

# 2GB DDR2 – SDRAM registered DIMM

240 Pin RDIMM

SEP02G72E2BF2SA-30R

2GB PC2-5300 in FBGA Technology

RoHS compliant

Options:

- Data Rate / Latency Marking  
 DDR2 533 MTs / CL4 -37  
 DDR2 667 MT/s / CL5 -30
  
- Module Density  
 2048MB with 18 dies and 2 ranks
  
- Standard Grade  $(T_A)$  0°C to 70°C  
 $(T_C)$  0°C to 85°C

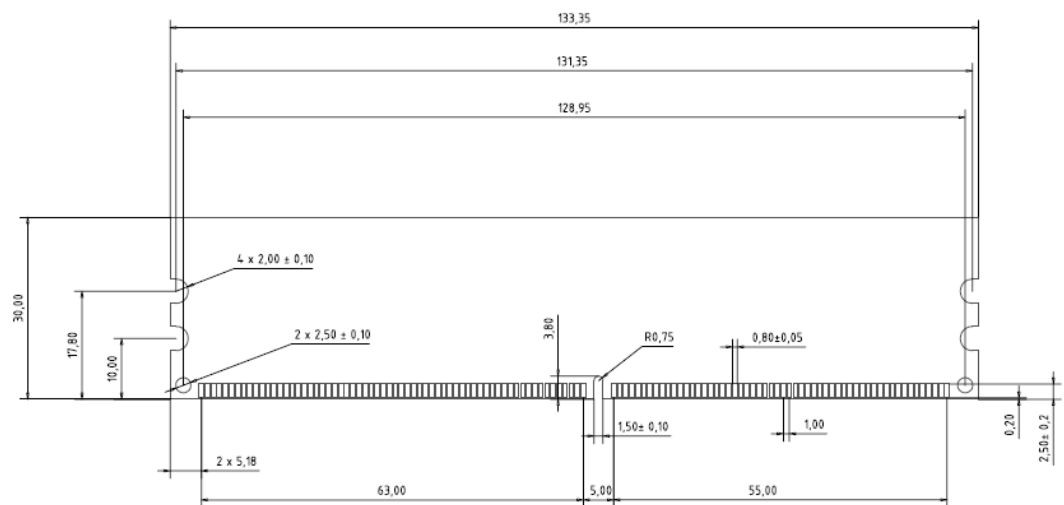
Environmental Requirements:

- Operating temperature ( $T_{AMBIENT}$ )  
 Standard Grade 0°C to 70°C
- Operating Humidity  
 10% to 90% relative humidity, noncondensing
- Operating Pressure  
 105 to 69 kPa (up to 10000 ft.)
- Storage Temperature  
 -55°C to 100°C
- Storage Humidity  
 5% to 95% relative humidity, noncondensing
- Storage Pressure  
 1682 PSI (up to 5000 ft.) at 50°C

Features:

- 240-pin 72-bit DDR2 registered Dual-In-Line Double Data Rate Synchronous DRAM Module for server applications
- Module organization: dual rank 256M x 72
- $V_{DD} = 1.8V \pm 0.1V$ ,  $V_{DDQ} = 1.8V \pm 0.1V$
- 1.8V I/O ( SSTL\_18 compatible)
- Serial Presence Detect with EEPROM
- Supports ECC error detection and correction
- JEDEC compatible DDR2 PLL/Register component with parity bit support for address and control bus
- Gold-contact pad
- This module family is fully pin and functional compatible to JEDEC. (see [www.jedec.org](http://www.jedec.org))
- The pcb and all components are manufactured according to the RoHS compliance specification [EU Directive 2002/95/EC Restriction of Hazardous Substances (RoHS)]
  
- **DDR2 SDRAM component Samsung K4T1G084QF**
- 128Mx8 DDR2 SDRAM in FBGA-60 package
- Four bit prefetch architecture
- Programmable CAS latency (CL)
- Posted CAS additive latency (AL)
- WRITE latency = READ latency – 1  $t_{CK}$
- Programmable burst length: 4 or 8
- Adjustable data-output drive strength
- On-die termination (ODT)
- DLL to align DQ and DQS transitions with CK

Figure: mechanical dimensions<sup>1</sup>



<sup>1</sup>if no tolerances specified ± 0.15mm

This Swissbit module is an industry standard 240-pin 8-byte DDR2 registered SDRAM Dual-In-line Memory Module (RDIMM) which is organized as x72 high speed CMOS memory arrays. All control and address signals are re-driven on the DIMM using register devices and a PLL for the clock distribution. This reduces capacitive loading to the system bus, but adds one cycle to the SDRAM timing. De-coupling capacitors, stub resistors, calibration resistors and termination resistors are mounted on the PCB board. The module uses double data rate architecture to achieve high-speed operation. DDR2 SDRAM modules operate from a differential clock (CK and CK#). READ and WRITE accesses to a DDR2 SDRAM module is burst-oriented; accesses start at a selected location and continue for a programmed number of locations in a programmed sequence. The burst length is either four or eight locations. An auto precharge function can be enabled to provide a self-timed row precharge that is initiated at the end of a burst access. The DDR2 SDRAM devices have a multibank architecture which allows a concurrent operation that is providing a high effective bandwidth. A self refresh mode is provided and a power-saving "power-down" mode. All inputs and all full drive-strength outputs are SSTL\_18 compatible.

The DDR2 SDRAM module uses the serial presence detect (SPD) function implemented via serial EEPROM using the standard I<sup>2</sup>C protocol. This nonvolatile storage device contains 256 bytes. The first 128 bytes are utilized by the DIMM manufacturer (Swissbit) to identify the module type, the module's organization and several timing parameters. The second 128 bytes are available to the end user.

