

# **DDR3L-1.35V**

## **SODIMM Module**

**4GB based on 4Gbit component**

**FBGA with Pb-Free**



**Revision 1.0 (JAN. 2012)**  
-Initial Release

### 1.0 Feature

- JEDEC standard 1.35V(1.28V~1.45V) & 1.5V(1.425V~1.575V) Power Supply
- VDDQ = 1.35V(1.28V~1.45V) & 1.5V(1.425V~1.575V)
- Programmable CAS latencies 6,7,8,9,10,11,13
- Programmable Additive Latency(Posted CAS) : 0, CL - 2, or CL - 1 clock
- Programmable CAS Write Latency(CWL) = 5 (DDR3-800), 6 (DDR3-1066), 7 (DDR3-1333), 8 (DDR3-1600) and 9 (DDR3-1866)
- 400MHz fCK for 800Mb/sec/pin, 533MHz fCK for 1066Mb/sec/pin, 667MHz fCK for 1333Mb/sec/pin, 800MHz fCK for 1600Mb/sec/pin, 900MHz fCK for 1866Mb/sec/pin
- Bi-directional Differential Data Strobe
- Burst Length: 8 (Interleave without any limit, sequential with starting address “000” only), 4 with tCCD = 4 which does not allow seamless read or write [either On the fly using A12 or MRS]
- On-Die termination using ODT pin
- 8 independent internal bank
- Asynchronous Reset
- Average Refresh Period 7.8us at lower than a TCASE 85°C, 3.9us at 85°C < TCASE < 95 °C
- Serial presence detect with EEPROM
- DIMM Dimension (Nominal) 30.00 mm high, 133.35 mm wide
- Based on JEDEC standard reference Raw Cards Lay out.
- RoHS compliant
- Gold plated contacts

### 2.0 Ordering Information

Part number	Density	Module Organization	Component composition	Component PKG	Module Rank	Description
W160SA4GSL	4GB	512Mx64	Samsung DRAM 512Mx8*16	TFBGA	1	4GB 1Rx8 PC3-12800U

Note: Second last Character of the Part Number stand for DRAM vendor  
S=Samsung; M=Micron; H=Hynix

### 3.0 Key Timing Parameters

	DD3-1600	Unit
CL-tRCD-tRP	11-11-11	tCK
CAS Latency	11	tCK
tCK(min)	1.25	ns
tRCD(min)	13.75	ns
tRP(min)	13.75	ns
tRAS(min)	35	ns
tRC(min)	48.75	ns

### 4.0 Absolute Maximum DC Rating

Symbol	Parameter	Rating	Units
V <sub>in</sub> , V <sub>out</sub>	Voltage on any pin relative to V <sub>SS</sub>	-0.4 ~ 1.975	V
V <sub>DD</sub>	Voltage on V <sub>DD</sub> & V <sub>DDQ</sub> supply relative to V <sub>SS</sub>	-0.4 ~ 1.975	V
V <sub>DDQ</sub>	Short circuit current	-0.4 ~ 1.975	V
V <sub>DDL</sub>	Power dissipation	-0.4 ~ 1.975	V
T <sub>STG</sub>	Storage Temperature	-55 ~ + 100	°C

