

**ECC UDIMM
DDR5 4800 16GB
Datasheet
(SQR-UD5N16G4K8SEBB)**

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Revision History

Rev	Date	Modification
1.0	1 ST Mar., 2022	Official release

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1. Description

DDR5 ECC UDIMM							
Part Number	Density	Data rate	DIMM Organization	Number of DRAM	Number of rank	side	ECC
SQR-UD5N16G4K8SEBB (SAMSUNG 2Gx8(16Gb) A-die)	16GB	4800 MT/s	2Gx72	10	1	1	Y

2. Features

● Key Parameter

Data rate	tCK (ns)	tRCD (ns)	tRP (ns)	tRAS (ns)	tRC (ns)
4800 MT/s	0.416	16.00	16.00	32	48.00

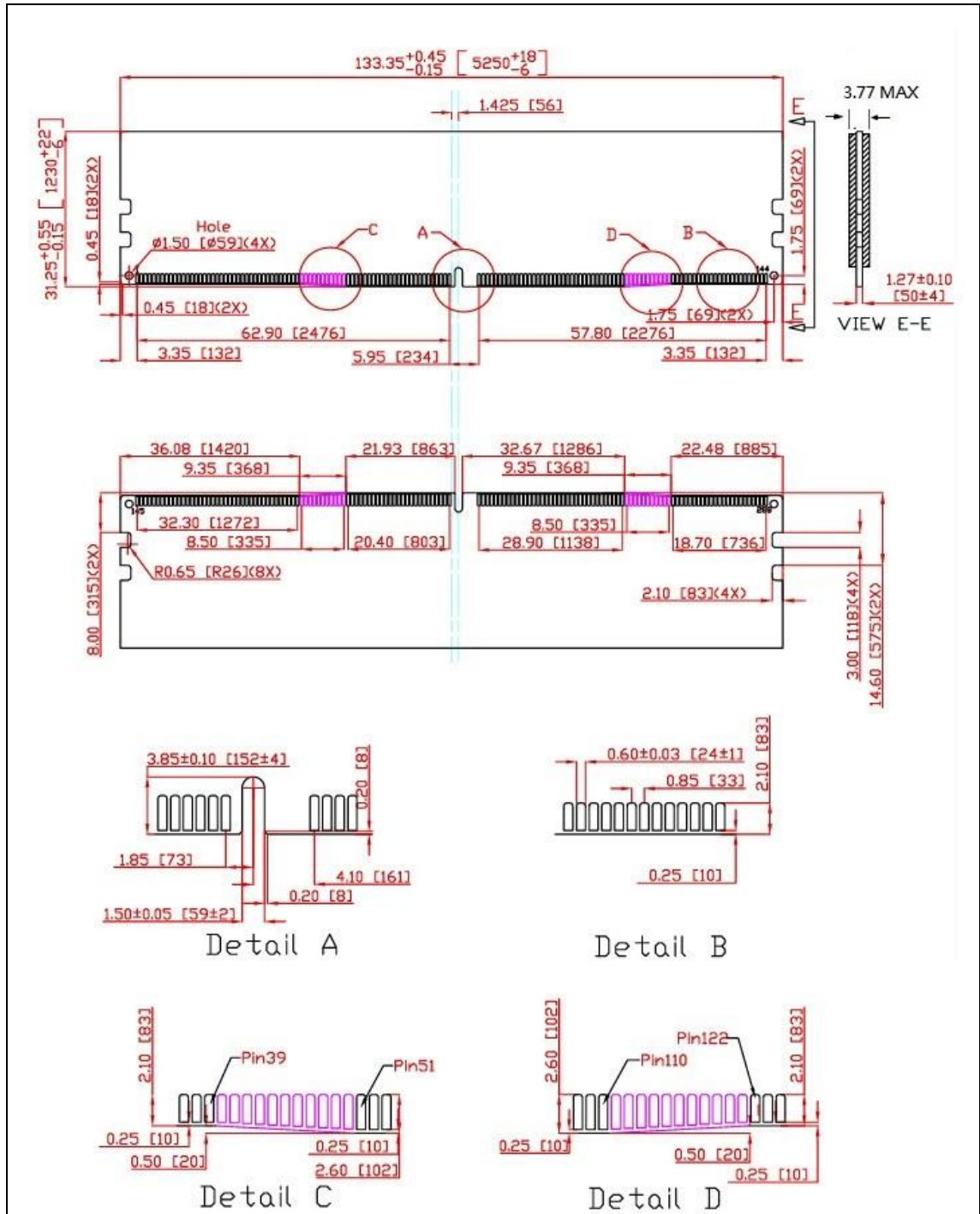
● tRFC parameter by Density

Parameter	8Gb	16Gb	24Gb	32Gb	Unit
tRFC1,min	195	295	TBD	TBD	ns
tRFC2,min	130	160	TBD	TBD	ns
tRFCsb,min	115	130	TBD	TBD	ns

- JEDEC Standard 288-pin Dual In-Line Memory Module
- Cl-tRCD-tRP: 40-39-39
- On-die, internal, adjustable VREF generation for DQ,CA,CS
- 16n-bit prefetch
- Two independent I/O sub channels
- Programmable /CAS Latency: 22,26,28,30,32,36,40,42
- Operating Temperature: Tc: 0-95C
 - ◆ tREFI 3.9us for 0°C ≤ Tcase < 85°C,
 - ◆ tREFI 1.95us for 85°C < Tcase ≤ 95°C
- On-Die ECC
- PMIC on DIMM, PMIC on DIMM, VIN_Bulk input supply range: 4.25 V to 5.5 V
- Fly-by topology
- I3C/I2C support
- Terminated control and C/A bus
- SPD EEPROM Hub and Integrated Thermal Sensor
- Halogen-free

3. Dimension

- (16GB, 1Ranks 2Gx8 DDR5 base UDIMM)



Note: All dimensions are in millimeters (mils) and should be kept within a tolerance of ± 0.15 (6), unless otherwise specified.

