

Approval Sheet

Customer	
Product Number	M4M0-4GSSXCSJ
Module speed	PC4-2400
Pin	288 pin
Cl-tRCD-tRP	17-17-17
Operating temperature (Tc)	0℃~95℃
Date	30 th October 2024

Rev 1.2

1. Features

Key Parameter

Industry Nomenclature	Speed Grade	Data Rate MT/s			CL	tRCD	tRP
		CL=13	CL=15	CL=17			
PC4-2400	S	1866	2133	2400	17	17	17

- JEDEC Standard 288-pin Mini Dual In-Line Memory Module
- Intend for PC4-2400 applications
- Inputs and Outputs are SSTL-12 compatible
- VDD=VDDQ= 1.2 Volt (1.14V~1.26V)
- VPP=2.5 Volt (2.375V~2.75V)
- VDDSPD=2.2-3.6V
- Low-Power auto self-refresh (LPASR)
- SDRAMs have 16 internal banks for concurrent operation (4 Bank Group of 4 banks each)
- Normal and Dynamic On-Die Termination for data, strobe and mask signals.
- Data bus inversion (DBI) for data bus
- Fixed burst chop (BC) of 4 and burst length (BL) of 8 via the MRS
- Selectable BC4 or BL8 on-the fly (OTF)
- Gold Plating Thickness 30μ"
- Fly-By topology
- Terminated control, command and address bus
- Programmable /CAS Latency: 10,11,12,13,14,15,16,17,18
- On-die VREFDQ generation and Calibration
- Temperature Sensor with SPD EEPROM
- RoHS and Halogen free (*Section 11*)
- ECC Function

2. Ordering Information

DDR4 VLP Mini-DIMM w/ ECC						
Part Number	Density	Speed	DIMM Organization	Number of DRAM	Number of rank	ECC
M4M0-4GSSXCSJ	4GB	PC4-2400	512Mx72	9	1	Y

3. Pin Configurations (Front side/Back side)

DDR4 512Mx8 base Mini-DIMM w/ ECC

Front	Pins		Back	Front	Pins		Back	Front	Pins		Back								
NC	1	145	VREFCA	ALERT_n	60	204	RESET_n	DQ32	96	240	DQ36								
NC	2	146	SAVE_n, NC	CKE0	61	205	RFU	VSS	97	241	VSS								
RFU	3	147	RFU	VDD	62	206	VDD	DQ33	98	242	DQ37								
VSS	4	148	VSS	ACT_n	63	207	CKE1, NC	VSS	99	243	VSS								
DQ0	5	149	DQ4	BG0	64	208	BG1	DQS4_c	100	244	DQS13_t %								
VSS	6	150	VSS	VDD	65	209	VDD	DQS4_t	101	245	DQS13_c *								
DQ1	7	151	DQ5	A12/BC_n	66	210	A11	VSS	102	246	VSS								
VSS	8	152	VSS	A9	67	211	A7	DQ34	103	247	DQ38								
DQS0_c	9	153	DQS9_t %	VDD	68	212	VDD	VSS	104	248	VSS								
DQS0_t	10	154	DQS9_c *	A8	69	213	A5	DQ35	105	249	DQ39								
VSS	11	155	VSS	A6	70	214	A4	VSS	106	250	VSS								
DQ2	12	156	DQ6	VDD	71	215	VDD	DQ40	107	251	DQ44								
VSS	13	157	VSS	A3	72	216	A2	VSS	108	252	VSS								
DQ3	14	158	DQ7	A1	73	217	RFU	DQ41	109	253	DQ45								
VSS	15	159	VSS	VDD	74	218	VDD	VSS	110	254	VSS								
DQ8	16	160	DQ12	CK0_t	75	219	CK1_t	DQS5_c	111	255	DQS14_t %								
VSS	17	161	VSS	CK0_c	76	220	CK1_c	DQS5_t	112	256	DQS14_c *								
DQ9	18	162	DQ13	VDD	77	221	VDD	VSS	113	257	VSS								
VSS	19	163	VSS	RFU	78	222	RFU	DQ42	114	258	DQ46								
DQS1_c	20	164	DQS10_t %	VTT	79	223	VTT	VSS	115	259	VSS								
DQS1_t	21	165	DQS10_c *	Key				DQ43	116	260	DQ47								
VSS	22	166	VSS	EVENT_n	80	224	PARITY	VSS	117	261	VSS								
DQ10	23	167	DQ14	VDD	81	225	VDD	DQ48	118	262	DQ52								
VSS	24	168	VSS	A0	82	226	BA1	VSS	119	263	VSS								
DQ11	25	169	DQ15	BA0	83	227	A10/AP	DQ49	120	264	DQ53								
VSS	26	170	VSS	VDD	84	228	VDD	VSS	121	265	VSS								
DQ16	27	171	DQ20	RAS_n/A16	85	229	A14_WE_n	DQS6_c	122	266	DQS15_t %								
VSS	28	172	VSS	CS0_n	86	230	A15_CAS_n	DQS6_t	123	267	DQS15_c *								
DQ17	29	173	DQ21	VDD	87	231	VDD	VSS	124	268	VSS								
VSS	30	174	VSS	ODT0	88	232	A13	DQ50	125	269	DQ54								
DQS2_c	31	175	DQS11_t %	CS1_n,NC	89	233	A17, NC	VSS	126	270	VSS								
DQS2_t	32	176	DQS11_c *	VDD	90	234	VDD	DQ51	127	271	DQ55								
VSS	33	177	VSS	ODT1,NC	91	235	C1, CS3_n, NC	VSS	128	272	VSS								
DQ18	34	178	DQ22	C0, CS2_n, NC	92	236	NC, C2	DQ56	129	273	DQ60								
VSS	35	179	VSS	VDD	93	237	VDD	VSS	130	274	VSS								
DQ19	36	180	DQ23	RFU	94	238	RFU	DQ57	131	275	DQ61								
VSS	37	181	VSS	VSS	95	239	VSS	VSS	132	276	VSS								
DQ24	38	182	DQ28	CS pin will based on Chip and Module configuration, normal CS2 and CS3 will be NC % These signals include TDQS_t, BDI_n and DM_n refer to below Pin153=/DM0, /DBI0; Pin164=/DM1, /DBI1; Pin175=/DM2, /DBI2; Pin186=/DM3, /DBI3 Pin197=/DM8, /DBI8; Pin244=/DM4, /DBI4; Pin255=/DM5, /DBI5; Pin266=/DM6, /DBI6 Pin277=/DM7, /DBI7 * These signals include TDQS_c and NC refer to below Pin154. 165. 176. 187. 198. 245. 256. 267. 278=NC															
VSS	39	183	VSS																
DQ25	40	184	DQ29																
VSS	41	185	VSS																
DQS3_c	42	186	DQS12_t %																
DQS3_t	43	187	DQS12_c *																
VSS	44	188	VSS																
DQ26	45	189	DQ30																
VSS	46	190	VSS																
DQ27	47	191	DQ31																
VSS	48	192	VSS																
CB0, NC	49	193	CB4, NC																
VSS	50	194	VSS																
CB1, NC	51	195	CB5, NC																
VSS	52	196	VSS																
DQS8_c	53	197	DQS17_t %																
DQS8_t	54	198	DQS17_c *																
VSS	55	199	VSS																
CB2, NC	56	200	CB6, NC																
VSS	57	201	VSS																
CB3, NC	58	202	CB7, NC																
VSS	59	203	VSS																
												DQ36 VSS DQ37 VSS DQS13_t % DQS13_c * VSS DQ38 VSS DQ39 VSS DQ44 VSS DQ45 VSS DQS14_t % DQS14_c * VSS DQ46 VSS DQ47 VSS DQ52 VSS DQ53 VSS DQS15_t % DQS15_c * VSS DQ54 VSS DQ55 VSS DQ60 VSS DQ61 VSS DQS16_t % DQS16_c * VSS DQ62 VSS DQ63 VSS SA1 SA2 SCL VPP VPP							

