DDR4 SODIMM 16GB 1RX8 3200 Datasheet

TMD4SHCAD1632W-00N0

TMD4SHCAD1632M-00N0

TMD4SHCAD1632S-00N0

Key Features

Standard Reference

l JEDEC Standard No. JESD79-4D

Supported Features

l VDD = 1.2V (1.14V~1.26V)

l VPP = 2.5V (2.375V~2.75V)

l 8-bit pre-fetch

l On Die Termination using ODT pin

l Data Bus inversion (DBI) for data bus

l CRC (Cyclic Redundancy Check) for Read/Write data security

l Internal VREF for data inputs

l External VPP for DRAM Activating Power

l Capability PPR and sPPR

l All of lead-free products are RoHS compliant

l Halogen-free

l Fly-by topology

l Terminated control, command, and address bus

l Golden Finger: 30μ''

l Anti-Sulfuration

l PCB RAW CARD: A2

l Operating temperature: -40-85℃(-W),-25~85℃(-M),0~85℃(-S)

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1. Introduction

1.1 General Description

The Unbuffered Small Outline DDR4 SDRAM DIMMs (Unbuffered Small Outline Double Data Rate Synchronous DRAM Dual In-Line Memory Modules) are low-power, high-speed operation memory modules. The DDR4 SDRAM Unbuffered Small Outline DIMMs are intended for use as main memories when installed in systems such as personal computers.

1.2 Product Line-up

Table 1 Product Line-up

Part Number	Density	Speed	Component Composition	# of Ranks
TMD4SHCAD1632W-00N0	16GB	DDR4-3200	2Gx8*8	1
TMD4SHCAD1632M-00N0				
TMD4SHCAD1632A-00N0				

1.3 Key Parameters

Table 2 Key Parameters

Grade	Speed (Mbps)	tCK (ns)	CAS Latency (tCK)	tRCD (ns)	tRP (ns)	tRAS (ns)	tRC (ns)	CL-tRCD-tRP
3200AA	3200	0.625	22	13.75	13.75	32	45.75	22-22-22

Table 3 Address Table

Organization	Number of Bank Groups	Bank Group Address	Bank Address in a Bank Group	Row Address	Column Address
2Gx8	4	BG0~BG1	BA0~BA1	A0~A15	A0~A9

