL, 2.5V LVCMOS, or 1.8V LVCMOS. The selection of the standard is determined by the PORTSTD pins for each port. These pins should be connected to either an LVTTTL or 2.5V LVCMOS power supply. This will determine the input clock, address, control, data, and Echo clock standard for each port as shown in *Table 2*. Please note that only 1.8V LVCMOS and HSTL are supported for 4-Mbit, 9-Mbit, 18-Mbit devices running at 250 MHz, and for 36-Mbit devices running at 200 MHz.

**Table 2. Port Standard Selection**

PORTSTD1	PORTSTD0	I/O Standard
VSS	VSS	LVTTTL
VSS	VTTTL	HSTL
VTTTL	VSS	2.5V LVCMOS
VTTTL	VTTTL	1.8V LVCMOS

**Clocking**

Separate clocks synchronize the operations on each port. Each port has one clock input C. In this mode, all the transactions on the address, control, and data will be on the C rising

edge. All transactions on the address, control, data input, output, and byte enables will occur on the C rising edge.

**Table 3. Data Pin Assignment**

BE Pin Name	Data Pin Name
$\overline{BE}[7]$	DQ[71:63]
$\overline{BE}[6]$	DQ[62:54]
$\overline{BE}[5]$	DQ[53:45]
$\overline{BE}[4]$	DQ[44:36]
$\overline{BE}[3]$	DQ[35:27]
$\overline{BE}[2]$	DQ[26:18]
$\overline{BE}[1]$	DQ[17:9]
$\overline{BE}[0]$	DQ[8:0]

**Selectable Pipelined/Flow-through Mode**

To meet data rate and throughput requirements, the FullFlex families offer selectable pipelined or flow-through mode. Echo clocks are not supported in flow-through mode and the DLL must be disabled.

Flow-through mode is selected by the FTSEL pin. Strapping this pin HIGH selects pipelined mode. Strapping this pin LOW selects flow-through mode.

**DLL**

The FullFlex families of devices have an on-chip DLL. Enabling the DLL reduces the clock to data valid ( $t_{CD}$ ) time allowing more set-up time for the receiving device. For operation below 100 MHz, the DLL must be disabled. This is selectable by strapping LowSPD low.

Whenever the operating frequency is altered beyond the Clock Input Cycle to Cycle Jitter spec, the DLL is required to be reset followed by 1024 clocks before any valid operation.

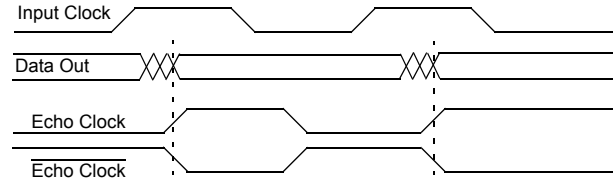
LowSPD pins can be used to reset the DLL(s) for a single port independent of all other circuitry. MRST can be used to reset all DLLs on the chip, for information on DLL lock and reset time, please see the Master Reset section below.

**Echo Clocking**

As the speed of data increases, on-board delays caused by parasitics make providing accurate clock trees extremely difficult. To counter this problem, the FullFlex families incorporate Echo Clocks. Echo Clocks are enabled on a per port basis. The dual-port receives input clocks that are used to clock in the address and control signals for a read operation. The dual-port retransmits the input clocks relative to the data output. The buffered clocks are provided on the CQ1/CQ1 and CQ0/CQ0 outputs. Each port has a pair of Echo clocks. Each

clock is associated with half the data bits. The output clock will match the corresponding ports I/O configuration.

To enable Echo clock outputs, tie CQEN HIGH. To disable Echo clock outputs, tie CQEN LOW.



**Figure 2. SDR Echo Clock Delay**

**Deterministic Access Control**

Deterministic Access Control is provided for ease of design. The circuitry detects when both ports are accessing the same location and provides an external BUSY flag to the port on which data may be corrupted. The collision detection logic saves the address in conflict (Busy Address) to a readable register. In the case of multiple collisions, the first Busy address will be written to the Busy Address register.

If both ports are accessing the same location at the same time and only one port is doing a write, if  $t_{CCS}$  is met, then the data being written to and read from the address is valid data. For example, if the right port is reading and the left port is writing and the left ports clock meets  $t_{CCS}$ , then the data being read from the address by the right port will be the old data. In the same case, if the right ports clock meets  $t_{CCS}$ , then the data being read out of the address from the right port will be the new data. In the above case, if  $t_{CCS}$  is violated by the either ports clock with respect to the other port and the right port gets the external BUSY flag, the data from the right port is corrupted. Table 4 shows the  $t_{CCS}$  timing that must be met to guarantee the data.

Table 5 shows that, in the case of the left port writing and the right port reading, when an external BUSY flag is asserted on the right port, the data read out of the device will not be guaranteed.

The value in the busy address register can be read back to the address lines. The required input control signals for this function are shown in Table 8. The value in the busy address register will be read out to the address lines  $t_{CA}$  after the same amount of latency as a data read operation. After an initial address match, the BUSY flag is asserted and the address under contention is saved in the busy address register. All following address matches cause the BUSY flag to be generated, however, none of the addresses are saved into the busy address register. Once a busy readback is performed, the address of the first match that happens at least two clocks cycles after the busy readback is saved into the busy address register.

**Table 4.  $t_{CCS}$  Timing for All Operating Modes**

Port A—Early Arriving Port		Port B—Late Arriving Port		$t_{CCS}$ C Rise to Opposite C Rise Set-up Time for Non-corrupt Data	Unit
Mode	Active Edge	Mode	Active Edge		
SDR	C	SDR	C	$t_{CYC(min)} - 0.5$	ns

**Table 5. Deterministic Access Control Logic**

Left Port	Right Port	Left Clock	Right Clock	BUSY <sub>L</sub>	BUSY <sub>R</sub>	Description
Read	Read	X	X	H	H	No Collision
Write	Read	>t <sub>CCS</sub>	0	H	H	Read OLD Data
		0	>t <sub>CCS</sub>	H	H	Read NEW Data
		<t <sub>CCS</sub>	0	H	H	Read OLD Data
				H	L	Data Not Guaranteed
		0	<t <sub>CCS</sub>	H	H	Read NEW Data
				H	L	Data Not Guaranteed
Read	Write	>t <sub>CCS</sub>	0	H	H	Read NEW Data
		0	>t <sub>CCS</sub>	H	H	Read OLD Data
		<t <sub>CCS</sub>	0	H	H	Read NEW Data
				L	H	Data Not Guaranteed
		0	<t <sub>CCS</sub>	H	H	Read OLD Data
				L	H	Data Not Guaranteed
Write	Write	0	>-t <sub>CCS</sub> & <t <sub>CCS</sub>	L	L	Array Data Corrupted
		0	>t <sub>CCS</sub>	L	H	Array Stores Right Port Data
		>t <sub>CCS</sub>	0	H	L	Array Stores Left Port Data

### Variable Impedance Matching (VIM)

Each port contains a Variable Impedance Matching circuit to set the impedance of the I/O driver to match the impedance of the on-board traces. The impedance is set for all outputs except JTAG and is done on a per port basis. To take advantage of the VIM feature, connect a calibrating resistor (RQ) that is five times the value of the intended line impedance from the ZQ pin to VSS. The output impedance is then adjusted to account for drifts in supply voltage and temperature every 1024 clock cycles. If a port's clock is suspended, the VIM circuit will retain its last setting until the clock is restarted. On restart, it will then resume periodic adjustment. In the case of a significant change in device temperature or supply voltage, recalibration will happen every 1024 clock cycles. A Master Reset will initialize the VIM circuitry. *Table 6* shows the VIM parameters and *Table 7* describes the VIM operation modes.

In order to disable VIM, the ZQ pin must be connected to VDDIO of the relative supply for the I/Os before a Master Reset.

**Table 6. Variable Impedance Matching Parameters**

Parameter	Min.	Max.	Unit	Tolerance
RQ Value	100	275	Ω	± 2%
Output Impedance	20	55	Ω	± 15%
Reset Time	N/A	1024	Cycles	N/A
Update Time	N/A	1024	Cycles	N/A

**Table 7. Variable Impedance Matching Operation**

RQ Connection	Output Configuration
100Ω - 275Ω to VSS	Output Driver Impedance = RQ/5 ± 15% at Vout = VDDIO/2
ZQ to VDDIO	VIM Disabled. Rout ≤ 20Ω at Vout = VDDIO/2

### Address Counter and Mask Register Operations<sup>[1]</sup>

Each port of the FullFlex family contains a programmable burst address counter. The burst counter contains four registers: a counter register, a mask register, a mirror register, and a busy address register.

The **counter register** contains the address used to access the RAM array. It is changed only by the master reset (MRST), Counter Reset, Counter Load, Retransmit, and Counter Increment operations.

The **mask register** value affects the Counter Increment and Counter Reset operations by preventing the corresponding bits of the counter register from changing. It also affects the counter interrupt output (CNTINT). The mask register is only changed by Mask Reset, Mask Load, and MRST. The Mask Load operation loads the value of the address bus into the mask register. The mask register defines the counting range of the counter register. The mask register is divided into two or three consecutive regions. Zero or more "0s" define the masked region and one or more "1s" define the unmasked portion of the counter register. The counter register may only be divided into up to three regions. The region containing the least significant bits must be no more than two "0s". Bits one and zero may be "10" respectively, masking the least significant counter bit and causing the counter to increment by two instead of one. If bits one and zero are "00", the two least significant bits are masked and the counter will increment by four instead of one. For example, in the case of a 256Kx72

configuration, a mask register value of 003FC divides the mask register into three regions. With bit 0 being the least significant bit and bit 17 being the most significant bit, the two least significant bits are masked, the next eight bits are unmasked, and the remaining bits are masked.

The **mirror register** is used to reload the counter register on retransmit operations (see “retransmit” below) and wrap functions (see “counter increment” below). The last value loaded into the counter register is stored in the mirror register. The mirror register is only changed by master reset (MRST), Counter Reset, and Counter Load.

Table 8 summarizes the operations of these registers and the required input control signals. All signals except MRST are synchronized to the ports clock.

#### Counter Load Operation<sup>[1]</sup>

The address counter and mirror registers are both loaded with the address value presented on the address lines. This value ranges from 0 to 1FFFFFF.

#### Mask Load Operation<sup>[1]</sup>

The mask register is loaded with the address value presented on the address bus. This value ranges from 0 to 1FFFFFF though not all values permit correct increment operations. Permitted values are in the form of  $2^n-1$ ,  $2^n-2$ , or  $2^n-4$ . The counter register can only be segmented in up to three regions. From the most significant bit to the least significant bit, permitted values have zero or more “0s”, one or more “1s”, and the least significant two bits can be “11”, “10”, or “00”. Thus

1FFFFFFE, 07FFFF, and 003FFC are permitted values but 02FFFF, 003FFA, and 07FFE4 are not.

#### Counter Readback Operation

The internal value of the counter register can be read out on the address lines. The address will be valid  $t_{CA}$  after the selected number of latency cycles configured by FTSEL. The data bus (DQ) is tri-stated on the cycle that the address is presented on the address lines. Figure 3 shows a block diagram of this logic.

#### Mask Readback Operation

The internal value of the mask register can be read out on the address lines. The address will be valid  $t_{CA}$  after the selected number of latency cycles configured by FTSEL. The data bus (DQ) is tri-stated on the cycle that the address is presented on the address lines. Figure 3 shows a block diagram of the operation.
















#### Counter Reset Operation

All unmasked bits of the counter and mirror registers are reset to “0”. All masked bits remain unchanged. A mask reset followed by a counter reset will reset the counter and mirror registers to 00000.

#### Mask Reset Operation

The mask register is reset to all “1s”, which unmask every bit of the burst counter.

**Table 8. Burst Counter and Mask Register Control Operation (Any Port)** [17, 18]

C	MRST	CNTRST	CNT/MSK	CNTEN	ADS	RET	Operation	Description
X	L	X	X	X	X	X	Master Reset	Reset address counter to all 0s, mask register to all 1s, and busy address to all 0's.
	H	L	H	X	X	X	Counter Reset	Reset counter and mirror unmasked portion to all 0s.
	H	L	L	X	X	X	Mask Reset	Reset mask register to all 1s.
	H	H	H	L	L	X	Counter Load	Load burst counter and mirror with external address value presented on address lines.
	H	H	L	L	L	X	Mask Load	Load mask register with value presented on the address lines.
	H	H	H	L	H	L	Retransmit	Load counter with value in the mirror register
	H	H	H	L	H	H	Counter Increment	Internally increment address counter value.
	H	H	H	H	H	H	Counter Hold	Constantly hold the address value for multiple clock cycles.
	H	H	H	H	L	H	Counter Readback	Read out counter internal value on address lines.
	H	H	L	H	L	H	Mask Readback	Read out mask register value on address lines.
	H	H	L	H	H	L	Busy Address Readback	Read out first busy address after last busy address readback
	H	H	L	L	H	X	Reserved	
	H	H	L	H	L	L	Reserved	
	H	H	L	H	H	H	Reserved	
	H	H	H	H	L	L	Reserved	
	H	H	H	H	H	L	Reserved	

**Notes:**

17. "X" = "Don't Care", "H" = HIGH, "L" = LOW.

18. Counter operation and mask register operation is independent of chip enables.

### Increment Operation<sup>[1]</sup>

Once the address counter is initially loaded with an external address, the counter can internally increment the address value and address the entire memory array. Only the unmasked bits of the counter register are incremented. In order for a counter bit to change, the corresponding bit in the mask register must be “1”. If the two least significant bits of the mask register are “11”, the burst counter will increment by one. If the two least significant bits are “10”, the burst counter will increment by two, and if they are “00”, the burst counter will increment by four. If all unmasked counter bits are incremented to “1” and  $\overline{WRP}$  is deasserted, the next increment will wrap the counter back to the initially loaded value. The cycle before the increment that results in all unmasked counter bits to become “1s”, a counter interrupt flag ( $\overline{CNTINT}$ ) is asserted if the counter is incremented again. This increment will cause the counter to reach its maximum value and the next increment will return the counter register to its initial value that was stored in the mirror register if  $\overline{WRP}$  is deasserted. If  $\overline{WRP}$  is asserted, the unmasked portion of the counter is filled with “0” instead. The example shown in *Figure 4* shows an example of the CYDD36S18V18 device with the mask register loaded with a mask value of 00007F unmasking the seven least significant bits. Setting the mask register to this value allows the counter to access the entire memory space. The address counter is then loaded with an initial value of 000005 assuming  $\overline{WRP}$  is deasserted. The masked bits, the seventh address through the twenty-first address, do not increment in an increment operation. The counter address will start at address 000005 and will increment its internal address value until it reaches the mask register value of 00007F. The counter wraps around the memory block to location 000005 at the next count.  $\overline{CNTINT}$  is issued when the counter reaches the maximum -1 count.

### Hold Operation

The value of all three registers can be constantly maintained unchanged for an unlimited number of clock cycles. Such operation is useful in applications where wait states are needed, or when address is available a few cycles ahead of data in a shared bus interface.

### Retransmit

Retransmit allows repeated access to the same block of memory without the need to reload the initial address. An internal mirror register stores the address counter value last loaded. While  $\overline{RET}$  is asserted low, the counter will continue to wrap back to the value in the mirror register independent of the state of  $\overline{WRP}$ .

### Counter Interrupt

The counter interrupt ( $\overline{CNTINT}$ ) is asserted LOW one clock cycle before an increment operation that results in the unmasked portion of the counter register being all “1s”. It is deasserted by counter reset, counter load, mask reset, mask load, and MRST.

### Counting by Two

When the two least significant bits of the mask register are “10,” the counter increments by two.

### Counting by Four

When the two least significant bits of the mask register are “00,” the counter increments by four.

### Mailbox Interrupts

The upper two memory locations can be used for message passing and permit communications between ports. *Table 9* shows the interrupt operation for both ports. The highest memory location is the mailbox for the right port and the maximum address - 1 is the mailbox for the left port.

When one port writes to the other port’s mailbox, the  $\overline{INT}$  flag of the port that the mailbox belongs to is asserted LOW. The  $\overline{INT}$  flag remains asserted until the mailbox location is read by the other port. When a port reads its mailbox, the  $\overline{INT}$  flag is deasserted high after one cycle of latency with respect to the input clock of the port to which the mailbox belongs and is independent of  $\overline{OE}$ .

*Table 9* shows that in order to set the  $\overline{INT}_R$  flag, a Write operation by the left port to address 1FFFFFF will assert  $\overline{INT}_R$  LOW. A valid Read of the 1FFFFFF location by the right port will reset  $\overline{INT}_R$  HIGH after one cycle of latency with respect to the right port’s clock. At least one byte enable has to be activated to set or reset the mailbox interrupt.

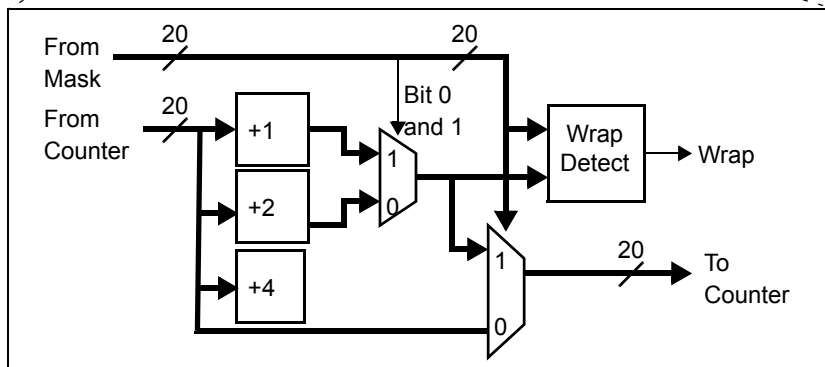
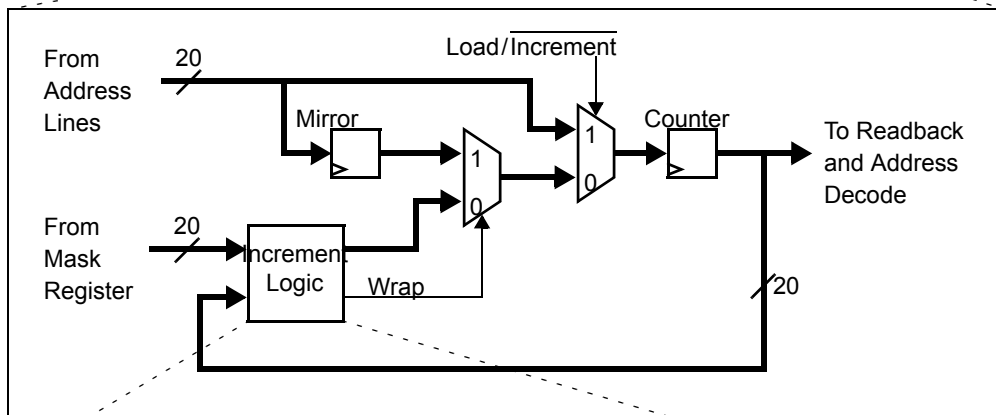
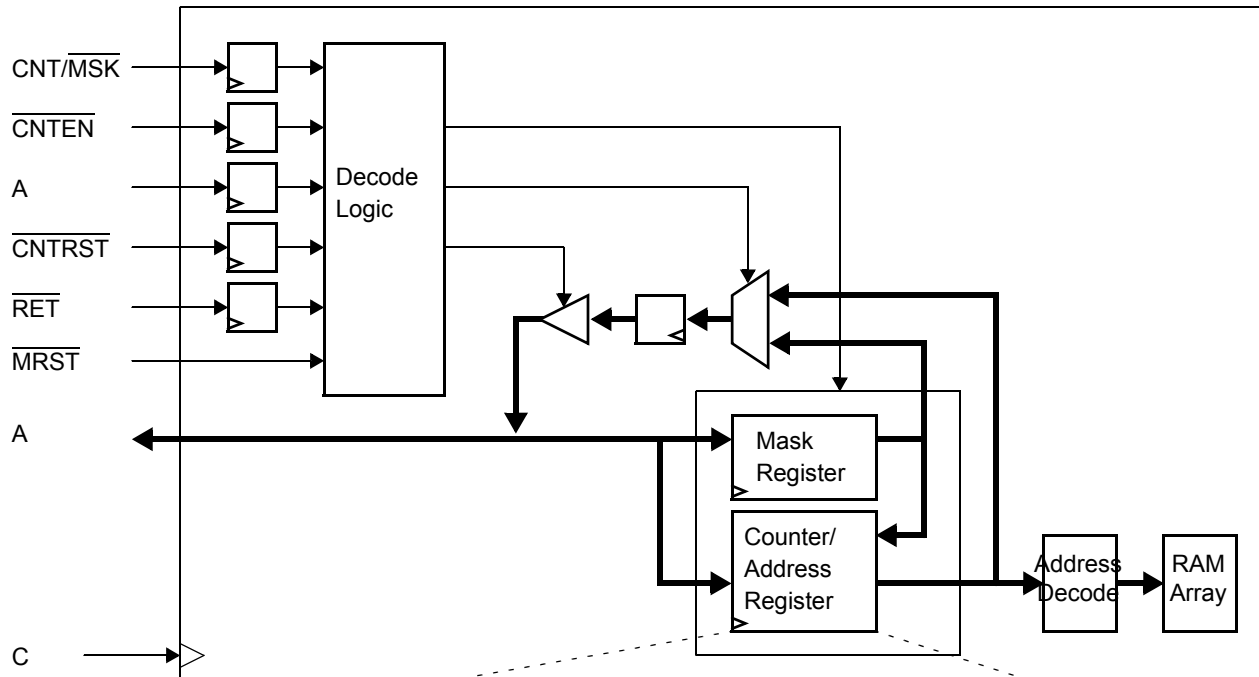


