

HYS64T32x00HDL-[25F/2.5/3/3S/3.7/5]-B
HYS64T64x20HDL-[25F/2.5/3/3S/3.7/5]-B
HYS64T128x21HDL-[25F/2.5/3/3S/3.7/5]-B

200 Pin Small-Outlined DDR2 SDRAMs Modules

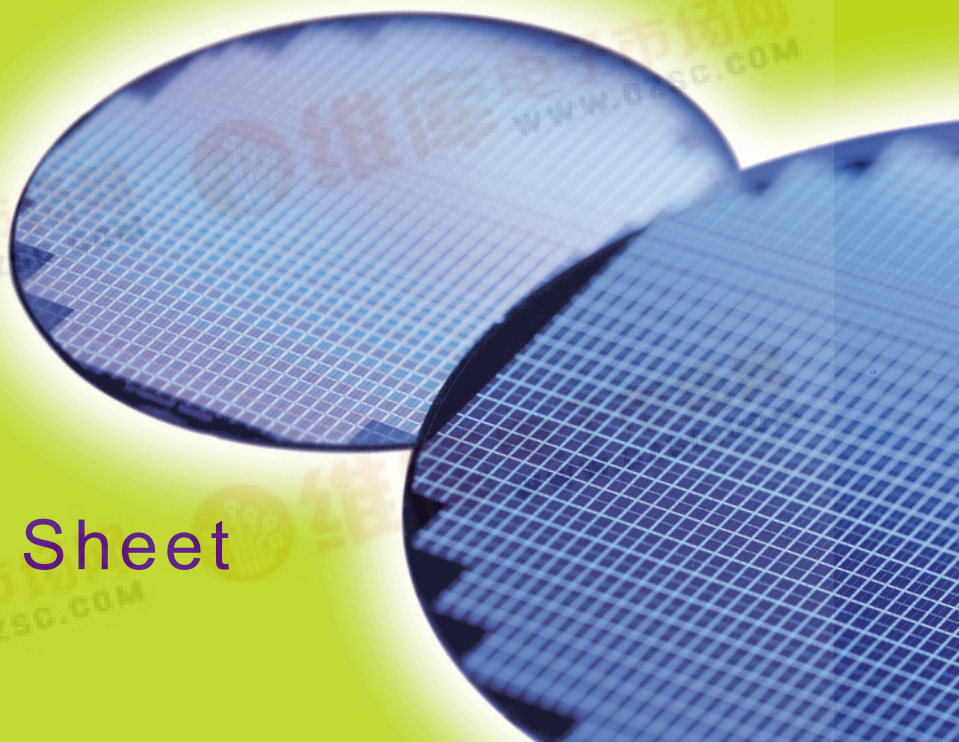
DDR2 SDRAM

SO-DIMM SDRAM

RoHS Compliant

Internet Data Sheet

Rev. 1.1



HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

HYS64T32x00HDL-[25F/2.5/3/3S/3.7/5]-B, HYS64T64x20HDL-[25F/2.5/3/3S/3.7/5]-B, HYS64T128x21HDL-[25F/2.5/3/3S/3.7/5]-B

Revision History: 2006-10, Rev. 1.1

Page	Subjects (major changes since last revision)
All	Adapted internet edition
4	Added -25F Product Types; Added 6Layer -3S and -3.7 Product Types
70, 71, 72	Updated Package Outline Drawings

Previous Revision: 2005-09, Rev 1.01

All	Qimonda update
15	Modified AC Timing Parameters

Previous Revision: 2005-06, Rev 1.0**We Listen to Your Comments**

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HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B SO-DIMM DDR2 SDRAM Module

1 Overview

This chapter gives an overview of the 200 Pin Small-Outlined DDR2 SDRAMs Modules product family and describes its main characteristics.

1.1 Features

- 200-Pin PC2–6400, PC2–5300, PC2–4200 and PC2–3200 DDR2 SDRAM memory modules for use as main memory when installed in systems such as mobile personal computers.
- 32M × 64, 64M × 64 and 128M × 64 module organization and 32M × 16, 64M × 8 chip organization
- 256MB, 512MB and 1GB modules built with 512-Mbit DDR2 SDRAMs in P-TFBGA-84 and P-TFBGA-60 chipsize packages
- Standard Double-Data-Rate-Two Synchronous DRAMs (DDR2 SDRAM) with a single + 1.8 V (± 0.1 V) power supply
- All speed grades faster than DDR2–400 comply with DDR2–400 timing specifications.
- Programmable CAS Latencies (3, 4, 5 and 6), Burst Length (8 & 4) and Burst Type
- Average Refresh Period 7.8 μ s at a T_{CASE} lower than 85°C, 3.9 μ s between 85°C and 95°C.
- Auto Refresh (CBR) and Self Refresh
- Programmable self refresh rate via EMRS2 setting
- Programmable partial array refresh via EMRS2 settings
- DCC enabling via EMRS2 setting
- All inputs and outputs SSTL_1.8 compatible
- Off-Chip Driver Impedance Adjustment (OCD) and On-Die Termination (ODT)
- Serial Presence Detect with E²PROM
- SO-DIMM Dimensions (nominal):
30 mm high, 67.60 mm wide
- Based on standard reference layouts Raw Card “A”, “C”, “E”
- RoHS compliant products¹⁾

TABLE 1
Performance Table

Product Type Speed Code			–25F	–2.5	–3	–3S	–3.7	–5	Unit
Speed Grade			PC2–6400 5–5–5	PC2–6400 6–6–6	PC2–5300 4–4–4	PC2–5300 5–5–5	PC2–4200 4–4–4	PC2–3200 3–3–3	—
Max. Clock Frequency	@CL6	f_{CK6}	400	400	—	—	—	—	MHz
	@CL5	f_{CK5}	400	333	333	333	266	200	MHz
	@CL4	f_{CK4}	266	266	333	266	266	200	MHz
	@CL3	f_{CK3}	200	200	200	200	200	200	MHz
Min. RAS-CAS-Delay			t_{RCD}	12.5	15	12	15	15	ns
Min. Row Precharge Time			t_{RP}	12.5	15	12	15	15	ns
Min. Row Active Time			t_{RAS}	45	45	45	45	40	ns
Min. Row Cycle Time			t_{RC}	57.5	60	57	60	55	ns

1) RoHS Compliant Product: Restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment as defined in the directive 2002/95/EC issued by the European Parliament and of the Council of 27 January 2003. These substances include mercury, lead, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated biphenyl ethers.

HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

1.2 Description

The Qimonda HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B module family are small outline DIMM modules “SO-DIMMs” with 30 mm height based on DDR2 technology. DIMMs are available as non-ECC modules in 32M × 64 (256 MB), 64M × 64 (512 MB) and 128M × 64 (1 GB) organization and density, intended for mounting into 200-pin connector sockets.

The memory array is designed with 512-Mbit Double-Data-Rate-Two (DDR2) Synchronous DRAMs. Decoupling

capacitors are mounted on the PCB board. The DIMMs feature serial presence detect based on a serial E²PROM device using the 2-pin I²C protocol. The first 128 bytes are programmed with configuration data and are write protected; the second 128 bytes are available to the customer.



TABLE 2
Ordering Information for RoHS Compliant Products

Product Type ¹⁾	Compliance Code ²⁾	Description	SDRAM Technology
PC2-6400			
HYS64T32000HDL-25F-B	256 MB 1R×16 PC2-6400S-555-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-25F-B	512 MB 2R×16 PC2-6400S-555-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-25F-B	1 GB 2Rx8 PC2-6400S-555-12-E0	2 Rank, Non-ECC	512 Mbit (×8)
PC2-6400			
HYS64T32000HDL-2.5-B	256 MB 1R×16 PC2-6400S-666-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-2.5-B	512 MB 2R×16 PC2-6400S-666-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-2.5-B	1 GB 2Rx8 PC2-6400S-666-12-E0	2 Rank, Non-ECC	512 Mbit (×8)
PC2-5300			
HYS64T32000HDL-3-B	256 MB 1R×16 PC2-5300S-444-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-3-B	512 MB 1R×16 PC2-5300S-444-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-3-B	1 GB 2Rx8 PC2-5300S-444-12-E0	2 Rank, Non-ECC	512 Mbit (×8)
PC2-5300			
HYS64T32000HDL-3S-B HYS64T32900HDL-3S-B	256 MB 1R×16 PC2-5300S-555-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-3S-B HYS64T64920HDL-3S-B	512 MB 1R×16 PC2-5300S-555-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-3S-B HYS64T128921HDL-3S-B	1 GB 2Rx8 PC2-5300S-555-12-E0	2 Rank, Non-ECC	512 Mbit (×8)
PC2-4200			
HYS64T32000HDL-3.7-B HYS64T32900HDL-3.7-B	256 MB 1R×16 PC2-4200S-444-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-3.7-B HYS64T64920HDL-3.7-B	512 MB 1R×16 PC2-4200S-444-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-3.7-B HYS64T128921HDL-3.7-B	1 GB 2Rx8 PC2-4200S-444-12-E0	2 Rank, Non-ECC	512 Mbit (×8)


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type ¹⁾	Compliance Code ²⁾	Description	SDRAM Technology
PC2-3200			
HYS64T32000HDL-5-B	256 MB 1R×16 PC2-3200S-333-12-C0	1 Rank, Non-ECC	512 Mbit (×16)
HYS64T64020HDL-5-B	512 MB 1R×16 PC2-3200S-333-12-A0	2 Rank, Non-ECC	512 Mbit (×16)
HYS64T128021HDL-5-B	1 GB 2Rx8 PC2-3200S-333-12-E0	2 Rank, Non-ECC	512 Mbit (×8)

- 1) All Product Type numbers end with a place code, designating the silicon die revision. Example: HYS64T64020HDL-3.7-B, indicating Rev. "B" dies are used for DDR2 SDRAM components. For all Qimonda DDR2 module and component nomenclature see **Chapter 6** of this data sheet.
- 2) The Compliance Code is printed on the module label and describes the speed grade, for example "PC2-4200S-444-12-A0", where 4200S means small-outlined unbuffered DIMM modules with 4.26 GB/sec Module Bandwidth and "444-12" means Column Address Strobe (CAS) latency = 4, Row Column Delay (RCD) latency = 4 and Row Precharge (RP) latency = 4 using the latest JEDEC SPD Revision 1.2 and produced on the Raw Card "A".

TABLE 3
Address Format

DIMM Density	Module Organization	Memory Ranks	ECC/ Non-ECC	# of SDRAMs	# of row/bank/column bits	Raw Card
256 MByte	32M × 64	1	Non-ECC	4	13/2/10	C
512 MByte	64M × 64	2	Non-ECC	8	13/2/10	A
1 GByte	128M × 64	2	Non-ECC	16	14/2/10	E

TABLE 4
Components on Modules

Product Type ¹⁾	DRAM Components ¹⁾	DRAM Density	DRAM Organisation	Note ²⁾
HYS64T32000HDL HYS64T32900HDL	HYB18T512160BF	512 Mbit	32M × 16	
HYS64T64020HDL HYS64T64920HDL	HYB18T512160BF	512 Mbit	32M × 16	
HYS64T128021HDL HYS64T128921HDL	HYB18T512800BF	512 Mbit	64M × 8	

- 1) Green Product
- 2) For a detailed description of all functionalities of the DRAM components on these modules see the component data sheet.



2 Chip Configuration

2.1 Chip Configuration

The chip configuration of the Small Outline DDR2 SDRAM DIMM is listed by function in **Table 5** (200 balls). The abbreviations used in columns Ball and Buffer Type are explained in **Table 6** and **Table 7** respectively. The Ball numbering is depicted in **Figure 1**.

