

2GB DDR2 – SDRAM SO-DIMM

200 Pin SO-DIMM

SEN02G64C4BF2SA-25R

2GB PC2-6400 in FBGA Technology

RoHS compliant

Options:

▪ Data Rate / Latency	Marking
DDR2 800 MT/s CL6	-25
DDR2 667 MT/s CL5	-30
DDR2 533 MT/s CL4	-37
▪ module density	
2048MB with 16 dies and 2 ranks	
▪ Standard Grade (T _A)	0°C to 70°C
	(T _C) 0°C to 85°C
Grade E (T _A)	0°C to 85°C
	(T _C) 0°C to 95°C*
Grade W (T _A)	-40°C to 85°C
	(T _C) -40°C to 95°C*

* The refresh rate has to be doubled when 85°C > T_C > 95°C

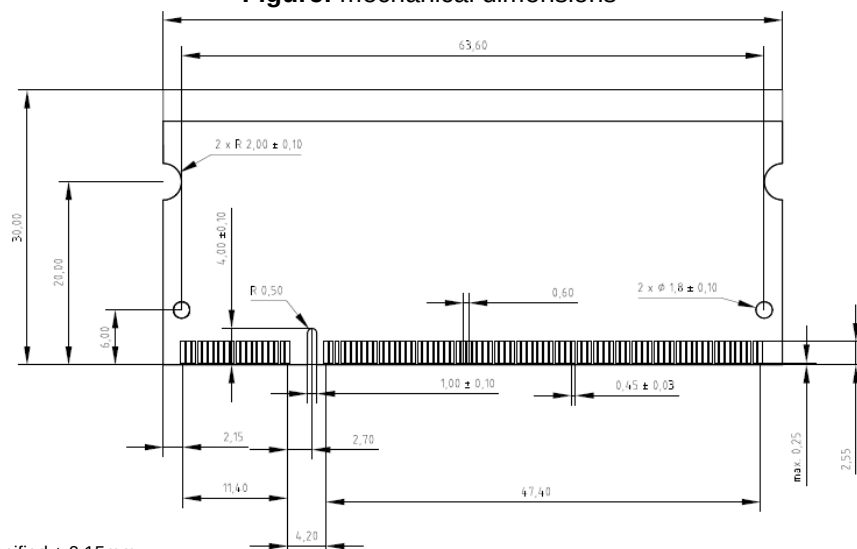
Environmental Requirements:

- Operating temperature (ambient)
 - Standard Grade 0°C to 70°C
 - Grade E 0°C to 85°C*
 - Grade W -40°C to 85°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:

- 200-pin 64-bit Small Outline, Dual-In-Line Double Data Rate Synchronous DRAM Module
- Module organization: dual rank 256M x 64
- VDD = 1.8V ± 0.1V, V_{DDQ} 1.8V ± 0.1V
- 1.8V I/O (SSTL_18 compatible)
- Auto Refresh (CBR) and Self Refresh 8k Refresh every 64ms
- Serial Presence Detect with EEPROM
- Gold-contact pad
- This module is fully pin and functional compatible to the JEDEC PC2-6400 spec. and JEDEC- Standard MO-224. (see 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 DIE Rev. F**
- 128Mx8 DDR2 SDRAM in FBGA-60 package
- Four bit prefetch architecture
- DLL to align DQ and DQS transitions with CK
- Eight internal device banks for concurrent operation
- 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)

Figure: mechanical dimensions¹



¹if no tolerances specified ± 0.15mm

This Swissbit module is an industry standard 200-pin 8-byte DDR2 SDRAM Small Outline Dual-In-line Memory Module (SO-DIMM) which is organized as x64 high speed CMOS memory arrays. The module uses internally configured octal-bank DDR2 SDRAM devices. 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 SSTL₁₈ compatible.

