

# DOUBLE DATA RATE (DDR) SDRAM

## FEATURES

- ROHS Compliant
- PC2100, PC2700 and PC3200 compatible
- VDD = +2.5V ±0.2V, VDDQ = +2.5V ±0.2V (For -6A & -75A)
- VDD = +2.6V ±0.1V, VDDQ = +2.6V ±0.1V (For -5B)
- Bi-directional data strobe (DQS) transmitted/ received with data, i.e. source-synchronous data capture (x16 has two: LDQS and UDQS – one per byte)
- Internal, pipelined double-data-rate (DDR) architecture; two data accesses per clock cycle
- Differential clock inputs (CK and CK#)
- Commands entered on each positive CK edge
- DQS edge-aligned with data for READs; center-aligned with data for WRITEs
- DLL to align DQ and DQS transitions with CK
- Four internal banks for concurrent operation
- Data mask (DM) for masking write data (x16 has two: LDM and UDM – one per byte)
- Programmable burst lengths: 2, 4, or 8
- Auto precharge option
- Auto Refresh
- Longer lead TSOP for improved reliability (OCPL)
- 2.5V I/O (SSTL\_2 compatible)
- These devices are optimized for single rank DIMM applications

## Options:

### Family:

SpecTek Memory

### Configuration:

 128 Meg x 4 (32 Meg x 4 x 4 banks)  
 64 Meg x 8 (16 Meg x 8 x 4 banks)  
 32 Meg x 16 (8 Meg x 16 x 4 banks)

### Design ID:

 DDR2 512 Megabit Design  
 (Call SpecTek Sales for details on availability of "x" placeholders)

### Voltage and refresh:

 2.5V, Auto Refresh  
 2.5V, Self or Auto Refresh

### Package Types (Lead-Free):

 66-pin Plastic TSOP, OCPL  
 (400 mil width, 0.65mm pin pitch)  
 60-ball (10mm x 12.5mm) FBGA

## Designation:

SAA

 128M4  
 64M8  
 32M16

Tx7x

 V8  
 R8

TLF

FNF

## Package Types (Leaded):

 66-pin Plastic TSOP, OCPL TLL  
 (400 mil width, 0.65mm pin pitch)  
 60-ball (10mm x 12.5mm) FBGA FNL

## Timing – Cycle Time:

 5ns @ CL=3 (PC3200 or DDR400B) -5B  
 6ns @ CL = 2.5 (PC2700 or DDR333) -6A  
 7.5ns @ CL = 2.5 (PC2100 or DDR266) -75A

Part number example:

SAA64M8T272V8TLF-5B

 (For part numbers prior to December 2004, refer to [page 12](#) for decoding, or for part numbers prior to July 7<sup>th</sup> 2006, refer to [page 13](#) for decoding.)

## PIN ASSIGNMENT (TOP VIEW) 66-PIN TSOP

x4	x8	x16			x16	x8	x4
VDD	VDD	VDD	1	•	66	VSS	VSS
NF	DQ0	DQ0	2		65	DQ15	DQ7
VDDQ	VDDQ	VDDQ	3		64	VSSQ	VSSQ
NC	NC	DQ1	4		63	DQ14	NC
DQ0	DQ1	DQ2	5		62	DQ13	DQ6
VSSQ	VSSQ	VSSQ	6		61	VDDQ	VDDQ
NC	NC	DQ3	7		60	DQ12	NC
NF	DQ2	DQ4	8		59	DQ11	DQ5
VDDQ	VDDQ	VDDQ	9		58	VSSQ	VSSQ
NC	NC	DQ5	10		57	DQ10	NC
DQ1	DQ3	DQ6	11		56	DQ9	DQ4
VSSQ	VSSQ	VSSQ	12		55	VDDQ	VDDQ
NC	NC	DQ7	13		54	DQ8	NC
NC	NC	NC	14		53	NC	NC
VDDQ	VDDQ	VDDQ	15		52	VSSQ	VSSQ
NC	NC	LDQS	16		51	UDQS	DQS
NC	NC	NC	17		50	DNU	DNU
VDD	VDD	VDD	18		49	VREF	VREF
DNU	DNU	DNU	19		48	VSS	VSS
NC	NC	LDM	20		47	UDM	DM
WE#	WE#	WE#	21		46	CK#	CK#
CAS#	CAS#	CAS#	22		45	CK	CK
RAS#	RAS#	RAS#	23		44	CKE	CKE
CS#	CS#	CS#	24		43	NC	NC
NC	NC	NC	25		42	A12	A12
BA0	BA0	BA0	26		41	A11	A11
BA1	BA1	BA1	27		40	A9	A9
A10/AP	A10/AP	A10/AP	28		39	A8	A8
A0	A0	A0	29		38	A7	A7
A1	A1	A1	30		37	A6	A6
A2	A2	A2	31		36	A5	A5
A3	A3	A3	32		35	A4	A4
VDD	VDD	VDD	33		34	VSS	VSS

	128 Meg x 4	64 Meg x 8	32 Meg x 16
Configuration	32 Meg x 4 x 4 banks	16 Meg x 8 x 4 banks	8 Meg x 16 x 4 banks
Refresh Count	8K	8K	8K
Row Addressing	8K(A0-A12)	8K(A0-A12)	8K(A0-A12)
Bank Addressing	4(BA0, BA1)	4(BA0, BA1)	4(BA0, BA1)
Column Addressing	4K(A0-A9, A11, A12)	2K(A0-A9, A11)	1K(A0-A9)

## GENERAL DESCRIPTION

The 512Mb DDR SDRAM is a high-speed CMOS, dynamic random-access memory containing 536,870,912 bits. It is internally configured as a quad-bank DRAM.

