2048MB DDR3 – SDRAM Ultra Low Profile ECC DIMM

240 Pin unbuffered ECC DIMM

SGU02G72H1BG2SA-xxRT

2GByte in FBGA Technology

RoHS compliant

Options:

- Data Rate / Latency — Marking
  DDR3 1066 MT/s CL7 — -BB
  DDR3 1333 MT/s CL9 — -CC
- 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 (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 unbuffered Dual-In-Line Double Data Rate Synchronous DRAM Module with ECC
- Module organization: dual rank 256 x 72
- V_{DD} = 1.5V ±0.075V, V_{DDQ} 1.5V ±0.075V
- 1.5V I/O (SSTL_15 compatible)
- Fly-by-bus with termination for C/A & CLK bus
- Supports ECC, error detection and correction
- Ultra Low Profile (ULP)
- On-board I2C temperature sensor with integrated serial presence-detect (SPD) EEPROM (according to JEDEC JESD21C)
- Gold-contact pad
- This module family is fully pin and functional compatible to JEDEC PC3-12800 spec and MO-269. (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)]

- **DDR3 - SDRAM component Samsung K4B1G0846G**
- 128Mx8 DDR3 SDRAM in PG-TFBGA-78 package
- 8-bit prefetch architecture
- Programmable CAS Latency, CAS Write Latency, Additive Latency, Burst Length and Burst Type.
- On-Die-Termination (ODT) and Dynamic ODT for improved signal integrity.
- Refresh. Self Refresh and Power Down Modes.
- ZQ Calibration for output driver and ODT.
- System Level Timing Calibration Support via Write Leveling and Multi Purpose Register (MPR) Read Pattern.

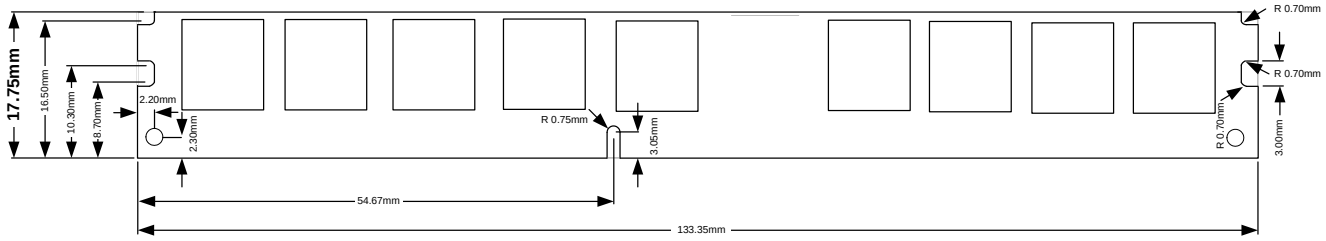


Figure: mechanical dimensions[1]

[1]if no tolerances specified ± 0.15mm

This Swissbit module is an industry standard 240-pin 8-byte DDR3 SDRAM Dual-In-line Memory Module (UDIMM) which is organized as x72 high speed CMOS memory arrays. The module uses internally configured octal-bank DDR3 SDRAM devices. The module uses double data rate architecture to achieve high-speed operation. DDR3 SDRAM modules operate from a differential clock (CK and CK#). READ and WRITE accesses to a DDR3 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 DDR3 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_15 compatible.
The DDR3 SDRAM module uses the serial presence detect (SPD) function implemented via serial EEPROM using the standard I^2C 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	DDR3 SDRAMs used	Row Addr.	Device Bank Addr.	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
133.35 (long) x 17.75 (high) x 4.00 [max] (thickness)

Timing Parameters

Part Number	Module Density	Transfer Rate	Clock Cycle/Data bit rate	Latency
SGU02G72H1BG2SA-BBRT	2048 MB	8.5 GB/s	1.87ns/1066MT/s	7-7-7
SGU02G72H1BG2SA-CCRT	2048 MB	10.6 GB/s	1.5ns/1333MT/s	9-9-9

Pin Name

A0 – A9, A11, A13	Address Inputs
A10/AP	Address Input / Autoprecharge Bit
A12/BC#	Address Input / Burst chop
BA0 – BA2	Bank Address Inputs
DQ0 – DQ63	Data Input / Output
CB0 – CB7	ECC check bits
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
S0#, S1#	Chip Select
CK0 – CK1	Clock Inputs, positive line

CK0# - CK1#	Clock Inputs, negative line
Event#	Temperature event: The EVENT# pin is asserted by the temperature sensor when critical
V_{DD}	Supply Voltage (1.5V± 0.075V)
V_{REF}DQ	Reference voltage: DQ, DM (VDD/2)
V_{REF}CA	Reference voltage: Control, command, and address (VDD/2)
V_{SS}	Ground
V_{TT}	Termination voltage: Used for control, command, and address (VDD/2).
V_{DDSPD}	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