The DDR2 SDRAM module uses the optional serial presence detect (SPD) function implemented via serial EEPROM using the standard I²C protocol. This nonvolatile storage device contains 256 bytes. The first 128 bytes are utilized by the SO-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 Addr.	Column Addr.	Refresh	Module Bank Select
256M x 64bit	16 x 128M x 8bit (1024Mbit)	14	BA0, BA1, BA2	10	8k	S0#, S1#

Module Dimensions
in mm
67.60 (long) x 30(high) x 3.80 [max] (thickness)

Timing Parameters

Part Number	Module Density	Transfer Rate	Clock Cycle/Data bit rate	Latency
SEN02G64C4BF2SA-25[E/W]R	2048 MB	6.4 GB/s	2.5ns / 800MT/s	6-6-6
SEN02G64C4BF2SA-30[E/W]R	2048 MB	5.3 GB/s	3.0ns / 667MT/s	5-5-5
SEN02G64C4BF2SA-37[E/W]R	2048 MB	4.2 GB/s	3.75ns / 533MT/s	4-4-4

Pin Name

A0-9, A11 – A13	Address Inputs
A10/AP	Address Input / Autoprecharge Bit
BA0 – BA2	Bank Address Inputs
DQ0 – DQ63	Data Input / Output
DM0-DM7	Input Data Mask
DQS0 - DQS7	Data Strobe, positive line
DQS0# - DQS7#	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
S0#, S1#	Chip Select

CK0 – CK1	Clock Inputs, positive line
CK0# – CK1#	Clock Inputs, negative line
V _{DD}	Supply Voltage (1.8V± 0.1V)
V _{REF}	Input / Output Reference
V _{SS}	Ground
V _{DDSPD}	Serial EEPROM Positive Power Supply
SCL	Serial Clock for Presence Detect
SDA	Serial Data Out for Presence Detect
SA0 – SA1	Presence Detect Address Inputs
ODT0, ODT1	On-Die Termination
NC	No Connection

