16Mb: 1 MEG x 18, 512K x 32/36 PIPELINED ZBT SRAM

16Mb ZBT® SRAM

MT55L1MY18P, MT55V1MV18P,
MT55L512Y32P, MT55V512V32P,
MT55L512Y36P, MT55V512V36P

3.3V VDD, 3.3V or 2.5V I/O; 2.5V VDD 2.5V I/O

FEATURES

- High frequency and 100 percent bus utilization
- Fast cycle times: 6ns, 7.5ns, and 10ns
- Single +3.3V ±5% or +2.5V ±5% power supply (VDD)
- Separate +3.3V or +2.5V isolated output buffer supply (VDDQ)
- Advanced control logic for minimum control signal interface
- Individual BYTE WRITE controls may be tied LOW
- Single R/W# (read/write) control pin
- CKE# pin to enable clock and suspend operations
- Three chip enables for simple depth expansion
- Clock-controlled and registered addresses, data I/Os and control signals
- Internally self-timed, fully coherent WRITE
- Internally self-timed, registered outputs to eliminate the need to control OE#
- SNOOZE MODE for reduced-power standby
- Common data inputs and data outputs
- Linear or Interleaved Burst Modes
- Burst feature (optional)
- 100-pin TQFP package
- 165-pin FBGA package
- Pin/function compatibility with 2Mb, 4Mb, and 8Mb ZBT SRAM

OPTIONS — TQFP MARKING*

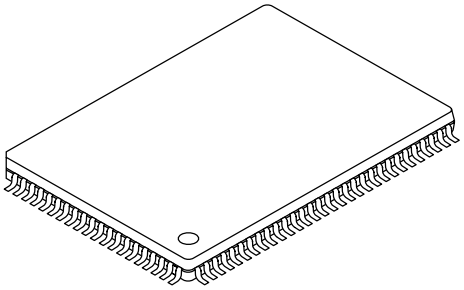
- Timing (Access/Cycle/MHz)
  - 3.5ns/6ns/166 MHz — -6
  - 4.2ns/7.5ns/133 MHz — -7.5
  - 5ns/10ns/100 MHz — -10
- Configurations
  - 3.3V VDD, 3.3V or 2.5V I/O
    - 1 Meg x 18 — MT55L1MY18P
    - 512K x 32 — MT55L512Y32P
    - 512K x 36 — MT55L512Y36P
  - 2.5V VDD, 2.5V I/O
    - 1 Meg x 18 — MT55V1MV18P
    - 512K x 32 — MT55V512V32P
    - 512K x 36 — MT55V512V36P
- Packages
  - 100-pin TQFP — T
  - 165-pin FBGA — F

*A part marking guide for the FBGA devices can be found on Micron's web site – http://www. micronsemi.com/support/index.html.

Part Number Example:

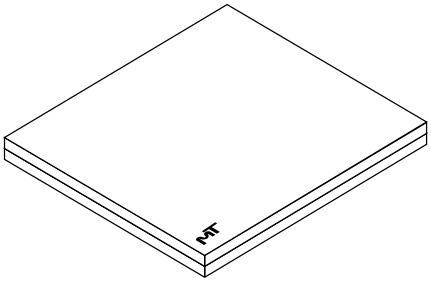
MT55L512Y32PT-7.5

100-Pin TQFP[1]



165-Pin FBGA

(Preliminary Package Data)



NOTE: 1. JEDEC-standard MS-026 BHA (LQFP).

GENERAL DESCRIPTION

The Micron® Zero Bus Turnaround™ (ZBT®) SRAM family employs high-speed, low-power CMOS designs using an advanced CMOS process.

Micron's 16Mb ZBT SRAMs integrate a 1 Meg x 18, 512K x 32, or 512K x 36 SRAM core with advanced synchronous peripheral circuitry and a 2-bit burst counter. These SRAMs are optimized for 100 percent bus utilization, eliminating any turnaround cycles for READ to WRITE, or WRITE to READ, transitions. All synchronous inputs pass through registers controlled by a positive-edge-triggered single clock input (CLK). The synchronous inputs include all addresses, all data

GENERAL DESCRIPTION (continued)

inputs, chip enable (CE#), two additional chip enables for easy depth expansion (CE2, CE2#), cycle start input (ADV/LD#), synchronous clock enable (CKE#), byte write enables (BWa#, BWb#, BWc# and BWd#) and read/write (R/W#).

Asynchronous inputs include the output enable (OE#, which may be tied LOW for control signal minimization), clock (CLK) and snooze enable (ZZ, which may be tied LOW if unused). There is also a burst mode pin (MODE) that selects between interleaved and linear burst modes. MODE may be tied HIGH, LOW or left unconnected if burst is unused. The data-out (Q), enabled by OE#, is registered by the rising edge of CLK. WRITE cycles can be from one to four bytes wide as controlled by the write control inputs.

All READ, WRITE, and DESELECT cycles are initiated by the ADV/LD# input. Subsequent burst addresses can be internally generated as controlled by the burst advance pin (ADV/LD#). Use of burst mode is optional. It is allowable to give an address for each individual READ and WRITE cycle. BURST cycles wrap around after the fourth access from a base address.

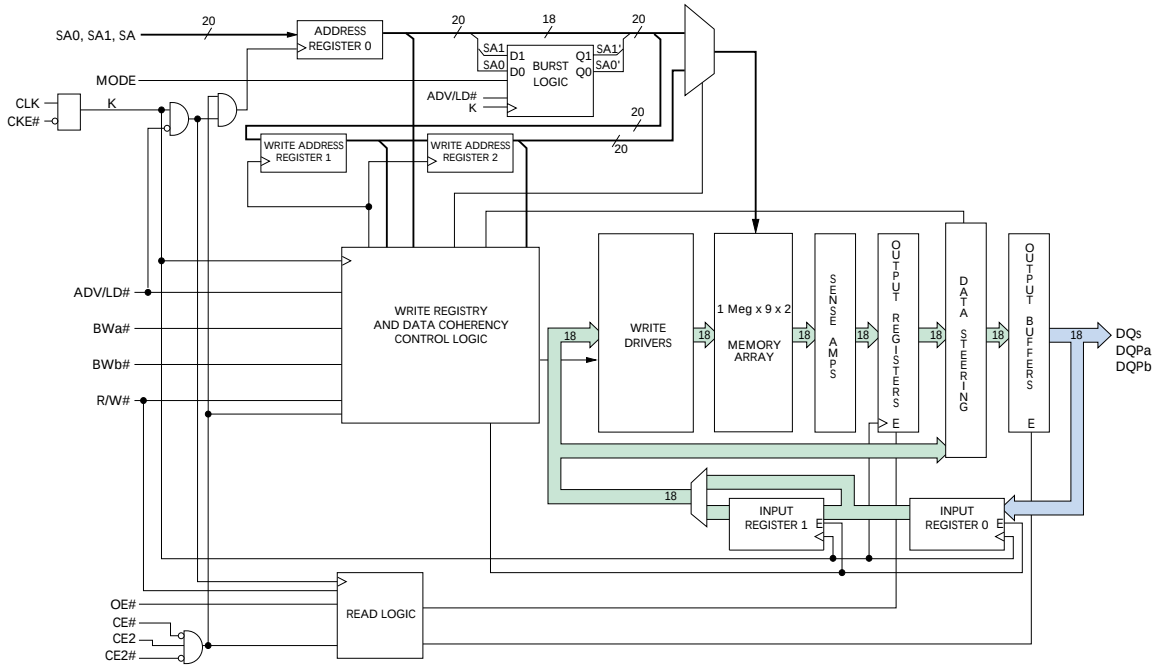
To allow for continuous, 100 percent use of the data bus, the pipelined ZBT SRAM uses a LATE LATE WRITE cycle. For example, if a WRITE cycle begins in clock cycle one, the address is present on rising edge one. BYTE WRITEs need to be asserted on the same cycle as the address. The data associated with the address is required two cycles later, or on the rising edge of clock cycle three.

Address and write control are registered on-chip to simplify WRITE cycles. This allows self-timed WRITE cycles. Individual byte enables allow individual bytes to be written. During a BYTE WRITE cycle, BWa# controls DQa pins; BWb# controls DQb pins; BWc# controls DQc pins; and BWd# controls DQd pins. Cycle types can only be defined when an address is loaded, i.e., when ADV/LD# is LOW. Parity/ECC bits are only available on the x36 versions.

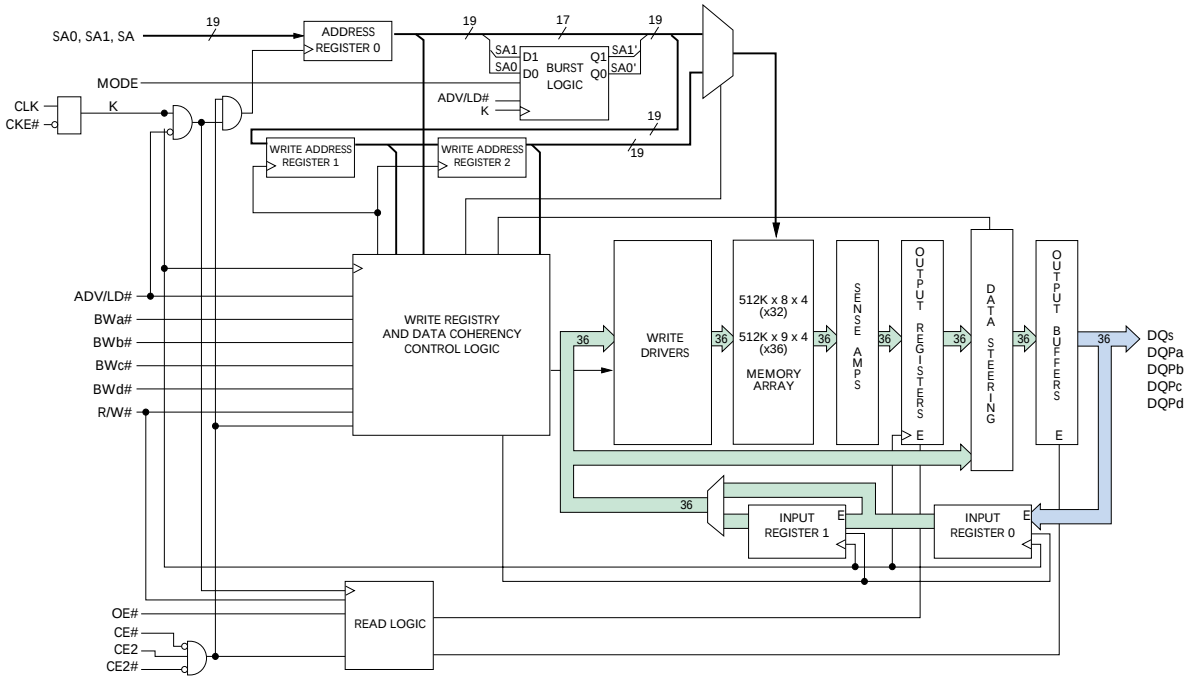
Micron's 16Mb ZBT SRAMs operate from a +3.3V or +2.5V V_{DD} power supply, and all 3.3V V_{DD} inputs and outputs are LVTTL-compatible. Users can implement either a 3.3V or 2.5V I/O for the +3.3V V_{DD} or a 2.5V I/O for the +2.5V V_{DD}. The device is ideally suited for systems requiring high bandwidth and zero bus turnaround delays.

Please refer to the Micron Web site (www.micronsemi.com/en/products/sram/) for the latest data sheet.

FUNCTIONAL BLOCK DIAGRAM
1 MEG x 18



FUNCTIONAL BLOCK DIAGRAM
512K x 32/36



NOTE: Functional block diagrams illustrate simplified device operation. See truth table, pin descriptions, and timing diagrams for detailed information.