Figure 3. Counter, Mask, and Mirror Logic Block Diagram<sup>[1]</sup>

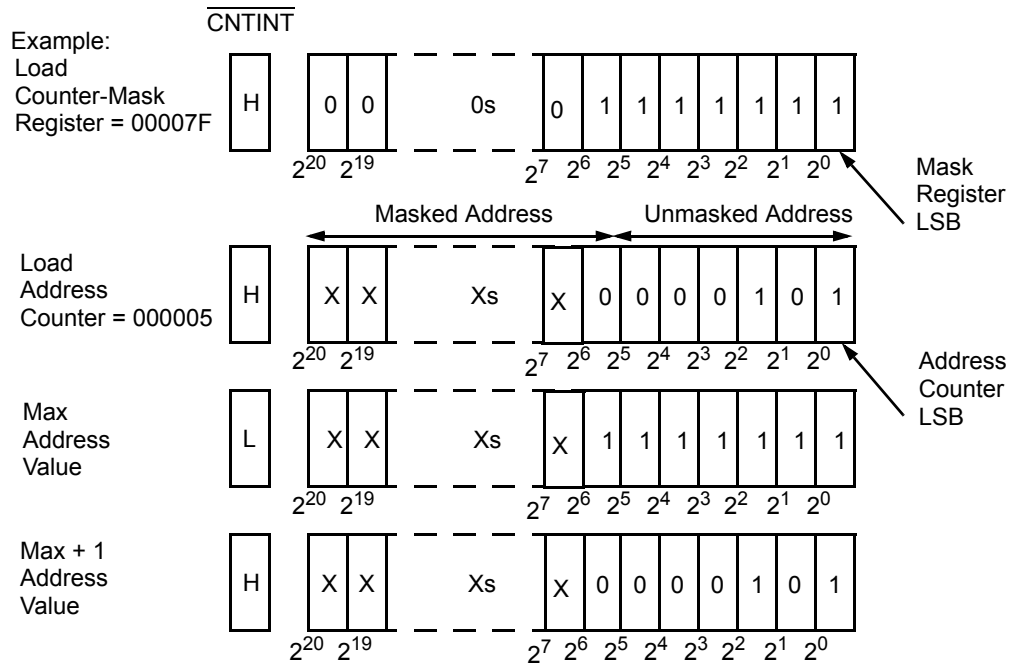


Figure 4. Programmable Counter-Mask Register Operation with  $\overline{\text{WRP}}$  deasserted<sup>[1, 22]</sup>

Table 9. Interrupt Operation Example<sup>[1, 17, 19, 20, 21]</sup>

Function	Left Port				Right Port			
	$\overline{\text{R/W}}_L$	$\overline{\text{CE}}_L$	$\text{A}_{0L-20L}$	$\overline{\text{INT}}_L$	$\overline{\text{R/W}}_R$	$\overline{\text{CE}}_R$	$\text{A}_{0R-20R}$	$\overline{\text{INT}}_R$
Set Right $\overline{\text{INT}}_R$ Flag	L	L	Max. Address	X	X	X	X	L
Reset Right $\overline{\text{INT}}_R$ Flag	X	X	X	X	H	L	Max. Address	H
Set Left $\overline{\text{INT}}_L$ Flag	X	X	X	L	L	L	Max. Address-1	X
Reset Left $\overline{\text{INT}}_L$ Flag	H	L	Max. Address-1	H	X	X	X	X

**Master Reset**

The FullFlex family of Dual-Ports undergo a complete reset when  $\overline{\text{MRST}}$  is asserted. The  $\overline{\text{MRST}}$  can be asserted asynchronously to the clocks and must remain asserted for at least  $t_{RS}$ . Once asserted  $\overline{\text{MRST}}$  deasserts  $\overline{\text{READY}}$ , initializes the internal burst counters, internal mirror registers, and internal Busy Addresses to zero, and initializes the internal mask register to all "1s". All mailbox interrupts ( $\overline{\text{INT}}$ ), Busy Address Outputs ( $\overline{\text{BUSY}}$ ), and burst counter interrupts ( $\overline{\text{CNTINT}}$ ) are deasserted upon master reset. Releasing  $\overline{\text{MRST}}$  also signifies that the power supplies and all port clocks are stable. This begins calibration of the DLL and VIM circuits.  $\overline{\text{READY}}$  will be asserted within 1024 clock cycles.  $\overline{\text{READY}}$  is a wired OR capable output with a strong pull-up and weak

pull-down. Up to four outputs may be connected together. For faster pull-down of the signal, connect a 250 Ohm resistor to VSS. If the DLL and VIM circuits are disabled for a port, the port will be operational within five clock cycles. However, the  $\overline{\text{READY}}$  will be asserted within 160 clock cycles.

**IEEE 1149.1 Serial Boundary Scan (JTAG)**

The FullFlex families incorporate an IEEE 1149.1 serial boundary scan test access port (TAP). The TAP operates using JEDEC-standard 3.3V or 2.5V I/O logic levels depending on the VTTL power supply. It is composed of four input connections and one output connection required by the test logic defined by the standard.

**Notes:**

- 19.  $\overline{\text{CE}}$  is internal signal.  $\overline{\text{CE}} = \text{LOW}$  if  $\overline{\text{CE}}_0 = \text{LOW}$  and  $\overline{\text{CE}}_1 = \text{HIGH}$ . For a single Read operation,  $\overline{\text{CE}}$  only needs to be asserted once at the rising edge of the C and can be deasserted after that. Data will be out after the following C edge and will be tri-stated after the next C edge.
- 20. OE is "Don't Care" for mailbox operation.
- 21. At least one of  $\overline{\text{BE}}_0, \overline{\text{BE}}_1, \overline{\text{BE}}_2, \overline{\text{BE}}_3, \overline{\text{BE}}_4, \overline{\text{BE}}_5, \overline{\text{BE}}_6,$  or  $\overline{\text{BE}}_7$  must be LOW.
- 22. The "X" in this diagram represents the counter's upper bits.



**Table 10. JTAG IDCODE Register Definitions**

Part Number	Configuration	Value
CYD36S72V18	512Kx72	0C026069h (x2)
CYD36S36V18	1024Kx36	0C023069h
CYD36S18V18	2048Kx36	0C024069h
CYD18S72V18	256Kx72	0C025069h
CYD18S36V18	512Kx36	0C026069h
CYD18S18V18	1024Kx18	0C027069h
CYD09S72V18	128Kx72	0C028069h
CYD09S36V18	256Kx36	0C029069h
CYD09S18V18	512Kx18	0C02A069h
CYD04S72V18	64Kx72	0C02B069h
CYD04S36V18	128Kx36	0C02C069h
CYD04S18V18	256Kx18	0C02D069h

**Table 11. Scan Registers Sizes**

Register Name	Bit Size
Instruction	4
Bypass	1
Identification	32
Boundary Scan	n <sup>[23]</sup>

**Table 12. Instruction Identification Codes**

Instruction	Code	Description
EXTEST	0000	Captures the Input/Output ring contents. Places the BSR between the TDI and TDO.
BYPASS	1111	Places the BYR between TDI and TDO.
IDCODE	1011	Loads the IDR with the vendor ID code and places the register between TDI and TDO.
HIGHZ	0111	Places BYR between TDI and TDO. Forces all FullFlex72 and FullFlex36 output drivers to a High-Z state.
CLAMP	0100	Controls boundary to 1/0. Places BYR between TDI and TDO.
SAMPLE/PRELOAD	1000	Captures the input/output ring contents. Places BSR between TDI and TDO.
RESERVED	All other codes	Other combinations are reserved. Do not use other than the above.

**Note:**

23. Details of the boundary scan length can be found in the BSDL file for the device.

### Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature .....	-65°C to + 150°C
Ambient Temperature with Power Applied.....	-55°C to + 125°C
Supply Voltage to Ground Potential .....	-0.5V to + 4.1V
DC Voltage Applied to Outputs in High-Z State.....	-0.5V to V <sub>DDIO</sub> + 0.5V
DC Input Voltage.....	-0.5V to V <sub>DDIO</sub> + 0.5V
Output Current into Outputs (LOW) .....	20 mA
Static Discharge Voltage .....	> 2200V (JEDEC JESD8-6, JESD8-B)
Latch-up Current.....	> 200 mA

### Operating Range

Range	Ambient Temperature	VCORE
Commercial	0°C to +70°C	1.8V ± 100 mV 1.5V ± 80 mV
Industrial	-40°C to +85°C	1.8V ± 100 mV 1.5V ± 80 mV

### Power Supply Requirements

	Min.	Typ.	Max.
LVTTTL VDDIO	3.0V	3.3V	3.6V
2.5V LVCMOS VDDIO	2.3V	2.5V	2.7V
HSTL VDDIO	1.4V	1.5V	1.9V
1.8V LVCMOS VDDIO	1.7V	1.8V	1.9V
3.3V VTTL	3.0V	3.3V	3.6V
2.5V VTTL	2.3V	2.5V	2.7V
HSTL VREF	0.68V	0.75V	0.95V

### Electrical Characteristics Over the Operating Range

Parameter	Description	Configuration	All Speed Bins <sup>[24]</sup>			Unit
			Min.	Typ.	Max.	
V <sub>OH</sub>	Output HIGH Voltage (V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -8 mA)	LVTTTL	2.4 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -4 mA)	HSTL (DC) <sup>[26]</sup>	VDDIO - 0.4 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -4 mA)	HSTL (AC) <sup>[26]</sup>	VDDIO - 0.5 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -6 mA)	2.5V LVCMOS	1.7 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -4 mA)	1.8V LVCMOS	VDDIO - 0.45 <sup>[25]</sup>			V
V <sub>OL</sub>	Output HIGH Voltage (V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 8 mA)	LVTTTL			0.4 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 4 mA)	HSTL (DC) <sup>[26]</sup>			0.4 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 4 mA)	HSTL (AC) <sup>[26]</sup>			0.5 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 6 mA)	2.5V LVCMOS			0.7 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 4 mA)	1.8V LVCMOS			0.45 <sup>[25]</sup>	V
V <sub>IH</sub>	Input HIGH Voltage	LVTTTL	2		VDDIO + 0.3	V
		HSTL (DC) <sup>[26]</sup>	VREF + 0.1		VDDIO + 0.3	V
		2.5V LVCMOS	1.7			V
		1.8V LVCMOS	1.26			V
V <sub>IL</sub>	Input LOW Voltage	LVTTTL	-0.3		0.8	V
		HSTL (DC) <sup>[26]</sup>	-0.3		VREF - 0.1	V
		2.5V LVCMOS	0.7			V
		1.8V LVCMOS	0.36			V

**Notes:**

24. LVTTTL and 2.5V LVCMOS are not available for 4-Mbit, 9-Mbit, 18-Mbit devices running at 250 MHz and 36-Mbit devices running at 200 MHz.

25. These parameters are met with VIM disabled.

26. The (DC) specifications are measured under steady state conditions. The (AC) specifications are measured while switching at speed.

**Electrical Characteristics** Over the Operating Range (continued)

Parameter	Description	Configuration	All Speed Bins <sup>[24]</sup>			Unit
			Min.	Typ.	Max.	
READY V <sub>OH</sub>	Output HIGH Voltage (V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -24 mA)	LVTTTL	2.7 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -12 mA)	HSTL(DC) <sup>[26]</sup>	V <sub>DDIO</sub> - 0.4 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -12 mA)	HSTL (AC) <sup>[26]</sup>	V <sub>DDIO</sub> - 0.5 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -15 mA)	2.5V LVCMOS	2.0 <sup>[25]</sup>			V
	(V <sub>DDIO</sub> = Min., I <sub>OH</sub> = -12 mA)	1.8V LVCMOS	V <sub>DDIO</sub> - 0.45 <sup>[25]</sup>			V
READY V <sub>OL</sub>	Output HIGH Voltage (V <sub>DDIO</sub> = Min., I <sub>O</sub> = 0.12 mA)	LVTTTL			0.4 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 0.12 mA)	HSTL(DC) <sup>[26]</sup>			0.4 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 0.12 mA)	HSTL (AC) <sup>[26]</sup>			0.5 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 0.15 mA)	2.5V LVCMOS			0.7 <sup>[25]</sup>	V
	(V <sub>DDIO</sub> = Min., I <sub>OL</sub> = 0.08 mA)	1.8V LVCMOS			0.45 <sup>[25]</sup>	V
I <sub>OZ</sub>	Output Leakage Current		-10		10	μA
I <sub>IX1</sub>	Input Leakage Current Except TDI, TMS, MRST		-10		10	μA
I <sub>IX2</sub>	Input Leakage Current TDI, TMS, MRST		-300		10	μA
I <sub>IX3</sub>	Input Leakage Current PORTSTD, DDRON		-10		300	μA

**Electrical Characteristics** Over the Operating Range

Parameter	Description	Configuration	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit	
			Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.		
I <sub>CC</sub>	Operating Current (V <sub>CORE</sub> = Max., I <sub>OUT</sub> = 0 mA) Outputs Disabled	512Kx72	Com.	N/A	N/A	1440	1800	1280	1620	1120	1430	mA
			Ind.	N/A	N/A	N/A	N/A	1330	1730	1170	1550	mA
		1024Kx36	Com.	N/A	N/A	1180	1500	1050	1350	930	1220	mA
			Ind.	N/A	N/A	N/A	N/A	1110	1470	980	1330	mA
		2048Kx18	Com.	N/A	N/A	1130	1430	1000	1290	890	1160	mA
			Ind.	N/A	N/A	N/A	N/A	1060	1410	940	1280	mA
		256Kx72	Com.	930	1140	800	980	700	880	N/A	N/A	mA
			Ind.	N/A	N/A	820	1030	730	930	N/A	N/A	mA
		512Kx36	Com.	750	920	640	800	570	720	N/A	N/A	mA
			Ind.	N/A	N/A	670	860	590	780	N/A	N/A	mA
		1024Kx18	Com.	710	880	610	770	540	690	N/A	N/A	mA
			Ind.	N/A	N/A	640	830	570	750	N/A	N/A	mA
		128Kx72	Com.	770	930	640	790	560	700	N/A	N/A	mA
			Ind.	N/A	N/A	660	830	580	740	N/A	N/A	mA
		256Kx36	Com.	630	740	540	640	470	570	N/A	N/A	mA
			Ind.	N/A	N/A	550	670	490	600	N/A	N/A	mA
		512Kx18	Com.	660	770	550	660	480	580	N/A	N/A	mA
			Ind.	N/A	N/A	570	690	500	610	N/A	N/A	mA
		64Kx72	Com.	740	880	620	740	540	650	N/A	N/A	mA
			Ind.	N/A	N/A	630	770	550	680	N/A	N/A	mA
128Kx36	Com.	610	690	510	590	450	520	N/A	N/A	mA		
	Ind.	N/A	N/A	520	600	460	530	N/A	N/A	mA		
256Kx18	Com.	630	720	530	610	460	530	N/A	N/A	mA		
	Ind.	N/A	N/A	540	620	470	550	N/A	N/A	mA		

**Electrical Characteristics** Over the Operating Range (continued)

Parameter	Description	Configuration	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit	
			Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.		
I <sub>SB1</sub>	Standby Current (Both Ports TTL Level) CE <sub>L</sub> and CE <sub>R</sub> ≥ V <sub>IH</sub> , f = f <sub>MAX</sub>	512Kx72	Com.	N/A	N/A	1000	1250	920	1160	830	1060	mA
			Ind.	N/A	N/A	N/A	N/A	970	1260	880	1170	mA
		1024Kx36	Com.	N/A	N/A	910	1140	820	1050	740	960	mA
			Ind.	N/A	N/A	N/A	N/A	880	1160	790	1080	mA
		2048Kx18	Com.	N/A	N/A	890	1110	810	1030	730	940	mA
			Ind.	N/A	N/A	N/A	N/A	860	1140	780	1050	mA
		256Kx72	Com.	570	700	500	630	460	580	N/A	N/A	mA
			Ind.	N/A	N/A	530	680	490	630	N/A	N/A	mA
		512Kx36	Com.	520	640	460	570	410	530	N/A	N/A	mA
			Ind.	N/A	N/A	480	630	440	580	N/A	N/A	mA
		1024Kx18	Com.	500	620	450	560	410	520	N/A	N/A	mA
			Ind.	N/A	N/A	470	610	430	570	N/A	N/A	mA
		128Kx72	Com.	460	560	400	490	360	450	N/A	N/A	mA
			Ind.	N/A	N/A	420	540	380	490	N/A	N/A	mA
		256Kx36	Com.	430	500	380	440	340	400	N/A	N/A	mA
			Ind.	N/A	N/A	390	470	360	430	N/A	N/A	mA
		512Kx18	Com.	450	520	390	460	350	410	N/A	N/A	mA
			Ind.	N/A	N/A	410	480	370	440	N/A	N/A	mA
		64Kx72	Com.	440	520	380	450	340	400	N/A	N/A	mA
			Ind.	N/A	N/A	390	480	350	430	N/A	N/A	mA
128Kx36	Com.	410	450	360	400	320	360	N/A	N/A	mA		
	Ind.	N/A	N/A	360	410	330	370	N/A	N/A	mA		
256Kx18	Com.	420	470	370	410	320	370	N/A	N/A	mA		
	Ind.	N/A	N/A	370	420	330	380	N/A	N/A	mA		