1.4 Part Number Decoder

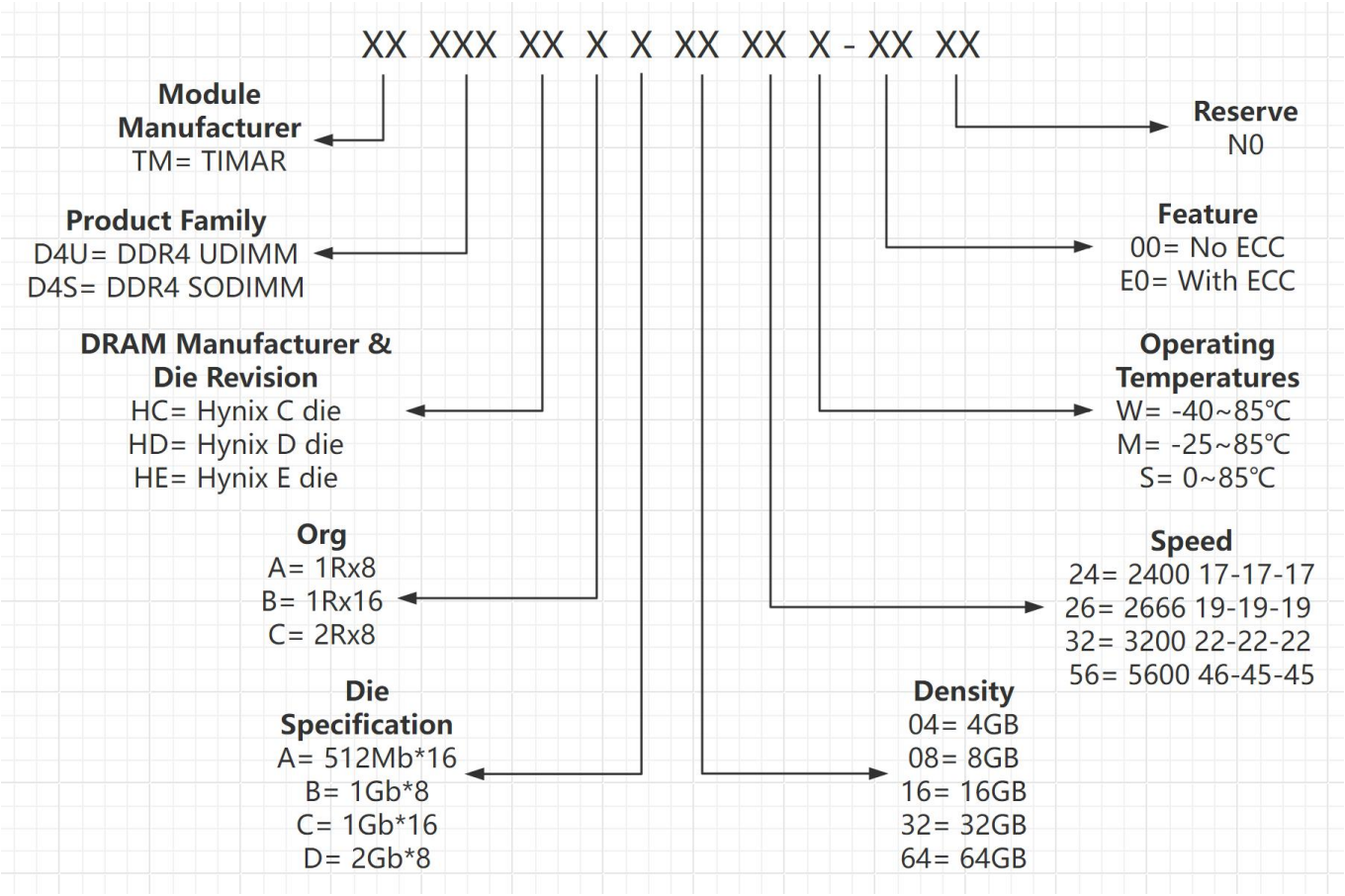

Figure 1 Part Number Decoder

2. Product Specifications

2.1 Pin Description

Table 4 Pin Description

Pin Name	Description	Pin Name	Description
A0-A16	SDRAM address bus	SCL	I2C serial bus clock for SPD/TS
BA0, BA1	SDRAM bank select	SDA	I2C serial bus data line for SPD/TS
BG0, BG1	SDRAM bank group select	SA0–SA2	I2C slave address select for SPD/TS
RAS_n[1]	SDRAM row address strobe	PARITY	SDRAM parity input
CAS_n[2]	SDRAM column address strobe	VDD	SDRAM I/O and core power supply
WE_n[3]	SDRAM write enable	VPP	SDRAM activating power supply
CS0_n, CS1_n CS2_n, CS3_n	Rank select lines	C0,C1	Chip ID lines for 3DS components
CKE0, CKE1	SDRAM clock enable lines	VREFCA	SDRAM command/address reference supply
ODT0, ODT1	SDRAM on-die termination control lines	VSS	Power supply return (ground)
ACT_n	SDRAM activate	VDDSPD	Serial SPD/TS positive power supply
DQ0–DQ63	DIMM memory data bus	ALERT_n	SDRAM ALERT_n
CB0–CB7	DIMM ECC check bits	RESET_n	Set SDRAMs to a known state
DQS0_t–DQS8_t	SDRAM data strobes (Positive line of differential pair)	EVENT_n	SPD signals a thermal event has occurred
DQS0_c–DQS8_c	SDRAM data strobes (Negative line of differential pair)	VTT	Termination supply for the Address, Command and Control bus
DM0_n–DM8_n, DBI0_n-DBI8_n	SDRAM data masks/data bus inversion (x8-based x64 x72 DIMMs)	NC	No connection
CK0_t, CK1_t	SDRAM clocks (Positive line of differential pair)		
CK0_c, CK1_c	SDRAM clocks (Negative line of differential pair)		

Notes:
1. RAS_n is a multiplexed function with A16.
2. CAS_n is a multiplexed function with A15.
3. WE_n is a multiplexed function with A14.