**5.0 DIMM Pin Configurations (Front side/Back side)**

Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back
1	V <sub>REF</sub> DQ	2	V <sub>SS</sub>	71	V <sub>SS</sub>	72	V <sub>SS</sub>	139	V <sub>SS</sub>	140	DQ38
3	V <sub>SS</sub>	4	DQ4	KEY				141	DQ34	142	DQ39
5	DQ0	6	DQ5	73	CKE0	74	CKE1	143	DQ35	144	V <sub>SS</sub>
7	DQ1	8	V <sub>SS</sub>	75	V <sub>DD</sub>	76	V <sub>DD</sub>	145	V <sub>SS</sub>	146	DQ44
9	V <sub>SS</sub>	10	/DQS0	77	NC	78	A15	147	DQ40	148	DQ45
11	DM0	12	DQS0	79	BA2	80	A14	149	DQ41	150	V <sub>SS</sub>
13	V <sub>SS</sub>	14	V <sub>SS</sub>	81	V <sub>DD</sub>	82	V <sub>DD</sub>	151	V <sub>SS</sub>	152	/DQS5
15	DQ2	16	DQ6	83	A12/BC	84	A11	153	DM5	154	DQS5
17	DQ3	18	DQ7	85	A9	86	A7	155	V <sub>SS</sub>	156	V <sub>SS</sub>
19	V <sub>SS</sub>	20	V <sub>SS</sub>	87	V <sub>DD</sub>	88	V <sub>DD</sub>	157	DQ42	158	DQ46
21	DQ8	22	DQ12	89	A8	90	A6	159	DQ43	160	DQ47
23	DQ9	24	DQ13	91	A5	92	A4	161	V <sub>SS</sub>	162	V <sub>SS</sub>
25	V <sub>SS</sub>	26	V <sub>SS</sub>	93	V <sub>DD</sub>	94	V <sub>DD</sub>	163	DQ48	164	DQ52
27	/DQS1	28	DM1	95	A3	96	A2	165	DQ49	166	DQ53
29	DQS1	30	/RESET	97	A1	98	A0	167	V <sub>SS</sub>	168	V <sub>SS</sub>
31	V <sub>SS</sub>	32	V <sub>SS</sub>	99	V <sub>DD</sub>	100	V <sub>DD</sub>	169	/DQS6	170	DM6
33	DQ10	34	DQ14	101	/CK0	102	CK1	171	DQS6	172	V <sub>SS</sub>
35	DQ11	36	DQ15	103	CK0	104	/CK1	173	V <sub>SS</sub>	174	DQ54
37	V <sub>SS</sub>	38	V <sub>SS</sub>	105	V <sub>DD</sub>	106	V <sub>DD</sub>	175	DQ50	176	DQ55
39	DQ16	40	DQ20	107	A10/AP	108	BA1	177	DQ51	178	V <sub>SS</sub>
41	DQ17	42	DQ21	109	BA0	110	/RAS	179	V <sub>SS</sub>	180	DQ60
43	V <sub>SS</sub>	44	V <sub>SS</sub>	111	V <sub>DD</sub>	112	V <sub>DD</sub>	181	DQ56	182	DQ61
45	/DQS2	46	DM2	113	/WE	114	/S0	183	DQ57	184	V <sub>SS</sub>
47	DQS2	48	V <sub>SS</sub>	115	/CAS	116	ODT0	185	V <sub>SS</sub>	186	/DQS7
49	V <sub>SS</sub>	50	DQ22	117	V <sub>DD</sub>	118	V <sub>DD</sub>	187	DM7	188	DQS7
51	DQ18	52	DQ23	119	A13	120	ODT1	189	V <sub>SS</sub>	190	V <sub>SS</sub>
53	DQ19	54	V <sub>SS</sub>	121	/S1	122	NC	191	DQ58	192	DQ62
55	V <sub>SS</sub>	56	DQ28	123	V <sub>DD</sub>	124	V <sub>DD</sub>	193	DQ59	194	DQ63
57	DQ24	58	DQ29	125	TEST	126	V <sub>REF</sub> CA	195	V <sub>SS</sub>	196	V <sub>SS</sub>
59	DQ25	60	V <sub>SS</sub>	127	V <sub>SS</sub>	128	V <sub>SS</sub>	197	SA0	198	NC
61	V <sub>SS</sub>	62	/DQS3	129	DQ32	130	DQ36	199	V <sub>DD</sub> SPD	200	SDA
63	DM3	64	DQS3	131	DQ33	132	DQ37	201	SA1	202	SCL
65	V <sub>SS</sub>	66	V <sub>SS</sub>	133	V <sub>SS</sub>	134	V <sub>SS</sub>	203	V <sub>tt</sub>	204	V <sub>tt</sub>
67	DQ26	68	DQ30	135	/DQS4	136	DM4				
69	DQ27	70	DQ31	137	DQS4	138	V <sub>SS</sub>				