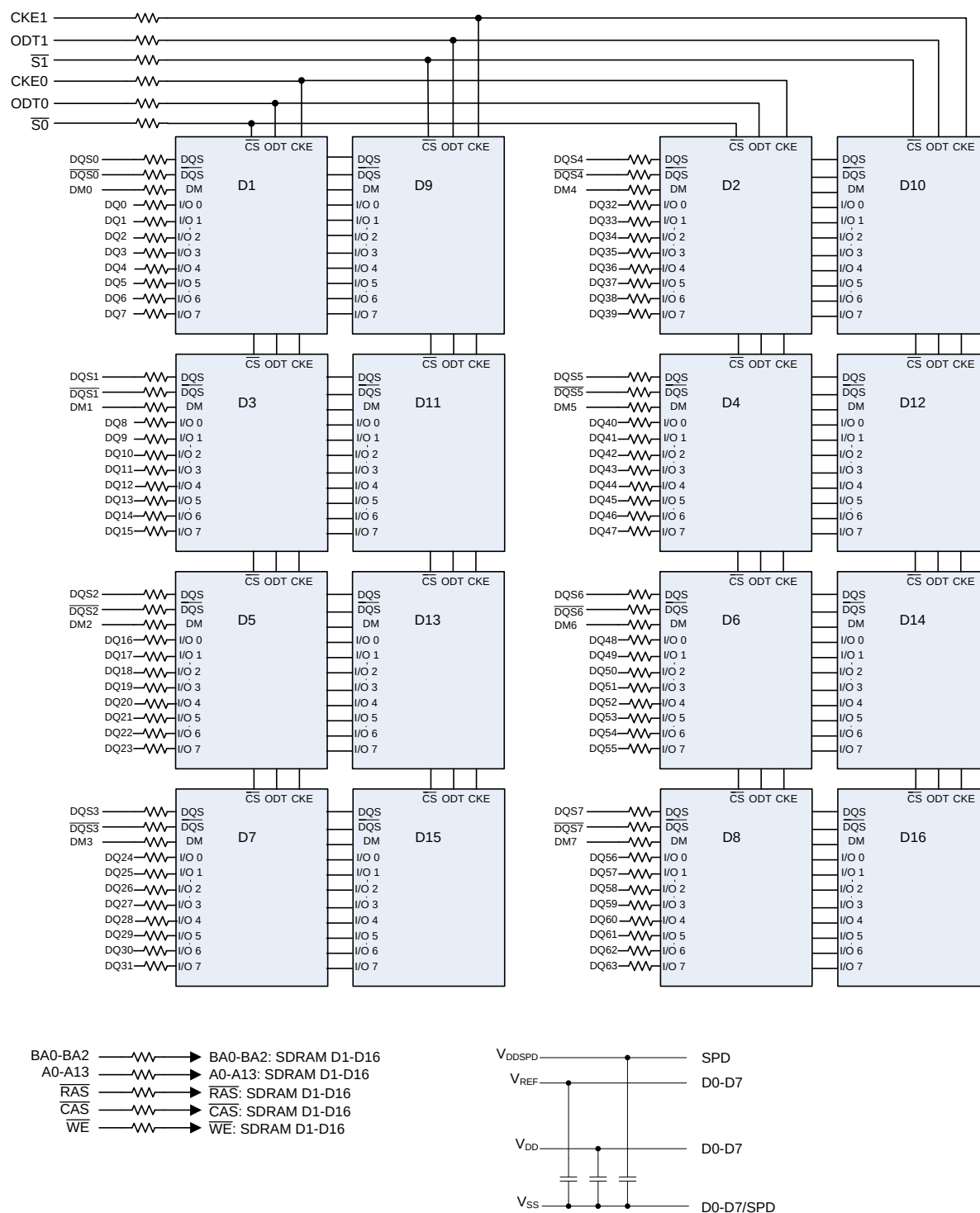
Pin Configuration

PIN #	Front Side	PIN #	Back Side	PIN #	Front Side	PIN #	Back Side
1	V _{REF}	2	V _{SS}	101	A1	102	A0
3	V _{SS}	4	DQ4	103	V _{DD}	104	V _{DD}
5	DQ0	6	DQ5	105	A10/AP	106	BA1
7	DQ1	8	V _{SS}	107	BA0	108	RAS#
9	V _{SS}	10	DM0	109	WE#	110	S0#
11	DQS0#	12	V _{SS}	111	V _{DD}	112	V _{DD}
13	DQS0	14	DQ6	113	CAS#	114	ODT0
15	V _{SS}	16	DQ7	115	S1#	116	A13
17	DQ2	18	V _{SS}	117	V _{DD}	118	V _{DD}
19	DQ3	20	DQ12	119	ODT1	120	NC (S3#)
21	V _{SS}	22	DQ13	121	V _{SS}	122	V _{SS}
23	DQ8	24	V _{SS}	123	DQ32	124	DQ36
25	DQ9	26	DM1	125	DQ33	126	DQ37
27	V _{SS}	28	V _{SS}	127	V _{SS}	128	V _{SS}
29	DQS1#	30	CK0	129	DQS4#	130	DM4
31	DQS1	32	CK0#	131	DQS4	132	V _{SS}
33	V _{SS}	34	V _{SS}	133	V _{SS}	134	DQ38
35	DQ10	36	DQ14	135	DQ34	136	DQ39
37	DQ11	38	DQ15	137	DQ35	138	V _{SS}
39	V _{SS}	40	V _{SS}	139	V _{SS}	140	DQ44
41	V _{SS}	42	V _{SS}	141	DQ40	142	DQ45
43	DQ16	44	DQ20	143	DQ41	144	V _{SS}
45	DQ17	46	DQ21	145	V _{SS}	146	DQS5#
47	V _{SS}	48	V _{SS}	147	DM5	148	DQS5
49	DQS2#	50	NC (EVENT#)	149	V _{SS}	150	V _{SS}
51	DQS2	52	DM2	151	DQ42	152	DQ46

PIN #	Front Side	PIN #	Back Side	PIN #	Front Side	PIN #	Back Side
53	Vss	54	Vss	153	DQ43	154	DQ47
55	DQ18	56	DQ22	155	Vss	156	Vss
57	DQ19	58	DQ23	157	DQ48	158	DQ52
59	Vss	60	Vss	159	DQ49	160	DQ53
61	DQ24	62	DQ28	161	Vss	162	Vss
63	DQ25	64	DQ29	163	NC (TEST)	164	CK1
65	Vss	66	Vss	165	Vss	166	CK1#
67	DM3	68	DQS3#	167	DQS6#	168	Vss
69	NC (RESET#)	70	DQS3	169	DQS6	170	DM6
71	Vss	72	Vss	171	Vss	172	Vss
73	DQ26	74	DQ30	173	DQ50	174	DQ54
75	DQ27	76	DQ31	175	DQ51	176	DQ55
77	Vss	78	Vss	177	Vss	178	Vss
79	CKE0	80	CKE1	179	DQ56	180	DQ60
81	VDD	82	VDD	181	DQ57	182	DQ61
83	NC (S2#)	84	NC (A15)	183	Vss	184	Vss
85	NC/BA2	86	NC (A14)	185	DM7	186	DQS7#
87	VDD	88	VDD	187	Vss	188	DQS7
89	A12	90	A11	189	DQ58	190	Vss
91	A9	92	A7	191	DQ59	192	DQ62
93	A8	94	A6	193	Vss	194	DQ63
95	VDD	96	VDD	195	SDA	196	Vss
97	A5	98	A4	197	SCL	198	SA0
99	A3	100	A2	199	VDDSPD	200	SA1