4. Pin Descriptions

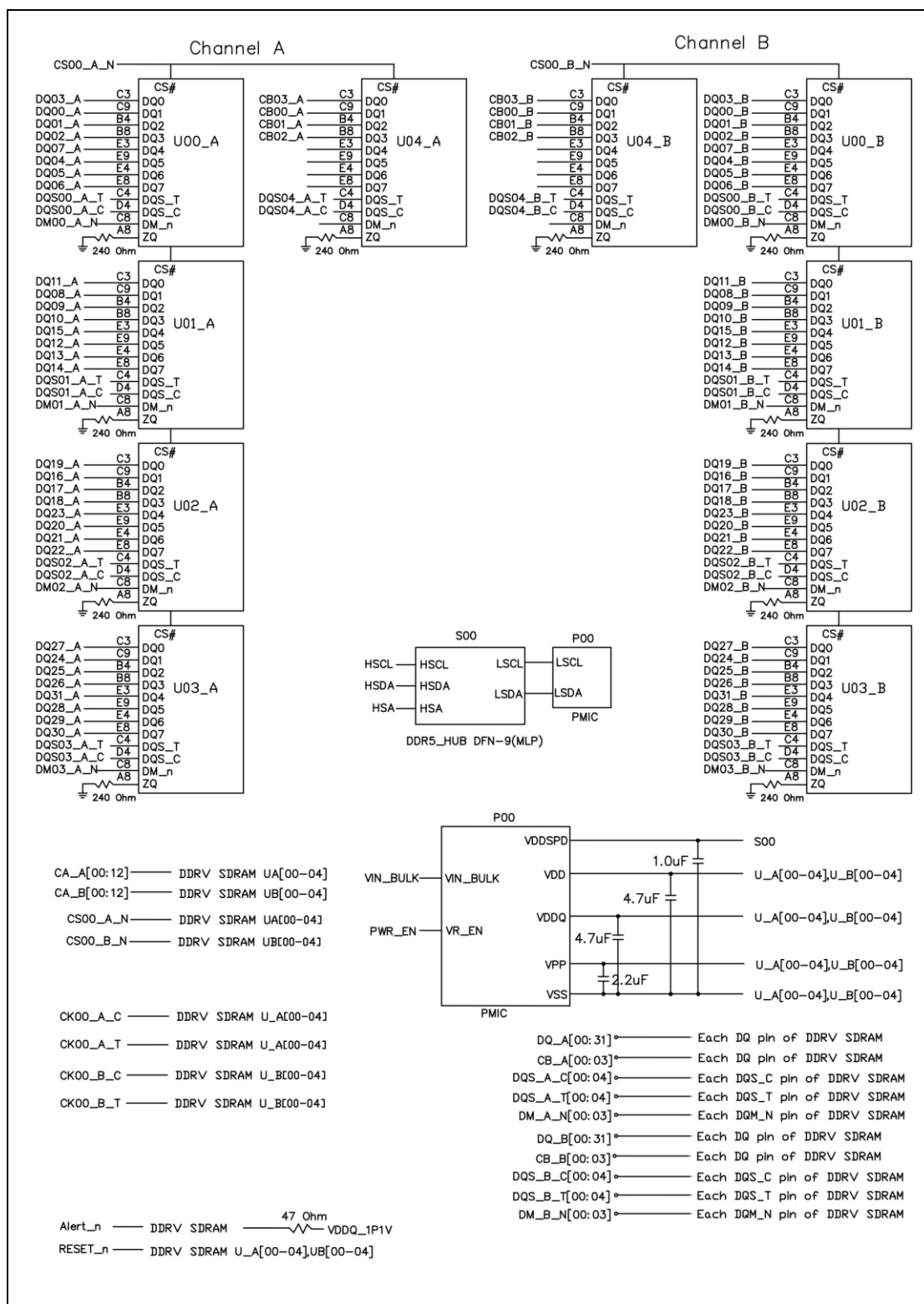
Symbol	Type	I/O Level	Description	Symbol	Type	I/O Level	Description
CK_t, CK_c	Input	VDDQ	Clock:	DQ[31:0]_A DQ[31:0]_B	Input/ Output	VDDQ	Data Input/Output
CA[12:0]_A CA[12:0]_B	Input	VDDQ	Command/Address Inputs	CB[3:0]_A CB[3:0]_B	Input/ Output	VDDQ	ECC Check Bits Input/Output
CS[1:0]_A CS[1:0]_B	Input	VDDQ	Chip Select	DQS[4:0]_A_t DQS[4:0]_B_t	Input/ Output	VDDQ	Data Strobe
ALERT_n	Output	VDDQ	Alert	DQS[4:0]_A_c DQS[4:0]_B_c	Input/ Output	VDDQ	Data Strobe
RESET_n	CMOS Input	VDDQ	Active Low Asynchronous Reset	DM[3:0]_A_n DM[3:0]_B_n	Input	VDDQ	Input Data Mask
PWR_GOOD	Input/ Output	VDDQ	Power Good Indicator	VIN_BULK	Supply		External Power Supply
HSCL	Input	VOUT	Host Sideband Bus Clock	PWR_EN	Input		PMIC Enable
HSDA	Input/ Output	VOUT	Host Sideband Bus Data	VSS	Supply		Ground
HAS	Input	GND	Host Sideband Bus Device ID	RFU			Reserved for future use

5. Pin Assignments

DDR5 2Gx8 base UDIMM

288-Pin DDR5 UDIMM Front								288-Pin DDR5 UDIMM Back							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	VIN_BULK	37	DQ20_A	73	CK0_A_c	109	Vss	145	VIN_BULK	181	DQ22_A	217	CK1_A_c	253	Vss
2	RFU	38	Vss	74	Vss	110	DQ5_B	146	VIN_BULK	182	Vss	218	Vss	254	DQ7_B
3	RFU	39	DQ21_A	75	RFU	111	Vss	147	PWR_GOOD	183	DQ23_A	219	RFU	255	Vss
4	HSC_L	40	Vss	76	RFU	112	DQ8_B	148	HAS	184	Vss	220	RFU	256	DQ10_B
5	HSDA	41	DQ24_A	77	Vss	113	Vss	149	RFU	185	DQ26_A	221	Vss	257	Vss
6	Vss	42	Vss	78	CK0_B_t	114	DQ9_B	150	Vss	186	Vss	222	CK1_B_t	258	DQ11_B
7	RFU	43	DQ25_A	79	CK0_B_c	115	Vss	151	PWR_EN	187	DQ27_A	223	CK1_B_c	259	Vss
8	Vss	44	Vss	80	Vss	116	DM1_B_n	152	RFU	188	Vss	224	Vss	260	DQS1_B_c
9	DQ0_A	45	DM3_A_n	81	RFU	117	Vss	153	Vss	189	DQS3_A_c	225	RFU	261	DQS1_B_t
10	Vss	46	Vss	82	CA12_B	118	DQ12_B	154	DQ2_A	190	DQS3_A_t	226	RFU	262	Vss
11	DQ1_A	47	DQ28_A	83	Vss	119	Vss	155	Vss	191	Vss	227	Vss	263	DQ14_B
12	Vss	48	Vss	84	CA10_B	120	DQ13_B	156	DQ3_A	192	DQ30_A	228	CA11_B	264	Vss
13	DQS0_A_c	49	DQ29_A	85	CA8_B	121	Vss	157	Vss	193	Vss	229	CA9_B	265	DQ15_B
14	DQS0_A_t	50	Vss	86	Vss	122	DQ16_B	158	DM0_A_n	194	DQ31_A	230	Vss	266	Vss
15	Vss	51	CB0_A	87	CA6_B	123	Vss	159	Vss	195	Vss	231	CA7_B	267	DQ18_B
16	DQ4_A	52	Vss	88	CA4_B	124	DQ17_B	160	DQ6_A	196	CB2_A	232	CA5_B	268	Vss
17	Vss	53	CB1_A	89	Vss	125	Vss	161	Vss	197	Vss	233	Vss	269	DQ19_B
18	DQ5_A	54	Vss	90	CA2_B	126	DQS2_B_c	162	DQ7_A	198	CB3_A	234	CA3_B	270	Vss
19	Vss	55	DQS4_A_c	91	CA0_B	127	DQS2_B_t	163	Vss	199	Vss	235	CA1_B	271	DM2_B_n
20	DQ8_A	56	DQS4_A_t	92	Vss	128	Vss	164	DQ10_A	200	ALERT_n	236	Vss	272	Vss
21	Vss	57	Vss	93	CS0_B_n	129	DQ20_B	165	Vss	201	Vss	237	CS1_B_n	273	DQ22_B
22	DQ9_A	58	CS0_A_n	94	Vss	130	Vss	166	DQ11_A	202	CS1_A_n	238	Vss	274	Vss
23	Vss	59	Vss	95	RESET_n	131	DQ21_B	167	Vss	203	Vss	239	DQS4_B_c	275	DQ23_B
24	DM1_A_n	60	CA0_A	96	Vss	132	Vss	168	DQS1_A_c	204	CA1_A	240	DQS4_B_t	276	Vss
25	Vss	61	CA2_A	97	CB0_B	133	DQ24_B	169	DQS1_A_t	205	CA3_A	241	Vss	277	DQ26_B
26	DQ12_A	62	Vss	98	Vss	134	Vss	170	Vss	206	Vss	242	CB2_B	278	Vss
27	Vss	63	CA4_A	99	CB1_B	135	DQ25_B	171	DQ14_A	207	CA5_A	243	Vss	279	DQ27_B
28	DQ13_A	64	CA6_A	100	Vss	136	Vss	172	Vss	208	CA7_A	244	CB3_B	280	Vss
29	Vss	65	Vss	101	DQ0_B	137	DM3_B_n	173	DQ15_A	209	Vss	245	Vss	281	DQS3_B_c
30	DQ16_A	66	CA8_A	102	Vss	138	Vss	174	Vss	210	CA9_A	246	DQ2_B	282	DQS3_B_t
31	Vss	67	CA10_A	103	DQ1_B	139	DQ28_B	175	DQ18_A	211	CA11_A	247	Vss	283	Vss
32	DQ17_A	68	Vss	104	Vss	140	Vss	176	Vss	212	Vss	248	DQ3_B	284	DQ30_B
33	Vss	69	CA12_A	105	DQS0_B_c	141	DQ29_B	177	DQ19_A	213	RFU	249	Vss	285	Vss
34	DQS2_A_c	70	RFU	106	DQS0_B_t	142	Vss	178	Vss	214	RFU	250	DM0_B_n	286	DQ31_B
35	DQS2_A_t	71	Vss	107	Vss	143	RFU	179	DM2_A_n	215	Vss	251	Vss	287	Vss
36	Vss	72	CK0_A_t	108	DQ4_B	144	RFU	180	Vss	216	CK1_A_t	252	DQ6_B	288	RFU