TABLE 5
Chip Configuration of SO-DIMM

Ball No.	Name	Pin Type	Buffer Type	Function
Clock Signals				
30	CK0	I	SSTL	Clock Signals 2:0, Complement Clock Signals 2:0
164	CK1	I	SSTL	
32	$\overline{\text{CK0}}$	I	SSTL	
166	$\overline{\text{CK1}}$	I	SSTL	
79	CKE0	I	SSTL	Clock Enable Rank 1:0
80	CKE1	I	SSTL	<i>Note: 2 Ranks module</i>
	NC	NC	—	Not Connected <i>Note: 1-rank module</i>
Control Signals				
110	$\overline{\text{S0}}$	I	SSTL	Chip Select Rank 1:0
115	$\overline{\text{S1}}$	I	SSTL	
	NC	NC	—	Not Connected <i>Note: 1-rank module</i>
108	$\overline{\text{RAS}}$	I	SSTL	Row Address Strobe
113	$\overline{\text{CAS}}$	I	SSTL	Column Address Strobe
109	$\overline{\text{WE}}$	I	SSTL	Write Enable
Address Signals				
107	BA0	I	SSTL	Bank Address Bus 2:0
106	BA1	I	SSTL	
85	BA2	I	SSTL	Bank Address Bus 2 Greater than 512Mb DDR2 SDRAMs
	NC	NC	SSTL	Less than 1Gb DDR2 SDRAMs


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Ball No.	Name	Pin Type	Buffer Type	Function
102	A0	I	SSTL	Address Bus 12:0
101	A1	I	SSTL	
100	A2	I	SSTL	
99	A3	I	SSTL	
98	A4	I	SSTL	
97	A5	I	SSTL	
94	A6	I	SSTL	
92	A7	I	SSTL	
93	A8	I	SSTL	
91	A9	I	SSTL	
105	A10	I	SSTL	
	AP	I	SSTL	
90	A11	I	SSTL	
89	A12	I	SSTL	Address Signal 12 <i>Note: Module based on 256 Mbit or larger dies</i>
116	A13	I	SSTL	Address Signal 13 <i>Note: 1 Gbit based module</i>
	NC	NC	—	Not Connected <i>Note: Module based on 512 Mbit or smaller dies</i>
Data Signals				
5	DQ0	I/O	SSTL	Data Bus 63:0 <i>Note: Data Input/Output Balls</i>
7	DQ1	I/O	SSTL	
17	DQ2	I/O	SSTL	
19	DQ3	I/O	SSTL	
4	DQ4	I/O	SSTL	
6	DQ5	I/O	SSTL	
14	DQ6	I/O	SSTL	
16	DQ7	I/O	SSTL	
23	DQ8	I/O	SSTL	
25	DQ9	I/O	SSTL	
35	DQ10	I/O	SSTL	
37	DQ11	I/O	SSTL	


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Ball No.	Name	Pin Type	Buffer Type	Function
20	DQ12	I/O	SSTL	Data Bus 63:0 Data Input/Output Balls
22	DQ13	I/O	SSTL	
36	DQ14	I/O	SSTL	
38	DQ15	I/O	SSTL	
43	DQ16	I/O	SSTL	
45	DQ17	I/O	SSTL	
55	DQ18	I/O	SSTL	
57	DQ19	I/O	SSTL	
44	DQ20	I/O	SSTL	
46	DQ21	I/O	SSTL	
56	DQ22	I/O	SSTL	
58	DQ23	I/O	SSTL	
61	DQ24	I/O	SSTL	
63	DQ25	I/O	SSTL	
73	DQ26	I/O	SSTL	
75	DQ27	I/O	SSTL	
62	DQ28	I/O	SSTL	
64	DQ29	I/O	SSTL	
74	DQ30	I/O	SSTL	
76	DQ31	I/O	SSTL	
123	DQ32	I/O	SSTL	
125	DQ33	I/O	SSTL	
135	DQ34	I/O	SSTL	
137	DQ35	I/O	SSTL	
124	DQ36	I/O	SSTL	
126	DQ37	I/O	SSTL	
134	DQ38	I/O	SSTL	
136	DQ39	I/O	SSTL	
141	DQ40	I/O	SSTL	
143	DQ41	I/O	SSTL	
151	DQ42	I/O	SSTL	
153	DQ43	I/O	SSTL	
140	DQ44	I/O	SSTL	
142	DQ45	I/O	SSTL	
152	DQ46	I/O	SSTL	
154	DQ47	I/O	SSTL	
157	DQ48	I/O	SSTL	
159	DQ49	I/O	SSTL	
173	DQ50	I/O	SSTL	
175	DQ51	I/O	SSTL	


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Ball No.	Name	Pin Type	Buffer Type	Function
158	DQ52	I/O	SSTL	Data Bus 63:0
160	DQ53	I/O	SSTL	
174	DQ54	I/O	SSTL	
176	DQ55	I/O	SSTL	
179	DQ56	I/O	SSTL	
181	DQ57	I/O	SSTL	
189	DQ58	I/O	SSTL	
191	DQ59	I/O	SSTL	
180	DQ60	I/O	SSTL	
182	DQ61	I/O	SSTL	
192	DQ62	I/O	SSTL	
194	DQ63	I/O	SSTL	
Data Strobe Signals				
13	DQS0	I/O	SSTL	Data Strobe Bus 7:0
11	$\overline{\text{DQS0}}$	I/O	SSTL	
31	DQS1	I/O	SSTL	
29	$\overline{\text{DQS1}}$	I/O	SSTL	
51	DQS2	I/O	SSTL	
49	$\overline{\text{DQS2}}$	I/O	SSTL	
70	DQS3	I/O	SSTL	
68	$\overline{\text{DQS3}}$	I/O	SSTL	
131	DQS4	I/O	SSTL	
129	$\overline{\text{DQS4}}$	I/O	SSTL	
148	DQS5	I/O	SSTL	
146	$\overline{\text{DQS5}}$	I/O	SSTL	
169	DQS6	I/O	SSTL	
167	$\overline{\text{DQS6}}$	I/O	SSTL	
188	DQS7	I/O	SSTL	
186	$\overline{\text{DQS7}}$	I/O	SSTL	
Data Mask Signals				
10	DM0	I	SSTL	Data Mask Bus 7:0
26	DM1	I	SSTL	
52	DM2	I	SSTL	
67	DM3	I	SSTL	
130	DM4	I	SSTL	
147	DM5	I	SSTL	
170	DM6	I	SSTL	
185	DM7	I	SSTL	


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Ball No.	Name	Pin Type	Buffer Type	Function
EEPROM				
197	SCL	I	CMOS	Serial Bus Clock
195	SDA	I/O	OD	Serial Bus Data
198	SA0	I	CMOS	Serial Address Select Bus 2:0
200	SA1	I	CMOS	
Power Supplies				
1	V _{REF}	AI	—	I/O Reference Voltage
199	V _{DDSPD}	PWR	—	EEPROM Power Supply
81,82,87,88,95,96,103,104,111,112,117,118	V _{DD}	PWR	—	Power Supply
2,3,8,9,12,15,18,21,24,27,28,33,34,39,40,41,42,47,48,53,54,59,60,65,66,71,72,77,78,121,122,127,128,132,133,138,139,144,145,149,150,155,156,,161,162,165,171,172,177,178,183,184,187,190,193,196	V _{SS}	GND	—	Ground Plane
Other Balls				
114	ODT0	I	SSTL	On-Die Termination Control 1:0
119	ODT1	I	SSTL	On-Die Termination Control 1 Note: 2 Rank modules
	NC	NC	—	Not Connected Note: 1 Rank modules
50,69,83,84,120,163,168	NC	NC	—	Not connected

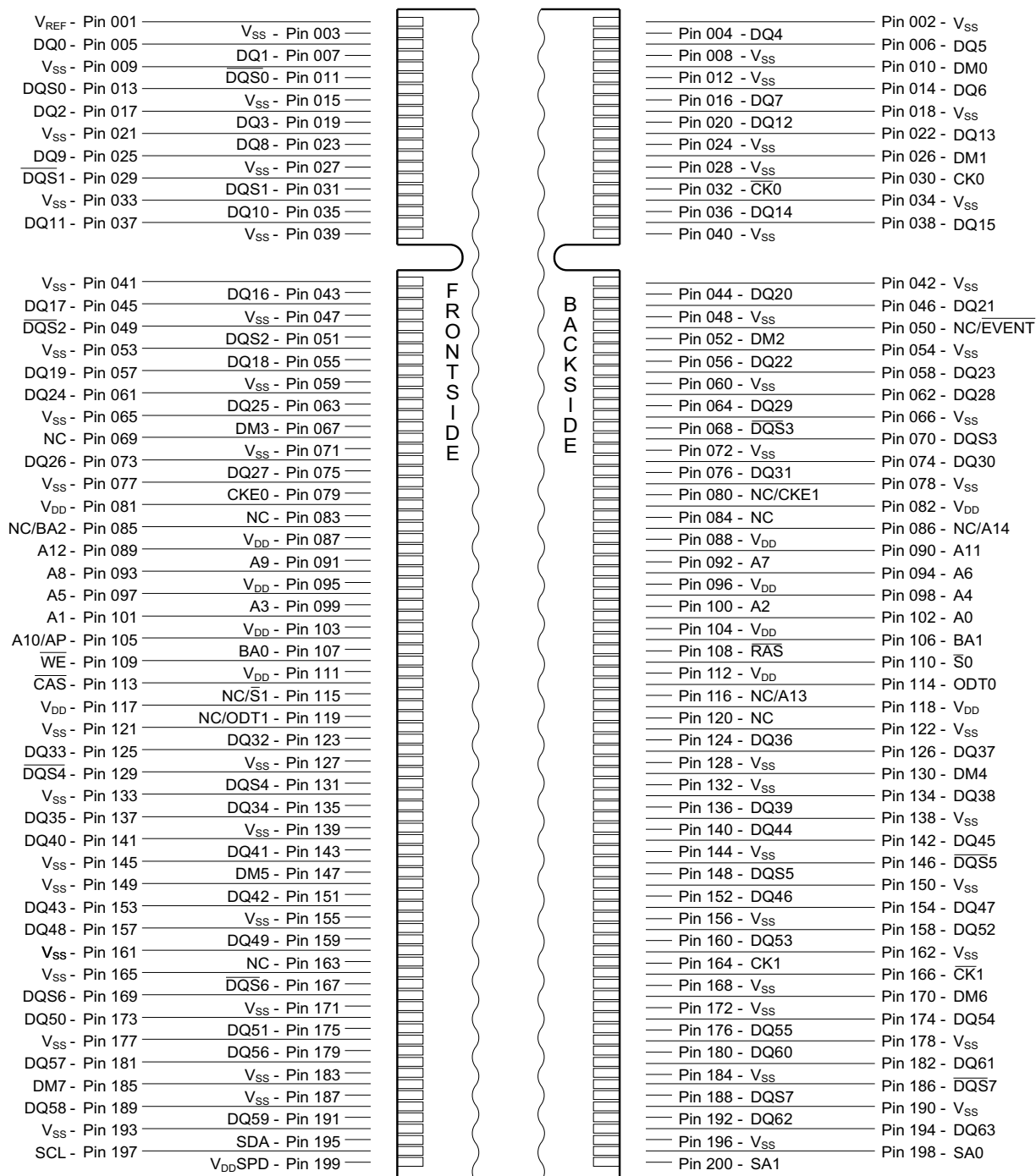
HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module**TABLE 6**
Abbreviations for Ball Type

Abbreviation	Description
I	Standard input-only Ball. Digital levels.
O	Output. Digital levels.
I/O	I/O is a bidirectional input/output signal.
AI	Input. Analog levels.
PWR	Power
GND	Ground
NC	Not Connected

TABLE 7
Abbreviations for Buffer Type

Abbreviation	Description
SSTL	Serial Stub Terminated Logic (SSTL_18)
LV-CMOS	Low Voltage CMOS
CMOS	CMOS Levels
OD	Open Drain. The corresponding ball has 2 operational states, active low and tristate, and allows multiple devices to share as a wire-OR.


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

FIGURE 1
Chip Configuration SO-DIMM (200 Ball)


MPPT0140



3 Electrical Characteristics

This chapter lists the electrical characteristics.

3.1 Absolute Maximum Ratings

Caution is needed not to exceed absolute maximum ratings of the DRAM device listed in **Table 8** at any time.

TABLE 8
Absolute Maximum Ratings

Symbol	Parameter	Rating		Unit	Note
		Min.	Max.		
V_{DD}	Voltage on V_{DD} pin relative to V_{SS}	-1.0	+2.3	V	1)
V_{DDQ}	Voltage on V_{DDQ} pin relative to V_{SS}	-0.5	+2.3	V	1)2)
V_{DDL}	Voltage on V_{DDL} pin relative to V_{SS}	-0.5	+2.3	V	1)2)
V_{IN}, V_{OUT}	Voltage on any pin relative to V_{SS}	-0.5	+2.3	V	1)
T_{STG}	Storage Temperature	-55	+100	°C	1)2)

1) When V_{DD} and V_{DDQ} and V_{DDL} are less than 500 mV; V_{REF} may be equal to or less than 300 mV.

2) Storage Temperature is the case surface temperature on the center/top side of the DRAM.

Attention: 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.

TABLE 9
DRAM Component Operating Temperature Range

Symbol	Parameter	Rating		Unit	Note
		Min.	Max.		
T_{OPER}	Operating Temperature	0	95	°C	1)2)3)4)

1) Operating Temperature is the case surface temperature on the center / top side of the DRAM.

2) The operating temperature range are the temperatures where all DRAM specification will be supported. During operation, the DRAM case temperature must be maintained between 0 - 95 °C under all other specification parameters.

3) Above 85 °C the Auto-Refresh command interval has to be reduced to $t_{REFI} = 3.9 \mu s$

4) When operating this product in the 85 °C to 95 °C TCASE temperature range, the High Temperature Self Refresh has to be enabled by setting EMR(2) bit A7 to “1”. When the High Temperature Self Refresh is enabled there is an increase of I_{DD6} by approximately 50%



3.2 DC Operating Conditions

This chapter contains the DC operating conditions tables.

TABLE 10
Supply Voltage Levels and DC Operating Conditions

Parameter	Symbol	Values			Unit	Note
		Min.	Typ.	Max.		
Device Supply Voltage	V_{DD}	1.7	1.8	1.9	V	
Output Supply Voltage	V_{DDQ}	1.7	1.8	1.9	V	1)
Input Reference Voltage	V_{REF}	$0.49 \times V_{DDQ}$	$0.5 \times V_{DDQ}$	$0.51 \times V_{DDQ}$	V	2)
SPD Supply Voltage	V_{DDSPD}	1.7	—	3.6	V	
DC Input Logic High	$V_{IH(DC)}$	$V_{REF} + 0.125$	—	$V_{DDQ} + 0.3$	V	
DC Input Logic Low	$V_{IL(DC)}$	-0.30	—	$V_{REF} - 0.125$	V	
In / Output Leakage Current	I_L	-5	—	5	μA	3)

1) Under all conditions, V_{DDQ} must be less than or equal to V_{DD} .

2) Peak to peak AC noise on V_{REF} may not exceed $\pm 2\% V_{REF(DC)}$. V_{REF} is also expected to track noise in V_{DDQ} .