PIN ASSIGNMENT TABLE

PIN #	x18	x32	x36
1	NC	NC	DQPc[1]
2	NC	DQc	DQc
3	NC	DQc	DQc
4	V_{DDQ}		
5	V_{SS}		
6	NC	DQc	DQc
7	NC	DQc	DQc
8	DQb	DQc	DQc
9	DQb	DQc	DQc
10	V_{SS}		
11	V_{DDQ}		
12	DQb	DQc	DQc
13	DQb	DQc	DQc
14	V_{DD}		
15	V_{DD}		
16	V_{DD}[2]		
17	V_{SS}		
18	DQb	DQd	DQd
19	DQb	DQd	DQd
20	V_{DDQ}		
21	V_{SS}		
22	DQb	DQd	DQd
23	DQb	DQd	DQd
24	DQb	DQd	DQd
25	NC	DQd	DQd

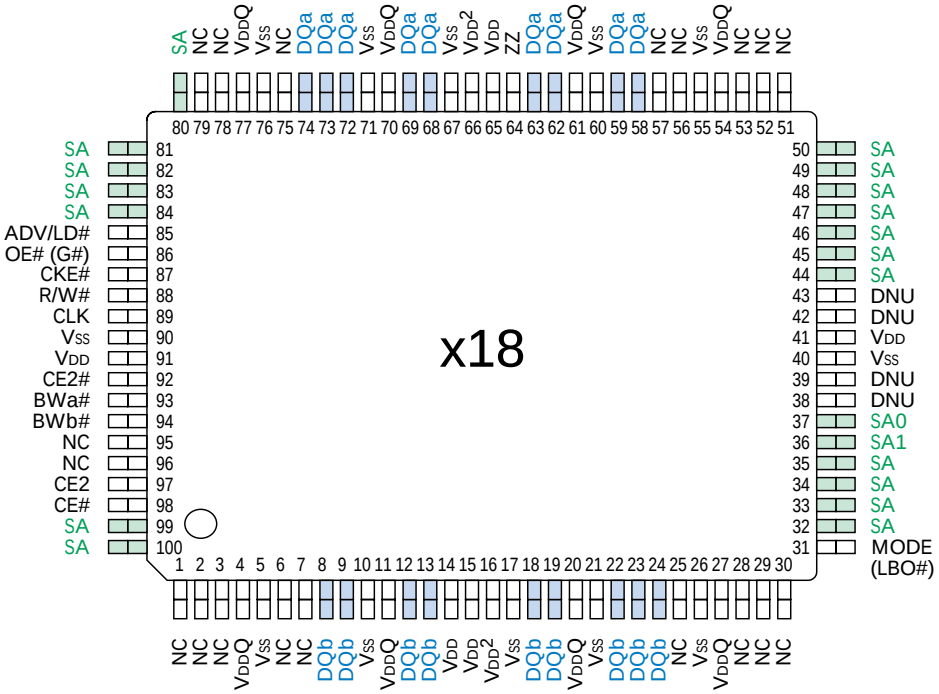
PIN #	x18	x32	x36
26	V_{SS}		
27	V_{DDQ}		
28	NC	DQd	DQd
29	NC	DQd	DQd
30	NC	NC	DQPd[1]
31	MODE (LBO#)		
32	SA		
33	SA		
34	SA		
35	SA		
36	SA1		
37	SA0		
38	DNU		
39	DNU		
40	V_{SS}		
41	V_{DD}		
42	DNU		
43	DNU		
44	SA		
45	SA		
46	SA		
47	SA		
48	SA		
49	SA		
50	SA		

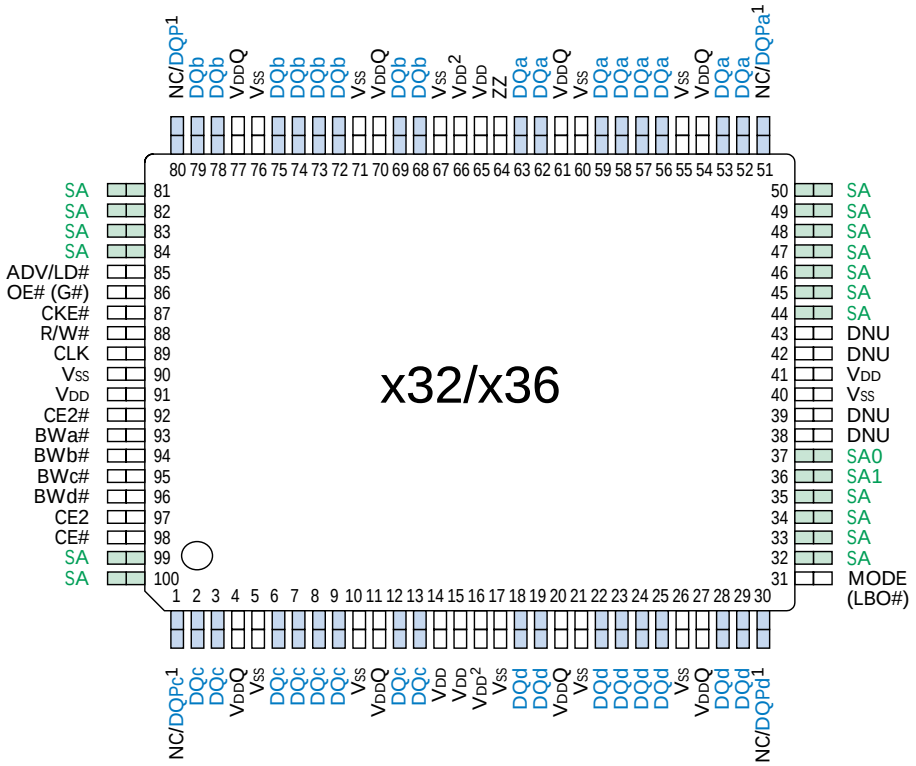
PIN #	x18	x32	x36
51	NC	NC	DQPa[1]
52	NC	DQa	DQa
53	NC	DQa	DQa
54	V_{DDQ}		
55	V_{SS}		
56	NC	DQa	DQa
57	NC	DQa	DQa
58	DQa		
59	DQa		
60	V_{SS}		
61	V_{DDQ}		
62	DQa		
63	DQa		
64	ZZ		
65	V_{DD}		
66	V_{DD}[2]		
67	V_{SS}		
68	DQa	DQb	DQb
69	DQa	DQb	DQb
70	V_{DDQ}		
71	V_{SS}		
72	DQa	DQb	DQb
73	DQa	DQb	DQb
74	DQa	DQb	DQb
75	NC	DQb	DQb

PIN #	x18	x32	x36
76	V_{SS}		
77	V_{DDQ}		
78	NC	DQb	DQb
79	NC	DQb	DQb
80	SA	NC	DQPb[1]
81	SA		
82	SA		
83	SA		
84	SA		
85	ADV/LD#		
86	OE# (G#)		
87	CKE#		
88	R/W#		
89	CLK		
90	V_{SS}		
91	V_{DD}		
92	CE2#		
93	BWa#		
94	BWb#		
95	NC	BWc#	BWc#
96	NC	BWd#	BWd#
97	CE2		
98	CE#		
99	SA		
100	SA		

NOTE: 1. NC for x32 version, DQPx for x36 version.
2. Pins 16 and 66 do not have to be connected directly to V_{DD} if the input voltage is ≥ V_{IH}.

PIN ASSIGNMENT (TOP VIEW)
100-PIN TQFP





NOTE: 1. NC for x32 version, DQx for x36 version.
2. Pins 16 and 66 do not have to be connected directly to V_{DD} if the input voltage is ≥ V_{IH}

TQFP PIN DESCRIPTIONS

x18	x32/36	SYMBOL	TYPE	DESCRIPTION
37 36 32-35, 44-50, 80-84, 99, 100	37 36 32-35, 44-50, 81-84, 99, 100	SA0 SA1 SA	Input	Synchronous Address Inputs: These inputs are registered and must meet the setup and hold times around the rising edge of CLK. SA0 and SA1 are the two least significant bits (LSB) of the address field and set the internal burst counter if burst is desired.
93 94 – –	93 94 95 96	BWa# BWb# BWc# BWd#	Input	Synchronous Byte Write Enables: These active LOW inputs allow individual bytes to be written when a WRITE cycle is active and must meet the setup and hold times around the rising edge of CLK. BYTE WRITEs need to be asserted on the same cycle as the address. BWs are associated with addresses and apply to subsequent data. BWa# controls DQa pins; BWb# controls DQb pins; BWc# controls DQc pins; BWd# controls DQd pins.
89	89	CLK	Input	Clock: This signal registers the address, data, chip enables, byte write enables and burst control inputs on its rising edge. All synchronous inputs must meet setup and hold times around the clock's rising edge.
98	98	CE#	Input	Synchronous Chip Enable: This active LOW input is used to enable the device and is sampled only when a new external address is loaded (ADV/LD# LOW).
92	92	CE2#	Input	Synchronous Chip Enable: This active LOW input is used to enable the device and is sampled only when a new external address is loaded (ADV/LD# LOW). This input can be used for memory depth expansion.
97	97	CE2	Input	Synchronous Chip Enable: This active HIGH input is used to enable the device and is sampled only when a new external address is loaded (ADV/LD# LOW). This input can be used for memory depth expansion.
86	86	OE# (G#)	Input	Output Enable: This active LOW, asynchronous input enables the data I/O output drivers. G# is the JEDEC-standard term for OE#.
85	85	ADV/LD#	Input	Synchronous Address Advance/Load: When HIGH, this input is used to advance the internal burst counter, controlling burst access after the external address is loaded. When ADV/LD# is HIGH, R/W# is ignored. A LOW on ADV/LD# clocks a new address at the CLK rising edge.
87	87	CKE#	Input	Synchronous Clock Enable: This active LOW input permits CLK to propagate throughout the device. When CKE# is HIGH, the device ignores the CLK input and effectively internally extends the previous CLK cycle. This input must meet setup and hold times around the rising edge of CLK.
64	64	ZZ	Input	Snooze Enable: This active HIGH, asynchronous input causes the device to enter a low-power standby mode in which all data in the memory array is retained. When ZZ is active, all other inputs are ignored. This pin has an internal pull-down and can be floating.

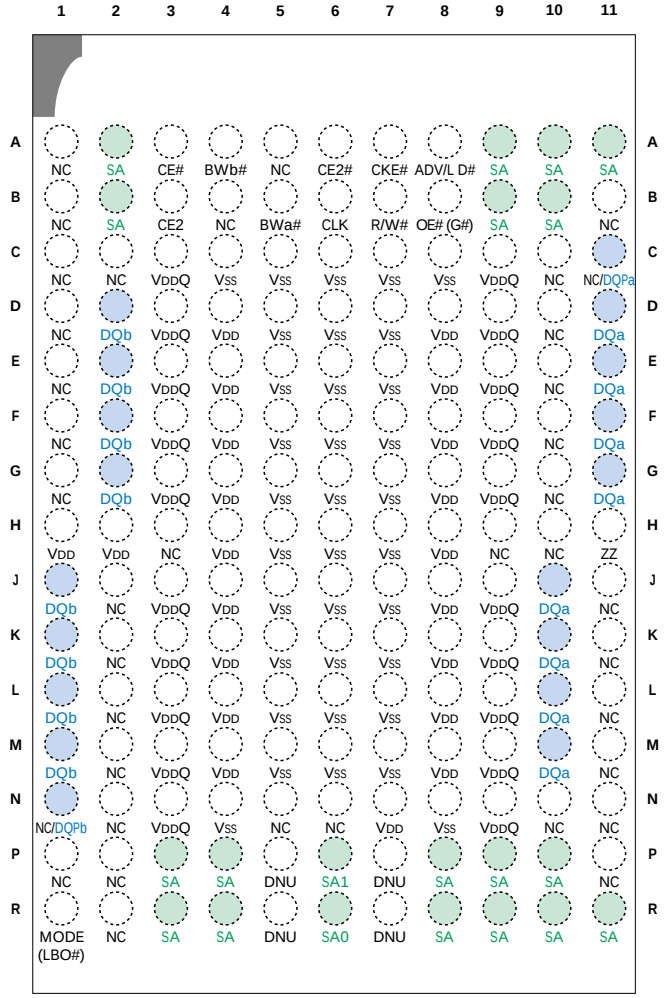
(continued on next page)

TQFP PIN DESCRIPTIONS (continued)

x18	x32/36	SYMBOL	TYPE	DESCRIPTION
88	88	R/W#	Input	Read/Write: This input determines the cycle type when ADV/LD# is LOW and is the only means for determining READs and WRITEs. READ cycles may not be converted into WRITEs (and vice versa) other than by loading a new address. A LOW on this pin permits BYTE WRITE operations and must meet the setup and hold times around the rising edge of CLK. Full bus-width WRITEs occur if all byte write enables are LOW.
31	31	MODE (LBO#)	Input	Mode: This input selects the burst sequence. A LOW on this pin selects linear burst. NC or HIGH on this pin selects interleaved burst. Do not alter input state while device is operating. LBO# is the JEDEC-standard term for MODE.
(a) 58, 59, 62, 63, 68, 69, 72-74 (b) 8, 9, 12, 13, 18, 19, 22-24	(a) 52, 53, 56-59, 62, 63 (b) 68, 69, 72-75, 78, 79 (c) 2, 3, 6-9, 12, 13 (d) 18, 19, 22-25, 28, 29	DQa DQb DQc DQd	Input/ Output	SRAM Data I/Os: Byte "a" associated with is DQa pins; Byte "b" is associated with DQb pins; Byte "c" is associated with DQc pins; Byte "d" is associated with DQd pins. Input data must meet setup and hold times around the rising edge of CLK.
– –	51 80 1 30	NC/DQPa NC/DQPb NC/DQPc NC/DQPd	NC/ I/O	No Connect/Data Bits: On the x32 version, these pins are no connect (NC) and can be left floating or connected to GND to minimize thermal impedance. On the x36 version, these bits are DQs.
14, 15, 16, 41, 65, 66, 91	14, 15, 16, 41, 65, 66, 91	V_{DD}	Supply	Power Supply: See DC Electrical Characteristics and Operating Conditions for range.
4, 11, 20, 27, 54, 61, 70, 77	4, 11, 20, 27, 54, 61, 70, 77	$V_{DD}Q$	Supply	Isolated Output Buffer Supply: See DC Electrical Characteristics and Operating Conditions for range.
5, 10, 17, 21, 26, 40, 55, 60, 67, 71, 76, 90	5, 10, 17, 21, 26, 40, 55, 60, 67, 71, 76, 90	V_{SS}	Supply	Ground: GND.
1-3, 6, 7, 25, 28-30, 51-53, 56, 57, 75, 78, 79, 95, 96	n/a	NC	–	No Connect: These pins can be left floating or connected to GND to minimize thermal impedance.
38, 39, 42, 43	38, 39, 42, 43	DNU	–	Do Not Use: These signals may either be unconnected or wired to GND to minimize thermal impedance.