2.2 Input/Output Function Description

Table 5 Input/Output Function Description

Symbol	Type	Function
CK0_t, CK0_c CK1_t, CK1_c	Input	Clock: CK_t and CK_c are differential clock inputs. All address and control input signals are sampled on the crossing of the positive edge of CK_t and negative edge of CK_c.
CKE0,CKE1	Input	Clock Enable: CKE HIGH activates and CKE LOW deactivates internal clock signals, device input buffers and output drivers. Taking CKE LOW provides Precharge Power-Down and Self-Refresh operation (all banks idle), or Active Power-Down (row Active in any bank). CKE is synchronous for Self-Refresh exit. After VREFCA and Internal DQ Vref have become stable during the power on and initialization sequence, they must be maintained during all operations (including Self-Refresh). CKE must be maintained high throughout read and write accesses. Input buffers, excluding CK_t,CK_c, ODT and CKE, are disabled during power-down. Input buffers, excluding CKE, are disabled during Self-Refresh.
CS0_n, CS1_n CS2_n, CS3_n	Input	Chip Select: All commands are masked when CS_n is registered HIGH. CS_n provides for external Rank selection on systems with multiple Ranks. CS_n is considered part of the command code.

Symbol	Type	Function
C0, C1	Input	Chip ID : Chip ID is only used for 3DS for 2, 4 high stack via TSV to select each slice of stacked component. Chip ID is considered part of the command code.
ODT0, ODT1	Input	On Die Termination: ODT (registered HIGH) enables RTT_NOM termination resistance internal to the DDR4 SDRAM. When enabled, ODT is only applied to each DQ, DQS_t, DQS_c and DM_n/DBI_n signal. The ODT pin will be ignored if MR1 is programmed to disable RTT_NOM.
ACT_n	Input	Activation Command Input : ACT_n defines the Activation command being entered along with CS_n. The input into RAS_n/A16, CAS_n/A15 and WE_n/A14 will be considered as Row Address A16, A15 and A14.
RAS_n/A16. CAS_n/A15. WE_n/A14	Input	Command Inputs: RAS_n/A16, CAS_n/A15 and WE_n/A14 (along with CS_n) define the command being entered. Those pins have multi-functions. For example, for activation with ACT_n Low, these are Addresses like A16, A15 and A14 but for non-activation command with ACT_n High, these are Command pins for Read, Write and other commands defined in command truth table.
DM_n/DBI_n	Input /Output	Input Data Mask and Data Bus Inversion: DM_n is an input mask signal for write data. Input data is masked when DM_n is sampled LOW coincident with that input data during a Write access. DM_n is sampled on both edges of DQS. DM is muxed with DBI function. DBI_n is an input/output identifying whether to store/output the true or inverted data. If DBI_n is LOW, the data will be stored/output after inversion inside the DDR4 SDRAM and not inverted if DBI_n is HIGH.
BG0 - BG1	Input	Bank Group Inputs: BG0 - BG1 define which bank group an Active, Read, Write or Precharge command is being applied. BG0 also determines which mode register is to be accessed during a MRS cycle. For x4/x8 based SDRAMs, BG0 and BG1 are valid. For x16 based SDRAM components only BG0 is valid.
BA0 - BA1	Input	Bank Address Inputs: BA0 - BA1 define to which bank an Active, Read, Write or Precharge command is being applied. Bank address also determines which mode register is to be accessed during a MRS cycle.
A0 - A16	Input	Address Inputs: Provide the row address for ACTIVATE Commands and the column address for Read/Write commands to select one location out of the memory array in the respective bank. A10/AP, A12/BC_n, RAS_n/A16, CAS_n/A15 and WE_n/A14 have additional functions. See other rows. The address inputs also provide the op-code during Mode Register Set commands.
A10 / AP	Input	Auto-precharge: A10 is sampled during Read/Write commands to determine whether Autoprecharge should be performed to the accessed bank after the Read/Write operation. (HIGH: Autoprecharge; LOW: no Autoprecharge). A10 is sampled during a Precharge command to determine whether the Precharge applies to one bank (A10 LOW) or all banks (A10 HIGH). If only one bank is to be precharged, the bank is selected by bank addresses.
A12 / BC_n	Input	Burst Chop: A12/BC_n is sampled during Read and Write commands to determine if burst chop (on-the-fly) will be performed. (HIGH, no burst chop; LOW: burst chopped). See command truth table for details.
RESET_n	Input	Active Low Asynchronous Reset: Reset is active when RESET_n is LOW, and inactive when RESET_n is HIGH. RESET_n must be HIGH during normal operation.
DQ	Input /Output	Data Input/ Output: Bi-directional data bus. If CRC is enabled via Mode register then CRC code is added at the end of Data Burst. Any DQ from DQ0-DQ3 may indicate the internal Vref level during test via Mode Register Setting MR4 A4=High. Refer to vendor specific data sheets to determine which DQ is used.
DQS_t,DQS_c	Input /Output	Data Strobe: output with read data, input with write data. Edge-aligned with read data, centered in write data. DDR4 SDRAMs support differential data strobe only and does not support single-ended.
PARITY	Input	Command and Address Parity Input: DDR4 Supports Even Parity check in DRAMs with MR setting. Once it's enabled via Register in MR5, then SDRAM calculates Parity with ACT_n, RAS_n/A16, CAS_n/A15, WE_n/A14, BG0-BG1, BA0-BA1, A16-A0. Command and address inputs shall have parity check performed when commands are latched via the rising edge of CK_t and when CS_n is low.
ALERT_n	Output	ALERT: It has multi-functions such as CRC error flag , Command and Address Parity error flag as Output signal. If there is error in CRC, then ALERT_n goes LOW for the period time interval and goes back HIGH. If there is error in Command Address Parity Check, then ALERT_n goes LOW for relatively long period until on going DRAM internal recovery transaction is complete. Using this signal or not is dependent on the system. This is an open drain signal. It requires a pullup resistor on the system.