### Module Configuration

Organization	DDR2 SDRAMs used	Row Addr.	Device Bank Select	Column Addr.	Refresh	Module Bank Select
256M x 72bit	18 x 128M x 8bit (1024Mbit)	14	BA0, BA1, BA2	10	8k	S0#, S1#

### Module Dimensions

in mm

133.33 (long) x 30(high) x 4 [max] (thickness)

### Timing Parameters

Part Number	Module Density	Transfer Rate	Clock Cycle/Data bit rate	Latency
SEP02G72E2BF2SA-37R	2048 MB	4.2 GB/s	3.7ns/533MT/s	4-4-4
SEP02G72E2BF2SA-30R	2048 MB	5.3 GB/s	3.0ns/667MT/s	5-5-5

### Pin Name

A0 – A13	Address Inputs
BA0 – BA2	Bank Address Inputs
DQ0 – DQ63	Data Input / Output
CB0 – CB7	Data check bits Input / Output
DM0 – DM8	Input Data Mask
DQS0 – DQS8	Data Strobe, positive line
DQS0# - DQS8#	Data Strobe, negative line (only used when differential data strobe mode is enabled)
RAS#	Row Address Strobe
CAS#	Column Address Strobe
WE#	Write Enable
CKE0 – CKE1	Clock Enable
CK0 – CK1	Clock Input, positive line
CK0# - CK1#	Clock Input, negative line
S0#, S1#	Chip Select
Reset#	Asynchronously forces all registered outputs LOW when RESET# is LOW. This signal can be used during power-up to ensure that CKE is LOW and DQs are High-Z.

PAR_IN	Parity bit for the address and control bus.
ERR_OUT	Parity error found on the address and control bus.
V <sub>DD</sub> / V <sub>DDQ</sub>	Supply Voltage (1.8V± 0.1V)
V <sub>REF</sub>	Input / Output Reference
V <sub>SS</sub>	Ground
V <sub>DDSPD</sub>	Serial EEPROM Positive Power Supply
SCL	Serial Clock for Presence Detect
SDA	Serial Data Out for Presence Detect
SA0 – SA2	Presence Detect Address Inputs
ODT0, ODT1	On-Die Termination
NC	No Connection