NC = No Connect, RFU = Reserved for Future Use

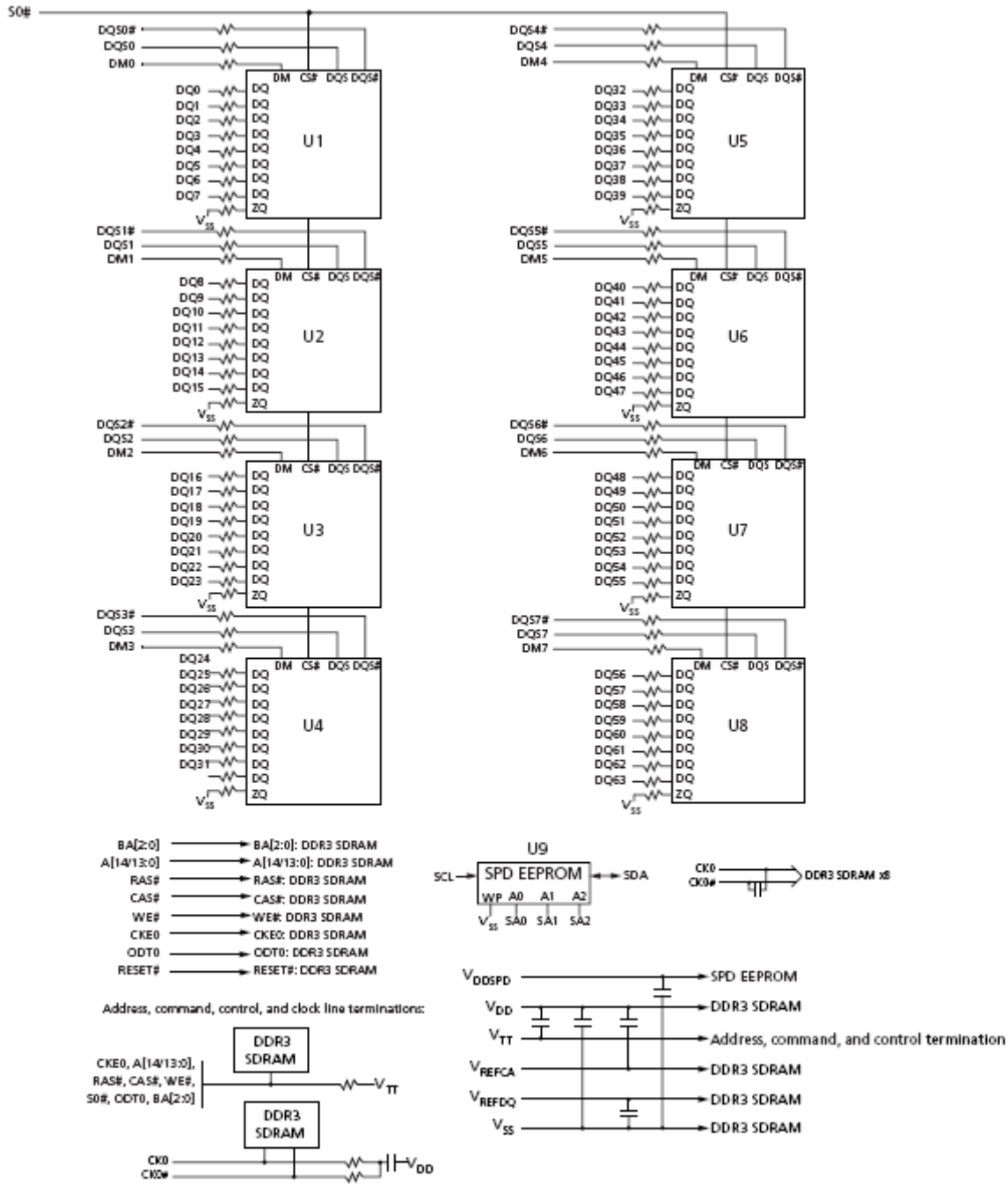
**6.0 DIMM Pin Description**

Pin Name	Function	Pin Name	Function
A0 ~ A15	Address input (Multiplexed)	ODT0~ODT1	On Die Termination
A10/AP	Address Input/Auto pre-charge	CB0~CB7	ECC Data check bits Input/Output
BA0 ~ BA2	Bank Select	DQ0~DQ63	Data Input/Output
/CK0 ~ /CK2, CK0~CK2	Clock input	/DQS0~/DQS8	Data strobes, negative line
CKE0, CKE1	Clock enable input	DM(0~8),	Data Masks/Data strobes (Read)
/S0, /S1	Chip select input	DQS0~DQS8	Data Strobes
/RAS	Row address strobe	RFU	Reserved for future used
/CAS	Column address strobe	V <sub>TT</sub>	SDRAM I/O termination power supply
/WE	Write Enable	TEST	Memory bus test tool
SCL	SPD Clock Input	V <sub>DD</sub>	Core Power
SDA	SPD Data Input/Output	V <sub>DDQ</sub>	I/O Power
SA0~SA2	SPD Address	V <sub>SS</sub>	Ground
Par_In	Parity bit for address & Control bus	V <sub>REFDQ</sub>	SDRAM Input/Output Reference Supply
Err_Out	Parity error found in the Address and Control bus	V <sub>DDSPD</sub>	Serial EEPROM Power Supply
/RESET	Register and PLL control pin	V <sub>REFCA</sub>	Command Address Reference Supply

**7.0 Address Configuration**

Organization	Row Address	Column Address	Bank Address	Auto Pre-charge
512Mx8(4Gb) base	A0-A15	A0-A9	BA0-BA2	A10/AP

**8.0 Functional Block Diagram: 4GB, 512Mx64 Module (Populated as 1 rank of x8)**



Note: 1. The ZQ ball on each DDR3 component is connected to an external 240Ω ± 1% resistor that is tied to ground. It is used for the calibration of the component's ODT and output driver.

**9.0 AC & DC Operating Conditions**

Recommended operating conditions (Voltage referenced to V<sub>SS</sub>=0V, TA=0 to 70°C)

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>DD</sub>	Supply Voltage	1.425	1.5	1.575	V
V <sub>DDQ</sub>	Supply Voltage for Output	1.425	1.5	1.575	V