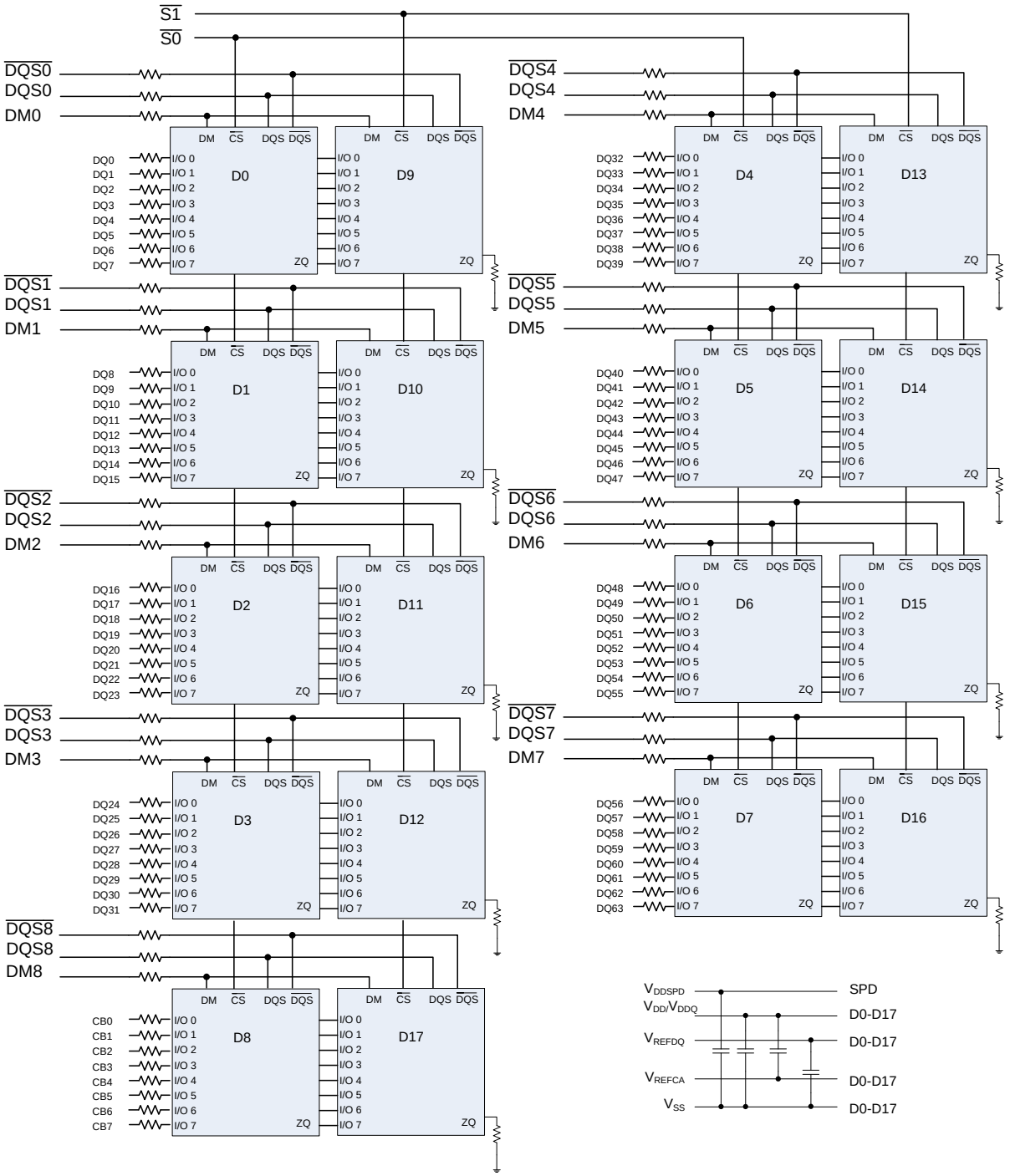
Frontside									
PIN	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**
1	V_{REFDQ}	27	DQ18	49	NC	75	V_{DD}	101	V_{SS}
2	V_{SS}	28	DQ19	50	CKE0	76	S1#	102	DQS6#
3	DQ0	29	V_{SS}	51	V_{DD}	77	ODT1	103	DQS6
4	DQ1	30	DQ24	52	BA2	78	V_{DD}	104	V_{SS}
5	V_{SS}	31	DQ25	53	NC(Err_Out#)	79	NC(S2#)	105	DQ50
6	DQS0#	32	V_{SS}	54	V_{DD}	80	V_{SS}	106	DQ51
7	DQS0	33	DQS3#	55	A11	81	DQ32	107	V_{SS}
8	V_{SS}	34	DQS3	56	A7	82	DQ33	108	DQ56
9	DQ2	35	V_{SS}	57	V_{DD}	83	V_{SS}	109	DQ57
10	DQ3	36	DQ26	58	A5	84	DQS4#	110	V_{SS}
11	V_{SS}	37	DQ27	59	A4	85	DQS4	111	DQS7#
12	DQ8	38	V_{SS}	60	V_{DD}	86	V_{SS}	112	DQS7
13	DQ9	39	CB0	61	A2	87	DQ34	113	V_{SS}
14	V_{SS}	40	CB1	62	V_{DD}	88	DQ35	114	DQ58
15	DQS1#	41	V_{SS}	63	CK1	89	V_{SS}	115	DQ59
16	DQS1	42	DQS8#	64	CK1#	90	DQ40	116	V_{SS}
17	V_{SS}	43	DQS8	65	V_{DD}	91	DQ41	117	SA0
18	DQ10	44	V_{SS}	66	V_{DD}	92	V_{SS}	118	SCL
19	DQ11	45	CB2	67	V_{REFCA}	93	DQS5#	119	SA2
20	V_{SS}	46	CB3	68	NC(Par_In)	94	DQS5	120	V_{TT}
21	DQ16	47	V_{SS}	69	V_{DD}	95	V_{SS}		
22	DQ17	48	NC	70	A10/ AP	96	DQ42		
23	V_{SS}			71	BA0	97	DQ43		
24	DQS2#			72	V_{DD}	98	V_{SS}		
25	DQS2			73	WE#	99	DQ48		
26	V_{SS}			74	CAS#	100	DQ49		