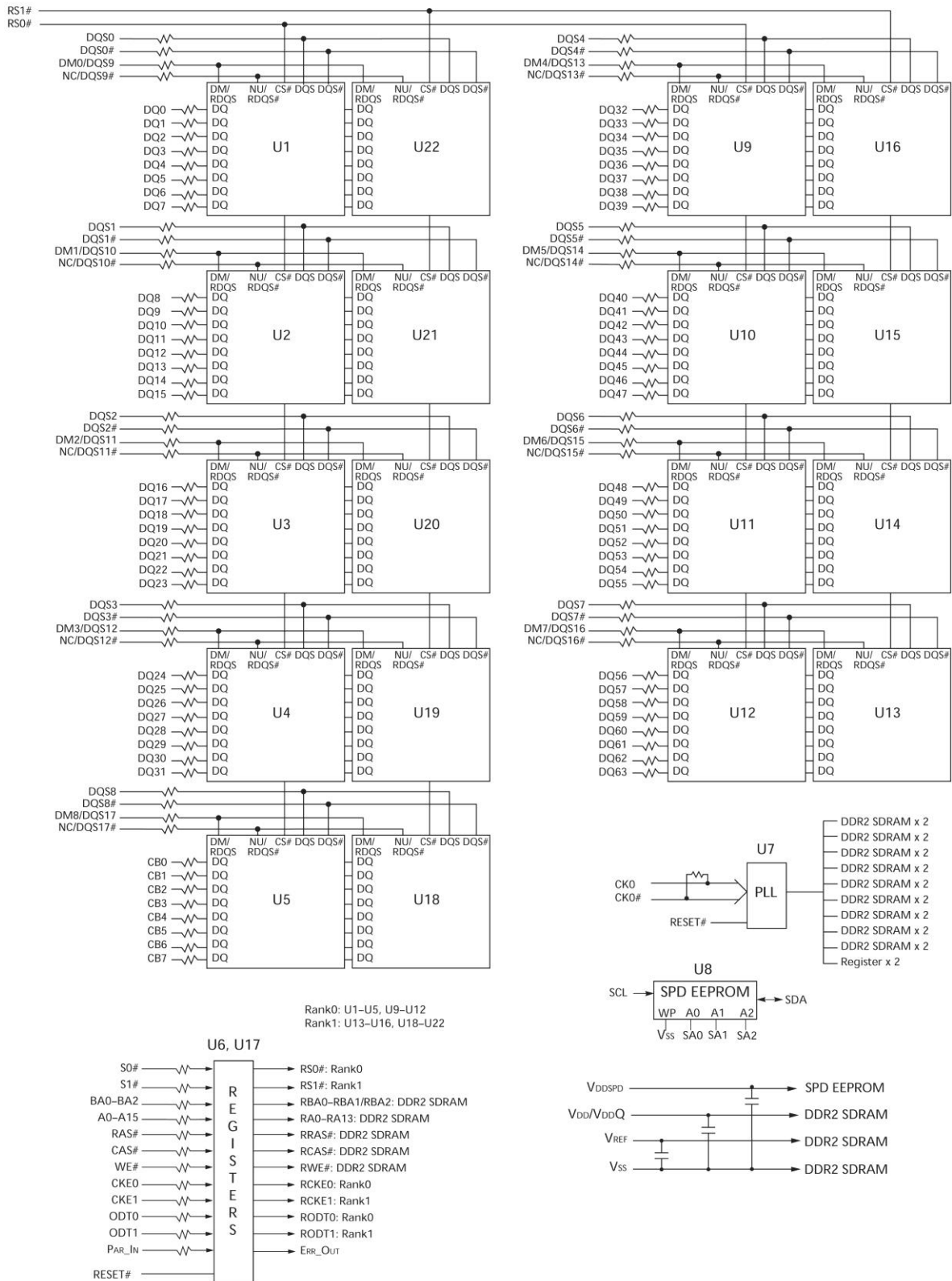
**Pin Configuration**

PIN #	Front Side	PIN #	Back Side	PIN #	Front Side	PIN #	Back Side
1	V <sub>REF</sub>	121	V <sub>SS</sub>	61	A4	181	V <sub>DDQ</sub>
2	V <sub>SS</sub>	122	DQ4	62	V <sub>DDQ</sub>	182	A3
3	DQ0	123	DQ5	63	A2	183	A1
4	DQ1	124	V <sub>SS</sub>	64	V <sub>DD</sub>	184	V <sub>DD</sub>
5	V <sub>SS</sub>	125	DM0 (DQS9)	65	V <sub>SS</sub>	185	CK0
6	DQS0#	126	NC (DQS9#)	66	V <sub>SS</sub>	186	CK0#
7	DQS0	127	V <sub>SS</sub>	67	V <sub>DD</sub>	187	V <sub>DD</sub>
8	V <sub>SS</sub>	128	DQ6	68	Par_In	188	A0
9	DQ2	129	DQ7	69	V <sub>DD</sub>	189	V <sub>DD</sub>
10	DQ3	130	V <sub>SS</sub>	70	A10/AP	190	BA1
11	V <sub>SS</sub>	131	DQ12	71	BA0	191	V <sub>DDQ</sub>
12	DQ8	132	DQ13	72	V <sub>DDQ</sub>	192	RAS#
13	DQ9	133	V <sub>SS</sub>	73	WE#	193	S0#
14	V <sub>SS</sub>	134	DM1 (DQS10)	74	CAS#	194	V <sub>DDQ</sub>
15	DQS1#	135	NC (DQS10#)	75	V <sub>DDQ</sub>	195	ODT0
16	DQS1	136	V <sub>SS</sub>	76	NC (S1#)	196	A13
17	V <sub>SS</sub>	137	NC (CK1)	77	NC (ODT1)	197	V <sub>DD</sub>
18	RESET	138	NC (CK1#)	78	V <sub>DDQ</sub>	198	V <sub>SS</sub>
19	NC	139	V <sub>SS</sub>	79	V <sub>SS</sub>	199	DQ36
20	V <sub>SS</sub>	140	DQ14	80	DQ32	200	DQ37
21	DQ10	141	DQ15	81	DQ33	201	V <sub>SS</sub>
22	DQ11	142	V <sub>SS</sub>	82	V <sub>SS</sub>	202	DM4 (DQS13)
23	V <sub>SS</sub>	143	DQ20	83	DQS4#	203	NC (DQS13#)
24	DQ16	144	DQ21	84	DQS4	204	V <sub>SS</sub>
25	DQ17	145	V <sub>SS</sub>	85	V <sub>SS</sub>	205	DQ38
26	V <sub>SS</sub>	146	DM2 (DQS11)	86	DQ34	206	DQ39
27	DQS2#	147	NC (DQS11#)	87	DQ35	207	V <sub>SS</sub>
28	DQS2	148	V <sub>SS</sub>	88	V <sub>SS</sub>	208	DQ44
29	V <sub>SS</sub>	149	DQ22	89	DQ40	209	DQ45
30	DQ18	150	DQ23	90	DQ41	210	V <sub>SS</sub>
31	DQ19	151	V <sub>SS</sub>	91	V <sub>SS</sub>	211	DM5 (DQS14)

PIN #	Front Side	PIN #	Back Side	PIN #	Front Side	PIN #	Back Side
32	V <sub>SS</sub>	152	DQ28	92	DQS5#	212	NC (DQS14#)
33	DQ24	153	DQ29	93	DQS5	213	V <sub>SS</sub>
34	DQ25	154	V <sub>SS</sub>	94	V <sub>SS</sub>	214	DQ46
35	V <sub>SS</sub>	155	DM3 (DQS12)	95	DQ42	215	DQ47
36	DQS3#	156	NC (DQS12#)	96	DQ43	216	V <sub>SS</sub>
37	DQS3	157	V <sub>SS</sub>	97	V <sub>SS</sub>	217	DQ52
38	V <sub>SS</sub>	158	DQ30	98	DQ48	218	DQ53
39	DQ26	159	DQ31	99	DQ49	219	V <sub>SS</sub>
40	DQ27	160	V <sub>SS</sub>	100	V <sub>SS</sub>	220	NC (CK2)
41	V <sub>SS</sub>	161	CB4	101	SA2	221	NC (CK2#)
42	CB0	162	CB5	102	NC (TEST)	222	V <sub>SS</sub>
43	CB1	163	V <sub>SS</sub>	103	V <sub>SS</sub>	223	DM6 (DQS15)
44	V <sub>SS</sub>	164	DM8 (DQS17)	104	DQS6#	224	NC (DQS15#)
45	DQS8#	165	NC (DQS17#)	105	DQS6	225	V <sub>SS</sub>
46	DQS8	166	V <sub>SS</sub>	106	V <sub>SS</sub>	226	DQ54
47	V <sub>SS</sub>	167	CB6	107	DQ50	227	DQ55
48	CB2	168	CB7	108	DQ51	228	V <sub>SS</sub>
49	CB3	169	V <sub>SS</sub>	109	V <sub>SS</sub>	229	DQ60
50	V <sub>SS</sub>	170	V <sub>DDQ</sub>	110	DQ56	230	DQ61
51	V <sub>DD</sub>	171	NC (CKE1)	111	DQ57	231	V <sub>SS</sub>
52	CKE0	172	V <sub>DD</sub>	112	V <sub>SS</sub>	232	DM7 (DQS16)
53	V <sub>DD</sub>	173	NC (A15)	113	DQS7#	233	NC (DQS16#)
54	BA2	174	NC (A14)	114	DQS7	234	V <sub>SS</sub>
55	Par_Out	175	V <sub>DDQ</sub>	115	V <sub>SS</sub>	235	DQ62
56	V <sub>DDQ</sub>	176	A12	116	DQ58	236	DQ63
57	A11	177	A9	117	DQ59	237	V <sub>SS</sub>
58	A7	178	V <sub>DD</sub>	118	V <sub>SS</sub>	238	V <sub>DDSPD</sub>
59	V <sub>DD</sub>	179	A8	119	SDA	239	SA0
60	A5	180	A6	120	SCL	240	SA1