V <sub>REFDQ(DC)</sub>	I/O Reference Voltage (DQ)	0.49*V <sub>DDQ</sub>	0.50*V <sub>DDQ</sub>	0.51*V <sub>DDQ</sub>	V
V <sub>REFCA(DC)</sub>	I/O Reference Voltage (CMD/Add)	0.49*V <sub>DDQ</sub>	0.50*V <sub>DDQ</sub>	0.51*V <sub>DDQ</sub>	V
V <sub>TT</sub>	Termination Voltage	0.49*V <sub>DDQ</sub>	0.50*V <sub>DDQ</sub>	0.51*V <sub>DDQ</sub>	V

**10.0 Capacitance (Max.)**

Symbol	Parameter/Condition	Min	Max	Unit
CCK	Input capacitance, CK and $\overline{CK}$	-	11	pF
CI1	Input capacitance, CKE and $\overline{CS}$	-	12	pF
CI2	Input capacitance, Addr, RAS, CAS, $\overline{WE}$	-	12	pF
CIO	Input capacitance, DQ, DM, DQS, $\overline{DQS}$	-	10	pF

**11.1 AC Timing Parameters & Specifications**

(AC operating conditions unless otherwise noted)

Parameter	Symbol	DDR3-1600		Units
		min	max	
Minimum Clock Cycle Time (DLL off mode)	tCK(DLL_OFF)	8	-	ns
Average Clock Period	tCK(avg)	-		ps
Clock Period	tCK(abs)	tCK(avg) min +tJIT(per)min	tCK(avg) max +tJIT(per)max	ps
Average high pulse width	tCH(avg)	0.47	0.53	tCK(avg)
Average low pulse width	tCL(avg)	0.47	0.53	tCK(avg)
Clock Period Jitter	tJIT(per)	-70	70	ps
Clock Period Jitter during DLL locking period	tJIT(per, lck)	-60	60	ps
Cycle to Cycle Period Jitter	tJIT(cc)	140	-	ps
Cycle to Cycle Period Jitter during DLL locking period	tJIT(cc, lck)	120	-	ps
Cumulative error across 2 cycles	tERR(2per)	- 103	103	ps
Cumulative error across 3 cycles	tERR(3per)	- 122	122	ps
Cumulative error across 4 cycles	tERR(4per)	- 136	136	ps
Cumulative error across 5 cycles	tERR(5per)	- 147	147	ps
Cumulative error across 6 cycles	tERR(6per)	- 155	155	ps
Cumulative error across 7 cycles	tERR(7per)	- 163	163	ps
Cumulative error across 8 cycles	tERR(8per)	- 169	169	ps
Cumulative error across 9 cycles	tERR(9per)	- 175	175	ps
Cumulative error across 10 cycles	tERR(10per)	- 180	180	ps