3) Input voltage for any connector pin under test of $0 V \leq V_{IN} \leq V_{DDQ} + 0.3 V$; all other pins at $0 V$. Current is per pin

TABLE 11
Operating Conditions

Parameter	Symbol	Values		Unit	Note
		Min.	Max.		
Operating temperature (ambient)	T_{OPR}	0	+65	°C	
DRAM Case Temperature	T_{CASE}	0	+95	°C	1)2)3)4)
Storage Temperature	T_{STG}	-50	+100	°C	
Barometric Pressure (operating & storage)	P_{Bar}	+69	+105	kPa	5)
Operating Humidity (relative)	H_{OPR}	10	90	%	

1) DRAM Component Case Temperature is the surface temperature in the center on the top side of any of the DRAMs.

2) Within the DRAM Component Case Temperature Range all DRAM specifications will be supported

3) Above 85 °C DRAM Case Temperature the Auto-Refresh command interval has to be reduced to $t_{REFI} = 3.9 \mu s$

4) When operating this product in the 85 °C to 95 °C T_{CASE} temperature range, the High Temperature Self Refresh has to be enabled by setting EMR(2) bit A7 to "1". When the High Temperature Self Refresh is enabled there is an increase of I_{DD6} by approximately 50%.

5) Up to 3000 m.



3.3 Timing Characteristics

This chapter describes the AC characteristics.

3.3.1 Speed Grade Definitions

All Speed grades faster than DDR2-DDR400B comply with DDR2-DDR400B timing specifications ($t_{CK} = 5\text{ns}$ with $t_{RAS} = 40\text{ns}$). Speed Grade Definition for DDR2-800 [Table 12], DDR2-667 [Table 13], DDR2-533C [Table 14] and DDR2-400 [Table 15]

TABLE 12
Speed Grade Definition Speed Bins for DDR2-800

Speed Grade			DDR2-800D		DDR2-800E		Unit	Note
QAG Sort Name			-2.5F		-2.5			
CAS-RCD-RP latencies			5-5-5		6-6-6		t_{CK}	
Parameter		Symbol	Min.	Max.	Min.	Max.	—	
Clock Frequency	@ CL = 3	t_{CK}	5	8	5	8	ns	1)2)3)4)
	@ CL = 4	t_{CK}	3.75	8	3.75	8	ns	1)2)3)4)
	@ CL = 5	t_{CK}	2.5	8	3	8	ns	1)2)3)4)
	@ CL = 6	t_{CK}	2.5	8	2.5	8	ns	1)2)3)4)
Row Active Time		t_{RAS}	45	70000	45	70000	ns	1)2)3)4)5)
Row Cycle Time		t_{RC}	57.5	—	60	—	ns	1)2)3)4)
RAS-CAS-Delay		t_{RCD}	12.5	—	15	—	ns	1)2)3)4)
Row Precharge Time		t_{RP}	12.5	—	15	—	ns	1)2)3)4)

- 1) Timings are guaranteed with CK/CK differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode. Timings are further guaranteed for normal OCD drive strength (EMRS(1) A1 = 0)
- 2) The CK/CK input reference level (for timing reference to CK/CK) is the point at which CK and CK cross. The DQS / DQS, RDQS / RDQS, input reference level is the crosspoint when in differential strobe mode.
- 3) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.
- 4) The output timing reference voltage level is V_{TT} .
- 5) $t_{RAS,MAX}$ is calculated from the maximum amount of time a DDR2 device can operate without a refresh command which is equal to $9 \times t_{REFI}$.



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TABLE 13
Speed Grade Definition Speed Bins for DDR2-667

Speed Grade			DDR2-667C		DDR2-667D		Unit	Note
QAG Sort Name			-3		-3S			
CAS-RCD-RP latencies			4-4-4		5-5-5		t_{CK}	
Parameter		Symbol	Min.	Max.	Min.	Max.	—	
Clock Frequency	@ CL = 3	t_{CK}	5	8	5	8	ns	1)2)3)4)
	@ CL = 4	t_{CK}	3	8	3.75	8	ns	1)2)3)4)
	@ CL = 5	t_{CK}	3	8	3	8	ns	1)2)3)4)
Row Active Time		t_{RAS}	45	70000	45	70000	ns	1)2)3)4)5)
Row Cycle Time		t_{RC}	57	—	60	—	ns	1)2)3)4)
RAS-CAS-Delay		t_{RCD}	12	—	15	—	ns	1)2)3)4)
Row Precharge Time		t_{RP}	12	—	15	—	ns	1)2)3)4)

- 1) Timings are guaranteed with $\overline{CK}/\overline{CK}$ differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode. Timings are further guaranteed for normal OCD drive strength (EMRS(1) A1 = 0) .
- 2) The $\overline{CK}/\overline{CK}$ input reference level (for timing reference to $\overline{CK}/\overline{CK}$) is the point at which $\overline{CK}$ and $\overline{CK}$ cross. The $\overline{DQS} / \overline{DQS}$, $\overline{RDQS} / \overline{RDQS}$, input reference level is the crosspoint when in differential strobe mode
- 3) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.
- 4) The output timing reference voltage level is V_{TT} .
- 5) $t_{RAS,MAX}$ is calculated from the maximum amount of time a DDR2 device can operate without a refresh command which is equal to $9 \times t_{REFI}$.


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TABLE 14

Speed Grade Definition Speed Bins for DDR2-533C

Speed Grade			DDR2-533C		Unit	Note
QAG Sort Name			-3.7			
CAS-RCD-RP latencies			4-4-4		t_{CK}	
Parameter		Symbol	Min.	Max.	—	
Clock Frequency	@ CL = 3	t_{CK}	5	8	ns	1)2)3)4)
	@ CL = 4	t_{CK}	3.75	8	ns	1)2)3)4)
	@ CL = 5	t_{CK}	3.75	8	ns	1)2)3)4)
Row Active Time		t_{RAS}	45	70000	ns	1)2)3)4)5)
Row Cycle Time		t_{RC}	60	—	ns	1)2)3)4)
RAS-CAS-Delay		t_{RCD}	15	—	ns	1)2)3)4)
Row Precharge Time		t_{RP}	15	—	ns	1)2)3)4)

- 1) Timings are guaranteed with $\overline{CK}/\overline{CK}$ differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode. Timings are further guaranteed for normal OCD drive strength (EMRS(1) A1 = 0)
- 2) The $\overline{CK}/\overline{CK}$ input reference level (for timing reference to $\overline{CK}/\overline{CK}$) is the point at which $\overline{CK}$ and $\overline{CK}$ cross. The $\overline{DQS}/\overline{DQS}$, $\overline{RDQS}/\overline{RDQS}$, input reference level is the crosspoint when in differential strobe mode.
- 3) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.
- 4) The output timing reference voltage level is V_{TT} .
- 5) $t_{RAS,MAX}$ is calculated from the maximum amount of time a DDR2 device can operate without a refresh command which is equal to $9 \times t_{REFI}$.


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TABLE 15

Speed Grade Definition Speed Bins for DDR2-400B

Speed Grade			DDR2-400B		Unit	Note
QAG Sort Name			-5			
CAS-RCD-RP latencies			3-3-3		t _{CK}	
Parameter		Symbol	Min.	Max.	—	
Clock Frequency	@ CL = 3	t _{CK}	5	8	ns	1)2)3)4)
	@ CL = 4	t _{CK}	5	8	ns	1)2)3)4)
	@ CL = 5	t _{CK}	5	8	ns	1)2)3)4)
Row Active Time		t _{RAS}	40	70000	ns	1)2)3)4)5)
Row Cycle Time		t _{RC}	55	—	ns	1)2)3)4)
RAS-CAS-Delay		t _{RCD}	15	—	ns	1)2)3)4)
Row Precharge Time		t _{RP}	15	—	ns	1)2)3)4)

- 1) Timings are guaranteed with $\overline{CK}/\overline{CK}$ differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode. Timings are further guaranteed for normal OCD drive strength (EMRS(1) A1 = 0) .
- 2) The $\overline{CK}/\overline{CK}$ input reference level (for timing reference to $\overline{CK}/\overline{CK}$) is the point at which $\overline{CK}$ and $\overline{CK}$ cross. The $\overline{DQS} / \overline{DQS}$, $\overline{RDQS} / \overline{RDQS}$, input reference level is the crosspoint when in differential strobe mode
- 3) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.
- 4) The output timing reference voltage level is V_{TT} .
- 5) $t_{RAS,MAX}$ is calculated from the maximum amount of time a DDR2 device can operate without a refresh command which is equal to $9 \times t_{REFI}$.



3.3.2 Component AC Timing Parameters

Timing Parameters for DDR2–800 [Table 16], DDR2–667 [Table 17], DDR2–533C [Table 18] and DDR2–400 [Table 19]

TABLE 16
DRAM Component Timing Parameter by Speed Grade - DDR2–800

Parameter	Symbol	DDR2–800		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
DQ output access time from CK / $\overline{\text{CK}}$	t_{AC}	–400	+400	ps	9)
DQS output access time from CK / $\overline{\text{CK}}$	t_{DQSCK}	–350	+350	ps	9)
Average clock high pulse width	$t_{\text{CH.AVG}}$	0.48	0.52	$t_{\text{CK.AVG}}$	10)11)
Average clock low pulse width	$t_{\text{CL.AVG}}$	0.48	0.52	$t_{\text{CK.AVG}}$	10)11)
Average clock period	$t_{\text{CK.AVG}}$	2500	8000	ps	10)11)
DQ and DM input setup time	$t_{\text{DS.BASE}}$	50	—	ps	12)13)14)
DQ and DM input hold time	$t_{\text{DH.BASE}}$	125	—	ps	13)14)15)
Control & address input pulse width for each input	t_{IPW}	0.6	—	$t_{\text{CK.AVG}}$	
DQ and DM input pulse width for each input	t_{DIPW}	0.35	—	$t_{\text{CK.AVG}}$	
Data-out high-impedance time from CK / $\overline{\text{CK}}$	t_{HZ}	—	$t_{\text{AC.MAX}}$	ps	9)16)
DQS/ $\overline{\text{DQS}}$ low-impedance time from CK / $\overline{\text{CK}}$	$t_{\text{LZ.DQS}}$	$t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}}$	ps	9)16)
DQ low impedance time from CK/ $\overline{\text{CK}}$	$t_{\text{LZ.DQ}}$	$2 \times t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}}$	ps	9)16)
DQS-DQ skew for DQS & associated DQ signals	t_{DQSQ}	—	200	ps	17)
CK half pulse width	t_{HP}	$\text{Min}(t_{\text{CH.ABS}}, t_{\text{CL.ABS}})$	—	ps	18)
DQ hold skew factor	t_{QHS}	—	300	ps	19)
DQ/DQS output hold time from DQS	t_{QH}	$t_{\text{HP}} - t_{\text{QHS}}$	—	ps	20)
Write command to DQS associated clock edges	WL	RL – 1		nCK	
DQS latching rising transition to associated clock edges	t_{DQSS}	– 0.25	+ 0.25	$t_{\text{CK.AVG}}$	21)
DQS input high pulse width	t_{DQSH}	0.35	—	$t_{\text{CK.AVG}}$	
DQS input low pulse width	t_{DQSL}	0.35	—	$t_{\text{CK.AVG}}$	
DQS falling edge to CK setup time	t_{DSS}	0.2	—	$t_{\text{CK.AVG}}$	21)
DQS falling edge hold time from CK	t_{DSH}	0.2	—	$t_{\text{CK.AVG}}$	21)
Write postamble	t_{WPST}	0.4	0.6	$t_{\text{CK.AVG}}$	
Write preamble	t_{WPPE}	0.35	—	$t_{\text{CK.AVG}}$	
Address and control input setup time	$t_{\text{IS.BASE}}$	175	—	ps	22)23)
Address and control input hold time	$t_{\text{IH.BASE}}$	250	—	ps	23)24)
Read preamble	t_{RPPE}	0.9	1.1	$t_{\text{CK.AVG}}$	25)26)
Read postamble	t_{RPST}	0.4	0.6	$t_{\text{CK.AVG}}$	25)27)
CAS to CAS command delay	t_{CCD}	2	—	nCK	
Write recovery time	t_{WR}	15	—	ns	1)
Auto-Precharge write recovery + precharge time	t_{DAL}	$\text{WR} + t_{\text{nRP}}$	—	nCK	28)29)
Internal write to read command delay	t_{WTR}	7.5	—	ns	1)30)


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Parameter	Symbol	DDR2-800		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	1)
Exit self-refresh to a non-read command	t_{XSNR}	$t_{RFC} + 10$	—	ns	1)
Exit self-refresh to read command	t_{XSRD}	200	—	nCK	
Exit precharge power-down to any valid command (other than NOP or Deselect)	t_{XP}	2	—	nCK	
Exit power down to read command	t_{XARD}	2	—	nCK	
Exit active power-down mode to read command (slow exit, lower power)	t_{XARDS}	8 – AL	—	nCK	
CKE minimum pulse width (high and low pulse width)	t_{CKE}	3	—	nCK	31)
Mode register set command cycle time	t_{MRD}	2	—	nCK	
MRS command to ODT update delay	t_{MOD}	0	12	ns	1)
OCD drive mode output delay	t_{OIT}	0	12	ns	1)
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	$t_{IS} + t_{CK.AVG} + t_{IH}$	—	ns	