(Sig): Signal in brackets may be routed to the socket connector, but is not used on the module

**FUNCTIONAL BLOCK DIAGRAM 2048MB DDR2 ECC Registered DIMM,  
2 RANKS AND 18 COMPONENTS**



**MAXIMUM ELECTRICAL DC CHARACTERISTICS**

PARAMETER/ CONDITION	SYMBOL	MIN	MAX	UNITS
Supply Voltage	$V_{DD}$	-1.0	2.3	V
I/O Supply Voltage	$V_{DDQ}$	-0.5	2.3	V
$V_{DDL}$ Supply Voltage	$V_{DDL}$	-0.5	2.3	V
Voltage on any pin relative to $V_{SS}$	$V_{in}, V_{out}$	-0.5	2.3	V
<b>INPUT LEAKAGE CURRENT</b> Any input $0V \leq V_{IN} \leq V_{DD}$ , $V_{REF}$ pin $0V \leq V_{IN} \leq 0.95V$ (All other pins not under test = 0V)	$I_I$			$\mu A$
Command/Address RAS#, CAS#, WE#, S#, CKE		-40	40	
CK, CK#		-20	20	
DM		-5	5	
<b>OUTPUT LEAKAGE CURRENT</b> (DQ's and ODT are disabled; $0V \leq V_{OUT} \leq V_{DDQ}$ )	$I_{OZ}$	-5	5	$\mu A$
DQ, DQS, DQS#				
$V_{REF}$ LEAKAGE CURRENT ; $V_{REF}$ is on a valid level	$I_{VREF}$	-16	16	$\mu A$

**DC OPERATING CONDITIONS**

PARAMETER/ CONDITION	SYMBOL	MIN	NOM	MAX	UNITS
Supply Voltage	$V_{DD}$	1.7	1.8	1.9	V
I/O Supply Voltage	$V_{DDQ}$	1.7	1.8	1.9	V
$V_{DDL}$ Supply Voltage	$V_{DDL}$	1.7	1.8	1.9	V
I/O Reference Voltage	$V_{REF}$	$0.49 \times V_{DDQ}$	$0.50 \times V_{DDQ}$	$0.51 \times V_{DDQ}$	V
I/O Termination Voltage (system)	$V_{TT}$	$V_{REF} - 0.04$	$V_{REF}$	$V_{REF} + 0.04$	V
Input High (Logic 1) Voltage	$V_{IH(DC)}$	$V_{REF} + 0.125$		$V_{DDQ} + 0.3$	V
Input Low (Logic 0) Voltage	$V_{IL(DC)}$	-0.3		$V_{REF} - 0.125$	V

**AC INPUT OPERATING CONDITIONS**

PARAMETER/ CONDITION	SYMBOL	MIN	MAX	UNITS
Input High (Logic 1) Voltage	$V_{IH(AC)}$	$V_{REF} + 0.25$	-	V
Input Low (Logic 0) Voltage	$V_{IL(AC)}$	-	$V_{REF} - 0.25$	V

**CAPACITANCE**

At DDR2 data rates, it is recommended to simulate the performance of the module to achieve optimum values. When inductance and delay parameters associated with trace lengths are used in simulations, they are significantly more accurate and realistic than a gross estimation of module capacitance. Simulations can then render a considerably more accurate result. JEDEC modules are now designed by using simulations to close timing budgets.

**I<sub>DD</sub> Specifications and Conditions**

(0°C ≤ T<sub>CASE</sub> ≤ + 85°C; V<sub>DDQ</sub> = +1.8V ± 0.1V, V<sub>DD</sub> = +1.8V ± 0.1V)

Parameter & Test Condition	Symbol	max.		Unit	
		5300-555	4200-444		
<b>OPERATING CURRENT *) :</b> One device bank Active-Precharge; t <sub>RC</sub> = t <sub>RC</sub> (I <sub>DD</sub> ); t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; DQ inputs changing once per clock cycle; Address and control inputs changing once every two clock cycles	I <sub>DD0</sub>	495	450	mA	
<b>OPERATING CURRENT *) :</b> One device bank; Active-Read-Precharge; I <sub>OUT</sub> = 0mA; BL = 4, CL = CL (I <sub>DD</sub> ), AL = 0; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ), t <sub>RC</sub> = t <sub>RC</sub> (I <sub>DD</sub> ), t <sub>RAS</sub> = t <sub>RAS</sub> MIN (I <sub>DD</sub> ), t <sub>RCD</sub> = t <sub>RCD</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; Address inputs changing once every two clock cycles; Data Pattern is same as I <sub>DD4W</sub>	I <sub>DD1</sub>	549	522	mA	
<b>PRECHARGE POWER-DOWN CURRENT:</b> All device banks idle; Power-down mode; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); CKE is LOW; All Control and Address bus inputs are not changing; DQ's are floating at V <sub>REF</sub>	I <sub>DD2P</sub>	180	180	mA	
<b>PRECHARGE QUIET STANDBY CURRENT:</b> All device banks idle; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH; All Control and Address bus inputs are not changing; DQ's are floating at V <sub>REF</sub>	I <sub>DD2Q</sub>	360	360	mA	
<b>PRECHARGE STANDBY CURRENT:</b> All device banks idle; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH; All other Control and Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle	I <sub>DD2N</sub>	450	432	mA	
<b>ACTIVE POWER-DOWN CURRENT:</b> All device banks open; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); CKE is LOW; All Control and Address bus inputs are not changing; DQ's are floating at V <sub>REF</sub>	I <sub>DD3P</sub>	Fast PDN Exit MR[12] = 0	414	396	mA
		Slow PDN Exit MR[12] = 1	270	270	
<b>ACTIVE STANDBY CURRENT:</b> All device banks open; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ), t <sub>RAS</sub> = t <sub>RAS</sub> MAX (I <sub>DD</sub> ), t <sub>RP</sub> = t <sub>RP</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; All other Control and Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle	I <sub>DD3N</sub>	576	540	mA	
<b>OPERATING READ CURRENT:</b> All device banks open, Continuous burst reads; One module rank active; I <sub>OUT</sub> = 0mA; BL = 4, CL = CL (I <sub>DD</sub> ), AL = 0; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ), t <sub>RAS</sub> = t <sub>RAS</sub> MAX (I <sub>DD</sub> ), t <sub>RP</sub> = t <sub>RP</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle	I <sub>DD4R</sub>	810	720	mA	