Symbol	Type	Function
EVENT_n	Output	I2C thermal event indicator. Open drain, requires a pullup resistor on the system.
SAVE_n	Input/ Output	Not used on SODIMMs. SODIMMs have no connection to this pin. See specifications of NVDIMMs for signal description.
SCL	Input	Bus clock used to strobe data into and out of I2C devices. Open drain and requires a pullup resistor on the system.
SDA	Input/ Output	I2C data. Open drain and requires a pullup resistor on the system.
SA0-SA2	Input	Device address for the SPD.
RFU		Reserved for Future Use. No on-DIMM electrical connection is present.
NC		No Connect: No on-DIMM electrical connection is present.
VDD	Supply	Power Supply: 1.2 V ± 0.06 V.
VSS	Supply	Ground.
VTT	Supply	Power Supply: 0.6 V.
VPP	Supply	DRAM Activating Power Supply: 2.5V (2.375V min, 2.75V max).
VREFCA	Supply	Reference voltage for CA.
VDDSPD	Supply	Power supply used to power the I2C bus on the SPD.

2.3 Pin Assignment

Table 6 Pin Assignment

Pin	Front Side	Pin	Back Side	Pin	Front Side	Pin	Back Side
1	VSS	2	VSS	131	A3	132	A2
3	DQ5	4	DQ4	133	A1	134	EVENT_n
5	VSS	6	VSS	135	VDD	136	VDD
7	DQ1	8	DQ0	137	CK0_t	138	CK1_t
9	VSS	10	VSS	139	CK0_c	140	CK1_C
11	DQS0_C	12	DM0_n, DBI0_n	141	VDD	142	VDD
13	DQS0_t	14	VSS	143	PARITY	144	A0
15	VSS	16	DQ6	KEY			
17	DQ7	18	VSS				
19	VSS	20	DQ2	145	BA1	146	A10/AP
21	DQ3	22	VSS	147	VDD	148	VDD
23	VSS	24	DQ12	149	CS0_n	150	BA0
25	DQ13	26	VSS	151	A14/WE_n	152	A16/RAS_n
27	VSS	28	DQ8	153	VDD	154	VDD
29	DQ9	30	VSS	155	ODT0	156	A15/CAS_n
31	VSS	32	DQS1_C	157	CS1_n	158	A13
33	DM1_n, DBI1_n	34	DQS1_t	159	VDD	160	VDD
35	VSS	36	VSS	161	ODT1	162	C0, CS2_n, NC
37	DQ15	38	DQ14	163	VDD	164	VREFCA
39	VSS	40	VSS	165	C1, CS3_n, NC	166	SA2