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

**FUNCTIONAL BLOCK DIAGRAMM 2048MB DDR2 SDRAM SODIMM,
2 RANKS AND 16 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
INPUT LEAKAGE CURRENT 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			μA
Command/Address RAS#, CAS#, WE#, S#, CKE		-40	40	
CK, CK#		-20	20	
DM		-5	5	
OUTPUT LEAKAGE CURRENT (DQ's and ODT are disabled; $0V \leq V_{OUT} \leq V_{DDQ}$)	I_{OZ}	-5	5	μA
DQ, DQS, DQS#				
V_{REF} LEAKAGE CURRENT ; V_{REF} is on a valid level	I_{VREF}	-16	16	μA

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.

Parameter & Test Condition	Symbol	max.			Unit	
		6400-666	5300-555	4200-444		
OPERATING CURRENT: *) One device bank Active-Precharge; $t_{RC}=t_{RC}(I_{DD})$; $t_{CK}=t_{CK}(I_{DD})$; 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_{DD0}	440	424	408	mA	
OPERATING CURRENT: *) One device bank; Active-Read-Precharge; $I_{OUT}=0mA$; BL = 4, CL = CL (I_{DD}), AL = 0; $t_{CK}=t_{CK}(I_{DD})$, $t_{RC}=t_{RC}(I_{DD})$, $t_{RAS}=t_{RAS} \text{ MIN}(I_{DD})$, $t_{RCD}=t_{RCD}(I_{DD})$; CKE is HIGH, CS# is HIGH between valid commands; Address inputs changing once every two clock cycles; Data Pattern is same as I_{DD4W}	I_{DD1}	488	464	440	mA	
PRECHARGE POWER-DOWN CURRENT: All device banks idle; Power-down mode; $t_{CK}=t_{CK}(I_{DD})$; CKE is LOW; All Control and Address bus inputs are not changing; DQ's are floating at V_{REF}	I_{DD2P}	160	160	160	mA	
PRECHARGE QUIET STANDBY CURRENT: All device banks idle; $t_{CK}=t_{CK}(I_{DD})$; CKE is HIGH, CS# is HIGH; All Control and Address bus inputs are not changing; DQ's are floating at V_{REF}	I_{DD2Q}	320	320	320	mA	
PRECHARGE STANDBY CURRENT: All device banks idle; $t_{CK}=t_{CK}(I_{DD})$; 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_{DD2N}	400	384	368	mA	
ACTIVE POWER-DOWN CURRENT: All device banks open; $t_{CK}=t_{CK}(I_{DD})$; CKE is LOW; All Control and Address bus inputs are not changing; DQ's are floating at V_{REF}	I_{DD3P}	Fast PDN Exit MR[12] = 0	368	352	336	mA
		Slow PDN Exit MR[12] = 1	240	240	240	mA
ACTIVE STANDBY CURRENT: All device banks open; $t_{CK}=t_{CK}(I_{DD})$, $t_{RAS}=t_{RAS} \text{ MAX}(I_{DD})$, $t_{RP}=t_{RP}(I_{DD})$; 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_{DD3N}	512	480	448	mA	