The 512Mb DDR SDRAM uses a double-data rate architecture to achieve high-speed operation. The double data rate architecture is essentially a  $2n$ -prefetch architecture with an interface designed to transfer two data words per clock cycle at the I/O pins. A single read or write access for the 512Mb DDR SDRAM effectively consists of a single  $2n$ -bit wide, one-clock-cycle data transfer at the internal DRAM core and two corresponding  $n$ -bit wide, one-half-clock-cycle data transfers at the I/O pins.

A bi-directional data strobe (DQS or LDQS/UDQS) is transmitted externally, along with data, for use in data capture at the receiver. DQS is a strobe transmitted by the DDR SDRAM during READs and by the memory controller during WRITEs. DQS is edge-aligned with data for READs and center-aligned with data for WRITEs. The x16 offering has two data strobes, one for the lower byte and one for the upper byte.

The 512Mb DDR SDRAM operates from a differential clock (CK and CK#); the crossing of CK going HIGH and CK# going LOW will be referred to as the positive edge of CK. Commands (address and control signals) are registered at every positive edge of CK. Input data is registered on both edges of DQS, and output data is referenced to both edges of DQS, as well as to both edges of CK.

Read and write accesses to the DDR SDRAM are burst oriented; accesses start at a selected location and continue for a programmed number of locations in a programmed sequence. Accesses begin with the registration of an ACTIVE command, which is then followed by a READ or WRITE command. The address bits registered coincident with the ACTIVE command are used to select the bank and row to be accessed. The address bits registered coincident with the READ or WRITE command are used to select the bank and the starting column location for the burst access.

The DDR SDRAM provides for programmable READ or WRITE burst lengths of 2, 4, or 8 locations. An auto precharge function may be enabled to provide a self-timed row precharge that is initiated at the end of the burst access.

As with standard SDR SDRAMs, the pipelined, multibank architecture of DDR SDRAMs allows for concurrent operation, thereby providing high effective bandwidth by hiding row precharge and activation time.

An auto refresh mode is provided, along with a power-saving power-down mode. All inputs are compatible with the JEDEC Standard for SSTL\_2. All full drive strength outputs are SSTL\_2, Class II compatible.

**NOTE 1:** The functionality and the timing specifications discussed in this data sheet are for the DLL-enabled mode of operation.

**NOTE 2:** Throughout the data sheet, the various figures and text refer to DQs as "DQ." The DQ term is to be interpreted as any and all DQ collectively, unless specifically stated otherwise.

Additionally, the x16 is divided in to two bytes — the lower byte and upper byte. For the lower byte (DQ0 through DQ7) DM refers to LDM and DQS refers to LDQS; and for the upper byte (DQ8 through DQ15) DM refers to UDM and DQS refers to UDQS.

## ABSOLUTE MAXIMUM RATINGS\*

(Voltages Relative to VSS)

V <sub>DD</sub> Supply	-1V to +3.6V
V <sub>DDQ</sub> Supply	-1V to +3.6V
V <sub>REF</sub> and Inputs	-1V to +3.6V
I/O Pins	-0.5V to V <sub>DDQ</sub> +0.5V
Operating Temperature, T <sub>A</sub> (ambient)	10°C to +70°C
Storage Temperature (plastic)	-55°C to +150°C
Power Dissipation	1W
Short Circuit Output Current	50mA

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## DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS

(For test conditions, see note 53)

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES
Supply Voltage (For -6A & -75A)	VDD	2.3	2.7	V	41
I/O Supply Voltage (For -6A & -75A)	VDDQ	2.3	2.7	V	41, 44
Supply Voltage (For -5B)	VDD	2.5	2.7	V	41
I/O Supply Voltage (For -5B)	VDDQ	2.5	2.7	V	41, 44
I/O Reference Voltage	VREF	0.49 X VDDQ	0.51 X VDDQ	V	6, 44
I/O Termination Voltage (system)	VTT	VREF - 0.04	VREF + 0.04	V	7, 44
Input High (Logic 1) Voltage	VIH (DC)	VREF + 0.15	VDD + 0.3	V	28
Input Low (Logic 0) Voltage	VIL (DC)	-0.3	VREF - 0.15	V	28
Clock Input Voltage Level; CK and CK#	VIN	-0.3	VDDQ + 0.3	V	
Clock Input Differential Voltage; CK and CK#	VID	0.36	VDDQ + 0.6	V	8
Clock Input Crossing Point Voltage; CK and CK#	VIX	1.15	1.35	V	9
INPUT LEAKAGE CURRENT Any input, $0V \leq V_{IN} \leq V_{DD}$ , VREF pin $0V \leq V_{IN} \leq 1.35V$ (All other pins not under test = 0V)	Ii	-2	2	$\mu A$	
OUTPUT LEAKAGE CURRENT (DQs are disabled; $0V \leq V_{OUT} \leq V_{DDQ}$ )	Ioz	-7	7	$\mu A$	
OUTPUT LEVELS: Full drive option - x4, x8, x16 High Current ( $V_{OUT} = V_{DDQ} - 0.373V$ , minimum VREF, minimum VTT) Low Current ( $V_{OUT} = 0.373V$ , maximum VREF, maximum VTT)	IOH IOL	-16.8 16.8	-- --	mA mA	37, 39
OUTPUT LEVELS: Reduced drive option - x16 only High Current ( $V_{OUT} = V_{DDQ} - 0.763V$ , minimum VREF, minimum VTT) Low Current ( $V_{OUT} = 0.763V$ , maximum VREF, maximum VTT)	IOHR IOLR	-9 9	-- --	mA mA	38, 39