CS pin will based on Chip and Module configuration, normal CS2 and CS3 will be NC

% These signals include TDQS_t, BDI_n and DM_n refer to below

Pin153=/DM0, /DBI0; Pin164=/DM1, /DBI1; Pin175=/DM2, /DBI2; Pin186=/DM3, /DBI3
Pin197=/DM8, /DBI8; Pin244=/DM4, /DBI4; Pin255=/DM5, /DBI5; Pin266=/DM6, /DBI6
Pin277=/DM7, /DBI7

* These signals include TDQS_c and NC refer to below

Pin154, 165, 176, 187, 198, 245, 256, 267, 278=NC

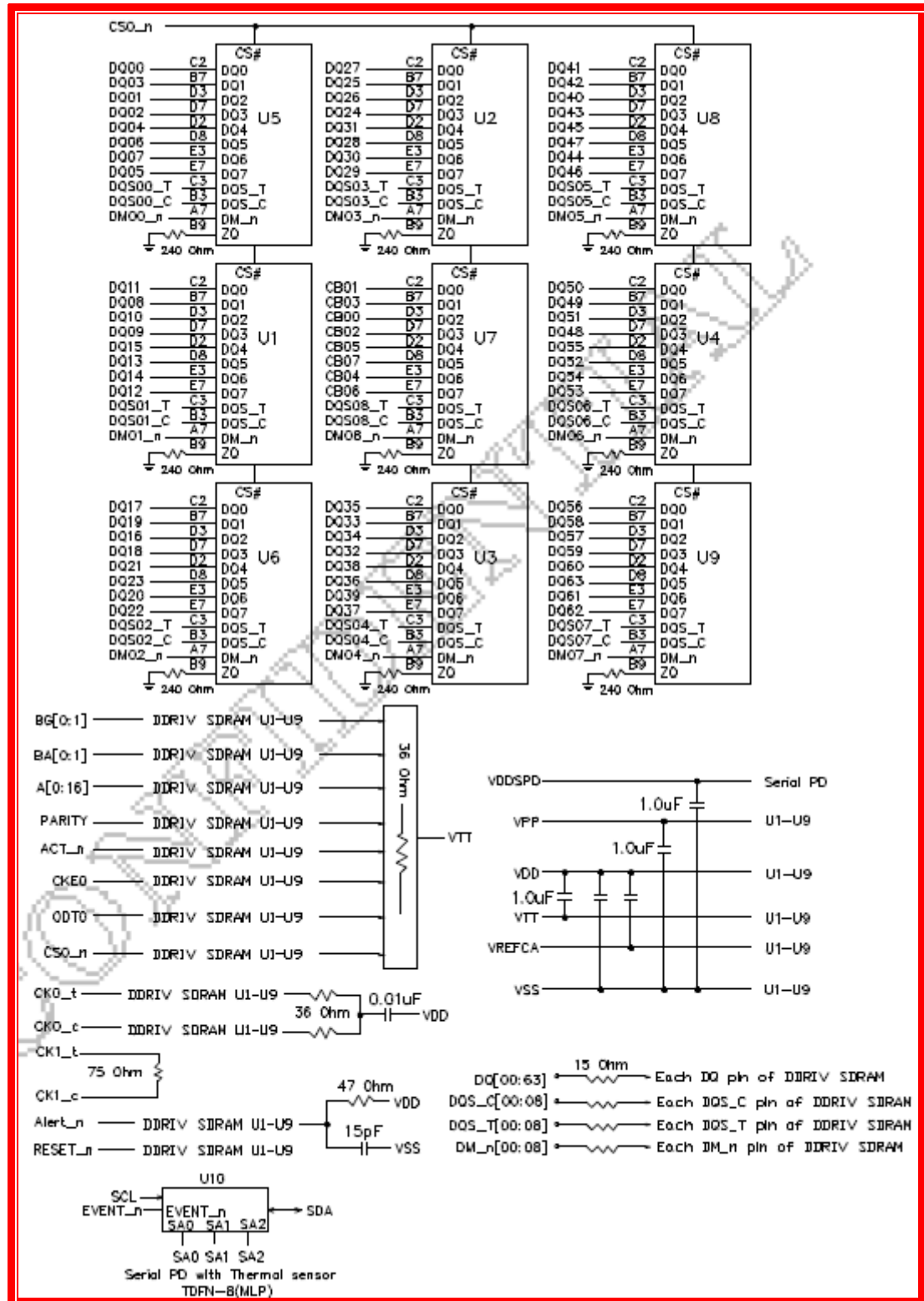
4. Architecture

Pin Definition

Pin Name	Description	Pin Name	Description
A0-A17	Register address input	SCL	I2C serial bus clock for SPD/TS and register
BA0, BA1	Register bank select input	SDA	I2C serial bus data line for SPD/TS and register
BG0, BG1	Register bank group select input	SA0-SA2	I2C slave address select for SPD/TS and register
RAS_n	Register row address strobe input	PAR	Register parity input
CAS_n	Register column address strobe input	VDD	SDRAM core power supply
WE_n	Register write enable input	VPP	SDRAM activating power supply
CS0_n, CS1_n, CS2_n, CS3_n	DIMM Rank Select Lines input	VREFCA	SDRAM command/address reference supply
CKE0, CKE1	Register clock enable lines input	VSS	Power supply return (ground)
ODT0, ODT1	Register on-die termination control lines input	VDDSPD	Serial SPD/TS positive power supply
ACT_n	Register input activate input	ALERT_n	Register ALERT_n output
DQ0-DQ63	DIMM memory data bus	RESET_n	Set Register and SDRAMs to a Known State
CB0-CB7	DIMM ECC check bits	EVENT_n	SPD signals a thermal event has occurred
DQS0_t-DQS17_t	Data buffer data strobes (positive)	VTT	SDRAM I/O termination supply
DQS0_c-DQS17_c	Data buffer data strobes (negative)	RFU	Reserved for future use
CK0_t, CK1_t	Register clock input (positive)		
CK0_c, CK1_c	Register clock input (negative)		

5. Function Block Diagram:

- (4GB, 1 Rank 512Mx8 DDR4 SDRAMs)



6. SDRAM Absolute Maximum Ratings

Symbol	Parameter		Rating	Units	Note
T _{OPER}	Operation Temperature	Normal Operating Temp.	0 to 85	°C	1,2
		Extended Temp.	85 to 95	°C	1,3
T _{STG}	Storage Temperature		-55 to 100	°C	4,5
V _{IN} , V _{OUT}	Voltage on any pins relative to V _{ss}		-0.3 to +1.5	V	4
V _{DD}	Voltage on VDD supply relative to V _{ss}		-0.3 to +1.5	V	4,6