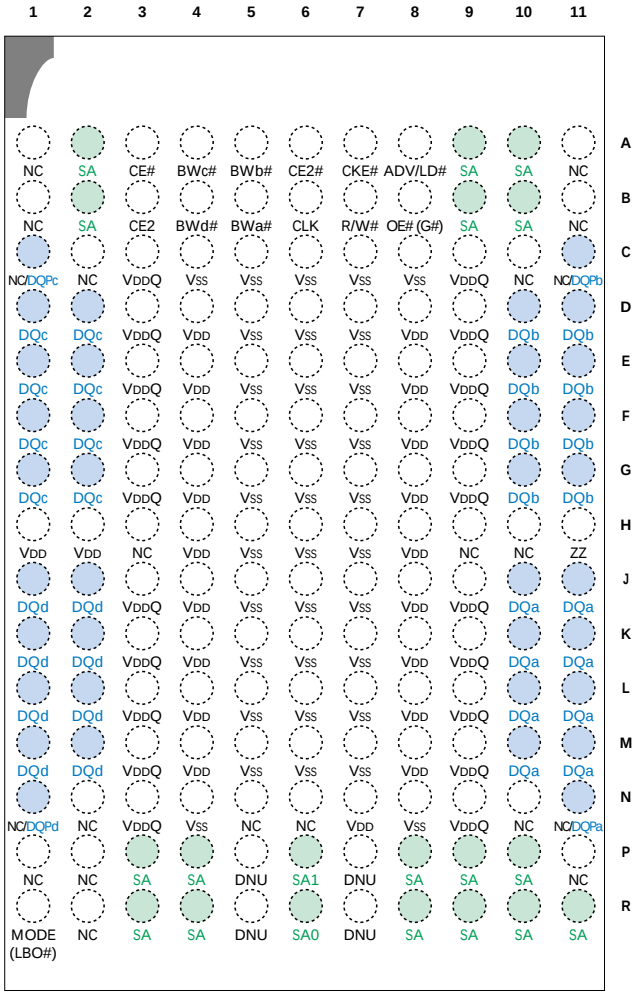
PIN LAYOUT (TOP VIEW)
165-PIN FBGA

x18



TOP VIEW

x32/x36



TOP VIEW

*No Connect (NC) is used on the x32 version. Parity (DQPx) is used on the x36 version.

FBGA PIN DESCRIPTIONS

x18	x32/x36	SYMBOL	TYPE	DESCRIPTION
6R 6P 2A, 9A, 10A, 11A, 2B, 9B, 10B, 3P, 4P, 8P, 9P, 10P, 3R, 4R, 8R, 9R, 10R, 11R	6R 6P 2A, 9A, 10A, 2B, 9B, 10B, 3P, 4P, 8P, 9P, 10P, 3R, 4R, 8R, 9R, 10R, 11R	SA0 SA1 SA	Input	Synchronous Address Inputs: These inputs are registered and must meet the setup and hold times around the rising edge of CLK.
5B 4A – –	5B 5A 4A 4B	BWa# BWb# BWc# BWd#	Input	Synchronous Byte Write Enables: These active LOW inputs allow individual bytes to be written and must meet the setup and hold times around the rising edge of CLK. A byte write enable is LOW for a WRITE cycle and HIGH for a READ cycle. For the x18 version, BWa# controls DQas and DQPa; BWb# controls DQbs and DQPb. For the x32 and x36 versions, BWa# controls DQas and DQPa; BWb# controls DQbs and DQPb; BWc# controls DQcs and DQPc; BWd# controls DQds and DQPd. Parity is only available on the x18 and x36 versions.
7A	7A	CKE#	Input	Synchronous Clock Enable: This active LOW input permits CLK to propogate throughout the device. When CKE# is HIGH, the device ignores the CLK input and effectively internally extends the previous CLK cycle. This input must meet the setup and hold times around the rising edge of CLK.
7B	7B	R/W#	Input	Read/Write: This input determines the cycle type when ADV/LD# is LOW and is the only means for determining READs and WRITEs. READ cycles may not be converted into WRITEs (and vice versa) other than by loading a new address. A LOW on this pin permits BYTE WRITE operations to meet the setup and hold times around the rising edge of CLK. Full bus-width WRITEs occur if all byte write enables are LOW.
6B	6B	CLK	Input	Clock: This signal registers the address, data, chip enable, byte write enables and burst control inputs on its rising edge. All synchronous inputs must meet setup and hold times around the clock's rising edge.
3A	3A	CE#	Input	Synchronous Chip Enable: This active LOW input is used to enable the device and conditions the internal use of ADSP#. CE# is sampled only when a new external address is loaded.
6A	6A	CE2#	Input	Synchronous Chip Enable: This active LOW input is used to enable the device and is sampled only when a new external address is loaded.
11H	11H	ZZ	Input	Snooze Enable: This active HIGH, asynchronous input causes the device to enter a low-power standby mode in which all data in the memory array is retained. When ZZ is active, all other inputs are ignored.
3B	3B	CE2	Input	Synchronous Chip Enable: This active HIGH input is used to enable the device and is sampled only when a new external address is loaded.

(continued on next page)

FBGA PIN DESCRIPTIONS (continued)

x18	x32/x36	SYMBOL	TYPE	DESCRIPTION
8B	8B	OE# (G#)	Input	Output Enable: This active LOW, asynchronous input enables the data I/O output drivers.
8A	8A	ADV/LD#	Input	Synchronous Address Advance/Load: When HIGH, this input is used to advance the internal burst counter, controlling burst access after the external address is loaded. When ADV/LD# is HIGH, R/W# is ignored. A LOW on ADV/LD# clocks a new address at the CLK rising edge.
1R	1R	MODE (LBO#)	Input	Mode: This input selects the burst sequence. A LOW on this input selects "linear burst." NC or HIGH on this input selects "interleaved burst." Do not alter input state while device is operating.
(a) 10J, 10K, 10L, 10M, 11D 11E, 11F, 11G (b) 2D, 2E, 2F, 2G, 1J, 1K, 1L, 1M	(a) 10J, 10K, 10L, 10M, 11J, 11K, 11L, 11M (b) 10D, 10E, 10F, 10G, 11D, 11E, 11F, 11G (c) 1D, 1E, 1F, 1G, 2D, 2E, 2F, 2G, (d) 1J, 1K, 1L, 1M, 2J, 2K, 2L, 2M	DQa DQb DQc DQd	Input/ Output	SRAM Data I/Os: For the x18 version, Byte "a" is associated with DQas; Byte "b" is associated with DQbs. For the x32 and x36 versions, Byte "a" is associated with DQas; Byte "b" is associated with DQbs; Byte "c" is associated with DQcs; Byte "d" is associated with DQds. Input data must meet setup and hold times around the rising edge of CLK.
11C 1N – –	11N 11C 1C 1N	NC/DQPa NC/DQPb NC/DQPc NC/DQPd	NC/ I/O	No Connect/Parity Data I/Os: On the x32 version, these are No Connect (NC). On the x18 version, Byte "a" parity is DQPa; Byte "b" parity is DQPb. On the x36 version, Byte "a" parity is DQPa; Byte "b" parity is DQPb; Byte "c" parity is DQPc; Byte "d" parity is DQPd.
1H, 2H, 4D, 4E, 4F, 4G, 4H, 4J, 4K, 4L, 4M, 7N, 8D, 8E, 8F, 8G,8H, 8J, 8K, 8L, 8M	1H, 2H, 4D, 4E, 4F, 4G, 4H, 4J, 4K, 4L, 4M, 7N, 8D, 8E, 8F, 8G,8H, 8J, 8K, 8L, 8M	V_{DD}	Supply	Power Supply: See DC Electrical Characteristics and Operating Conditions for range.
3C, 3D, 3E, 3F, 3G, 3J, 3K, 3L, 3M, 3N, 9C, 9D, 9E, 9F, 9G, 9J, 9K, 9L, 9M, 9N	3C, 3D, 3E, 3F, 3G, 3J, 3K, 3L, 3M, 3N, 9C, 9D, 9E, 9F, 9G, 9J, 9K, 9L, 9M, 9N	$V_{DD}Q$	Supply	Isolated Output Buffer Supply: See DC Electrical Characteristics and Operating Conditions for range.

(continued on next page)

FBGA PIN DESCRIPTIONS (continued)

x18	x32/x36	SYMBOL	TYPE	DESCRIPTION
4C, 4N, 5C, 5D, 5E, 5F, 5G, 5H, 5J, 5K, 5L, 5M, 6C, 6D, 6E, 6F, 6G, 6H, 6J, 6K, 6L, 6M, 7C, 7D, 7E, 7F, 7G, 7H, 7J, 7K, 7L, 7M, 8C, 8N	4C, 4N, 5C, 5D, 5E, 5F, 5G, 5H, 5J, 5K, 5L, 5M, 6C, 6D, 6E, 6F, 6G, 6H, 6J, 6K, 6L, 6M, 7C, 7D, 7E, 7F, 7G, 7H, 7J, 7K, 7L, 7M, 8C, 8N	V_{SS}	Supply	Ground: GND.
5P, 7P, 5R, 7R	5P, 7P, 5R, 7R	DNU	–	Do Not Use: These signals may either be unconnected or wired to GND to improve package heat dissipation.
1A, 1B, 1C, 1D, 1E, 1F, 1G, 1P, 2C, 2J, 2K, 2L, 2M, 2N, 2P, 2R, 3H, 4B, 5A, 5N, 6N, 9H, 10C, 10D, 10E, 10F, 10G, 10H, 10N, 11B, 11J, 11K, 11L, 11M, 11N, 11P	1A, 1B, 1P, 2C, 2N, 2P, 2R, 3H, 5N, 6N, 9H, 10C, 10H, 10N, 11A, 11B, 11P	NC	–	No Connect: These signals are not internally connected and may be connected to ground to improve package heat dissipation.

INTERLEAVED BURST ADDRESS TABLE (MODE = NC OR HIGH)

FIRST ADDRESS (EXTERNAL)	SECOND ADDRESS (INTERNAL)	THIRD ADDRESS (INTERNAL)	FOURTH ADDRESS (INTERNAL)
X...X00	X...X01	X...X10	X...X11
X...X01	X...X00	X...X11	X...X10
X...X10	X...X11	X...X00	X...X01
X...X11	X...X10	X...X01	X...X00

LINEAR BURST ADDRESS TABLE (MODE = LOW)

FIRST ADDRESS (EXTERNAL)	SECOND ADDRESS (INTERNAL)	THIRD ADDRESS (INTERNAL)	FOURTH ADDRESS (INTERNAL)
X...X00	X...X01	X...X10	X...X11
X...X01	X...X10	X...X11	X...X00
X...X10	X...X11	X...X00	X...X01
X...X11	X...X00	X...X01	X...X10

PARTIAL TRUTH TABLE FOR READ/WRITE COMMANDS (x18)