## AC INPUT OPERATING CONDITIONS

(For test conditions, see note 53)

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES
Input High (Logic 1) Voltage	VIH (AC)	VREF + 0.310	--	V	14, 28, 40
Input Low (Logic 0) Voltage	VIL (AC)	--	VREF - 0.310	V	14, 28, 40
Clock Input Differential Voltage; CK and CK#	VID (AC)	0.7	VDDQ + 0.6	V	8
Clock Input Crossing Point Voltage; CK and CK#	VIX (AC)	0.5 X VDDQ - 0.2	0.5 X VDDQ + 0.2	V	9
I/O Reference Voltage	VREF (AC)	0.49 X VDDQ	0.51 X VDDQ	V	6

## CAPACITANCE (x4, x8)

(For test conditions, see note 53)

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTES
Delta Input/Output Capacitance: DQs, DQS, DM	DCIO	--	0.50	pF	24
Delta Input Capacitance: Command and Address	DCI1	--	0.50	pF	29
Delta Input Capacitance: CK, CK#	DCI2	--	0.25	pF	29
Input/Output Capacitance: DQs, DQS, DM	CIO	4.0	5.0	pF	
Input Capacitance: Command and Address	C11	2.0	3.0	pF	
Input Capacitance: CK, CK#	C12	2.0	3.0	pF	
Input Capacitance: CKE	C13	2.0	3.0	pF	

**IDD SPECIFICATIONS AND CONDITIONS (x4, x8)**

(For test conditions, see note 53)

PARAMETER/CONDITION	SYMBOL	-5B	-6A	-75	UNITS	NOTES
OPERATING CURRENT: One bank; Active-Precharge; $t_{RC} = t_{RC}(\text{MIN})$ ; $t_{CK} = t_{CK}(\text{MIN})$ ; DQ, DM, and DQS inputs changing once per clock cycle; Address and control inputs changing once every two clock cycles;	IDD0	155	135	120	mA	22, 48
OPERATING CURRENT: One bank; Active-Read-Precharge; Burst = 2; $t_{RC} = t_{RC}(\text{MIN})$ ; $t_{CK} = t_{CK}(\text{MIN})$ ; $I_{OUT} = 0\text{mA}$ ; Address and control inputs changing once per clock cycle	IDD1	185	160	135	mA	22, 48
PRECHARGE POWER-DOWN STANDBY CURRENT: All banks idle; Power-down mode; $t_{CK} = t_{CK}(\text{MIN})$ ; CKE=LOW;	Standard 'V' parts	10	10	10	mA	23, 32, 50
	Self Refresh 'R' parts	6	3	5	mA	23, 32, 50
PRECHARGE FLOATING STANDBY CURRENT: CS# = HIGH; All banks idle; $t_{CK} = t_{CK}(\text{MIN})$ ; CKE = HIGH; Address and other control inputs changing once per clock cycle. $V_{IN} = V_{REF}$ for DQ, DQS, and DM	IDD2F	55	50	50	mA	51
ACTIVE POWER-DOWN STANDBY CURRENT: One bank active; Power-down mode; $t_{CK} = t_{CK}(\text{MIN})$ ; CKE = LOW	IDD3P	45	35	25	mA	23, 32, 50
ACTIVE STANDBY CURRENT: CS# = HIGH; CKE = HIGH; One bank; Active-Precharge; $t_{RC} = t_{RAS}(\text{MAX})$ ; $t_{CK} = t_{CK}(\text{MIN})$ ; DQ, DM, and DQS inputs changing twice per clock cycle; Address and other control inputs changing once per clock cycle.	IDD3N	60	55	65	mA	22
OPERATING CURRENT: Burst = 2; Reads; Continuous burst; One bank active; Address and control inputs changing once per clock cycle; $t_{CK} = t_{CK}(\text{MIN})$ ; $I_{OUT} = 0\text{mA}$	IDD4R	190	170	155	mA	22, 48
OPERATING CURRENT: Burst = 2; Writes; Continuous burst; One bank active; Address and control inputs changing once per clock cycle; $t_{CK} = t_{CK}(\text{MIN})$ ; DQ, DM, and DQS inputs changing twice per clock cycle	IDD4W	190	155	130	mA	22
AUTO REFRESH CURRENT	$t_{RC} = t_{RFC}(\text{MIN})$	345	260	260	mA	22, 50
SELF REFRESH CURRENT (Part number 'R' only)		6	5	4	mA	11
OPERATING CURRENT: Four bank interleaving READs (BL = 4) with auto precharge, $t_{RC} = t_{RC}(\text{MIN})$ ; $t_{CK} = t_{RC}(\text{MIN})$ ; Address and control inputs change only during Active, READ, or WRITE commands.	IDD7	450	400	335	mA	22, 49

**CAPACITANCE (x16)**

(For test conditions, see note 53)

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTES
Delta Input/Output Capacitance: DQ0 – DQ7, LDQS, LDM	DCiOL	--	0.50	pF	24
Delta Input/Output Capacitance: DQ8-DQ15, UDQS, UDM	DCiOU	--	0.50	pF	24
Delta Input Capacitance: Command and Address	DCi1	--	0.50	pF	29
Delta Input Capacitance: CK, CK#	DCi2	--	0.25	pF	29
Input/Output Capacitance: DQs, LDQS, UDQS, LDM, UDM	CiO	4.0	5.0	pF	
Input Capacitance: Command and Address	Ci1	2.0	3.0	pF	
Input Capacitance: CK, CK#	Ci2	2.0	3.0	pF	
Input Capacitance: CKE	Ci3	2.0	3.0	pF	

**I<sub>DD</sub> SPECIFICATIONS AND CONDITIONS (x16)**

(For test conditions, see note 53)