Parameter & Test Condition	Symbol	max.			Unit
		6400-666	5300-555	4200-444	
OPERATING READ CURRENT: *) All device banks open, Continuous burst reads; One module rank active; $I_{OUT} = 0mA$; $BL = 4$, $CL = CL(I_{DD})$, $AL = 0$; $t_{CK} = t_{CK}(I_{DD})$, $t_{RAS} = t_{RAS} MAX(I_{DD})$, $t_{RP} = t_{RP}(I_{DD})$; 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_{DD4R}	720	640	560	mA
OPERATING WRITE CURRENT: *) All device banks open, Continuous burst writes; One module rank active; $BL = 4$, $CL = CL(I_{DD})$, $AL = 0$; $t_{CK} = t_{CK}(I_{DD})$, $t_{RAS} = t_{RAS} MAX(I_{DD})$, $t_{RP} = t_{RP}(I_{DD})$; 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_{DD4W}	616	560	510	mA
BURST REFRESH CURRENT: $t_{CK} = t_{CK}(I_{DD})$; refresh command at every $t_{RFC}(I_{DD})$ 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_{DD5}	1680	1600	1520	mA
SELF REFRESH CURRENT: CK and $CK\#$ at 0V; $CKE \leq 0.2V$; All other Control and Address bus inputs are floating at V_{REF} ; DQ's are floating at V_{REF}	I_{DD6}	160	160	160	mA
OPERATING CURRENT: *) Four device bank interleaving READS, $I_{OUT} = 0mA$; $BL = 4$, $CL = CL(I_{DD})$, $AL = t_{RCD}(I_{DD}) - 1 \times t_{CK}(I_{DD})$; $t_{CK} = t_{CK}(I_{DD})$, $t_{RC} = t_{RC}(I_{DD})$, $t_{RRD} = t_{RRD}(I_{DD})$, $t_{RCD} = t_{RCD}(I_{DD})$; 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_{DD7}	1360	1240	1120	mA

TIMING VALUES USED FOR I_{DD} MEASUREMENT

I_{DD} MEASUREMENT CONDITIONS				
SYMBOL	6400-666	5300-555	4200-444	Unit
$CL(I_{DD})$	6	5	4	t_{CK}
$t_{RCD}(I_{DD})$	15	15	15	ns
$t_{RC}(I_{DD})$	60	60	60	ns
$t_{RRD}(I_{DD})$	7.5	7.5	7.5	ns
$t_{CK}(I_{DD})$	2.5	3.0	3.75	ns
$t_{RAS} MIN(I_{DD})$	45	45	45	ns
$t_{RAS} MAX(I_{DD})$	70,000	70,000	70,000	ns
$t_{RP}(I_{DD})$	15	15	15	ns
$t_{RFC}(I_{DD})$	105	105	105	ns

DDR2 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.8V ± 0.1V, V_{DD} = +1.8V ± 0.1V)