Pin	Front Side	Pin	Back Side	Pin	Front Side	Pin	Back Side
41	DQ10	42	DQ11	167	VSS	168	VSS
43	VSS	44	VSS	169	DQ37	170	DQ36
45	DQ21	46	DQ20	171	VSS	172	VSS
47	VSS	48	VSS	173	DQ33	174	DQ32
49	DQ17	50	DQ16	175	VSS	176	VSS
51	VSS	52	VSS	177	DQS4_C	178	DM4_n, DBI4_n
53	DQS2_c	54	DM2_n, DBI2_n	179	DQS4_t	180	VSS
55	DQS2_t	56	VSS	181	VSS	182	DQ39
57	VSS	58	DQ22	183	DQ38	184	VSS
59	DQ23	60	VSS	185	VSS	186	DQ35
61	VSS	62	DQ18	187	DQ34	188	VSS
63	DQ19	64	VSS	189	VSS	190	DQ45
65	VSS	66	DQ28	191	DQ44	192	VSS
67	DQ29	68	VSS	193	VSS	194	DQ41
69	VSS	70	DQ24	195	DQ40	196	VSS
71	DQ25	72	VSS	197	VSS	198	DQS5_c
73	VSS	74	DQS3_c	199	DM5_n, DBI5_n	200	DQS5_t
75	DM3_n, DBI3_n	76	DQS3_t	201	VSS	202	VSS
77	VSS	78	VSS	203	DQ46	204	DQ47
79	DQ30	80	DQ31	205	VSS	206	VSS
81	VSS	82	VSS	207	DQ42	208	DQ43
83	DQ26	84	DQ27	209	VSS	210	VSS
85	VSS	86	VSS	211	DQ52	212	DQ53
87	CB5, NC	88	CB4, NC	213	VSS	214	VSS
89	VSS	90	VSS	215	DQ49	216	DQ48
91	CB1, NC	92	CB0, NC	217	VSS	218	VSS
93	VSS	94	VSS	219	DQS6_C	220	DM6_n, DBI6_n
95	DQS8_c	96	DBI8_n	221	DQS6_t	222	VSS
97	DQS8_t	98	VSS	223	VSS	224	DQ54
99	VSS	100	CB6, NC	225	DQ55	226	VSS
101	CB2, NC	102	VSS	227	VSS	228	DQ50
103	VSS	104	CB7, NC	229	DQ51	230	VSS
105	CB3, NC	106	VSS	231	VSS	232	DQ60
107	VSS	108	RESET_n	233	DQ61	234	VSS
109	CKE0	110	CKE1	235	VSS	236	DQ57
111	VDD	112	VDD	237	DQ56	238	VSS
113	BG1	114	ACT_n	239	VSS	240	DQS7_c
115	BG0	116	ALERT_n	241	DM7_n, DBI7_n	242	DQS7_t

Pin	Front Side	Pin	Back Side	Pin	Front Side	Pin	Back Side
117	VDD	118	VDD	243	VSS	244	VSS
119	A12	120	A11	245	DQ62	246	DQ63
121	A9	122	A7	247	VSS	248	VSS
123	VDD	124	VDD	249	DQ58	250	DQ59
125	A8	126	A5	251	VSS	252	VSS
127	A6	128	A4	253	SCL	254	SDA
129	VDD	130	VDD	255	VDDSPD	256	SA0
				257	VPP	258	VTT
				259	VPP	260	SA1

2.4 DQ Map

Table 7 DQ Map
*DDR4 SDRAM, single-rank, x8-FBGA 78-ball-based, x64 Unbuffered, 260-pin SODIMM

Module Pin Number	Module DQ	IC No.	IC DQ	Module Pin Number	Module DQ	IC No.	IC DQ
8	0	U1	5	28	8	U9	6
7	1		7	29	9		4
20	2		6	41	10		5
21	3		4	42	11		7
4	4		3	24	12		0
3	5		1	25	13		2
16	6		2	38	14		3
17	7		0	37	15		1
50	16	U2	5	70	24	U8	6
49	17		7	71	25		4
62	18		6	83	26		5
63	19		4	84	27		7
46	20		3	66	28		0
45	21		1	67	29		2
58	22		2	79	30		1
59	23		0	80	31		3
174	32	U4	5	195	40	U7	0
173	33		7	194	41		2
187	34		4	207	42		3
186	35		6	208	43		1
170	36		3	191	44		6
169	37		1	190	45		4
183	38		0	203	46		5
182	39		2	204	47		7

Module Pin Number	Module DQ	IC No.	IC DQ	Module Pin Number	Module DQ	IC No.	IC DQ
216	48	U5	5	237	56	U6	6
215	49		7	236	57		4
228	50		6	249	58		5
229	51		4	250	59		7
211	52		1	232	60		0
212	53		3	233	61		2
224	54		2	245	62		1
225	55		0	246	63		3