6. Block Diagram



7. Thermal Characteristics

Symbol	Parameter		Rating	Units	Note
T_c	Operation Temperature	Normal Operating Temp.	0 to 85	°C	1,2,3
		Extended Temp.	85 to 95	°C	1,2,3,4
T_{STG}	Storage Temperature		-55 to 100	°C	5

Note:

1. Maximum operating case temperature; T_c is measured in the center of the package.
2. A thermal solution must be designed to ensure the DRAM device does not exceed the maximum T_c during operation.
3. Device functionality is not guaranteed if the DRAM device exceeds the maximum T_c during operation.
4. If T_c exceeds 85°C, the DRAM must be refreshed externally at 2X refresh, which is a 1.95μs interval refresh rate.
5. Storage temperature is defined as the temperature of the top/center of the DRAM and does not reflect the storage temperatures of shipping trays.

8. IDD, IDDQ and IPP Specifications

Symbol	Description	Value (Typical)		Units
		IDD Max.	IPP Max.	
IDD0	Operating One Bank Active-Precharge Current	1030	80	mA
IDD0F	Operating Four Bank Active-Precharge Current	1420	100	mA
IDD2N	Precharge Standby Current	920	60	mA
IDD2P	Precharge Power-Down Current	880	60	mA
IDD3N	Active Standby Current	1420	70	mA
IDD3P	Active Power-Down Current	1420	70	mA
IDD4R	Operating Burst Read Current	3770	90	mA
IDD4W	Operating Burst Write Current	3490	370	mA
IDD5B	Burst Refresh Current (Normal Refresh Mode)	2770	280	mA
IDD5C	Burst Refresh Current (Same Bank Refresh Mode)	1350	120	mA
IDD6N	Self Refresh Current: Normal Temperature Range	1020	150	mA
IDD6E	Self Refresh Current: Extended Temperature Range	5020	230	mA
IDD7	Operating Bank Interleave Read Current	800	60	mA
IDD8	Maximum Power Saving Deep Power Down Current	1030	80	mA

The above information may be change due to the update of the device specifications and is for reference only.

9. Timing Parameters

Parameter	Symbol	4400		4800		5200		Unit
		Min	Max	Min	Max	Min	Max	
Clock Timing								
Average clock period	tCK,AVG	0.454	<0.500	0.416	<0.454	0.384	<0.416	ns
Command and Address Timing								
Read to Read command delay for same bank group	tCCD_L	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK
WRITE to WRITE command delay for same bank group	tCCD_L_WR	32nCK, 20ns (MAX)		32nCK, 20ns (MAX)		32nCK, 20ns (MAX)		nCK
WRITE to WRITE command delay for same bank group, second WRITE not RMW	tCCD_L_WR2	16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		nCK
Read to Read or Write to Write command delay for different bank group for BL16, BC8 OTF	tCCD_S	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to different bank group for 2KB page size	tRRD_S,2K	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to different bank group for 1KB page size	tRRD_S,1K	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to same bank group for 2KB page size	tRRD_L,2K	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK
ACTIVATE to ACTIVATE command delay to same bank group for 1KB page size	tRRD_L,1K	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK

Four activate window for 2KB page size	tFAW,2K	40nCK, 18.160ns (MAX)		40nCK, 16.640ns (MAX)		40nCK, 15.360ns (MAX)		ns
Four activate window for 1KB page size	tFAW,1K	32nCK, 14.528ns (MAX)		32nCK, 13.312ns (MAX)		32nCK, 12.288ns (MAX)		ns
Delay from start of internal WRITE transaction to internal READ command for different bank group	tWTR_S	4nCK, 2.5ns (MAX)		4nCK, 2.5ns (MAX)		4nCK, 2.5ns (MAX)		ns
Delay from start of internal WRITE transaction to internal READ command for same bank group	tWTR_L	16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		ns
Delay from start of internal WRITE transaction to internal READ with AUTO PRECHARGE command for same bank	tWTRA	tWR-tRTP		tWR-tRTP		tWR-tRTP		ns
Internal READ command to PRECHARGE command delay	tRTP	12nCK, 7.5ns (MAX)		12nCK, 7.5ns (MAX)		12nCK, 7.5ns (MAX)		ns
PRECHARGE to PRECHARGE delay	tPPD	2		2		2		nCK
WRITE recovery time	tWR	29.964		29.952		29.952		ns
DLL locking time	tDLLK	1280		1536		1536		nCK
Mode Register Read/Write Timing								
Mode register READ command period	tMRR	14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		
Mode register READ pattern to mode register READ pattern command spacing	tMRR_p	8		8		8		nCK
Mode register WRITE command period	tMRW	5ns,8nCK (MAX)		5ns,8nCK (MAX)		5ns,8nCK (MAX)		
Mode register SET command delay	tMRD	14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		
DFE mode register WRITE	tDFE	80		80		80		ns