- For details and notes see the relevant Qimonda component data sheet
- $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$. See notes ⁵⁾⁶⁾⁷⁾⁸⁾
- Timing that is not specified is illegal and after such an event, in order to guarantee proper operation, the DRAM must be powered down and then restarted through the specified initialization sequence before normal operation can continue.
- Timings are guaranteed with CK/CK differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode.
- The CK / CK input reference level (for timing reference to CK / CK) is the point at which CK and CK cross. The DQS / DQS, RDQS / RDQS, input reference level is the crosspoint when in differential strobe mode.
- Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, CKE = $0.2 \times V_{DDQ}$ is recognized as low.
- The output timing reference voltage level is V_{TT} .
- New units, ' $t_{CK.AVG}$ ' and 'nCK', are introduced in DDR2-667 and DDR2-800. Unit ' $t_{CK.AVG}$ ' represents the actual $t_{CK.AVG}$ of the input clock under operation. Unit 'nCK' represents one clock cycle of the input clock, counting the actual clock edges. Note that in DDR2-400 and DDR2-533, ' t_{CK} ' is used for both concepts. Example: $t_{XP} = 2$ [nCK] means; if Power Down exit is registered at T_m , an Active command may be registered at $T_m + 2$, even if $(T_m + 2 - T_m)$ is $2 \times t_{CK.AVG} + t_{ERR.2PER(MIN)}$.
- When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{ERR(6-10PER)}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{ERR(6-10PER).MIN} = -272$ ps and $t_{ERR(6-10PER).MAX} = +293$ ps, then $t_{DQSCK.MIN(DERATED)} = t_{DQSCK.MIN} - t_{ERR(6-10PER).MAX} = -400$ ps – 293 ps = – 693 ps and $t_{DQSCK.MAX(DERATED)} = t_{DQSCK.MAX} - t_{ERR(6-10PER).MIN} = 400$ ps + 272 ps = + 672 ps. Similarly, $t_{LZ.DQ}$ for DDR2-667 derates to $t_{LZ.DQ.MIN(DERATED)} = -900$ ps – 293 ps = – 1193 ps and $t_{LZ.DQ.MAX(DERATED)} = 450$ ps + 272 ps = + 722 ps. (Caution on the MIN/MAX usage!)
- Input clock jitter spec parameter. These parameters are referred to as 'input clock jitter spec parameters' and these parameters apply to DDR2-667 and DDR2-800 only. The jitter specified is a random jitter meeting a Gaussian distribution.
- These parameters are specified per their average values, however it is understood that the relationship between the average timing and the absolute instantaneous timing holds all the times (min. and max. of SPEC values are to be used for calculations).
- Input waveform timing t_{DS} with differential data strobe enabled MR[bit10] = 0, is referenced from the input signal crossing at the $V_{IH.AC}$ level to the differential data strobe crosspoint for a rising signal, and from the input signal crossing at the $V_{IL.AC}$ level to the differential data strobe crosspoint for a falling signal applied to the device under test. DQS, DQS signals must be monotonic between $V_{i(DC).MAX}$ and $V_{i(DC).MIN}$. See **Figure 3**.
- If t_{DS} or t_{DH} is violated, data corruption may occur and the data must be re-written with valid data before a valid READ can be executed.
- These parameters are measured from a data signal ((L/U)DM, (L/U)DQ0, (L/U)DQ1, etc.) transition edge to its respective data strobe signal ((L/U/R)DQS / DQS) crossing.
- Input waveform timing t_{DH} with differential data strobe enabled MR[bit10] = 0, is referenced from the differential data strobe crosspoint to the input signal crossing at the $V_{IH.DC}$ level for a falling signal and from the differential data strobe crosspoint to the input signal crossing at the $V_{IL.DC}$ level for a rising signal applied to the device under test. DQS, DQS signals must be monotonic between $V_{i(DC).MAX}$ and $V_{i(DC).MIN}$. See **Figure 3**.

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- 16) t_{HZ} and t_{LZ} transitions occur in the same access time as valid data transitions. These parameters are referenced to a specific voltage level which specifies when the device output is no longer driving (t_{HZ}), or begins driving (t_{LZ}).
- 17) t_{DQSQ} : Consists of data pin skew and output pattern effects, and p-channel to n-channel variation of the output drivers as well as output slew rate mismatch between DQS / $\overline{DQS}$ and associated DQ in any given cycle.
- 18) t_{HP} is the minimum of the absolute half period of the actual input clock. t_{HP} is an input parameter but not an input specification parameter. It is used in conjunction with t_{QHS} to derive the DRAM output timing t_{QH} . The value to be used for t_{QH} calculation is determined by the following equation; $t_{HP} = \text{MIN}(t_{CH,ABS}, t_{CL,ABS})$, where, $t_{CH,ABS}$ is the minimum of the actual instantaneous clock high time; $t_{CL,ABS}$ is the minimum of the actual instantaneous clock low time.
- 19) t_{QHS} accounts for: 1) The pulse duration distortion of on-chip clock circuits, which represents how well the actual t_{HP} at the input is transferred to the output; and 2) The worst case push-out of DQS on one transition followed by the worst case pull-in of DQ on the next transition, both of which are independent of each other, due to data pin skew, output pattern effects, and pchannel to n-channel variation of the output drivers.
- 20) $t_{QH} = t_{HP} - t_{QHS}$, where: t_{HP} is the minimum of the absolute half period of the actual input clock; and t_{QHS} is the specification value under the max column. {The less half-pulse width distortion present, the larger the t_{QH} value is; and the larger the valid data eye will be.}
Examples: 1) If the system provides t_{HP} of 1315 ps into a DDR2-667 SDRAM, the DRAM provides t_{QH} of 975 ps minimum. 2) If the system provides t_{HP} of 1420 ps into a DDR2-667 SDRAM, the DRAM provides t_{QH} of 1080 ps minimum.
- 21) These parameters are measured from a data strobe signal ((L/U/R)DQS / $\overline{DQS}$) crossing to its respective clock signal (CK / $\overline{CK}$) crossing. The spec values are not affected by the amount of clock jitter applied (i.e. $t_{JIT,PER}$, $t_{JIT,CC}$, etc.), as these are relative to the clock signal crossing. That is, these parameters should be met whether clock jitter is present or not.
- 22) Input waveform timing is referenced from the input signal crossing at the $V_{IH,AC}$ level for a rising signal and $V_{IL,AC}$ for a falling signal applied to the device under test. See **Figure 4**.
- 23) These parameters are measured from a command/address signal (CKE, CS, RAS, CAS, WE, ODT, BA0, A0, A1, etc.) transition edge to its respective clock signal (CK / $\overline{CK}$) crossing. The spec values are not affected by the amount of clock jitter applied (i.e. $t_{JIT,PER}$, $t_{JIT,CC}$, etc.), as the setup and hold are relative to the clock signal crossing that latches the command/address. That is, these parameters should be met whether clock jitter is present or not.
- 24) Input waveform timing is referenced from the input signal crossing at the $V_{IL,DC}$ level for a rising signal and $V_{IH,DC}$ for a falling signal applied to the device under test. See **Figure 4**.
- 25) t_{RPST} end point and t_{RPRE} begin point are not referenced to a specific voltage level but specify when the device output is no longer driving (t_{RPST}), or begins driving (t_{RPRE}). **Figure 2** shows a method to calculate these points when the device is no longer driving (t_{RPST}), or begins driving (t_{RPRE}) by measuring the signal at two different voltages. The actual voltage measurement points are not critical as long as the calculation is consistent.
- 26) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{JIT,PER}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT,PER,MIN} = -72$ ps and $t_{JIT,PER,MAX} = +93$ ps, then $t_{RPRE,MIN(DERATED)} = t_{RPRE,MIN} + t_{JIT,PER,MIN} = 0.9 \times t_{CK,AVG} - 72$ ps = + 2178 ps and $t_{RPRE,MAX(DERATED)} = t_{RPRE,MAX} + t_{JIT,PER,MAX} = 1.1 \times t_{CK,AVG} + 93$ ps = + 2843 ps. (Caution on the MIN/MAX usage!).
- 27) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{JIT,DUTY}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT,DUTY,MIN} = -72$ ps and $t_{JIT,DUTY,MAX} = +93$ ps, then $t_{RPST,MIN(DERATED)} = t_{RPST,MIN} + t_{JIT,DUTY,MIN} = 0.4 \times t_{CK,AVG} - 72$ ps = + 928 ps and $t_{RPST,MAX(DERATED)} = t_{RPST,MAX} + t_{JIT,DUTY,MAX} = 0.6 \times t_{CK,AVG} + 93$ ps = + 1592 ps. (Caution on the MIN/MAX usage!).
- 28) $DAL = WR + RU\{t_{RP}(ns) / t_{CK}(ns)\}$, where RU stands for round up. WR refers to the tWR parameter stored in the MRS. For t_{RP} , if the result of the division is not already an integer, round up to the next highest integer. t_{CK} refers to the application clock period. Example: For DDR2-533 at $t_{CK} = 3.75$ ns with t_{WR} programmed to 4 clocks. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns}) \text{ clocks} = 4 + (4) \text{ clocks} = 8 \text{ clocks}$.
- 29) $t_{DAL,nCK} = WR [nCK] + t_{nRP,nCK} = WR + RU\{t_{RP} [ps] / t_{CK,AVG}[ps]\}$, where WR is the value programmed in the EMR.
- 30) t_{WTR} is at least two clocks ($2 \times t_{CK}$) independent of operation frequency.
- 31) $t_{CKE,MIN}$ of 3 clocks means CKE must be registered on three consecutive positive clock edges. CKE must remain at the valid input level the entire time it takes to achieve the 3 clocks of registration. Thus, after any CKE transition, CKE may not transition from its valid level during the time period of $t_{IS} + 2 \times t_{CK} + t_{IH}$.


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TABLE 17
DRAM Component Timing Parameter by Speed Grade - DDR2-667

Parameter	Symbol	DDR2-667		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
DQ output access time from CK / $\overline{\text{CK}}$	t_{AC}	-450	+450	ps	9)
DQS output access time from CK / $\overline{\text{CK}}$	$t_{DQ\text{SCK}}$	-400	+400	ps	9)
Average clock high pulse width	$t_{CH.AVG}$	0.48	0.52	$t_{CK.AVG}$	10)11)
Average clock low pulse width	$t_{CL.AVG}$	0.48	0.52	$t_{CK.AVG}$	10)11)
Average clock period	$t_{CK.AVG}$	3000	8000	ps	
DQ and DM input setup time	$t_{DS.BASE}$	100	—	ps	12)13)14)
DQ and DM input hold time	$t_{DH.BASE}$	175	—	ps	13)14)15)
Control & address input pulse width for each input	t_{IPW}	0.6	—	$t_{CK.AVG}$	
DQ and DM input pulse width for each input	t_{DIPW}	0.35	—	$t_{CK.AVG}$	
Data-out high-impedance time from CK / $\overline{\text{CK}}$	t_{HZ}	—	$t_{AC.MAX}$	ps	9)16)
DQS/ $\overline{\text{DQS}}$ low-impedance time from CK / $\overline{\text{CK}}$	$t_{LZ.DQS}$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)16)
DQ low impedance time from CK/ $\overline{\text{CK}}$	$t_{LZ.DQ}$	$2 \times t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)16)
DQS-DQ skew for DQS & associated DQ signals	t_{DQSQ}	—	240	ps	17)
CK half pulse width	t_{HP}	$\text{Min}(t_{CH.ABS}, t_{CL.ABS})$	—	ps	18)
DQ hold skew factor	t_{QHS}	—	340	ps	19)
DQ/DQS output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—	ps	20)
Write command to DQS associated clock edges	WL	RL-1		nCK	
DQS latching rising transition to associated clock edges	t_{DQSS}	- 0.25	+ 0.25	$t_{CK.AVG}$	21)
DQS input high pulse width	t_{DQSH}	0.35	—	$t_{CK.AVG}$	
DQS input low pulse width	t_{DQSL}	0.35	—	$t_{CK.AVG}$	
DQS falling edge to CK setup time	t_{DSS}	0.2	—	$t_{CK.AVG}$	21)
DQS falling edge hold time from CK	t_{DSH}	0.2	—	$t_{CK.AVG}$	21)
Write postamble	t_{WPST}	0.4	0.6	$t_{CK.AVG}$	
Write preamble	t_{WPRE}	0.35	—	$t_{CK.AVG}$	
Address and control input setup time	$t_{IS.BASE}$	200	—	ps	22)23)
Address and control input hold time	$t_{IH.BASE}$	275	—	ps	23)24)
Read preamble	t_{RPRE}	0.9	1.1	$t_{CK.AVG}$	25)26)
Read postamble	t_{RPST}	0.4	0.6	$t_{CK.AVG}$	25)27)
CAS to CAS command delay	t_{CCD}	2	—	nCK	
Write recovery time	t_{WR}	15	—	ns	1)
Auto-Precharge write recovery + precharge time	t_{DAL}	$WR + t_{nRP}$	—	nCK	28)29)
Internal write to read command delay	t_{WTR}	7.5	—	ns	1)30)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	1)
Exit self-refresh to a non-read command	t_{XSNR}	$t_{RFC} + 10$	—	ns	1)
Exit self-refresh to read command	t_{XSRD}	200	—	nCK	


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Parameter	Symbol	DDR2-667		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
Exit precharge power-down to any valid command (other than NOP or Deselect)	t_{XP}	2	—	nCK	
Exit power down to read command	t_{XARD}	2	—	nCK	
Exit active power-down mode to read command (slow exit, lower power)	t_{XARDS}	7 – AL	—	nCK	
CKE minimum pulse width (high and low pulse width)	t_{CKE}	3	—	nCK	³¹⁾
Mode register set command cycle time	t_{MRD}	2	—	nCK	
MRS command to ODT update delay	t_{MOD}	0	12	ns	¹⁾
OCD drive mode output delay	t_{OIT}	0	12	ns	¹⁾
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	$t_{IS} + t_{CK.AVG} + t_{IH}$	—	ns	