Parameter & Test Condition	Symbol	max.		Unit
		5300-555	4200-444	
<b>OPERATING WRITE CURRENT:</b> All device banks open, Continuous burst writes; One module rank active; BL = 4, CL = CL (I <sub>DD</sub> ), AL = 0; t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ), t <sub>RAS</sub> = t <sub>RAS</sub> MAX (I <sub>DD</sub> ), t <sub>RP</sub> = t <sub>RP</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle	I <sub>DD4W</sub>	693	630	mA
<b>BURST REFRESH CURRENT:</b> t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ); refresh command at every t <sub>RFC</sub> (I <sub>DD</sub> ) interval, CKE is HIGH, CS# is HIGH between valid commands; All other Control and Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle	I <sub>DD5</sub>	1890	1800	mA
<b>SELF REFRESH CURRENT:</b> CK and CK# at 0V; CKE ≤ 0.2V; All other Control and Address bus inputs are floating at V <sub>REF</sub> ; DQ's are floating at V <sub>REF</sub>	I <sub>DD6</sub>	180	180	mA
<b>OPERATING CURRENT*):</b> Four device bank interleaving READs, I <sub>OUT</sub> = 0mA; BL = 4, CL = CL (I <sub>DD</sub> ), AL = t <sub>RCD</sub> (I <sub>DD</sub> ) - 1 x t <sub>CK</sub> (I <sub>DD</sub> ); t <sub>CK</sub> = t <sub>CK</sub> (I <sub>DD</sub> ), t <sub>RC</sub> = t <sub>RC</sub> (I <sub>DD</sub> ), t <sub>RRD</sub> = t <sub>RRD</sub> (I <sub>DD</sub> ), t <sub>RCD</sub> = t <sub>RCD</sub> (I <sub>DD</sub> ); CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are not changing during DESELECT; DQ inputs changing once per clock cycle	I <sub>DD7</sub>	1530	1395	mA

\*) Value calculated as one module rank in this operating condition, and all other module ranks in IDD2P (CKE LOW) mode.

#### TIMING VALUES USED FOR I<sub>DD</sub> MEASUREMENT

I <sub>DD</sub> MEASUREMENT CONDITIONS			
SYMBOL	5300-555	4200-444	Unit
CL (I <sub>DD</sub> )	5	4	t <sub>CK</sub>
t <sub>RCD</sub> (I <sub>DD</sub> )	15	15	ns
t <sub>RC</sub> (I <sub>DD</sub> )	60	60	ns
t <sub>RRD</sub> (I <sub>DD</sub> )	7.5	7.5	ns
t <sub>CK</sub> (I <sub>DD</sub> )	3.0	3.75	ns
t <sub>RAS</sub> MIN (I <sub>DD</sub> )	45	45	ns
t <sub>RAS</sub> MAX (I <sub>DD</sub> )	70'000	70'000	ns
t <sub>RP</sub> (I <sub>DD</sub> )	15	15	ns
t <sub>RFC</sub> (I <sub>DD</sub> )	127.5	127.5	ns



**DDR2 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS**
 $(0^{\circ}\text{C} \leq T_{\text{CASE}} \leq +85^{\circ}\text{C}; V_{\text{DDQ}} = +1.8\text{V} \pm 0.1\text{V}, V_{\text{DD}} = +1.8\text{V} \pm 0.1\text{V})$ 

AC CHARACTERISTICS			5300-555		4200-444		Unit
PARAMETER		SYMBOL	MIN	MAX	MIN	MAX	
Clock cycle time	CL = 6	$t_{\text{CK}}(6)$	-	-	-	-	ns
	CL = 5	$t_{\text{CK}}(5)$	3.0	8.0	3.75	8.0	ns
	CL = 4	$t_{\text{CK}}(4)$	3.75	8.0	3.75	8.0	ns
	CL = 3	$t_{\text{CK}}(3)$	5.0	8.0	5.0	8.0	ns
CK high-level width		$t_{\text{CH}}$	0.48	0.52	0.45	0.55	$t_{\text{CK}}$
CK low-level width		$t_{\text{CL}}$	0.48	0.52	0.45	0.55	$t_{\text{CK}}$
Half clock period		$t_{\text{HP}}$	min ( $t_{\text{CH}}, t_{\text{CL}}$ )		min ( $t_{\text{CH}}, t_{\text{CL}}$ )		ps
Access window (output) of DQ <sub>s</sub> from CK/CK#		$t_{\text{AC}}$	-0.45	+0.45	-0.50	+0.50	ns
Data-out high-impedance window from CK/CK#		$t_{\text{HZ}}$		+0.45 (= $t_{\text{AC}} \text{ max}$ )		+0.50 (= $t_{\text{AC}} \text{ max}$ )	ns
Data-out low-impedance window from CK/CK#		$t_{\text{LZ}}$	-0.45 (= $t_{\text{AC}} \text{ min}$ )	+0.45 (= $t_{\text{AC}} \text{ max}$ )	-0.50 (= $t_{\text{AC}} \text{ min}$ )	+0.50 (= $t_{\text{AC}} \text{ max}$ )	ns
DQ and DM input setup time relative to DQS		$t_{\text{DS}}$	0.10		0.10		ns
DQ and DM input hold time relative to DQS		$t_{\text{DH}}$	0.175		0.35		ns
DQ and DM input pulse width ( for each input )		$t_{\text{DIPW}}$	0.35		0.35		$t_{\text{CK}}$
Data hold skew factor		$t_{\text{QHS}}$		0.34		0.4	ns
DQ-DQS hold, DQS to first DQ to go non-valid, per access		$t_{\text{QH}}$	$t_{\text{HP}} - t_{\text{QHS}}$		$t_{\text{HP}} - t_{\text{QHS}}$		ns
Data valid output window		$t_{\text{DVW}}$	$t_{\text{QH}} - t_{\text{DQSQ}}$		$t_{\text{QH}} - t_{\text{DQSQ}}$		ns
DQS input high pulse width		$t_{\text{DQSH}}$	0.35		0.35		$t_{\text{CK}}$
DQS input low pulse width		$t_{\text{DQSL}}$	0.35		0.35		$t_{\text{CK}}$
DQS falling edge to CK rising - setup time		$t_{\text{DSS}}$	0.2		0.2		$t_{\text{CK}}$
DQS falling edge from CK rising - hold time		$t_{\text{DSH}}$	0.2		0.2		$t_{\text{CK}}$
DQS -DQ skew, DQS to last DQ valid, per group, per access		$t_{\text{DQSQ}}$		0.24		0.30	ns
DQS read preamble		$t_{\text{RPRE}}$	0.9	1.1	0.9	1.1	$t_{\text{CK}}$
DQS read postamble		$t_{\text{RPST}}$	0.4	0.6	0.4	0.6	$t_{\text{CK}}$
DQS write preamble		$t_{\text{WPRE}}$	0.35		0.25		$t_{\text{CK}}$
DQS write preamble setup time		$t_{\text{WPRES}}$	0		0		ns
DQS write postamble		$t_{\text{WPST}}$	0.4	0.6	0.4	0.6	$t_{\text{CK}}$
Positive DQS latching edge to associated clock edge		$t_{\text{DQSS}}$	-0.25	+0.25	- 0.25	+ 0.25	$t_{\text{CK}}$
Write command to first DQS latching transition			WL- $t_{\text{DQSS}}$	WL+ $t_{\text{DQSS}}$	WL- $t_{\text{DQSS}}$	WL+ $t_{\text{DQSS}}$	$t_{\text{CK}}$
Address and control input pulse width ( for each input )		$t_{\text{IPW}}$	0.6		0.6		$t_{\text{CK}}$
Address and control input setup time		$t_{\text{ISa}}$	0.2		0.5		ns