Signals in brackets (…) may be connected at the DIMM socket, but are not used on the DIMM

Backside									
PIN	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**	**PIN**	**Symbol**
121	V_{SS}	147	DQ23	169	CKE1	195	ODT0	221	DM6(DQS15)
122	DQ4	148	V_{SS}	170	V_{DD}	196	A13	222	NC(DQS15#)
123	DQ5	149	DQ28	171	NC(A15)	197	V_{DD}	223	V_{SS}
124	V_{SS}	150	DQ29	172	NC(A14)	198	NC(S3#)	224	DQ54
125	DM0(DQS9)	151	V_{SS}	173	V_{DD}	199	V_{SS}	225	DQ55
126	NC(DQS9#)	152	DM3(DQS12)	174	A12, BC#	200	DQ36	226	V_{SS}
127	V_{SS}	153	NC(DQS12#)	175	A9	201	DQ37	227	DQ60
128	DQ6	154	V_{SS}	176	V_{DD}	202	V_{SS}	228	DQ61
129	DQ7	155	DQ30	177	A8	203	DM4(DQS13)	229	V_{SS}
130	V_{SS}	156	DQ31	178	A6	204	NC(DQS13#)	230	DM7(DQS16)
131	DQ12	157	V_{SS}	179	V_{DD}	205	V_{SS}	231	NC(DQS16#)
132	DQ13	158	CB4	180	A3	206	DQ38	232	V_{SS}
133	V_{SS}	159	CB5	181	A1	207	DQ39	233	DQ62
134	DM1(DQS10)	160	V_{SS}	182	V_{DD}	208	V_{SS}	234	DQ63
135	NC(DQS10#)	161	DM8(DQS17)	183	V_{DD}	209	DQ44	235	V_{SS}
136	V_{SS}	162	NC(DQS17#)	184	CK0	210	DQ45	236	V_{DDSPD}
137	DQ14	163	V_{SS}	185	CK0#	211	V_{SS}	237	SA1
138	DQ15	164	CB6	186	V_{DD}	212	DM5(DQS14)	238	SDA
139	V_{SS}	165	CB7	187	NC(EVENT#)	213	NC(DQS14#)	239	V_{SS}
140	DQ20	166	V_{SS}	188	A0	214	V_{SS}	240	V_{TT}
141	DQ21	167	NC(TEST)	189	V_{DD}	215	DQ46		
142	V_{SS}	168	RESET#	190	BA1	216	DQ47		
143	DM2(DQS11)			191	V_{DD}	217	V_{SS}		
144	NC(DQS11#)			192	RAS#	218	DQ52		
145	V_{SS}			193	S0#	219	DQ53		
146	DQ22			194	V_{DD}	220	V_{SS}		

Signals in brackets (…) may be connected at the DIMM socket, but are not used on the DIMM

