



### Identification

DTM65517 1Gx72  
8GB 4Rx4 PC2-5300F-555-11-AA0

### Performance range

Clock / Module Speed / CL-t<sub>RCD</sub>-t<sub>RP</sub>  
333MHz / DDR2-667 / 5-5-5

### Features

240-pin JEDEC-compliant DIMM, 133.35 mm wide by 30.35 mm high
Data Transfer Rate: 5.3 Gigabytes/sec
Operating Voltage: VDD = 1.8 V ±0.1; VCC = 1.5V ±0.1
SMBus interface to AMB for configuration register access
MBIST and IBIST test functions
Transparent mode for DDR2 SDRAM test support
Full DIMM Heat Spreader
High-speed differential point-to-point link
Fully RoHS Compliant

### Description

The DTM65517 is a Quad Rank PC2-5300 Fully Buffered 1Gx72 ECC DIMM that conforms to the JEDEC FB-DIMM standard. Twin sets of two ranks each are comprised of eighteen 512Mx4 DDR2 SDRAMs, using Dual-Die Packaging, each die being 256Mx4. One IDT (Rev L4) Advanced Memory Buffer (AMB) is used as the interface between the system memory bus and DIMM DRAMs. One 2K-bit EEPROM is used for Serial Presence Detect. For improved thermal performance, a Full DIMM Heat Spreader with thermal interface material (TIM) is attached to the front and back of the DIMM.

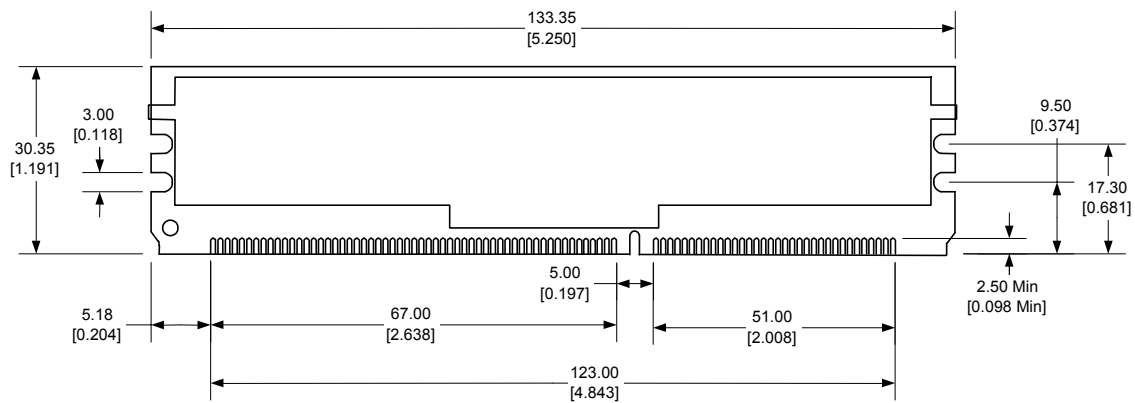
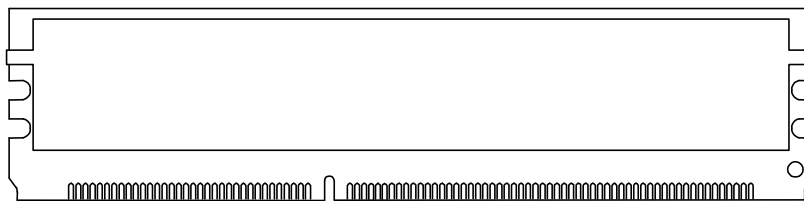
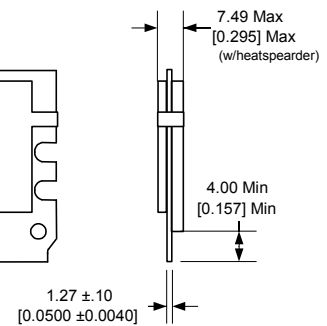
### Pin Configurations

Front side			Back side		
1 VDD	31 /PN3	61 /PN9	91 /PS9	121 VDD	151 SN3
2 VDD	32 /PN3	62 VSS	92 VSS	122 VDD	152 /SN3
3 VDD	33 VSS	63 PN10	93 PS5	123 VDD	153 VSS
4 VSS	34 PN4	64 /PN10	94 /PS5	124 VSS	154 SN4
5 VDD	35 /PN4	65 VSS	95 VSS	125 VDD	155 /SN4
6 VDD	36 VSS	66 PN11	96 PS6	126 VDD	156 VSS
7 VDD	37 PN5	67 /PN11	97 /PS6	127 VDD	157 SN5
8 VSS	38 /PN5	68 VSS	98 VSS	128 VSS	158 /SN5
9 VCC	39 VSS	69 VSS	99 PS7	129 VCC	159 VSS
10 VCC	40 PN13	70 PS0	100 /PS7	130 VCC	160 SN13
11 VSS	41 /PN13	71 /PS0	101 VSS	131 VSS	161 /SN13
12 VCC	42 VSS	72 VSS	102 PS8	132 VCC	162 VSS
13 VCC	43 VSS	73 PS1	103 /PS8	133 VCC	163 VSS
14 VSS	44 RFU	74 /PS1	104 VSS	134 VSS	164 RFU1
15 VTT	45 RFU	75 VSS	105 RFU2	135 VTT	165 RFU1
16 VID1	46 VSS	76 PS2	106 RFU2	136 VID0	166 VSS
17 /RESET	47 VSS	77 /PS2	107 VSS	137 M_TEST	167 VSS
18 VSS	48 PN12	78 VSS	108 VDD	138 VSS	168 SN12
19 RFU2	49 /PN12	79 PS3	109 VDD	139 RFU2	169 /SN12
20 RFU2	50 VSS	80 /PS3	110 VSS	140 RFU2	170 VSS
21 VSS	51 PN6	81 VSS	111 VDD	141 VSS	171 SN6
22 PN0	52 /PN6	82 PS4	112 VDD	142 SN0	172 /SN6
23 /PN0	53 VSS	83 /PS4	113 VDD	143 /SN0	173 VSS
24 VSS	54 PN7	84 VSS	114 VSS	144 VSS	174 SN7
25 PN1	55 /PN7	85 VSS	115 VDD	145 SN1	175 /SN7
26 /PN1	56 VSS	86 RFU1	116 VDD	146 /SN1	176 VSS
27 VSS	57 PN8	87 RFU1	117 VTT	147 VSS	177 SN8
28 PN2	58 /PN8	88 VSS	118 SA2	148 SN2	178 /SN8
29 /PN2	59 VSS	89 VSS	119 SDA	149 /SN2	179 VSS
30 VSS	60 PN9	90 PS9	120 SCL	150 VSS	180 SN9
					210 SS9
					211 /SS9
					212 VSS
					213 SS5
					214 /SS5
					215 VSS
					216 SS6
					217 /SS6
					218 VSS
					219 SS7
					220 /SS7
					221 VSS
					222 SS8
					223 /SS8
					224 VSS
					225 RFU2
					226 RFU2
					227 VSS
					228 SCK
					229 /SCK
					230 VSS
					231 VDD
					232 VDD
					233 VDD
					234 VSS
					235 VDD
					236 VDD
					237 VTT
					238 VDDSPD
					239 SA0
					240 SA1