PARAMETER/CONDITION	SYMBOL	-5B	-6A	-75	UNITS	NOTES	
OPERATING CURRENT: One bank; Active-Precharge; 'RC = 'RC (MIN); 'CK = 'CK (MIN); DQ, DM, and DQS inputs changing once per clock cycle; Address and control inputs changing once every two clock cycles;	IDD0	155	135	120	mA	22, 48	
OPERATING CURRENT: One bank; Active-Read-Precharge; Burst = 2; 'RC = 'RC (MIN); 'CK = 'CK (MIN); IOUT = 0mA; Address and control inputs changing once per clock cycle	IDD1	185	160	145	mA	22, 48	
PRECHARGE POWER-DOWN STANDBY CURRENT: All banks idle; Power-down mode; 'CK = 'CK(MIN); CKE=LOW;	Standard 'V' parts	IDD2P	10	10	10	mA	23, 32, 50
	Self Refresh 'R' parts	IDD2P	6	3	5	mA	23, 32, 50
PRECHARGE FLOATING STANDBY CURRENT: CS# = HIGH; All banks idle; 'CK = 'CK (MIN); CKE = HIGH; Address and other control inputs changing once per clock cycle. VIN = VREF for DQ, DQS, and DM	IDD2F	55	55	55	mA	51	
ACTIVE POWER-DOWN STANDBY CURRENT: One bank active; Power-down mode; 'CK = 'CK (MIN); CKE = LOW	IDD3P	45	35	25	mA	23, 32, 50	
ACTIVE STANDBY CURRENT: CS# = HIGH; CKE = HIGH; One bank; Active-Precharge; 'RC = 'RAS (MAX); 'CK = 'CK (MIN); DQ, DM, and DQS inputs changing twice per clock cycle; Address and other control inputs changing once per clock cycle.	IDD3N	60	65	65	mA	22	
OPERATING CURRENT: Burst = 2; Reads; Continuous burst; One bank active; Address and control inputs changing once per clock cycle; 'CK = 'CK (MIN); IOUT = 0Ma	IDD4R	210	190	180	mA	22, 48	
OPERATING CURRENT: Burst = 2; Writes; Continuous burst; One bank active; Address and control inputs changing once per clock cycle; 'CK = 'CK (MIN); DQ, DM, and DQS inputs changing twice per clock cycle	IDD4W	190	165	155	mA	22	
AUTO REFRESH CURRENT	'RC = tRFC (MIN)	IDD5	345	260	260	mA	22, 50
SELF REFRESH CURRENT (Part number 'R' only)		IDD6	6	5	4	mA	11
OPERATING CURRENT: Four bank interleaving READs (BL = 4) with auto precharge, 'RC = 'RC (MIN); 'CK = 'RC (MIN); Address and control inputs change only during Active, READ, or WRITE commands.	IDD7	405	400	335	mA	22, 49	

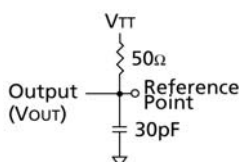
**ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS**

(For test conditions, see note 53)

AC CHARACTERISTICS			-5B		-6A		-75			
PARAMETER	SYMBOL	MIN	MIN	MAX	MAX	MIN	MAX	UNITS	NOTES	
Access window of DQs from CK/CK#	'AC	-0.70	+0.70	-0.70	+0.70	-0.75	+0.75	ns		
CK high-level width	'CH	0.45	0.55	0.45	0.55	0.45	0.55	'CK	30	
CK low-level width	'CL	0.45	0.55	0.45	0.55	0.45	0.55	'CK	30	
Clock cycle time	CL = 3	'CK	5.0	7.5				ns	52	
	CL = 2.5	'CK			6.0	13	7.5	13	ns	52
DQ and DM input hold time relative to DQS	'DH	0.40		0.45		0.5		ns	26, 31	
DQ and DM input setup time relative to DQS	'DS	0.40		0.45		0.5		ns	26, 31	
DQ and DM input pulse width (for each input)	'DIPW	1.75		1.75		1.75		ns	31	
Access window of DQS from CK/CK#	'DQSCK	-0.60	+0.60	-0.60	+0.60	-0.75	+0.75	ns		
DQS input high pulse width	'DQSH	0.35		0.35		0.35		'CK		
DQS input low pulse width	'DQSL	0.35		0.35		0.35		'CK		
DQS-DQ skew, DQS to last DQ valid, per group, per access	'DQSQ		0.40		0.45		0.5	ns	25, 26	
Write command to first DQS latching transition	'DQSS	0.72	1.28	0.75	1.25	0.75	1.25	'CK		
DQS falling edge to CK rising – setup time	'DSS	0.2		0.2		0.2		'CK		
DQS falling edge from CK rising – hold time	'DSH	0.2		0.2		0.2		'CK		
Half clock period	'HP	'CH, 'CL		'CH, 'CL		'CH, 'CL		ns	34	
Data-out high-impedance window from CK/CK#	'HZ		+0.70		+0.70		+0.75	ns	18	
Data-out low-impedance window from CK/CK#	'LZ	-0.70		-0.70		-0.75		ns	18	
Address and control input hold time (fast slew rate)	'IH <sub>f</sub>	0.6		0.75		.90		ns	14	
Address and control input setup time (fast slew rate)	'IS <sub>f</sub>	0.6		0.75		.90		ns	14	
Address and control input hold time (slow slew rate)	'IH <sub>s</sub>	0.7		0.80		1		ns	14	
Address and control input setup time (slow slew rate)	'IS <sub>s</sub>	0.7		0.80		1		ns	14	
LOAD MODE REGISTER command cycle time	'MRD	10		12		15		ns		
DQ-DQS hold, DQS to first DQ to go non-valid, per access	'QH	tHP – tQHS		tHP – tQHS		tHP – tQHS		ns	25, 26	
Data hold skew factor	'QHS		0.5		0.6		0.75	ns		
ACTIVE to READ with Auto precharge command	'RAP	NA		NA		NA		ns	46	
ACTIVE to PRECHARGE command	'RAS	40	16,000	42	16,000	45	16,000	ns	35	
ACTIVE to ACTIVE/AUTO REFRESH command period	'RC	55		60		65		ns		
AUTO REFRESH command period	'RFC	70		72		75		ns	50	
ACTIVE to READ or WRITE delay	'RCD	15		18		20		ns		
PRECHARGE command period	'RP	15		18		20		ns		
DQS read preamble	'RPRE	0.9	1.1	0.9	1.1	0.9	1.1	'CK	42	
DQS read postamble	'RPST	0.4	0.6	0.4	0.6	0.4	0.6	'CK		
ACTIVE bank a to ACTIVE bank b command	'RRD	10		12		15		ns		
DQS write preamble	'WPRE	0.25		0.25		0.25		'CK		
DQS write preamble setup time	'WPRES	0		0		0		ns	20, 21	
DQS write postamble	'WPST	0.4	0.6	0.4	0.6	0.4	0.6	'CK	19	
Write recovery time	'WR	15		15		15		ns		
Internal WRITE to READ command delay	'WTR	2		1		1		'CK		
Data valid output window	na	tQH - tDQSQ		tQH - tDQSQ		tQH - tDQSQ		ns	25	
REFRESH to REFRESH command interval	'REFC		70.3		70.3		70.3	μs	23	
Average periodic refresh interval	'REFI		7.8		7.8		7.8	μs	23	
Terminating voltage delay to V <sub>dd</sub>	'VTD	0		0		0		ns		
Exit SELF REFRESH to non-READ command (Part number R only)	'XSNR	75		75		75		ns		
Exit SELF REFRESH to READ command (Part number R only)	'XSRD	200		200		200		'CK		