**11.2 AC Timing Parameters & Specifications (con't)**

Parameter	Symbol	DDR3-1600		Units
		min	max	
Cumulative error across 11 cycles	tERR(11per)	- 184	184	ps
Cumulative error across 12 cycles	tERR(12per)	- 188	188	ps
Cumulative error across n = 13, 14 ... 49, 50 cycles	tERR(nper)	tERR(nper)min = (1 + 0.68ln(n))*tJIT(per)min tERR(nper)max = (1 = 0.68ln(n))*tJIT(per)max		ps
Absolute clock HIGH pulse width	tCH(abs)	0.43	-	tCK(avg)
Absolute clock Low pulse width	tCL(abs)	0.43	-	tCK(avg)
<b>Data Timing</b>				
DQS, /DQS to DQ skew, per group, per access	tDQSQ	-	100	ps
DQ output hold time from DQS, /DQS	tQH	0.38	-	tCK(avg)
DQ low-impedance time from CK, /CK	tLZ(DQ)	-450	225	ps
DQ high-impedance time from CK, /CK	tHZ(DQ)	-	225	ps
Data setup time to DQS, /DQS referenced to Vih(ac)/Vil(ac) levels	tDS(base) AC175	TBD	-	ps
	tDS(base) AC150	10	-	ps
Data hold time to DQS, /DQS referenced to Vih(ac)/Vil(ac) levels	tDH(base) DC100	45	-	ps
DQ and DM Input pulse width for each input	tDIPW	360	-	ps
<b>Data Strobe Timing</b>				
DQS, /DQS READ Preamble	tRPRE	0.9	-	tCK
DQS, /DQS differential READ Postamble	tRPST	0.3	-	tCK
DQS, /DQS output high time	tQSH	0.4	-	tCK(avg)
DQS, /DQS output low time	tQSL	0.4	-	tCK(avg)
DQS, /DQS WRITE Preamble	tWPRE	0.9	-	tCK
DQS, /DQS WRITE Postamble	tWPST	0.3	-	tCK
DQS, /DQS rising edge output access time from rising CK, /CK	tDQSCK	-225	225	ps
DQS, /DQS low-impedance time (Referenced from RL-1)	tLZ(DQS)	-450	225	ps
DQS, /DQS high-impedance time (Referenced from RL+BL/2)	tHZ(DQS)	-	225	ps
DQS, DQS differential input low pulse width	tDQSL	0.45	0.55	tCK
DQS, DQS differential input high pulse width	tDQSH	0.45	0.55	tCK
DQS, DQS rising edge to CK, /CK rising edge	tDQSS	-0.27	0.27	tCK(avg)
DQS, DQS falling edge setup time to CK, /CK rising edge	tDSS	0.18	-	tCK(avg)
DQS, DQS falling edge hold time to CK, /CK rising edge	tDSH	0.18	-	tCK(avg)
DLL locking time	tDLLK	512	-	nCK
internal READ Command to PRECHARGE Command delay	tRTP	max (4tCK, 7.5ns)	-	
Delay from start of internal write transaction to internal read command	tWTR	max (4tCK, 7.5ns)	-	
WRITE recovery time	tWR	15	-	ns
Mode Register Set command cycle time	tMRD	4	-	nCK
Mode Register Set command update delay	tMOD	max (12tCK, 15ns)	-	
CAS# to CAS# command delay	tCCD	4	-	nCK
Auto precharge write recovery + precharge time	tDAL(min)	WR + roundup (tRP / tCK(AVG))		nCK