AC CHARACTERISTICS			6400-666		5300-555		4200-444		Unit
PARAMETER		SYMBOL	MIN	MAX	MIN	MAX	MIN	MAX	
Clock cycle time	CL = 6	t _{CK} (6)	2.5	8.0	-	+	-	-	ns
	CL = 5	t _{CK} (5)	3.0-	8.0-	3.0	8.0	-	-	ns
	CL = 4	t _{CK} (4)	3.75	8.0	3.75	8.0	3.75	8.0	ns
	CL = 3	t _{CK} (3)	-	-	5.0	8.0	5.0	8.0	ns
CK high-level width		t _{CH}	0.48	0.52	0.45	0.55	0.45	0.55	t _{CK}
CK low-level width		t _{CL}	0.48	0.52	0.45	0.55	0.45	0.55	t _{CK}
Half clock period		t _{HP}	min (t _{CH} , t _{CL})		min (t _{CH} , t _{CL})		min (t _{CH} , t _{CL})		ps
Access window (output) of DQ _s from CK/CK#		t _{AC}	-0.40	+0.40	-0.45	+0.45	-0.50	+0.50	ns
Data-out high-impedance window from CK/CK#		t _{HZ}		t _{AC} max		+0.45 (= t _{AC} max)		+0.50 (= t _{AC} max)	ns
Data-out low-impedance window from CK/CK#		t _{LZ}	t _{AC} min	t _{AC} max	-0.45 (= t _{AC} min)	+0.45 (= t _{AC} max)	-0.50 (= t _{AC} min)	+0.50 (= t _{AC} max)	ns
DQ and DM input setup time relative to DQS		t _{DS}	0.05		0.10		0.10		ns
DQ and DM input hold time relative to DQS		t _{DH}	0.125		0.30		0.35		ns
DQ and DM input pulse width (for each input)		t _{DIPW}	0.35		0.35		0.35		t _{CK}
Data hold skew factor		t _{QHS}		0.3		0.34		0.4	ns
DQ-DQS hold, DQS to first DQ to go non-valid, per access		t _{QH}	t _{HP} - t _{QHS}		t _{HP} - t _{QHS}		t _{HP} - t _{QHS}		ns
Data valid output window		t _{DVW}	t _{QH} - t _{DQSQ}		t _{QH} - t _{DQSQ}		t _{QH} - t _{DQSQ}		ns
DQS input high pulse width		t _{DQSH}	0.35		0.35		0.35		t _{CK}
DQS input low pulse width		t _{DQSL}	0.35		0.35		0.35		t _{CK}
DQS falling edge to CK rising - setup time		t _{DSS}	0.2		0.2		0.2		t _{CK}
DQS falling edge from CK rising - hold time		t _{DSH}	0.2		0.2		0.2		t _{CK}
DQS -DQ skew, DQS to last DQ valid, per group, per access		t _{DQSQ}		0.2		0.24		0.30	ns
DQS read preamble		t _{RPRE}	0.9	1.1	0.9	1.1	0.9	1.1	t _{CK}
DQS read postamble		t _{RPST}	0.4	0.6	0.4	0.6	0.4	0.6	t _{CK}
DQS write preamble		t _{WPRES}	0.35		0.35		0.25		t _{CK}
DQS write preamble setup time		t _{WPRES}	0		0		0		ns
DQS write postamble		t _{WPST}	0.4	0.6	0.4	0.6	0.4	0.6	t _{CK}
Positive DQS latching edge to associated clock edge		t _{DQSS}	- 0.25	+ 0.25	- 0.25	+ 0.25	- 0.25	+ 0.25	t _{CK}
Write command to first DQS latching transition			WL- t _{DQSS}	WL+ t _{DQSS}	WL- t _{DQSS}	WL+ t _{DQSS}	WL- t _{DQSS}	WL+ t _{DQSS}	t _{CK}
Address and control input pulse width (for each input)		t _{IPW}	0.6		0.6		0.6		t _{CK}
Address and control input setup time		t _{ISa}	0.175		0.4		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		6400-666		5300-555		4200-444		Unit
PARAMETER	SYMBOL	Min	Max	MIN	MAX	MIN	MAX	
Address and control input hold time	t_{IH}	0.25		0.4		0.5		ns