- For details and notes see the relevant Qimonda component data sheet
- $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$. See notes ⁵⁾⁶⁾⁷⁾⁸⁾
- Timing that is not specified is illegal and after such an event, in order to guarantee proper operation, the DRAM must be powered down and then restarted through the specified initialization sequence before normal operation can continue.
- Timings are guaranteed with CK/CK differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode.
- The CK / $\overline{\text{CK}}$ input reference level (for timing reference to CK / $\overline{\text{CK}}$) is the point at which CK and $\overline{\text{CK}}$ cross. The DQS / $\overline{\text{DQS}}$, RDQS / $\overline{\text{RDQS}}$, input reference level is the crosspoint when in differential strobe mode.
- Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, CKE = 0.2 x V_{DDQ} is recognized as low.
- The output timing reference voltage level is V_{TT} .
- New units, ' $t_{CK.AVG}$ ' and 'nCK', are introduced in DDR2-667 and DDR2-800. Unit ' $t_{CK.AVG}$ ' represents the actual $t_{CK.AVG}$ of the input clock under operation. Unit 'nCK' represents one clock cycle of the input clock, counting the actual clock edges. Note that in DDR2-400 and DDR2-533, ' t_{CK} ' is used for both concepts. Example: $t_{XP} = 2$ [nCK] means; if Power Down exit is registered at T_m , an Active command may be registered at $T_m + 2$, even if $(T_m + 2 - T_m)$ is $2 \times t_{CK.AVG} + t_{ERR.2PER(Min)}$.
- When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{ERR(6-10per)}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{ERR(6-10PER).MIN} = -272$ ps and $t_{ERR(6-10PER).MAX} = +293$ ps, then $t_{DQSK.MIN(DERATED)} = t_{DQSK.MIN} - t_{ERR(6-10PER).MAX} = -400 \text{ ps} - 293 \text{ ps} = -693 \text{ ps}$ and $t_{DQSK.MAX(DERATED)} = t_{DQSK.MAX} - t_{ERR(6-10PER).MIN} = 400 \text{ ps} + 272 \text{ ps} = +672 \text{ ps}$. Similarly, $t_{LZ.DQ}$ for DDR2-667 derates to $t_{LZ.DQ.MIN(DERATED)} = -900 \text{ ps} - 293 \text{ ps} = -1193 \text{ ps}$ and $t_{LZ.DQ.MAX(DERATED)} = 450 \text{ ps} + 272 \text{ ps} = +722 \text{ ps}$. (Caution on the MIN/MAX usage!)
- Input clock jitter spec parameter. These parameters are referred to as 'input clock jitter spec parameters' and these parameters apply to DDR2-667 and DDR2-800 only. The jitter specified is a random jitter meeting a Gaussian distribution.
- These parameters are specified per their average values, however it is understood that the relationship between the average timing and the absolute instantaneous timing holds all the times (min. and max of SPEC values are to be used for calculations).
- Input waveform timing t_{DS} with differential data strobe enabled MR[bit10] = 0, is referenced from the input signal crossing at the $V_{IH.AC}$ level to the differential data strobe crosspoint for a rising signal, and from the input signal crossing at the $V_{IL.AC}$ level to the differential data strobe crosspoint for a falling signal applied to the device under test. DQS, DQS signals must be monotonic between $V_{IL(DC).MAX}$ and $V_{IH(DC).MIN}$. See **Figure 3**.
- If t_{DS} or t_{DH} is violated, data corruption may occur and the data must be re-written with valid data before a valid READ can be executed.
- These parameters are measured from a data signal ((L/U)DM, (L/U)DQ0, (L/U)DQ1, etc.) transition edge to its respective data strobe signal ((L/U/R)DQS / $\overline{\text{DQS}}$) crossing.
- Input waveform timing t_{DH} with differential data strobe enabled MR[bit10] = 0, is referenced from the differential data strobe crosspoint to the input signal crossing at the $V_{IH.DC}$ level for a falling signal and from the differential data strobe crosspoint to the input signal crossing at the $V_{IL.DC}$ level for a rising signal applied to the device under test. DQS, DQS signals must be monotonic between $V_{IL.DC}.MAX$ and $V_{IH.DC}.MIN$. See **Figure 3**.
- t_{HZ} and t_{LZ} transitions occur in the same access time as valid data transitions. These parameters are referenced to a specific voltage level which specifies when the device output is no longer driving (t_{HZ}), or begins driving (t_{LZ}).
- t_{DQSQ} : Consists of data pin skew and output pattern effects, and p-channel to n-channel variation of the output drivers as well as output slew rate mismatch between DQS / $\overline{\text{DQS}}$ and associated DQ in any given cycle.

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- 18) t_{HP} is the minimum of the absolute half period of the actual input clock. t_{HP} is an input parameter but not an input specification parameter. It is used in conjunction with t_{QHS} to derive the DRAM output timing t_{QH} . The value to be used for t_{QH} calculation is determined by the following equation; $t_{HP} = \text{MIN}(t_{CH,ABS}, t_{CL,ABS})$, where, $t_{CH,ABS}$ is the minimum of the actual instantaneous clock high time; $t_{CL,ABS}$ is the minimum of the actual instantaneous clock low time.
- 19) t_{QHS} accounts for: 1) The pulse duration distortion of on-chip clock circuits, which represents how well the actual t_{HP} at the input is transferred to the output; and 2) The worst case push-out of DQS on one transition followed by the worst case pull-in of DQ on the next transition, both of which are independent of each other, due to data pin skew, output pattern effects, and pchannel to n-channel variation of the output drivers.
- 20) $t_{QH} = t_{HP} - t_{QHS}$, where: t_{HP} is the minimum of the absolute half period of the actual input clock; and t_{QHS} is the specification value under the max column. {The less half-pulse width distortion present, the larger the t_{QH} value is; and the larger the valid data eye will be.}
Examples: 1) If the system provides t_{HP} of 1315 ps into a DDR2-667 SDRAM, the DRAM provides t_{QH} of 975 ps minimum. 2) If the system provides t_{HP} of 1420 ps into a DDR2-667 SDRAM, the DRAM provides t_{QH} of 1080 ps minimum.
- 21) These parameters are measured from a data strobe signal ((L/U/R)DQS / $\overline{DQS}$) crossing to its respective clock signal (CK / $\overline{CK}$) crossing. The spec values are not affected by the amount of clock jitter applied (i.e. $t_{JIT,PER}$, $t_{JIT,CC}$, etc.), as these are relative to the clock signal crossing. That is, these parameters should be met whether clock jitter is present or not.
- 22) Input waveform timing is referenced from the input signal crossing at the $V_{IH,AC}$ level for a rising signal and $V_{IL,AC}$ for a falling signal applied to the device under test. See **Figure 4**.
- 23) These parameters are measured from a command/address signal (CKE, CS, RAS, CAS, WE, ODT, BA0, A0, A1, etc.) transition edge to its respective clock signal (CK / $\overline{CK}$) crossing. The spec values are not affected by the amount of clock jitter applied (i.e. $t_{JIT,PER}$, $t_{JIT,CC}$, etc.), as the setup and hold are relative to the clock signal crossing that latches the command/address. That is, these parameters should be met whether clock jitter is present or not.
- 24) Input waveform timing is referenced from the input signal crossing at the $V_{IL,DC}$ level for a rising signal and $V_{IH,DC}$ for a falling signal applied to the device under test. See **Figure 4**.
- 25) t_{RPST} end point and t_{RPRE} begin point are not referenced to a specific voltage level but specify when the device output is no longer driving (t_{RPST}), or begins driving (t_{RPRE}). **Figure 2** shows a method to calculate these points when the device is no longer driving (t_{RPST}), or begins driving (t_{RPRE}) by measuring the signal at two different voltages. The actual voltage measurement points are not critical as long as the calculation is consistent.
- 26) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{JIT,PER}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT,PER,MIN} = -72$ ps and $t_{JIT,PER,MAX} = +93$ ps, then $t_{RPRE,MIN(DERATED)} = t_{RPRE,MIN} + t_{JIT,PER,MIN} = 0.9 \times t_{CK,AVG} - 72$ ps = + 2178 ps and $t_{RPRE,MAX(DERATED)} = t_{RPRE,MAX} + t_{JIT,PER,MAX} = 1.1 \times t_{CK,AVG} + 93$ ps = + 2843 ps. (Caution on the MIN/MAX usage!).
- 27) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{JIT,DUTY}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT,DUTY,MIN} = -72$ ps and $t_{JIT,DUTY,MAX} = +93$ ps, then $t_{RPST,MIN(DERATED)} = t_{RPST,MIN} + t_{JIT,DUTY,MIN} = 0.4 \times t_{CK,AVG} - 72$ ps = + 928 ps and $t_{RPST,MAX(DERATED)} = t_{RPST,MAX} + t_{JIT,DUTY,MAX} = 0.6 \times t_{CK,AVG} + 93$ ps = + 1592 ps. (Caution on the MIN/MAX usage!).
- 28) $DAL = WR + RU\{t_{RP}(ns) / t_{CK}(ns)\}$, where RU stands for round up. WR refers to the tWR parameter stored in the MRS. For t_{RP} , if the result of the division is not already an integer, round up to the next highest integer. t_{CK} refers to the application clock period. Example: For DDR2-533 at $t_{CK} = 3.75$ ns with t_{WR} programmed to 4 clocks. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns}) \text{ clocks} = 4 + (4) \text{ clocks} = 8 \text{ clocks}$.
- 29) $t_{DAL,nCK} = WR [nCK] + t_{nRP,nCK} = WR + RU\{t_{RP} [ps] / t_{CK,AVG}[ps]\}$, where WR is the value programmed in the EMR.
- 30) t_{WTR} is at least two clocks ($2 \times t_{CK}$) independent of operation frequency.
- 31) $t_{CKE,MIN}$ of 3 clocks means CKE must be registered on three consecutive positive clock edges. CKE must remain at the valid input level the entire time it takes to achieve the 3 clocks of registration. Thus, after any CKE transition, CKE may not transition from its valid level during the time period of $t_{IS} + 2 \times t_{CK} + t_{IH}$.