**Electrical Characteristics** Over the Operating Range (continued)

Parameter	Description	Configuration	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit	
			Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.		
I <sub>SB2</sub>	Standby Current (One Port TTL or CMOS Level) $CE_L \mid CE_R \geq V_{IH}, f = f_{MAX}$	512Kx72	Com.	N/A	N/A	1300	1570	1160	1410	1020	1260	mA
			Ind.	N/A	N/A	N/A	N/A	1210	1520	1070	1370	mA
		1024Kx36	Com.	N/A	N/A	1090	1330	980	1210	870	1100	mA
			Ind.	N/A	N/A	N/A	N/A	1030	1330	920	1210	mA
		2048Kx18	Com.	N/A	N/A	1040	1270	930	1160	830	1050	mA
			Ind.	N/A	N/A	N/A	N/A	980	1270	880	1160	mA
		256Kx72	Com.	760	890	650	790	580	710	N/A	N/A	mA
			Ind.	N/A	N/A	680	840	610	760	N/A	N/A	mA
		512Kx36	Com.	630	760	550	670	490	610	N/A	N/A	mA
			Ind.	N/A	N/A	570	730	520	670	N/A	N/A	mA
		1024Kx18	Com.	600	730	520	640	470	580	N/A	N/A	mA
			Ind.	N/A	N/A	550	690	490	640	N/A	N/A	mA
		128Kx72	Com.	620	730	520	630	460	560	N/A	N/A	mA
			Ind.	N/A	N/A	550	670	480	610	N/A	N/A	mA
		256Kx36	Com.	540	610	460	530	400	470	N/A	N/A	mA
			Ind.	N/A	N/A	480	560	430	500	N/A	N/A	mA
		512Kx18	Com.	550	620	460	530	410	480	N/A	N/A	mA
			Ind.	N/A	N/A	480	560	430	510	N/A	N/A	mA
		64Kx72	Com.	590	680	500	580	440	510	N/A	N/A	mA
			Ind.	N/A	N/A	510	610	450	550	N/A	N/A	mA
128Kx36	Com.	510	560	440	480	380	420	N/A	N/A	mA		
	Ind.	N/A	N/A	450	500	390	440	N/A	N/A	mA		
256Kx18	Com.	520	570	440	490	390	430	N/A	N/A	mA		
	Ind.	N/A	N/A	450	500	400	450	N/A	N/A	mA		

**Electrical Characteristics** Over the Operating Range

Parameter	Description	Configuration		All Speed Bins <sup>[24]</sup>		Unit
				Typ.	Max.	
I <sub>SB3</sub>	Standby Current (Both Ports CMOS Level) CE <sub>L</sub> and CE <sub>R</sub> ≥ V <sub>CORE</sub> - 0.2V, f = 0	512Kx72	Com.	410	590	mA
			Ind.	460	700	mA
		1024Kx36	Com.	410	590	mA
			Ind.	460	700	mA
		2048Kx18	Com.	410	590	mA
			Ind.	460	700	mA
		256Kx72	Com.	210	300	mA
			Ind.	230	350	mA
		512Kx36	Com.	210	300	mA
			Ind.	230	350	mA
		1024Kx18	Com.	210	300	mA
			Ind.	230	350	mA
		128Kx72	Com.	150	200	mA
			Ind.	170	220	mA
		256Kx36	Com.	150	200	mA
			Ind.	170	220	mA
		512Kx18	Com.	150	200	mA
			Ind.	170	220	mA
		64Kx72	Com.	130	150	mA
			Ind.	140	170	mA
128Kx36	Com.	130	150	mA		
	Ind.	140	170	mA		
256Kx18	Com.	130	150	mA		
	Ind.	140	170	mA		

**Table 13. Capacitance**

Signals	Packages			
	CYDD18S72V18 CYDD09S72V18 CYDD04S72V18 CYDD18S36V18 CYDD09S36V18 CYDD04S36V18	CYDD18S18V18 CYDD09S18V18 CYDD04S18V18	CYDD36S72V18 CYDD36S36V18	CYDD36S18V18
OE	12 pF	12 pF	20 pF	20 pF
BE, DQ	10 pF	18 pF	16 pF	30 pF
All other signals	10 pF	10 pF	16 pF	16 pF

AC Test Load and Waveforms

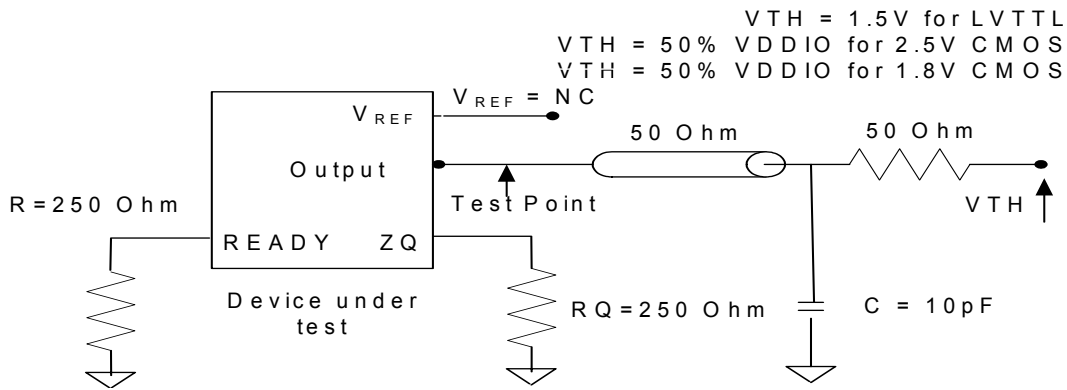


Figure 5. Output Test Load for LVTTL/CMOS

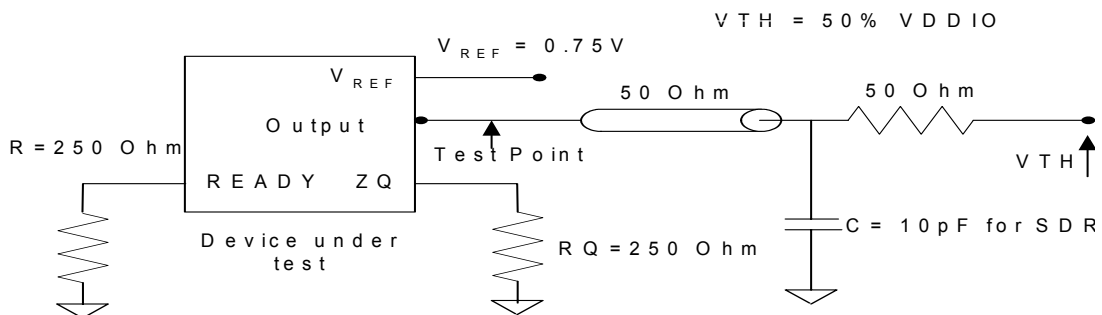
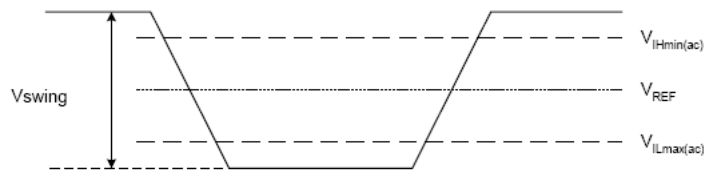


Figure 6. Output Test Load for HSTL

AC Input Test Signal Waveform



$V_{swing} = 1.0V$   
 $V_{REF} = 0.75V$   
 $V_{IH} = 1.25V$   
 $V_{IL} = 0.25V$   
 Slew = 2.0V/ns  
 All input parameters are referenced to  $V_{REF}$

Figure 7. HSTL Input Waveform



**Switching Characteristics** Over the Operating Range

**Table 14. SDR Mode with DLL Enabled (LOWSPD-HIGH)<sup>[29]</sup>**

Parameter	Description	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>MAX</sub> (PIPELINED)	Maximum Operating Frequency for Pipelined Mode	100	250	100	200	100	167	100	133	MHz
f <sub>MAX</sub> (FLOW-THROUGH)	Maximum Operating Frequency for Flow-through Mode		100		77		66.7		55.6	MHz
t <sub>CYC</sub> (PIPELINED)	C Clock Cycle Time for Pipelined Mode	4.00 <sup>[30]</sup>	10.00	5.00 <sup>[30]</sup>	10.00	6.00 <sup>[30]</sup>	10.00	7.00 <sup>[30]</sup>	10.00	ns
t <sub>CYC</sub> (FLOW-THROUGH)	C Clock Cycle Time for Flow-through Mode	10.00 <sup>[30]</sup>		13.00 <sup>[30]</sup>		15.00 <sup>[30]</sup>		18.00 <sup>[30]</sup>		ns
t <sub>CKD</sub>	C Clock Duty Time	45	55	45	55	45	55	45	55	%
t <sub>SD</sub>	Data Input Set-up Time to C Rise	HSTL	1.20 <sup>[28,30]</sup>		1.50 <sup>[28,30]</sup>		1.70 <sup>[28,30]</sup>		1.80 <sup>[28,30]</sup>	ns
		1.8V LVCMOS								
		2.5V LVCMOS 3.3V LVTTTL	1.45 <sup>[28,30]</sup>		1.75 <sup>[28,30]</sup>		1.95 <sup>[28,30]</sup>		2.05 <sup>[28,30]</sup>	ns
t <sub>HD</sub>	Data Input Hold Time after C Rise	0.50		0.50		0.50		0.50		ns
t <sub>SAC</sub>	Address & Control Input Setup Time to C Rise	HSTL	1.20 <sup>[28,30]</sup>		1.50 <sup>[28,30]</sup>		1.70 <sup>[28,30]</sup>		1.80 <sup>[28,30]</sup>	ns
		1.8V LVCMOS								
		2.5V LVCMOS 3.3V LVTTTL	1.45 <sup>[28,30]</sup>		1.75 <sup>[28,30]</sup>		1.95 <sup>[28,30]</sup>		2.05 <sup>[28,30]</sup>	ns
t <sub>HAC</sub>	Address & Control Input Hold Time after C Rise	0.50		0.50		0.60		0.70		ns
t <sub>OE</sub>	Output Enable to Data Valid		3.40 <sup>[28,30]</sup>		4.40 <sup>[28,30]</sup>		5.00 <sup>[28,30]</sup>		5.50 <sup>[28,30]</sup>	ns
t <sub>OLZ</sub> <sup>[27]</sup>	$\overline{OE}$ to Low Z	1.00		1.00		1.00		1.00		ns
t <sub>OHZ</sub> <sup>[27]</sup>	$\overline{OE}$ to High Z	1.00	3.40 <sup>[28,30]</sup>	1.00	4.40 <sup>[28,30]</sup>	1.00	5.00 <sup>[28,30]</sup>	1.00	5.50 <sup>[28,30]</sup>	ns
t <sub>CD1</sub>	C Rise to DQ Valid for Flow-through Mode (LowSPD = 1)		7.20 <sup>[28,30]</sup>		9.00 <sup>[28,30]</sup>		11.00 <sup>[28,30]</sup>		13.00 <sup>[28,30]</sup>	ns
t <sub>CD2</sub> <sup>[31]</sup>	C Rise to DQ Valid for Pipelined Mode (LowSPD = 1)		2.64 <sup>[28,30]</sup>		3.30 <sup>[28,30]</sup>		4.00 <sup>[28,30]</sup>		4.50 <sup>[28,30]</sup>	ns
t <sub>CA1</sub>	C Rise to Address Readback Valid for Flow-through Mode		7.20 <sup>[30]</sup>		9.00 <sup>[30]</sup>		11.00 <sup>[30]</sup>		13.00 <sup>[30]</sup>	ns
t <sub>CA2</sub>	C Rise to Address Readback Valid for Pipelined Mode		4.00 <sup>[30]</sup>		5.00 <sup>[30]</sup>		6.00 <sup>[30]</sup>		7.50 <sup>[30]</sup>	ns
t <sub>DC</sub> <sup>[31]</sup>	DQ Output Hold after C Rise	1.00		1.00		1.00		1.00		ns
t <sub>CCQ</sub> <sup>[31]</sup>	C Rise to CQ Rise	1.00	2.64 <sup>[30]</sup>	1.00	3.30 <sup>[30]</sup>	1.00	4.00 <sup>[30]</sup>	1.00	4.50 <sup>[30]</sup>	ns
t <sub>JIT</sub>	Clock Input Cycle to Cycle Jitter		+/- 200		+/- 200		+/- 200		+/- 200	ps

**Notes:**

27. Parameters specified with the load capacitance in Figure 5 and Figure 6.

28. For the x18 devices, add 200 ps to this parameter in the table above.

29. Test conditions assume a signal transition time of 2 V/ns.

 30. Add 15% to this parameter if a V<sub>CORE</sub> of 1.5V is used.

31. This parameter assumes input clock cycle to cycle jitter of +/- 0ps.

**Table 14.SDR Mode with DLL Enabled (LOWSPD-HIGH)<sup>[29]</sup> (continued)**

Parameter	Description		-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>CQHQV</sub> <sup>[31]</sup>	Echo Clock (CQ) High to Output Valid	HSTL 1.8V LVCMOS		0.60 <sup>[28]</sup>		0.70 <sup>[28]</sup>		0.80 <sup>[28]</sup>		0.90 <sup>[28]</sup>	ns
		2.5V LVCMOS 3.3V LVTTTL		0.70 <sup>[28]</sup>		0.80 <sup>[28]</sup>		0.90 <sup>[28]</sup>		1.00 <sup>[28]</sup>	ns
t <sub>CQHQX</sub> <sup>[31]</sup>	Echo Clock (CQ) High to Output Hold	HSTL 1.8V LVCMOS	-0.60		-0.70		-0.80		-0.90		ns
		2.5V LVCMOS 3.3V LVTTTL	-0.75		-0.85		-0.95		-1.05		ns
t <sub>CKHZ1</sub> <sup>[27]</sup>	C Rise to DQ Output High Z in Flow-through Mode		1.00	7.20 <sup>[28,30]</sup>	1.00	9.00 <sup>[28,30]</sup>	1.00	11.00 <sup>[28,30]</sup>	1.00	13.00 <sup>[28,30]</sup>	ns
t <sub>CKLZ1</sub> <sup>[27]</sup>	C Rise to DQ Output Low Z in Flow-through Mode		1.00		1.00		1.00		1.00		ns
t <sub>CKHZ2</sub> <sup>[27,31]</sup>	C Rise to DQ Output High Z in Pipelined Mode		1.00	2.64 <sup>[28,30]</sup>	1.00	3.30 <sup>[28,30]</sup>	1.00	4.00 <sup>[28,30]</sup>	1.00	4.50 <sup>[28,30]</sup>	ns
t <sub>CKLZ2</sub> <sup>[27,31]</sup>	C Rise to DQ Output Low Z in Pipelined Mode		1.00		1.00		1.00		1.00		ns
t <sub>AC</sub>	Address Output Hold after C Rise		1.00		1.00		1.00		1.00		ns
t <sub>CKHZA1</sub> <sup>[27]</sup>	C Rise to Address Output High Z for Flow-through Mode		1.00	7.20 <sup>[30]</sup>	1.00	9.00 <sup>[30]</sup>	1.00	11.00 <sup>[30]</sup>	1.00	13.00 <sup>[30]</sup>	ns
t <sub>CKHZA2</sub> <sup>[27]</sup>	C Rise to Address Output High Z for Pipelined Mode		1.00	4.00 <sup>[30]</sup>	1.00	5.00 <sup>[30]</sup>	1.00	6.00 <sup>[30]</sup>	1.00	7.50 <sup>[30]</sup>	ns
t <sub>CKLZA</sub> <sup>[27]</sup>	C Rise to Address Output Low Z		1.00		1.00		1.00		1.00		ns
t <sub>SCINT</sub>	C Rise to $\overline{\text{CNTINT}}$ Low		1.00	2.64 <sup>[30]</sup>	1.00	3.30 <sup>[30]</sup>	1.00	4.00 <sup>[30]</sup>	1.00	4.50 <sup>[30]</sup>	ns
t <sub>RCINT</sub>	C Rise to $\overline{\text{CNTINT}}$ High		1.00	2.64 <sup>[30]</sup>	1.00	3.30 <sup>[30]</sup>	1.00	4.00 <sup>[30]</sup>	1.00	4.50 <sup>[30]</sup>	ns
t <sub>SINT</sub>	C Rise to $\overline{\text{INT}}$ Low		0.50	6.00 <sup>[30]</sup>	0.50	7.00 <sup>[30]</sup>	0.50	8.00 <sup>[30]</sup>	0.50	8.50 <sup>[30]</sup>	ns
t <sub>RINT</sub>	C Rise to $\overline{\text{INT}}$ High		0.50	6.00 <sup>[30]</sup>	0.50	7.00 <sup>[30]</sup>	0.50	8.00 <sup>[30]</sup>	0.50	8.50 <sup>[30]</sup>	ns
t <sub>BSY</sub>	C Rise to $\overline{\text{BUSY}}$ Valid		1.00	2.64 <sup>[30]</sup>	1.00	3.30 <sup>[30]</sup>	1.00	4.00 <sup>[30]</sup>	1.00	4.50 <sup>[30]</sup>	ns

**Table 15.SDR Mode with DLL Disabled (LOWSPD-LOW)<sup>[29]</sup>**

Parameter	Description	All Speed Bins		Unit
		Min.	Max.	
f <sub>MAX</sub> (PIPELINED)	Maximum Operating Frequency for Pipelined Mode		100	MHz
f <sub>MAX</sub> (FLOW-THROUGH)	Maximum Operating Frequency for Flow-through Mode		55.6	MHz
t <sub>CYC</sub> (PIPELINED)	C Clock Cycle Time for Pipelined Mode	10.00 <sup>[30]</sup>		ns
t <sub>CYC</sub> (FLOW-THROUGH)	C Clock Cycle Time for Flow-through Mode	18.00 <sup>[30]</sup>		ns
t <sub>CKD</sub>	C Clock Duty Time	45	55	%
t <sub>SD</sub>	Data Input Set-up Time to C Rise	HSTL/1.8V LVCMOS	1.80 <sup>[28,30]</sup>	ns
		2.5V LVCMOS/3.3V LVTTTL	2.05 <sup>[28,30]</sup>	ns
t <sub>HD</sub>	Data Input Hold Time after C Rise	0.50		ns
t <sub>SAC</sub>	Address & Control Input Setup Time to C Rise	HSTL/1.8V LVCMOS	1.80 <sup>[28,30]</sup>	ns
		2.5V LVCMOS/3.3V LVTTTL	2.05 <sup>[28,30]</sup>	ns
t <sub>HAC</sub>	Address & Control Input Hold Time after C Rise	0.70		ns
t <sub>OE</sub>	Output Enable to Data Valid		5.50 <sup>[28,30]</sup>	ns
t <sub>OLZ</sub> <sup>[27]</sup>	OE to Low Z	1.00		ns