NOTE: M\_TEST is not used

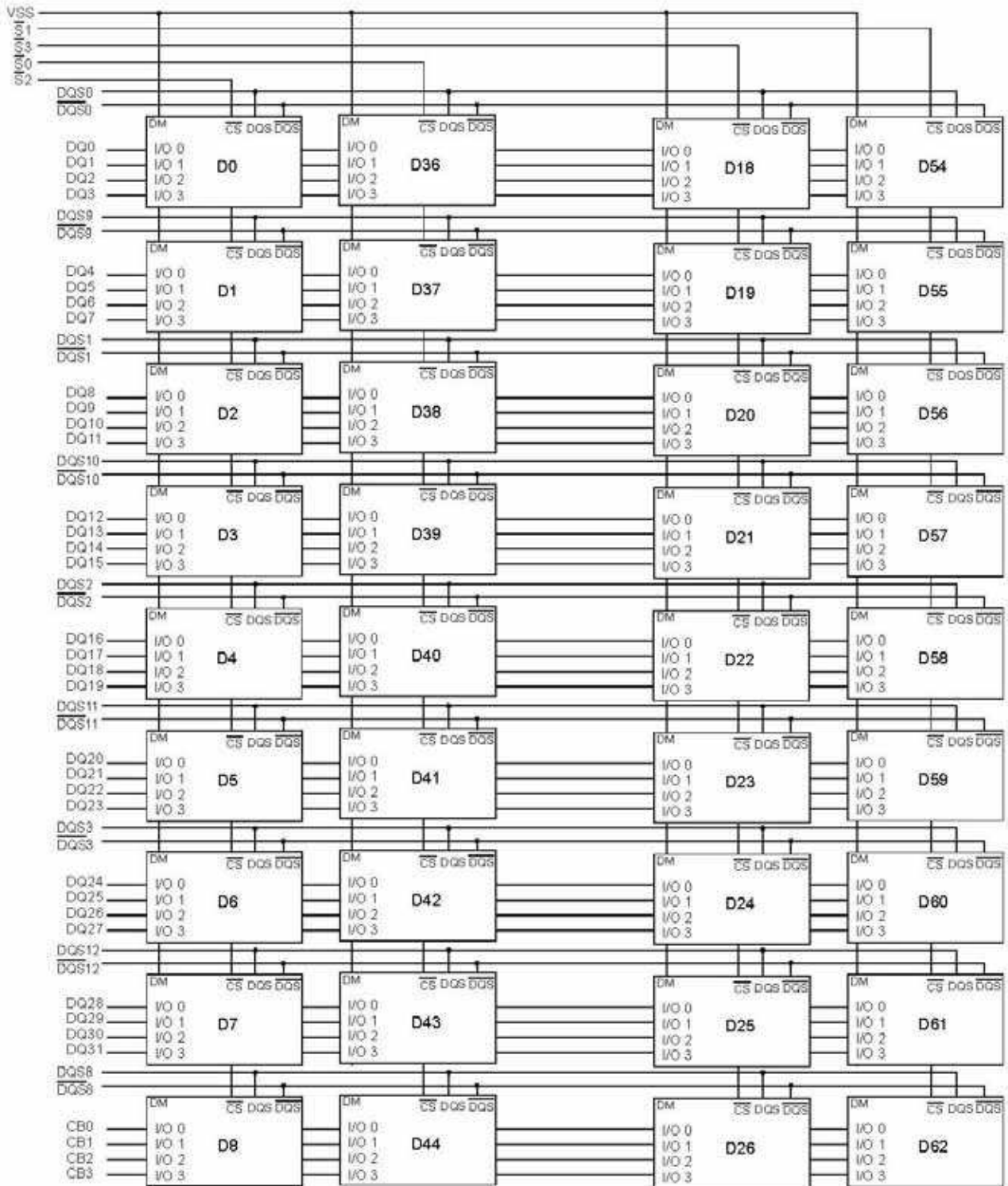
### Pin Names

Pin Names	Function
SCK, /SCK	System Clock Input
PN, /PN[13:0]	Primary Northbound Data
PS, /PS[9:0]	Primary Southbound Data
SN, /SN[13:0]	Secondary Northbound Data
SS, /SS[9:0]	Secondary Southbound Data
SCL	Serial Clock, EEPROM
SDA	Serial Data, EEPROM
/RESET	AMB Reset Signal
VCC	AMB Core Power and AMB Channel Interface Power (1.5 V)
VDD	DRAM Power and AMB DRAM I/O Power (1.8 V)
VTT	DRAM Address/Command/Clock Termination Power (VDD/2)
VDDSPD	SPD Power
VSS	Ground
RFU	Reserved For Future Use
DNU	Do Not Use
M_TEST	Margin Test
SA[2:0]	Serial Address, EEPROM

**Front view****Back view****Side view****Notes**

Tolerances on all dimensions except where otherwise indicated are  $\pm 0.13$  [0.005].