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FIGURE 2

Method for calculating transitions and endpoint

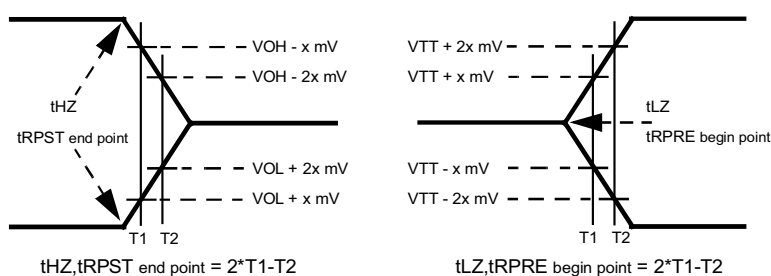


FIGURE 3

Differential input waveform timing - t_{DS} and t_{DH}

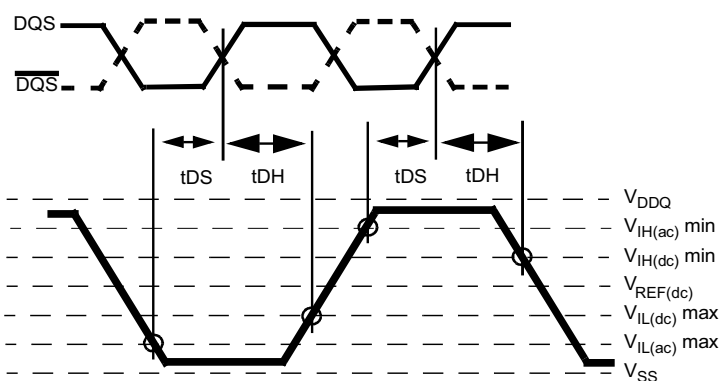


FIGURE 4

Differential input waveform timing - t_{IS} and t_{IH}

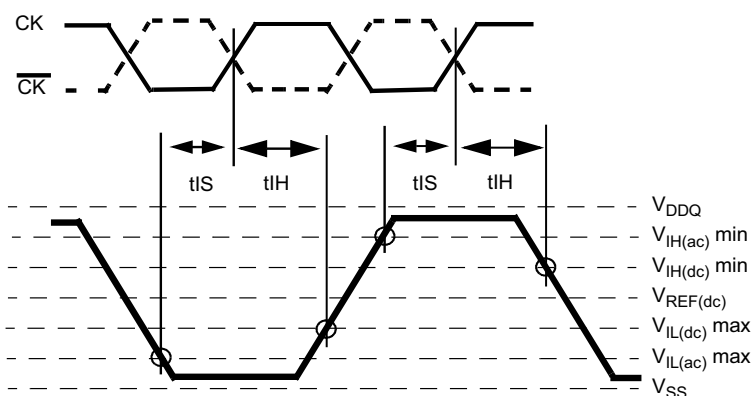




TABLE 18
DRAM Component Timing Parameter by Speed Grade - DDR2-533

Parameter	Symbol	DDR2-533		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
DQ output access time from CK / $\overline{\text{CK}}$	t_{AC}	-500	+500	ps	
$\overline{\text{CAS}}$ A to $\overline{\text{CAS}}$ B command period	t_{CCD}	2	—	t_{CK}	
CK, $\overline{\text{CK}}$ high-level width	t_{CH}	0.45	0.55	t_{CK}	
CKE minimum high and low pulse width	t_{CKE}	3	—	t_{CK}	
CK, $\overline{\text{CK}}$ low-level width	t_{CL}	0.45	0.55	t_{CK}	
Auto-Precharge write recovery + precharge time	t_{DAL}	WR + t_{RP}	—	t_{CK}	⁸⁾¹⁸⁾
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	$t_{\text{IS}} + t_{\text{CK}} + t_{\text{IH}}$	—	ns	⁹⁾
DQ and DM input hold time (differential data strobe)	$t_{\text{DH}}(\text{base})$	225	—	ps	¹⁰⁾
DQ and DM input hold time (single ended data strobe)	$t_{\text{DH1}}(\text{base})$	-25	—	ps	¹¹⁾
DQ and DM input pulse width (each input)	t_{DIPW}	0.35	—	t_{CK}	
DQS output access time from CK / $\overline{\text{CK}}$	t_{DQSCK}	-450	+450	ps	
DQS input low (high) pulse width (write cycle)	$t_{\text{DQSL,H}}$	0.35	—	t_{CK}	
DQS-DQ skew (for DQS & associated DQ signals)	t_{DQSQ}	—	300	ps	¹¹⁾
Write command to 1st DQS latching transition	t_{DQSS}	- 0.25	+ 0.25	t_{CK}	
DQ and DM input setup time (differential data strobe)	$t_{\text{DS}}(\text{base})$	100	—	ps	¹¹⁾
DQ and DM input setup time (single ended data strobe)	$t_{\text{DS1}}(\text{base})$	-25	—	ps	¹¹⁾
DQS falling edge hold time from CK (write cycle)	t_{DSH}	0.2	—	t_{CK}	
DQS falling edge to CK setup time (write cycle)	t_{DSS}	0.2	—	t_{CK}	
Clock half period	t_{HP}	MIN. (t_{CL} , t_{CH})		—	¹²⁾
Data-out high-impedance time from CK / $\overline{\text{CK}}$	t_{HZ}	—	$t_{\text{AC,MAX}}$	ps	¹³⁾
Address and control input hold time	$t_{\text{IH}}(\text{base})$	375	—	ps	¹¹⁾
Address and control input pulse width (each input)	t_{IPW}	0.6	—	t_{CK}	
Address and control input setup time	$t_{\text{IS}}(\text{base})$	250	—	ps	¹¹⁾
DQ low-impedance time from CK / $\overline{\text{CK}}$	$t_{\text{LZ}}(\text{DQ})$	$2 \times t_{\text{AC,MIN}}$	$t_{\text{AC,MAX}}$	ps	¹⁴⁾
DQS low-impedance from CK / $\overline{\text{CK}}$	$t_{\text{LZ}}(\text{DQS})$	$t_{\text{AC,MIN}}$	$t_{\text{AC,MAX}}$	ps	¹⁴⁾
Mode register set command cycle time	t_{MRD}	2	—	t_{CK}	
OCD drive mode output delay	t_{OIT}	0	12	ns	
Data output hold time from DQS	t_{QH}	$t_{\text{HP}} - t_{\text{QHS}}$	—	—	
Data hold skew factor	t_{QHS}	—	400	ps	


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Parameter	Symbol	DDR2-533		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
Average periodic refresh Interval	t_{REFI}	—	7.8	μ S	14)15)
		—	3.9	μ S	16)18)
Auto-Refresh to Active/Auto-Refresh command period	t_{RFC}	105	—	ns	17)
Precharge-All (4 banks) command period	t_{RP}	$t_{RP} + 1t_{CK}$	—	ns	
Precharge-All (8 banks) command period	t_{RP}	$15 + 1t_{CK}$	—	ns	
Read preamble	t_{RPRE}	0.9	1.1	t_{CK}	14)
Read postamble	t_{RPST}	0.40	0.60	t_{CK}	14)
Active bank A to Active bank B command period	t_{RRD}	7.5	—	ns	14)18)
		10	—	ns	16)20)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	
Write preamble	t_{WPRE}	$0.25 \times t_{CK}$	—	t_{CK}	
Write postamble	t_{WPST}	0.40	0.60	t_{CK}	19)
Write recovery time for write without Auto-Precharge	t_{WR}	15	—	ns	
Write recovery time for write with Auto-Precharge	WR	t_{WR}/t_{CK}	—	t_{CK}	20)
Internal Write to Read command delay	t_{WTR}	7.5	—	ns	21)
Exit power down to any valid command (other than NOP or Deselect)	t_{XARD}	2	—	t_{CK}	22)
Exit active power-down mode to Read command (slow exit, lower power)	t_{XARDS}	6 – AL	—	t_{CK}	22)
Exit precharge power-down to any valid command (other than NOP or Deselect)	t_{XP}	2	—	t_{CK}	
Exit Self-Refresh to non-Read command	t_{XSNR}	$t_{RFC} + 10$	—	ns	
Exit Self-Refresh to Read command	$t_{XS RD}$	200	—	t_{CK}	

1) For details and notes see the relevant Qimonda component data sheet

2) $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$. See notes ⁵⁾⁶⁾⁷⁾⁸⁾

3) Timing that is not specified is illegal and after such an event, in order to guarantee proper operation, the DRAM must be powered down and then restarted through the specified initialization sequence before normal operation can continue.

4) Timings are guaranteed with CK/CK differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode.

5) The CK / CK input reference level (for timing reference to CK / CK) is the point at which CK and CK cross. The DQS / DQS, RDQS / RDQS, input reference level is the crosspoint when in differential strobe mode.

6) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.

7) The output timing reference voltage level is V_{TT} .

8) For each of the terms, if not already an integer, round to the next highest integer. t_{CK} refers to the application clock period. WR refers to the WR parameter stored in the MR.

9) The clock frequency is allowed to change during self-refresh mode or precharge power-down mode.

10) For timing definition, refer to the Component data sheet.

11) Consists of data pin skew and output pattern effects, and p-channel to n-channel variation of the output drivers as well as output Slew Rate mis-match between DQS / DQS and associated DQ in any given cycle.

12) MIN (t_{CL} , t_{CH}) refers to the smaller of the actual clock low time and the actual clock high time as provided to the device (i.e. this value can be greater than the minimum specification limits for t_{CL} and t_{CH}).


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- 13) The t_{HZ} , t_{RPST} and t_{LZ} , t_{RPRE} parameters are referenced to a specific voltage level, which specify when the device output is no longer driving (t_{HZ} , t_{RPST}), or begins driving (t_{LZ} , t_{RPRE}). t_{HZ} and t_{LZ} transitions occur in the same access time windows as valid data transitions. These parameters are verified by design and characterization, but not subject to production test.
- 14) The Auto-Refresh command interval has been reduced to 3.9 μ s when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 15) 0 °C $\leq T_{CASE} \leq$ 85 °C
- 16) 85 °C $< T_{CASE} \leq$ 95 °C
- 17) A maximum of eight Auto-Refresh commands can be posted to any given DDR2 SDRAM device.
- 18) The t_{RRD} timing parameter depends on the page size of the DRAM organization. See **Table 2 “Ordering Information for RoHS Compliant Products” on Page 4**.
- 19) The maximum limit for the t_{WPST} parameter is not a device limit. The device operates with a greater value for this parameter, but system performance (bus turnaround) degrades accordingly.
- 20) WR must be programmed to fulfill the minimum requirement for the t_{WR} timing parameter, where $WR_{MIN}[\text{cycles}] = t_{WR}(\text{ns})/t_{CK}(\text{ns})$ rounded up to the next integer value. $t_{DAL} = WR + (t_{RP}/t_{CK})$. For each of the terms, if not already an integer, round to the next highest integer. t_{CK} refers to the application clock period. WR refers to the WR parameter stored in the MRS.
- 21) Minimum t_{WTR} is two clocks when operating the DDR2-SDRAM at frequencies $\leq$ 200 MHz.
- 22) User can choose two different active power-down modes for additional power saving via MRS address bit A12. In “standard active power-down mode” (MR, A12 = “0”) a fast power-down exit timing t_{XARD} can be used. In “low active power-down mode” (MR, A12 = “1”) a slow power-down exit timing t_{XARDS} has to be satisfied.

TABLE 19
DRAM Component Timing Parameter by Speed Grade - DDR2-400

Parameter	Symbol	DDR2-400		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
DQ output access time from CK / $\overline{\text{CK}}$	t_{AC}	-600	+600	ps	
CAS A to $\overline{\text{CAS}}$ B command period	t_{CCD}	2	—	t_{CK}	
CK, $\overline{\text{CK}}$ high-level width	t_{CH}	0.45	0.55	t_{CK}	
CKE minimum high and low pulse width	t_{CKE}	3	—	t_{CK}	
CK, $\overline{\text{CK}}$ low-level width	t_{CL}	0.45	0.55	t_{CK}	
Auto-Precharge write recovery + precharge time	t_{DAL}	$WR + t_{RP}$	—	t_{CK}	8)22)
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	$t_{IS} + t_{CK} + t_{IH}$	—	ns	9)
DQ and DM input hold time (differential data strobe)	$t_{DH}(\text{base})$	275	—	ps	10)
DQ and DM input hold time (single ended data strobe)	$t_{DH1}(\text{base})$	-25	—	ps	11)
DQ and DM input pulse width (each input)	t_{DIPW}	0.35	—	t_{CK}	
DQS output access time from CK / $\overline{\text{CK}}$	t_{DQSCK}	-500	+500	ps	
DQS input low (high) pulse width (write cycle)	$t_{DQSL,H}$	0.35	—	t_{CK}	
DQS-DQ skew (for DQS & associated DQ signals)	t_{DQSQ}	—	350	ps	11)
Write command to 1st DQS latching transition	t_{DQSS}	- 0.25	+ 0.25	t_{CK}	
DQ and DM input setup time (differential data strobe)	$t_{DS}(\text{base})$	150	—	ps	11)
DQ and DM input setup time (single ended data strobe)	$t_{DS1}(\text{base})$	-25	—	ps	11)


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Parameter	Symbol	DDR2-400		Unit	Note ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
DQS falling edge hold time from CK (write cycle)	t_{DSH}	0.2	—	t_{CK}	
DQS falling edge to CK setup time (write cycle)	t_{DSS}	0.2	—	t_{CK}	
Clock half period	t_{HP}	MIN. (t_{CL} , t_{CH})			12)
Data-out high-impedance time from CK / $\overline{CK}$	t_{HZ}	—	$t_{AC.MAX}$	ps	13)
Address and control input hold time	$t_{IH}(base)$	475	—	ps	11)
Address and control input pulse width (each input)	t_{IPW}	0.6	—	t_{CK}	
Address and control input setup time	$t_{IS}(base)$	350	—	ps	11)
DQ low-impedance time from CK / $\overline{CK}$	$t_{LZ}(DQ)$	$2 \times t_{AC.MIN}$	$t_{AC.MAX}$	ps	14)
DQS low-impedance from CK / $\overline{CK}$	$t_{LZ}(DQS)$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	14)
Mode register set command cycle time	t_{MRD}	2	—	t_{CK}	
OCD drive mode output delay	t_{OIT}	0	12	ns	
Data output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—	—	
Data hold skew factor	t_{QHS}	—	450	ps	
Average periodic refresh Interval	t_{REFI}	—	7.8	μs	14)15)
		—	3.9	μs	16)18)
Auto-Refresh to Active/Auto-Refresh command period		105	—	ns	17)
Precharge-All (4 banks) command period	t_{RP}	$t_{RP} + 1t_{CK}$	—	ns	
Precharge-All (8 banks) command period	t_{RP}	$15 + 1t_{CK}$	—	ns	
Read preamble	t_{RPRE}	0.9	1.1	t_{CK}	14)
Read postamble	t_{RPST}	0.40	0.60	t_{CK}	14)
Active bank A to Active bank B command period	t_{RRD}	7.5	—	ns	14)18)
		10	—	ns	16)20)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	
Write preamble	t_{WPRE}	$0.25 \times t_{CK}$	—	t_{CK}	
Write postamble	t_{WPST}	0.40	0.60	t_{CK}	19)
Write recovery time for write without Auto-Precharge	t_{WR}	15	—	ns	
Write recovery time for write with Auto-Precharge	WR	t_{WR}/t_{CK}	—	t_{CK}	20)
Internal Write to Read command delay	t_{WTR}	10	—	ns	21)
Exit power down to any valid command (other than NOP or Deselect)	t_{XARD}	2	—	t_{CK}	22)
Exit active power-down mode to Read command (slow exit, lower power)	t_{XARDS}	6 – AL	—	t_{CK}	22)
Exit precharge power-down to any valid command (other than NOP or Deselect)	t_{XP}	2	—	t_{CK}	
Exit Self-Refresh to non-Read command	t_{XSNR}	$t_{RFC} + 10$	—	ns	
Exit Self-Refresh to Read command	t_{XSRD}	200	—	t_{CK}	