## NOTES

1. All voltages referenced to VSS.
2. Tests for AC timing, IDD, and electrical AC and DC characteristics may be conducted at nominal reference/supply voltage levels, but the related specifications and device operations are guaranteed for the full voltage range specified.
3. Outputs measured with equivalent load: properly initialized, and is averaged at the defined cycle rate.
4. AC timing and IDD tests may use a VIL- to-VIH swing

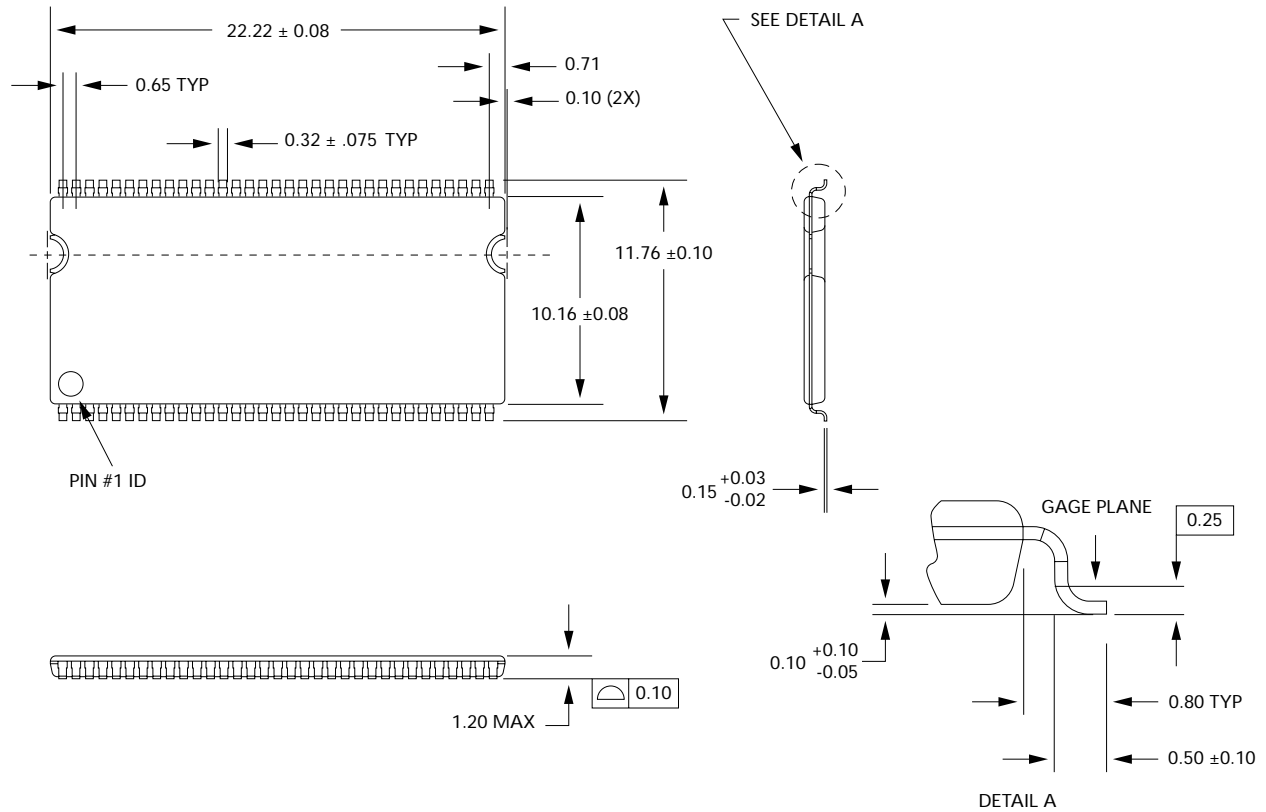


of up to 1.5V in the test environment, but input timing is still referenced to VREF (or to the crossing point for CK/CK#), and parameter specifications are guaranteed for the specified AC input levels under normal use conditions. The minimum slew rate for the input signals used to test the device is 1V/ns in the range between VIL(AC) and VIH(AC).