FUNCTIONAL BLOCK DIAGRAMM 2048MB DDR3 SDRAM DIMM, 2 RANKS AND 18 COMPONENTS



BA0-BA2 → BA0-BA2: SDRAM D0-D17
A0-A13 → A0-A13: SDRAM D0-D17
$\overline{RAS}$ → $\overline{RAS}$: SDRAM D0-D17
$\overline{CAS}$ → $\overline{CAS}$: SDRAM D0-D17
$\overline{WE}$ → $\overline{WE}$: SDRAM D0-D17
ODT0 → ODT: SDRAM D0-D8
ODT1 → ODT: SDRAM D9-D17
CKE0 → CKE: SDRAM D0-D8
CKE1 → CKE: SDRAM D9-D17
CK0,CK1 → CK: SDRAM D0-D17
$\overline{CK0,CK1}$ → $\overline{CK}$: SDRAM D0-D17
$\overline{RESET}$ → $\overline{RESET}$: SDRAM D0-D17

Notes:
1. DQ-to-I/O wiring is shown as recommended but may be changed.
2. DQ/DQS/$\overline{DQS}$/ODT/DM/CKE/$\overline{S}$ relationship must be maintained as shown.
3. DQ, DM, DQS/$\overline{DQS}$ resistors: Refer to associated topology diagram.
4. Refer to the appropriate clock wiring topology under the DIMM wiring details section of the JEDED document.
5. For each DRAM, a unique ZQ resistor is connected to GND. The ZQ resistor is 240Ω±1%.
6. Refer to associated figure for SPD details.

MAXIMUM ELECTRICAL DC CHARACTERISTICS

PARAMETER/ CONDITION	SYMBOL	MIN	MAX	UNITS
Supply Voltage	V_{DD}	-0.4	1.975	V
I/O Supply Voltage	V_{DDQ}	-0.4	1.975	V
V_{DDL} Supply Voltage	V_{DDL}	-0.4	1.975	V
Voltage on any pin relative to V_{SS}	V_{IN}, V_{OUT}	-0.4	1.975	V
INPUT LEAKAGE CURRENT Any input 0V ≤ V_{IN} ≤ V_{DD}, V_{REF} pin 0V ≤ V_{IN} ≤ 0.95V (All other pins not under test = 0V)	I_I			µA
Command/Address RAS#, CAS#, WE#, S#, CKE		-16	16	
CK, CK#		-16	16	
DM		-2	2	
OUTPUT LEAKAGE CURRENT (DQ's and ODT are disabled; 0V ≤ V_{OUT} ≤ V_{DDQ})	I_{OZ}	-5	5	µA
DQ, DQS, DQS#				
V_{REF} LEAKAGE CURRENT ; V_{REF} is on a valid level	I_{VREF}	-8	8	µA

DC OPERATING CONDITIONS

PARAMETER/ CONDITION	SYMBOL	MIN	NOM	MAX	UNITS
Supply Voltage	V_{DD}	1.425	1.5	1.575	V
I/O Supply Voltage	V_{DDQ}	1.425	1.5	1.575	V
V_{DDL} Supply Voltage	V_{DDL}	1.425	1.5	1.575	V
I/O Reference Voltage	V_{REF}	0.49 x V_{DDQ}	0.50 x V_{DDQ}	0.51x V_{DDQ}	V
I/O Termination Voltage (system)	V_{TT}	0.49 x V_{DDQ}-20mV	0.50 x V_{DDQ}	0.51x V_{DDQ}+20mV	V
Input High (Logic 1) Voltage	$V_{IH\ (DC)}$	V_{REF} + 0.1		V_{DDQ} + 0.3	V
Input Low (Logic 0) Voltage	$V_{IL\ (DC)}$	-0.3		V_{REF} – 0.1	V

AC INPUT OPERATING CONDITIONS

PARAMETER/ CONDITION	SYMBOL	MIN	MAX	UNITS
Input High (Logic 1) Voltage	$V_{IH\ (AC)}$	V_{REF} + 0.175	-	V
Input Low (Logic 0) Voltage	$V_{IL\ (AC)}$	-	V_{REF} - 0.175	V

CAPACITANCE

At DDR3 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_{DD} Specifications and Conditions

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.5V ± 0.075V, V_{DD} = +1.5V ± 0.075V)

Parameter & Test Condition		Symbol	max.		Unit
			10600-999	8500-777	
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}	405	405	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} 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}	468	450	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}	Fast Exit	I_{DD2P}	216	216	mA
	Slow Exit		180	180	
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}	270	270	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}	270	270	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} (always fast exit)		I_{DD3P}	270	270	mA
ACTIVE STANDBY CURRENT: All device banks open; 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; All other Control and Address bus inputs are changing once every two clock cycles; DQ inputs changing once per clock cycle		I_{DD3N}	360	360	mA
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	630	mA