**Table 15.SDR Mode with DLL Disabled (LOWSPD-LOW)<sup>[29]</sup>**

Parameter	Description	All Speed Bins		Unit
		Min.	Max.	
t <sub>OHZ</sub> <sup>[27]</sup>	OE to High Z	1.00	5.50 <sup>[28,30]</sup>	ns
t <sub>CD1</sub>	C Rise to DQ Valid for Flow-through Mode (LowSPD = 0)		13.00 <sup>[28,30]</sup>	ns
t <sub>CD2</sub> <sup>[31]</sup>	C Rise to DQ Valid for Pipelined Mode (LowSPD = 0)		6.00 <sup>[28,30]</sup>	ns
t <sub>CA1</sub>	C Rise to Address Readback Valid for Flow-through Mode		13.00 <sup>[30]</sup>	ns
t <sub>CA2</sub>	C Rise to Address Readback Valid for Pipelined Mode		7.50 <sup>[30]</sup>	ns
t <sub>DC</sub> <sup>[31]</sup>	DQ Output Hold after C Rise	1.00		ns
t <sub>CCQ</sub> <sup>[31]</sup>	C Rise to CQ Rise	1.00	6.00 <sup>[30]</sup>	ns
t <sub>CQHQV</sub> <sup>[31]</sup>	Echo Clock (CQ) High to Output Valid	HSTL/1.8V LVCMOS	0.90 <sup>[28]</sup>	ns
		2.5V LVCMOS/3.3V LVTTTL	1.00 <sup>[28]</sup>	ns
t <sub>CQHQX</sub> <sup>[31]</sup>	Echo Clock (CQ) High to Output Hold	HSTL/1.8V LVCMOS	-0.90	ns
		2.5V LVCMOS/3.3V LVTTTL	-1.05	ns
t <sub>CKHZ1</sub> <sup>[27]</sup>	C Rise to DQ Output High Z in Flow-through Mode	1.00	13.00 <sup>[28,30]</sup>	ns
t <sub>CKLZ1</sub> <sup>[27]</sup>	C Rise to DQ Output Low Z in Flow-through Mode	1.00		ns
t <sub>CKHZ2</sub> <sup>[27,31]</sup>	C Rise to DQ Output High Z in Pipelined Mode	1.00	6.00 <sup>[28,30]</sup>	ns
t <sub>CKLZ2</sub> <sup>[27,31]</sup>	C Rise to DQ Output Low Z in Pipelined Mode	1.00		ns
t <sub>AC</sub>	Address Output Hold after C Rise	1.00		ns
t <sub>CKHZA1</sub> <sup>[27]</sup>	C Rise to Address Output High Z for Flow-through mode	1.00	13.00 <sup>[30]</sup>	ns
t <sub>CKHZA2</sub> <sup>[27]</sup>	C Rise to Address Output High Z for Pipelined Mode	1.00	7.50 <sup>[30]</sup>	ns
t <sub>CKLZA</sub> <sup>[27]</sup>	C Rise to Address Output Low Z	1.00		ns
t <sub>SCINT</sub>	C Rise to $\overline{\text{CNTINT}}$ Low	1.00	4.50 <sup>[30]</sup>	ns
t <sub>RCINT</sub>	C Rise to CNTINT High	1.00	4.50 <sup>[30]</sup>	ns
t <sub>SINT</sub>	C Rise to INT Low	0.50	8.50 <sup>[30]</sup>	ns
t <sub>RINT</sub>	C Rise to INT High	0.50	8.50 <sup>[30]</sup>	ns
t <sub>BSY</sub>	C Rise to BUSY Valid	1.00	4.50 <sup>[30]</sup>	ns

**Table 16.Master Reset Timing**

Parameter	Description	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>PUP</sub>	Power-Up Time	1		1		1		1		ms
t <sub>RS</sub>	Master Reset Pulse Width	5		5		5		5		cycles
t <sub>RSR</sub>	Master Reset Recovery Time	5		5		5		5		cycles
t <sub>RSF</sub>	Master Reset to Outputs Inactive/Hi Z		12		15		18		22.50	ns
t <sub>RDY</sub> <sup>[32]</sup>	Master Reset Release to Port Ready		1024		1024		1024		1024	cycles
t <sub>CORDY</sub> <sup>[33]</sup>	C Rise to Port Ready		8 <sup>[30]</sup>		9.5 <sup>[30]</sup>		11 <sup>[30]</sup>		13 <sup>[30]</sup>	ns

**Table 17.JTAG Timing**

Parameter	Description	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>JTAG</sub>	JTAG TAP Controller Frequency		20		20		20		20	MHz

**Notes:**

32. READY is a wired OR capable output with a weak pull-down. For a decreased falling delay, connect a 250-Ω resistor to VSS.

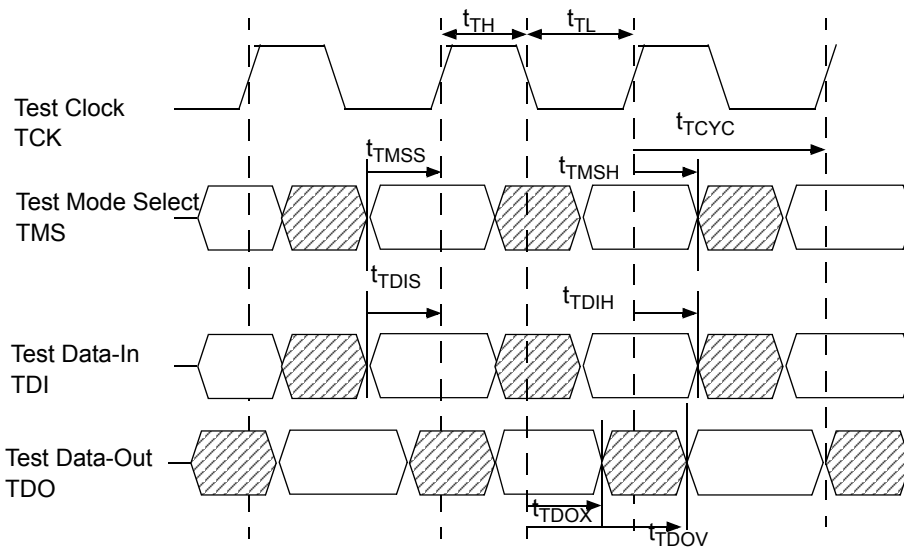
33. Add this propagation delay after t<sub>RDY</sub> for all Master Reset Operations.

Table 17. JTAG Timing

Parameter	Description	-250 <sup>[24]</sup>		-200 <sup>[24]</sup>		-167		-133		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>TCYC</sub>	TCK Cycle Time	50		50		50		50		ns
t <sub>TH</sub>	TCK High Time	20		20		20		20		ns
t <sub>TL</sub>	TCK Low Time	20		20		20		20		ns
t <sub>TMSS</sub>	TMS Set-up to TCK Rise	10		10		10		10		ns
t <sub>TMSH</sub>	TMS Hold to TCK Rise	10		10		10		10		ns
t <sub>TDIS</sub>	TDI Set-up to TCK Rise	10		10		10		10		ns
t <sub>TDIH</sub>	TDI Hold to TCK Rise	10		10		10		10		ns
t <sub>TDOV</sub>	TCK Low to TDO Valid		10		10		10		10	ns
t <sub>TDOX</sub>	TCK Low to TDO Invalid	0		0		0		0		ns
t <sub>JXZ</sub>	TCK Low to TDO High Z		15		15		15		15	ns
t <sub>JZX</sub>	TCK Low to TDO Active		15		15		15		15	ns
t <sub>JZX</sub>	TCK Low to TDO Active		15		15		15		15	ns

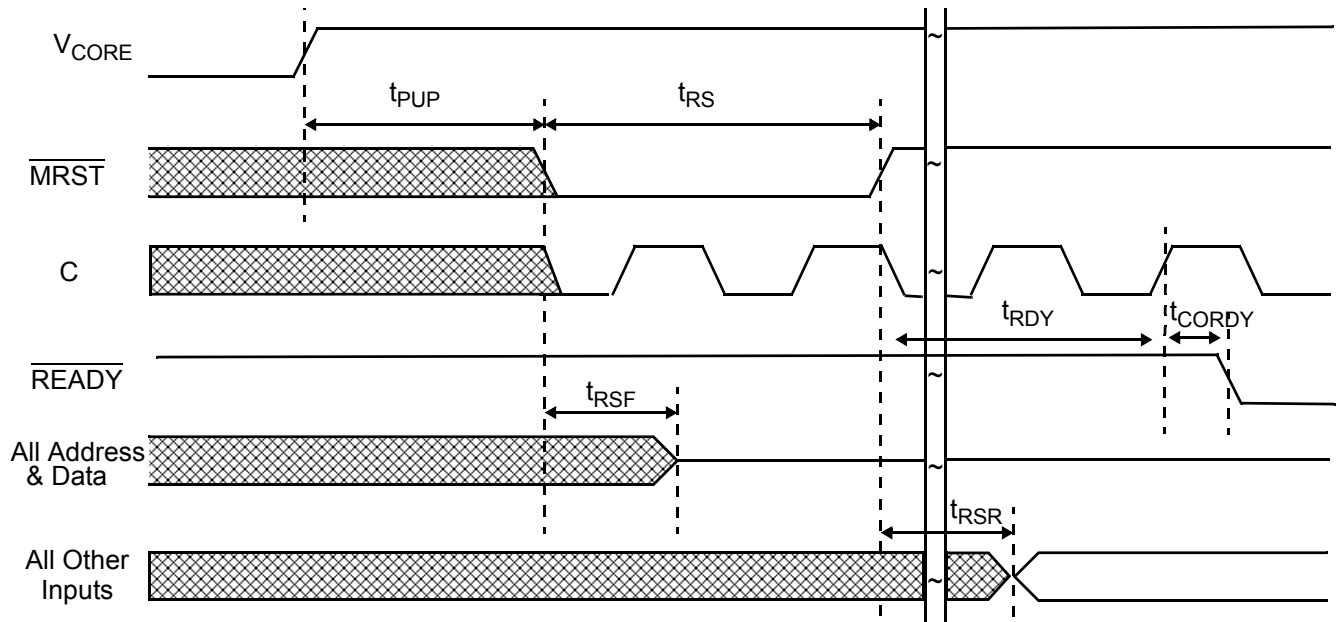
Switching Waveforms

JTAG Timing

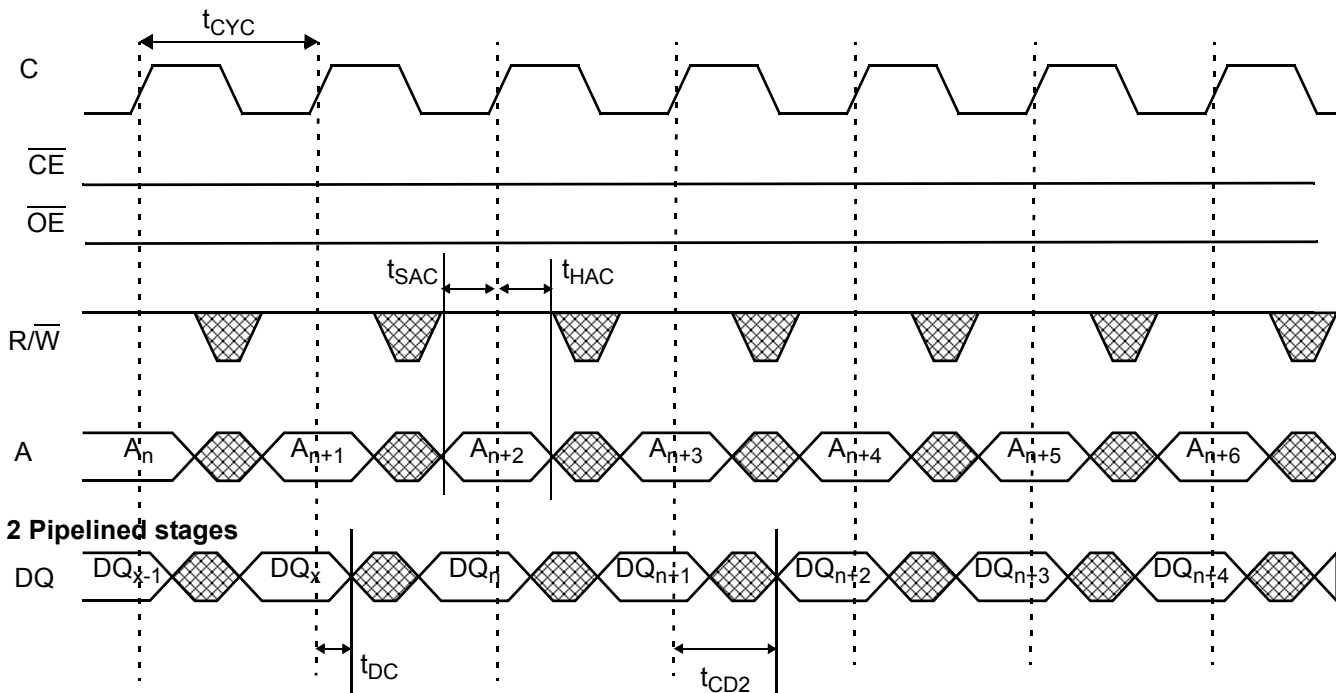


**Switching Waveforms (continued)**

**Master Reset<sup>[32]</sup>**

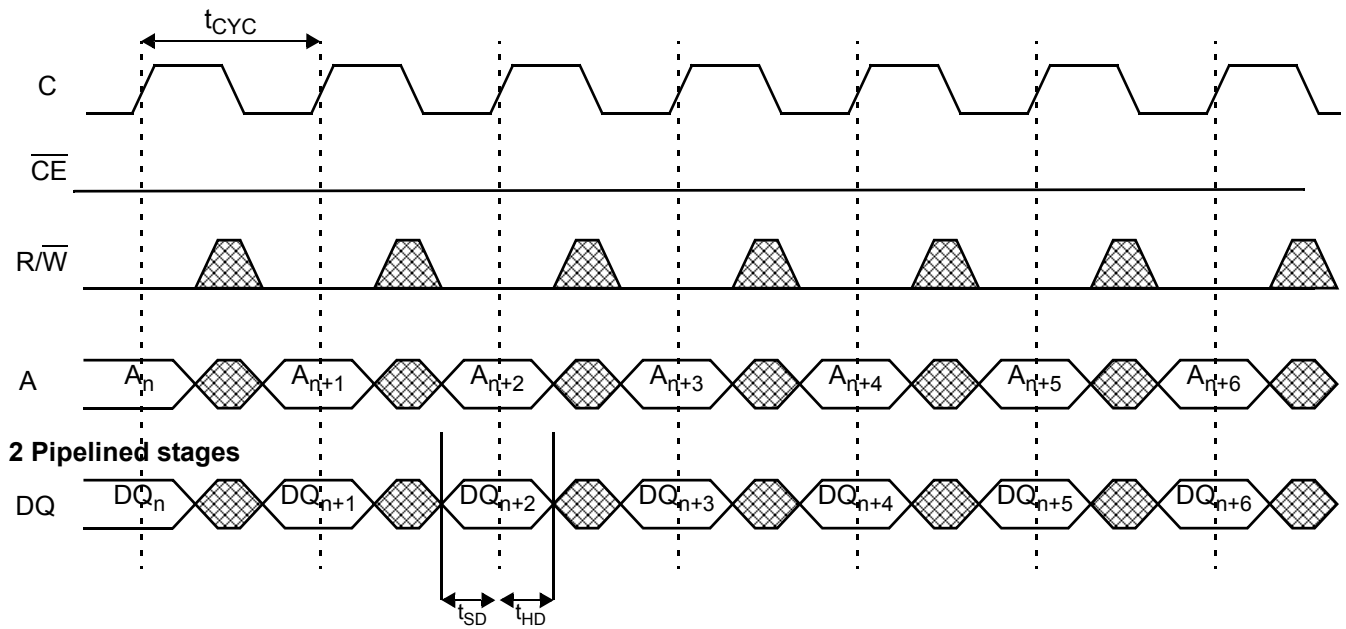


**READ Cycle for Pipelined Mode**

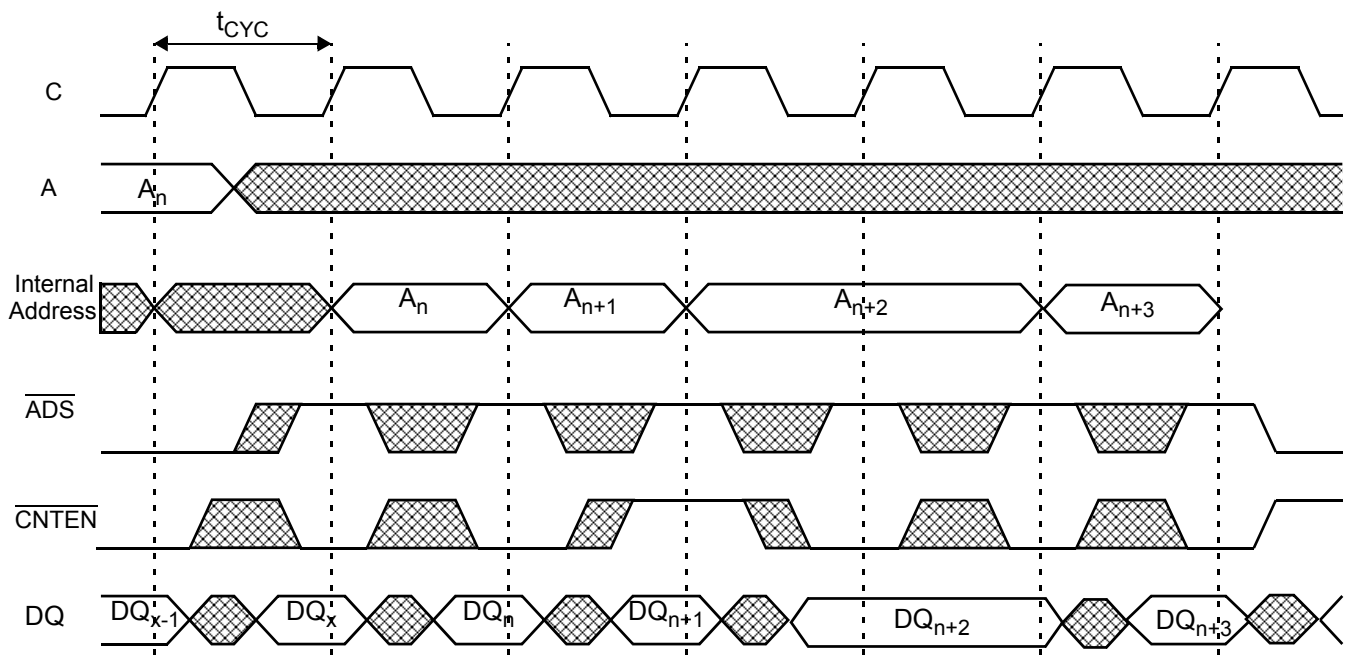


Switching Waveforms (continued)