update delay time								
Data Strobe Timing								
DQS_t, DQS_c differential READ preamble	tRPRE	TBD		TBD		TBD		tCK
DQS_t, DQS_c differential READ postamble	tRPST	TBD		TBD		TBD		tCK
DQS_t, DQS_c rising edge output timing location from rising CK_t, CK_c	tDQSCK	-0.286	0.286	-0.3	0.3	TBD	TBD	tCK
DQS_t, DQS_c rising edge output variance window	tDQSCKI		0.475		0.49		TBD	tCK
Data Strobe Timing								
2-tCK WRITE preamble enable window	tWPRE_EN_2 tCK	1.5		1.5		1.5		tCK
3-tCK WRITE preamble enable window	tWPRE_EN_3 tCK	2.5		2.5		2.5		tCK
4-tCK WRITE preamble enable window	tWPRE_EN_4 tCK	2.5		2.5		2.5		tCK
DQS_t, DQS_c differential WRITE postamble	tWPST	TBD		TBD		TBD		tCK
Final trained value of host DQS_t-DQS_c timing relative to CWL CK_t-CK_c edge	tDQSoffset	-0.5	0.5	-0.5	0.5	-0.5	0.5	tCK
Write leveling setup time	tWLS	-80	80	-80	80	-80	80	ps
Write leveling hold time	tWLH	-80	80	-80	80	-80	80	ps
Voltage/temperature drift window of first rising DQS_t preamble edge relative to CWL CK_t-CK_c edge (x4/x8/x16)	tDQSD	-0.25 x tWPRE_E N_ntCK	0.25 x tWPRE_E N_ntCK	-0.25 x tWPRE_E N_ntCK	0.25 x tWPRE_E N_ntCK	-0.25 x tWPRE_E N_ntCK	0.25 x tWPRE_E N_ntCK	tCK
Host and system voltage/ temperature drift window of first rising DQS_t preamble edge relative to CWL CK_t-CK_c edge	tDQSS	-0.25 x tWPRE_EN_ntCK						tCK

(x4/x8/x16)								
MPSM Timing								
MPSM exit to first valid command delay	tMPSMX	tMRD		tMRD		tMRD		ns
ZQ Calibration Timing								
ZQ calibration time	tZQCAL	1		1		1		μs
ZQ calibration latch time	tZQLAT	30ns, 8nCK (MIN)		30ns, 8nCK (MIN)		30ns, 8nCK (MIN)		
Reset Timing								
RESET_n low time for reset initialization with stable power	tPW_RESET	1		1		1		μs
Time after RESET_n assertion to ODT off	tRST_ADC		50		50		50	ns
Self Refresh Timing								
Command pass disable delay	tCPDED	5ns,8nCK (MAX)		5ns,8nCK (MAX)		5ns,8nCK (MAX)		
Self refresh CS_n low pulse width	tCSL	10		10		10		ns
Self refresh exit CS_n high pulse width	tCSH_Srexit	13	30	13	30	13	30	ns
Self refresh exit CS_n low pulse width	tCSL_Srexit	3nCK	30ns	3nCK	30ns	3nCK	30ns	
Self refresh exit CS_n low pulse width with frequency change	tCSL_FreqChg	VREFCA_time		VREFCA_time		VREFCA_time		ns
Valid clock requirement before SRX	tCKSRX	3.5ns, 8nCK (MAX)		3.5ns, 8nCK (MAX)		3.5ns, 8nCK (MAX)		ns
Valid clock requirement after SRE	tCKLCS	tCPDED + 1nCK		tCPDED + 1nCK		tCPDED + 1nCK		nCK
Self refresh exit CS_n HIGH	tCASRX	0		0		0		ns
Exit self refresh to commands not requiring a locked DLL	tXS	tRFC1		tRFC1		tRFC1		ns
Exit self refresh to commands requiring a locked DLL	tXS_DLL	tDLLK		tDLLK		tDLLK		ns

Power-Down Timing								
Command pass disable delay	tCPDED	5ns,8nCK (MAX)		5ns,8nCK (MAX)		5ns,8nCK (MAX)		ns
Power-down time	tPD	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	ns
Exit power-down to next valid command	tXP	7.5ns, 8nCK (MAX)		7.5ns, 8nCK (MAX)		7.5ns, 8nCK (MAX)		ns
Timing of ACT command to POWER DOWN ENTRY command	tACTPDEN	2		2		2		nCK
Timing of PREab, PREsb or PREpb command to POWER DOWN ENTRY command	tPRPDEN	2		2		2		nCK
Timing of READ or READ w/ AP command to POWER DOWN ENTRY command	tRDPDEN	CL +RBL/2+1		CL +RBL/2+1		CL +RBL/2+1		nCK
Timing of WRITE command to POWER DOWN ENTRY command	tWRPDEN	CWL +WBL/ 2+ (tWR/ tCK(avg)) +1		CWL +WBL/ 2+ (tWR/ tCK(avg)) +1		CWL +WBL/ 2+ (tWR/ tCK(avg)) +1		nCK
Timing of WRITE w/ AP command to POWER DOWN ENTRY command	tWRAPDEN	CWL +WBL/ 2+-0.25 x tWPRES_EN_n tCKWR+1		CWL +WBL/ 2+-0.25 x tWPRES_EN_n tCKWR+1		CWL +WBL/ 2+-0.25 x tWPRES_EN_n tCKWR+1		nCK
Timing of REFab or REFsb command to POWER DOWN ENTRY command	tREFPDEN	2		2		2		nCK
Timing of MRR command to POWER DOWN ENTRY command	tMRRPDEN	CL+8+1		CL+8+1		CL+8+1		nCK
Timing of MRW command to POWER DOWN ENTRY command	tMRWPDEN	tMRD (MIN)		tMRD (MIN)		tMRD (MIN)		nCK
Timing of MPC command to POWER DOWN	tMPCPDEN	tMPC_delay		tMPC_delay		tMPC_delay		nCK

ENTRY command								
MPC Command Timing								
MPC to any other valid command	tMPC_Delay	tMRD		tMRD		tMRD		nCK
Time between stable MPC command and first falling CS edge (setup)	tMC_MPC_Setup	3		3		3		nCK
Time between first rising CS edge and stable MPC command (HOLD)	tMC_MPC_Hold	3		3		3		nCK
Time CS _n is held LOW to register MPC command	tMPC_CS	3.5	8	3.5	8	3.5	8	nCK
PDA Timing								
PDA ENUMERATE ID command to any other command cycle	tPDA_DELAY	tPDA_DQS_DELAY (MAX) + BL/2 + 19ns		tPDA_DQS_DELAY (MAX) + BL/2 + 19ns		TBD		ns
Delay to rising strobe edge used for sampling DQ during PDA operation	tPDA_DQS_DELAY	5	18	5	18	TBD	TBD	ns
DQS setup time during PDA operation	tPDA_S	3		3		TBD		nCK
DQS hold time during PDA operation	tPDA_H	3		3		TBD		nCK
Read Training Timing								
Registration of MRW continuous burst mode exit to next valid command delay	tCont_Exit_Delay		tCont_Exit + tMRW		tCont_Exit + tMRW		tCont_Exit + tMRW	ns
Registration of MRW continuous burst mode exit to end of training mode	tCont_Exit		CL+BL/2+10nCK		CL+BL/2+10nCK		CL+BL/2+10nCK	ns
Read Preamble Timing								
Delay from MRW command to DQS driven	tSDOn		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)	
Delay from MRW command to DQS disabled	tSDOff		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)	
CA Training Mode Timing								
Registration of CATM entry	tCATM_Entry	20		20		20		ns