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- 1) For details and notes see the relevant Qimonda component data sheet
- 2) $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$. See notes ⁵⁾⁶⁾⁷⁾⁸⁾
- 3) Timing that is not specified is illegal and after such an event, in order to guarantee proper operation, the DRAM must be powered down and then restarted through the specified initialization sequence before normal operation can continue.
- 4) Timings are guaranteed with $\overline{\text{CK}}/\overline{\text{CK}}$ differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode.
- 5) The $\overline{\text{CK}} / \overline{\text{CK}}$ input reference level (for timing reference to $\overline{\text{CK}} / \overline{\text{CK}}$) is the point at which $\overline{\text{CK}}$ and $\overline{\text{CK}}$ cross. The $\overline{\text{DQS}} / \overline{\text{DQS}}$, $\overline{\text{RDQS}} / \overline{\text{RDQS}}$, input reference level is the crosspoint when in differential strobe mode.
- 6) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $\text{CKE} = 0.2 \times V_{DDQ}$ is recognized as low.
- 7) The output timing reference voltage level is V_{TT} .
- 8) For each of the terms, if not already an integer, round to the next highest integer. t_{CK} refers to the application clock period. WR refers to the WR parameter stored in the MR.
- 9) The clock frequency is allowed to change during self-refresh mode or precharge power-down mode.
- 10) For timing definition, refer to the Component data sheet.
- 11) Consists of data pin skew and output pattern effects, and p-channel to n-channel variation of the output drivers as well as output Slew Rate mis-match between $\overline{\text{DQS}} / \overline{\text{DQS}}$ and associated $\overline{\text{DQ}}$ in any given cycle.
- 12) MIN (t_{CL} , t_{CH}) refers to the smaller of the actual clock low time and the actual clock high time as provided to the device (i.e. this value can be greater than the minimum specification limits for t_{CL} and t_{CH}).
- 13) The t_{HZ} , t_{RPST} and t_{LZ} , t_{RPRE} parameters are referenced to a specific voltage level, which specify when the device output is no longer driving (t_{HZ} , t_{RPST}), or begins driving (t_{LZ} , t_{RPRE}). t_{HZ} and t_{LZ} transitions occur in the same access time windows as valid data transitions. These parameters are verified by design and characterization, but not subject to production test.
- 14) The Auto-Refresh command interval has be reduced to 3.9 μs when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 15) $0^\circ\text{C} \leq T_{\text{CASE}} \leq 85^\circ\text{C}$
- 16) $85^\circ\text{C} < T_{\text{CASE}} \leq 95^\circ\text{C}$
- 17) A maximum of eight Auto-Refresh commands can be posted to any given DDR2 SDRAM device.
- 18) The t_{RRD} timing parameter depends on the page size of the DRAM organization. See **Table 2 “Ordering Information for RoHS Compliant Products” on Page 4**.
- 19) The maximum limit for the t_{WPST} parameter is not a device limit. The device operates with a greater value for this parameter, but system performance (bus turnaround) degrades accordingly.
- 20) WR must be programmed to fulfill the minimum requirement for the t_{WR} timing parameter, where $WR_{\text{MIN}}[\text{cycles}] = t_{\text{WR}}(\text{ns})/t_{\text{CK}}(\text{ns})$ rounded up to the next integer value. $t_{\text{DAL}} = \text{WR} + (t_{\text{RP}}/t_{\text{CK}})$. For each of the terms, if not already an integer, round to the next highest integer. t_{CK} refers to the application clock period. WR refers to the WR parameter stored in the MRS.
- 21) Minimum t_{WTR} is two clocks when operating the DDR2-SDRAM at frequencies $\leq 200 \text{ MHz}$.
- 22) User can choose two different active power-down modes for additional power saving via MRS address bit A12. In “standard active power-down mode” (MR, A12 = “0”) a fast power-down exit timing t_{XARD} can be used. In “low active power-down mode” (MR, A12 = “1”) a slow power-down exit timing t_{XARDS} has to be satisfied.

3.3.3 ODT AC Electrical Characteristics

ODT AC Character. and Operating Conditions: DDR2–667 &DDR2–800 [Table 20] and DDR2–533C & DDR2–400B [Table 21]

TABLE 20
ODT AC Character. and Operating Conditions for DDR2-667 & DDR2-800

Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOND}	ODT turn-on delay	2	2	nCK	1)
t_{AON}	ODT turn-on	$t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}} + 0.7 \text{ ns}$	ns	1)2)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{\text{AC.MIN}} + 2 \text{ ns}$	$2 t_{\text{CK}} + t_{\text{AC.MAX}} + 1 \text{ ns}$	ns	1)
t_{AOFD}	ODT turn-off delay	2.5	2.5	nCK	1)
t_{AOF}	ODT turn-off	$t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}} + 0.6 \text{ ns}$	ns	1)3)


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Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{\text{AC.MIN}} + 2 \text{ ns}$	$2.5 t_{\text{CK}} + t_{\text{AC.MAX}} + 1 \text{ ns}$	ns	1)
t_{ANPD}	ODT to Power Down Mode Entry Latency	3	—	nCK	1)
t_{AXPD}	ODT Power Down Exit Latency	8	—	nCK	1)

- 1) New units, ' $t_{\text{CK.AVG}}$ ' and 'nCK', are introduced in DDR2-667 and DDR2-800. Unit ' $t_{\text{CK.AVG}}$ ' represents the actual $t_{\text{CK.AVG}}$ of the input clock under operation. Unit 'nCK' represents one clock cycle of the input clock, counting the actual clock edges. Note that in DDR2-400 and DDR2-533, ' t_{CK} ' is used for both concepts. Example: $t_{\text{XP}} = 2 [\text{nCK}]$ means; if Power Down exit is registered at T_m , an Active command may be registered at $T_m + 2$, even if $(T_m + 2 - T_m)$ is $2 \times t_{\text{CK.AVG}} + t_{\text{EPR.2PER(MIN)}}$.
- 2) ODT turn on time min is when the device leaves high impedance and ODT resistance begins to turn on. ODT turn on time max is when the ODT resistance is fully on. Both are measured from t_{AOND} , which is interpreted differently per speed bin. For DDR2-667/800, t_{AOND} is 2 clock cycles after the clock edge that registered a first ODT HIGH counting the actual input clock edges.
- 3) ODT turn off time min. is when the device starts to turn off ODT resistance. ODT turn off time max is when the bus is in high impedance. Both are measured from t_{AOFD} . Both are measured from t_{AOFD} , which is interpreted differently per speed bin. For DDR2-667/800, if $t_{\text{CK.AVG}} = 3 \text{ ns}$ is assumed, $t_{\text{AOFD}} = 1.5 \text{ ns}$ ($0.5 \times 3 \text{ ns}$) after the second trailing clock edge counting from the clock edge that registered a first ODT LOW and by counting the actual input clock edge.

TABLE 21

ODT AC Character. and Operating Conditions for DDR2-533 & DDR2-400

Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOND}	ODT turn-on delay	2	2	t_{CK}	
t_{AON}	ODT turn-on	$t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}} + 1 \text{ ns}$	ns	1)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{\text{AC.MIN}} + 2 \text{ ns}$	$2 t_{\text{CK}} + t_{\text{AC.MAX}} + 1 \text{ ns}$	ns	
t_{AOFD}	ODT turn-off delay	2.5	2.5	t_{CK}	
t_{AOF}	ODT turn-off	$t_{\text{AC.MIN}}$	$t_{\text{AC.MAX}} + 0.6 \text{ ns}$	ns	2)
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{\text{AC.MIN}} + 2 \text{ ns}$	$2.5 t_{\text{CK}} + t_{\text{AC.MAX}} + 1 \text{ ns}$	ns	
t_{ANPD}	ODT to Power Down Mode Entry Latency	3	—	t_{CK}	
t_{AXPD}	ODT Power Down Exit Latency	8	—	t_{CK}	

- 1) ODT turn on time min is when the device leaves high impedance and ODT resistance begins to turn on. ODT turn on time max is when the ODT resistance is fully on. Both are measured from t_{AOND} , which is interpreted differently per speed bin. For DDR2-400/533, t_{AOND} is 10 ns ($= 2 \times 5 \text{ ns}$) after the clock edge that registered a first ODT HIGH if $t_{\text{CK}} = 5 \text{ ns}$.
- 2) ODT turn off time min. is when the device starts to turn off ODT resistance. ODT turn off time max is when the bus is in high impedance. Both are measured from t_{AOFD} . Both are measured from t_{AOFD} , which is interpreted differently per speed bin. For DDR2-400/533, t_{AOFD} is 12.5 ns ($= 2.5 \times 5 \text{ ns}$) after the clock edge that registered a first ODT HIGH if $t_{\text{CK}} = 5 \text{ ns}$.



3.4 I_{DD} Specifications and Conditions

List of tables defining I_{DD} Specifications and Conditions.

- **Table 22 “IDD Measurement Conditions” on Page 32**
- **Table 24 “IDD Specification for HYS64T[32/64/128]xxxHDL-[25F/2.5]-B” on Page 34**
- **Table 25 “IDD Specification for HYS64T[32/64/128]xxxHDL-[3/3S]-B” on Page 35**
- **Table 26 “IDD Specification for HYS64T[32/64/128]xxxHDL-[3.7/5]-B” on Page 36**

TABLE 22
 I_{DD} Measurement Conditions

Parameter	Symbol	Note 1)2)3)4)5)
Operating Current 0 One bank Active - Precharge; $t_{CK} = t_{CK.MIN}$, $t_{RC} = t_{RC.MIN}$, $t_{RAS} = t_{RAS.MIN}$, CKE is HIGH, $\overline{CS}$ is HIGH between valid commands. Address and control inputs are SWITCHING, Databus inputs are SWITCHING.	I_{DD0}	
Operating Current 1 One bank Active - Read - Precharge; $I_{OUT} = 0$ mA, $BL = 4$, $t_{CK} = t_{CK.MIN}$, $t_{RC} = t_{RC.MIN}$, $t_{RAS} = t_{RAS.MIN}$, $t_{RCD} = t_{RCD.MIN}$, $AL = 0$, $CL = CL_{MIN}$, CKE is HIGH, $\overline{CS}$ is HIGH between valid commands. Address and control inputs are SWITCHING, Databus inputs are SWITCHING.	I_{DD1}	6)
Precharge Standby Current All banks idle; $\overline{CS}$ is HIGH; CKE is HIGH; $t_{CK} = t_{CK.MIN}$; Other control and address inputs are SWITCHING, Databus inputs are SWITCHING.	I_{DD2N}	
Precharge Power-Down Current Other control and address inputs are STABLE, Data bus inputs are FLOATING.	I_{DD2P}	
Precharge Quiet Standby Current All banks idle; $\overline{CS}$ is HIGH; CKE is HIGH; $t_{CK} = t_{CK.MIN}$; Other control and address inputs are STABLE, Data bus inputs are FLOATING.	I_{DD2Q}	
Active Standby Current Burst Read: All banks open; Continuous burst reads; $BL = 4$; $AL = 0$, $CL = CL_{MIN}$; $t_{CK} = t_{CK.MIN}$; $t_{RAS} = t_{RAS.MAX}$, $t_{RP} = t_{RP.MIN}$; CKE is HIGH, $\overline{CS}$ is HIGH between valid commands. Address inputs are SWITCHING; Data Bus inputs are SWITCHING; $I_{OUT} = 0$ mA.	I_{DD3N}	
Active Power-Down Current All banks open; $t_{CK} = t_{CK.MIN}$, CKE is LOW; Other control and address inputs are STABLE, Data bus inputs are FLOATING. MRS A12 bit is set to LOW (Fast Power-down Exit);	$I_{DD3P(0)}$	
Active Power-Down Current All banks open; $t_{CK} = t_{CK.MIN}$, CKE is LOW; Other control and address inputs are STABLE, Data bus inputs are FLOATING. MRS A12 bit is set to HIGH (Slow Power-down Exit);	$I_{DD3P(1)}$	
Operating Current - Burst Read All banks open; Continuous burst reads; $BL = 4$; $AL = 0$, $CL = CL_{MIN}$; $t_{CK} = t_{CK.MIN}$, $t_{RAS} = t_{RAS.MAX}$, $t_{RP} = t_{RP.MIN}$; CKE is HIGH, $\overline{CS}$ is HIGH between valid commands; Address inputs are SWITCHING; Data bus inputs are SWITCHING; $I_{OUT} = 0$ mA.	I_{DD4R}	6)
Operating Current - Burst Write All banks open; Continuous burst writes; $BL = 4$; $AL = 0$, $CL = CL_{MIN}$; $t_{CK} = t_{CK.MIN}$; $t_{RAS} = t_{RAS.MAX}$, $t_{RP} = t_{RP.MAX}$; CKE is HIGH, $\overline{CS}$ is HIGH between valid commands. Address inputs are SWITCHING; Data Bus inputs are SWITCHING;	I_{DD4W}	
Burst Refresh Current $t_{CK} = t_{CK.MIN}$, Refresh command every $t_{RFC} = t_{RFC.MIN}$ interval, CKE is HIGH, $\overline{CS}$ is HIGH between valid commands, Other control and address inputs are SWITCHING, Data bus inputs are SWITCHING.	I_{DD5B}	


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Parameter	Symbol	Note 1)2)3)4)5)
Distributed Refresh Current $t_{CK} = t_{CK,MIN.}$; Refresh command every $t_{RFC} = t_{REFI}$ interval, CKE is LOW and $\overline{CS}$ is HIGH between valid commands, Other control and address inputs are SWITCHING, Data bus inputs are SWITCHING.	I_{DD5D}	
Self-Refresh Current CKE ≤ 0.2 V; external clock off, CK and $\overline{CK}$ at 0 V; Other control and address inputs are FLOATING, Data bus inputs are FLOATING. I_{DD6} current values are guaranteed up to T_{CASE} of 85 °C max.	I_{DD6}	
All Bank Interleave Read Current All banks are being interleaved at minimum t_{RC} without violating t_{RRD} using a burst length of 4. Control and address bus inputs are STABLE during DESELECTS. $I_{out} = 0$ mA.	I_{DD7}	6)

1) $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$

2) I_{DD} specifications are tested after the device is properly initialized and I_{DD} parameter are specified with ODT disabled.

