

Features

- 204-Pin Small Outline Dual In-Line Memory Module (SO-DIMM)
- 2GB: 256Mx64 Unbuffered DDR3 SO-DIMM based on 256Mx8 DDR3 SDRAM devices
- 4GB / 8GB: 512Mx64 / 1024Mx64 Unbuffered DDR3 SO-DIMM based on 512Mx8 DDR3 SDRAM devices
- Intended for 667MHz applications
- Inputs and outputs are SSTL-15 compatible
- VDD = VDDQ = 1.35V -0.0675V/+0.1V (Backward Compatible to VDD = VDDQ = 1.5V ±0.075V)
- VDD = VDDQ = 1.5V ±0.075V
- SDRAMs have 8 internal banks for concurrent operation
- Differential clock inputs
- Data is read or written on both clock edges
- DRAM DLL aligns DQ and DQS transitions with clock transitions.
- Auto Self-Refresh option
- Nominal and Dynamic On-Die Termination support
- Extended operating temperature range
- Serial Presence Detect
- Programmable Operation:
 - DIMM $\overline{\text{CAS}}$ Latency: 5, 6, 7,8,9,10,11
 - Burst Type: Sequential or Interleave
 - Burst Length: BC4, BL8
 - Operation: Burst Read and Write
- Address and control signals are fully synchronous to positive clock edge
- Two different termination values (Rtt_Nom & Rtt_WR)
- 15/10/1 (row/column/rank) Addressing for 2GB
- 16/10/1 (row/column/rank) Addressing for 4GB
- 16/10/2 (row/column/rank) Addressing for 8GB
- Gold contacts
- SDRAMs are in 78-ball BGA Package (2GB)
- SDRAMs are in 78-ball BGA Package (4GB/8GB)
- RoHS compliance and Halogen Free

Description

D936966G2MG / D937066G2MG / D937166G2MG are unbuffered 204-Pin Double Data Rate 3 (DDR3) Synchronous DRAM Small Outline Dual In-Line Memory Module (SO-DIMM), organized as one rank of 256Mx64 (2GB), one rank of 512Mx64 (4GB) and two ranks of 1024Mx64 (8GB) high-speed memory array. Modules use eight 256Mx8 (2GB) 78-ball BGA packaged devices, eight 512Mx8 (4GB) and sixteen 512Mx8 (8GB) 78-ball BGA packaged devices. These DIMMs are manufactured using raw cards developed for broad industry use as reference designs. The use of these common design files minimizes electrical variation between suppliers. All DDR3 SODIMMs provide a high-performance, flexible 8-byte interface in a space-saving footprint. The DIMM is intended for use in applications operating of 667MHz clock speeds and achieves high-speed data transfer rates of 10600Mbps. Prior to any access operation, the device $\overline{\text{CAS}}$ latency and burst/length/operation type must be programmed into the DIMM by address inputs A0-A15 and I/O inputs BA0-BA2 using the mode register set cycle.

Pin Description

Pin Name	Description	Pin Name	Description
CK0, CK1	Clock Inputs, positive line	DQ0-DQ63	Data input/output
$\overline{\text{CK0}}, \overline{\text{CK1}}$	Clock Inputs, negative line	DQS0-DQS7	Data strobes
CKE0, CKE1	Clock Enable	$\overline{\text{DQS0}}-\overline{\text{DQS7}}$	Data strobes complement
$\overline{\text{RAS}}$	Row Address Strobe	DM0-DM7	Data Masks
$\overline{\text{CAS}}$	Column Address Strobe	$\overline{\text{EVENT}}$	Temperature event pin
$\overline{\text{WE}}$	Write Enable	$\overline{\text{RESET}}$	Reset pin
$\overline{\text{S0}}, \overline{\text{S1}}$	Chip Selects	$V_{\text{REFDQ}}, V_{\text{REFCA}}$	Input/output Reference
A0-A9, A11, A13-A15	Address Inputs	V_{DDSPD}	SPD and Temp sensor power
A10/AP	Address Input/Auto-Precharge	SA0, SA1	Serial Presence Detect Address Inputs
A12/ $\overline{\text{BC}}$	Address Input/Burst Chop	Vtt	Termination voltage
BA0-BA2	SDRAM Bank Address Inputs	V_{SS}	Ground
ODT0, ODT1	Active termination control lines	V_{DD}	Core and I/O power
SCL	Serial Presence Detect Clock Input	NC	No Connect
SDA	Serial Presence Detect Data input/output		