**11.3 AC Timing Parameters & Specifications (con't)**

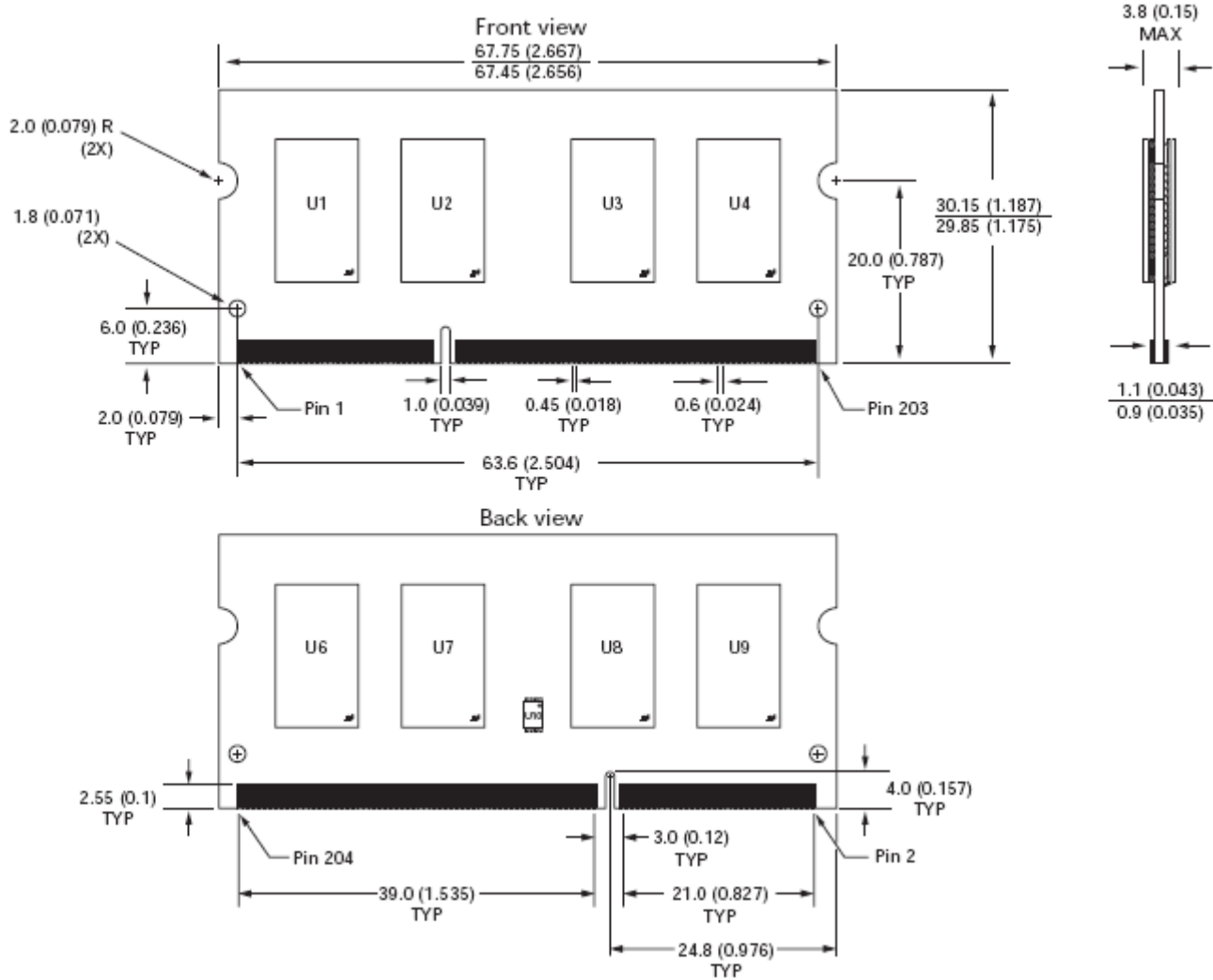
Parameter	Symbol	DDR3-1600		Units
		min	max	
Multi-Purpose Register Recovery Time	tMPRR	1	-	nCK
ACTIVE to PRECHARGE command period	tRAS	36	70,000	ns
ACTIVE to ACTIVE command period for 1KB page size	tRRD	max (4tCK,6ns)	-	
ACTIVE to ACTIVE command period for 2KB page size	tRRD	max (4tCK,7.5ns)	-	
Four activate window for 1KB page size	tFAW	30	-	ns
Four activate window for 2KB page size	tFAW	40	-	ns
Command and Address setup time to CK, /CK referenced to Vih(ac) / Vil(ac) levels	tIS(base) AC175	45	-	ps
	tIS(base) AC150	45+125	-	ps
Command and Address hold time from CK, /CK referenced to Vih(ac) / Vil(ac) levels	tIH(base) DC100	120	-	ps
Control & Address Input pulse width for each input	tIPW	560	-	ps
<b>Calibration Timing</b>				
Power-up and RESET calibration time	tZQinitl	512	-	tCK
Normal operation Full calibration time	tZQoper	256	-	tCK
Normal operation short calibration time	tZQCS	64	-	tCK
<b>Reset Timing</b>				
Exit Reset from CKE HIGH to a valid command	tXPR	max(5tCK, tRFC+ 10ns)	-	
<b>Self Refresh Timing</b>				
Exit Self Refresh to commands not requiring a locked DLL	tXS	max(5tCK, tRFC+ 10ns)	-	
Exit Self Refresh to commands requiring a locked DLL	tXSDLL	tDLLK(min)	-	nCK
Minimum CKE low width for Self refresh entry to exit timing	tCKESR	tCKE(min) + 1tCK	-	
Valid Clock Requirement after Self Refresh Entry (SRE)	tCKSRE	max(5tCK, 10ns)	-	
Valid Clock Requirement before Self Refresh Exit (SRX)	tCKSRX	max(5tCK, 10ns)	-	
<b>Power Down Timing</b>				
Exit Power Down with DLL on to any valid command; Exit Precharge Power Down with DLL frozen to commands not requiring a locked DLL	tXP	max (3tCK,6ns)	-	
Exit Precharge Power Down with DLL frozen to commands requiring a locked DLL	tXPDLL	max(10tCK, 24ns)	-	
CKE minimum pulse width	tCKE	max(3tCK, 5 ns)	-	
Command pass disable delay	tCPDED	1	-	nCK
Power Down Entry to Exit Timing	tPD	tCKE(min)	9*tREFI	tCK
Timing of ACT command to Power Down entry	tACTPDEN	1	-	nCK
Timing of PRE command to Power Down entry	tPRPDEN	1	-	nCK
Timing of RD/RDA command to Power Down entry	tRDPDEN	RL + 4 + 1	-	
Timing of WR command to Power Down entry (BL8OTF, BL8MRS, BL4OTF)	tWRPDEN	WL + 4 + (tWR/tCK)	-	nCK
Timing of WRA command to Power Down entry (BL8OTF, BL8MRS, BL4OTF)	tWRAPDEN	WL + 4 + WR+1	-	nCK
Timing of WR command to Power Down entry (BL4MRS)	tWRPDEN	WL + 2 + (tWR/ tCK(avg))	-	nCK