FUNCTION	R/W#	BWa#	BWb#
READ	H	X	X
WRITE Byte “a”	L	L	H
WRITE Byte “b”	L	H	L
WRITE All Bytes	L	L	L
WRITE ABORT/NOP	L	H	H

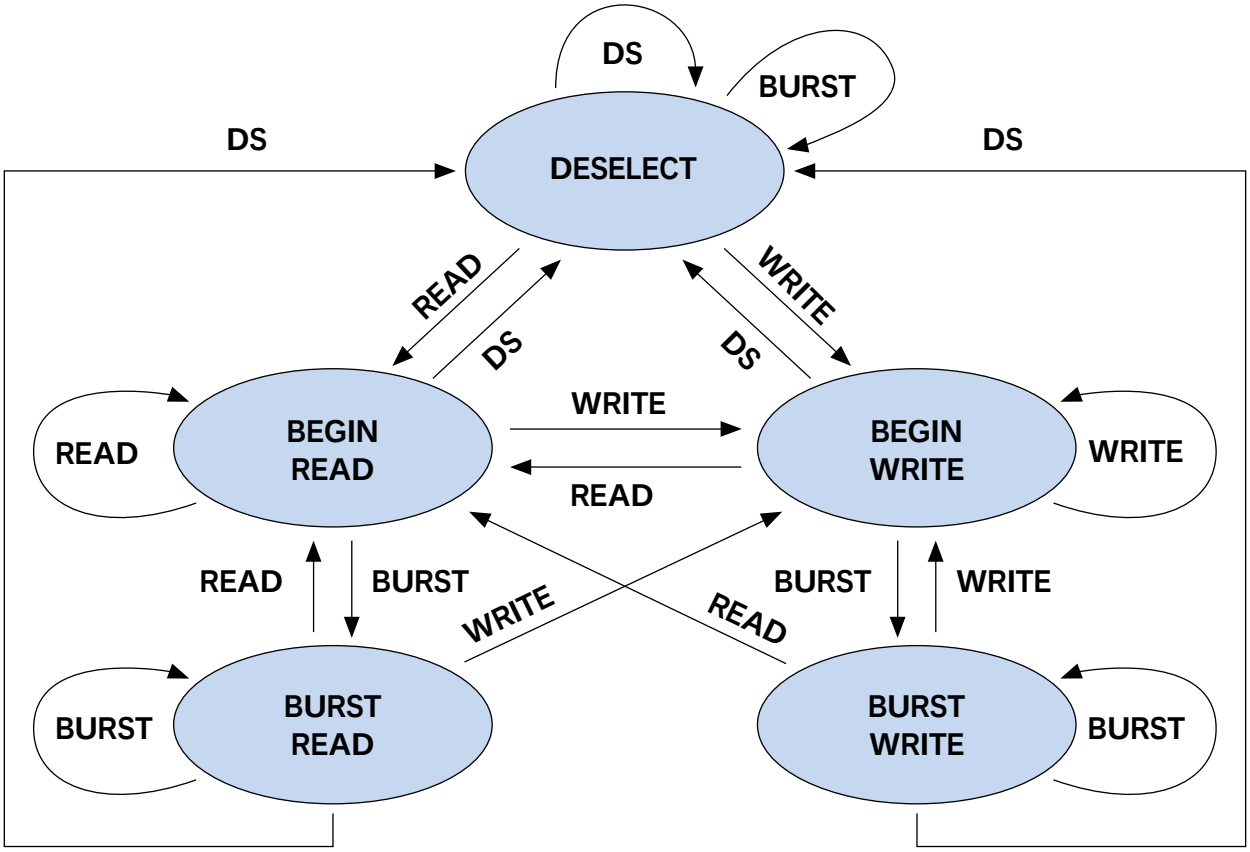
NOTE: Using R/W# and byte write(s), any one or more bytes may be written.

PARTIAL TRUTH TABLE FOR READ/WRITE COMMANDS (x32/x36)

FUNCTION	R/W#	BWa#	BWb#	BWc#	BWd#
READ	H	X	X	X	X
WRITE Byte “a”	L	L	H	H	H
WRITE Byte “b”	L	H	L	H	H
WRITE Byte “c”	L	H	H	L	H
WRITE Byte “d”	L	H	H	H	L
WRITE All Bytes	L	L	L	L	L
WRITE ABORT/NOP	L	H	H	H	H

NOTE: Using R/W# and byte write(s), any one or more bytes may be written.

STATE DIAGRAM FOR ZBT SRAM



KEY:

COMMAND	OPERATION
DS	DESELECT
READ	New READ
WRITE	New WRITE
BURST	BURST READ, BURST WRITE or CONTINUE DESELECT

NOTE: 1. A STALL or IGNORE CLOCK EDGE cycle is not shown in the above diagram. This is because CKE# HIGH only blocks the clock (CLK) input and does not change the state of the device.
2. States change on the rising edge of the clock (CLK).

TRUTH TABLE

(Notes 5-10)

OPERATION	ADDRESS USED	CE#	CE2#	CE2	ZZ	ADV/ LD#	R/W#	BWx	OE#	CKE#	CLK	DQ	NOTES
DESELECT Cycle	None	H	X	X	L	L	X	X	X	L	L→H	High-Z	
DESELECT Cycle	None	X	H	X	L	L	X	X	X	L	L→H	High-Z	
DESELECT Cycle	None	X	X	L	L	L	X	X	X	L	L→H	High-Z	
CONTINUE DESELECT Cycle	None	X	X	X	L	H	X	X	X	L	L→H	High-Z	1
READ Cycle (Begin Burst)	External	L	L	H	L	L	H	X	L	L	L→H	Q	
READ Cycle (Continue Burst)	Next	X	X	X	L	H	X	X	L	L	L→H	Q	1, 11
NOP/DUMMY READ (Begin Burst)	External	L	L	H	L	L	H	X	H	L	L→H	High-Z	2
DUMMY READ (Continue Burst)	Next	X	X	X	L	H	X	X	H	L	L→H	High-Z	1, 2, 11
WRITE Cycle (Begin Burst)	External	L	L	H	L	L	L	L	X	L	L→H	D	3
WRITE Cycle (Continue Burst)	Next	X	X	X	L	H	X	L	X	L	L→H	D	1, 3, 11
NOP/WRITE ABORT (Begin Burst)	None	L	L	H	L	L	L	H	X	L	L→H	High-Z	2, 3
WRITE ABORT (Continue Burst)	Next	X	X	X	L	H	X	H	X	L	L→H	High-Z	1, 2, 3, 11
IGNORE CLOCK EDGE (Stall)	Current	X	X	X	L	X	X	X	X	H	L→H	–	4
SNOOZE MODE	None	X	X	X	H	X	X	X	X	X	X	High-Z	

NOTE:
1. CONTINUE BURST cycles, whether READ or WRITE, use the same control inputs. The type of cycle performed (READ or WRITE) is chosen in the initial BEGIN BURST cycle. A CONTINUE DESELECT cycle can only be entered if a DESELECT cycle is executed first.
2. DUMMY READ and WRITE ABORT cycles can be considered NOPs because the device performs no external operation. A WRITE ABORT means a WRITE command is given, but no operation is performed.
3. OE# may be wired LOW to minimize the number of control signals to the SRAM. The device will automatically turn off the output drivers during a WRITE cycle. OE# may be used when the bus turn-on and turn-off times do not meet an application's requirements.
4. If an IGNORE CLOCK EDGE command occurs during a READ operation, the DQ bus will remain active (Low-Z). If it occurs during a WRITE cycle, the bus will remain in High-Z. No WRITE operations will be performed during the IGNORE CLOCK EDGE cycle.
5. X means "Don't Care." H means logic HIGH. L means logic LOW. BWx = H means all byte write signals (BWa#, BWb#, BWc# and BWd#) are HIGH. BWx = L means one or more byte write signals are LOW.
6. BWa# enables WRITEs to Byte "a" (DQa pins); BWb# enables WRITEs to Byte "b" (DQb pins); BWc# enables WRITEs to Byte "c" (DQc pins); BWd# enables WRITEs to Byte "d" (DQd pins).
7. All inputs except OE# and ZZ must meet setup and hold times around the rising edge (LOW to HIGH) of CLK.
8. Wait states are inserted by setting CKE# HIGH.
9. This device contains circuitry that will ensure that the outputs will be in High-Z during power-up.
10. The device incorporates a 2-bit burst counter. Address wraps to the initial address every fourth burst cycle.
11. The address counter is incremented for all CONTINUE BURST cycles.

3.3V V_{DD}, ABSOLUTE MAXIMUM RATINGS*

Voltage on V_{DD} Supply Relative to V_{SS} ..... -0.5V to +4.6V
Voltage on $V_{DD}Q$ Supply Relative to V_{SS} ..... -0.5V to V_{DD}
V_{IN} ..... -0.5V to $V_{DD}Q$ + 0.5V
Storage Temperature (TQFP) ..... -55ºC to +150ºC
Storage Temperature (FBGA) ..... -55ºC to +125ºC
Junction Temperature** ..... +150ºC
Short Circuit Output Current 100mA

2.5V V_{DD}, ABSOLUTE MAXIMUM RATINGS*

Voltage on V_{DD} Supply Relative to V_{SS} ..... -0.3V to +3.6V
Voltage on $V_{DD}Q$ Supply Relative to V_{SS} ..... -0.3V to +3.6V
V_{IN} ..... -0.3V to $V_{DD}Q$ + 0.3V
Storage Temperature (plastic) ..... -55ºC to +150ºC
Storage Temperature (FBGA) ..... -55ºC to +125ºC
Junction Temperature** ..... +150ºC
Short Circuit Output Current 100mA

*Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**Junction temperature depends upon package type, cycle time, loading, ambient temperature and airflow. See Micron Technical Note TN-05-14 for more information.

3.3V V_{DD}, 3.3V I/O DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS

(0ºC ≤ T_A ≤ +70ºC; V_{DD} = +3.3V ±0.165V, $V_{DD}Q$ = +3.3V ±0.165V unless otherwise noted)

DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS	NOTES
Input High (Logic 1) Voltage		V_{IH}	2.0	V_{DD} + 0.3	V	1, 2
Input High (Logic 1) Voltage	DQ pins	V_{IH}	2.0	V_{DD} + 0.3	V	1, 2
Input Low (Logic 0) Voltage		V_{IL}	-0.3	0.8	V	1, 2
Input Leakage Current	0V ≤ V_{IN} ≤ V_{DD}	I_{LI}	-1.0	1.0	µA	3, 6
Output Leakage Current	Output(s) disabled, 0V ≤ V_{IN} ≤ V_{DD}	I_{LO}	-1.0	1.0	µA	
Output High Voltage	I_{OH} = -4.0mA	V_{OH}	2.4	–	V	1, 4
Output Low Voltage	I_{OL} = 8.0mA	V_{OL}	–	0.4	V	1, 4
Supply Voltage		V_{DD}	3.135	3.465	V	1
Isolated Output Buffer Supply		$V_{DD}Q$	3.135	V_{DD}	V	1, 5

NOTE:
1. All voltages referenced to V_{SS} (GND).
2. For 3.3V V_{DD}:
   Overshoot: $V_{IH} \le +4.6V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Undershoot: $V_{IL} \ge -0.7V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Power-up: $V_{IH} \le +3.6V$ and $V_{DD} \le 3.135V$ for $t \le 200ms$
   For 2.5V V_{DD}:
   Overshoot: $V_{IH} \le +3.6V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Undershoot: $V_{IL} \ge -0.5V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Power-up: $V_{IH} \le +2.65V$ and $V_{DD} \le 2.375V$ for $t \le 200ms$
3. MODE pin has an internal pull-up, and input leakage = ±10µA.
4. The load used for V_{OH}, V_{OL} testing is shown in Figure 2. AC load current is higher than the shown DC values. AC I/O curves are available upon request.
5. $V_{DD}Q$ should never exceed V_{DD}. V_{DD} and $V_{DD}Q$ can be externally wired together to the same power supply.
6. Ms# pin has an internal pull-down , and input leakage = ±10µA.

3.3V V_{DD}, 2.5V I/O DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS

(0ºC ≤ T_A ≤ +70ºC; V_{DD} = +3.3V ±0.165V; $V_{DD}Q$ = ±0.125V unless otherwise noted)

DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS	NOTES
Input High (Logic 1) Voltage	Data bus (DQx)	$V_{IH}Q$	1.7	$V_{DD}Q$ + 0.3	V	1, 2
	Inputs	V_{IH}	1.7	V_{DD} + 0.3	V	1, 2
Input Low (Logic 0) Voltage		V_{IL}	-0.3	0.7	V	1, 2
Input Leakage Current	0V ≤ V_{IN} ≤ V_{DD}	I_{LI}	-1.0	1.0	µA	3, 4
Output Leakage Current	Output(s) disabled, 0V ≤ V_{IN} ≤ $V_{DD}Q$ (DQx)	I_{LO}	-1.0	1.0	µA	
Output High Voltage	I_{OH} = -2.0mA	V_{OH}	1.7	–	V	1
	I_{OH} = -1.0mA	V_{OH}	2.0	–	V	1
Output Low Voltage	I_{OL} = 2.0mA	V_{OL}	–	0.7	V	1
	I_{OL} = 1.0mA	V_{OL}	–	0.4	V	1
Supply Voltage		V_{DD}	3.135	3.465	V	1
Isolated Output Buffer Supply		$V_{DD}Q$	2.375	2.625	V	1

2.5V V_{DD}, 2.5V I/O DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS

(0ºC ≤ T_A ≤ +70ºC; V_{DD} = +3.3V ±0.165V; $V_{DD}Q$ = +2.5V ±0.125V unless otherwise noted)

DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS	NOTES
Input High (Logic 1) Voltage	Data bus (DQx)	$V_{IH}Q$	1.7	$V_{DD}Q$ + 0.3	V	1, 2
	Inputs	V_{IH}	1.7	V_{DD} + 0.3	V	1, 2
Input Low (Logic 0) Voltage		V_{IL}	-0.3	0.7	V	1, 2
Input Leakage Current	0V ≤ V_{IN} ≤ V_{DD}	I_{LI}	-1.0	1.0	µA	3, 4
Output Leakage Current	Output(s) disabled, 0V ≤ V_{IN} ≤ $V_{DD}Q$ (DQx)	I_{LO}	-1.0	1.0	µA	
Output High Voltage	I_{OH} = -2.0mA	V_{OH}	1.7	–	V	1
	I_{OH} = -1.0mA	V_{OH}	2.0	–	V	1
Output Low Voltage	I_{OL} = 2.0mA	V_{OL}	–	0.7	V	1
	I_{OL} = 1.0mA	V_{OL}	–	0.4	V	1
Supply Voltage		V_{DD}	2.375	3.625	V	1
Isolated Output Buffer Supply		$V_{DD}Q$	2.375	3.625	V	1

NOTE: 1. All voltages referenced to V_{SS} (GND).
2. For 3.3V V_{DD}:
   Overshoot: $V_{IH} \le +4.6V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Undershoot: $V_{IL} \ge -0.7V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Power-up: $V_{IH} \le +3.6V$ and $V_{DD} \le 3.135V$ for $t \le 200ms$
   For 2.5V V_{DD}:
   Overshoot: $V_{IH} \le +3.6V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Undershoot: $V_{IL} \ge -0.5V$ for $t \le {}^tKC/2$ for $I \le 20mA$
   Power-up: $V_{IH} \le +2.65V$ and $V_{DD} \le 2.375V$ for $t \le 200ms$
3. MODE pin has an internal pull-up, and input leakage = ±10µA.
4. Ms# pin has an internal pull-down , and input leakage = ±10µA.