**DDR2 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Continued)**
 $(0^{\circ}\text{C} \leq T_{\text{CASE}} \leq +85^{\circ}\text{C}; V_{\text{DDQ}} = +1.8\text{V} \pm 0.1\text{V}, V_{\text{DD}} = +1.8\text{V} \pm 0.1\text{V})$ 

AC CHARACTERISTICS		5300-555		4200-444		Unit
PARAMETER	SYMBOL	MIN	MAX	MIN	MAX	
Address and control input hold time	$t_{\text{IH}}$	0.275		0.5		ns
CAS# to CAS# command delay	$t_{\text{CCD}}$	2		2		$t_{\text{CK}}$
ACTIVE to ACTIVE (same bank) command period	$t_{\text{RC}}$	60		55		ns
ACTIVE bank <i>a</i> to ACTIVE bank <i>b</i> command	$t_{\text{RRD}}$	7.5		7.5		ns
ACTIVE to READ or WRITE delay	$t_{\text{RCD}}$	15		15		ns
Four bank Activate period	$t_{\text{FAW}}$	37.5		37.5		ns
ACTIVE to PRECHARGE command	$t_{\text{RAS}}$	45	70'000	40	70,000	ns
Internal READ to precharge command delay	$t_{\text{RTP}}$	7.5		7.5		ns
Write recovery time	$t_{\text{WR}}$	15		15		ns
Auto precharge write recovery + precharge time	$t_{\text{DAL}}$	$t_{\text{WR}} + t_{\text{RP}}$		$t_{\text{WR}} + t_{\text{RP}}$		ns
Internal WRITE to READ command delay	$t_{\text{WTR}}$	7.5		7.5		ns
PRECHARGE command period	$t_{\text{RP}}$	15		15		ns
PRECHARGE ALL command period	$t_{\text{RPA}}$	$t_{\text{RP}} + t_{\text{CK}}$		$t_{\text{RP}} + t_{\text{CK}}$		ns
LOAD MODE command cycle time	$t_{\text{MRD}}$	2		2		$t_{\text{CK}}$
CKE low to CK, CK# uncertainty	$t_{\text{DELAY}}$	$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$		$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$		$t_{\text{CK}}$
REFRESH to ACTIVE or REFRESH to REFRESH command interval	$t_{\text{RFC}}$	127.5		127.5		ns
Average periodic refresh interval ( $0^{\circ}\text{C} \leq T_{\text{CASE}} \leq 85^{\circ}\text{C}$ )	$t_{\text{REFI}}$		7.8		7.8	$\mu\text{s}$
( $85^{\circ}\text{C} \leq T_{\text{CASE}} \leq 95^{\circ}\text{C}$ )	$t_{\text{REFI}}$		3.9		3.9	$\mu\text{s}$
Exit SELF REFRESH to non-READ command	$t_{\text{XSNR}}$	$t_{\text{RFC}}(\text{min}) + 10$		$t_{\text{RFC}}(\text{min}) + 10$		ns
Exit SELF REFRESH to READ command	$t_{\text{XSRD}}$	200		200		$t_{\text{CK}}$
Exit SELF REFRESH timing reference	$t_{\text{ISXR}}$	$t_{\text{IS}}$		$t_{\text{IS}}$		ps
ODT turn-on delay	$t_{\text{AOND}}$	2	2	2	2	$t_{\text{CK}}$
ODT turn-on	$t_{\text{AON}}$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT turn-off delay	$t_{\text{AOFD}}$			2.5	2.5	$t_{\text{CK}}$
ODT turn-off	$t_{\text{AOF}}$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 600$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 600$	ps
ODT turn-on (power-down mode)	$t_{\text{AONPD}}$	$t_{\text{AC}}(\text{min}) + 2,000$	$2 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT turn-off (power-down mode)	$t_{\text{AOFPD}}$	$t_{\text{AC}}(\text{min}) + 2,000$	$2.5 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2.5 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT to power-down entry latency	$t_{\text{ANPD}}$			3		$t_{\text{CK}}$