**11.4 AC Timing Parameters & Specifications (con't)**

Parameter	Symbol	DDR3-1600		Units
		min	max	
Timing of WRA command to Power Down entry (BL4MRS)	tWRAPDEN	WL +2 +WR +1	-	nCK
Timing of REF command to Power Down entry	tREFPDEN	1	-	
Timing of MRS command to Power Down entry	tMRSPDEN	tMOD(min)	-	
<b>ODT Timing</b>				
ODT high time without write command or with write command and BC4	ODTH4	4	-	nCK
ODT high time with Write command and BL8	ODTH8	6	-	nCK
Asynchronous RTT turn-on delay (Power-Down with DLL frozen)	tAONPD	2	8.5	ns
Asynchronous RTT turn-off delay (Power-Down with DLL frozen)	tAOFPD	2	8.5	ns
ODT turn-on	tAON	-225	225	ps
RTT_NOM and RTT_WR turn-off time from ODTL off reference	tAOF	0.3	0.7	tCK(avg)
RTT dynamic change skew	tADC	0.3	0.7	tCK(avg)
<b>Write Leveling Timing</b>				
First DQS pulse rising edge after tDQSS margining mode is programmed	tWLMRD	40	-	tCK
DQS/DQS delay after tDQSS margining mode is programmed	tWLDQSEN	25	-	tCK
Setup time for tDQSS latch	tWLS	165	-	ps
Hold time of tDQSS latch	tWLH	165	-	ps
Write leveling output delay	tWLO	0	7.5	ns
Write leveling output error	tWLOE	0	2	ns

**12.0 Physical Dimensions: 512Mbx8 Based, 512Mx64, 1 Rank**



Units: Millimeter  
Tolerances: ± 0.13) unless otherwise specified