TQFP CAPACITANCE

DESCRIPTION	CONDITIONS	SYMBOL	TYP	MAX	UNITS	NOTES
Control Input Capacitance	T_A = 25ºC; f = 1 MHz	C_I	3	4	pF	1
Input/Output Capacitance (DQ)	V_{DD} = 3.3V	C_O	4	5	pF	1
Address Capacitance		C_A	3	3.5	pF	1
Clock Capacitance		C_{CK}	3	3.5	pF	1

FBGA CAPACITANCE

DESCRIPTION	CONDITIONS	SYMBOL	TYP	MAX	UNITS	NOTES
Address/Control Input Capacitance	T_A = 25ºC; f = 1 MHz	C_I	2.5	3.5	pF	1
Output Capacitance (Q)		C_O	4	5	pF	1
Clock Capacitance		C_{CK}	2.5	3.5	pF	1

TQFP THERMAL RESISTANCE

DESCRIPTION	CONDITIONS	SYMBOL	TYP	UNITS	NOTES
Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	θ_{JA}	46	ºC/W	1
Thermal Resistance (Junction to Top of Case)		θ_{JC}	2.8	ºC/W	1

FBGA THERMAL RESISTANCE

DESCRIPTION	CONDITIONS	SYMBOL	TYP	UNITS	NOTES
Junction to Ambient (Airflow of 1m/s)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	θ_{JA}	40	ºC/W	1
Junction to Case (Top)		θ_{JC}	9	ºC/W	1
Junction to Pins (Bottom)		θ_{JB}	17	ºC/W	1

NOTE: 1. This parameter is sampled.

I_{DD} OPERATING CONDITIONS AND MAXIMUM LIMITS

(Note 1) ($0^oC \le T_A \le +70^oC$)

				MAX				
DESCRIPTION	**CONDITIONS**	**SYMBOL**	**TYP**	**-6**	**-7.5**	**-10**	**UNITS**	**NOTES**
Power Supply Current: Operating	Device selected; All inputs ≤ V_{IL} or ≥ V_{IH}; Cycle time ≥ ^tKC (MIN); V_{DD} = MAX; Outputs open	I_{DD}	TBD	475	425	325	mA	2, 3, 4
Power Supply Current: Idle	Device selected; V_{DD} = MAX; CKE# ≥ V_{IH}; All inputs ≤ V_{SS} + 0.2 or ≥ V_{DD} - 0.2; Cycle time ≥ ^tKC (MIN)	I_{DD1}	TBD	32	29	24	mA	2, 3, 4
CMOS Standby	Device deselected; V_{DD} = MAX; All inputs ≤ V_{SS} + 0.2 or ≥ V_{DD} - 0.2; All inputs static; CLK frequency = 0	I_{SB2}	TBD	10	10	10	mA	3, 4
TTL Standby	Device deselected; V_{DD} = MAX; All inputs ≤ V_{IL} or ≥ V_{IH}; All inputs static; CLK frequency = 0	I_{SB3}	TBD	25	25	25	mA	3, 4
Clock Running	Device deselected; V_{DD} = MAX; ADV/LD# ≥ V_{IH}; All inputs ≤ V_{SS} + 0.2 or ≥ V_{DD} - 0.2; Cycle time ≥ ^tKC (MIN)	I_{SB4}	TBD	120	105	75	mA	3, 4
Snooze Mode	ZZ ≥ V_{IH}	I_{SB2Z}	TBD	10	10	10	mA	4

NOTE:
1. If V_{DD} = +3.3V, then $V_{DD}Q$ = +3.3V or +2.5V. If V_{DD} = +2.5V, then $V_{DD}Q$ = +2.5V. Voltage tolerances: +3.3V ±0.165 or +2.5V ±0.125V for all values of V_{DD} and $V_{DD}Q$.
2. I_{DD} is specified with no output current and increases with faster cycle times. $I_{DD}Q$ increases with faster cycle times and greater output loading.
3. "Device deselected" means device is in a deselected cycle as defined in the truth table. "Device selected" means device is active (not in deselected mode).
4. Typical values are measured at 3.3V, 25ºC and 10ns cycle time.

AC ELECTRICAL CHARACTERISTICS

(Notes 6, 8, 9, 10) ($0^oC \leq T_A \leq +70^oC$)

DESCRIPTION	SYMBOL	-6		-7.5		-10		UNITS	NOTES
		MIN	MAX	MIN	MAX	MIN	MAX		
Clock									
Clock cycle time	^tKHKH	6.0		7.5		10		ns	
Clock frequency	^fKF		166		133		100	MHz	
Clock HIGH time	^tKHKL	1.8		2.2		3.2		ns	1
Clock LOW time	^tKLKH	1.8		2.2		3.2		ns	1
Output Times									
Clock to output valid	^tKHQV		3.5		4.2		5.0	ns	
Clock to output invalid	^tKHQX	1.5		1.5		1.5		ns	2
Clock to output in Low-Z	$^tKHQX1$	1.5		1.5		1.5		ns	2, 3, 4, 5
Clock to output in High-Z	^tKHQZ	1.5	3.0	1.5	3.0	1.5	3.3	ns	2, 3, 4, 5
OE# to output valid	^tGLQV		3.5		4.2		5.0	ns	6
OE# to output in Low-Z	^tGLQX	0		0		0		ns	2, 3, 4, 5
OE# to output in High-Z	^tGHQZ		3.5		4.2		5.0	ns	2, 3, 4, 5
Setup Times									
Address	^tAVKH	1.5		1.7		2.0		ns	7
Clock enable (CKE#)	^tEVKH	1.5		1.7		2.0		ns	7
Control signals	^tCVKH	1.5		1.7		2.0		ns	7
Data-in	^tDVKH	1.5		1.7		2.0		ns	7
Hold Times									
Address	^tKHAX	0.5		0.5		0.5		ns	7
Clock enable (CKE#)	^tKHEX	0.5		0.5		0.5		ns	7
Control signals	^tKHCX	0.5		0.5		0.5		ns	7
Data-in	^tKHDX	0.5		0.5		0.5		ns	7

NOTE:
1. Measured as HIGH above V_{IH} and LOW below V_{IL}.
2. Refer to Technical Note TN-55-01, "Designing with ZBT SRAMs," for a more thorough discussion of these parameters.
3. This parameter is sampled.
4. This parameter is measured with output loading as shown in Figure 2 for 3.3V I/O and Figure 4 for 2.5V I/O.
5. Transition is measured ±200mV from steady state voltage.
6. OE# can be considered a "Don't Care" during WRITEs; however, controlling OE# can help fine-tune a system for turnaround timing.
7. This is a synchronous device. All addresses must meet the specified setup and hold times for all rising edges of CLK when they are being registered into the device. All other synchronous inputs must meet the setup and hold times with stable logic levels for all rising edges of clock (CLK) when the chip is enabled. Chip enable must be valid at each rising edge of CLK when ADV/LD# is LOW to remain enabled.
8. Test conditions as specified with output loading as shown in Figure 1 for 3.3V I/O ($V_{DD}Q$ = +3.3V ±0.165V) and Figure 3 for 2.5V I/O ($V_{DD}Q$ = +2.5V +0.4V/-0.125V).
9. A WRITE cycle is defined by R/W# LOW having been registered into the device at ADV/LD# LOW. A READ cycle is defined by R/W# HIGH with ADV/LD# LOW. Both cases must meet setup and hold times.
10. If V_{DD} = +3.3V, then $V_{DD}Q$ = +3.3V or +2.5V. If V_{DD} = +2.5V, then $V_{DD}Q$ = +2.5V.
    Voltage tolerances: +3.3V ±0.165 or +2.5V ±0.125V for all values of V_{DD} and $V_{DD}Q$.

3.3V V_{DD}, 3.3V I/O AC TEST CONDITIONS

Input pulse levels	V_{IH} = (V_{DD}/2.2) + 1.5V
	V_{IL} = (V_{DD}/2.2) - 1.5V
Input rise and fall times	1ns
Input timing reference levels	V_{DD}/2.2
Output reference levels	$V_{DD}Q$/2.2
Output load	See Figures 1 and 2

3.3V I/O Output Load Equivalents

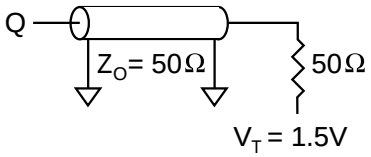


Figure 1

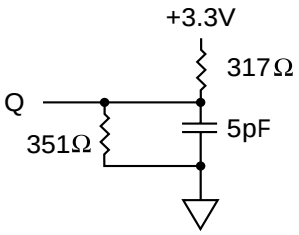


Figure 2

3.3V V_{DD}, 2.5V I/O AC TEST CONDITIONS

Input pulse levels	V_{IH} = (V_{DD}/2.64) + 1.25V
	V_{IL} = (V_{DD}/2.64) - 1.25V
Input rise and fall times	1ns
Input timing reference levels	V_{DD}/2.64
Output reference levels	$V_{DD}Q$/2
Output load	See Figures 3 and 4

2.5V V_{DD}, 2.5V I/O AC TEST CONDITIONS

Input pulse levels	V_{IH} = (V_{DD}/2) + 1.25V
	V_{IL} = (V_{DD}/2) - 1.25V
Input rise and fall times	1ns
Input timing reference levels	V_{DD}/2
Output reference levels	$V_{DD}Q$/2
Output load	See Figures 3 and 4

2.5V I/O Output Load Equivalents

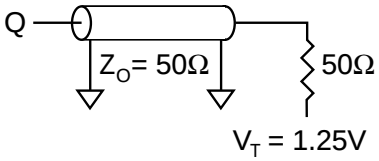


Figure 3

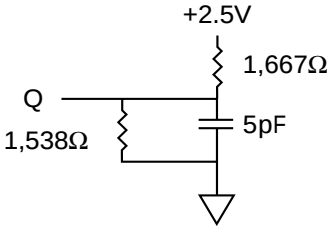


Figure 4

LOAD DERATING CURVES

Micron 1 Meg x 18, 512K x 32, and 512K x 36 SyncBurst SRAM timing is dependent upon the capacitive loading on the outputs.

Consult the factory for copies of I/O current versus voltage curves.

SNOOZE MODE

SNOOZE MODE is a low-current, "power-down" mode in which the device is deselected and current is reduced to I_{SB2Z}. The duration of SNOOZE MODE is dictated by the length of time the ZZ pin is in a HIGH state. After the device enters SNOOZE MODE, all inputs except ZZ become disabled and all outputs go to High-Z.