V _{DDQ}	Voltage on VDDQ supply relative to V _{ss}		-0.3 to +1.5	V	4,6

Note:

- 1) Operating Temperature T_{OPER} is the case surface temperature on the center/top side of the DRAM.
- 2) The Normal Temperature Range specifies the temperatures where all DRAM specifications will be supported. During operation, the DRAM case temperature must be maintained between 0-85°C under all operating conditions.
- 3) Some applications require operation of the Extended Temperature Range between 85°C and 95°C case temperature. Full specifications are guaranteed in this range, but the following additional conditions apply:
 - a) Refresh commands must be doubled in frequency, therefore reducing the refresh interval tREFI to 3.9us.
 - b) If Self-Refresh operation is required in the Extended Temperature Range, then it is mandatory to either use the Manual Self-Refresh mode with Extended Temperature Range capability (MR2 A6 = 0b and MR2 A7 = 1b), in this case IDD6 current can be increased around 10~20% than normal Temperature range.
4. Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is stressing only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
5. Storage Temperature is the case surface temperature on the center/top side of the DRAM. For the measurement conditions, please refer to JESD51-2 standard.
6. VDD and VDDQ must be within 300 mV of each other at all times;and VREF must be not greater than 0.6 x VDDQ, When VDD and VDDQ are less than 500 mV; VREF may be equal to or less than 300 mV

7. Operating Condition

Symbol	Parameter	Min	Nom	Max	Units	Notes
V _{DD}	Supply Voltage	1.14	1.2	1.26	V	1
V _{PP}	DRAM activating power supply	2.375	2.5	2.75	V	2
V _{REFCA(DC)}	Input reference voltage command/ address bus	0.49 x V _{DD}	0.5 x V _{DD}	0.51 x V _{DD}	V	3
V _{TT}	Termination Voltage	0.49 x V _{DD}	0.5 x V _{DD}	0.51 x V _{DD}	V	4
Note: 1. VDDQ tracks with VDD; VDDQ and VDD are tied together. 2. VPP must be greater than or equal to VDD at all times. 3. VREFCA must not be greater than 0.6 x VDD. When VDD is less than 500mV, VREF may be less than or equal to 300mV. 4. VTT termination voltages in excess of the specification limit adversely affect the voltage margins of command and address signals and reduce timing margins.						