WRITE Cycle for Pipelined and Flow-through Modes

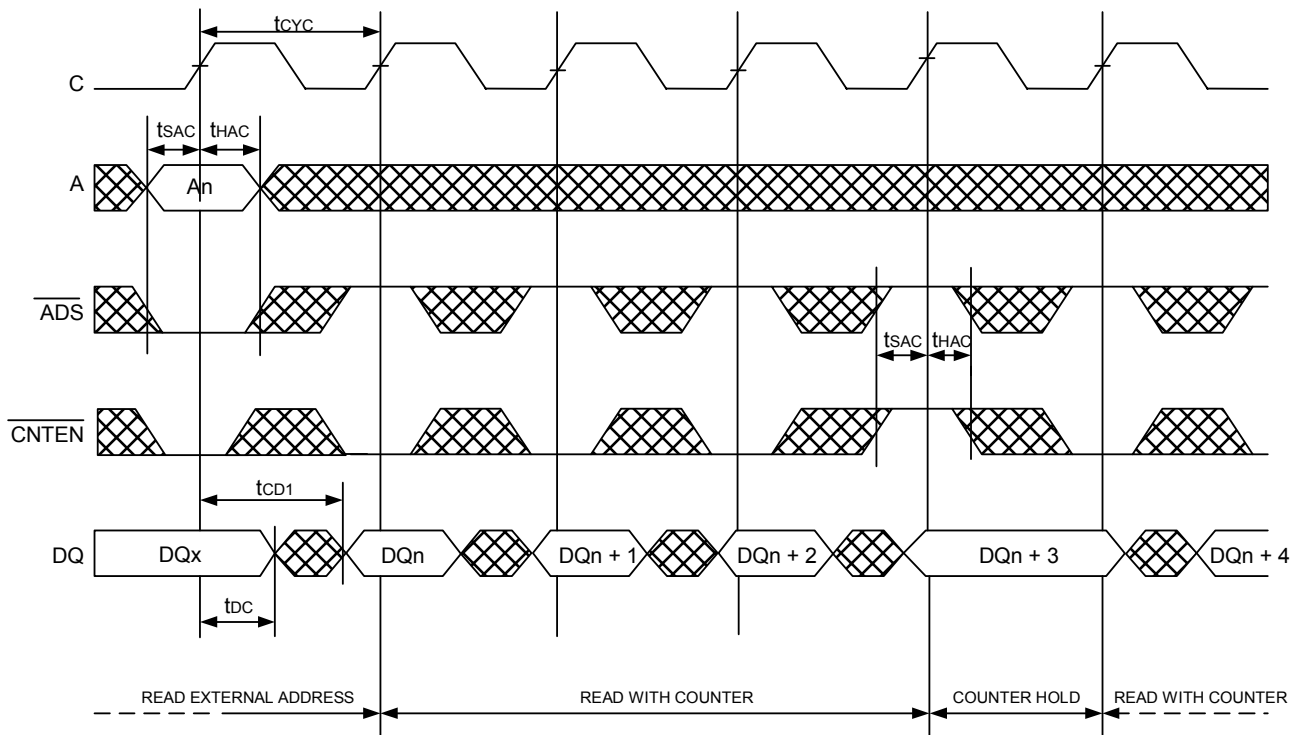


READ with Address Counter Advance for Pipelined Mode



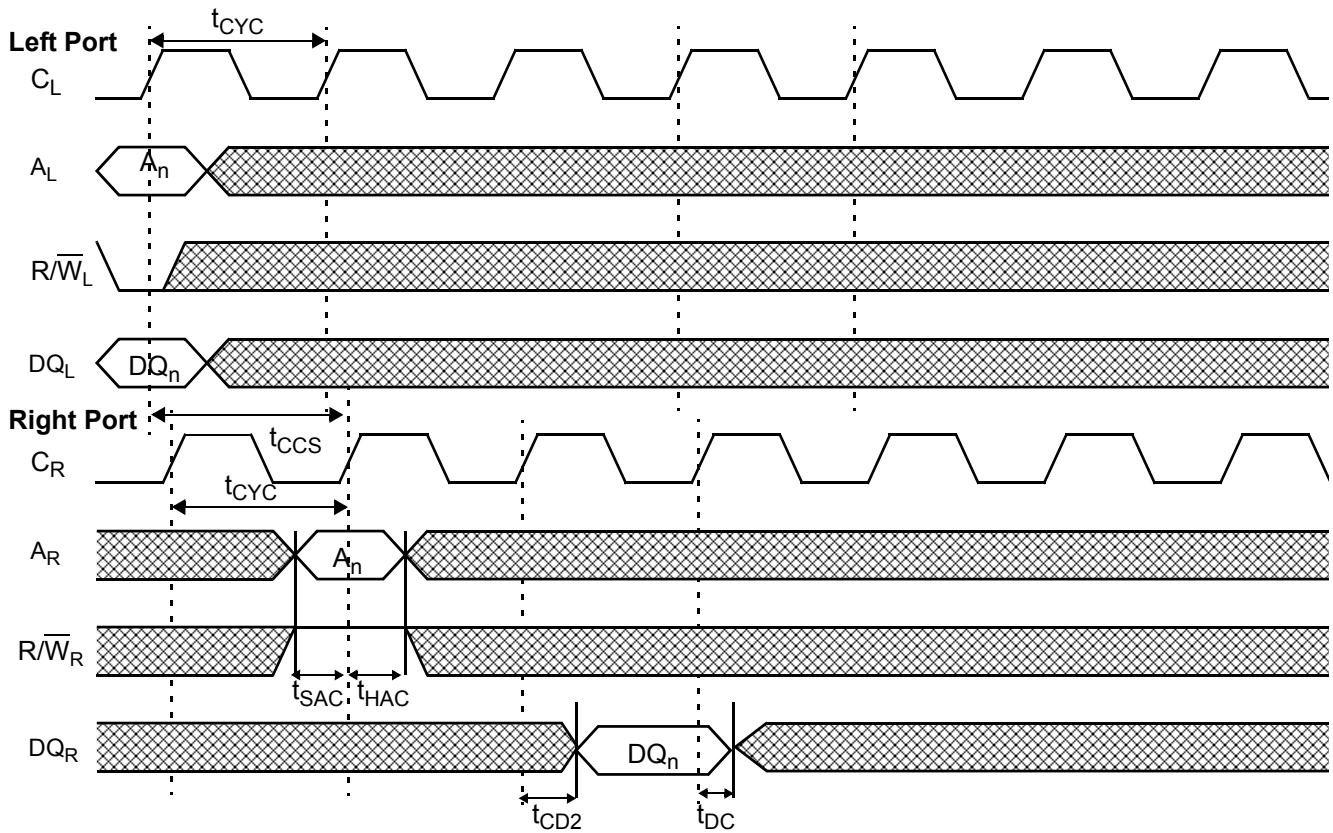
Switching Waveforms (continued)

READ with Address Counter Advance for Flow-through Mode

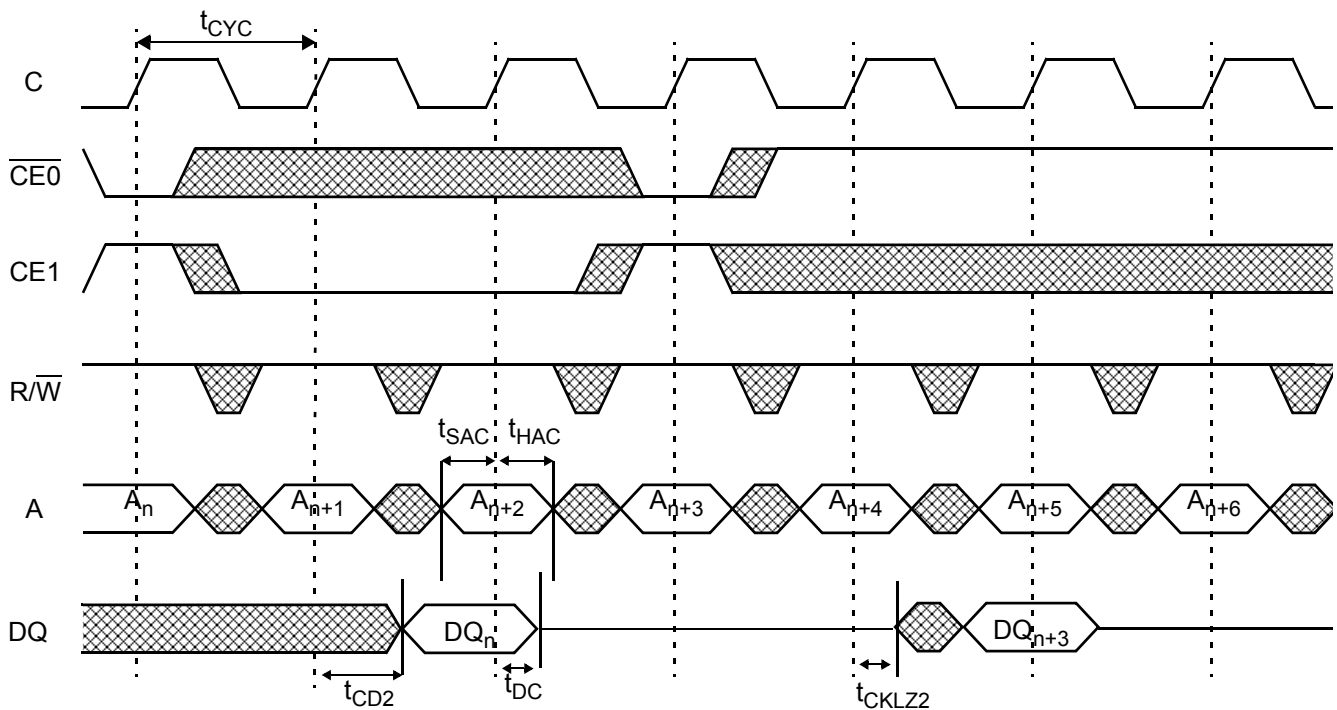


Switching Waveforms (continued)

Port-to-Port WRITE-READ for Pipelined Mode



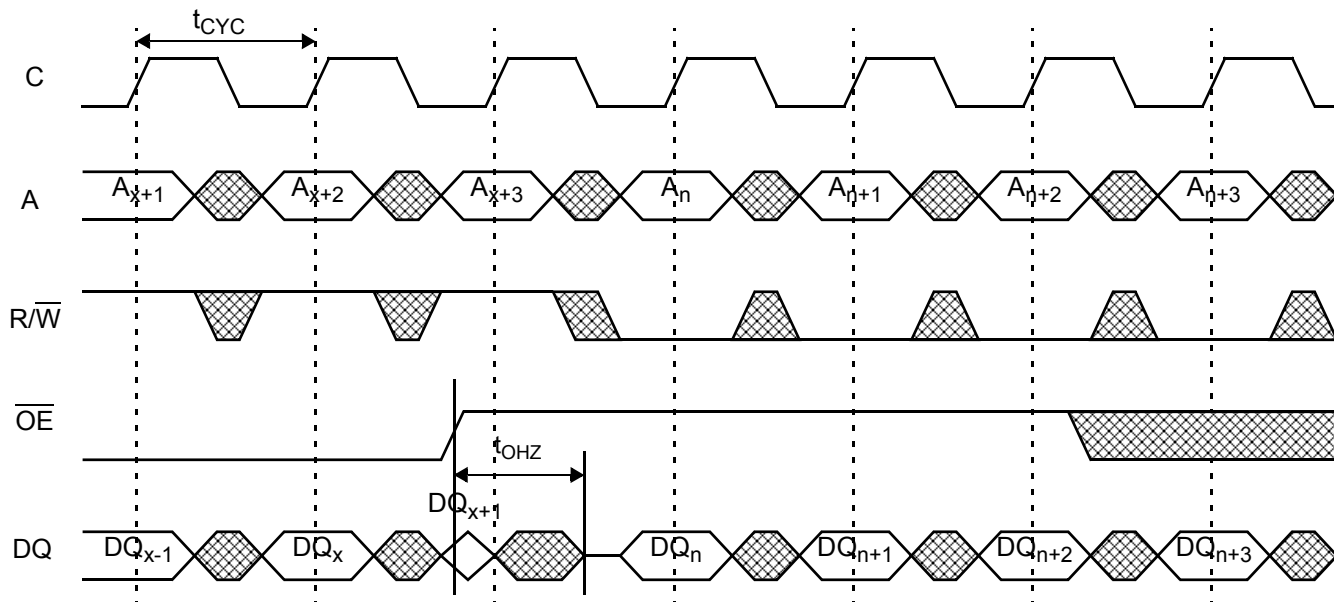
Chip Enable READ for Pipelined Mode



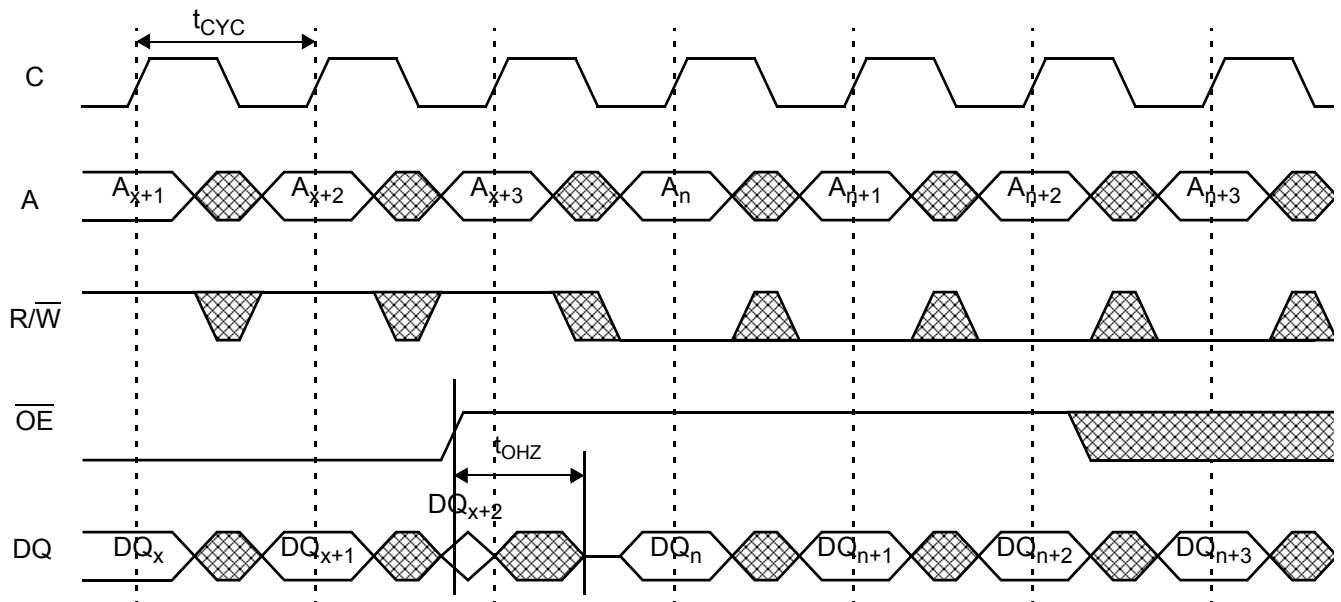


Switching Waveforms (continued)