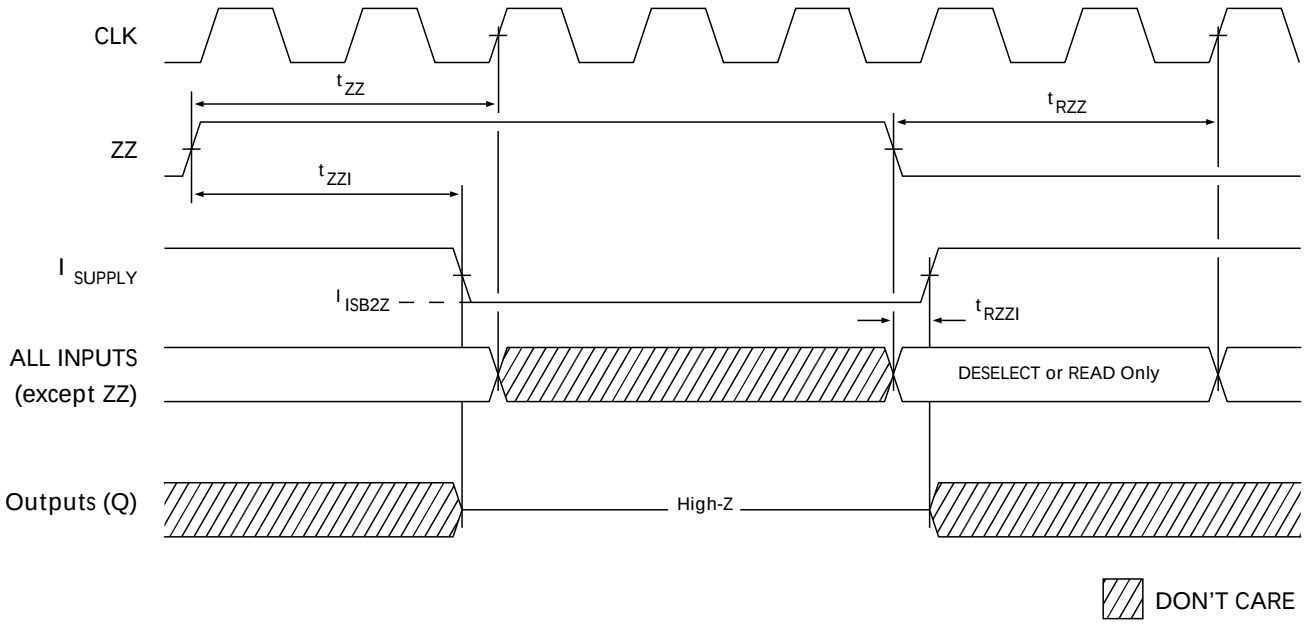
The ZZ pin is an asynchronous, active HIGH input that causes the device to enter SNOOZE MODE. When the ZZ pin becomes a logic HIGH, I_{SB2Z} is guaranteed after the time ^{t}ZZI is met. Any READ or WRITE operation pending when the device enters SNOOZE MODE is not guaranteed to complete successfully. Therefore, SNOOZE MODE must not be initiated until valid pending operations are completed. Similarly, when exiting SNOOZE MODE during ^{t}RZZ, only a DESELECT or READ cycle should be given.

SNOOZE MODE ELECTRICAL CHARACTERISTICS

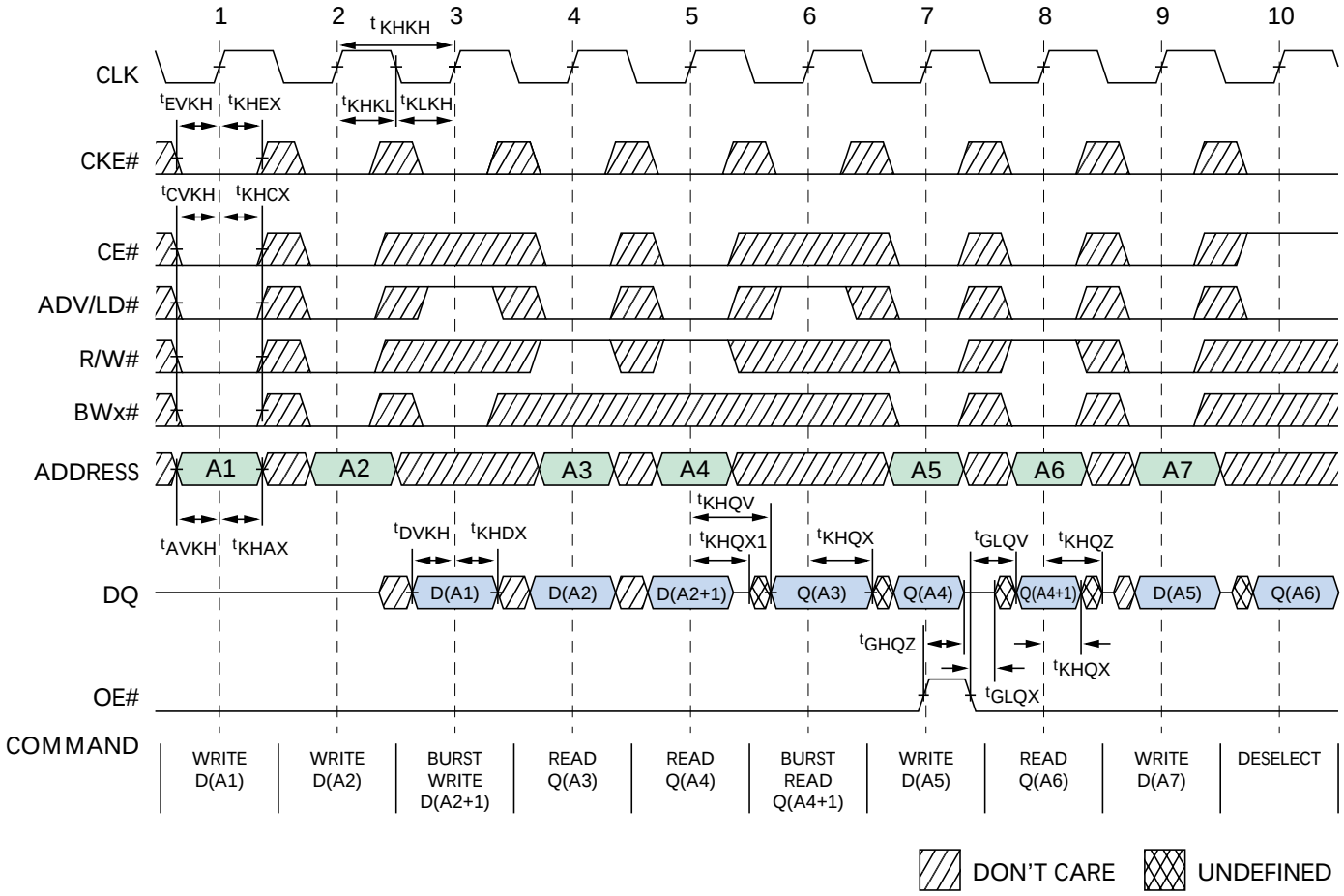
DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS	NOTES
Current during SNOOZE MODE	ZZ ≥ V_{IH}	I_{SB2Z}		10	mA	
ZZ active to input ignored		^{t}ZZ	0	2($^{t}KHKH$)	ns	1
ZZ inactive to input sampled		^{t}RZZ	0	2($^{t}KHKH$)	ns	1
ZZ active to snooze current		^{t}ZZI		2($^{t}KHKH$)	ns	1
ZZ inactive to exit snooze current		$^{t}RZZI$	0		ns	1

NOTE: 1. This parameter is sampled.

SNOOZE MODE WAVEFORM



READ/WRITE TIMING



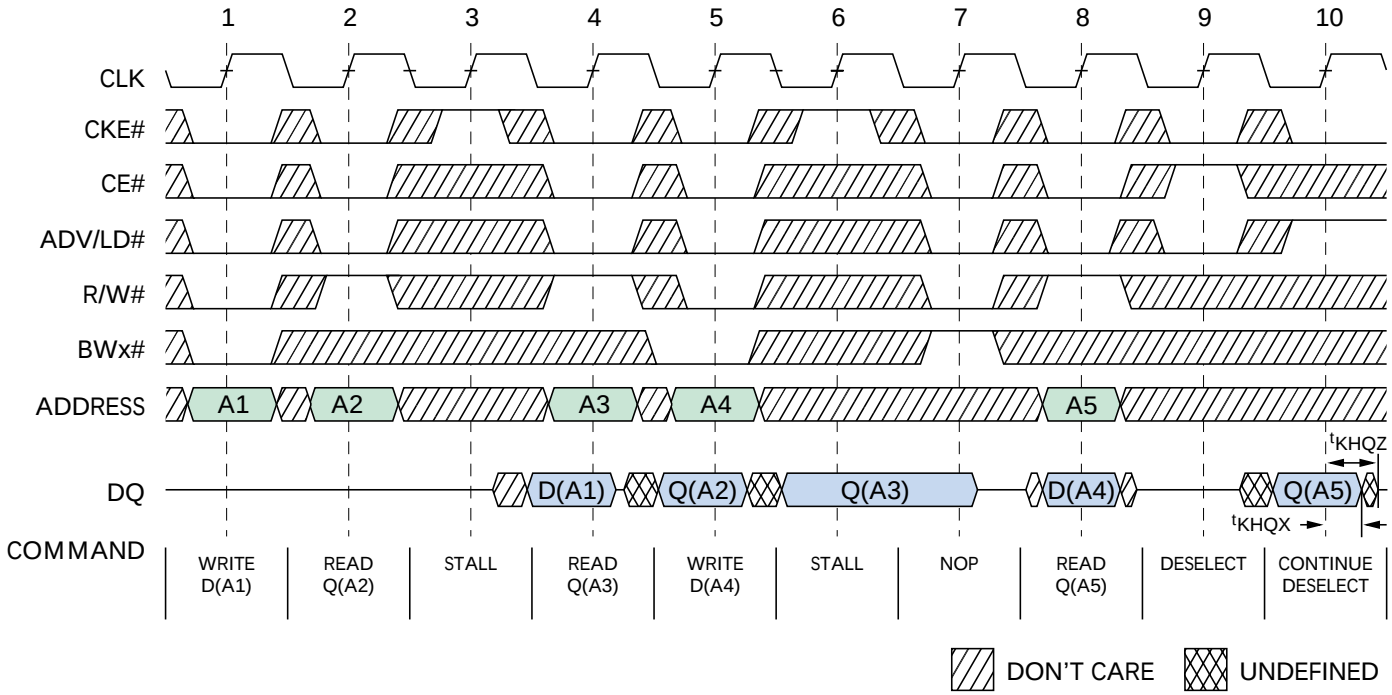
READ/WRITE TIMING PARAMETERS

	-6		-7.5		-10		
SYMBOL	MIN	MAX	MIN	MAX	MIN	MAX	UNITS
tKHKH	6.0		7.5		10		ns
fKF		166		133		100	MHz
tKHKL	1.7		2.0		3.2		ns
tKLKH	1.7		2.0		3.2		ns
tKHQV		3.5		4.2		5.0	ns
tKHQX	1.5		1.5		1.5		ns
tKHQX1	1.5		1.5		1.5		ns
tKHQZ	1.5	3.5	1.5	3.5	1.5	3.5	ns
tGLQV		3.5		4.2		5.0	ns
tGLQX	0		0		0		ns

	-6		-7.5		-10		
SYMBOL	MIN	MAX	MIN	MAX	MIN	MAX	UNITS
tGHQZ		3.5		4.2		5.0	ns
tAVKH	1.5		1.7		2.0		ns
tEVKH	1.5		1.7		2.0		ns
tCVKH	1.5		1.7		2.0		ns
tDVKH	1.5		1.7		2.0		ns
tKHAX	0.5		0.5		0.5		ns
tKHEX	0.5		0.5		0.5		ns
tKHCX	0.5		0.5		0.5		ns
tKHDX	0.5		0.5		0.5		ns

NOTE: 1. For this waveform, ZZ is tied LOW.
2. Burst sequence order is determined by MODE (0 = linear, 1 = interleaved). BURST operations are optional.
3. CE# represents three signals. When CE# = 0, it represents CE# = 0, CE2# = 0, CE2 = 1.
4. Data coherency is provided for all possible operations. If a READ is initiated, the most current data is used. The most recent data may be from the input data register.

NOP, STALL, AND DESELECT CYCLES



NOP, STALL, AND DESELECT TIMING PARAMETERS

	-6		-7.5		-10		
SYM	MIN	MAX	MIN	MAX	MIN	MAX	UNITS
^{t}KHQX	1.5		1.5		1.5		ns
^{t}KHQZ	1.5	3.5	1.5	3.5	1.5	3.5	ns

NOTE:
1. The IGNORE CLOCK EDGE or STALL cycle (clock 3) illustrates CKE# being used to create a "pause." A WRITE is not performed during this cycle.
2. For this waveform, ZZ and OE# are tied LOW.
3. CE# represents three signals. When CE# = 0, it represents CE# = 0, CE2# = 0, CE2 = 1.
4. Data coherency is provided for all possible operations. If a READ is initiated, the most current data is used. The most recent data may be from the input data register.

IEEE 1149.1 SERIAL BOUNDARY SCAN (JTAG)

The 16Mb SRAM incorporates a serial boundary scan test access port (TAP). This port operates in accordance with IEEE Standard 1149.1-1990 but does not have the set of functions required for full 1149.1 compliance. These functions from the IEEE specification are excluded because their inclusion places an added delay in the critical speed path of the SRAM. Note that the TAP controller functions in a manner that does not conflict with the operation of other devices using 1149.1 fully compliant TAPs. The TAP operates using JEDEC-standard 2.5V I/O logic levels.

The SRAM contains a TAP controller, instruction register, boundary scan register, bypass register and ID register.

DISABLING THE JTAG FEATURE

These pins can be left floating (unconnected), if the JTAG function is not to be implemented. Upon power-up, the device will come up in a reset state which will not interfere with the operation of the device.