Parameter & Test Condition	Symbol	max.		Unit
		10600-999	8500-777	
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}	720	630	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}	1620	1530	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}	180	180	mA
OPERATING CURRENT*) : Four device bank interleaving READs, I_{OUT} = 0mA; BL = 4, CL = CL (I_{DD}), AL = t_{RCD} (I_{DD}) – 1 x 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}	1260	1035	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_{DD} MEASUREMENT

I_{DD} MEASUREMENT CONDITIONS			
SYMBOL	**10600-999**	**8500-777**	**Unit**
CL (I_{DD})	9	7	t_{CK}
t_{RCD} (I_{DD})	13.5	13.125	ns
t_{RC} (I_{DD})	49.5	50.625	ns
t_{RRD} (I_{DD})	6	7.5	ns
t_{CK} (I_{DD})	1.5	1.87	ns
t_{RAS} MIN (I_{DD})	36	37.5	ns
t_{RAS} MAX (I_{DD})	70'200	70'200	ns
t_{RP} (I_{DD})	13.5	13.125	ns
t_{RFC} (I_{DD})	110	110	ns

DDR3 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.5V ± 0.075V, V_{DD} = +1.5V ± 0.075V)

AC CHARACTERISTICS			10600-999		8500-777		
PARAMETER		**SYMBOL**	**MIN**	**MAX**	**Min**	**MAX**	**Unit**
Clock cycle time	CL = 10	t_{CK} (10)	1.5	<1.875	-	-	ns
	CL = 9	t_{CK} (9)	1.5	<1.875	-	-	ns
	CL = 8	t_{CK} (8)	1.875	<2.5	-	-	ns
	CL = 7	t_{CK} (7)	1.875	<2.5	1.875	<2.5	ns
	CL = 6	t_{CK} (6)	2.5	3.3	2.5	3.3	ns
CK high-level width		t_{CH} (avg)	0.47	0.53	0.47	0.53	t_{CK}
CK low-level width		t_{CL} (avg)	0.47	0.53	0.47	0.53	t_{CK}
Data-out high-impedance window from CK/CK#		t_{HZ}		250		300	ps
Data-out low-impedance window from CK/CK#		t_{LZ}	-500	250	-600	300	ps
DQ and DM input setup time relative to DQS		$t_{DS(Base)}$	30		25		ps
DQ and DM input hold time relative to DQS		$t_{DH(Base)}$	65		100		ps
DQ and DM input setup time relative to DQS V_{REF}=1V/ns		t_{DS1V}	180		200		ps
DQ and DM input hold time relative to DQS V_{REF}=1V/ns		t_{DH1V}	165		200		ps
DQ and DM input pulse width (for each input)		t_{DIPW}	400		490		ps
DQS, DQS# to DQ skew, per access		t_{DQSQ}		125		150	ps
DQ-DQS hold, DQS to first DQ to go non-valid, per access		t_{QH}	0.38		0.38		t_{CK} (AVG)
DQS input high pulse width		t_{DQSH}	0.45	0.55	0.45	0.55	t_{CK}
DQS input low pulse width		t_{DQSL}	0.45	0.55	0.45	0.55	t_{CK}
DQS, DQS# rising to/from CK, CK#		t_{DQSCK}	-255	255	-300	300	ps
DQS, DQS# rising to/from CK, CK# when DLL disabled		$t_{DQSCK\ DLL\ DIS}$	1	10	1	10	ns
DQS falling edge to CK rising - setup time		t_{DSS}	0.2		0.2		t_{CK}
DQS falling edge from CK rising - hold time		t_{DSH}	0.2		0.2		t_{CK}
DQS read preamble		t_{RPRE}	0.9	Note1	0.9	Note1	t_{CK}
DQS read postamble		t_{RPST}	0.3	Note2	0.3	Note2	t_{CK}
DQS write preamble		t_{WPRE}	0.9		0.9		t_{CK}
DQS write postamble		t_{WPST}	0.3		0.3		t_{CK}
Positive DQS latching edge to associated clock edge		t_{DQSS}	- 0.25	+ 0.25	- 0.25	+ 0.25	t_{CK}
Address and control input pulse width (for each input)		t_{IPW}	620		780		ps
CTRL, CMD, Addr setup to CK, CK#		$t_{IS(Base)}$	65		125		ps
CTRL, CMD, Addr setup to CK, CK# V_{REF} @ 1V/ns		$t_{IS(1V)}$	240		300		ps

1 The maximum preamble is bound by tLZDQS (MAX)

2 The maximum postamble is bound by tHZDQS (MAX)

DDR3 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Continued)

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.5V ± 0.075V, V_{DD} = +1.5V ± 0.075V)