8. Operating, Standby, and Refresh Currents

- 4GB Mini-DIMM w/ ECC (1 Rank 512Mx8 DDR4 SDRAMs)

Symbol	Proposed Conditions	Value		Units
		IDD Max.	IPP Max.	
IDD0	Operating One Bank Active-Precharge Current (AL=0)CKE: High; External clock: On; tCK, nRC, nRAS, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: Highbetween ACT and PRE; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: Cycling with one bank active at a time: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	324	27	mA
IDD0A	Operating One Bank Active-Precharge Current (AL=CL-1) AL = CL-1, Other conditions: see IDD0	360	27	mA
IDD1	Operating One Bank Active-Read-Precharge Current (AL=0)CKE: High; External clock: On; tCK, nRC, nRAS, nRCD, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: Highbetween ACT, RD and PRE; Command, Address, Bank Group Address, Bank Address Inputs, Data IO: partially toggling; DM_n: stable at 1; Bank Activity: Cycling with one bank active at a time: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	378	27	mA
IDD1A	Operating One Bank Active-Read-Precharge Current (AL=CL-1) AL = CL-1, Other conditions: see IDD1	414	27	mA
IDD2N	Precharge Standby Current (AL=0)CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	180	18	mA
IDD2NA	Precharge Standby Current (AL=CL-1) AL = CL-1, Other conditions: see IDD2N	189	18	mA

IDD2NT	Precharge Standby ODT Current CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VSSQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: toggling according ; Pattern Details: Refer to Component Datasheet for detail pattern	198	18	mA
IDD2NL	Precharge Standby Current with CAL enabled Same definition like for IDD2N, CAL enabled3	144	18	mA
IDD2NG	Precharge Standby Current with Gear Down mode enabled Same definition like for IDD2N, Gear Down mode enabled3	180	18	mA
IDD2ND	Precharge Standby Current with DLL disabled Same definition like for IDD2N, DLL disabled3	162	18	mA
IDD2N_par	Precharge Standby Current with CA parity enabled Same definition like for IDD2N, CA parity enabled3	198	18	mA
IDD2P	Precharge Power-Down Current CKE: Low; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL:0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0	117	18	mA
IDD2Q	Precharge Quiet Standby Current CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks closed; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0	162	18	mA
IDD3N	Active Standby Current CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks open; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	279	18	mA

IDD3NA	Active Standby Current (AL=CL-1) AL = CL-1, Other conditions: see IDD3N	279	18	mA
IDD3P	Active Power-Down Current CKE: Low; External clock: On; tCK, CL: sRefer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: stable at 1; Command, Address, Bank Group Address, Bank Address Inputs: stable at 0; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: all banks open; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0	162	18	mA
IDD4R	Operating Burst Read Current CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 82; AL: 0; CS_n: High between RD; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: seamless read data burst with different data between one burst and the next one according ; DM_n: stable at 1; Bank Activity: all banks open, RD commands cycling through banks: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	999	27	mA
IDD4RA	Operating Burst Read Current (AL=CL-1) AL = CL-1, Other conditions: see IDD4R	1071	27	mA
IDD4RB	Operating Burst Read Current with Read DBI Read DBI enabled3, Other conditions: see IDD4R	1044	27	mA
IDD4W	Operating Burst Write Current CKE: High; External clock: On; tCK, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: High between WR; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: seamless write data burst with different data between one burst and the next one ; DM_n: stable at 1; Bank Activity: all banks open, WR commands cycling through banks: 0,0,1,1,2,2,... ; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at HIGH; Pattern Details: Refer to Component Datasheet for detail pattern	936	18	mA
IDD4WA	Operating Burst Write Current (AL=CL-1) AL = CL-1, Other conditions: see IDD4W	1008	18	mA
IDD4WB	Operating Burst Write Current with Write DBI Write DBI enabled3, Other conditions: see IDD4W	936	18	mA

IDD4WC	Operating Burst Write Current with Write CRC Write CRC enabled ³ , Other conditions: see IDD4W	846	18	mA
IDD4W_par	Operating Burst Write Current with CA Parity CA Parity enabled ³ , Other conditions: see IDD4W	1089	18	mA
IDD5B	Burst Refresh Current (1X REF) CKE: High; External clock: On; tCK, CL, nRFC: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n: High between REF; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; Data IO: VDDQ; DM_n: stable at 1; Bank Activity: REF command every nRFC ; Output Buffer and RTT: Enabled in Mode Registers ² ; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	1773	189	mA
IDD5B2	Burst Refresh Current (2X REF) tRFC=tRFC_x2, Other conditions: see IDD5B	1404	153	mA
IDD5B4	Burst Refresh Current (4X REF) tRFC=tRFC_x4, Other conditions: see IDD5B	1125	117	mA
IDD6N	Self Refresh Current: Normal Temperature Range TCASE: 0 - 85°C; Low Power Array Self Refresh (LP ASR) : Normal ⁴ ; CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n: stable at 1; Bank Activity: Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers ² ; ODT Signal: MIDDLEVEL	171	36	mA
IDD6E	Self-Refresh Current: Extended Temperature Range) TCASE: 0 - 95°C; Low Power Array Self Refresh (LP ASR) : Extended ⁴ ; CKE: Low; External clock: Off; CK_t and CK_c: LOW; CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: 0; CS_n, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Extended Temperature Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers ² ; ODT Signal: MID-LEVEL	180	45	mA

IDD6R	Self-Refresh Current: Reduced Temperature Range TCASE: 0 - 45 °C; Low Power Array Self Refresh (LP ASR) : Reduced4; CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: see Table 34 on p age 37; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Extended Temperature Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: MIDLEVEL	171	36	mA
IDD6A	Auto Self-Refresh Current TCASE: 0 - 95°C; Low Power Array Self Refresh (LP ASR) : Auto4;CKE: Low; External clock: Off; CK_t and CK_c#: LOW; CL: see Table 34 on p age 37; BL: 81; AL: 0; CS_n#, Command, Address, Bank Group Address, Bank Address, Data IO: High; DM_n:stable at 1; Bank Activity: Auto Self-Refresh operation; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: MID-LEVEL	171	36	mA
IDD7	Operating Bank Interleave Read Current CKE: High; External clock: On; tCK, nRC, nRAS, nRCD, nRRD, nFAW, CL: Refer to Component Datasheet for detail pattern; BL: 81; AL: CL-1; CS_n: High between ACT and RDA; Command, Address, Bank Group Address, Bank Address Inputs: partially toggling ; DataIO: read data bursts with different data between one burst and the next one ; DM_n: stable at 1; Bank Activity: two times interleaved cycling through banks (0, 1, ...7) with different addressing; Output Buffer and RTT: Enabled in Mode Registers2; ODT Signal: stable at 0; Pattern Details: Refer to Component Datasheet for detail pattern	1386	99	mA
IDD8	Maximum Power Down Current TBD	54	18	mA