All dimensions are expressed: millimeters [inches]





### Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit	Note
Temperature, DDR2 DRAM Case	$T_{Case}$	0 to +95	C	1, 2
Temperature, Storage	$T_{STG}$	-55 to +100	C	1
Voltage on any pin relative to $V_{SS}$	$V_{IN}, V_{OUT}$	-0.3 to 1.75	V	1
Voltage on $V_{CC}$ relative to $V_{SS}$	$V_{CC}$	-0.3 to 1.75	V	1
Voltage on $V_{DD}$ relative to $V_{SS}$	$V_{DD}$	-0.5 to 2.3	V	1
Voltage on $V_{TT}$ relative to $V_{SS}$	$V_{TT}$	-0.5 to 2.3	V	1
Power Dissipation	$P_D$	21	W	1

Notes:

1. Operation at or above absolute maximum rating can adversely affect device reliability.
2. For  $85\text{ C} < T_{Case} \leq 95\text{ C}$ ,  $t_{REFI} = 3.9\ \mu\text{s max}$ .

### DC Operating Conditions ( $T_A = 0$ to $70\text{ C}$ , Voltage referenced to $V_{SS} = 0\text{V}$ )

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Note
AMB Supply Voltage	$V_{CC}$	1.455	1.5	1.575	V	
DDR2 Supply Voltage	$V_{DD}$	1.7	1.8	1.9	V	
Termination Voltage	$V_{TT}$	$0.48 \times V_{DD}$	$0.50 \times V_{DD}$	$0.52 \times V_{DD}$	V	
EEPROM Supply Voltage (SPD)	$V_{DDSPD}$	3.0	3.3	3.6	V	
Input High Voltage (SPD)	$V_{IH(DC)}$			$V_{DDSPD}$	V	1
Input Low Voltage (SPD)	$V_{IL(DC)}$	1.0		0.8	V	1
Input High Voltage (RESET/BFUNC)	$V_{IH(DC)}$	1.0			V	2
Input Low Voltage( RESET/BFUNC)	$V_{IL(DC)}$			0.5	V	2
Leakage Current (RESET/BFUNC)	$I_L$	-90		90	$\mu\text{A}$	2
Leakage Current (Link)	$I_L$	-5		5	$\mu\text{A}$	

Notes:

1. Applies to SMB and SPD bus signals.
2. Applies to AMB CMOS signal /RESET.

### Differential Transmitter Output Specification

Parameter	Symbol	MIN	MAX	Units
Differential peak-to-peak output voltage for large voltage swing $V_{TX-DIFFp-p} = 2 *  V_{TX-D+} - V_{TX-D-} $	VTX-DIFFp-p_L(1)	900	1300	mV
Differential peak-to-peak output voltage for regular voltage swing $V_{TX-DIFFp-p} = 2 *  V_{TX-D+} - V_{TX-D-} $	VTX-DIFFp-p_R(1)	800	---	mV
Differential peak-to-peak output voltage for small voltage swing $V_{TX-DIFFp-p} = 2 *  V_{TX-D+} - V_{TX-D-} $	VTX-DIFFp-p_S(1)	520	---	mV
DC common mode output voltage for large voltage swing Defined as: $V_{TX-CM} = DC(aveg) \text{ of }  V_{TX-D+} + V_{TX-D-} /2$	VTX-CM_L(1)	---	375	mV
DC common mode output voltage for small voltage swing Defined as: $V_{TX-CM} = DC(aveg) \text{ of }  V_{TX-D+} + V_{TX-D-} /2$	VTX-CM_S(1)	135	280	mV
De-emphasized differential output voltage ratio for -3.5 dB de-emphasis -	VTX-DE-3.5-Ratio(1,2,3)	-3	-4	dB
De-emphasized differential output voltage ratio for -6 dB de-emphasis	VTX-DE-6-Ratio(1,2,3)	-5	-7	dB
AC peak-to-peak common mode output voltage for large swing $V_{TX-CM-AC} = \text{Max}  V_{TX-D+} + V_{TX-D-} /2 - \text{Min}  V_{TX-D+} + V_{TX-D-} /2$	VTX-CM-ACp-p L(1,4)	---	90	mV
AC peak-to-peak common mode output voltage for regular swing $V_{TX-CM-AC} = \text{Max}  V_{TX-D+} + V_{TX-D-} /2 - \text{Min}  V_{TX-D+} + V_{TX-D-} /2$	VTX-CM-ACp-p R(1,4)	---	80	mV
AC peak-to-peak common mode output voltage for small swing $V_{TX-CM-AC} = \text{Max}  V_{TX-D+} + V_{TX-D-} /2 - \text{Min}  V_{TX-D+} + V_{TX-D-} /2$	VTX-CM-ACp-p S(1,4)	---	70	mV
Maximum single-ended voltage in EI condition, DC + AC	VTX-IDLE-SE(5,6)	---	50	mV
Maximum single-ended voltage in EI condition, DC only	VTX-IDLE-SE-DC(5,6,7)	---	20	mV
Maximum peak-to-peak differential voltage in EI condition	VTX-IDLE-DIFFp-p(6)	---	40	mV
Single-ended voltage(w.r.t. VSS) on D+/D-	VTX-SE(1,7)	-75	750	mV
Minimum TX eye width, 3.2 and 4 Gb/s	TTX-Eye-MIN(1,9,10)	0.7	---	UI
Maximum TX deterministic jitter, 3.2 and 4 Gb/s	TTX-DJ-DD(1,9,10,11)	---	0.2	UI
Instantaneous pulse width	TTX-PULSE(12)	0.85	---	UI
Differential TX output rise/fall time Given by 20%-80% voltage levels	TTX-RISE, TTX-FALL(1)	30	90	ps
Mismatch between rise and fall times	TTX-RF-MISMATCH	---	20	ps
Differential return loss Measured over 0.1 GHz to 2.4GHz	RLTX-DIFF	8	---	dB
Common mode return loss Measured over 0.1 GHz to 2.4GHz	RLTX-CM	6	---	dB
Transmitter termination resistance	RTX(13)	41	55	$\Omega$
D+/D- TX resistance difference $RTX-Match-DC = 2 *  RTX-D+ - RTX-D-  / (RTX-D+ + RTX-D-)$ Bounds are applied separately to high and low output voltage states	RTX-Match-DC		4	%
Lane-to-lane skew at TX	LTX-SKEW 1(14,16)	---	100+3UI	ps
Lane-to-lane skew at TX	LTX-SKEW 2(15,16)	---	100+2UI	ps
Maximum TX Drift (resync mode)	TTX-DRIFT-RESYNC(17)	---	240	ps
Maximum TX Drift (resample mode only)	TTX-DRIFT-RESAMPLE(17)	---	120	ps
Bit Error Ratio	BER(18)	---	$10^{-12}$	