5. The AC and DC input level specifications areas defined in the SSTL\_2 Standard (i.e., the receiver will effectively switch as a result of the signal crossing the AC input level, and will remain in that state as long as the signal does not ring back above [below] the DC input LOW [HIGH] level).
6. VREF is expected to equal VDDQ/2 of the transmitting device and to track variations in the DC level of the same. Peak-to-peak noise (non-common mode) on VREF may not exceed  $\pm 2$  percent of the DC value. Thus, from VDDQ/2, VREF is allowed  $\pm 25$ mV for DC error and an additional  $\pm 25$ mV for AC noise.
7. VTT is not applied directly to the device. VTT is a system supply for signal termination resistors, is expected to be set equal to VREF and must track variations in the DC level of VREF.
8. VID is the magnitude of the difference between the input level on CK and the input level on CK#.
9. The value of VIX is expected to equal VDDQ/2 of the transmitting device and must track variations in the DC level of the same.
10. IDD is dependent on output loading and cycle rates. Specified values are obtained with minimum cycle time at CL = 2.5 for -65A and -75A (CL=3 for -5B) with the outputs open.
11. Enables on-chip refresh and address counters.
12. IDD specifications are tested after the device is properly initialized, and is averaged at the defined cycle rate.
13. This parameter is sampled. VDD = +2.5V  $\pm 0.2$ V, VDDQ = +2.5V  $\pm 0.2$ V, VREF = VSS, f = 100 MHz, TA = 25°C, VOUT(DC) = VDDQ/2, VOUT (peak to peak) = 0.2V. DM input is grouped with I/O pins, reflecting the fact that they are matched in loading.
14. Command/Address input slew rate = 0.5V/ns. For slew rates of 1V/ns and faster, tIS and tIH are reduced to 900ps. If the slew rate is less than 0.5V/ns, timing must be derated: tIS have an additional 50ps per each 100mV/ns reduction in slew rate from the 500mV/ns. tIH has 0ps added, that is, it remains constant. If the slew rate exceeds 4.5V/ns, functionality is uncertain.
15. The CK/CK# input reference level (for timing referenced to CK/CK#) is the point at which CK and CK# cross; the input reference level for signals other than CK/CK# is VREF.
16. Inputs are not recognized as valid until VREF stabilizes. Exception: during the period before VREF stabilizes,  $CKE \leq 0.3 \times VDDQ$  is recognized as LOW.
17. The output timing reference level, as measured at the timing reference point indicated in Note 3, is VTT.
18. tHZ and tLZ transitions occur in the same access time windows as valid data transitions. These parameters are not referenced to a specific voltage level, but specify when the device output is no longer driving (HZ) or begins driving (LZ).
19. The maximum limit for this parameter is not a device limit. The device will operate with a greater value for this parameter, but system performance (bus turnaround) will degrade accordingly.
20. This is not a device limit. The device will operate with a negative value, but system performance could be degraded due to bus turnaround.
21. It is recommended that DQS be valid (HIGH or LOW) on or before the WRITE command. The case shown (DQS going from High-Z to logic LOW) applies when no WRITES were previously in progress on the bus. If a previous WRITE was in progress, DQS could be HIGH during this time, depending on tDQSS.
22. MIN ( tRC or tRFC) for IDD measurements is the smallest multiple of tCK that meets the minimum absolute value for the respective parameter. tRAS (MAX) for IDD measurements is the largest multiple of tCK that meets the maximum absolute value for tRAS.
23. The refresh period 64ms. This equates to an average refresh rate of 7.8125 $\mu$ s. However, an AUTO REFRESH command must be asserted at least once every 70.3 $\mu$ s; burst refreshing or posting by the DRAM controller greater than eight refresh cycles is not allowed.
24. The I/O capacitance per DQS and DQ byte/group will not differ by more than this maximum amount for any given device.