TEST ACCESS PORT (TAP)

TEST CLOCK (TCK)

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

TEST MODE SELECT (TMS)

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

TEST DATA-IN (TDI)

The TDI pin is used to serially input information into the registers and can be connected to the input of any of the registers. The register between TDI and TDO is chosen by the instruction that is loaded into the TAP instruction register. For information on loading the instruction register, see Figure 5. TDI is internally pulled up and can be unconnected if the TAP is unused in an application. TDI is connected to the most significant bit (MSB) of any register. (See Figure 6.)

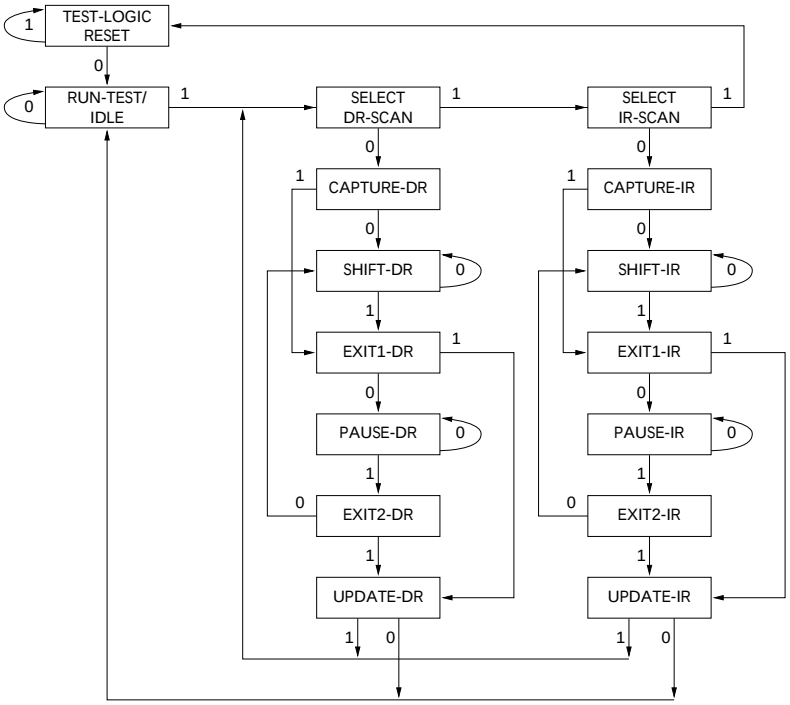


Figure 5
TAP Controller State Diagram

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

TEST DATA-OUT (TDO)

The TDO output pin is used to serially clock data-out from the registers. The output is active depending upon the current state of the TAP state machine. (See Figure 5.) The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register. (See Figure 6.)

PERFORMING A TAP RESET

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

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

TAP REGISTERS

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

INSTRUCTION REGISTER

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the TDI and TDO pins as shown in Figure 5. Upon power-up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state as described in the previous section.

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

BYPASS REGISTER

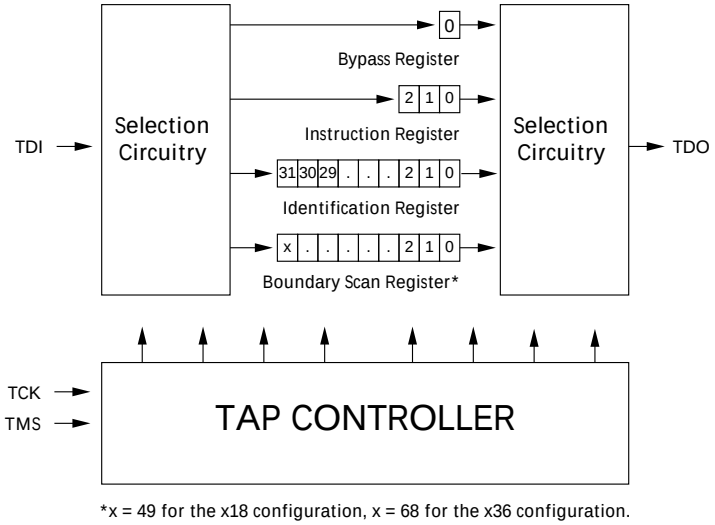
To save time when serially shifting data through registers, it is sometimes advantageous to skip certain chips. The bypass register is a single-bit register that can be placed between the TDI and TDO pins. This allows data to be shifted through the SRAM with minimal delay. The bypass register is set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

BOUNDARY SCAN REGISTER

The boundary scan register is connected to all the input and bidirectional pins on the SRAM. The x36 configuration has a 68-bit-long register, and the x18 configuration has a 49-bit-long register.

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

The Boundary Scan Order tables show the order in which the bits are connected. Each bit corresponds to one of the pins on the SRAM package. The MSB of the register is connected to TDI, and the LSB is connected to TDO.



*x = 49 for the x18 configuration, x = 68 for the x36 configuration.

Figure 6
TAP Controller Block Diagram

IDENTIFICATION (ID) REGISTER

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

TAP INSTRUCTION SET

OVERVIEW

Eight different instructions are possible with the three-bit instruction register. All combinations are listed in the Instruction Codes table. Three of these instructions are listed as RESERVED and should not be used. The other five instructions are described in detail below.

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

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

EXTEST

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

The TAP controller does recognize an all-0 instruction. When an EXTEST instruction is loaded into the instruction register, the SRAM responds as if a SAMPLE/PRELOAD instruction has been loaded. There is one difference between the two instructions. Unlike the SAMPLE/PRELOAD instruction, EXTEST places the SRAM outputs in a High-Z state.

IDCODE

The IDCODE instruction causes a vendor-specific, 32-bit code to be loaded into the instruction register. It also places the instruction register between the TDI and TDO pins and allows the IDCODE to be shifted out of the device when the TAP controller enters the Shift-DR state. The IDCODE instruction is loaded into the instruction register upon power-up or whenever the TAP controller is given a test logic reset state.

SAMPLE Z

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

SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. The PRELOAD portion of this instruction is not implemented, so the device TAP controller is not fully 1149.1-compliant.

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

The user must be aware that the TAP controller clock can only operate at a frequency up to 10 MHz, while the SRAM clock operates more than an order of magnitude faster. Because there is a large difference in the clock frequencies, it is possible that during the Capture-DR state, an input or output will undergo a transition. The TAP may then try to capture a signal while in transition (metastable state). This will not harm the device, but there is no guarantee as to the value that will be captured. Repeatable results may not be possible.

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

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

Note that since the PRELOAD part of the command is not implemented, putting the TAP to the Update-DR state while performing a SAMPLE/PRELOAD instruction will have the same effect as the Pause-DR command.

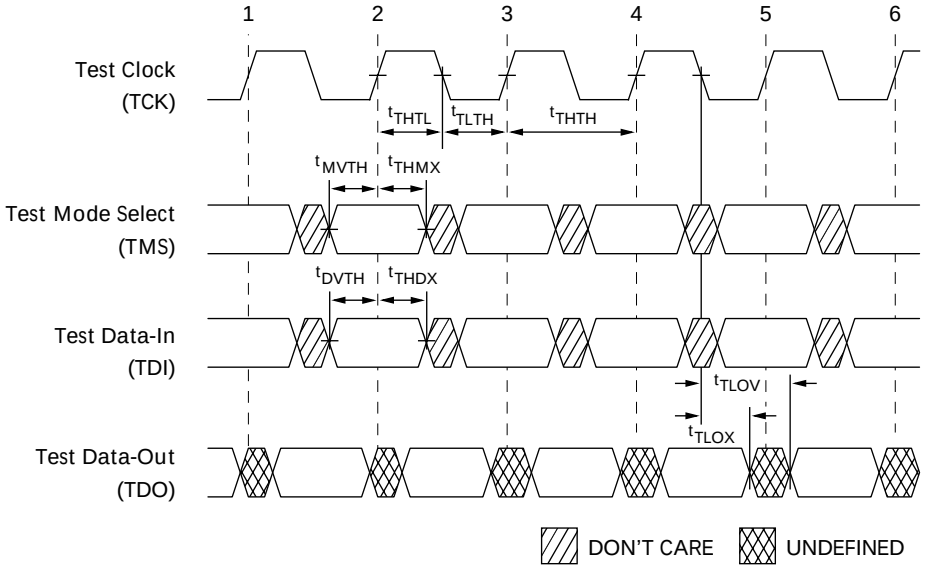
BYPASS

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

RESERVED

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

TAP TIMING



TAP AC ELECTRICAL CHARACTERISTICS

(Notes 1, 2) (+20ºC ≤ T_J ≤ +100ºC; +2.4V ≤ V_{DD} ≤ +2.6V)

DESCRIPTION	SYMBOL	MIN	MAX	UNITS
Clock				
Clock cycle time	^tTHTH	100		ns
Clock frequency	^fTF		10	MHz
Clock HIGH time	^tTHTL	40		ns
Clock LOW time	^tTLTH	40		ns
Output Times				
TCK LOW to TDO unknown	^tTLOX	0		ns
TCK LOW to TDO valid	^tTLOV		20	ns
TDI valid to TCK HIGH	^tDVTH	10		ns
TCK HIGH to TDI invalid	^tTHDX	10		ns
Setup Times				
TMS setup	^tMVTH	10		ns
Capture setup	^tCS	10		ns
Hold Times				
TMS hold	^tTHMX	10		ns
Capture hold	^tCH	10		ns

NOTE: 1. ^tCS and ^tCH refer to the setup and hold time requirements of latching data from the boundary scan register.
2. Test conditions are specified using the load in Figure 7.

TAP AC TEST CONDITIONS

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

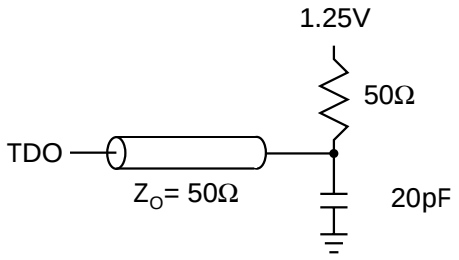


Figure 7
TAP AC Output Load Equivalent

TAP DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS

(+20ºC ≤ T_J ≤ +110ºC; +2.4V ≤ V_{DD} ≤ +2.6V unless otherwise noted)

DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS	NOTES
Input High (Logic 1) Voltage		V_{IH}	1.7	V_{DD} + 0.3	V	1, 2
Input Low (Logic 0) Voltage		V_{IL}	-0.3	0.7	V	1, 2
Input Leakage Current	0V ≤ V_{IN} ≤ V_{DD}	I_{LI}	-5.0	5.0	µA	
Output Leakage Current	Output(s) disabled, 0V ≤ V_{IN} ≤ $V_{DD}Q$ (DQx)	I_{LO}	-5.0	5.0	µA	
Output Low Voltage	I_{OLC} = 100µA	V_{OL1}		0.2	V	1
Output Low Voltage	I_{OLT} = 2mA	V_{OL2}		0.7	V	1
Output High Voltage	I_{OHC} = 100µA	V_{OH1}	2.1		V	1
Output High Voltage	I_{OHT} = 2mA	V_{OH2}	1.7		V	1

NOTE: 1. All voltages referenced to V_{SS} (GND).
2. Overshoot: V_{IH} (AC) ≤ V_{DD} + 1.5V for t ≤ $^tKHKH/2$
Undershoot: V_{IL} (AC) ≥ -0.5V for t ≤ $^tKHKH/2$
Power-up: V_{IH} ≤ +2.6V and V_{DD} ≤ 2.4V and $V_{DD}Q$ ≤ 1.4V for t ≤ 200ms
During normal operation, $V_{DD}Q$ must not exceed V_{DD}. Control input signals (such as LD#, R/W#, etc.) may not have pulse widths less than ^tKHKL (MIN) or operate at frequencies exceeding ^fKF (MAX).

IDENTIFICATION REGISTER DEFINITIONS

INSTRUCTION FIELD	512K x 18	DESCRIPTION
REVISION NUMBER (31:28)	xxxx	Reserved for version number.
DEVICE DEPTH (27:23)	00111	Defines depth of 256K or 512K words.
DEVICE WIDTH (22:18)	00011	Defines width of x18 or x36 bits.
MICRON DEVICE ID (17:12)	xxxxxx	Reserved for future use.
MICRON JEDEC ID CODE (11:1)	00000101100	Allows unique identification of SRAM vendor.
ID Register Presence Indicator (0)	1	Indicates the presence of an ID register.

SCAN REGISTER SIZES

REGISTER NAME	BIT SIZE
Instruction	3
Bypass	1
ID	32
Boundary Scan	68

INSTRUCTION CODES

INSTRUCTION	CODE	DESCRIPTION
EXTEST	000	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM outputs to High-Z state. This instruction is not 1149.1-compliant.
IDCODE	001	Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operations.
SAMPLE Z	010	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a High-Z state.
RESERVED	011	Do Not Use: This instruction is reserved for future use.
SAMPLE/PRELOAD	100	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Does not affect SRAM operation. This instruction does not implement 1149.1 preload function and is therefore not 1149.1-compliant.
RESERVED	101	Do Not Use: This instruction is reserved for future use.
RESERVED	110	Do Not Use: This instruction is reserved for future use.
BYPASS	111	Places the bypass register between TDI and TDO. This operation does not affect SRAM operations.