## NOTES FOR TRANSMITTER OUTPUT SPECIFICATIONS:

1. Specified at the package pins into a timing and voltage compliance test load. Common-mode measurements are performed using a 101010 pattern.
2. This is the ratio of the  $V_{TX-DIFFp-p}$  of the second and following bits after a transition divided by the  $V_{TX-DIFFp-p}$  of the first bit after a transition.
3. De-emphasis is disabled in the calibration state.
4. Includes all sources of AC common mode noise
5. Single-ended voltages below that value that are simultaneously detected on D+ and D- are interpreted as the Electrical Idle condition.
6. Specified at the package pins into a voltage compliance test load. Transmitters meet both single-ended and differential output E1 specifications.
7. This specification, considered with  $V_{RX-IDLE-SE-DC}$ , implies a maximum 15mV single-ended DC offset between Tx and Rx pins during the electrical idle condition. This in turn allows a ground offset between adjacent FB-DIMM agents of 26mV when worst-case termination resistance matching is considered.
8. The maximum value is specified to be at least  $(V_{TX-DIFFp-p} L / 4) + V_{TX-CM L} + (V_{TX-CM-ACp-p} / 2)$
9. This number does not include the effects of SSC or reference clock jitter.
10. These timing specifications apply to resync mode only.
11. Defined as the dual-dirac deterministic jitter as described in Section 4 of the JEDEC FB-DIMM High Speed Differential PTP Link Draft Spec rev 0.8.
12. Pulse width measured at 0V differential.
13. The termination small signal resistance; tolerance across voltages from 100mV to 400mV shall not exceed  $\pm 5\%$  with regard to the average of the values measured at 100mV and at 400mV for that pin.
14. Lane to Lane skew at the Transmitter pins for an end component.
15. Lane to Lane skew at the Transmitter pins for an intermediate component (assuming zero Lane to Lane skew at the Receiver pins of the incoming PORT).
16. This is a static skew. A FB-DIMM component is not allowed to change its lane to lane phase relationship after initialization.
17. Measured from the reference clock edge to the center of the output eye. This specification is met across specified voltage and temperature ranges for a single component. Drift rate of change is significantly below the tracking capability of the receiver.
18. BER per differential lane.

### Differential Receiver Input Specification

Parameter	Symbol	MIN	MAX	Units
Differential peak-to-peak input voltage VRX-DIFFp-p = 2 *   VRX-D+ - VRX-D-	VRX-DIFFp-p_L(1)	170	1300	mV
Maximum single-ended voltage for EI condition, DC + AC	VRX-IDLE-SE(2,3,4)	---	65	mV
Maximum single-ended voltage for EI condition, DC only	VRX-IDLE-SE-DC(2,3,4,5)	---	35	mV
Single-ended voltage (w.r.t. VSS) on D+/D-	VRX-SE(4)	-300	900	mV
Single-pulse peak differential input voltage	VRX-DIFF-PULSE(4,6)	85	---	mV
Amplitude ratio between adjacent symbols 1100mV < VRX-DIFFp-p ≤ 1300mV	VRX-DIFF-ADJ-RATIO-HI(4,7)	---	3	
Amplitude ratio between adjacent symbols VRX-DIFFp-p ≤ 1100mV	VRX-DIFF-ADJ-RATIO(4,7)	---	4	
Maximum RX inherent timing error, 3.2 and 4 Gb/s	TRX-TJ-MAX(4,8,9)	---	0.4	UI
Maximum RX inherent deterministic timing error, 3.2 and 4 Gb/s	TRX-DJ-DD(4,8,9,10)	---	0.3	UI
Single-pulse width at zero-voltage crossing	TRX-PW-ZC(4,6)	0.55	---	UI
Single-pulse width at minimum-level crossing	TRX-PW-ML(4,6)	0.2	---	UI
Differential RX input rise/fall time, given by 20%-80% voltage levels	TRX-RISE, TRX-FALL	50	---	ps
Common mode of the input voltage Defined as: VRX-CM = DC(avg) of   VRX-D+ + VRX-D-   / 2	VRX-CM(1,11)	120	400	mV
AC peak-to-peak common mode of input voltage VRX-CM-AC = Max   VRX-D+ + VRX-D-   / 2 - Min   VRX-D+ + VRX-D-   / 2	VRX-CM-ACp-p(1)	---	270	mV
Ratio of VRX-CM-ACp-p to minimum VRX-DIFFp-p	VRX-CM-EH-Ratio(12)	---	45	%
Differential return loss Measured over 0.1 GHz to 2.4GHz	RLRX-DIFF	9	---	dB
Common mode return loss Measured over 0.1 GHz to 2.4GHz	RLRX-CM	6	---	dB
RX termination resistance	RRX(13)	41	55	Ω
D+/D- RX resistance difference RRX-Match-DC = 2 *   RRX-D+ - RRX-D-   / ( RRX-D+ + RRX-D- )	RRX-Match-DC	---	4	%
Lane-to-lane PCB skew at RX Lane to Lane PCB skew at the Receiver that must be tolerated.	LRX-PCB-SKEW(14)	---	6	UI
Minimum RX Drift Tolerance	TRX-DRIFT(15)	400	---	ps
Minimum data tracking 3dB bandwidth	FTRK(16)	0.2	---	MHz
Electrical idle entry detect time	TEI-ENTRY - DETECT(17)	---	60	ns
Electrical idle exit detect time	TEI-EXIT-DETECT	---	30	ns
Bit Error Ratio	BER(18)	---	10 <sup>-12</sup>	