command to start of training samples time								
Registration of CATM exit CS_n assertion to end of training mode (when DQ is no longer driven by the device).	tCATM_Exit		14		14		14	ns
Registration of CATM exit to next valid command delay	tCATM_Exit_Delay	20		20		20		ns
Time from sample evaluation to output on DQ bus	tCATM_Valid		20		20		20	ns
Time output is available on DQ bus	tCATM_DQ_Window	2		2		2		nCK
CS_n assertion duration to exit CATM	tCATM_CS_Exit	2	8	2	8	2	8	nCK
Registration of CSTM entry command to start of training samples time	tCSTM_Entry	20		20		20		ns
Min time between last CS_n pulse and first pulse of MPC command to exit CSTM	tCSTM_Min_to_MPC_exit	4		4		4		nCK
Registration of CSTM exit command to end of training mode	tCSTM_Exit		20		20		20	ns
Time from sample evaluation to output on DQ bus	tCSTM_Valid		20		20		20	ns
Time output is available on DQ bus	tCSTM_DQ_Window	2		2		2		nCK
Registration of CSTM exit to next valid command delay	tCSTM_Exit_Delay	20		20		20		ns
Write Leveling Timing								
Write leveling pulse enable: time from write leveling training enable MRW	tWLPEN	0	15	0	15	0	15	ns

to when internal write leveling pulse logic level is valid								
Write leveling output delay	tWLO	0	9.5	0	9.5	0	9.5	ns
Write leveling output error	tWLOE	0	2	0	2	0	2	ns
Width of write leveling internal pulse	tWL_Pulse_Width	2		2		2		tCK
VREFCA/VREFCS Timing								
VREFCA/VREFCS command to any other valid command delay	tVREFCA_Delay/ tVREFCS_Delay	tMRD		tMRD		tMRD		nCK
Time CS_n is held LOW to register VREFCA/VREFCS command	tVREFCA_CS/ tVREFCS_CS	3.5	8	3.5	8	3.5	8	nCK
hPPR/sPPR Timing								
hPPR programming time (x4/x8)	tPGMa	1000		1000		1000		ms
hPPR programming time (x16)	tPGMb	2000		2000		2000		ms
sPPR programming time	tPGM_sPPR	CWL +8tCK +tWR		CWL +8tCK +tWR		CWL +8tCK +tWR		tCK
hPPR/sPPR recognition time	tPGM_Exit	tRP		tRP		tRP		ns
hPPR program exit and new address setting time	tPGMPST	50		50		50		μs
sPPR program exit and new address setting time	tPGMPST_sPPR	tMRD		tMRD		tMRD		ns
DQS Interval Oscillator Readout Timing								
Delay time from DQS interval oscillator stop to mode register readout	tOSCO	tMPC_De lay		tMPC_De lay		tMPC_De lay		nCK
DQS interval oscillator start gap in automatic stop mode	tOSCS	tMPC_Delay + DQS interval timer runtime						nCK
ECS Timing								
ECS operation time	tECSc	176nCK, 110ns (MAX)		176nCK, 110ns (MAX)		176nCK, 110ns (MAX)		
CRC Error Reporting Timing								

CRC error to ALERT n_latency	tCRC_ALERT	3	13	3	13	3	13	ns
CRC ALERT_n pulse width	CRC_ALERT_ PW	12	20	12	20	12	20	nCK

Parameter	Symbol	4400		4800		5200		Unit
		Min	Max	Min	Max	Min	Max	
Clock Timing								
Average clock period	tCK,AVG	0.454	<0.500	0.416	<0.454	0.384	<0.416	ns
Command and Address Timing								
Read to Read command delay for same bank group	tCCD_L	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK
WRITE to WRITE command delay for same bank group	tCCD_L_WR	32nCK, 20ns (MAX)		32nCK, 20ns (MAX)		32nCK, 20ns (MAX)		nCK
WRITE to WRITE command delay for same bank group, second WRITE not RMW	tCCD_L_WR2	16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		nCK
Read to Read or Write to Write command delay for different bank group for BL16, BC8 OTF	tCCD_S	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to different bank group for 2KB page size	tRRD_S,2K	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to different bank group for 1KB page size	tRRD_S,1K	8		8		8		nCK
ACTIVATE to ACTIVATE command delay to same bank group for 2KB page size	tRRD_L,2K	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK
ACTIVATE to ACTIVATE command delay to same bank group for 1KB page size	tRRD_L,1K	8nCK,5ns (MAX)		8nCK,5ns (MAX)		8nCK,5ns (MAX)		nCK
Four activate window for 2KB page size	tFAW,2K	40nCK, 18.160ns (MAX)		40nCK, 16.640ns (MAX)		40nCK, 15.360ns (MAX)		ns
Four activate window for 1KB page size	tFAW,1K	32nCK, 14.528ns (MAX)		32nCK, 13.312ns (MAX)		32nCK, 12.288ns (MAX)		ns
Delay from start of internal WRITE	tWTR_S	4nCK, 2.5ns		4nCK, 2.5ns		4nCK, 2.5ns		ns

transaction to internal READ command for different bank group		(MAX)		(MAX)		(MAX)		
Delay from start of internal WRITE transaction to internal READ command for same bank group	tWTR_L	16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		16nCK, 10ns (MAX)		ns
Delay from start of internal WRITE transaction to internal READ with AUTO PRECHARGE command for same bank	tWTRA	tWR-tRTP		tWR-tRTP		tWR-tRTP		ns
Internal READ command to PRECHARGE command delay	tRTP	12nCK, 7.5ns (MAX)		12nCK, 7.5ns (MAX)		12nCK, 7.5ns (MAX)		ns
PRECHARGE to PRECHARGE delay	tPPD	2		2		2		nCK
WRITE recovery time	tWR	29.964		29.952		29.952		ns
DLL locking time	tDLLK	1280		1536		1536		nCK
Mode Register Read/Write Timing								
Mode register READ command period	tMRR	14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		
Mode register READ pattern to mode register READ pattern command spacing	tMRR_p	8		8		8		nCK
Mode register WRITE command period	tMRW	5ns, 8nCK (MAX)		5ns, 8nCK (MAX)		5ns, 8nCK (MAX)		
Mode register SET command delay	tMRD	14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		14ns, 16nCK (MAX)		
DFE mode register WRITE update delay time	tDFE	80		80		80		ns
Data Strobe Timing								
DQS_t, DQS_c differential READ preamble	tRPRE	TBD		TBD		TBD		tCK
DQS_t, DQS_c differential READ postamble	tRPST	TBD		TBD		TBD		tCK
DQS_t, DQS_c rising edge output timing location from rising CK_t, CK_c	tDQSK	-0.286	0.286	-0.3	0.3	TBD	TBD	tCK
DQS_t, DQS_c rising edge output variance window	tDQSKI		0.475		0.49		TBD	tCK
Data Strobe Timing								
2-tCK WRITE preamble	tWPRE_EN_2	1.5		1.5		1.5		tCK