9. Timing Parameters

Clock Timing				
Parameter	Symbol	MIN	MAX	Units
Minimum Clock Cycle Time (DLL off mode)	tCK (DLL_OFF)	8	20	ns
Average Clock Period	tCK(avg)	0.833	<0.938	ns
Average high pulse width	tCH(avg)	0.48	0.52	tCK(avg)
Average low pulse width	tCL(avg)	0.48	0.52	tCK(avg)
Absolute Clock Period	tCK(abs)	tCK(avg)min + tJIT(per)min_ to t	tCK(avg)m ax + tJIT(per)m ax_tot	tCK(avg)
Absolute clock HIGH pulse width	tCH(abs)	0.45	-	tCK(avg)
Absolute clock LOW pulse width	tCL(abs)	0.45	-	tCK(avg)
Clock Period Jitter- total	JIT(per)_tot	-42	42	ps
Clock Period Jitter- deterministic	JIT(per)_dj	-21	21	ps
Clock Period Jitter during DLL lock-ing period	tJIT(per, lck)	-33	33	ps
Cycle to Cycle Period Jitter	tJIT(cc)_to-tal	83		ps
Cycle to Cycle Period Jitter during DLL locking period	tJIT(cc, lck)	67		ps
Cumulative error across 2 cycles	tERR(2per)	-61	61	ps
Cumulative error across 3 cycles	tERR(3per)	-73	73	ps
Cumulative error across 4 cycles	tERR(4per)	-81	81	ps
Cumulative error across 5 cycles	tERR(5per)	-87	87	ps
Cumulative error across 6 cycles	tERR(6per)	-92	92	ps
Cumulative error across 7 cycles	tERR(7per)	-97	97	ps

Cumulative error across 8 cycles	tERR(8per)	-101	101	ps
Cumulative error across 9 cycles	tERR(9per)	-104	104	ps
Cumulative error across 10 cycles	tERR(10per)	-107	107	ps
Cumulative error across 11 cycles	tERR(11per)	-110	110	ps
Cumulative error across 12 cycles	tERR(12per)	-112	112	ps
Cumulative error across 13 cycles	tERR(13per)	-114	114	ps
Cumulative error across 14 cycles	tERR(14per)	-116	116	ps
Cumulative error across 15 cycles	tERR(15per)	-118	118	ps
Cumulative error across 16 cycles	tERR(16per)	-120	120	ps
Cumulative error across 17 cycles	tERR(17per)	-122	122	ps
Cumulative error across 18 cycles	tERR(18per)	-124	124	ps
Cumulative error across n = 13, 14 . . . 49, 50 cycles	tERR(nper)	$tERR(nper)_{min} = ((1 + 0.68\ln(n)) * tJIT(per)_{total\ min})$ $tERR(nper)_{max} = ((1 + 0.68\ln(n)) * tJIT(per)_{total\ max})$		ps
Command and Address setup time to CK_t, CK_c referenced to Vih(ac) / Vil(ac) levels	tIS(base)	62	-	ps
Command and Address setup time to CK_t, CK_c referenced to Vref levels	tIS(Vref)	162	-	ps
Command and Address hold time to CK_t, CK_c referenced to Vih(dc) / Vil(dc) levels	tIH(base)	87	-	ps
Command and Address hold time to CK_t, CK_c referenced	tIH(Vref)	162	-	ps

to Vref levels				
Control and Address Input pulse width for each input	tIPW	410	-	ps
Command and Address Timing				
Parameter	Symbol	MIN	MAX	Units
CAS_n to CAS_n command delay for same bank group	tCCD_L	max(5 nCK, 5 ns)	-	nCK
CAS_n to CAS_n command delay for different bank group	tCCD_S	4	-	nCK
ACTIVATE to ACTIVATE Command delay to different bank group for 2KB page size	tRRD_S(2K)	Max(4nCK, 5.3ns)	-	nCK
ACTIVATE to ACTIVATE Command delay to different bank group for 1KB page size	tRRD_S(1K)	Max(4nCK, 3.3ns)	-	nCK
ACTIVATE to ACTIVATE Command delay to different bank group for 1/2KB page size	tRRD_S(1/2K)	Max(4nCK, 3.3ns)	-	nCK
ACTIVATE to ACTIVATE Command delay to same bank group for 2KB page size	tRRD_L(2K)	Max(4nCK, 6.4ns)	-	nCK
ACTIVATE to ACTIVATE Command delay to same bank group for 1KB page size	tRRD_L(1K)	Max(4nCK, 4.9ns)	-	nCK
ACTIVATE to ACTIVATE Command delay to same bank group for 1/2KB page size	tRRD_L(1/2K)	Max(4nCK, 4.9ns)	-	nCK
Four activate window for 2KB page size	tFAW_2K	Max(28nCK, 30ns)	-	ns
Four activate window for 1KB page size	tFAW_1K	Max(20nCK, 21ns)	-	ns
Four activate window for 1/2KB page size	tFAW_1/2K	Max(16nCK, 13ns)	-	ns
Delay from start of internal write transaction to internal read com-mand for different	tWTR_S	max(2nCK, 2.5ns)	-	