## NOTES FOR RECEIVER INPUT SPECIFICATIONS:

1. Specified at the package pins into a timing and voltage compliant test setup. Note that signal levels at the pad are lower than at the pin.
2. Single-ended voltages below that value that are simultaneously detected on D+ and D- are interpreted as the Electrical Idle condition. Worst-case margins are determined by comparing EI levels with common mode levels during normal operation for the case with transmitter using small voltage swing (see RX Single-ended Electrical Idle Levels and RX Common Mode Levels).
3. Multiple lanes need to detect the EI condition before the device can act upon the EI detection.
4. Specified at the package pins into a timing and voltage compliance test setup.
5. This specification, considered with  $V_{TX-IDLE-SE-DC}$ , implies a maximum 15mV single-ended DC offset between TX and RX pins during the electrical idle condition. This in turn allows a ground offset between adjacent FB-DIMM of 26mV when worstcase termination resistance matching is considered.
6. The single-pulse mask provides sufficient symbol energy for reliable RX reception. Each symbol complies with both the single-pulse mask and the cumulative eye mask (see RX Single-Pulse Min Width and Amplitude Mask, Pulse Shifted Early, and RX Single-Pulse Min Width and Amplitude Mask, Pulse Shifted Late).
7. The relative amplitude ratio limit between adjacent symbols prevents excessive inter-symbol interference in the Rx. Each symbol must comply with the peak amplitude ratio with regard to both the preceding and subsequent symbols (see RX Maximum Adjacent Symbol Amplitude).
8. This number does not include the effects of SSC or reference clock jitter.
9. This number includes setup and hold of the RX sampling flop.
10. Defined as the dual-dirac deterministic timing error as described in Section 4.2.2 of the JEDEC FB-DIMM High-Speed Differential PTP Link Draft Spec, rev 0.8.
11. Allows for 15mV DC offset between transmit and receive devices.
12. The received differential signal satisfies both this ratio as well as the absolute maximum AC peak-to-peak common mode specification. For example, if  $V_{RX-DIFFp-p}$  is 200mV, the maximum AC peak-to-peak common mode is the lesser of  $(200\text{ mV} * 0.45 = 90\text{mV})$  and  $V_{RX-CM-ACp-p}$ .
13. The termination small signal resistance; tolerance across voltages from 100mV to 400mV shall not exceed  $\pm 5\Omega$  with regard to the average of the values measured at 100mV and at 400mV for that pin.
14. This number represents the lane-to-lane skew between TX and RX pins and does not include the transmitter output skew from the component driving the signal to the receiver. This is one component of the end-to-end channel skew in the AMB specification.
15. Measured from the reference clock edge to the center of the input eye. This specification is met across specified voltage and temperature ranges. Drift rate of change is significantly below the tracking capability of the receiver.
16. This bandwidth number assumes the specified minimum data transition density. Maximum jitter at 0.2MHz is 0.05UI.
17. The specified time includes the time required to forward the EI entry condition.
18. BER per differential lane.

### Advanced Memory Buffer FBD Timing/Electrical

Parameter	Symbol	MIN	MAX	Units
EI Assertion Pass-Through Timing	tEI PROPAGATE		4	CLKs
EI Deassertion Pass-Through Timing	tEID		tBitlock	CLKs
EI Assertion Duration	tEI	100		CLKs
Bit Lock Interval	tBITLOCK		119	Frames
Frame Lock Interval	tFRAMELOCK		154	Frames

### Advanced Memory Buffer Latency Parameters

Parameter	Symbol	MIN	MAX	Units
CMD to Data Latency (Data Rate = 533)	tC2D_AMB	20.3	25.1	ns
Resample Delay	tRESAMPLE_AMB_NB, RESAMPLE_AMB_SB	0.9	2.2	ns
Resync Delay	tRESYNC_AMB_NB, tRESYNC_AMB_SB	2.3	3.9	ns

Notes:

1. tC2D\_AMB is the measured delay at AMB balls between the center of the first UI command frame on primary southbound lane 8 (AMB balls U29 and U28), and the center of the first UI of return on primary northbound lane 0 (AMB balls U1 and U2) - CL (DRAM CAS latency) value \* frame clock period - AL (DRAM additional latency) value \* frame clock period. This definition assumes that SB lane 8 is the latest lane to arrive at the AMB balls. This will typically be the case since SB lane 8 is the longest SB lane on FBDIMMs. If, due to large lane-to-lane skew at the DIMM gold finger, another lane is the latest lane to arrive at the AMB balls, this other lane must be used instead for the tC2D\_AMB measurement.
2. tRESAMPLE\_AMB\_NB is the measured delay at AMB balls between the center of the first UI of a frame on secondary northbound lane 0 (AMB balls V4 and V5), and the center of the first UI of the same frame on primary northbound lane 0 (AMB balls U1 and U2).
3. tRESAMPLE\_AMB\_SB is the measured delay at AMB balls between the center of the first UI of a frame on primary southbound lane 8 (AMB balls U29 and U28), and the center of the first UI of the same frame on secondary southbound lane 8 (AMB balls Y26 and W26).
4. tRESYNC\_AMB\_NB is the measured delay at AMB balls between the center of the first UI of a frame on secondary northbound lane 0 (AMB balls V4 and V5), and the center of the first UI of the same frame on primary northbound lane 0 (AMB balls U1 and U2).
5. tRESYNC\_AMB\_SB is the measured delay at AMB balls between the center of the first UI of a frame on primary southbound lane 8 (AMB balls U29 and U28), and the center of the first UI of the same frame on secondary southbound lane 8 (AMB balls Y26 and W26).