CAS# to CAS# command delay	t_{CCD}	2		2		2		t_{CK}
ACTIVE to ACTIVE (same bank) command period	t_{RC}	60		55		55		ns
ACTIVE bank a to ACTIVE bank b command	t_{RRD}	7.5		7.5		7.5		ns
ACTIVE to READ or WRITE delay	t_{RCD}	15		15		15		ns
Four bank Activate period	t_{FAW}	37.5		37.5		37.5		ns
ACTIVE to PRECHARGE command	t_{RAS}	45	70,000	40	70,000	40	70,000	ns
Internal READ to precharge command delay	t_{RTP}	7.5		7.5		7.5		ns
Write recovery time	t_{WR}	15		15		15		ns
Auto precharge write recovery + precharge time	t_{DAL}	$t_{\text{WR}} + t_{\text{RP}}$		$t_{\text{WR}} + t_{\text{RP}}$		$t_{\text{WR}} + t_{\text{RP}}$		ns
Internal WRITE to READ command delay	t_{WTR}	7.5		7.5		7.5		ns
PRECHARGE command period	t_{RP}	15		15		15		ns
PRECHARGE ALL command period	t_{RPA}	$t_{\text{RP}} + t_{\text{CK}}$		$t_{\text{RP}} + t_{\text{CK}}$		$t_{\text{RP}} + t_{\text{CK}}$		ns
LOAD MODE command cycle time	t_{MRD}	2		2		2		t_{CK}
CKE low to CK, CK# uncertainty	t_{DELAY}	$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$		$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$		$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$		t_{CK}
REFRESH to ACTIVE or REFRESH to REFRESH command interval	t_{RFC}	105	70,000	105	70,000	105	70,000	ns
Average periodic refresh interval ($0^{\circ}\text{C} < T_{\text{C}} < 85^{\circ}\text{C}$)	t_{REFI}	-	7.8	-	7.8	-	7.8	μs
Average periodic refresh interval ($85^{\circ}\text{C} < T_{\text{C}} < 95^{\circ}\text{C}$)		-	3.9	-	3.9	-	3.9	
Exit SELF REFRESH to non-READ command	t_{XSNR}	$t_{\text{RFC}}(\text{min}) + 10$		$t_{\text{RFC}}(\text{min}) + 10$		$t_{\text{RFC}}(\text{min}) + 10$		ns
Exit SELF REFRESH to READ command	t_{XSRD}	200		200		200		t_{CK}
Exit SELF REFRESH timing reference	t_{ISXR}	t_{IS}		t_{IS}		t_{IS}		ps
ODT turn-on delay	t_{AOND}	2	2	2	2	2	2	t_{CK}
ODT turn-on	t_{AON}	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT turn-off delay	t_{AOFD}	2.5	2.5	2.5	2.5	2.5	2.5	t_{CK}
ODT turn-off	t_{AOF}	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 600$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 600$	$t_{\text{AC}}(\text{min})$	$t_{\text{AC}}(\text{max}) + 600$	ps
ODT turn-on (power-down mode)	t_{AONPD}	$t_{\text{AC}}(\text{min}) + 2,000$	$2 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT turn-off (power-down mode)	t_{AOFPD}	$t_{\text{AC}}(\text{min}) + 2,000$	$2.5 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2.5 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	$t_{\text{AC}}(\text{min}) + 2,000$	$2.5 \times t_{\text{CK}} + t_{\text{AC}}(\text{max}) + 1,000$	ps
ODT to power-down entry latency	t_{ANPD}	3		3		3		t_{CK}