2.5 Speed Bins

Table 8 DDR4-3200 Speed Bin and Operation

DDR4-3200 Speed Bin						Unit
CL-nRCD-nRP				22-22-22		
Parameter			Symbol	Min	Max	
Internal READ command to the first data			tAA	13.75	18.00	ns
Internal READ command to first data with read DBI enabled			tAA DBI	tAA(MIN) + 4nCK	tAA(MIN) + 4nCK	ns
ACTIVATE to internal READ or WRITE delay time			tRCD	13.75	_	ns
PRECHARGE command period			tRP	13.75	_	ns
ACTIVATE-to-PRECHARGE command period			tRAS	32	9 x tREFI	ns
ACTIVATE-to-ACTIVATE or REFRESH command period			tRC	45.75	_	ns
	Normal	Read DBI				
CWL=9	CL=9	CL=11	tCK(AVG)	Reserved		ns
	CL=10	CL=12	tCK(AVG)	Reserved		ns
CWL=9, 11	CL=10	CL=12	tCK(AVG)	Reserved		ns
	CL=11	CL=13	tCK(AVG)	1.25	<1.5	ns
	CL=12	CL=14	tCK(AVG)	1.25	<1.5	ns
CWL=10, 12	CL=12	CL=14	tCK(AVG)	Reserved		ns
	CL=13	CL=15	tCK(AVG)	1.071	<1.25	ns
	CL=14	CL=16	tCK(AVG)	1.071	<1.25	ns
CWL=11, 14	CL=14	CL=17	tCK(AVG)	Reserved		ns
	CL=15	CL=18	tCK(AVG)	0.937	<1.071	ns
	CL=16	CL=19	tCK(AVG)	0.937	<1.071	ns
CWL=12, 16	CL=15	CL=18	tCK(AVG)	Reserved		ns
	CL=16	CL=19	tCK(AVG)	Reserved		ns
	CL=17	CL=20	tCK(AVG)	0.833	<0.937	ns
	CL=18	CL=21	tCK(AVG)	0.833	<0.937	ns
CWL=14, 18	CL=17	CL=20	tCK(AVG)	Reserved		ns
	CL=18	CL=21	tCK(AVG)	Reserved		ns

DDR4-3200 Speed Bin						Unit
CL-nRCD-nRP				22-22-22		
Parameter			Symbol	Min	Max	
	CL=19	CL=22	tCK(AVG)	0.75	<0.833	ns
	CL=20	CL=23	tCK(AVG)	0.75	<0.833	ns
CWL=16, 20	CL=20	CL=24	tCK(AVG)	Reserved		ns
	CL=22	CL=26	tCK(AVG)	0.625	<0.75	ns
	CL=24	CL=28	tCK(AVG)	0.625	<0.75	ns
Supported CL Settings				10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24		nCK
Supported CL Settings with DBI				12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26, 28		nCK
Supported CLW Settings				9, 10, 11, 12, 14, 16, 18, 20		nCK

2.6 Dram Component Operating Temperature Range

Table 9 Temperature Range

Symbol	Parameter	Rating	Unit
T_{OPER}	Normal Operating Temperature Range	-40 to 85(-W) -25 to 85(-M) 0 to 85(-S)	℃
	Extended Temperature Range	85 to 95	℃

Notes:
1. Operating Temperature TOPER is the case surface temperature on the center / top side of the DRAM. For measurement conditions, please refer to the JEDEC document JESD51-2.
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℃ under all operating conditions.
3. Some applications require operation of the DRAM in the Extended Temperature Range between 85℃ and 95℃ case temperature. Full specifications are guaranteed in this range, but the following additional conditions apply:
a. Refresh commands must be doubled in frequency to reduce the Refresh interval tREFI to 3.9 µs. It is also possible to specify a component with 1X refresh (tREFI to 7.8µs) in the Extended Temperature Range. Please refer to the DIMM SPD for option availability
b. If Self-Refresh operation is required in the Extended Temperature Range, it is mandatory to either use the Manual Self-Refresh mode with Extended Temperature Range capability (MR2 A6 = 0b and MR2 A7 = 1b) or enable the optional Auto Self-Refresh mode (MR2 A6 = 1b and MR2 A7 = 0b).

Table 10 Absolute Maximum DC Ratings

Symbol	Parameter	Rating	Units
VDD	Voltage on VDD pin relative to Vss	-0.3 ~ 1.5	V
VDDQ	Voltage on VDDQ pin relative to Vss	-0.3 ~ 1.5	V
VPP	Voltage on VPP pin relative to Vss	-0.3 ~ 3.0	V
VIN, VOUT	Voltage on any pin except VREFCA relative to Vss	-0.3 ~ 1.5	V
TSTG	Storage Temperature	-55 to +100	℃

Notes:
1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating 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.
2. 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.