OE Controlled WRITE for Pipelined Mode

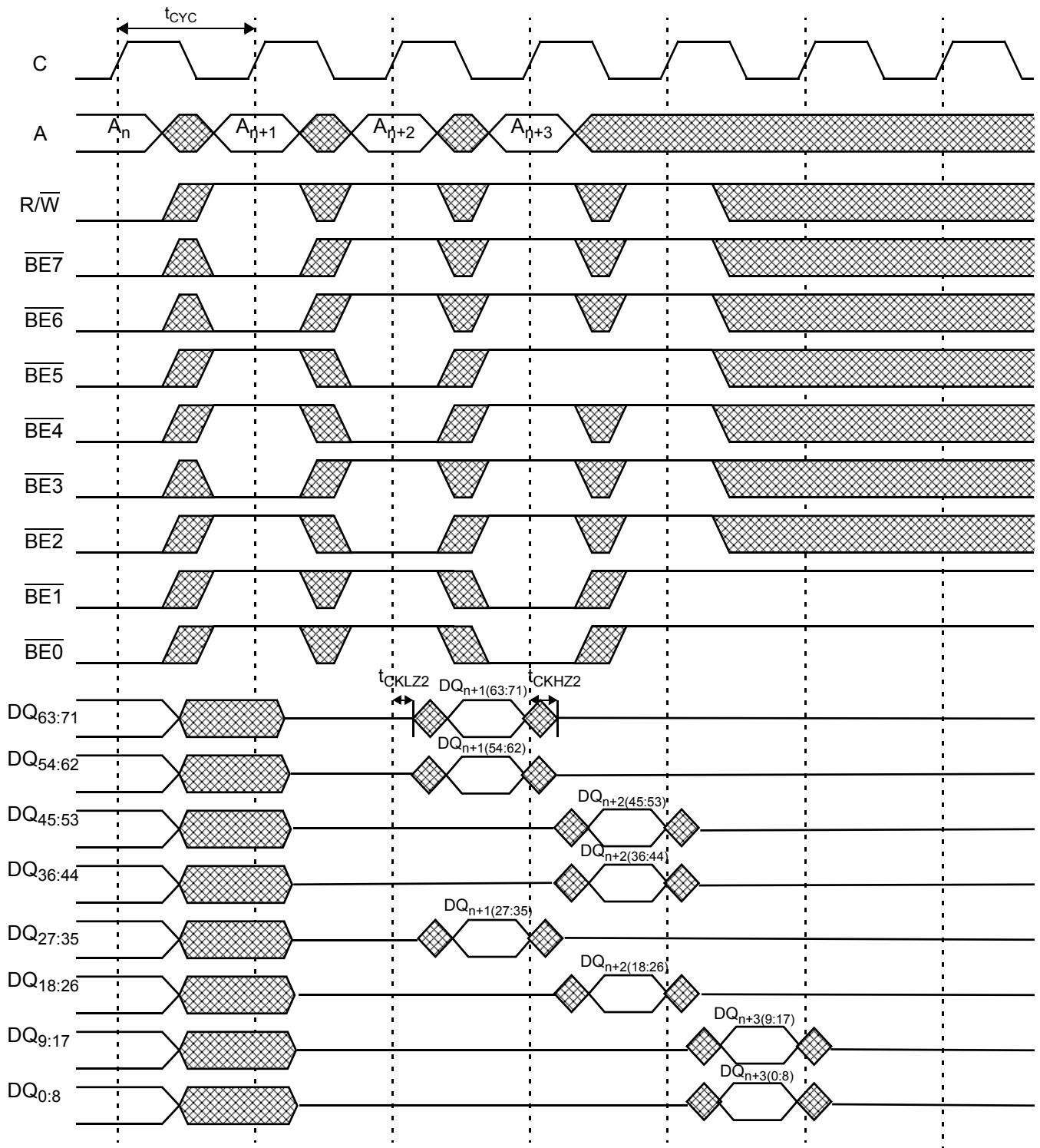


OE Controlled WRITE for Flow-through Mode



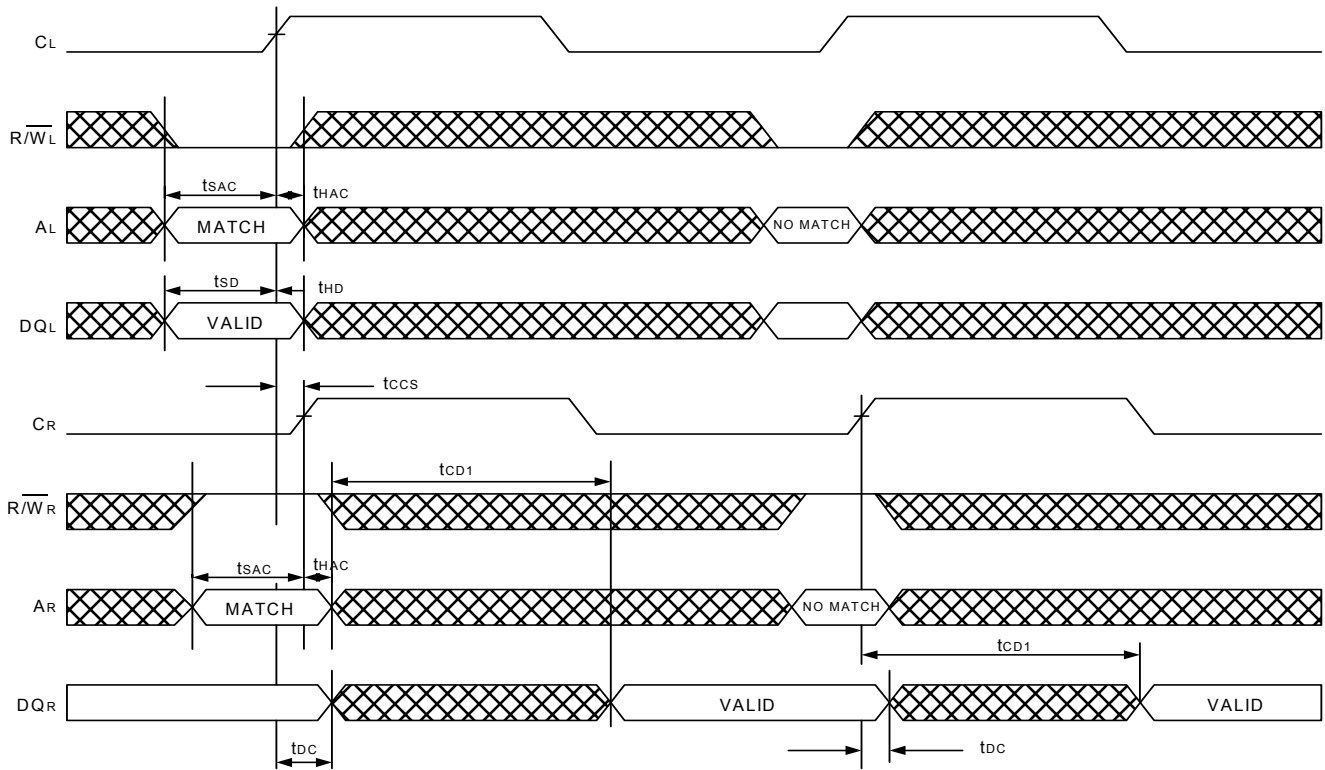
**Switching Waveforms (continued)**

**Byte-Enable READ for Pipelined Mode**

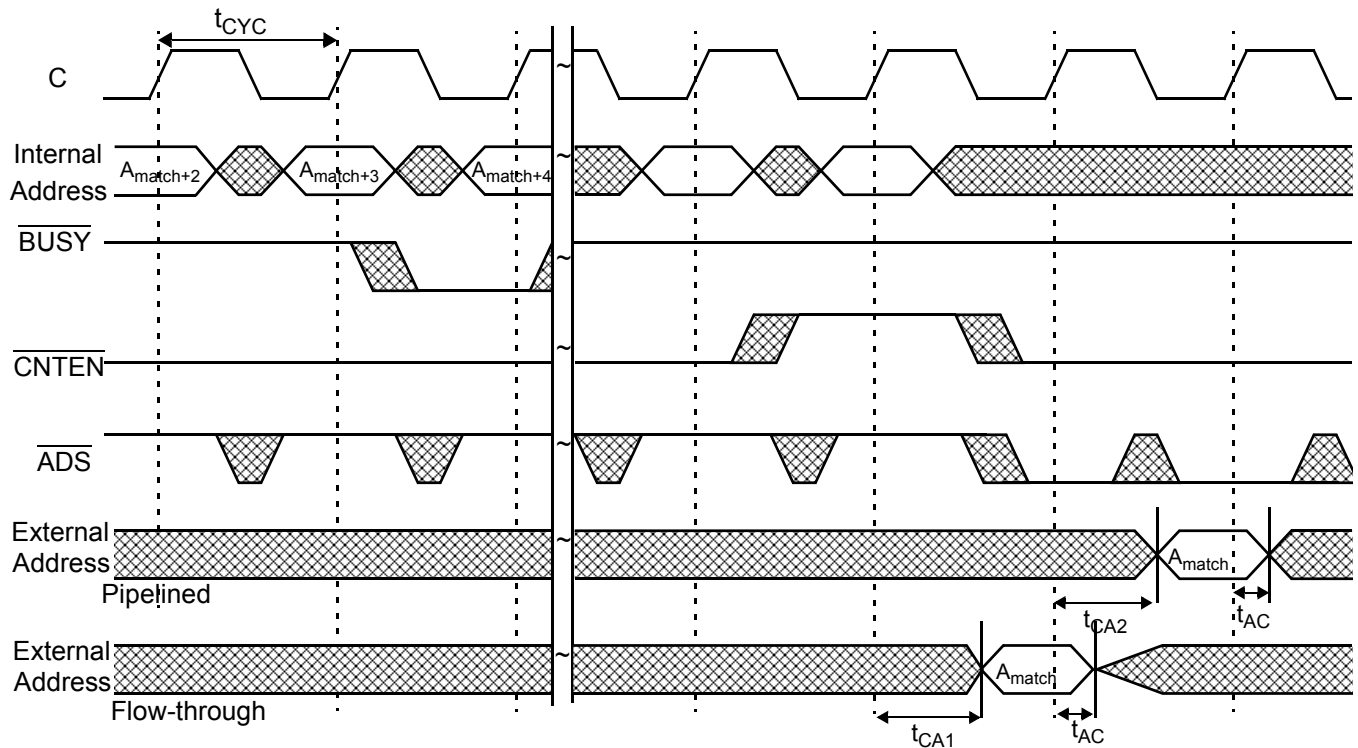


Switching Waveforms (continued)

Port-to-Port WRITE-to-READ for Flow-through Mode



Busy Address Readback for Pipelined and Flow-through Modes, DDRON = CNT/MSK = RET = LOW<sup>[34]</sup>

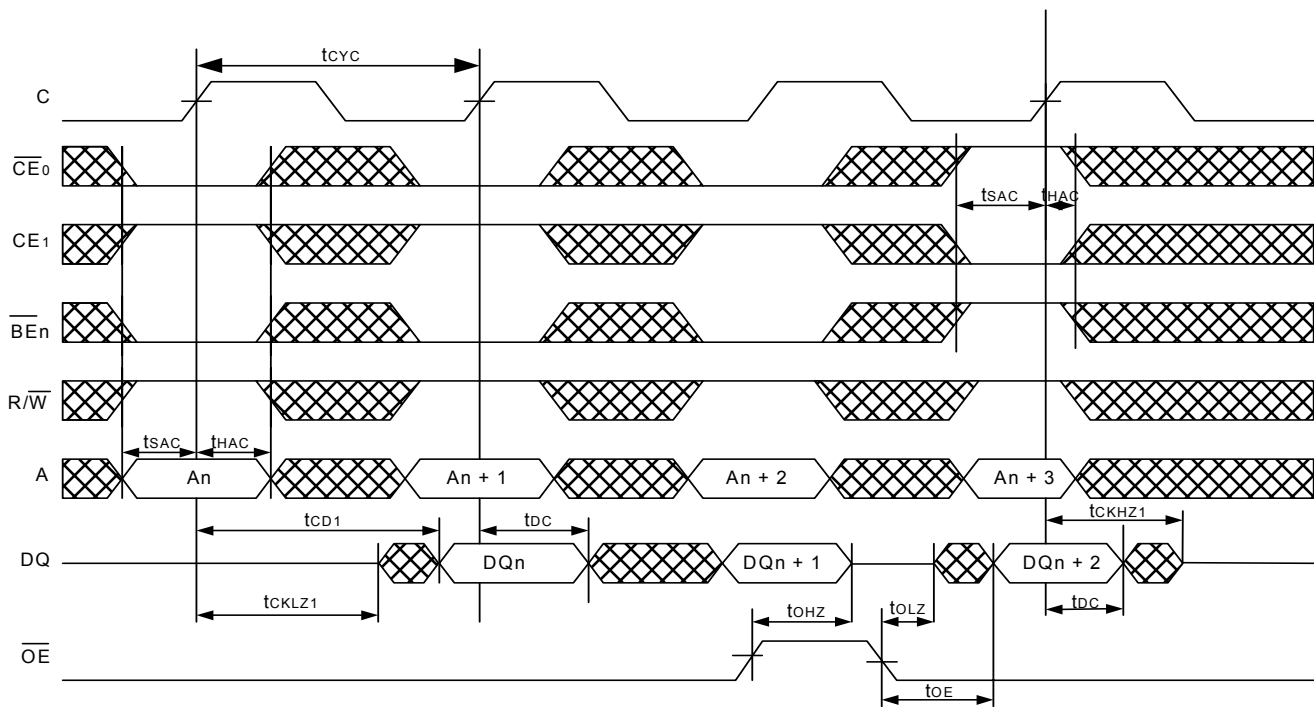


Note:

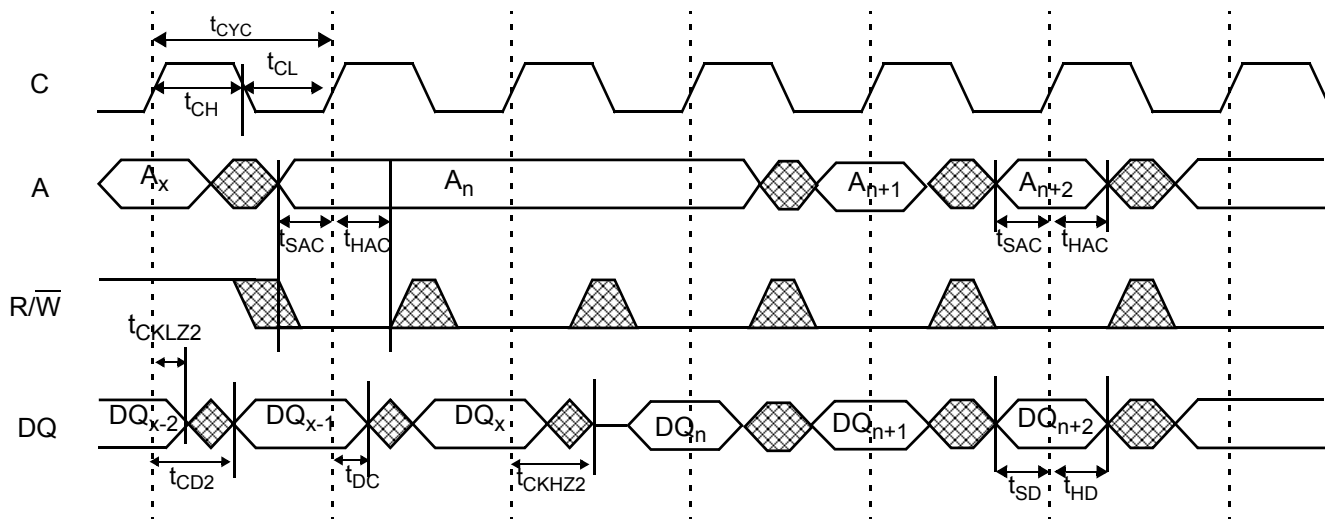
34.  $A_{match}$  is the matching address which will be reported on the address bus of the losing port. The counter operation selected for reporting the address is "Busy Address Readback."

Switching Waveforms (continued)

Read Cycle for Flow-through Mode



READ-to-WRITE for Pipelined Mode (OE = V<sub>IL</sub>)<sup>[35,36,37]</sup>

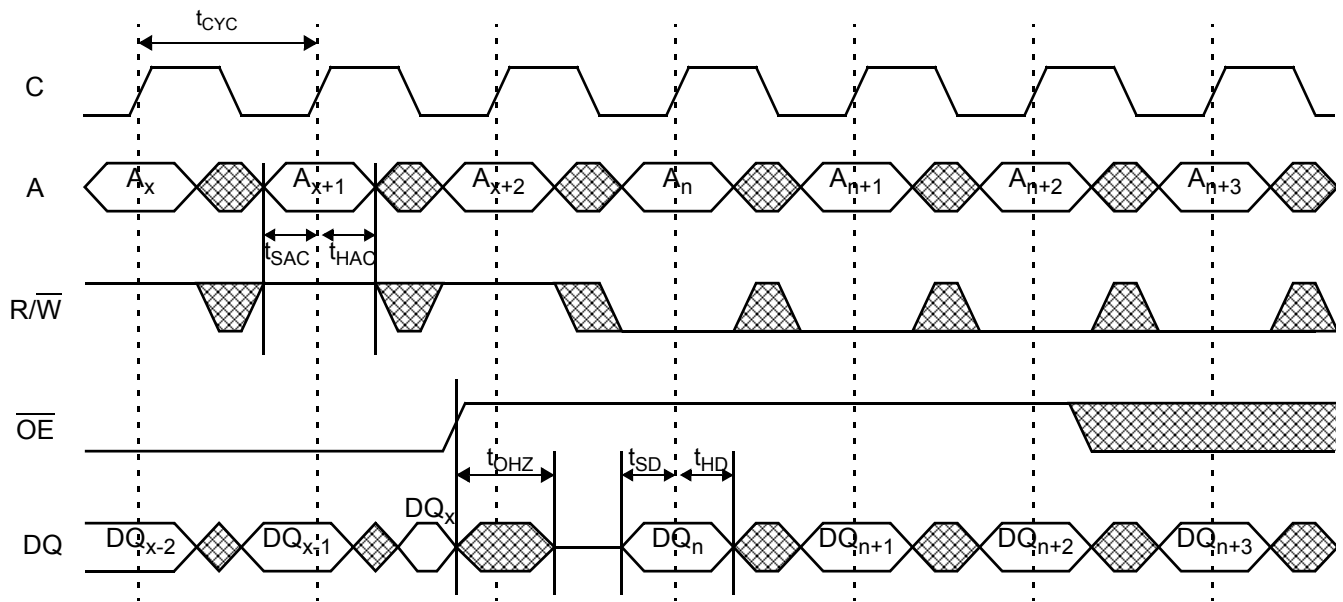


Notes:

- 35. When  $\overline{OE} = V_{IL}$ , the last read operation is allowed to complete before the DQ bus is tri-stated and the user is allowed to drive write data.
- 36. Two dummy writes should be issued to accomplish bus turnaround. The 3rd instruction is the first valid write.
- 37. Chip enable or all byte enables should be held inactive during the two dummy writes to avoid data corruption.

**Switching Waveforms** (continued)

**READ-to-WRITE for Pipelined Mode ( $\overline{OE}$  Controlled)**<sup>[38,39]</sup>

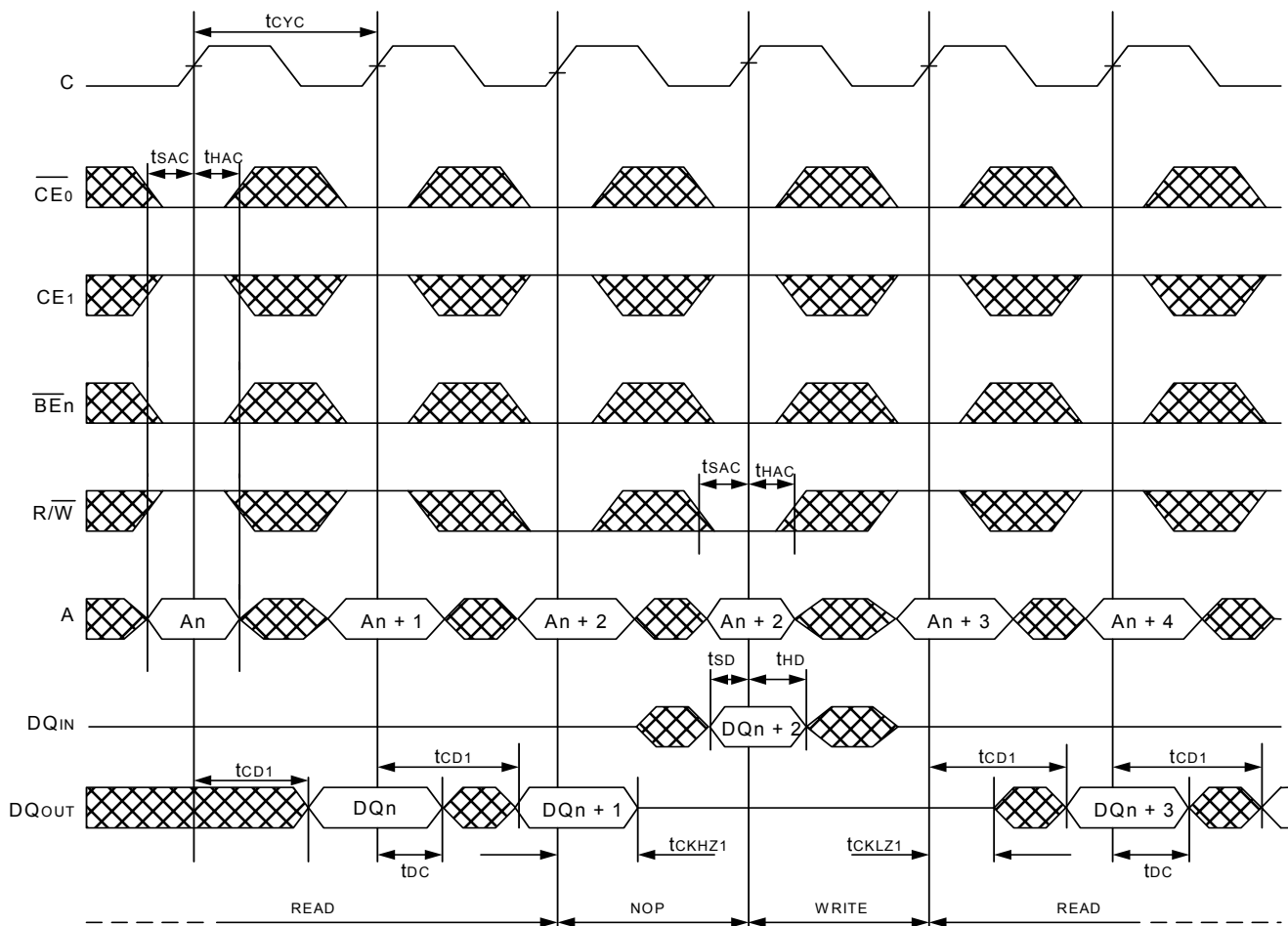


**Notes:**

- 38.  $\overline{OE}$  should be deasserted and  $t_{OHZ}$  allowed to elapse before the first write operation is issued.
- 39. Any write scheduled to complete after  $\overline{OE}$  is deasserted will be preempted.

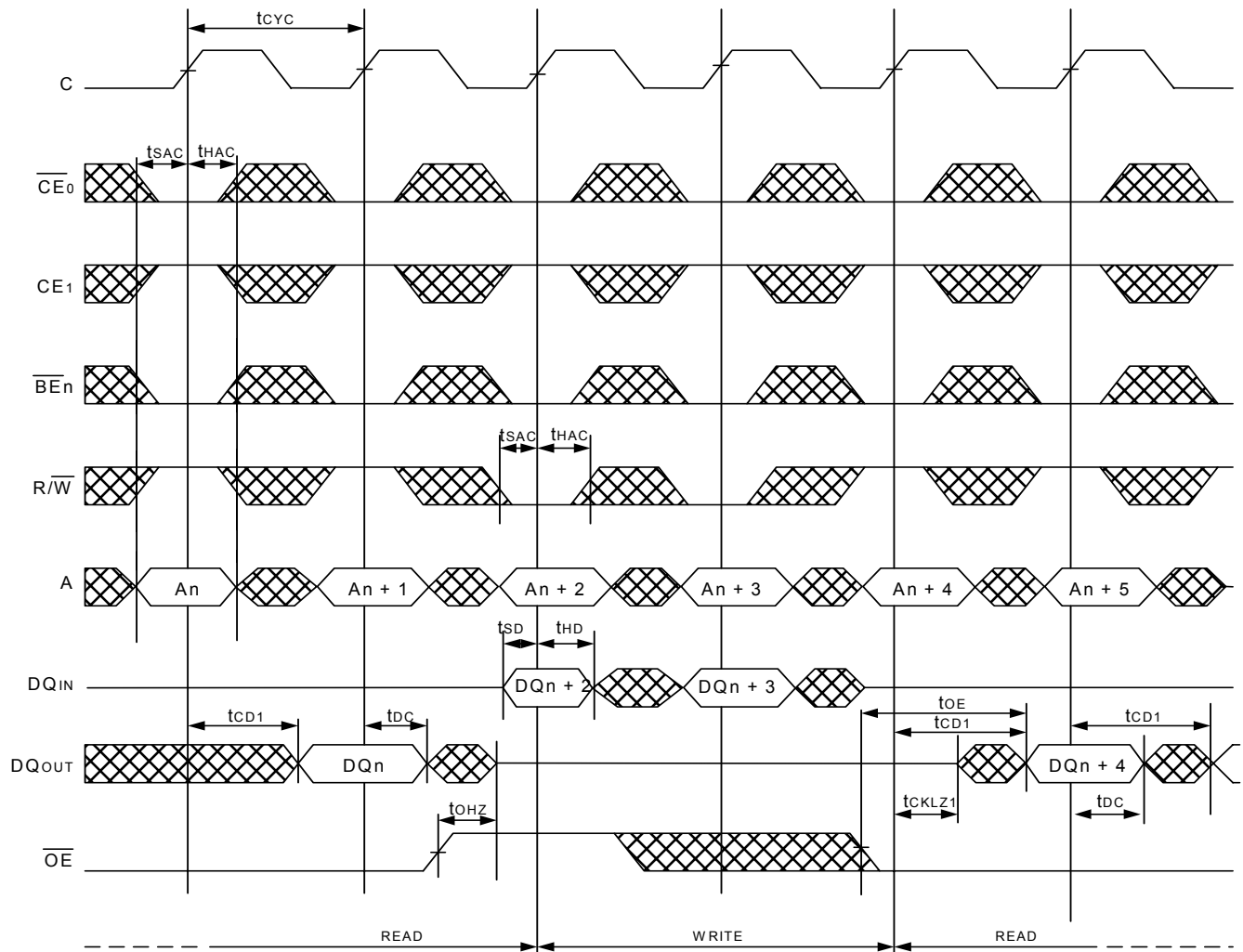
Switching Waveforms (continued)