**DDR2 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Continued)**
 $(0^{\circ}\text{C} \leq T_{\text{CASE}} \leq +85^{\circ}\text{C}; V_{\text{DDQ}} = +1.8\text{V} \pm 0.1\text{V}, V_{\text{DD}} = +1.8\text{V} \pm 0.1\text{V})$ 

AC CHARACTERISTICS		5300-555		4200-444		Unit
PARAMETER	SYMBOL	MIN	MAX	MIN	MAX	
ODT power-down exit latency	$t_{\text{AXPD}}$	8		8		$t_{\text{CK}}$
ODT enable from MRS command	$T_{\text{MOD}}$	0	12	0	12	ns
Exit active power-down to READ command, MR [bit 12 = 0]	$t_{\text{XARD}}$	2		2		$t_{\text{CK}}$
Exit active power-down to READ command, MR [bit 12 = 1]	$t_{\text{XARDS}}$	7 – AL		6 – AL		$t_{\text{CK}}$
Exit precharge power-down to any non-READ command	$t_{\text{XP}}$	2		2		$t_{\text{CK}}$
CKE minimum high/low time	$t_{\text{CKE}}$	3		3		$t_{\text{CK}}$

**Register Specifications**

Parameter	Symbol	Pins	Conditions	Min	Max	Units
DC high-level input voltage	$V_{\text{IH(DC)}}$	Address, control, command	SSTL_18	$V_{\text{REF(DC)}} + 125$	$V_{\text{DDQ}} + 250$	mV
DC low-level input voltage	$V_{\text{IL(DC)}}$	Address, control, command	SSTL_18	0	$V_{\text{REF(DC)}} - 125$	mV
AC high-level input voltage	$V_{\text{IH(AC)}}$	Address, control, command	SSTL_18	$V_{\text{REF(DC)}} + 250$	$V_{\text{DD}}$	mV
AC low-level input voltage	$V_{\text{IL(AC)}}$	Address, control, command	SSTL_18	0	$V_{\text{REF(DC)}} - 250$	mV
Output high voltage	$V_{\text{OH}}$	Parity output	LVC MOS	1.2	-	V
Output low voltage	$V_{\text{OL}}$	Parity output	LVC MOS	-	0.5	V
Input current	$I_{\text{I}}$	All pins	$V_{\text{I}} = V_{\text{DDQ}}$ or $V_{\text{SSQ}}$	-5	+5	$\mu\text{A}$
Static standby	$I_{\text{DD}}$	All pins	RESET# = $V_{\text{SSQ}}$ ( $I_{\text{O}} = 0$ )	-	100	$\mu\text{A}$
Static operating	$I_{\text{DD}}$	All pins	RESET# = $V_{\text{SSQ}}$ ; $V_{\text{I}} = V_{\text{IH(AC)}}$ or $V_{\text{IL(DC)}}$ $I_{\text{O}} = 0$	-	40	mA
Dynamic operating (clock tree)	$I_{\text{DDD}}$	n/a	RESET# = $V_{\text{DD}}$ , $V_{\text{I}} = V_{\text{IH(AC)}}$ or $V_{\text{IL(AC)}}$ , $I_{\text{O}} = 0$ ; CK and CK# switching 50% duty cycle	-	Varies by manufacturer	$\mu\text{A}$
Dynamic operating (per each input)	$I_{\text{DDD}}$	n/a	RESET# = $V_{\text{DD}}$ , $V_{\text{I}} = V_{\text{IH(AC)}}$ or $V_{\text{IL(AC)}}$ , $I_{\text{O}} = 0$ ; CK and CK# switching 50% duty cycle; One data input switching at $t_{\text{CK}/2}$ , 50% duty cycle	-	Varies by manufacturer	$\mu\text{A}$
Input capacitance (per device, per pin)	$C_{\text{I}}$	Data	$V_{\text{I}} = V_{\text{REF}} \pm 250\text{mV}$ ; $V_{\text{DDQ}} = 1.8\text{V}$	2.5	3.5	pF
Input capacitance (per device, per pin)	$C_{\text{I}}$	RESET#	$V_{\text{I}} = V_{\text{DDQ}}$ or $V_{\text{SSQ}}$	-	Varies by manufacturer	pF

Notes: 1. Timing and switching specifications for the register listed above are critical for proper operation of the DDR2 SDRAM registered DIMMs. These are meant to be a subset of the parameters for the specific device used on the module. Detailed information for this register is available in JEDEC standard JESD82.