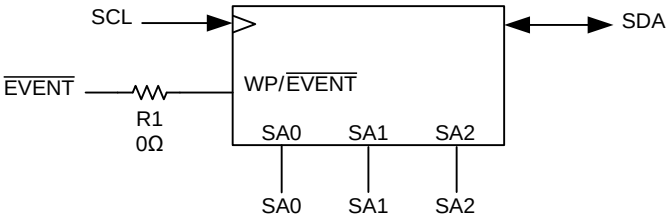
AC CHARACTERISTICS			10600-999		8500-777		
PARAMETER		SYMBOL	MIN	MAX	MIN	MAX	Unit
CTRL, CMD, Addr hold to CK, CK#		$t_{IH(Base)}$	140		200		ps
CTRL, CMD, Addr hold to CK, CK# V_{REF} @ 1V/ns		$t_{IH(1V)}$	240		300		ps
CAS# to CAS# command delay		t_{CCD}	4		4		t_{CK}
ACTIVE to ACTIVE (same bank) command period		t_{RC}	49.5		50.625		ns
ACTIVE bank *a* to ACTIVE bank *b* command		t_{RRD}	max 4nCK,10ns		max 4nCK,7.5ns		ns
ACTIVE to READ or WRITE delay		t_{RCD}	13.5		13.125		ns
Four bank Activate period	1K Page size	t_{FAW}	30		37.5		ns
	2K Page size		45		50		
ACTIVE to PRECHARGE command		t_{RAS}	36	70’200	37.5	70’200	ns
Internal READ to precharge command delay		t_{RTP}	max 4nCK,7.5ns		max 4nCK,7.5ns		ns
Write recovery time		t_{WR}	15		15		ns
Auto precharge write recovery + precharge time		t_{DAL}	$t_{WR} + t_{RP}/t_{CK}$		$t_{WR} + t_{RP}/t_{CK}$		ns
Internal WRITE to READ command delay		t_{WTR}	max 4nCK,7.5ns		max 4nCK,7.5ns		ns
PRECHARGE command period		t_{RP}	13.5		13.125		ns
LOAD MODE command cycle time		t_{MRD}	4		4		t_{CK}
REFRESH to ACTIVE or REFRESH to REFRESH command interval		t_{RFC}	110	70’200	110	70’200	ns
Average periodic refresh interval 0 °C ≤ T_{CASE} ≤ 85°C		t_{REFI}		7.8		7.8	µs
85 °C < T_{CASE} ≤ 95°C		$t_{REFI\ (IT)}$		3.9		3.9	
RTT turn-on from ODTL on reference		t_{AON}	-250	250	-300	300	ps
RTT turn-on from ODTL off reference		t_{AOF}	0.3	0.7	0.3	0.7	t_{CK}
Asynchronous RTT turn-on delay (power Down with DLL off)		t_{AONPD}	2	8,5	2	8,5	ns
Asynchronous RTT turn-off delay (power Down with DLL off)		t_{AOFPD}	2	8,5	2	8,5	ns
RTT dynamic change skew		t_{ADC}	0.3	0.7	0.3	0.7	t_{CK}
Exit self refresh to commands not requiring a locked DLL		t_{XS}	max 5nCK,tR FC + 10ns		max 5nCK,tR FC + 10ns		ns
Write levelling setup from rising CK, CK# crossing to rising DQS, DQS# crossing		t_{WLS}	195		245		ps
Write levelling setup from rising DQS, DQS# crossing to rising CK, CK# crossing		t_{WLH}	195		245		ps
First DQS, DQS# rising edge		t_{WLMRD}	40		40		t_{CK}
DQS, DQS# delay		$t_{WLDQSEN}$	25		25		t_{CK}

DDR3 SDRAM COMPONENT ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Continued)

(0°C ≤ T_{CASE} ≤ + 85°C; V_{DDQ} = +1.5V ± 0.075V, V_{DD} = +1.5V ± 0.075V)

AC CHARACTERISTICS		10600-999		8500-777		
PARAMETER	**SYMBOL**	**MIN**	**MAX**	**Min**	**MAX**	**Unit**
Exit reset from CKE HIGH to a valid command	t_{XPR}	max 5nCK, t_{RFC} + 10ns		max 5nCK, t_{RFC} + 10ns		t_{CK}
Begin power supply ramp to power supplies stable	t_{VDDPR}		200		200	ms
RESET# LOW to power supplies stable	t_{RPS}		200		200	ms
RESET# LOW to I/O and RTT High-Z	t_{IOz}		20		20	ns
Exit precharge power-down to any non-READ command	t_{XP}	max 3nCK,6ns		max 3nCK,7.5ns		t_{CK}
CKE minimum high/low time	t_{CKE}	max 3nCK, 5.625ns		max 3nCK, 5.625ns		t_{CK}