DDR3 SDRAM Pin Assignment

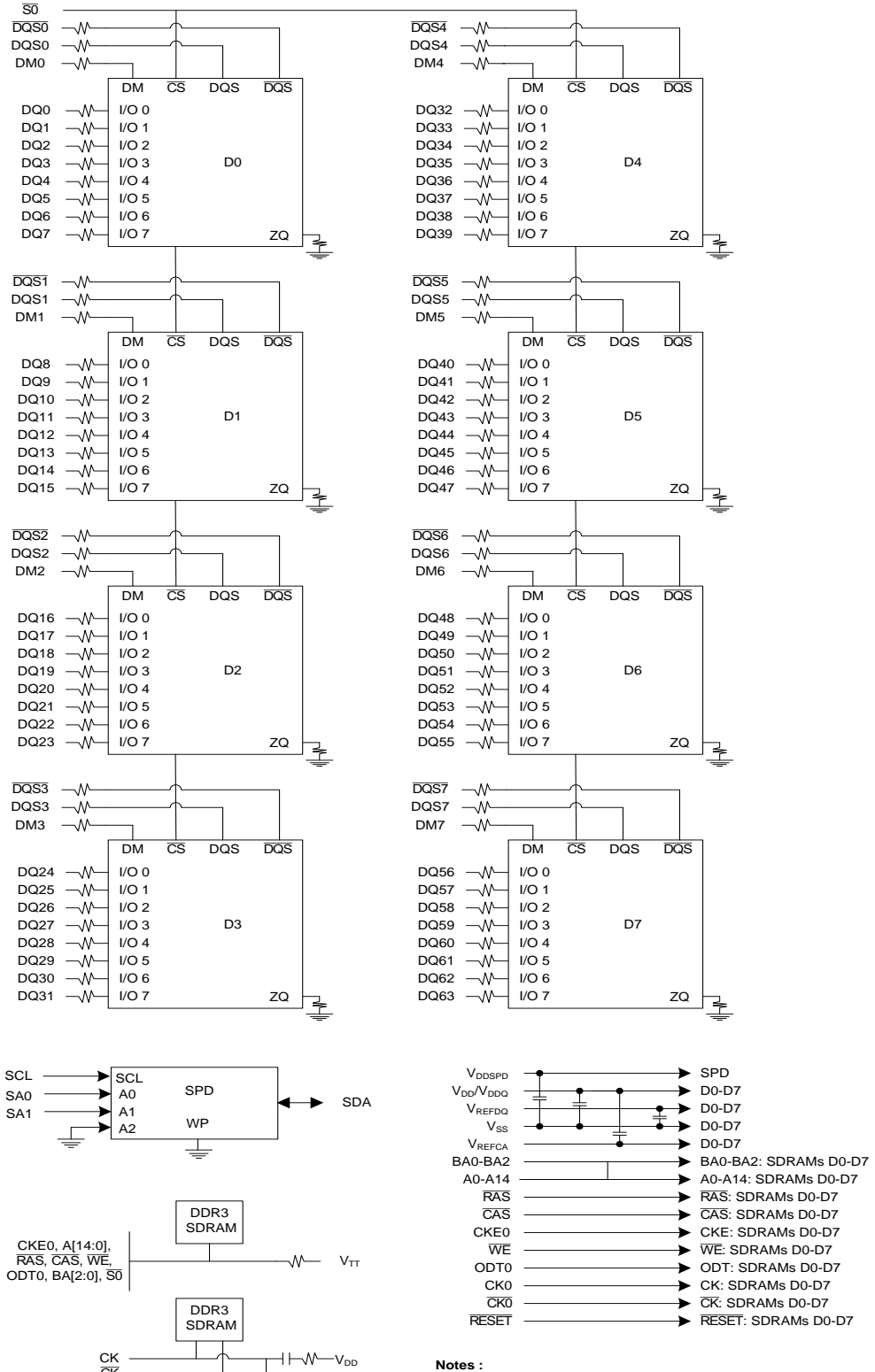
Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back
1	V _{REFDQ}	2	V _{SS}	53	DQ19	54	V _{SS}	105	V _{DD}	106	V _{DD}	155	V _{SS}	156	V _{SS}
3	V _{SS}	4	DQ4	55	V _{SS}	56	DQ28	107	A10/AP	108	BA1	157	DQ42	158	DQ46
5	DQ0	6	DQ5	57	DQ24	58	DQ29	109	BA0	110	RAS	159	DQ43	160	DQ47
7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