**AMB Power Specification** ( $T_A = 0$  to  $70$  C, Voltage referenced to  $V_{SS} = 0V$ )

Parameter	Symbol	Test Condition	Power Supply	Value	Unit
Idle Current	IDD_IDLE_0	Single or last FBDIMM: L0 state, idle (0 BW); primary channel enabled, secondary channel disabled, CKE high; command and address lines stable, DDR2 SDRAM clock active.	1.5 V	2200	mA
			1.8 V	900	
Idle Current	IDD_IDLE_1	First FBDIMM: L0 state, idle (0 BW); primary and secondary channels enabled, CKE high; command and address lines stable, DDR2 SDRAM clock active.	1.5 V	3000	mA
			1.8 V	900	
Active Power	IDD_TDP_0	TDP BW, Single or Last DIMM; L0 State; TDP Channel BW=2.4GB/s@667, 67% READ, 33% WRITE; primary channel enabled; secondary channel disabled, CKE high; command and address lines stable, DDR2 SDRAM clock active.	1.5 V	2600	mA
			1.8 V	1600	
Active Power	IDD_TDP_1	TDP BW, First DIMM; L0 State; TDP Channel BW=2.4GB/s@667, DIMM BW=1.6GB/s@667; 67% READ, 33% WRITE; primary channel enabled; secondary channel enabled, CKE high; command and address lines stable, DDR2 SDRAM clock active.	1.5 V	3300	mA
			1.8 V	1400	
Training	IDD_TRAINING	Primary and secondary channels enabled; 100% toggle on all channel lanes; DDR2 SDRAM devices idle (0 BW); CKE HIGH, command and address lines stable; DDR2 SDRAM clock active.	1.5 V	3500	mA
			1.8 V	900	

### DRAM AC Characteristics (AC operating conditions unless otherwise noted)

Parameter	Symbol	Min Value	Max Value	Unit	Note
Row Cycle Time	$t_{RC}$	60	-	ns	
Auto Refresh Row Cycle Time	$t_{RFC}$	127.5	-	ns	
Row Active Time	$t_{RAS}$	45	70K	ns	
Row Address to Column Address Delay	$t_{RCD}$	15	-	ns	
Row Active to row Active Delay	$t_{RRD}$	7.5	-	ns	
Column Address to Column Address Delay	$t_{CCD}$	2	-	CLK	
Row Precharge time	$t_{RP}$	15	-	ns	
Write Recovery Time	$t_{WR}$	15	-	ns	
Auto Precharge Write Recovery + Precharge Time	$t_{DAL}$	$(t_{WR}/t_{CK}) + (t_{RP}/t_{CK})$	-	ns	
System Clock Cycle Time	$t_{CK}$	3000	8000	ps	
Clock High Level Width	$t_{CH}$	0.45	0.55	CLK	
Clock Low Level Width	$t_{CL}$	0.45	0.55	CLK	
DQ output access time from CK & /CK	$t_{AC}$	-0.500	+0.500	ns	
DQS-Out edge to Clock Edge skew	$t_{DQSCK}$	-0.450	+0.450	ns	
DQS-Out edge to Data-out edge skew	$t_{DQSQ}$	-	0.300	ns	
Data-Out hold time from DQS	$t_{QH}$	$t_{HP} - t_{QHS}$	-	ns	1
Data hold skew factor	$t_{QHS}$	-	0.400	ns	1
Clock Half Period	$t_{HP}$	$\min(t_{CL}, t_{CH})$	-	ns	1
Input Setup Time (fast slew rate)	$t_{IS}$	0.250	-	ns	2,3,5,6
Input Hold Time (fast slew rate)	$t_{IH}$	0.375	-	ns	2,3,5,6
Input Pulse Width	$t_{IPW}$	0.6	-	CLK	6
Write DQS High Level Width	$t_{DQSH}$	0.35	-	CLK	
Write DQS Low Level Width	$t_{DQSL}$	0.35	-	CLK	
CLK to First Rising edge to DQS-In	$t_{DQSS}$	WL - 0.25	WL + 0.25	CLK	
Data-In Setup Time to DQS-In (DQ & DM)	$t_{DS}$	0.100	-	ns	7
Data-In Hold Time to DQS-In (DQ & DM)	$t_{DH}$	0.225	-	ns	7

Notes:

1. This calculation accounts for  $t_{DQSQ}(\max)$ , the pulse width distortion of on-chip and jitter.
2. Data sampled at the rising edges of the clock: A0~A13, BA0~BA2, CKE, /S[1:0], /RAS, /CAS, /WE
3. For command/address input slew rate  $\geq 1.0$  V/ns
4. For command/address input slew rate  $\geq 0.5$  V/ns and  $< 1.0$  V/ns
5. CK,/CK slew rates are  $\geq 1.0$  V/ns
6. These Parameters guarantee device timing, but they are not necessarily tested on each device, and they may be guaranteed by design or tester correlation.
7. Data latched at both rising and falling edges of Data Strobes (DQS)

**AC Operating Conditions** (AC operating conditions unless otherwise noted)

Parameter	Symbol	Min Value	Max Value	Unit	Note
DQ Input Pulse Width	$t_{DIPW}$	0.35	-	CLK	
Read DQS Preamble Time	$t_{RPRE}$	0.9	1.1	CLK	
Read DQS Postamble Time	$t_{RPST}$	0.4	0.6	CLK	
Write DQS Preamble Hold Time	$t_{WPRE}$	0.35	-	CLK	
Write DQS Postamble Time	$t_{WPST}$	0.4	0.6	CLK	
Mode Register Set Delay	$t_{MRD}$	2	-	CLK	
Exit Self Refresh to Non-Read Command	$t_{XSNR}$	$t_{RFC} + 10$	-	ns	
Exit Self Refresh to Read Command	$t_{XSRD}$	200	-	CLK	
Average Periodic Refresh Interval	$t_{REFI}$	-	7.8	$\mu$ s	1
		-	3.9	$\mu$ s	2