Temperature Sensor with Serial Presence-Detect EEPROM



Temperature Sensor with Serial Presence-Detect EEPROM Operating Conditions

Parameter / Condition	Symbol	MIN	MAX	Unit
Supply voltage	V_{DDSPD}	+3	+3.6	V
Supply current: V_{DD} = 3.3V	I_{DD}		+2.0	mA
Input high voltage: Logic 1; SCL, SDA	V_{IH}	+1.45	V_{DDSPD} +1	V
Input low voltage: Logic 0; SCL, SDA	V_{IL}	-	550	mV
Output low voltage: I_{OUT} = 2.1mA	V_{OL}	-	400	mV
Input current	I_{IN}	-5.0	5.0	µA
Temperature sensing range		TBD	TBD	°C
Temperature sensor accuracy		TBD	TBD	°C

A.C. Characteristics of Temperature Sensor

V_{CC} = 3.3 V ± 10%, T_A = −40°C to +125°C

Symbol	Parameter / Condition	MIN	MAX	Unit
f_{SCL}	SCL clock frequency	10	400	kHz
t_{BUF}	Bus Free Time Between STOP and START	1300		ns
t_F	SDA fall time		300	ns
t_R	SDA rise time		300	ns
$t_{HD:DAT}$	Data hold time (accepted for Input Data)	0		ns
	Data Hold Time (guaranteed for Output Data)	300	900	ns
$t_{H:STA}$	Start condition hold time	600		ns
t_{HIGH}	High Period of SCL	600		ns
t_{LOW}	Low Period of SCL	1300		ns
$t_{SU:DAT}$	Data setup time	100		ns
$t_{SU:STA}$	Start condition setup time	600		ns
$t_{SU:STO}$	Stop condition setup time	600		ns
$t_{TIMEOUT}$	SMBus SCL Clock Low Timeout	25	35	ms
t_I	Noise Pulse Filtered at SCL and SDA Inputs		100	ns
t_{WR}	Write Cycle Time		5	ms
t_{PU}	Power-up Delay to Valid Temperature Recording		100	ms

Temperature Characteristics of Temperature Sensor

V_{CC} = 3.3 V ± 10%, T_A = −40°C to +125°C

Parameter	Test Conditions/Comments	MAX	Unit
Temperature Reading Error Class B, JC42.4 compliant	+75°C ≤ T_A ≤ +95°C, active range	±1.0	°C
	+40°C ≤ T_A ≤ +125°C, monitor range	±2.0	°C
	-40°C ≤ T_A ≤ +125°C, sensing range	±3.0	°C
ADC Resolution		12	Bits
Temperature Resolution		0.0625	°C
Conversion Time		100	Ms
Thermal Resistance[1] θ_{JA}	Junction-to-Ambient (Still Air)	92	°C/W

[1] Power Dissipation is defined as $P_J = (T_J - T_A)/\theta_{JA}$, where TJ is the junction temperature and TA is the ambient temperature. The thermal resistance value refers to the case of a package being used on a standard 2-layer PCB.

Slave Address Bits of Temperature Sensor

Device	Device Type Identifier				Select Address Signals			R/W#
	b7[1]	b6	b5	b4	b3	b2	b1	b0
EEPROM	1	0	1	0	A_2	A_1	A_0	R/W#
Temp. Sensor	0	0	1	1	A_2	A_1	A_0	R/W#

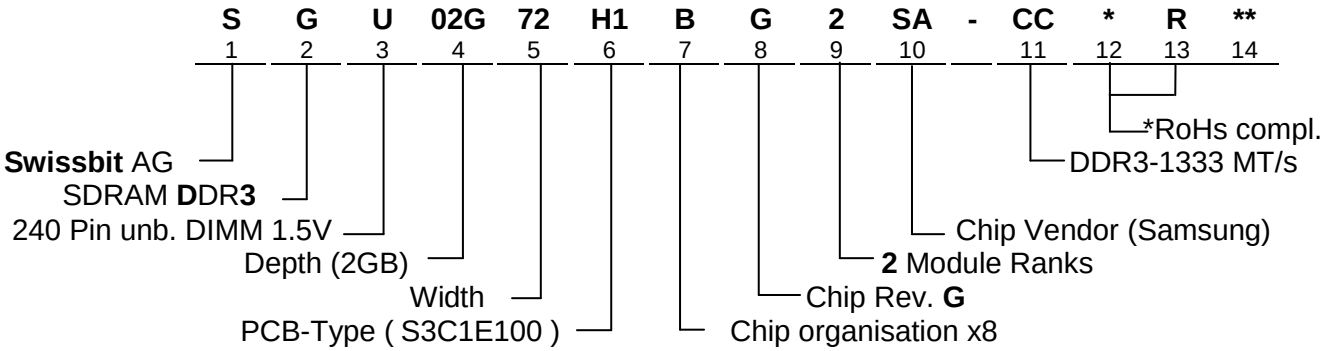
[1] The most significant bit, b7, is sent first.