3. VDD and VDDQ must be within 300 mV of each other at all times;and VREFCA must be not greater than 0.6 x VDDQ, When VDD and VDDQ are less than 500 mV; VREFCA may be equal to or less than 300 mV.
4. VPP must be equal or greater than VDD/VDDQ at all times.
5. Overshoot area above 1.5V is specified in DDR4 Device Operation.

Table 11 AC & DC Operating Conditions

Symbol	Parameter	Rating			Unit
		Min.	Typ.	Max.	
VDD	Supply Voltage	1.14	1.2	1.26	V
VDDQ	Supply Voltage for Output	1.14	1.2	1.26	V
VPP	Supply Voltage for DRAM Activating	2.375	2.5	2.75	V

Notes:
1. Under all conditions VDDQ must be less than or equal to VDD.
2. VDDQ tracks with VDD. AC parameters are measured with VDD and VDDQ tied together.
3. DC bandwidth is limited to 20MHz.

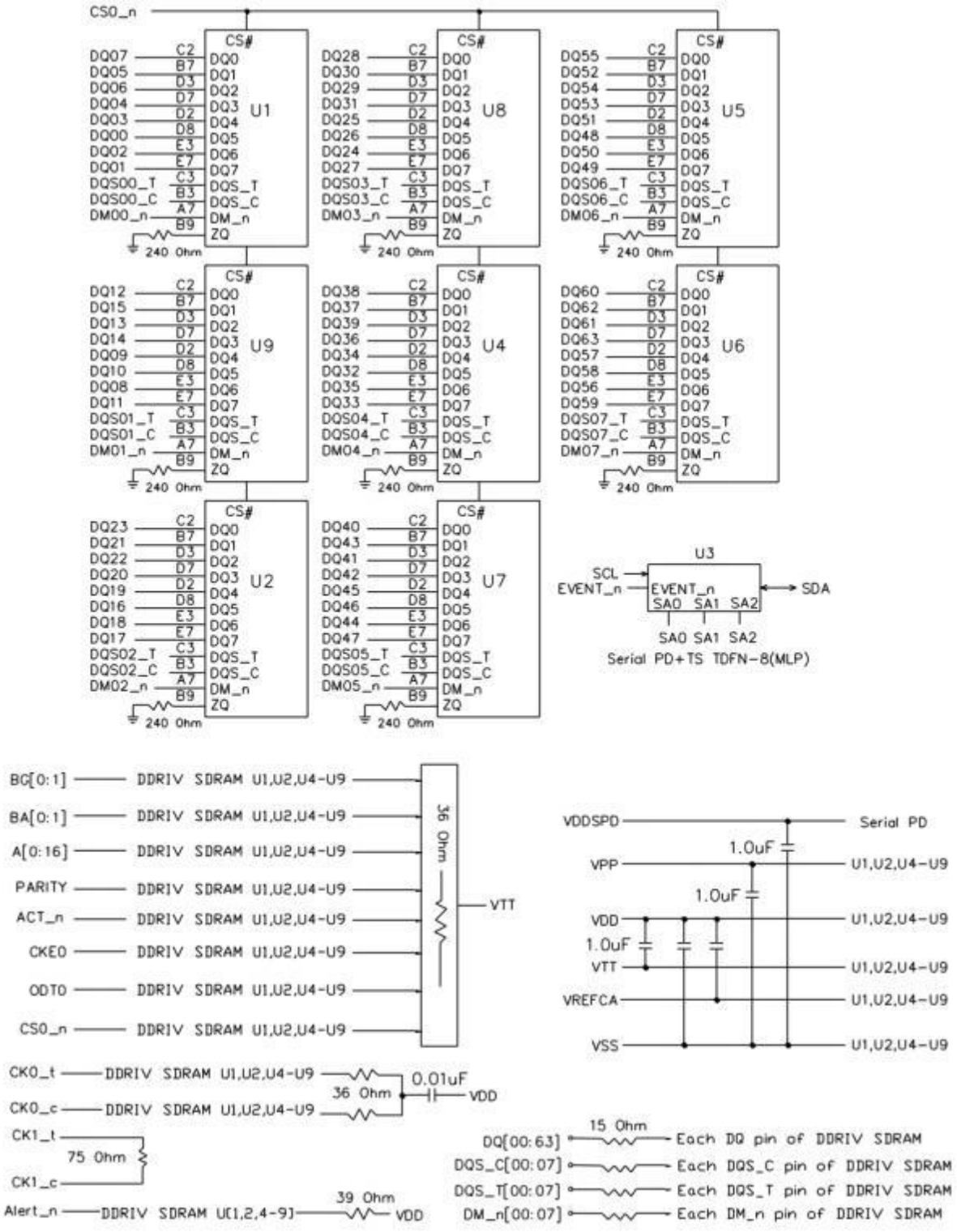

Figure 2 Functional Diagram

3. PCB Specifications

3.1 General Specifications

1.Board size: 69.6 x 30 mm ± 0.15 mm

2.Thickness: 1.2 ± 0.1 mm

3.Pin count: 260 PIN

3.2 Module Dimension

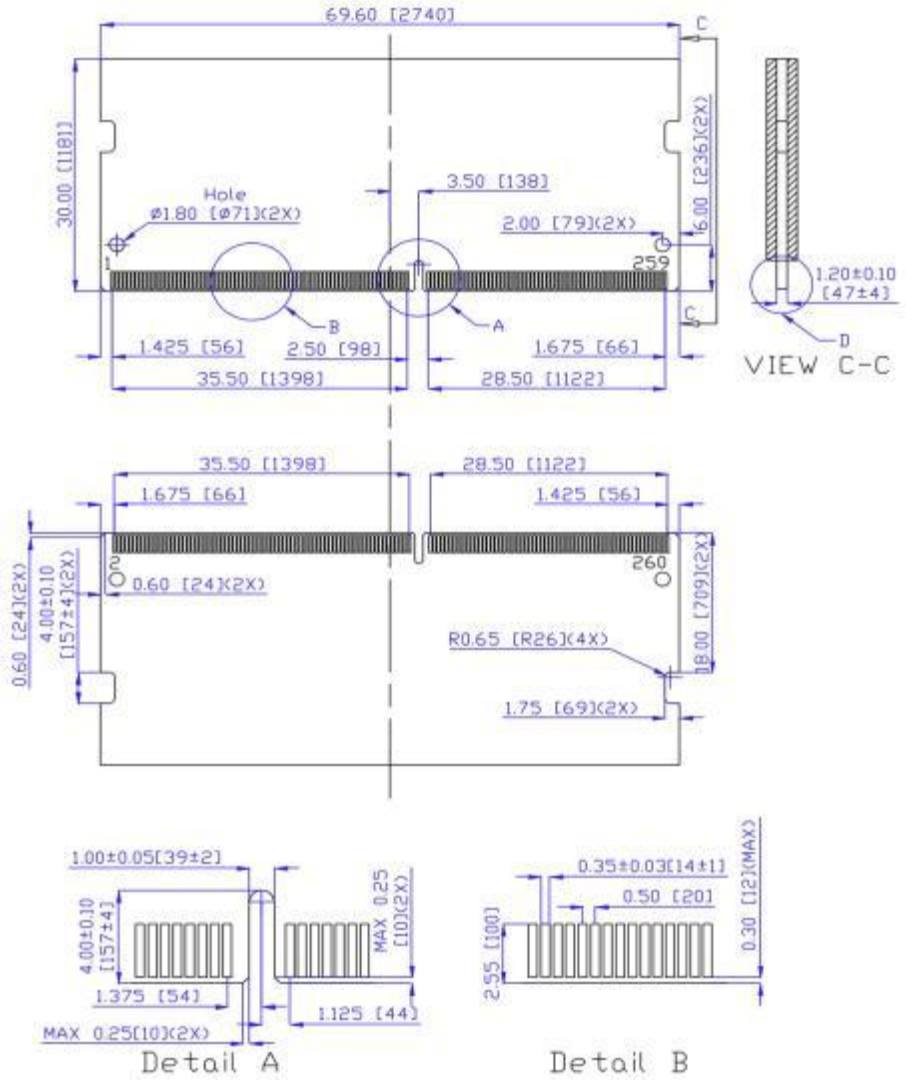

Figure 3 Module Dimension

Revision History

Version	Date	Changes
1.0	2023.10	Initial release
1.1	2024.05	Added -25℃