bank group				
Delay from start of internal write transaction to internal read com-mand for same bank group	tWTR_L	max(4nCK,7.5ns)	-	
Internal READ Command to PRE-CHARGE Command delay	tRTP	max(4nCK,7.5ns)	-	
WRITE recovery time	tWR	15	-	ns
Write recovery time when CRC and DM are enabled	tWR_CRC_DM	tWR+max(5nCK,3.75ns)	-	ns
delay from start of internal write transaction to internal read com-mand for different bank group with both CRC and DM enabled	tWTR_S_CRC_DM	tWTR_S+max(5nCK,3.75ns)	-	ns
delay from start of internal write transaction to internal read com-mand for same bank group with both CRC and DM enabled	tWTR_L_CRC_DM	tWTR_L+max(5nCK,3.75ns)	-	ns
DLL locking time	tDLLK	768	-	nCK
Mode Register Set command cycle time	tMRD	8	-	nCK
Mode Register Set command up-date delay	tMOD	max(24nCK,15ns)	-	
Multi-Purpose Register Recovery Time	tMPRR	1	-	nCK
Multi Purpose Register Write Re-covey Time	tWR_MPR	tMOD (min) + AL + PL	-	-
Auto precharge write recovery + precharge time	tDAL(min)	Programmed WR + roundup (tRP / tCK(avg))		nCK
DQ0 or DQL0 driven to 0 set-up time to first DQS rising edge	tPDA_S	0.5	-	UI
DQ0 or DQL0 driven to 0 hold time from last DQS fall-ing	tPDA_H	0.5	-	UI

edge				
CS_n to Command Address Latency				
CS_n to Command Address Latency	tCAL	5	-	nCK
DRAM Data Timing				
DQS_t,DQS_c to DQ skew, per group, per access	tDQSQ	-	0.16	tCK(avg) /2
DQ output hold time from DQS_t,DQS_c	tQH	0.78	-	tCK(avg) /2
Data Valid Window per device: tQH - tDQSQ for a device	tDVWd	0.64	-	UI
Data Valid Window per device, per pin: tQH - tDQSQ each device's out-put	tDVWp	0.72	-	UI
Data Strobe Timing				
DQS_t, DQS_c differential READ Preamble	tRPRE	0.9	-	tCK
DQS_t, DQS_c differential READ Postamble	tRPST	0.33	-	tCK
DQS_t,DQS_c differential output high time	tQSH	0.4	-	tCK
DQS_t,DQS_c differential output low time	tQSL	0.4	-	tCK
DQS_t, DQS_c differential WRITE Preamble	tWPRE	0.9	-	tCK
DQS_t, DQS_c differential WRITE Postamble	tWPST	0.33	-	tCK
DQS_t and DQS_c low-impedance time (Referenced from RL-1)	tLZ(DQS)	-330	175	ps
DQS_t and DQS_c high-impedance time (Referenced from RL+BL/2)	tHZ(DQS)	-	175	ps
DQS_t, DQS_c differential input low pulse width	tDQSL	0.46	0.54	tCK
DQS_t, DQS_c differential	tDQSH	0.46	0.54	tCK

input high pulse width				
DQS_t, DQS_c rising edge to CK_t, CK_c rising edge (1 clock preamble)	tDQSS	-0.27	0.27	tCK
DQS_t, DQS_c falling edge setup time to CK_t, CK_c rising edge	tDSS	0.18	-	tCK
DQS_t, DQS_c falling edge hold time from CK_t, CK_c rising edge	tDSH	0.18	-	tCK
DQS_t, DQS_c rising edge output timing locatino from rising	tDQSK (DLL On)	-175	175	ps
DQS_t, DQS_c rising edge output variance window per DRAM	tDQSKI (DLL On)		290	ps
MPSM Timing				
Command path disable delay upon MPSM entry	tMPED	tMOD(min) + tCPDED(min)	-	
Valid clock requirement after MPSM entry	tCKMPE	tMOD(min) + tCPDED(min)	-	
Valid clock requirement before MPSM exit	tCKMPX	tCKSRX(min)		
Exit MPSM to commands not requiring a locked DLL	tXMP	txs(imin)		
Exit MPSM to commands requiring a locked DLL	tXMPDLL	tXMP(min) + tXSDLL(min)		
CS setup time to CKE	tMPX_S	tISmin + tIHmin	-	
Calibration Timing				
Power-up and RESET calibration time	tZQinit	1024	-	nCK
Normal operation Full calibration time	tZQoper	512	-	nCK
Normal operation Short calibration time	tZQCS	128	-	nCK
Reset/Self Refresh Timing				

Exit Reset from CKE HIGH to a valid command	command tXPR	max (5nCK,tRFC(min))+ 10ns)	-	
Exit Self Refresh to commands not requiring a locked DLL	tXS	tRFC(min)+1 0ns	-	
SRX to commands not requiring a locked DLL in Self Refresh ABORT	tX-S_ABORT(min)	tRFC4(min)+ 10ns	-	
Exit Self Refresh to ZQCL,ZQCS and MRS (CL,CWL,WR,RTP and Gear Down)	tXS_FAST (min)	tRFC4(min)+ 10ns	-	
Exit Self Refresh to commands re-quiring a locked DLL	tXSDLL	tDLLK(min)	-	
Minimum CKE low width for Self re-fresh entry to exit timing	tCKESR	tCKE(min)+1 nCK	-	
Minimum CKE low width for Self re-fresh entry to exit timing with CA Parity enabled	tCKESR_PAR	tCKE(min)+ 1nCK+PL	-	
Valid Clock Requirement after Self Refresh Entry (SRE) or Power- Down Entry (PDE)	tCKSRE	max(5nCK,10 ns)	-	
Valid Clock Requirement after Self Refresh Entry (SRE) or Power- Down when CA Parity is enabled	tCKS-RE_PAR	max (5nCK,10ns) +PL	-	
Valid Clock Requirement before Self Refresh Exit (SRX) or Power-Down Exit (PDX) or Reset Exit	tCKSRX	max(5nCK,10 ns)	-	
Power Down Timing				
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	(4nCK,6ns)	-	