## Notes:

1. For  $0\text{ C} < T_{Case} \leq 85\text{ C}$
2. For  $85\text{ C} < T_{Case} \leq 95\text{ C}$

### SERIAL PRESENCE DETECT MATRIX

Byte#	Function	Value	Hex
0	Number of SPD Bytes Written / SPD Device Size / CRC Coverage		92
	Bit 3 ~ Bit 0. SPD Bytes Used -	176	
	Bit 6 ~ Bit 4. SPD Bytes Total -	256	
	Bit 7. CRC Coverage -	Bytes 0-116	
1	SPD Revision	Rev. 1.1	11
2	Key Byte / DRAM Device Type	DDR2 FBDIMM	09
3	Voltage Levels of this Assembly		12
	Bit 3 ~ Bit 0. Power Supply 1 -	1.5V	
	Bit 7 ~ Bit 4. Power Supply 2 -	1.8V	
4	SDRAM Addressing		49
	Bit 1, 0. Number of Banks -	8	
	Bit 5 ~ Bit 3. Column Address Bits -	11	
	Bit 7 ~ Bit 5. Row Address Bits -	14	
5	Module Physical Attributes		23
	Bit 3 ~ Bit 0. Module Thickness (mm) -	7<x<=8.0	
	Bit 4 ~ Bit 2. Module Height (mm) -	30<x<=35	
	Bit 7, 6. Reserved	0	
6	Module Type		07
	Bit 3 ~ Bit 0. Module Type -	FB-DIMM	
	Bit 7 ~ Bit 4. Reserved	Reserved	
7	Module Organization		20
	Bit 3 ~ Bit 0. SDRAM Device Width -	4-Bits	
	Bit 5 ~ Bit 3. Number of Ranks -	4 Ranks	
	Bit 7, 6. Reserved	0	
8	Fine Timebase Dividend / Divisor		00
	Bit 3 ~ Bit 0. Fine Timebase (FTB) Dividend -	0	
	Bit 7 ~ Bit 4. Fine Timebase (FTB) Divisor -	0	
9	Medium Timebase Dividend.	1 (MTB = 0.25ns)	01
10	Medium Timebase Divisor.	4 (MTB = 0.25ns)	04
11	SDRAM Minimum Cycle Time (tCKmin).	3.0 ns	0C
12	SDRAM Maximum Cycle Time (tCKmax).	8.0 ns	20
13	SDRAM CAS Latencies Supported.		24
	Bit 3 ~ Bit 0. Minimum CL (clocks) -	4	
	Bit 7 ~ Bit 4. CL Range (clocks) -	2	
14	SDRAM Minimum CAS Latency Time (tAAmin).	15 ns	3C
15	SDRAM Write Recovery Times Supported		42
	Bit 3 ~ Bit 0. Minimum WR (clocks) -	2	
	Bit 7 ~ Bit 4. WR Range (clocks) -	4	
16	SDRAM Write Recovery Time (tWR).	15.0 ns	3C
17	SDRAM Write Latencies Supported		42
	Bit 3 ~ Bit 0. Minimum WL (clocks) -	2	

	Bit 7 ~ Bit 4. WL Range (clocks) -	4	
18	SDRAM Additive Latencies Supported.		
	Bit 3 ~ Bit 0. Minimum AL (clocks)-	0	50
	Bit 7 ~ Bit 4. AL Range (clocks) -	5	
19	SDRAM Minimum RAS to CAS Delay (tRCD).	15 ns	3C
20	SDRAM Minimum Row Active to Row Active Delay (tRRD).	7.5 ns	1E
21	SDRAM Minimum Row Precharge Time (tRP).	15 ns	3C
22	SDRAM Upper Nibbles for tRAS and tRC.		
	Bit 3 ~ Bit 0. tRAS Most Significant Nibble -		00
	Bit 7 ~ Bit 4. tRC Most Significant Nibble -		
23	SDRAM Minimum Active to Precharge Time (tRAS).	45.0 ns	B4
24	SDRAM Minimum Active to Active/Refresh Time (tRC).	60.0 ns	F0
25	SDRAM Minimum Refresh Recovery Time Delay (tRFC), (LSB).	127.5 ns	FE
26	SDRAM Minimum Refresh Recovery Time Delay (tRFC), (MSB).	127.5 ns	01
27	SDRAM Minimum Internal Write to Read Command Delay (tWTR).	7.5ns	1E
28	SDRAM Minimum Internal Read to Precharge Command Delay (tRTP).	7.5ns	1E
29	SDRAM Burst Lengths Supported		
	Bit 0. BL = 4 -	X	03
	Bit 1. BL = 8 -	X	
	Bit 6 ~ Bit 2.TBD		
	Bit 7. Burst Chop -		
30	SDRAM Terminations Supported.		
	Bit 0. 150 ohms ODT -	X	07
	Bit 1. 75 ohms ODT -	X	
	Bit 2. 50 ohms ODT -	X	
	Bit 6 ~ Bit 3.TBD		
31	SDRAM Drivers Supported.		
	Bit 0. Weak Driver -	X	01
	Bit 7 ~ Bit 1. TBD		
32	SDRAM Average Refresh Interval (tREFI) / Double Refresh mode bit / High Temperature self-refresh rate support indication.		
	Bit 0 ~ Bit 3. Average Refresh Interval (tREFI) uS -	7.8	C2
	Bit 5, Bit 4. TBD	0	
	Bit 6. High Temperature Self-Refresh -	1-Required	
	Bit 7. Double Refresh Requirement -	1-Supported	
33	Tcasemax Delta.		
	Bit 3 ~ Bit 0. DT4R4W Delta, Subfield B: 0.4 °C -	0	51
	Bit 7 ~ Bit 4. Tcasemax, Subfield A: 2 °C -	10	
34	Thermal Resistance of SDRAM Package. °C/W	24.5	31
35	SDRAM Case Temperature Rise from Ambient due to Activate-Precharge minus 2.8 °C offset temperature (DT0). °C		
	Bit 1, Bit 0. Reserved	0	04
	Bit 7 ~ Bit 2. DT0 -	0.3	
36	SDRAM Case Temperature Rise from Ambient due to Precharge/Quiet Standby (DT2N/DT2Q). °C	1.5	0F