enable window	tCK							
3-tCK WRITE preamble enable window	tWPRE_EN_3 tCK	2.5		2.5		2.5		tCK
4-tCK WRITE preamble enable window	tWPRE_EN_4 tCK	2.5		2.5		2.5		tCK
DQS_t, DQS_c differential WRITE postamble	tWPST	TBD		TBD		TBD		tCK
Final trained value of host DQS_t-DQS_c timing relative to CWL CK_t-CK_c edge	tDQsoffset	-0.5	0.5	-0.5	0.5	-0.5	0.5	tCK
Write leveling setup time	tWLS	-80	80	-80	80	-80	80	ps
Write leveling hold time	tWLH	-80	80	-80	80	-80	80	ps
Voltage/temperature drift window of first rising DQS_t preamble edge relative to CWL CK_t-CK_c edge (x4/x8/x16)	tDQSD	-0.25 x tWPRE_EN_ntCK	0.25 x tWPRE_EN_ntCK	-0.25 x tWPRE_EN_ntCK	0.25 x tWPRE_EN_ntCK	-0.25 x tWPRE_EN_ntCK	0.25 x tWPRE_EN_ntCK	tCK
Host and system voltage/ temperature drift window of first rising DQS_t preamble edge relative to CWL CK_t-CK_c edge (x4/x8/x16)	tDQSS	-0.25 x tWPRE_EN_ntCK						tCK
MPSM Timing								
MPSM exit to first valid command delay	tMPSMX	tMRD		tMRD		tMRD		ns
ZQ Calibration Timing								
ZQ calibration time	tZQCAL	1		1		1		μs
ZQ calibration latch time	tZQLAT	30ns, 8nCK (MIN)		30ns, 8nCK (MIN)		30ns, 8nCK (MIN)		
Reset Timing								
RESET_n low time for reset initialization with stable power	tPW_RESET	1		1		1		μs
Time after RESET_n assertion to ODT off	tRST_ADC		50		50		50	ns
Self Refresh Timing								
Command pass disable delay	tCPDED	5ns,8nCK (MAX)		5ns,8nCK (MAX)		5ns,8nCK (MAX)		
Self refresh CS_n low pulse width	tCSL	10		10		10		ns
Self refresh exit CS_n high pulse width	tCSH_Srexit	13	30	13	30	13	30	ns
Self refresh exit CS_n low pulse width	tCSL_Srexit	3nCK	30ns	3nCK	30ns	3nCK	30ns	

Self refresh exit CS_n low pulse width with frequency change	tCSL_FreqChg	VREFCA_time		VREFCA_time		VREFCA_time		ns
Valid clock requirement before SRX	tCKSRX	3.5ns, 8nCK (MAX)		3.5ns, 8nCK (MAX)		3.5ns, 8nCK (MAX)		ns
Valid clock requirement after SRE	tCKLCS	tCPDED + 1nCK		tCPDED + 1nCK		tCPDED + 1nCK		nCK
Self refresh exit CS_n HIGH	tCASRX	0		0		0		ns
Exit self refresh to commands not requiring a locked DLL	tXS	tRFC1		tRFC1		tRFC1		ns
Exit self refresh to commands requiring a locked DLL	tXS_DLL	tDLLK		tDLLK		tDLLK		ns
Power-Down Timing								
Command pass disable delay	tCPDED	5ns, 8nCK (MAX)		5ns, 8nCK (MAX)		5ns, 8nCK (MAX)		ns
Power-down time	tPD	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	7.5ns, 8nCK (MAX)	5*tREFI1 (normal) 9*tREFI2 (FGR)	ns
Exit power-down to next valid command	tXP	7.5ns, 8nCK (MAX)		7.5ns, 8nCK (MAX)		7.5ns, 8nCK (MAX)		ns
Timing of ACT command to POWER DOWN ENTRY command	tACTPDEN	2		2		2		nCK
Timing of PREab, PREsb or PREpb command to POWER DOWN ENTRY command	tPRPDEN	2		2		2		nCK
Timing of READ or READ w/ AP command to POWER DOWN ENTRY command	tRDPDEN	CL + RBL/2+1		CL + RBL/2+1		CL + RBL/2+1		nCK
Timing of WRITE command to POWER DOWN ENTRY command	tWRPDEN	CWL + WBL/ 2+ (tWR/ tCK(avg)) +1		CWL + WBL/ 2+ (tWR/ tCK(avg)) +1		CWL + WBL/ 2+ (tWR/ tCK(avg)) +1		nCK
Timing of WRITE w/ AP command to POWER DOWN ENTRY command	tWRAPDEN	CWL + WBL/ 2+ - 0.25 x tWPRES_EN_n tCKWR+1		CWL + WBL/ 2+ - 0.25 x tWPRES_EN_n tCKWR+1		CWL + WBL/ 2+ - 0.25 x tWPRES_EN_n tCKWR+1		nCK
Timing of REFab or REFsb command to POWER DOWN ENTRY command	tREFPDEN	2		2		2		nCK
Timing of MRR command to POWER	tMRRPDEN	CL+8+1		CL+8+1		CL+8+1		nCK

DOWN ENTRY command								
Timing of MRW command to POWER DOWN ENTRY command	tMRWPDEN	tMRD (MIN)		tMRD (MIN)		tMRD (MIN)		nCK
Timing of MPC command to POWER DOWN ENTRY command	tMPCPDEN	tMPC_delay		tMPC_delay		tMPC_delay		nCK
MPC Command Timing								
MPC to any other valid command	tMPC_Delay	tMRD		tMRD		tMRD		nCK
Time between stable MPC command and first falling CS edge (setup)	tMC_MPC_Setup	3		3		3		nCK
Time between first rising CS edge and stable MPC command (HOLD)	tMC_MPC_Hold	3		3		3		nCK
Time CS_n is held LOW to register MPC command	tMPC_CS	3.5	8	3.5	8	3.5	8	nCK
PDA Timing								
PDA ENUMERATE ID command to any other command cycle	tPDA_DELAY	tPDA_DQS_DELAY (MAX) + BL/2 + 19ns		tPDA_DQS_DELAY (MAX) + BL/2 + 19ns		TBD		ns
Delay to rising strobe edge used for sampling DQ during PDA operation	tPDA_DQS_DELAY	5	18	5	18	TBD	TBD	ns
DQS setup time during PDA operation	tPDA_S	3		3		TBD		nCK
DQS hold time during PDA operation	tPDA_H	3		3		TBD		nCK
Read Training Timing								
Registration of MRW continuous burst mode exit to next valid command delay	tCont_Exit_Delay		tCont_Exit + tMRW		tCont_Exit + tMRW		tCont_Exit + tMRW	ns
Registration of MRW continuous burst mode exit to end of training mode	tCont_Exit		CL+BL/2+10nCK		CL+BL/2+10nCK		CL+BL/2+10nCK	ns
Read Preamble Timing								
Delay from MRW command to DQS driven	tSDOn		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)	
Delay from MRW command to DQS disabled	tSDOff		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)		12nCK, 20ns (MAX)	