Input/Output Functional Description

Symbol	Type	Polarity	Function
CK0, CK1 $\overline{CK0}, \overline{CK1}$	Input	Cross point	The system clock inputs. All address and command lines are sampled on the cross point of the rising edge of CK and falling edge of \overline{CK} . A Delay Locked Loop (DLL) circuit is driven from the clock inputs and output timing for read operations is synchronized to the input clock.
CKE0, CKE1	Input	Active High	Activates the DDR3 SDRAM CK signal when high and deactivates the CK signal when low. By deactivating the clocks, CKE low initiates the Power Down mode or the Self Refresh mode.
$\overline{S0}, \overline{S1}$	Input	Active Low	Enables the associated DDR3 SDRAM command decoder when low and disables the command decoder when high. When the command decoder is disabled, new commands are ignored but previous operations continue, Rank 0 is selected by $\overline{S0}$; Rank 1 is selected by $\overline{S1}$.
$\overline{RAS}, \overline{CAS}, \overline{WE}$	Input	Active Low	When sampled at the positive rising edge of CK and falling edge of \overline{CK} , signals $\overline{RAS}, \overline{CAS}, \overline{WE}$ define the operation to be executed by the SDRAM.
ODT0, ODT1	Input	Active High	Asserts on-die termination for DQ, DM, DQS, and \overline{DQS} signals if enabled via the DDR3 SDRAM mode register.
DM0 – DM7	Input	Active High	The data write masks, associated with one data byte. In Write mode, DM operates as a byte mask by allowing input data to be written if it is low but blocks the write operation if it is high. In Read mode, DM lines have no effect.
DQS0 – DQS7 $\overline{DQS0} – \overline{DQS7}$	I/O	Cross point	The data strobes, associated with one data byte, sourced with data transfers. In Write mode, the data strobe is sourced by the controller and is centered in the data window. In Read mode, the data strobe is sourced by the DDR3 SDRAM and is sent at the leading edge of the data window. \overline{DQS} signals are complements, and timing is relative to the cross point of respective DQS and \overline{DQS} . If the module is to be operated in single ended strobe mode, all DQS signals must be tied on the system board to V_{SS} and DDR3 SDRAM mode registers programmed appropriately.
BA0, BA1, BA2	Input	-	Selects which DDR3 SDRAM internal bank of four or eight is activated.
A0 – A9 A10/AP A11 A12/ \overline{BC} A13 – A15	Input	-	During a Bank Activate command cycle, defines the row address when sampled at the cross point of the rising edge of CK and falling edge of \overline{CK} . During a Read or Write command cycle, defines the column address when sampled at the cross point of the rising edge of CK and falling edge of \overline{CK} . In addition to the column address, AP is used to invoke autoprecharge operation at the end of the burst read or write cycle. If AP is high, autoprecharge is selected and BA0-BAn defines the bank to be precharged. If AP is low, autoprecharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA0-BAn to control which bank(s) to precharge. If AP is high, all banks will be precharged regardless of the state of BA0-BAn inputs. If AP is low, then BA0-BAn are used to define which bank to precharge.
DQ0 – DQ63	Input	-	Data Input/Output pins.
$V_{DD}, V_{DDSPD}, V_{SS}$	Supply	-	Power supplies for core, I/O, Serial Presence Detect, Temp sensor, and ground for the module.
V_{REFDQ}, V_{REFCA}	Supply	-	Reference voltage for SSTL15 inputs
SDA	I/O	-	This is a bidirectional pin used to transfer data into or out of the SPD EEPROM and temp sensor. A resistor must be connected from the SDA bus line to V_{DDSPD} on the system planar to act as a pull up.
SCL	Input	-	This signal is used to clock data into and out of the SPD EEPROM and Temp sensor.
SA0 – SA2	Input	-	Address pins used to select the Serial Presence Detect and Temp sensor base address.
\overline{EVENT}	Output	-	The \overline{EVENT} pin is reserved for use to flag critical module temperature.
\overline{RESET}	Input	-	This signal resets the DDR3 SDRAM
ZQ	Supply	-	Reference pin for ZQ calibration

Functional Block Diagram

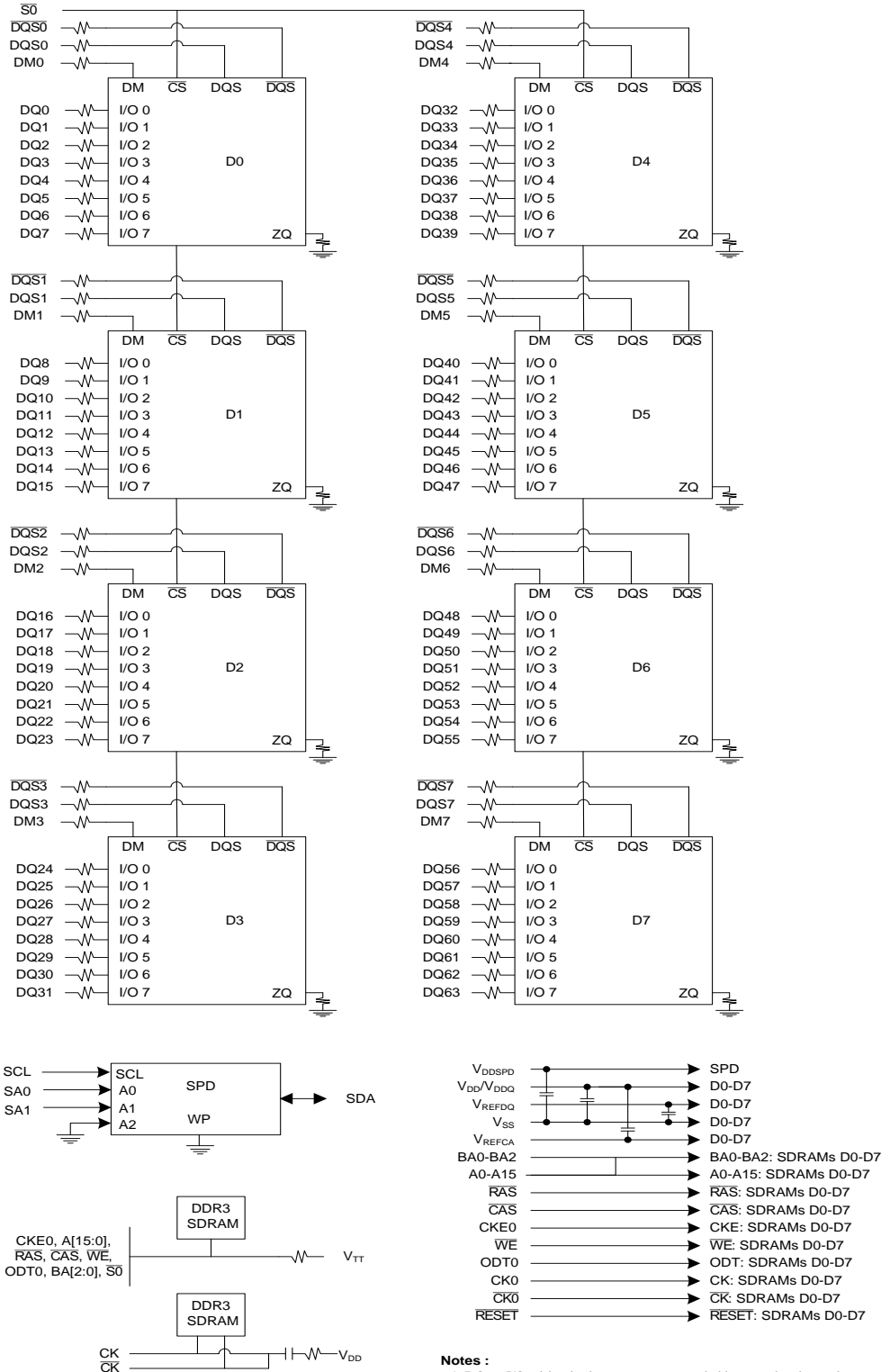
[2GB – 1 Rank, 256Mx8 DDR3 SDRAMs]