25. The valid data window is derived by achieving other specifications -  $t_{HP}$  ( $t_{CK}/2$ ),  $t_{DQSQ}$ , and  $t_{QH}$  ( $t_{QH} = t_{HP} - t_{QHS}$ ). The data valid window derates directly proportional with the clock duty cycle and a practical data valid window can be derived. The clock is allowed a maximum duty cycle variation of 45/55. Functionality is uncertain when operating beyond a 45/55 ratio. The data valid window derating curves are provided below for duty cycles ranging between 50/50 and 45/55.
26. Referenced to each output group: x4 = DQS with DQ0-DQ3; x8 = DQS with DQ0-DQ7; x16 = LDQS with DQ0-DQ7 and UDQS with DQ8-DQ15.
27. This limit is actually a nominal value and does not result in a fail value.  $\overline{CKE}$  is HIGH during REFRESH command period ( $t_{RFC} [MIN]$ ) else  $\overline{CKE}$  is LOW (i.e., during standby).
28. To maintain a valid level, the transitioning edge of the input must:
  - a) Sustain a constant slew rate from the Current AC level through to the target AC level,  $V_{IL}(AC)$   $V_{IH}(AC)$ .
  - b) Reach at least the target AC level.
  - c) After the AC target level is reached, continue to maintain at least the target DC level,  $V_{IL}(DC)$  or  $V_{IH}(DC)$ .
29. The Input capacitance per pin group will not differ by more than this maximum amount for any given device.
30.  $\overline{CK}$  and  $\overline{CK\#}$  input slew rate must be  $\geq 1V/ns$ .
31.  $\overline{DQ}$  and  $\overline{DM}$  input slew rates must not deviate from  $\overline{DQS}$  by more than 10%. If the  $\overline{DQ}/\overline{DM}/\overline{DQS}$  slew rate is less than 0.5V/ns, timing must be derated: 50ps must be added to  $t_{DS}$  and  $t_{DH}$  for each 100mv/ns reduction in slew rate. If slew rate exceeds 4V/ns, functionality is uncertain.
32.  $V_{DD}$  must not vary more than 4% if  $\overline{CKE}$  is not active while any bank is active.
33. The clock is allowed up to  $\pm 150ps$  of jitter. Each timing parameter is allowed to vary by the same amount.
34.  $t_{HP} min$  is the lesser of  $t_{CL}$  minimum and  $t_{CH}$  minimum actually applied to the device  $\overline{CK}$  and  $\overline{CK\#}$  inputs, collectively during bank active.
35. READs and WRITEs with auto precharge are not allowed to be issued until  $t_{RAS} (MIN)$  can be satisfied prior to the internal precharge command being issued.
36. Applies to x16 only. First  $\overline{DQS}$  ( $\overline{LDQS}$  or  $\overline{UDQS}$ ) to transition to last  $\overline{DQ}$  ( $\overline{DQ0-DQ15}$ ) to transition valid. Initial JEDEC specifications suggested this to be same as  $t_{DQSQ}$ .
37. Note 37 is not used.
38. Note 38 is not used.
39. Note 39 is not used.
40.  $V_{IH}$  overshoot:  $V_{IH}(MAX) = V_{DDQ} + 1.5V$  for a pulse width  $\leq 3ns$  and the pulse width can not be greater than 1/3 of the cycle rate.  $V_{IL}$  undershoot:  $V_{IL}(MIN) = -1.5V$  for a pulse width  $\leq 3ns$  and the pulse width can not be greater than 1/3 of the cycle rate.
41.  $V_{DD}$  and  $V_{DDQ}$  must track each other.
42. Note 42 is not used.
43. Note 43 is not used.
44. During initialization,  $V_{DDQ}$ ,  $V_{TT}$ , and  $V_{REF}$  must be equal to or less than  $V_{DD} + 0.3V$ . Alternatively,  $V_{TT}$  may be 1.35V maximum during power up, even if  $V_{DD}/V_{DDQ}$  are 0 volts, provided a minimum of 42 ohms of series resistance is used between the  $V_{TT}$  supply and the input pin.
45. Note 45 is not used.
46.  $t_{RAP} \geq t_{RCD}$ .
47. Note 47 is not used.
48. Random addressing changing 50% of data changing at every transfer.
49. Random addressing changing 100% of data changing at every transfer.
50.  $\overline{CKE}$  must be active (high) during the entire time a refresh command is executed. That is, from the time the AUTO REFRESH command is registered,  $\overline{CKE}$  must be active at each rising clock edge, until  $\overline{REF}$  later.
51.  $IDD2N$  specifies the  $\overline{DQ}$ ,  $\overline{DQS}$ , and  $\overline{DM}$  to be driven to a valid high or low logic level.  $IDD2Q$  is similar to  $IDD2F$  except  $IDD2Q$  specifies the address and control inputs to remain stable. Although  $IDD2F$ ,  $IDD2N$ , and  $IDD2Q$  are similar,  $IDD2F$  is "worst case."
52. Whenever the operating frequency is altered, not including jitter, the DLL is required to be reset. This is followed by 200 clock cycles.
53. For -6A & -75A;  
 $10^{\circ}C < T_A < +70^{\circ}C$ ;  $V_{DD}/V_{DDQ} = +2.5V \pm 0.2V$ .  
 For -5B;  
 $10^{\circ}C < T_A < +70^{\circ}C$ ;  $V_{DD}/V_{DDQ} = +2.6V \pm 0.1V$ .

### 66-Pin Plastic TSOP (400mil)



- NOTE:**
1. All dimensions in millimeters  $\frac{\text{MAX}}{\text{MIN}}$  or typical here noted.
  2. Package width and length do not include mold protrusion; allowable mold protrusion is 0.25mm per side.

### Ball Assignment (Top View) 60-Ball FBGA

x4 (Top View)

1	2	3	4	5	6	7	8	9
VssQ	NF	Vss	● A ●	VDD	NF	VDDQ		
NC	VDDQ	DQ3	● B ●	DQ0	VssQ	NC		
NC	VssQ	NF	● C ●	NF	VDDQ	NC		
NC	VDDQ	DQ2	● D ●	DQ1	VssQ	NC		
NC	VssQ	DQS	● E ●	NC	VDDQ	NC		
VREF	Vss	DM	● F ●	NC	VDD	DNU		
	CK	CK#	● G ●	WE#	CAS#			
	A12	CKE	● H ●	RAS#	CS#			
	A11	A9	● J ●	BA1	BA0			
	A8	A7	● K ●	A0	A10			
	A6	A5	● L ●	A2	A1			
	A4	Vss	● M ●	VDD	A3			