CA Training Mode Timing								
Registration of CAM entry command to start of training samples time	tCATM_Entry	20		20		20		ns
Registration of CATM exit CS_n assertion to end of training mode (when DQ is no longer driven by the device).	tCATM_Exit		14		14		14	ns
Registration of CATM exit to next valid command delay	tCATM_Exit_Delay	20		20		20		ns
Time from sample evaluation to output on DQ bus	tCATM_Valid		20		20		20	ns
Time output is available on DQ bus	tCATM_DQ_Window	2		2		2		nCK
CS_n assertion duration to exit CATM	tCATM_CS_Exit	2	8	2	8	2	8	nCK
Registration of CSTM entry command to start of training samples time	tCSTM_Entry	20		20		20		ns
Min time between last CS_n pulse and first pulse of MPC command to exit CSTM	tCSTM_Min_to_MPC_exit	4		4		4		nCK
Registration of CSTM exit command to end of training mode	tCSTM_Exit		20		20		20	ns
Time from sample evaluation to output on DQ bus	tCSTM_Valid		20		20		20	ns
Time output is available on DQ bus	tCSTM_DQ_Window	2		2		2		nCK
Registration of CSTM exit to next valid command delay	tCSTM_Exit_Delay	20		20		20		ns
Write Leveling Timing								
Write leveling pulse enable: time from write leveling training enable MRW to when internal write leveling pulse logic level is valid	tWLPEN	0	15	0	15	0	15	ns
Write leveling output delay	tWLO	0	9.5	0	9.5	0	9.5	ns
Write leveling output error	tWLOE	0	2	0	2	0	2	ns
Width of write leveling	tWL_Pulse_	2		2		2		tCK

internal pulse	Width							
VREFCA/VREFCS Timing								
VREFCA/VREFCS command to any other valid command delay	tVREFCA_Delay/ tVREFCS_Delay	tMRD		tMRD		tMRD		nCK
Time CS_n is held LOW to register VREFCA/VREFCS command	tVREFCA_CS/ tVREFCS_CS	3.5	8	3.5	8	3.5	8	nCK
hPPR/sPPR Timing								
hPPR programming time (x4/x8)	tPGMa	1000		1000		1000		ms
hPPR programming time (x16)	tPGMb	2000		2000		2000		ms
sPPR programming time	tPGM_sPPR	CWL +8tCK +tWR		CWL +8tCK +tWR		CWL +8tCK +tWR		tCK
hPPR/sPPR recognition time	tPGM_Exit	tRP		tRP		tRP		ns
hPPR program exit and new address setting time	tPGMPST	50		50		50		μs
sPPR program exit and new address setting time	tPGMPST_sP PR	tMRD		tMRD		tMRD		ns
DQS Interval Oscillator Readout Timing								
Delay time from DQS interval oscillator stop to mode register readout	tOSCO	tMPC_De lay		tMPC_De lay		tMPC_De lay		nCK
DQS interval oscillator start gap in automatic stop mode	tOSCS	tMPC_Delay + DQS interval timer runtime						nCK
ECS Timing								
ECS operation time	tECSc	176nCK, 110ns (MAX)		176nCK, 110ns (MAX)		176nCK, 110ns (MAX)		
CRC Error Reporting Timing								
CRC error to ALERT_n_latency	tCRC_ALERT	3	13	3	13	3	13	ns
CRC ALERT_n pulse width	CRC_ALERT_ PW	12	20	12	20	12	20	nCK

10. SPD

Byte Number	Function Described	Hex Value
0	Number of Bytes in SPD Device	30
1	SPD Revision for Base Configuration Parameters	10
2	Key Byte / Host Bus Command Protocol Type	12
3	Key Byte / Module Type	02
4	First SDRAM Density and Package	04
5	First SDRAM Addressing	00
6	First SDRAM I/O Width	20
7	First SDRAM Bank Groups & Banks Per Bank Group	62
8	Second SDRAM Density and Package	00
9	Second SDRAM Addressing	00
10	Second SDRAM I/O Width	00
11	Second SDRAM Bank Groups & Banks Per Bank Group	00
12	SDRAM BL32 & Post Package Repair	A0
13	SDRAM Duty Cycle Adjuster & Partial Array Self Refresh	01
14	SDRAM Fault Handling	07
15	Reserved	00
16	SDRAM Nominal Voltage, VDD	00
17	SDRAM Nominal Voltage, VDDQ	00
18	SDRAM Nominal Voltage, VPP	00
19	Reserved	00
20	SDRAM Minimum Cycle Time ($t_{CKAVGmin}$), Least Significant Byte	A0
21	SDRAM Minimum Cycle Time ($t_{CKAVGmin}$), Most Significant Byte	01
22	SDRAM Maximum Cycle Time ($t_{CKAVGmax}$), Least Significant Byte	F2
23	SDRAM Maximum Cycle Time ($t_{CKAVGmax}$), Most Significant Byte	03
24	CAS Latencies Supported, First Byte	7A
25	CAS Latencies Supported, Second Byte	0D
26	CAS Latencies Supported, Third Byte	00
27	CAS Latencies Supported, Fourth Byte	00
28	CAS Latencies Supported, Fifth Byte	00
29	Reserved	00
30	SDRAM Minimum CAS Latency Time (t_{AAmin}), Least Significant Byte	80
31	SDRAM Minimum CAS Latency Time (t_{AAmin}), Most Significant Byte	3E
32	SDRAM Minimum RAS to CAS Delay Time (t_{RCDmin}), Least Significant Byte	80
33	SDRAM Minimum RAS to CAS Delay Time (t_{RCDmin}), Most Significant Byte	3E
34	SDRAM Minimum Row Precharge Delay Time (t_{RPmin}), Least Significant Byte	80

35	SDRAM Minimum Row Precharge Delay Time (t_{RPmin}), Most Significant Byte	3E
36	SDRAM Minimum Active to Precharge Delay Time (t_{RASmin}), Least Significant Byte	00
37	SDRAM Minimum Active to Precharge Delay Time (t_{RASmin}), Most Significant Byte	7D
38	SDRAM Minimum Active to Active/Refresh Delay Time (t_{RCmin}), Least Significant Byte	80
39	SDRAM Minimum Active to Active/Refresh Delay Time (t_{RCmin}), Most Significant Byte	BB
40	SDRAM Minimum Write Recovery Time (t_{WRmin}), Least Significant Byte	30
41	SDRAM Minimum Write Recovery Time (t_{WRmin}), Most Significant Byte	75
42	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFC1min}$, $t_{RFC1_slr min}$), Least Significant Byte	27
43	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFC1min}$, $t_{RFC1_slr min}$), Most Significant Byte	01
44	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFC2min}$, $t_{RFC2_slr min}$), Least Significant Byte	A0
45	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFC2min}$, $t_{RFC2_slr min}$), Most Significant Byte	00
46	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFCsbmin}$, $t_{RFCsb_slr min}$), Least Significant Byte	82
47	SDRAM Minimum Refresh Recovery Delay Time ($t_{RFCsb_dlr min}$), Most Significant Byte	00
48	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFC1_dlr min}$), Least Significant Byte	00
49	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFC1_dlr min}$), Most Significant Byte	00
50	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFC2_dlr min}$), Least Significant Byte	00
51	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFC2_dlr min}$), Most Significant Byte	00
52	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFCsb_dlr min}$), Least Significant Byte	00
53	SDRAM Minimum Refresh Recovery Delay Time, 3DS Different Logical Rank ($t_{RFCsb_dlr min}$), Most Significant Byte	00
54	SDRAM Refresh Management, First Byte, First SDRAM	D4
55	SDRAM Refresh Management, Second Byte, First SDRAM	00
56	SDRAM Refresh Management, First Byte, Second SDRAM	00
57	SDRAM Refresh Management, Second Byte, Second SDRAM	00
58	SDRAM Adaptive Refresh Management Level A, First Byte, First SDRAM	D4
59	SDRAM Adaptive Refresh Management Level A, Second Byte, First SDRAM	00
60	SDRAM Adaptive Refresh Management Level A, First Byte, Second SDRAM	00
61	SDRAM Adaptive Refresh Management Level A, Second Byte, Second SDRAM	00
62	SDRAM Adaptive Refresh Management Level B, First Byte, First SDRAM	D4
63	SDRAM Adaptive Refresh Management Level B, Second Byte, First SDRAM	00
64	SDRAM Adaptive Refresh Management Level B, First Byte, Second SDRAM	00
65	SDRAM Adaptive Refresh Management Level B, Second Byte, Second SDRAM	00
66	SDRAM Adaptive Refresh Management Level C, First Byte, First SDRAM	D4
67	SDRAM Adaptive Refresh Management Level C, Second Byte, First SDRAM	00
68	SDRAM Adaptive Refresh Management Level C, First Byte, Second SDRAM	00
69	SDRAM Adaptive Refresh Management Level C, Second Byte, Second SDRAM	00
70	SDRAM Minimum Active to Active Command Delay Time, Same Bank Group (t_{RRD_Lmin}), Least Significant Byte	88
71	SDRAM Minimum Active to Active Command Delay Time, Same Bank Group (t_{RRD_Lmin}), Most Significant Byte	13