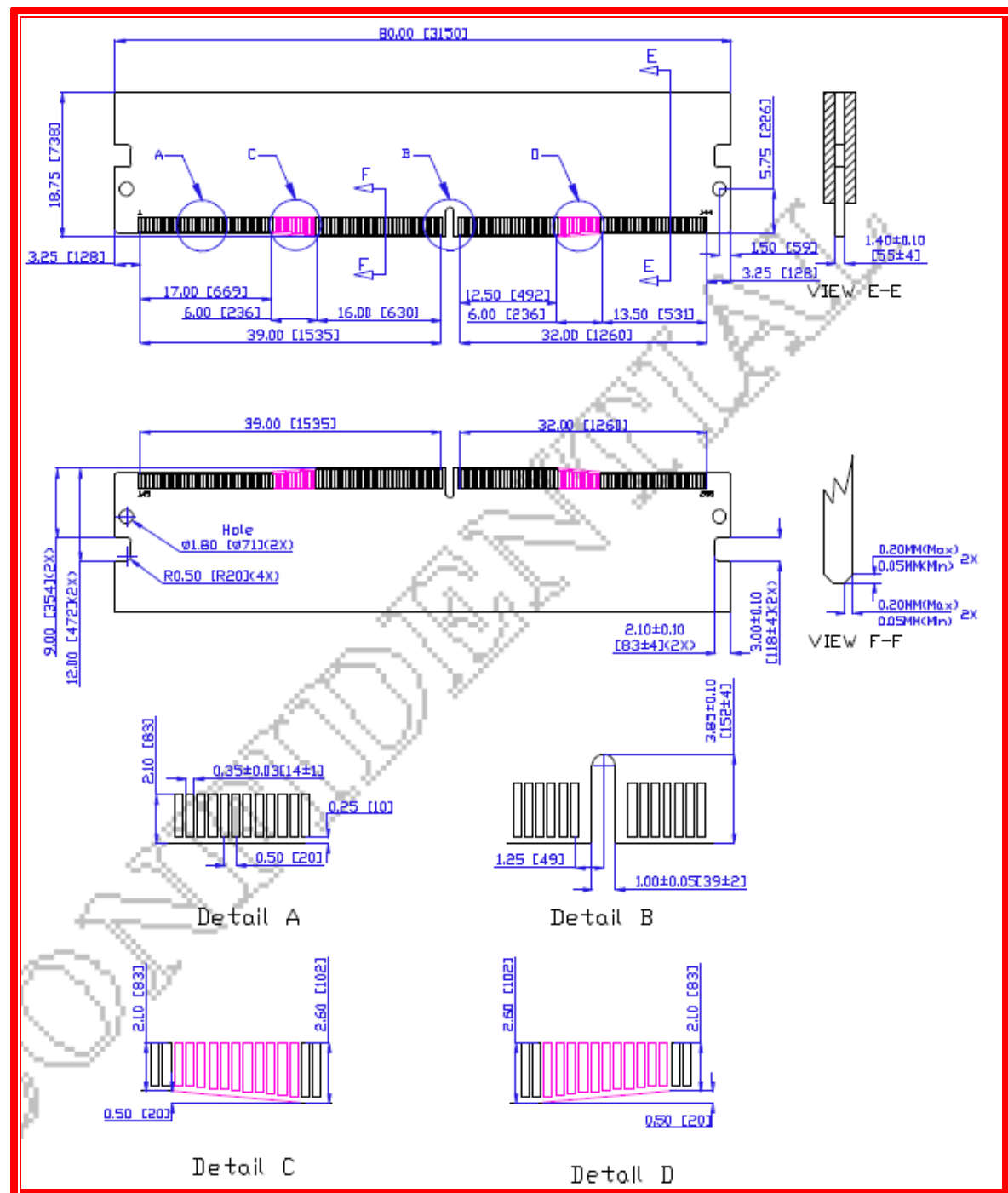
CKE minimum pulse width	tCKE	max (3nCK, 5ns)	-	
Command pass disable delay	tCPDED	4	-	nCK
Power Down Entry to Exit Timing	tPD	tCKE(min)	9*tREFI	
Timing of ACT command to Power Down entry	tACTPDEN	2	-	nCK
Timing of PRE or PREA command to Power Down entry	tPRPDEN	2	-	nCK
Timing of RD/RDA command to Power Down entry	tRDPDEN	RL+4+1	-	nCK
Timing of WR command to Power Down entry (BL8OTF, BL8MRS, BC4OTF)	tWRPDEN	WL+4+(tWR/tCK(avg))	-	nCK
Timing of WRA command to Power Down entry (BL8OTF, BL8MRS, BC4OTF)	tWRAPDEN	WL+4+WR+1	-	nCK
Timing of WR command to Power Down entry (BC4MRS)	tWRP-BC4DEN	WL+2+(tWR/tCK(avg))	-	nCK
Timing of WRA command to Power Down entry (BC4MRS)	tWRAP-BC4DEN	WL+2+WR+1	-	nCK
Timing of REF command to Power Down entry	tREFPDEN	2	-	nCK
Timing of MRS command to Power Down entry	tMRSPDEN	tMOD(min)	-	
PDA Timing				
Mode Register Set command cycle time in PDA mode	tMRD_PDA	max(16nCK,10ns)		
Mode Register Set command up-date delay in PDA mode	tMOD_PDA	tMOD		
ODT Timing				
Asynchronous RTT turn-on delay (Power-Down with DLL frozen)	tAONAS	1.0	9.0	ns
Asynchronous RTT turn-off delay (Power-Down with DLL	tAOFAS	1.0	9.0	ns