FBGA BOUNDARY SCAN ORDER (x18)

FBGA BIT#	SIGNAL NAME	FBGA PIN ID
1	SA	TBD
2	SA	TBD
3	SA	TBD
4	SA	TBD
5	SA	TBD
6	SA	TBD
7	SA	TBD
8	DQa	TBD
9	DQa	TBD
10	DQa	TBD
11	DQa	TBD
12	ZZ	TBD
13	DQa	TBD
14	DQa	TBD
15	DQa	TBD
16	DQa	TBD
17	NC/DQPa	TBD
18	SA	TBD
19	SA	TBD
20	SA	TBD
21	SA	TBD
22	SA	TBD
23	ADV/LD#	TBD
24	OE# (G#)	TBD
25	CKE#	TBD
26	R/W#	TBD
27	CLK	TBD
28	CE2#	TBD
29	BWa#	TBD
30	BWb#	TBD
31	CE2	TBD
32	CE#	TBD
33	SA	TBD
34	SA	TBD

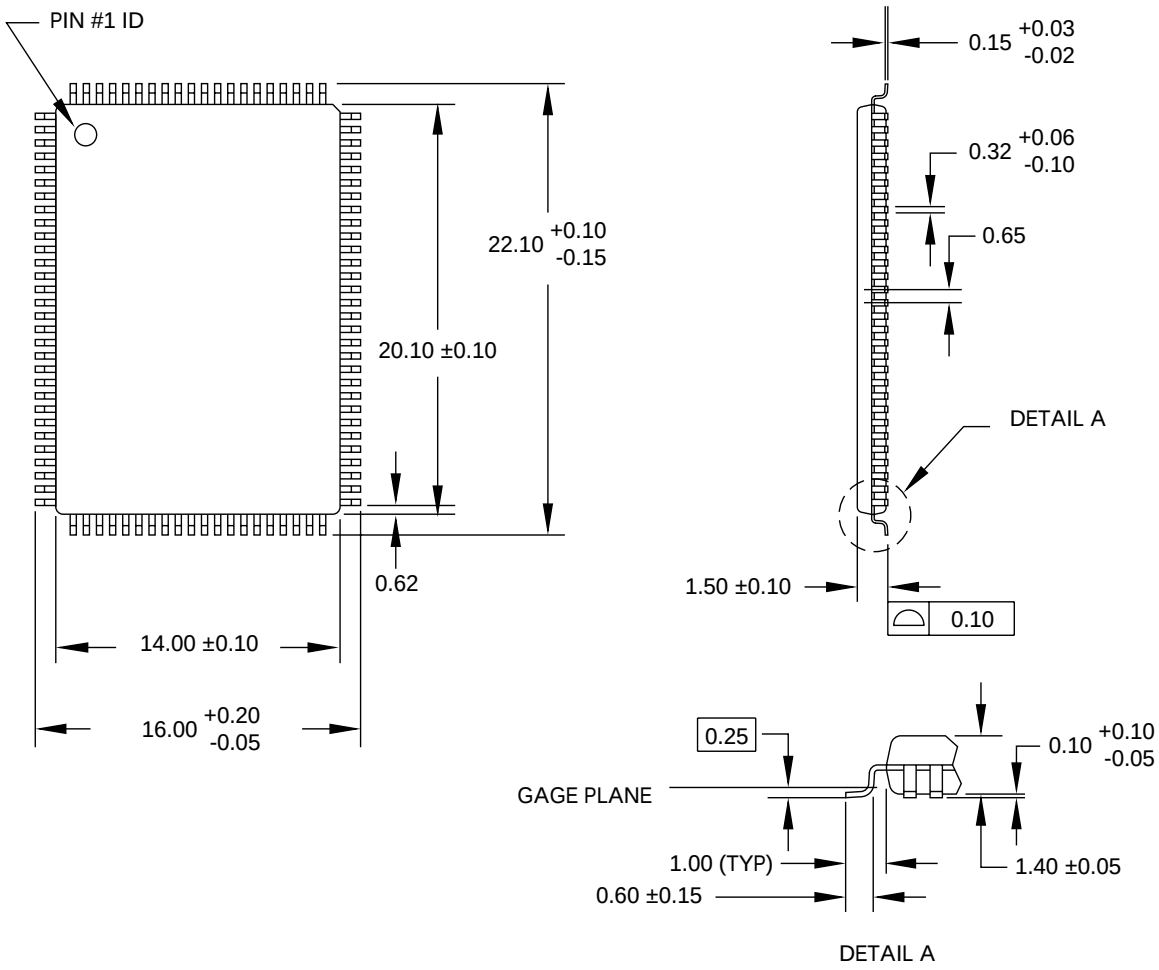
FBGA BIT#	SIGNAL NAME	FBGA PIN ID
35	DQb	TBD
36	DQb	TBD
37	DQb	TBD
38	DQb	TBD
39	MS#	TBD
40	DQb	TBD
41	DQb	TBD
42	DQb	TBD
43	DQb	TBD
44	NC/DQPb	TBD
45	MODE (LBO#)	TBD
46	SA	TBD
47	SA	TBD
48	SA	TBD
49	SA	TBD
50	SA1	TBD
51	SA0	TBD

FBGA BOUNDARY SCAN ORDER (x32/36)

FBGA BIT#	SIGNAL NAME	FBGA PIN ID
1	SA	TBD
2	SA	TBD
3	SA	TBD
4	SA	TBD
5	SA	TBD
6	SA	TBD
7	SA	TBD
8	NC/DQPa	TBD
9	DQa	TBD
10	DQa	TBD
11	DQa	TBD
12	DQa	TBD
13	DQa	TBD
14	DQa	TBD
15	DQa	TBD
16	DQa	TBD
17	ZZ	TBD
18	DQb	TBD
19	DQb	TBD
20	DQb	TBD
21	DQb	TBD
22	DQb	TBD
23	DQb	TBD
24	DQb	TBD
25	DQb	TBD
26	NC/DQPb	TBD
27	SA	TBD
28	SA	TBD
29	SA	TBD
30	SA	TBD
31	ADV/LD#	TBD
32	OE# (G#)	TBD
33	CKE#	TBD
34	R/W#	TBD
35	CLK	TBD
36	CE2#	TBD

FBGA BIT#	SIGNAL NAME	FBGA PIN ID
37	BWa#	TBD
38	BWb#	TBD
39	BWc#	TBD
40	BWd#	TBD
41	CE2	TBD
42	CE#	TBD
43	SA	TBD
44	SA	TBD
45	NC/DQPc	TBD
46	DQc	TBD
47	DQc	TBD
48	DQc	TBD
49	DQc	TBD
50	DQc	TBD
51	DQc	TBD
52	DQc	TBD
53	DQc	TBD
54	MS#	TBD
55	DQd	TBD
56	DQd	TBD
57	DQd	TBD
58	DQd	TBD
59	DQd	TBD
60	DQd	TBD
61	DQd	TBD
62	DQd	TBD
63	NC/DQPd	TBD
64	MODE (LBO#)	TBD
65	SA	TBD
66	SA	TBD
67	SA	TBD
68	SA	TBD
69	SA1	TBD
70	SA0	TBD

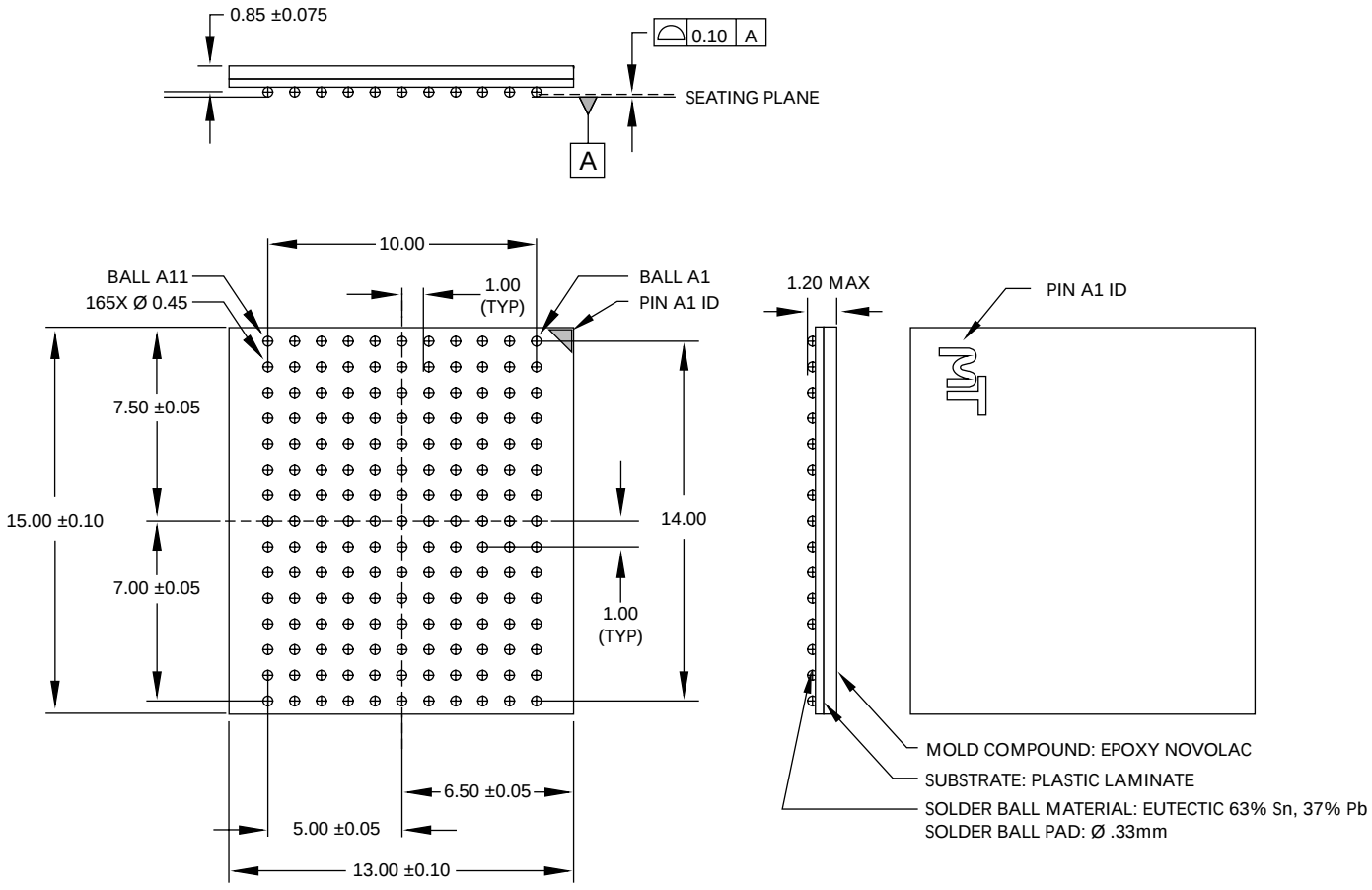
100-PIN PLASTIC TQFP
(JEDEC LQFP)



NOTE: 1. All dimensions in millimeters $\frac{\text{MAX}}{\text{MIN}}$ or typical where noted.

2. Package width and length do not include mold protrusion; allowable mold protrusion is 0.25mm per side.

165-PIN FBGA



NOTE: 1. All dimensions in millimeters $\frac{\text{MAX}}{\text{MIN}}$ or typical where noted.

2. Package width and length do not include mold protrusion; allowable mold protrusion is 0.25mm per side.

8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-3900
E-mail: prodmktg@micron.com, Internet: http://www.micronsemi.com, Customer Comment Line: 800-932-4992

REVISION HISTORY

Removed FBGA Part Marking Guide, Rev. 8/00, ADVANCE Aug/22/00

Changed FBGA capacitance values, Rev. 7/00, ADVANCE Aug/8/00
C_I; TYP 2.5 pF from 4 pF; MAX 3.5 pF from 5 pF
C_O; TYP 4 pF from 6 pF; MAX 5 pF from 7 pF
C_{CK}; TYP 2.5 pF from 5 pF; MAX 3.5 pF from 6 pF

Added 165-Pin FBGA Package, Rev. 7/00, ADVANCE Jun/28/00
Added FBGA Part Marking References
Removed 119-Pin PBGA and references
Removed Smart ZBT and references

Added note: ZZ has internal pull-down, Rev. 4/00, ADVANCE Apr/13/00

Updated Boundary Scan Order, Rev. 3/00, ADVANCE Apr/6/00

Added BGA JTAG functionality, Rev. 1/00, ADVANCE Jan/18/00
Added 119-pin PBGA package
Added SMART ZBT functionality
Added ADVANCE status

MT55L1MY18P, Rev. 11/99, DRAFT Nov/11/99