- Notes :**
1. DQ-to-I/O wiring is shown as recommended but may be changed.
 2. DQ/DQS/DQS/ODT/DM/CKE/S relationships must be maintained as shown.
 3. For each DRAM, a unique ZQ resistor is connected to ground. The ZQ resistor is $240\Omega \pm 1\%$.
 4. One SPD exists per module.

Functional Block Diagram

[4GB – 1 Rank, 512Mx8 DDR3 SDRAMs]

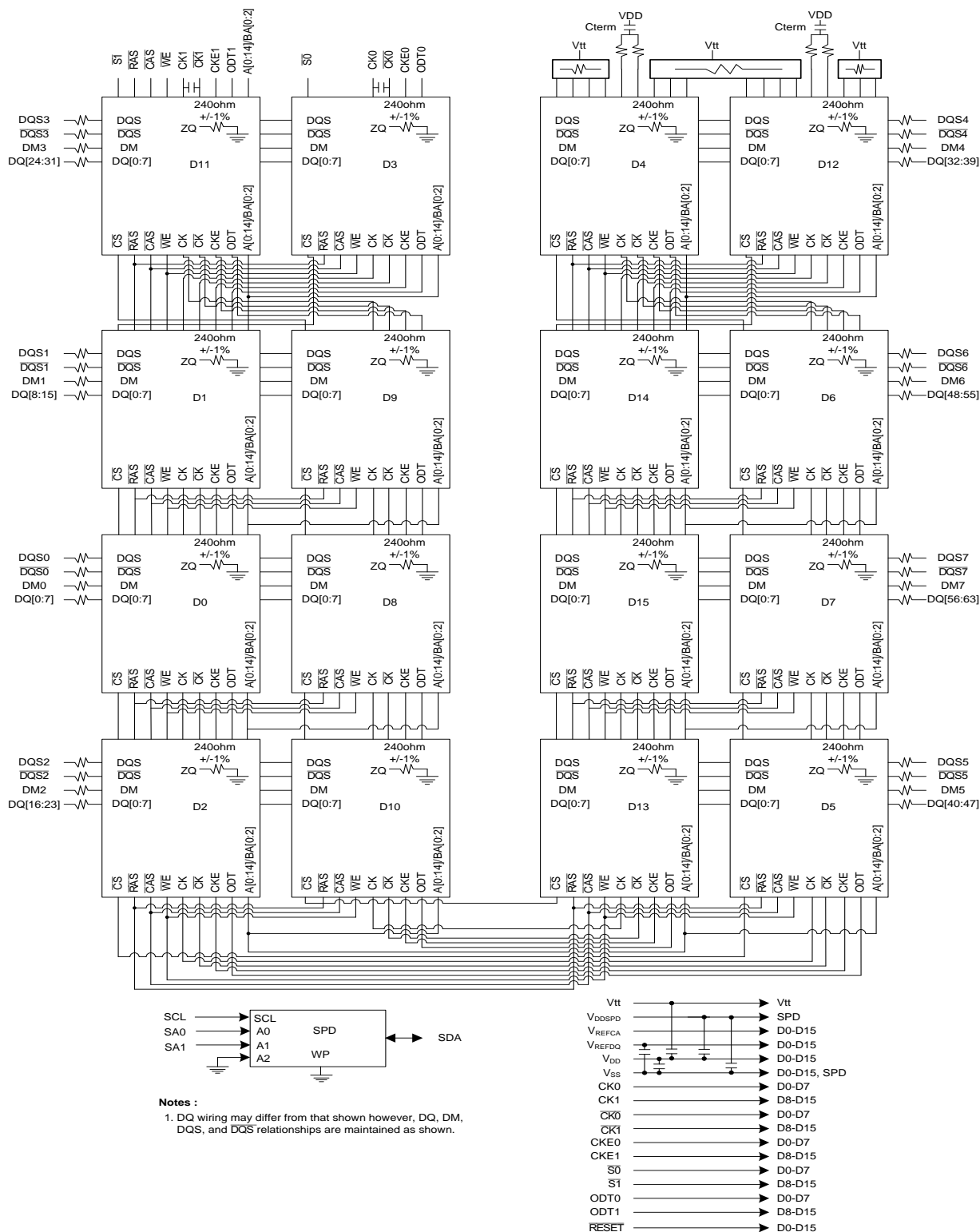


Notes :

1. DQ-to-I/O wiring is shown as recommended but may be changed.
2. DQ/DQS/DQS/ODT/DM/CKE/S relationships must be maintained as shown.
3. For each DRAM, a unique ZQ resistor is connected to ground. The ZQ resistor is 240Ω ±1%.
4. One SPD exists per module.

Functional Block Diagram

[8GB – 2 Ranks, 512Mx8 DDR3 SDRAMs]



Environmental Requirements

Symbol	Parameter	Rating	Units
T _{OPR}	Operating Temperature (ambient)	0 to 85	°C
T _{STG}	Storage Temperature	-55 to +100	°C

Note: Stress greater than those listed may cause permanent damage to the device. This is a stress rating only, and device functional operation at or above the conditions indicated is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Absolute Maximum DC Ratings

Symbol	Parameter	Rating	Units	Note
V _{DD}	Voltage on VDD pins relative to Vss	-0.4 V ~ 1.975 V	V	1, 3
V _{DDQ}	Voltage on VDDQ pins relative to Vss	-0.4 V ~ 1.975 V	V	1, 3
V _{IN} , V _{OUT}	Voltage on I/O pins relative to Vss	-0.4 V ~ 1.975 V	V	1
T _{STG}	Storage Temperature	-55 to +100	°C	1, 2

Note:

- 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
- 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.
- VDD and VDDQ must be within 300 mV of each other at all times; and VREF must be not greater

Operating temperature Conditions

Symbol	Parameter	Rating	Units	Note
T _{OPER}	Normal Operating Temperature Range	0 to 85	°C	1, 2
	Extended Temperature Range	85 to 95	°C	1, 3

Note:

- 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.
- 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 to 85 °C under all operating conditions
- Some applications require operation of the DRAM in the Extended Temperature Range between 85 °C and 95 °C case temperature. Full specifications are supported in this range, but the following additional conditions apply:
 - Refresh commands must be doubled in frequency, therefore reducing the Refresh interval tREFI to 3.9 μs. It is also possible to specify a component with 1X refresh (tREFI to 7.8 μs) in the Extended Temperature Range. Please refer to supplier data sheet and/or the DIMM SPD for option availability.
 - 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) or enable the optional Auto Self-Refresh mode (MR2 A6 = 1b and MR2 A7 = 0b). Please refer to the supplier data sheet and/or the DIMM SPD for Auto Self-Refresh option availability, Extended Temperature Range support and tREFI requirements in the Extended Temperature Range.

DC Electrical Characteristics and Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units	Notes
V _{DD}	Supply Voltage	1.425	1.5	1.575	V	1,2
V _{DDQ}	Output Supply Voltage	1.425	1.5	1.575	V	1,2

Note:

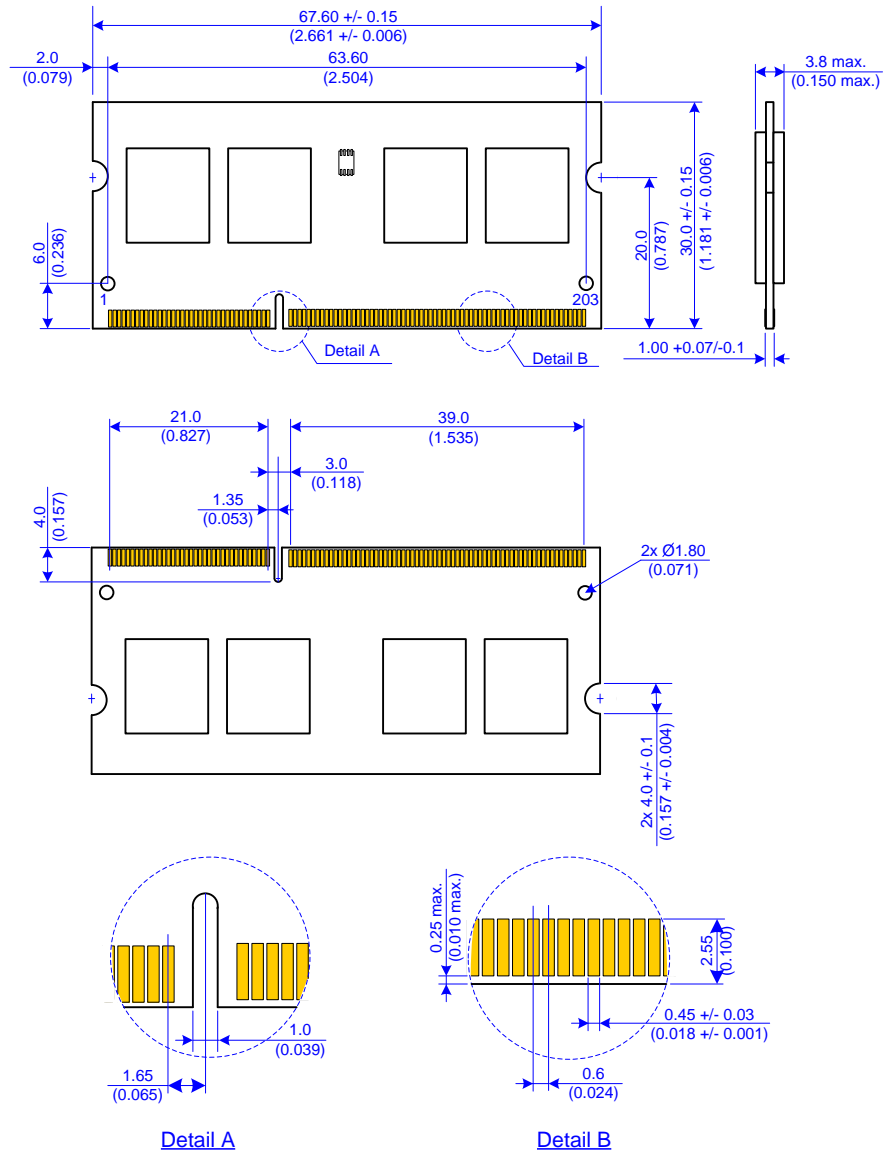
- Under all conditions VDDQ must be less than or equal to VDD.
- VDDQ tracks with VDD. AC parameters are measured with VDD and VDDQ tied together.

AC Timing Specifications for DDR3 SDRAM Devices Used on Module (1333MHz)

Parameter	Symbol	DDR3-1333		Units	Notes
		Min.	Max.		
Clock Timing					
Minimum Clock Cycle Time (DLL off mode)	tCK (DLL_OFF)	8	-	ns	
Average Clock Period	tCK(avg)	Refer to "Standard Speed Bins"		ps	
Average high pulse width	tCH(avg)	0.47	0.53	tCK(avg)	
Average low pulse width	tCL(avg)	0.47	0.53	tCK(avg)	
Absolute Clock Period	tCK(abs)	Min.: tCK(avg)min + tJIT(per)min Max.: tCK(avg)max + tJIT(per)max		ps	
Absolute clock HIGH pulse width	tCH(abs)	0.43	-	tCK(avg)	
Absolute clock LOW pulse width	tCL(abs)	0.43	-	tCK(avg)	
Clock Period Jitter	JIT(per)	-80	80	ps	
Clock Period Jitter during DLL locking period	JIT(per, lck)	-70	70	ps	
Cycle to Cycle Period Jitter	tJIT(cc)	160	160	ps	
Cycle to Cycle Period Jitter during DLL locking period	JIT(cc, lck)	140	140	ps	
Duty Cycle Jitter	tJIT(duty)	-	-	ps	
Cumulative error across 2 cycles	tERR(2per)	-118	118	ps	
Cumulative error across 3 cycles	tERR(3per)	-140	140	ps	
Cumulative error across 4 cycles	tERR(4per)	-155	155	ps	
Cumulative error across 5 cycles	tERR(5per)	-168	168	ps	
Cumulative error across 6 cycles	tERR(6per)	-177	177	ps	
Cumulative error across 7 cycles	tERR(7per)	-186	186	ps	
Cumulative error across 8 cycles	tERR(8per)	-193	193	ps	
Cumulative error across 9 cycles	tERR(9per)	-200	200	ps	
Cumulative error across 10 cycles	tERR(10per)	-205	205	ps	
Cumulative error across 11 cycles	tERR(11per)	-210	210	ps	
Cumulative error across 12 cycles	tERR(12per)	-215	215	ps	