37	SDRAM Case Temperature Rise from Ambient due to Precharge Power-Down (DT2P). °C	0.15	0A
38	SDRAM Case Temperature Rise from Ambient due to Active Standby (DT3N). °C	1.65	0B
39	SDRAM Case Temperature Rise from Ambient due to Page Open Burst Read/DT4R4W Mode Bit (DT4R/DT4R4W Mode Bit).		18
	Bit 0. DT4R4W Mode Bit, Subfield B: 0.4 °C	0	
	Bit 7 ~ Bit 1. DT4R, Subfield A: 0.4 °C -	17.6	
40	SDRAM Case Temperature Rise from Ambient due to Burst Refresh (DT5B). °C	9	12
41	SDRAM Case Temperature Rise from Ambient due to Bank Interleave Reads with Auto-Precharge (DT7). °C	10.5	15
42-74	Reserved	UNUSED	00
75	QR Control		29
76	QR ODT control for rank 0 and rank 1 reads and writes		44
77	QR ODT1 and ODT2 control for reads		66
78	ODT definition for rank 2 and 3		AA
79	FBD ODT Definition		22
	Bit 1, Bit 0. Rank 0 ODT -	150 Ohms	
	Bit 3, Bit 2. TBD -	TBD	
	Bit 5, Bit 4. Rank 1 ODT -	150 Ohms	
	Bit 7, Bit 6. TBD	0	
80	Reserved	UNUSED	00
81	Channel Protocols Supported, Least Significant Byte		02
	Bit 0, DDR2 Base Non-ECC Protocol -	0-Not Supported	
	Bit 1. DDR2 Base ECC Protocol -	1-Supported	
	Bit 7 ~ Bit 2. TBD -	0	
82	Channel Protocols Supported, Most Significant Byte	UNUSED	00
83	Back-to-back Turnaround Cycles		10
	Bit 1, Bit 0. Rank Read-to-Read -	0 add-l clock	
	Bit 3, Bit 2. Write-to-Read -	0 add-l clock	
	Bit 5, Bit 4. Read-to-Write -	1 add-l clock	
	Bit 7, Bit 6. TBD	0	
84	AMB Read Access Time for DDR2-800 (AMB.LINKPARNXT[1:0] = 11)		4A
	Bit 3 ~ Bit 0. Read Access Fine Granularity (UI)	10	
	Bit 7 ~ Bit 4. Read Access Coarse Granularity (tCK)	4	
85	AMB Read Access Time for DDR2-667 (AMB.LINKPARNXT[1:0] = 10)		46
	Bit 3 ~ Bit 0. Read Access Fine Granularity (UI)	6	
	Bit 7 ~ Bit 4. Read Access Coarse Granularity (tCK)	4	
86	AMB Read Access Time for DDR2-533 (AMB.LINKPARNXT[1:0] = 01)		38
	Bit 3 ~ Bit 0. Read Access Fine Granularity (UI)	8	
	Bit 7 ~ Bit 4. Read Access Coarse Granularity (tCK)	3	
87	Thermal Resistance of AMB Package from Top (Case) to Ambient ( Psi T-A AMB ). °C/W	21	2A
88	AMB Case Temperature Rise from Ambient due to AMB in Idle_0 State (DT AMB Idle_0). °C	58	3A

89	AMB Case Temperature Rise from Ambient due to AMB in Idle_1 State (DT AMB Idle_1). °C	71	47
90	AMB Case Temperature Rise from Ambient due to AMB in Idle_2 State (DT AMB Idle_2). °C	58	3A
91	AMB Case Temperature Rise from Ambient due to AMB in Active_1 State (DT AMB Active_1). °C	95	5F
92	AMB Case Temperature Rise from Ambient due to AMB in Active_2 State (DT AMB Active_2). °C	79	4F
93	AMB Case Temperature Rise from Ambient due to AMB in L0s State (DT AMB L0s). °C	UNUSED	00
94-97	Reserved	UNUSED	00
98	AMB Junction Temperature Maximum (Tjmax). °C	125	1F
99	Reserved		0A
100	Reserved	UNUSED	00
101	AMB Personality Bytes: Pre-initialization.		A5
102	AMB Personality Bytes: Pre-initialization.		02
103	AMB Personality Bytes: Pre-initialization.		DA
104	AMB Personality Bytes: Pre-initialization.		66
105	AMB Personality Bytes: Pre-initialization.		97
106	AMB Personality Bytes: Pre-initialization.		9C
107	AMB Personality Bytes: Post-initialization.		DB
108	AMB Personality Bytes: Post-initialization.		36
109	AMB Personality Bytes: Post-initialization.		04
110	AMB Personality Bytes: Post-initialization.		AF
111	AMB Personality Bytes: Post-initialization.		E8
112	AMB Personality Bytes: Post-initialization.		E8
113	AMB Personality Bytes: Post-initialization.		E8
114	AMB Personality Bytes: Post-initialization.		E8
115	AMB Manufacturer's JEDEC ID Code.		7F
116	AMB Manufacturer's JEDEC ID Code.		B3
117	Module ID: Module Manufacturer's JEDEC ID Code.		01
118	Module ID: Module Manufacturer's JEDEC ID Code.		91
119	Module ID: Module Manufacturing Location.		00
120,121	Module ID: Module Manufacturing Date	[date]	##
122-125	Module ID: Module Serial Number.	[serial number]	##
126	Cyclical Redundancy Code (CRC).		24
127	Cyclical Redundancy Code (CRC).		94
128-131	Module Part Number		20
132	Module Part Number	D	44
133	Module Part Number	A	41
134	Module Part Number	T	54
135	Module Part Number	A	41
136	Module Part Number	R	52

137	Module Part Number	A	41
138	Module Part Number	M	4D
139	Module Part Number		20
140	Module Part Number	6	36
141	Module Part Number	5	35
142	Module Part Number	5	35
143	Module Part Number	1	31
144	Module Part Number	7	37
145	Module Part Number		20
146,147	Module Revision Code	UNUSED	00
148,149	SDRAM Manufacturer's JEDEC ID Code	UNUSED	00
150	Manufacturer's Specific Data		00
151	Manufacturer's Specific Data		00
152-175	Manufacturer's Specific Data	UNUSED	00
176-255	Open for customer use	UNUSED	00



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