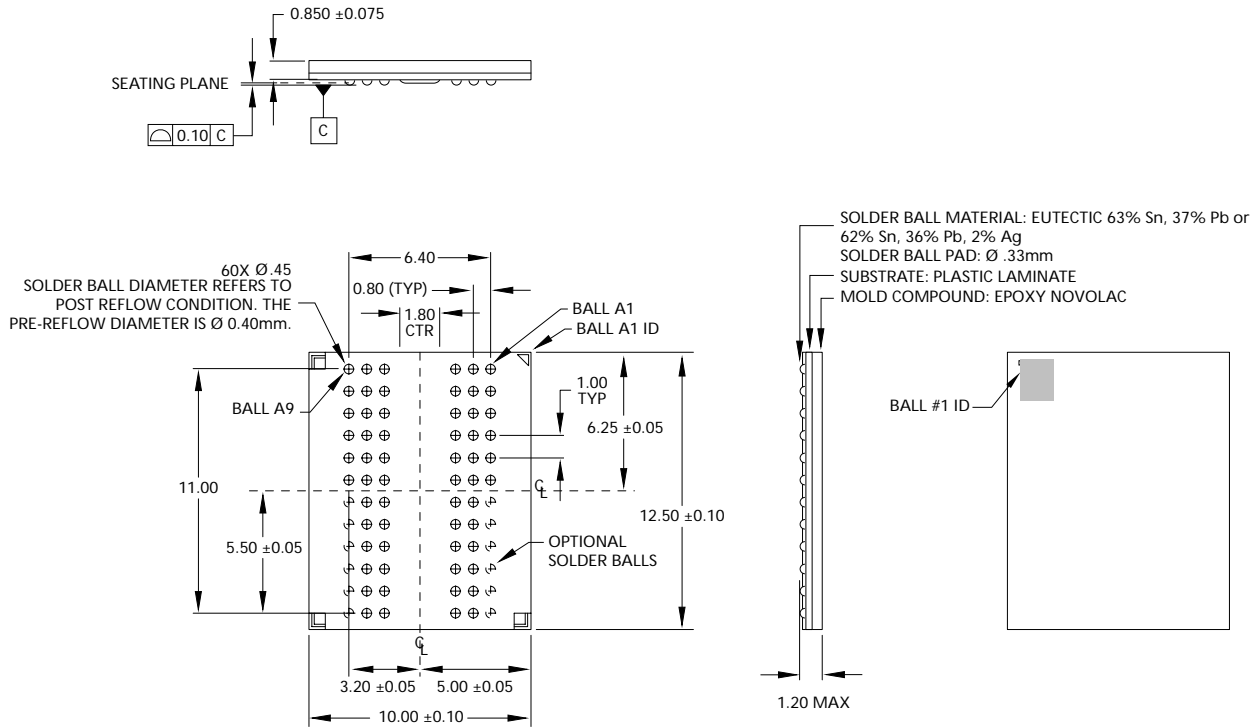
x8 (Top View)

1	2	3	4	5	6	7	8	9
VssQ	DQ7	Vss	● A ●	VDD	DQ0	VDDQ		
NC	VDDQ	DQ6	● B ●	DQ1	VssQ	NC		
NC	VssQ	DQ5	● C ●	DQ2	VDDQ	NC		
NC	VDDQ	DQ4	● D ●	DQ3	VssQ	NC		
NC	VssQ	DQS	● E ●	NC	VDDQ	NC		
VREF	Vss	DM	● F ●	NC	VDD	DNU		
	CK	CK#	● G ●	WE#	CAS#			
	A12	CKE	● H ●	RAS#	CS#			
	A11	A9	● J ●	BA1	BA0			
	A8	A7	● K ●	A0	A10			
	A6	A5	● L ●	A2	A1			
	A4	Vss	● M ●	VDD	A3			

x16 (Top View)

1	2	3	4	5	6	7	8	9
VssQ	DQ15	Vss	● A ●	VDD	DQ0	VDDQ		
DQ14	VDDQ	DQ13	● B ●	DQ2	VssQ	DQ1		
DQ12	VssQ	DQ11	● C ●	DQ4	VDDQ	DQ3		
DQ10	VDDQ	DQ9	● D ●	DQ6	VssQ	DQ5		
DQ8	VssQ	UDQS	● E ●	LDQS	VDDQ	DQ7		
VREF	Vss	UDM	● F ●	LDM	VDD	DNU		
	CK	CK#	● G ●	WE#	CAS#			
	A12	CKE	● H ●	RAS#	CS#			
	A11	A9	● J ●	BA1	BA0			
	A8	A7	● K ●	A0	A10			
	A6	A5	● L ●	A2	A1			
	A4	Vss	● M ●	VDD	A3			

### 60-Ball FBGA (10mm x 12.5mm)



NOTE:  
All dimensions in millimeters.

**PART NUMBERS FOR PRODUCT PRIOR TO DECEMBER 2004**

**OPTIONS**

**MARKING**

- Configuration
 

128 Meg x 4 (32 Meg x 4 x 4 banks)	S40128
64 Meg x 8 (16 Meg x 8 x 4 banks)	S80064
32 Meg x 16 (8 Meg x 16 x 4 banks)	S160032
  
- Voltage and refresh
 

2.5V, Auto Refresh	VM
2.5V, Self or Auto Refresh	RM
  
- Parent Device Configuration
 

128 Meg x 4	K
64 Meg x 8	J
32 Meg x 16	L
  
- Package
 

66-pin Plastic TSOP, OCPL (400 mil width, 0.65mm pin pitch)	TW
60-ball (10mm x 12.5mm) FBGA	FN
  
- Timing – Cycle Time
 

5ns @ CL=3 (PC3200 or DDR400B)	-5B
6ns @ CL = 2.5 (PC2700 or DDR333)	-6A
7.5ns @ CL = 2.5 (PC2100 or DDR266)	-75A

(Example part number: S80064VMJTW-6A )

[http://www.spectek.com/menus/part\\_guides.asp](http://www.spectek.com/menus/part_guides.asp)