Read-to-Write-to-Read for Flow-through Mode ( $\overline{OE} = \text{LOW}$ )



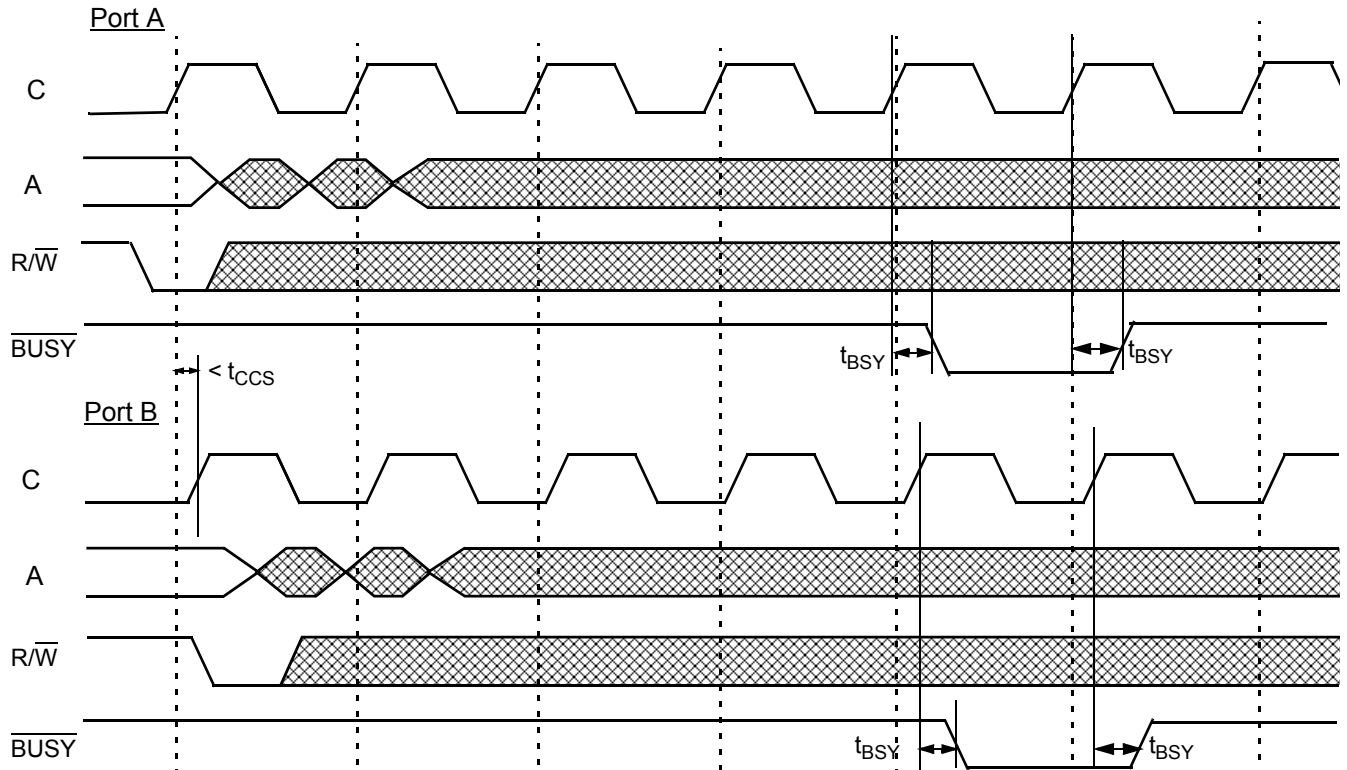
Switching Waveforms (continued)

Read-to-Write-to-Read for Flow-through Mode ( $\overline{OE}$  Controlled)

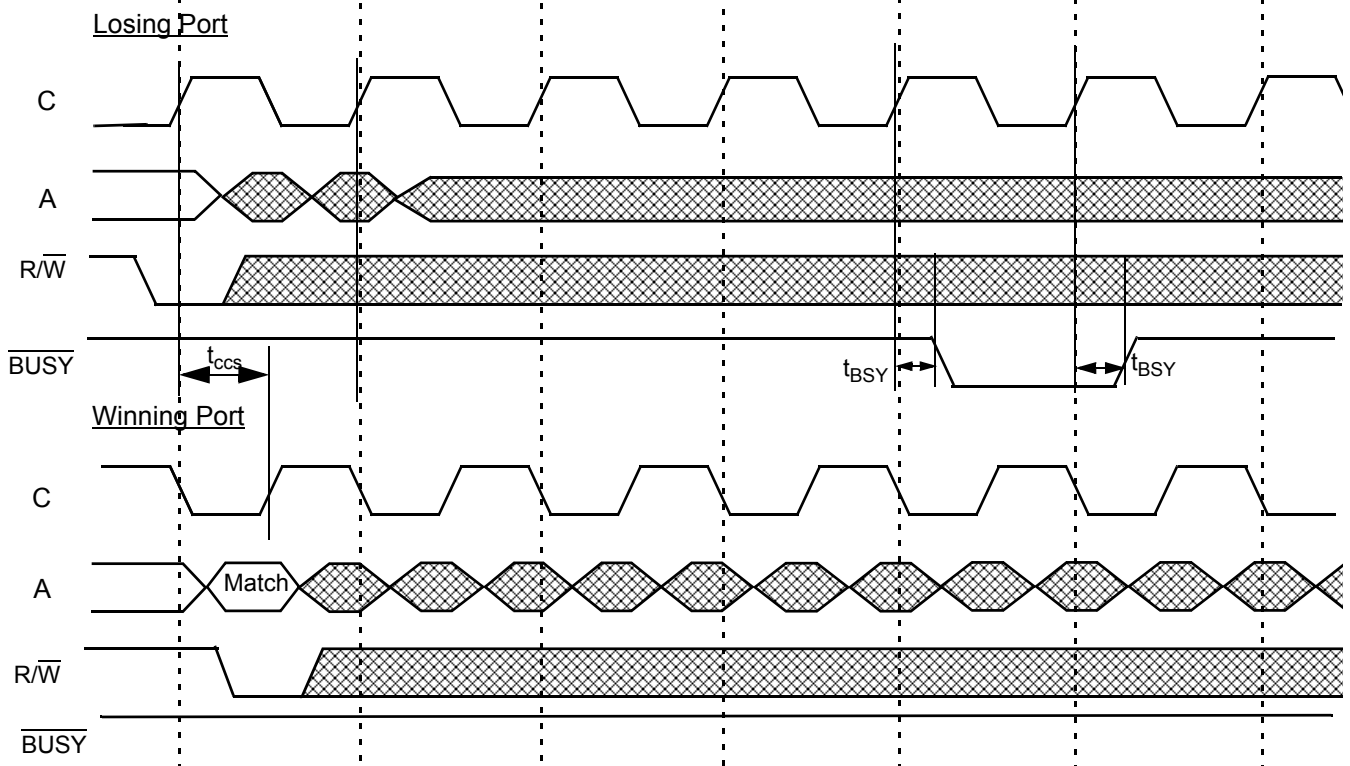


**Switching Waveforms** (continued)

**BUSY Timing, WRITE-WRITE Collision for Pipelined and Flow-through Modes, Clock Timing Violates  $t_{CCS}$ . (Flag Both Ports)**



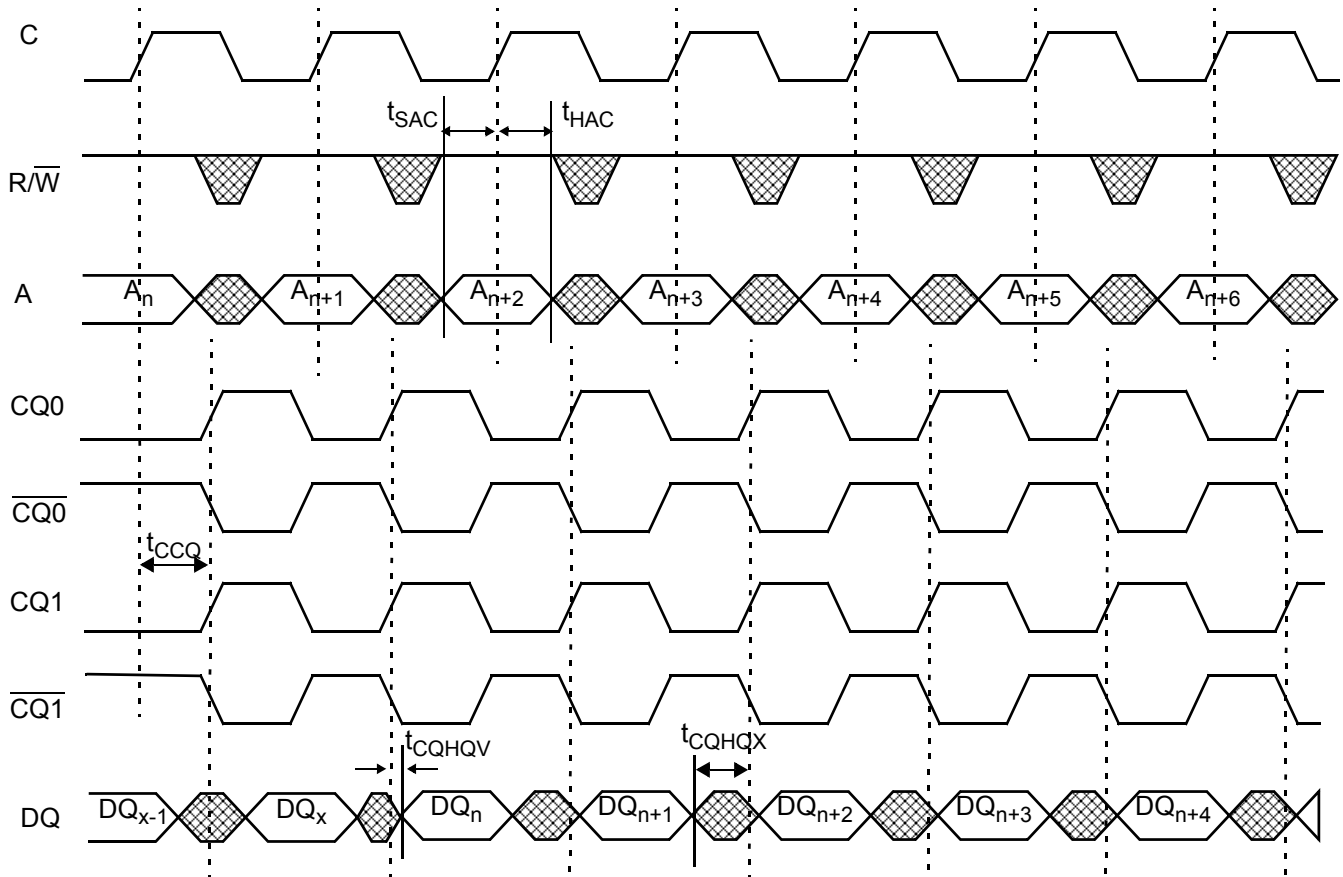
**BUSY Timing, WRITE-WRITE Collision for Pipelined and Flow-through Modes, Clock Timing Meets  $t_{CCS}$ . (Flag Losing Port)**





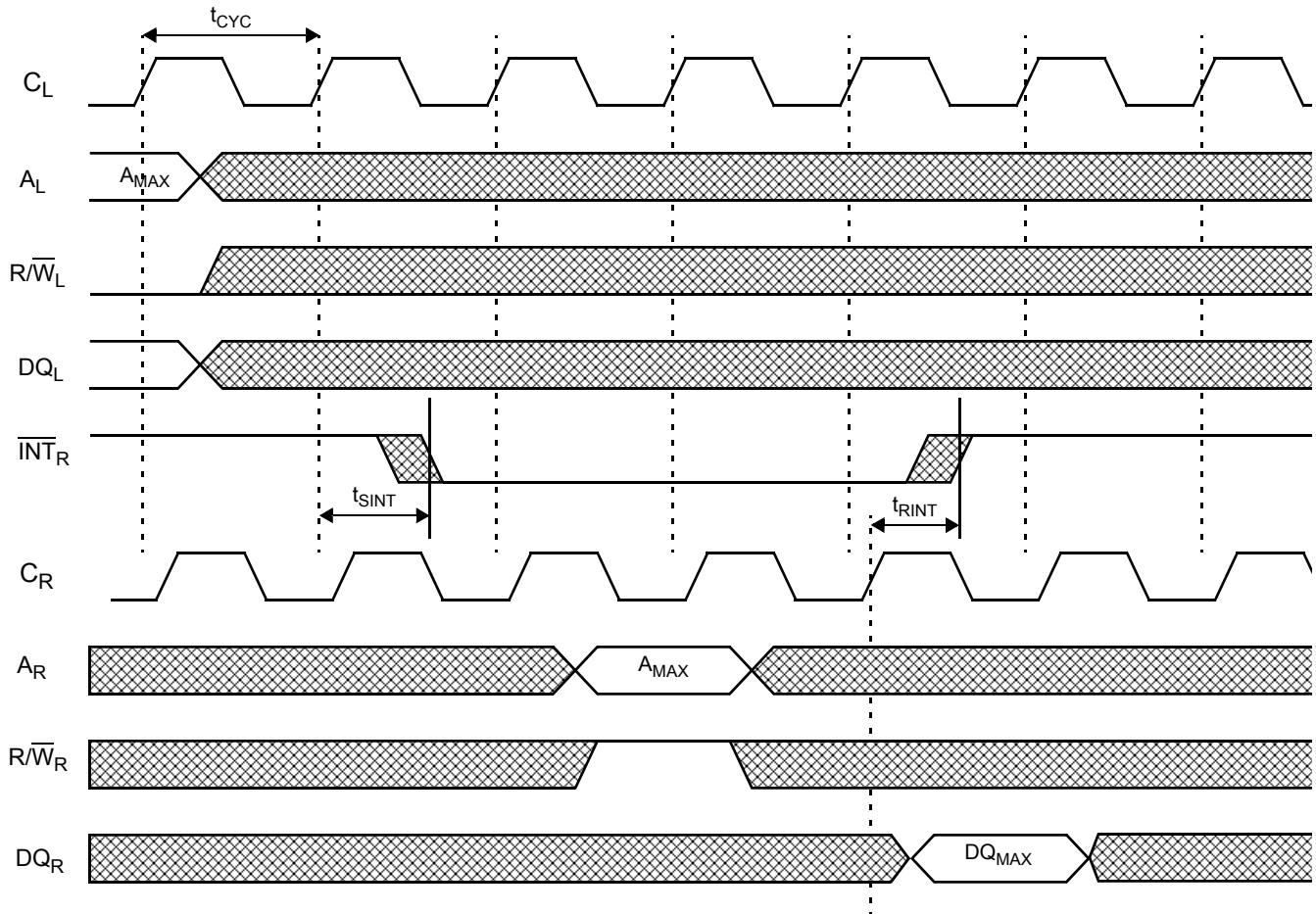
Switching Waveforms (continued)

Read with Echo Clock for Pipelined and Flow-through Modes (CQEN = HIGH)



**Switching Waveforms** (continued)

**Mailbox Interrupt Output**



**Ordering Information**
**512K × 72 (36 Mbit) 1.8V/1.5V Synchronous CYD36S72V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
200	CYD36S72V18-200BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S72V18-200BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
167	CYD36S72V18-167BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S72V18-167BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S72V18-167BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S72V18-167BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial
133	CYD36S72V18-133BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S72V18-133BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S72V18-133BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S72V18-133BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial

**256K × 72 (18 Mbit) 1.8V/1.5V Synchronous CYD18S72V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD18S72V18-250BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S72V18-250BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD18S72V18-200BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S72V18-200BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S72V18-200BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S72V18-200BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD18S72V18-167BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S72V18-167BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S72V18-167BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S72V18-167BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial

**128K × 72 (9 Mbit) 1.8V/1.5V Synchronous CYD09S72V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD09S72V18-250BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S72V18-250BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD09S72V18-200BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S72V18-200BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S72V18-200BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S72V18-200BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD09S72V18-167BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S72V18-167BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S72V18-167BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S72V18-167BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial

**Ordering Information** (continued)

**64K × 72 (4 Mbit) 1.8V/1.5V Synchronous CYD04S72V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD04S72V18-250BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S72V18-250BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD04S72V18-200BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S72V18-200BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S72V18-200BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S72V18-200BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD04S72V18-167BGXC	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S72V18-167BGC	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S72V18-167BGXI	BY484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S72V18-167BGI	BG484	484-ball Grid Array 23 mm x 23 mm with 1.0 mm pitch (Leaded)	Industrial

**1024K × 36 (36 Mbit) 1.8V/1.5V Synchronous CYD36S36V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
200	CYD36S36V18-200BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S36V18-200BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
167	CYD36S36V18-167BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S36V18-167BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S36V18-167BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S36V18-167BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial
133	CYD36S36V18-133BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S36V18-133BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S36V18-133BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S36V18-133BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial

**512K × 36 (18 Mbit) 1.8V/1.5V Synchronous CYD18S36V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD18S36V18-250BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S36V18-250BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD18S36V18-200BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S36V18-200BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S36V18-200BBXI	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S36V18-200BBI	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD18S36V18-167BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S36V18-167BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S36V18-167BBXI	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S36V18-167BBI	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Industrial

**Ordering Information** (continued)

**256K × 36 (9 Mbit) 1.8V/1.5V Synchronous CYD09S36V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD09S36V18-250BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S36V18-250BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD09S36V18-200BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S36V18-200BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S36V18-200BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S36V18-200BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD09S36V18-167BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S36V18-167BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S36V18-167BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S36V18-167BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial

**128K × 36 (4 Mbit) 1.8V/1.5V Synchronous CYD04S36V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD04S36V18-250BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S36V18-250BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD04S36V18-200BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S36V18-200BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S36V18-200BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S36V18-200BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD04S36V18-167BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S36V18-167BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S36V18-167BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S36V18-167BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial

**2048K × 18 (36 Mbit) 1.8V/1.5V Synchronous CYD36S18V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
200	CYD36S18V18-200BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S18V18-200BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
167	CYD36S18V18-167BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S18V18-167BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S18V18-167BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S18V18-167BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial
133	CYD36S18V18-133BGXC	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD36S18V18-133BGC	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD36S18V18-133BGXI	BY484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD36S18V18-133BGI	BG484S	484-ball Grid Array 27 mm x 27 mm with 1.0 mm pitch (Leaded)	Industrial

**Ordering Information** (continued)

**1024K × 18 (18 Mbit) 1.8V/1.5V Synchronous CYD18S18V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD18S18V18-250BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S18V18-250BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD18S18V18-200BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S18V18-200BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S18V18-200BBXI	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S18V18-200BBI	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD18S18V18-167BBXC	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD18S18V18-167BBC	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD18S18V18-167BBXI	BW256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD18S18V18-167BBI	BB256	256-ball Grid Array 19 mm x 19 mm with 1.0 mm pitch (Leaded)	Industrial

**512K × 18 (9 Mbit) 1.8V/1.5V Synchronous CYD09S18V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD09S18V18-250BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S18V18-250BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD09S18V18-200BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S18V18-200BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S18V18-200BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S18V18-200BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD09S18V18-167BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD09S18V18-167BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD09S18V18-167BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD09S18V18-167BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial