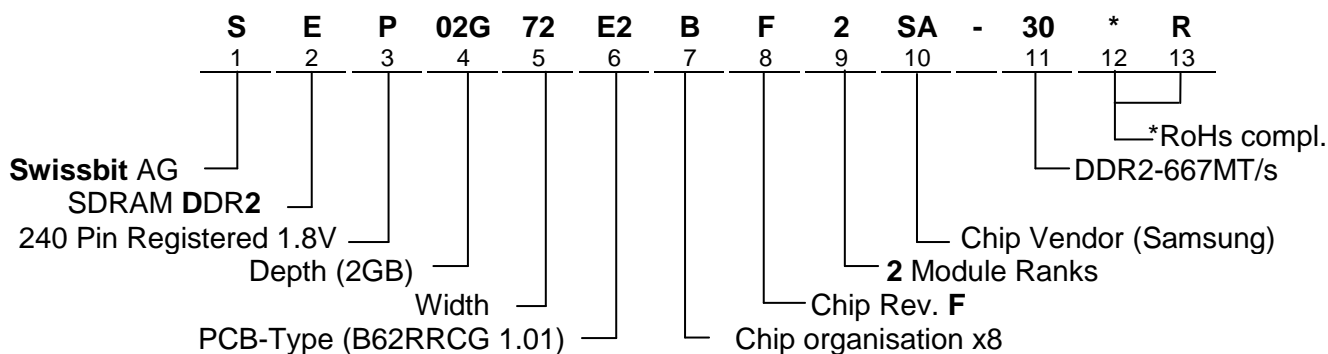
**SERIAL PRESENCE-DETECT MATRIX**

BYTE	DESCRIPTION	5300-555	4200-444
0	NUMBER OF SPD BYTES USED	0x80	
1	TOTAL NUMBER OF BYTES IN SPD DEVICE	0x08	
2	FUNDAMENTAL MEMORY TYPE	0x08	
3	NUMBER OF ROW ADDRESSES ON ASSEMBLY	0x0E	
4	NUMBER OF COLUMN ADDRESSES ON ASSEMBLY	0x0A	
5	DIMM HIGHT AND MODULE RANKS	0x61	
6	MODULE DATA WIDTH	0x48	
7	MODULE DATA WIDTH (continued)	0x00	
8	MODULE VOLTAGE INTERFACE LEVELS ( $V_{DDQ}$ )	0x05	
9	SDRAM CYCLE TIME, ( $t_{CK}$ ) [max CL] CAS LATENCY = 5 (4200 + 5300)	0x30	0x3D
10	SDRAM ACCESS FROM CLOCK, ( $t_{AC}$ ) [max CL] CAS LATENCY = 5 (4200 + 5300)	0x45	0x50
11	MODULE CONFIGURATION TYPE	0x06	
12	REFRESH RATE / TYPE	0x82	
13	SDRAM DEVICE WIDTH (PRIMARY SDRAM)	0x08	
14	ERROR- CHECKING SDRAM DATA WIDTH	0x08	
15	MINIMUM CLOCK DELAY, BACK-TO-BACK RANDOM COLUMN ACCESS	0x00	
16	BURST LENGTHS SUPPORTED	0x0C	
17	NUMBER OF BANKS ON SDRAM DEVICE	0x08	
18	CAS LATENCIES SUPPORTED	0x38	
19	MODULE THICKNESS	0x01	
20	DDR2 DIMM TYPE	0x01	
21	SDRAM MODULE ATTRIBUTES	0x05	
22	SDRAM DEVICE ATTRIBUTES: Weak Driver and 50Ω ODT	0x07	
23	SDRAM CYCLE TIME, ( $t_{CK}$ ) [max CL – 1] CAS LATENCY = 4 (4200 + 5300)	0x3D	
24	SDRAM ACCESS FROM CK, ( $t_{AC}$ ) [max CL – 1] CAS LATENCY = 4 (4200 + 5300)	0x50	
25	SDRAM CYCLE TIME, ( $t_{CK}$ ) [max CL – 2] CAS LATENCY = 3 (4200 + 5300)	0x50	
26	SDRAM ACCESS FROM CK, ( $t_{AC}$ ) [max CL – 2] CAS LATENCY = 3 (4200 + 5300)	0x60	
27	MINIMUM ROW PRECHARGE TIME, ( $t_{RP}$ )	0x3C	
28	MINIMUM ROW ACTIVE TO ROW ACTIVE, ( $t_{RRD}$ )	0x1E	
29	MINIMUM RAS# TO CAS# DELAY, ( $t_{RCD}$ )	0x3C	
30	MINIMUM RAS# PULSE WIDTH, ( $t_{RAS}$ )	0x2D	
31	MODULE BANK DENSITY	0x01	

**SERIAL PRESENCE-DETECT MATRIX (continued)**

BYTE	DESCRIPTION	5300-555	4200-444
32	ADDRESS AND COMMAND SETUP TIME, (t <sub>ISb</sub> )	0x20	0x25
33	ADDRESS AND COMMAND HOLD TIME, (t <sub>IHb</sub> )	0x27	0x37
34	DATA / DATA MASK INPUT SETUP TIME, (t <sub>DSb</sub> )	0x10	0x10
35	DATA / DATA MASK INPUT HOLD TIME, (t <sub>DHb</sub> )	0x17	0x22
36	WRITE RECOVERY TIME, (t <sub>WR</sub> )	0x3C	
37	WRITE to READ Command Delay, (t <sub>WTR</sub> )	0x1E	
38	READ to PRECHARGE Command Delay, (t <sub>RTP</sub> )	0x1E	
39	Mem Analysis Probe	0x00	
40	Extension for Bytes 41 and 42	0x06	
41	MIN ACTIVE AUTO REFRESH TIME, (t <sub>RC</sub> )	0x3C	
42	MINIMUM AUTO REFRESH TO ACTIVE / AUTO REFRESH COMMAND PERIOD, (t <sub>RFC</sub> )	0x7F	
43	SDRAM DEVICE MAX CYCLE TIME, (t <sub>CKMAX</sub> )	0x80	
44	SDRAM DEVICE MAX DQS-DQ SKEW TIME, (t <sub>DQSQ</sub> )	0x18	0x1E
45	SDRAM DEVICE MAX READ DATA HOLD SKEW FACTOR, (t <sub>QHS</sub> )	0x22	0x28
46	PLL Relock Time	0x0F	
47-61	Optional Features, not supported	0x00	
62	SPD REVISION	0x13	
63	CHECKSUM FOR BYTES 0-62	0x41	0x85
64-67	MANUFACTURER'S JEDEC ID CODE	0x7F7F7FDA	
68-71	MANUFACTURER'S JEDEC ID CODE (continued)	0x00	
72	MANUFACTURING LOCATION	Xx	
73-90	MODULE PART NUMBER (ASCII)	"SEP02G72E2BF2SA-xx"	
91	PCB IDENTIFICATION CODE	X	
92	IDENTIFICATION CODE (continued)	X	
93	YEAR OF MANUFACTURE IN BCD	X	
94	WEEK OF MANUFACTURE IN BCD	X	
95-98	MODULE SERIAL NUMBER	X	
99-127	MANUFACTURER-SPECIFIC DATA (RSVD)	0x00	
128-255	Open for customer use	0xff	

**Part Number Code**



\* optional / additional information

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