SERIAL PRESENCE-DETECT MATRIX

Byte	Byte Description	10600-999	8500-777
0	CRC RANGE, EEPROM BYTES, BYTES USED	0x92	
1	SPD REVISON	0x10	
2	DRAM DEVICE TYPE	0x0B	
3	MODULE TYPE (FORM FACTOR)	0x02	
4	SDRAM DEVICE DENSITY & BANKS	0x02	
5	SDRAM DEVICE ROW & COLUMN COUNT	0x11	
6	BYTE 6 RESERVED	0x00	
7	MODULE RANKS & DEVICE DQ COUNT	0x09	
8	ECC TAG & MODULE MEMORY BUS WIDTH	0x0B	
9	FINE TIMEBASE DIVIDEND/DIVISOR	0x52	
10	MEDIUM TIMEBASE DIVIDEND	0x01	
11	MEDIUM TIMEBASE DIVISOR	0x08	
12	MIN SDRAM CYCLE TIME ($t_{CK\ MIN}$)	0x0C	0x0F
13	BYTE 13 RESERVED	0x00	
14	CAS LATENCIES SUPPORTED (CL4 => CL11)	0x3C	0x1C
15	CAS LATENCIES SUPPORTED (CL12 => CL18)	0x00	
16	MIN CAS LATENCY TIME ($t_{AA\ MIN}$)	0x69	
17	MIN WRITE RECOVERY TIME ($t_{WR\ MIN}$)	0x78	
18	MIN RAS# TO CAS# DELAY ($t_{RCD\ MIN}$)	0x69	
19	MIN ROW ACTIVE TO ROW ACTIVE DELAY ($t_{RRD\ MIN}$)	0x30	0x3C
20	MIN ROW PRECHARGE DELAY ($t_{RP\ MIN}$)	0x69	
21	UPPER NIBBLE FOR t_{RAS} & t_{RC}	0x11	
22	MIN ACTIVE TO PRECHARGE DELAY ($t_{RAS\ MIN}$)	0x20	0x2C
23	MIN ACTIVE TO ACTIVE/REFRESH DELAY ($t_{RC\ MIN}$)	0x89	0x95
24	MIN REFRESH RECOVERY DELAY ($t_{RFC\ MIN}$) LSB	0x70	
25	MIN REFRESH RECOVERY DELAY ($t_{RFC\ MIN}$) MSB	0x03	
26	MIN INTERNAL WRITE TO READ CMD DELAY ($t_{WTR\ MIN}$)	0x3C	
27	MIN INTERNAL READ TO PRECHARGE CMD DELAY ($t_{RTP\ MIN}$)	0x3C	
28	MIN FOUR ACTIVE WINDOW DELAY ($t_{FAW\ MIN}$) MSB	0x00	0x01
29	MIN FOUR ACTIVE WINDOW DELAY ($t_{FAW\ MIN}$) LSB	0xF0	0x2C
30	SDRAM DEVICE OUTPUT DRIVERS SUPPORTED	0x83	
31	SDRAM DEVICE THERMAL & REFRESH OPTIONS	0x01	

Byte	Byte Description	10600-999	8500-777
32	MODULE THERMAL SENSOR	0x80	
33	SDRAM DEVICE TYPE	0x00	
	BYTES 32-59 RESERVED	0x00	
60	MODULE HEIGHT (NOMINAL)	0x03	
61	MODULE THICKNESS (MAX)	0x11	
62	REFERENCE RAW CARD ID	0x04	
63	ADDRESS MAPPING EDGE CONECTOR TO DRAM	0x01	
64-116	BYTES 64-116 RESEVED	0x00	
117	MODULE MFR ID (LSB)	0x83	
118	MODULE MFR ID (MSB)	0xDA	
119	MODULE MFR LOCATION ID	0x01 (Switzerland) 0x02 (Germany) 0x03 (USA)	
120	MODULE MFR YEAR	x	
121	MODULE MFR WEEK	x	
122-125	MODULE SERIAL NUMBER	x	
126-127	CRC	0x346A	0x76C3
128-145	MODULE PART NUMBER	"SGU02G72H1BG2SA-xx"	
146	MODULE DIE REV	0x52	
147	MODULE PCB REV	0x54	
148	DRAM DEVICE MFR ID (LSB)	0x80	
149	DRAM DEVICE MFR (MSB)	0xCE	
150-175	MFR RESERVED BYTES 150-175	0xFF	
176-255	CUSTOMER RESERVED BYTES 176-255	0xFF	

Part Number Code



* optional / additional information
** T = Termal Sensor on Module

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