frozen)				
RTT dynamic change skew	tADC	0.3	0.7	tCK(avg)
Write Leveling Timing				
First DQS_t/DQS_n rising edge af-ter write leveling mode is pro-grammed	tWLMRD	40	-	nCK
DQS_t/DQS_n delay after write lev-eling mode is programmed	tWLDQSEN	25	-	nCK
Write leveling setup time from rising CK_t, CK_c crossing to rising DQS_t/DQS_n crossing	tWLS	0.13	-	tCK(avg)
Write leveling hold time from rising DQS_t/DQS_n crossing to rising CK_t, CK_ crossing	tWLH	0.13	-	tCK(avg)
Write leveling output delay	tWLO	0	9.5	ns
Write leveling output error	tWLOE			ns
CA Parity Timing				
Commands not guaranteed to be executed during this time	tPAR_UN-KNOWN	-	PL	
Delay from errant command to ALERT_n assertion	tPAR_ALER T_ON	-	PL+6ns	
Pulse width of ALERT_n signal when asserted	tPAR_ALER T_PW	72	144	nCK
Time from when Alert is asserted till controller must start providing DES commands in Persistent CA parity mode	tPAR_ALER T_RSP	-	64	nCK
Parity Latency	PL	5		nCK
CRC Error Reporting				
CRC error to ALERT_n latency	tCRC_ALER T	3	13	ns
CRC ALERT_n pulse width	CRC_ALER T_PW	6	10	nCK
tREFI				
tRFC1 (min)	2Gb	160	-	ns

	4Gb	260	-	ns
	8Gb	350	-	ns
	16Gb	550	-	ns
tRFC2 (min)	2Gb	110	-	ns
	4Gb	160	-	ns
	8Gb	260	-	ns
	16Gb	350	-	ns
tRFC3 (min)	2Gb	90	-	ns
	4Gb	110	-	ns
	8Gb	160	-	ns
	16Gb	260	-	ns

10. PACKAGE DIMENSION

- (4GB, 1Rank 512Mx8 DDR4 base Mini-DIMM w/ ECC)



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

11. RoHS Declaration

innodisk

宜鼎國際股份有限公司
Innodisk Corporation

Page 1/2

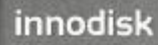
Tel:(02)7703-3000 Internet: <https://www.innodisk.com/>

RoHS 自我宣告書 (RoHS Declaration of Conformity)

Manufacturer Products: All Innodisk EM FLASH, DRAM and EP products

- 一、宜鼎國際股份有限公司（以下稱本公司）特此保證售予貴公司之所有產品，皆符合歐盟 2011/65/EU 及 (EU) 2015/863 關於 RoHS 之規範要求。
Innodisk Corporation declares that all products sold to the company, are complied with European Union RoHS Directive (2011/65/EU) and (EU) 2015/863 requirement.
- 二、本公司同意因本保證書或與本保證書相關事宜有所爭議時，雙方宜友好協商，達成協議。
Innodisk Corporation agrees that both parties shall settle any dispute arising from or in connection with this Declaration of Conformity by friendly negotiations.
- 三、本公司聲明我們的產品符合 RoHS 指令的附件中 7(a)、7(c)-1、6(c) 允許豁免。
We declare, our products permitted by the following exemptions specified in the Annex of the RoHS directive.
- ※ 7(a) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead).
- ※ 7(c)-1 Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectric devices, or in a glass or ceramic matrix compound.
- ※ 6(c) Copper alloy containing up to 4% lead by weight. (This exemption applies to products that use antennas)

Name of hazardous substance	Limited of RoHS ppm (mg/kg)
鉛 (Pb)	< 1000 ppm
汞 (Hg)	< 1000 ppm
鎘 (Cd)	< 100 ppm
六價鉻 (Cr 6+)	< 1000 ppm
多溴聯苯 (PBBs)	< 1000 ppm
多溴二苯醚 (PBDEs)	< 1000 ppm
鄰苯二甲酸二(2-乙基己基)酯 (DEHP)	< 1000 ppm
鄰苯二甲酸丁酯苯甲酯 (BBP)	< 1000 ppm
鄰苯二甲酸二丁酯 (DBP)	< 1000 ppm
鄰苯二甲酸二異丁酯 (DIBP)	< 1000 ppm



宜鼎國際股份有限公司

Page 2/2

Innodisk Corporation
立 保 證 書 人 (Guarantor)

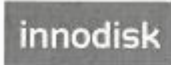
Company name 公司名稱： Innodisk Corporation 宜鼎國際股份有限公司

Company Representative 公司代表人： 蘭川勝

Company Representative Title 公司代表人職稱： Chairman 董事長

Date 日期： 2023 / 06 / 14

12. REACH Declaration

	宜鼎國際股份有限公司 Innodisk Corporation REACH Declaration
Tel:(02)7703-3000 Fax:(02) 7703-3555 Internet: https://www.innodisk.com/	
Innodisk Corporation pursues its social responsibility for global environmental preservation by committing to be compliant with REACH regulation (REGULATION (EC) No 1907/2006). We hereby confirm that the product(s),	
Scope: Flash Memory, DRAM Module and Embedded Peripherals Products.	
■ The standard products of not listed in the <u>Appendix2</u> meet the requirements of REACH SVHC regulations(SVHCs < 0.1% in Article), as described in the candidate list table currently including 240 substances (release date: 23-JAN-2024) and shown on the ECHA website. https://echa.europa.eu/candidate-list-table ■ The standard products listed in the <u>Appendix2</u> contain(s) one or more hazardous substances or constituents exceeding 0.1 % by weight in article if not otherwise specified in candidate list table. Where the threshold value is exceeded, the substances in question are to be declared in accompanying. (SVHCs > 0.1% in Article). ■ Comply with REACH Annex XVII.	
	
Guarantor	
Company name 公司名稱: <u>Innodisk Corporation 宜鼎國際股份有限公司</u>	
Company Representative 公司代表人: <u> Yichuan Chen 陳怡全</u>	
Company Representative Title 公司代表人職稱: <u>Quality Assurance Div. SR. Manager 品質處經理</u>	
Date 日期: <u>2024 / 02 / 19</u>	

1

Revision Log

Rev	Date	Modification
0.1	15 th February 2017	Preliminary Edition
1.0	15 th February 2017	Official Released
1.1	8 th September 2017	Modified typo
1.2	30 th October 2024	Update IDD table