DDR2 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Continued)

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.8V ± 0.1V, V_{DD} = +1.8V ± 0.1V)

AC CHARACTERISTICS		6400-666		5300-555		4200-444		Unit
PARAMETER	SYMBOL	Min	Max	MIN	MAX	MIN	MAX	
ODT power-down exit latency	t _{AXPD}	8		8		8		t _{CK}
ODT enable from MRS command	T _{MOD}	12		12		12		ns
Exit active power-down to READ command, MR [bit 12 = 0]	t _{XARD}	2		2		2		t _{CK}
Exit active power-down to READ command, MR [bit 12 = 1]	t _{XARDS}	8 – AL		7 – AL		6 – AL		t _{CK}
Exit precharge power-down to any non-READ command	t _{XP}	2		2		2		t _{CK}
CKE minimum high/low time	t _{CKE}	3		3		3		t _{CK}

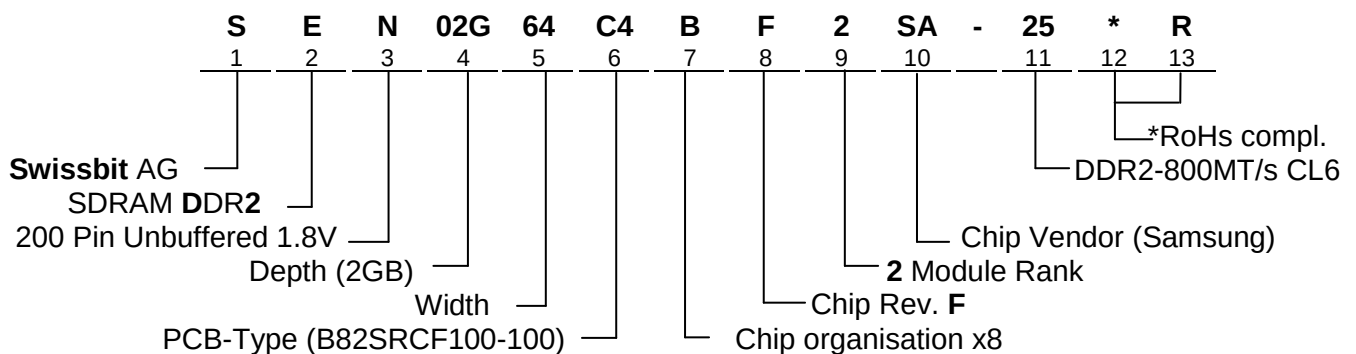
SERIAL PRESENCE-DETECT MATRIX

BYTE	DESCRIPTION	6400-666	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	0x40		
7	MODULE DATA WIDTH (continued)	0x00		
8	MODULE VOLTAGE INTERFACE LEVELS (V _{DDQ})	0x05		
9	SDRAM CYCLE TIME, (t _{CK}) [max CL] CL = 6 (6400), CL = 5 (5300), CL = 4 (4200)	0x25	0x30	0x3D
10	SDRAM ACCESS FROM CLOCK, (t _{AC}) [max CL] CL = 6 (6400), CL = 5 (5300), CL = 4 (4200)	0x40	0x45	0x50
11	MODULE CONFIGURATION TYPE	0x00		
12	REFRESH RATE / TYPE	0x82		
13	SDRAM DEVICE WIDTH (PRIMARY SDRAM)	0x08		
14	ERROR- CHECKING SDRAM DATA WIDTH	0x00		
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	0x70	0x38	
19	MODULE THICKNESS	0x01		
20	DDR2 DIMM TYPE	0x04		
21	SDRAM MODULE ATTRIBUTES	0x00		
22	SDRAM DEVICE ATTRIBUTES: Weak Driver and 50Ω ODT	0x07		
23	SDRAM CYCLE TIME, (t _{CK}) [max CL – 1] CL = 5 (6400), CL = 4 (5300), CL = 3 (4200)	0x30	0x3D	
24	SDRAM ACCESS FROM CK, (t _{AC}) [max CL – 1] CL = 5 (6400), CL = 4 (5300), CL = 3 (4200)	0x45	0x50	
25	SDRAM CYCLE TIME, (t _{CK}) [max CL – 2] CL = 2 (6400), CL = 3 (5300)	0x3D	0x50	
26	SDRAM ACCESS FROM CK, (t _{AC}) [max CL – 2] CAS LATENCY = 3 (5300)	0x50	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	6400-666	5300-555	4200-444
32	ADDRESS AND COMMAND SETUP TIME, (t_{ISb})	0x17	0x20	0x25
33	ADDRESS AND COMMAND HOLD TIME, (t_{IHb})	0x25	0x27	0x37
34	DATA / DATA MASK INPUT SETUP TIME, (t_{DSb})	0x05	0x10	
35	DATA / DATA MASK INPUT HOLD TIME, (t_{DHB})	0x12	0x17	0x22
36	WRITE RECOVERY TIME, (t_{WR})	0x3C		
37	WRITE to READ Command Delay, (t_{WTR})	0x1E		
38	READ to PRECHARGE Command Delay, (t_{RTP})	0x1E		
39	Mem Analysis Probe	0x00		
40	Extension for Bytes 41 and 42	0x06		
41	MIN ACTIVE AUTO REFRESH TIME, (t_{RC})	0x3C		
42	MINIMUM AUTO REFRESH TO ACTIVE / AUTO REFRESH COMMAND PERIOD, (t_{RFC})	0x7F		
43	SDRAM DEVICE MAX CYCLE TIME, (t_{CKMAX})	0x80		
44	SDRAM DEVICE MAX DQS-DQ SKEW TIME, (t_{DOSQ})	0x14	0x18	0x1E
45	SDRAM DEVICE MAX READ DATA HOLD SKEW FACTOR, (t_{QHS})	0x1E	0x22	0x28
46	PLL Relock Time	0x00		
47-61	Optional Features, not supported	0x00		
62	SPD REVISION	0x13		
63	CHECKSUM FOR BYTES 0-62	0xE4	0x1A	0x5E
64-66	MANUFACTURER'S JEDEC ID CODE	0x7F		
67	MANUFACTURER'S JEDEC ID CODE (continued)	0xDA		
68-71	RESERVED	0x00		
72	MANUFACTURING LOCATION	0x01 (Switzerland) 0x02 (Germany) 0x03 (USA)		
73-90	MODULE PART NUMBER (ASCII)	"SEN02G64C4BF2SA-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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