Cumulative error across n = 13, 14 . . . 49, 50 cycles	tERR(nper)	tERR(nper)min = (1 + 0.68ln(n)) * tJIT(per)min tERR(nper)max = (1 + 0.68ln(n)) * tJIT(per)max		ps	
Data Timing					
DQS, DQS# to DQ skew, per group, per access	tDQSQ	-	125	ps	
DQ output hold time from DQS, DQS#	tQH	0.38	-	tCK(avg)	
DQ low-impedance time from CK, CK#	tLZ(DQ)	-500	250	ps	
DQ high impedance time from CK, CK#	tHZ(DQ)	-	250	ps	
Data setup time to DQS, DQS# referenced to Vih(ac) / Vil(ac) levels	tDS(base) AC175	-		ps	
Data setup time to DQS, DQS# referenced to Vih(ac) / Vil(ac) levels	tDS(base) AC150	30		ps	
Data hold time from DQS, DQS# referenced to Vih(dc) / Vil(dc) levels	tDH(base) DC100	65		ps	
DQ and DM Input pulse width for each input	tDIPW	400	-	ps	
Data Strobe Timing					
DQS,DQS# differential READ Preamble	tRPRE	0.9		tCK(avg)	
DQS, DQS# differential READ Postamble	tRPST	0.3		tCK(avg)	
DQS, DQS# differential output high time	tQSH	0.4	-	tCK(avg)	
DQS, DQS# differential output low time	tQSL	0.4	-	tCK(avg)	
DQS, DQS# differential WRITE Preamble	tWPRE	0.9	-	tCK(avg)	
DQS, DQS# differential WRITE Postamble	tWPST	0.3	-	tCK(avg)	
DQS, DQS# rising edge output access time from rising CK, CK#	tDQSCK	-255	255	tCK(avg)	
DQS and DQS# low-impedance time (Referenced from RL - 1)	tLZ(DQS)	-500	250	tCK(avg)	
DQS and DQS# high-impedance time (Referenced from RL + BL/2)	tHZ(DQS)	-	250	tCK(avg)	
DQS, DQS# differential input low pulse width	tDQSL	0.45	0.55	tCK(avg)	
DQS, DQS# differential input high pulse width	tDQSH	0.45	0.55	tCK(avg)	
DQS, DQS# rising edge to CK, CK# rising edge	tDQSS	-0.25	0.25	tCK(avg)	
DQS, DQS# falling edge setup time to CK, CK# rising edge	tDSS	0.2	-	tCK(avg)	
DQS, DQS# falling edge hold time from CK, CK# rising edge	tDSH	0.2	-	tCK(avg)	
Command and Address Timing					
DLL locking time	tDLLK	512	-	nCK	