**256K × 18 (4 Mbit) 1.8V/1.5V Synchronous CYD04S18V18 Dual-Port SRAM**

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
250	CYD04S18V18-250BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S18V18-250BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
200	CYD04S18V18-200BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S18V18-200BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S18V18-200BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S18V18-200BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial
167	CYD04S18V18-167BBXC	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Commercial
	CYD04S18V18-167BBC	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Commercial
	CYD04S18V18-167BBXI	BW256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Lead-Free)	Industrial
	CYD04S18V18-167BBI	BB256	256-ball Grid Array 17 mm x 17 mm with 1.0 mm pitch (Leaded)	Industrial

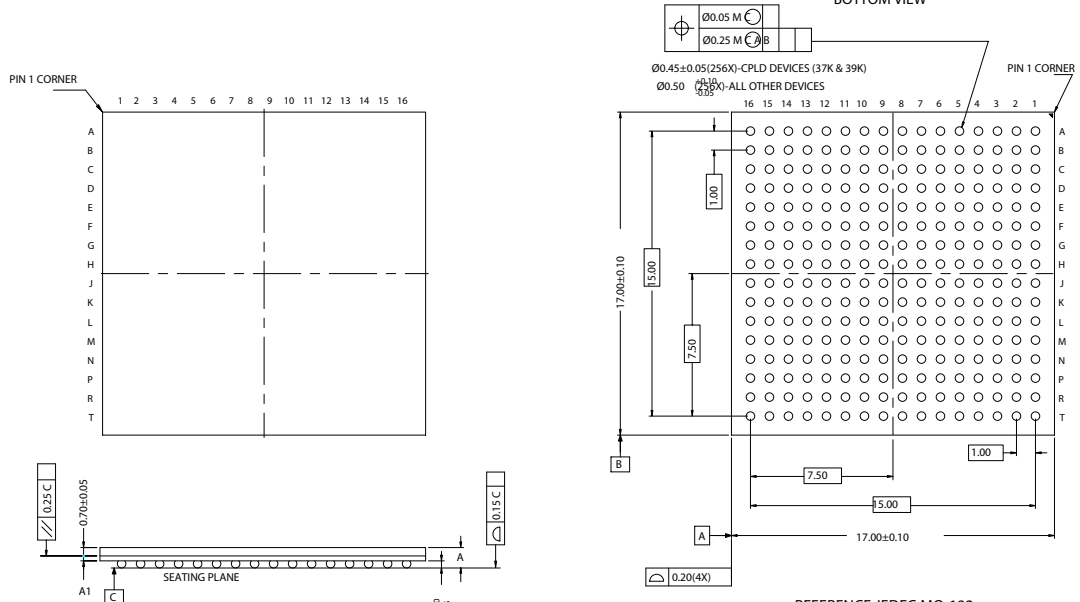
Package Diagrams

256-ball Lead-Free FBGA (17 x 17 mm) BW256

TOP VIEW

256-ball Leaded FBGA (17 x 17 mm) BB256

BOTTOM VIEW



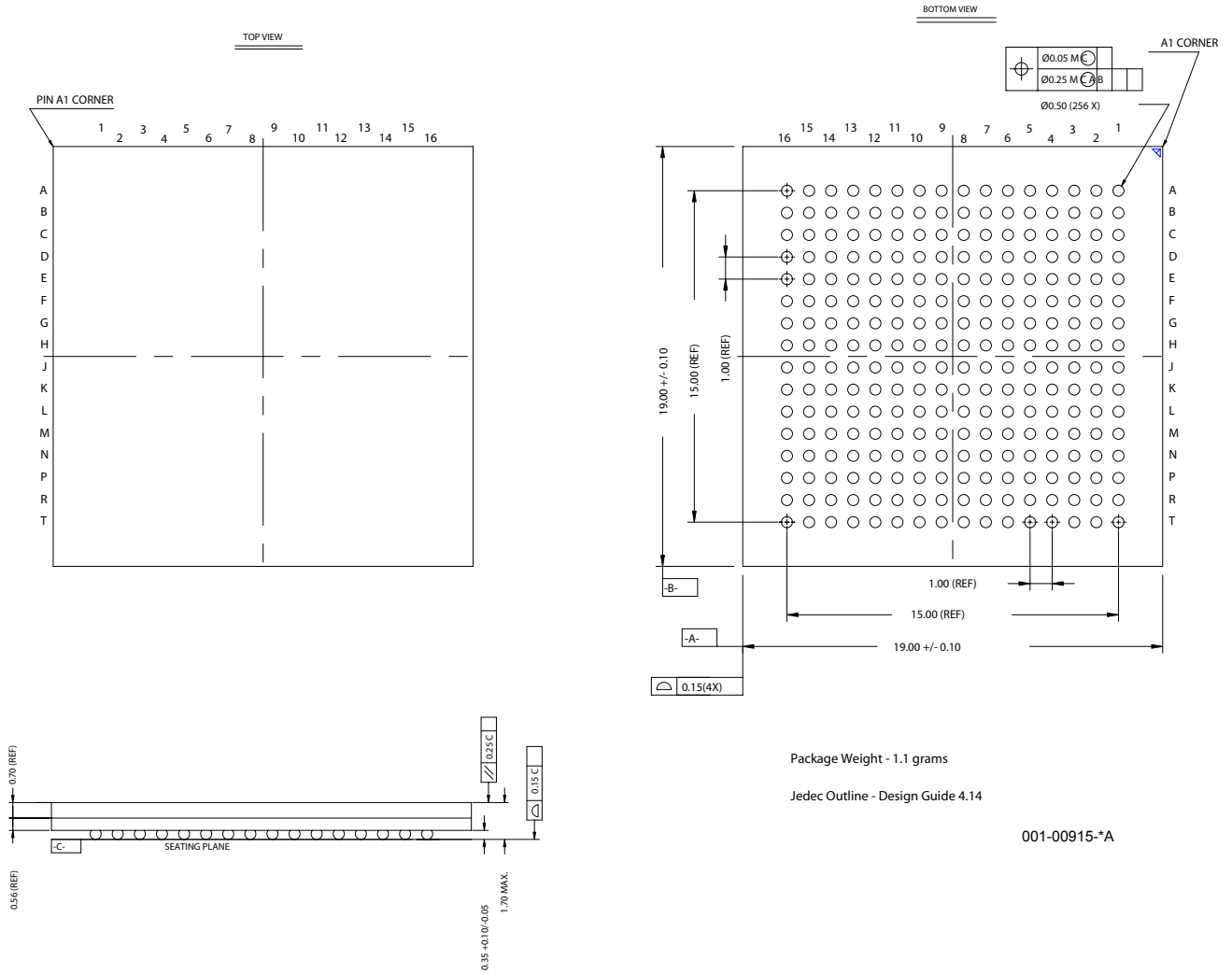
A1	0.36	0.56	
A	1.40 MAX. 1.70 MAX.		

REFERENCE JEDEC MO-192

51-85108-\*F

**Package Diagrams (continued)**

**256-ball Lead-Free FBGA (19 x 19 x 1.7 mm) BW256**  
**256-ball Leaded FBGA (19 x 19 x 1.7 mm) BB256**

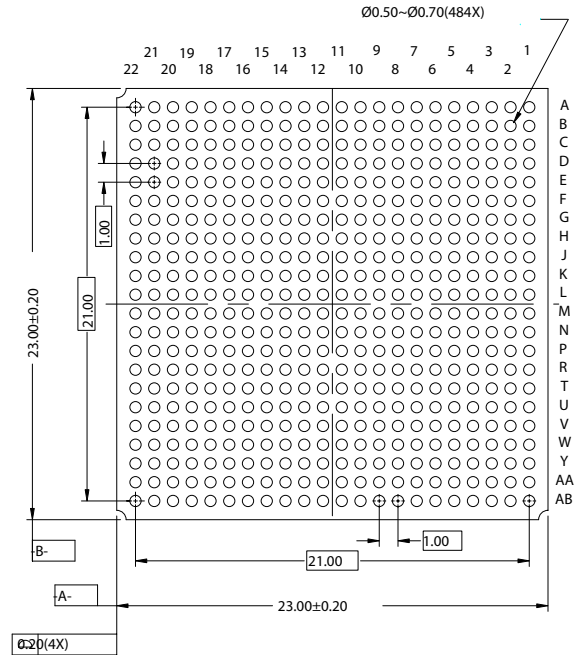
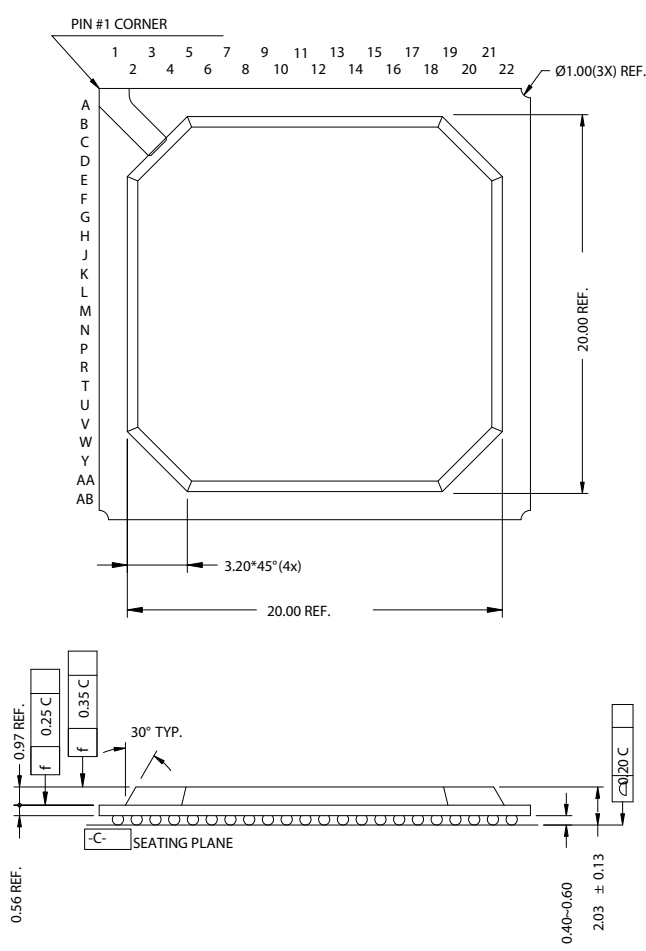




**Package Diagrams** (continued)

**484-ball Lead-Free PBGA (23 mm x 23 mm x 2.03 mm) BY484**

**484-ball Leaded PBGA (23 mm x 23 mm x 2.03 mm) BG484**



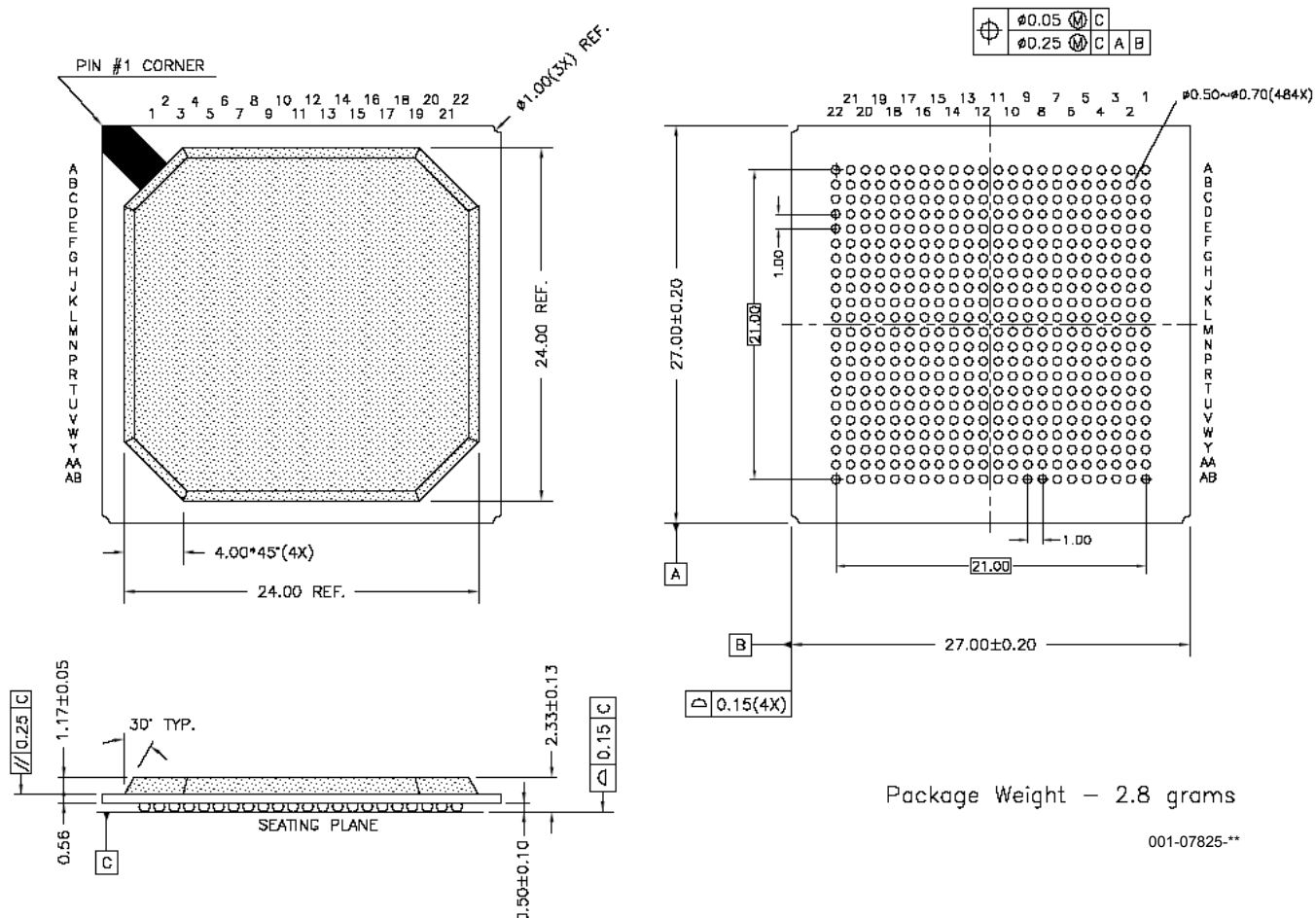
Package Weight - 2.0 grams  
Jedec Outline - Design Guide 4.14

51-85218-\*\*

Package Diagrams (continued)

484-ball Lead-Free PBGA (27 mm x 27 mm x 2.33 mm) BY484S

484-ball Leaded PBGA (27 mm x 27 mm x 2.33 mm) BG484S



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**Document History Page**

Document Title: FullFlex™ Synchronous SDR Dual-Port SRAM				
Document Number: 38-06082				
REV.	ECN NO.	Issue Date	Orig. of Change	Description of Change
**	302411	See ECN	YDT	New data sheet
*A	334036	See ECN	YDT	Corrected typo on page 1 Reproduced PDF file to fix formatting errors
*B	395800	See ECN	SPN	<p>Added statement about no echo clocks for flow-through mode</p> <p>Updated electrical characteristics</p> <p>Added note 16 and 17 (1.5V timing)</p> <p>Added note 33 (timing for x18 devices)</p> <p>Updated input edge rate (note 34)</p> <p>Updated table 5 on deterministic access control logic</p> <p>Added description of busy readback in deterministic access control section</p> <p>Changed dummy write descriptions</p> <p>Updated ZQ pins connection details</p> <p>Updated note 24, B0 to BE0</p> <p>Added power supply requirements to <math>\overline{MRST}</math> and VC_SEL</p> <p>Added note 4 (VIM disable)</p> <p>Updated supply voltage to ground potential to 4.1V</p> <p>Updated parameters on table 15</p> <p>Updated and added parameters to table 16</p> <p>Updated x72 pinout to SDR only pinout</p> <p>Updated 484 PBGA pin diagram</p> <p>Updated the pin definition of <math>\overline{MRST}</math></p> <p>Updated the pin definition of VC_SEL</p> <p>Updated READY description to include Wired OR note</p> <p>Updated master reset to include wired OR note for <math>\overline{READY}</math></p> <p>Updated minimum <math>V_{OH}</math> value for the 1.8V LVCMOS configuration</p> <p>Updated electrical characteristics to include <math>I_{OH}</math> and <math>I_{OL}</math> values</p> <p>Updated electrical characteristics to include <math>\overline{READY}</math></p> <p>Added <math>I_{X3}</math></p> <p>Updated maximum input capacitance</p> <p>Added Notes 33 and 34 Removed Notes 15 and 17</p> <p>Updated Pin Definitions for CQ0, <math>\overline{CQ0}</math>, CQ1, and <math>\overline{CQ1}</math></p> <p>Removed -100 Speed bin from Table.1 Selection Guide</p> <p>Changed voltage name from <math>V_{DDQ}</math> to <math>V_{DDIO}</math></p> <p>Changed voltage name from <math>V_{DD}</math> to <math>V_{CORE}</math></p> <p>Moved the Mailbox Interrupt Timing Diagram to be the final timing diagram</p> <p>Updated the Package Type for the CYD36S18V18 parts</p> <p>Updated the Package Type for the CYD36S18V18 parts</p> <p>Updated the Package Type for the CYD18S18V18 parts</p> <p>Updated the Package Type for the CYD18S36V18 parts</p> <p>Included the Package Diagram for the 256-Ball FBGA (19 x 19 mm) BW256</p> <p>Included an OE Controlled Write for Flow-through Mode Switching Waveform</p> <p>Included a Read with Echo Clock Switching Waveform</p> <p>Updated Figure 5 and Figure 6</p> <p>Updated Electrical Characteristics for <math>\overline{READY} V_{OH}</math> and <math>\overline{READY} V</math></p> <p>Updated Electrical Characteristics for <math>V_{OH}</math> and <math>V_{OL}</math> for the -167 and -133 speeds</p> <p>Included a Unit column for Table 5</p> <p>Removed Switching Characteristic <math>t_{CA}</math> from chart</p> <p>Included <math>t_{OHZ}</math> in Switching Waveform OE Controlled Write for Pipelined Mode</p> <p>Included <math>t_{CKLZ2}</math> in Waveform Read-to-Write-to-Read for Flow-through Mode</p>
*C	402238	SEE ECN	KGH	<p>Updated AC Test Load and Waveforms</p> <p>Included FullFlex36 SDR 484-ball BGA Pinout (Top View)</p> <p>Included FullFlex18 SDR 484-ball BGA Pinout (Top View)</p> <p>Included Timing Parameter <math>t_{CORDY}</math></p>

Document Title: FullFlex™ Synchronous SDR Dual-Port SRAM Document Number: 38-06082				
REV.	ECN NO.	Issue Date	Orig. of Change	Description of Change
*D	458131	SEE ECN	YDT	Changed ordering information with lead-free part numbers Removed VC_SEL Added I/O and core voltage adders Removed references to bin drop for LVTTTL/2.5V LVCMOS and 1.5V core modes Updated Cin and Cout Updated ICC, ISB1, ISB2 and ISB3 tables Updated busy address read back timing diagram Added HTSL input waveform Removed HSTL (AC) from DC tables Added 484-ball 27 mmx27 mmx2.33 mm PBGA package
*E	470031	SEE ECN	YDT	Changed VOL of 1.8V LVCMOS to 0.45V Updated tRSF VREF is NC when HSTL is not used Formatted pin description table Changed VDDIO pins for 36M x 36 and 36M x 18 pinouts Changed 36Mx72 JTAG IDCODE
*F	500001	SEE ECN	YDT	DLL Change, added Clock Input Cycle to Cycle Jitter Modified DLL description Changed Input Capaciance Table Changed tCCS number Added note 31