72	SDRAM Minimum Active to Active Command Delay Time, Same Bank Group (t_{RRD_Lmin}), Lower Clock Limit	08
73	SDRAM Minimum CAS_n to CAS_n Command Delay Time, Same Bank Group (t_{CCD_Lmin}), Least Significant Byte	88
74	SDRAM Minimum CAS_n to CAS_n Command Delay Time, Same Bank Group (t_{CCD_Lmin}), Most Significant Byte	13
75	SDRAM Minimum CAS_n to CAS_n Command Delay Time, Same Bank Group (t_{CCD_Lmin}), Lower Clock Limit	08
76	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Same Bank Group ($t_{CCD_L_WRmin}$), Least Significant Byte	20
77	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Same Bank Group ($t_{CCD_L_WRmin}$), Most Significant Byte	4E
78	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Same Bank Group ($t_{CCD_L_WRmin}$), Lower Clock Limit	20
79	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Second Write not RMW, Same Bank Group ($t_{CCD_L_WR2min}$), Least Significant Byte	10
80	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Second Write not RMW, Same Bank Group ($t_{CCD_L_WR2min}$), Most Significant Byte	27
81	SDRAM Minimum Write CAS_n to Write CAS_n Command Delay Time, Second Write not RMW, Same Bank Group ($t_{CCD_L_WR2min}$), Lower Clock Limit	10
82	SDRAM Minimum Four Activate Window (t_{FAWmin}), Least Significant Byte	15
83	SDRAM Minimum Four Activate Window (t_{FAWmin}), Most Significant Byte	34
84	SDRAM Minimum Four Activate Window (t_{FAWmin}), Lower Clock Limit	20
85	SDRAM Minimum Internal Write to Read Command Delay Time, Same Bank Group, (t_{WTR_Lmin}), Least Significant Byte	10
86	SDRAM Minimum Internal Write to Read Command Delay Time, Same Bank Group, (t_{WTR_Lmin}), Most Significant Byte	27
87	SDRAM Minimum Internal Write to Read Command Delay Time, Same Bank Group, (t_{WTR_Lmin}), Lower Clock Limit	10
88	SDRAM Minimum Internal Write to Read Command Delay Time, Different Bank Group, (t_{WTR_Smin}), Least Significant Byte	C4
89	SDRAM Minimum Internal Write to Read Command Delay Time, Different Bank Group, (t_{WTR_Smin}), Most Significant Byte	09
90	SDRAM Minimum Internal Write to Read Command Delay Time, Different Bank Group, (t_{WTR_Smin}), Lower Clock Limit	04
91	SDRAM Minimum Internal Read to Precharge Command Delay Time, (t_{RTPmin}), Least Significant Byte	4C
92	SDRAM Minimum Internal Read to Precharge Command Delay Time, (t_{RTPmin}), Most Significant Byte	1D
93	SDRAM Minimum Internal Read to Precharge Command Delay Time, (t_{RTPmin}), Lower Clock Limit	0C
94~127	Reserved -- must be coded as 0x00	00
128~191	Reserved for future use	00
192	SPD Revision for SPD bytes 192~447	10
193	Hashing Sequence	00
194	SPD Manufacturer ID Code, First Byte	80
195	SPD Manufacturer ID Code, Second Byte	B3
196	SPD Device Type	80
197	SPD Device Revision Number	21
198	PMIC 0 Manufacturer ID Code, First Byte	80
199	PMIC 0 Manufacturer ID Code, Second Byte	B3
200	PMIC 0 Device Type	82
201	PMIC 0 Revision Number	20

202	PMIC 1 Manufacturer ID Code, First Byte	00
203	PMIC 1 Manufacturer ID Code, Second Byte	00
204	PMIC 1 Device Type	00
205	PMIC 1 Revision Number	00
206	PMIC 2 Manufacturer ID Code, First Byte	00
207	PMIC 2 Manufacturer ID Code, Second Byte	00
208	PMIC 2 Device Type	00
209	PMIC 2 Revision Number	00
210	Thermal Sensor Manufacturer ID Code, First Byte	00
211	Thermal Sensor Manufacturer ID Code, Second Byte	00
212	Thermal Sensor Device Type	00
213	Thermal Sensor Revision Number	00
214	DRAM Specification Level	00
215	SPD Specification Level	00
216	PMIC0 Specification Level	00
217	PMIC1 Specification Level	00
218	PMIC2 Specification Level	00
219	TS Specification Level	00
220	DIMM Specification Level	00
221~229	Reserved	00
230	Module Nominal Height	11
231	Module Maximum Thickness	01
232	Reference Raw Card Used	03
233	DIMM Attributes	71
234	Module Organization	00
235	Memory Channel Bus Width	2A
236~239	Reserved	00
240~447	Reserved	00
448~509	Reserved for future use	00
510~511	CRC for SPD bytes 0~509	D4 4C
512	Module Manufacturer ID Code, First Byte	8A
513	Module Manufacturer ID Code, Second Byte	C8
514	Module Manufacturing Location	02
515~516	Module Manufacturing Date	-
517~520	Module Serial Number	-
521~550	Module Part Number	53 51 52 2D 55 44 35 4E 31 36 47 34 4B 38 53 45 42 42 20 20 20 20 20 20 20 20 20 20 20 20
551	Module Revision Code	00

552	DRAM Manufacturer ID Code, First Byte	80
553	DRAM Manufacturer ID Code, Second Byte	2C
554	DRAM Stepping	00
555~639	Manufacturer's Specific Data	-
640~703	End User Programmable	00
704~767	End User Programmable	00
768~831	End User Programmable	00
832~895	End User Programmable	00
896~959	End User Programmable	00
960~1023	End User Programmable	00

Appendix: Part Number Table

Product	Advantech PN
SGRAM 16GB ECC U-DDR5-4800 2Gx8 SAMSUNG (0~85)	SQR-UD5N16G4K8SEBB