Package Dimensions

[2GB – 1 Rank, 256Mx8 DDR3 SDRAMs]

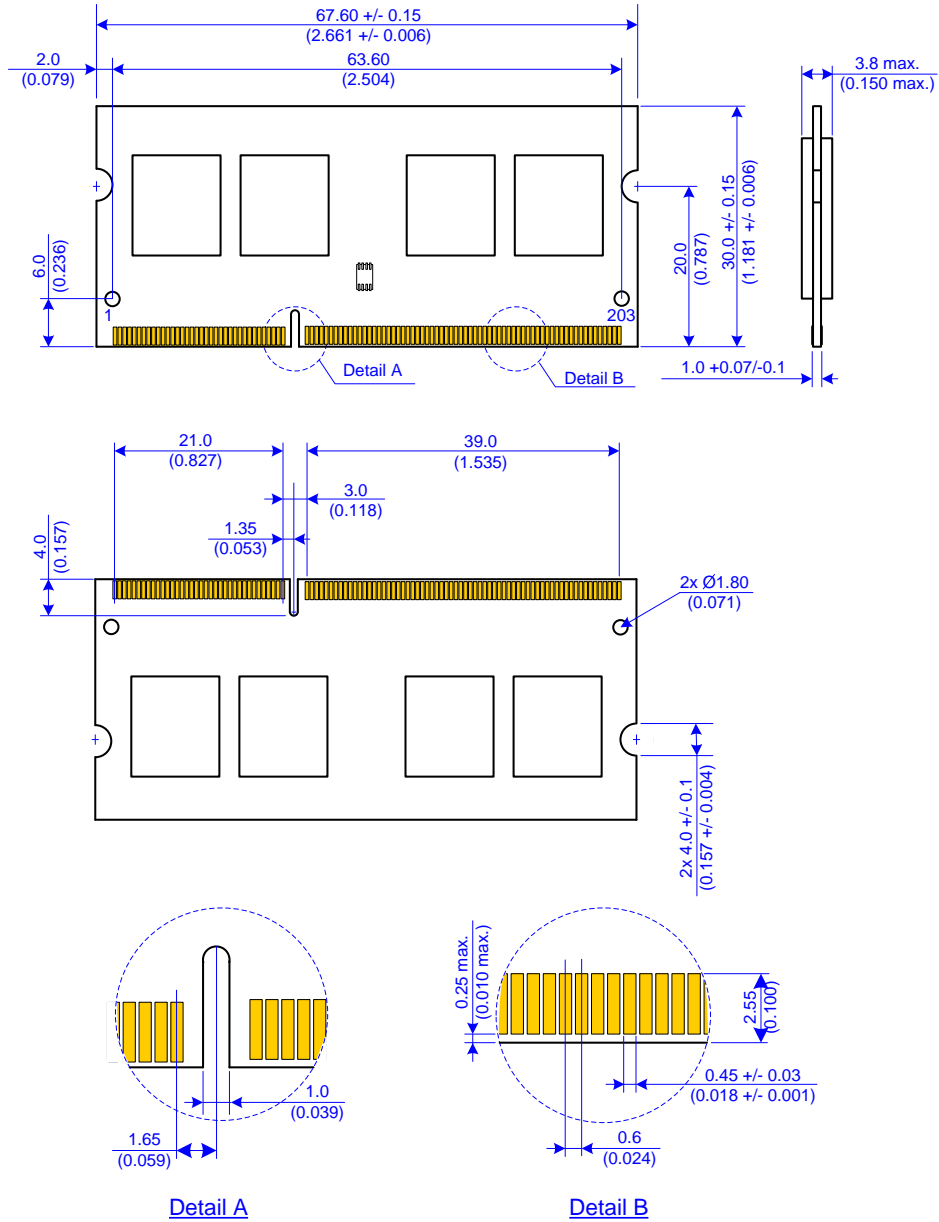


Units: Millimeters (Inches)

Note: Device position and scale are only for reference.

Package Dimensions

[4GB – 1 Rank, 512Mx8 DDR3 SDRAMs]

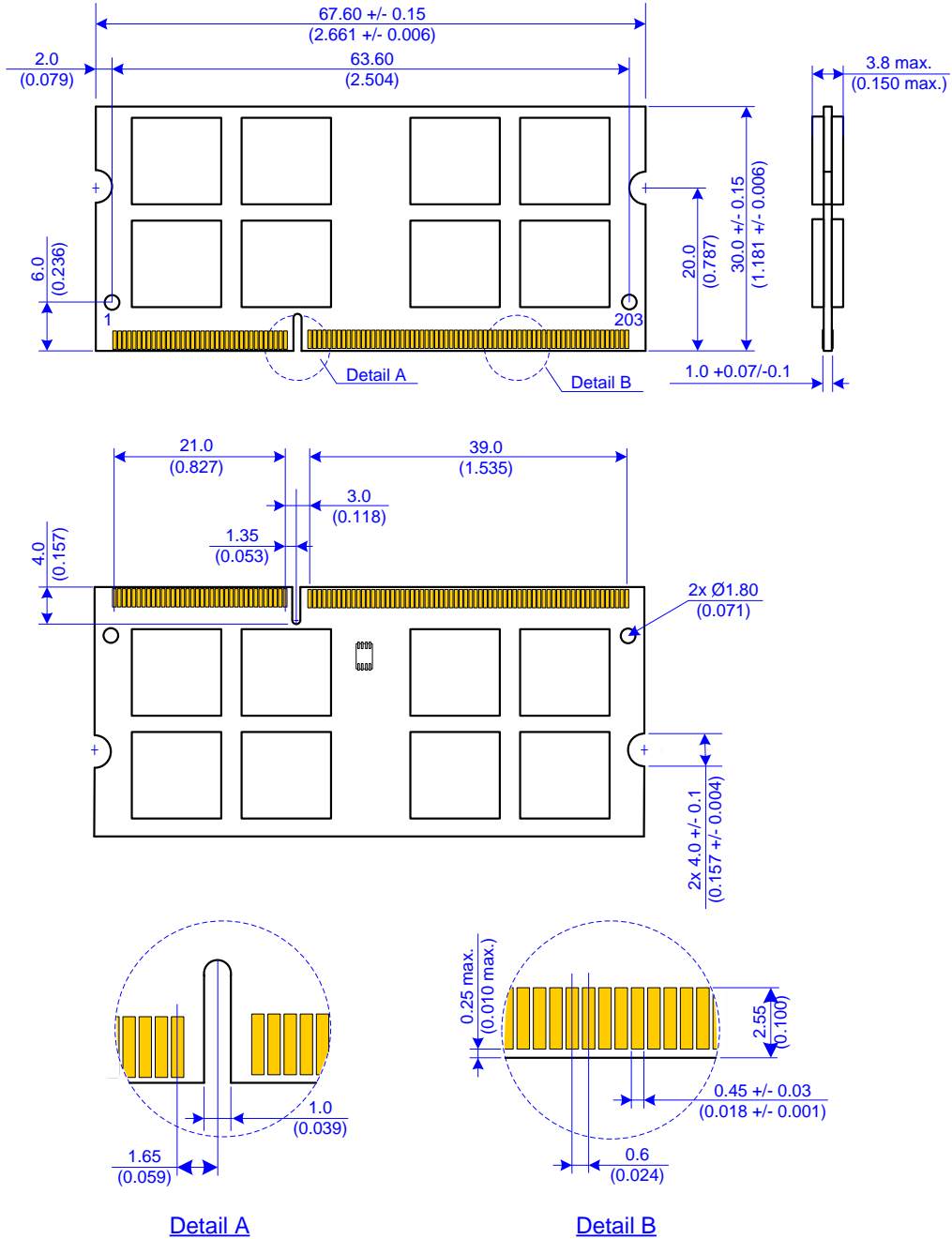


Units: Millimeters (Inches)

Note: Device position and scale are only for reference.

Package Dimensions

[8GB – 2 Ranks, 512Mx8 DDR3 SDRAMs]



Units: Millimeters (Inches)

Note: Device position and scale are only for reference.

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