3) Definitions for I_{DD} see **Table 23**

4) For two rank modules: for all active current measurements the other rank is in Precharge Power-Down Mode I_{DD2P}

5) For details and notes see the relevant Qimonda component data sheet

6) I_{DD1} , I_{DD4R} and I_{DD7} current measurements are defined with the outputs disabled ($I_{OUT} = 0$ mA). To achieve this on module level the output buffers can be disabled using an EMRS(1) (Extended Mode Register Command) by setting A12 bit to HIGH.

TABLE 23
Definitions for I_{DD}

Parameter	Description
LOW	$V_{IN} \leq V_{IL(ac),MAX}$, HIGH is defined as $V_{IN} \geq V_{IH(ac),MIN}$
STABLE	Inputs are stable at a HIGH or LOW level
FLOATING	Inputs are $V_{REF} = V_{DDQ} / 2$
SWITCHING	Inputs are changing between HIGH and LOW every other clock (once per 2 cycles) for address and control signals, and inputs changing between HIGH and LOW every other data transfer (once per cycle) for DQ signals not including mask or strobes


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TABLE 24
 I_{DD} Specification for HYS64T[32/64/128]xxxHDL-[25F/2.5]-B

Product Type	HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B	HYS64T32000HDL-2.5-B	HYS64T64020HDL-2.5-B	HYS64T128021HDL-2.5-B	Unit	Note ¹⁾
Organization	256 MB	512 MB	1 GB	256 MB	512 MB	1 GB		
	1 Rank	2 Ranks	2 Ranks	1 Rank	2 Ranks	2 Ranks		
	×64	×64	×64	×64	×64	×64		
	-25F	-25F	-25F	-2.5	-2.5	-2.5		
Symbol	Max.	Max.	Max.	Max.	Max.	Max.		
I_{DD0}	420	448	728	400	428	696	mA	2)
I_{DD1}	480	508	856	460	488	820	mA	2)
I_{DD2P}	30	60	112	28	56	110	mA	3)
I_{DD2N}	205	410	820	200	408	820	mA	3)
I_{DD2Q}	180	360	720	180	360	720	mA	3)
I_{DD3P} (MRS = 0)	160	312	624	156	310	620	mA	3)
I_{DD3P} (MRS = 1)	40	72	144	40	70	140	mA	4)3)
I_{DD3N}	240	480	960	240	480	960	mA	5)3)
I_{DD4R}	720	750	1300	720	748	1300	mA	2)
I_{DD4W}	800	830	1300	800	828	1300	mA	2)
I_{DD5B}	580	610	1220	580	608	1220	mA	2)
I_{DD5D}	40	72	144	40	70	140	mA	3)6)
I_{DD6}	24	40	80	24	40	80	mA	3)6)
I_{DD7}	1060	1088	1416	1020	1048	1340	mA	2)

1) Calculated values from component data. ODT disabled. I_{DD1} , I_{DD4R} , and I_{DD7} , are defined with the outputs disabled.

2) The other rank is in I_{DD2P} Precharge Power-Down Current mode

3) Both ranks are in the same I_{DD} current mode

4) Fast: MRS(12)=0

5) Slow: MRS(12)=1

6) I_{DD5D} and I_{DD6} values are for $0^{\circ}\text{C} \leq T_{\text{Case}} \leq 85^{\circ}\text{C}$


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TABLE 25
 I_{DD} Specification for HYS64T[32/64/128]xxxHDL-[3/3S]-B

Product Type	HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B	HYS64T32000HDL-3S-B HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B HYS64T128921HDL-3S-B	Unit	Note ¹⁾
Organization	256 MB	512 MB	1 GB	256 MB	512 MB	1 GB		
	1 Rank	2 Ranks	2 Ranks	1 Rank	2 Ranks	2 Ranks		
	×64	×64	×64	×64	×64	×64		
	-3	-3	-3	-3S	-3S	-3S		
Symbol	Max.	Max.	Max.	Max.	Max.	Max.		
I_{DD0}	380	410	660	360	390	620	mA	2)
I_{DD1}	420	450	780	400	430	740	mA	2)
I_{DD2P}	30	60	110	30	60	110	mA	3)
I_{DD2N}	180	360	720	180	360	720	mA	3)
I_{DD2Q}	160	320	640	160	320	640	mA	3)
I_{DD3P} (MRS = 0)	130	260	530	130	260	530	mA	3)
I_{DD3P} (MRS = 1)	40	70	140	40	70	140	mA	4)3)
I_{DD3N}	200	400	800	200	400	800	mA	5)3)
I_{DD4R}	620	650	1100	620	650	1100	mA	2)
I_{DD4W}	680	710	1100	680	710	1100	mA	2)
I_{DD5B}	560	590	1180	560	590	1180	mA	2)
I_{DD5D}	40	70	140	40	70	140	mA	3)6)
I_{DD6}	20	40	80	20	40	80	mA	3)6)
I_{DD7}	1010	1040	1340	960	990	1270	mA	2)

1) Calculated values from component data. ODT disabled. I_{DD1} , I_{DD4R} , and I_{DD7} , are defined with the outputs disabled.

2) The other rank is in I_{DD2P} Precharge Power-Down Current mode

3) Both ranks are in the same I_{DD} current mode

4) Fast: MRS(12)=0

5) Slow: MRS(12)=1

6) I_{DD5D} and I_{DD6} values are for $0^{\circ}\text{C} \leq T_{\text{Case}} \leq 85^{\circ}\text{C}$


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TABLE 26
 I_{DD} Specification for HYS64T[32/64/128]xxxHDL-[3.7/5]-B

Product Type	HYS64T32000HDL-3.7-B HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B HYS64T128921HDL-3.7-B	HYS64T32000HDL-5-B	HYS64T64020HDL-5-B	HYS64T128021HDL-5-B	Unit	Note ¹⁾
Organization	256 MB 1 Rank ×64 -3.7	512 MB 2 Ranks ×64 -3.7	1 GB 2 Ranks ×64 -3.7	256 MB 1 Rank ×64 -5	512 MB 2 Ranks ×64 -5	1 GB 2 Ranks ×64 -5		
Symbol	Max.	Max.	Max.	Max.	Max.	Max.		
I_{DD0}	320	350	580	300	330	540	mA	2)
I_{DD1}	360	390	660	330	360	620	mA	2)
I_{DD2P}	30	60	110	30	60	110	mA	3)
I_{DD2N}	150	300	610	140	270	540	mA	3)
I_{DD2Q}	140	280	560	130	260	510	mA	3)
I_{DD3P} (MRS = 0)	110	220	450	100	190	380	mA	3)
I_{DD3P} (MRS = 1)	40	70	140	40	70	140	mA	4)3)
I_{DD3N}	170	340	690	160	310	620	mA	5)3)
I_{DD4R}	520	550	940	460	490	820	mA	2)
I_{DD4W}	580	610	940	520	550	820	mA	2)
I_{DD5B}	520	550	1100	500	530	1060	mA	2)
I_{DD5D}	40	70	140	40	70	140	mA	3)6)
I_{DD6}	20	40	80	20	40	80	mA	3)6)
I_{DD7}	920	950	1220	880	910	1180	mA	2)

1) Calculated values from component data. ODT disabled. I_{DD1} , I_{DD4R} , and I_{DD7} are defined with the outputs disabled.

2) The other rank is in I_{DD2P} Precharge Power-Down Current mode

3) Both ranks are in the same I_{DD} current mode

4) Fast: MRS(12)=0

5) Slow: MRS(12)=1

6) I_{DD5D} and I_{DD6} values are for $0^{\circ}\text{C} \leq T_{\text{Case}} \leq 85^{\circ}\text{C}$



4 SPD Codes

This chapter lists all hexadecimal byte values stored in the EEPROM of the products described in this data sheet. SPD stands for serial presence detect. All values with XX in the table are module specific bytes which are defined during production.

List of SPD Code Tables

- Table 27 “SPD codes for PC2-6400 5-5-5” on Page 37
- Table 28 “SPD codes for PC2-6400 6-6-6” on Page 42
- Table 29 “SPD codes for PC2-5300 4-4-4” on Page 46
- Table 30 “SPD codes for PC2-5300 5-5-5” on Page 50
- Table 31 “SPD codes for PC2-4200 4-4-4” on Page 55
- Table 32 “SPD codes for PC2-5300 4-4-4” on Page 60

TABLE 27

SPD codes for PC2-6400 5-5-5

Product Type		HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-555	PC2-6400S-555	PC2-6400S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80
1	Total number of Bytes in EEPROM	08	08	08
2	Memory Type (DDR2)	08	08	08
3	Number of Row Addresses	0D	0D	0E
4	Number of Column Addresses	0A	0A	0A
5	DIMM Rank and Stacking Information	60	61	61
6	Data Width	40	40	40
7	Not used	00	00	00
8	Interface Voltage Level	05	05	05
9	t_{CK} @ CL_{MAX} (Byte 18) [ns]	25	25	25
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	40	40	40


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-555	PC2-6400S-555	PC2-6400S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
11	Error Correction Support (non-ECC, ECC)	00	00	00
12	Refresh Rate and Type	82	82	82
13	Primary SDRAM Width	10	10	08
14	Error Checking SDRAM Width	00	00	00
15	Not used	00	00	00
16	Burst Length Supported	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04
18	Supported CAS Latencies	70	70	70
19	DIMM Mechanical Characteristics	01	01	01
20	DIMM Type Information	04	04	04
21	DIMM Attributes	00	00	00
22	Component Attributes	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	25	25	25
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	40	40	40
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	3D	3D	3D
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	50	50	50
27	$t_{RP.MIN}$ [ns]	32	32	32
28	$t_{RRD.MIN}$ [ns]	28	28	1E
29	$t_{RCD.MIN}$ [ns]	32	32	32
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D
31	Module Density per Rank	40	40	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	17	17	17
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	25	25	25
34	$t_{DS.MIN}$ [ns]	05	05	05
35	$t_{DH.MIN}$ [ns]	12	12	12
36	$t_{WR.MIN}$ [ns]	3C	3C	3C


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-555	PC2-6400S-555	PC2-6400S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E
39	Analysis Characteristics	00	00	00
40	t_{RC} and t_{RFC} Extension	30	30	30
41	$t_{RC.MIN}$ [ns]	39	39	39
42	$t_{RFC.MIN}$ [ns]	69	69	69
43	$t_{CK.MAX}$ [ns]	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	14	14	14
45	$t_{QHS.MAX}$ [ns]	1E	1E	1E
46	PLL Relock Time	00	00	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	56	56	50
48	Psi(T-A) DRAM	7A	7A	7A
49	ΔT_0 (DT0)	7F	7F	5F
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	3B	3B	3B
51	ΔT_{2P} (DT2P)	36	36	36
52	ΔT_{3N} (DT3N)	2E	2E	2E
53	$\Delta T_{3P.fast}$ (DT3P fast)	5A	5A	5A
54	$\Delta T_{3P.slow}$ (DT3P slow)	2A	2A	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	68	68	5A
56	ΔT_{5B} (DT5B)	22	22	22
57	ΔT_7 (DT7)	3D	3D	27
58	Psi(ca) PLL	00	00	00
59	Psi(ca) REG	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00
62	SPD Revision	12	12	12


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-555	PC2-6400S-555	PC2-6400S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
63	Checksum of Bytes 0-62	54	55	3A
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00
72	Module Manufacturer Location	xx	xx	xx
73	Product Type, Char 1	36	36	36
74	Product Type, Char 2	34	34	34
75	Product Type, Char 3	54	54	54
76	Product Type, Char 4	33	36	31
77	Product Type, Char 5	32	34	32
78	Product Type, Char 6	30	30	38
79	Product Type, Char 7	30	32	30
80	Product Type, Char 8	30	30	32
81	Product Type, Char 9	48	48	31
82	Product Type, Char 10	44	44	48
83	Product Type, Char 11	4C	4C	44
84	Product Type, Char 12	32	32	4C
85	Product Type, Char 13	35	35	32
86	Product Type, Char 14	46	46	35
87	Product Type, Char 15	42	42	46
88	Product Type, Char 16	20	20	42


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-25F-B	HYS64T64020HDL-25F-B	HYS64T128021HDL-25F-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-555	PC2-6400S-555	PC2-6400S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
89	Product Type, Char 17	20	20	20
90	Product Type, Char 18	20	20	20
91	Module Revision Code	3x	3x	3x
92	Test Program Revision Code	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx
99 - 127	Not used	00	00	00
128 - 255	Blank for customer use	FF	FF	FF



HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

TABLE 28

SPD codes for PC2-6400 6-6-6

Product Type		HYS64T32000HDL-2.5-B	HYS64T64020HDL-2.5-B	HYS64T128021HDL-2.5-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-666	PC2-6400S-666	PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80
1	Total number of Bytes in EEPROM	08	08	08
2	Memory Type (DDR2)	08	08	08
3	Number of Row Addresses	0D	0D	0E
4	Number of Column Addresses	0A	0A	0A
5	DIMM Rank and Stacking Information	60	61	61
6	Data Width	40	40	40
7	Not used	00	00	00
8	Interface Voltage Level	05	05	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	25	25	25
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	40	40	40
11	Error Correction Support (non-ECC, ECC)	00	00	00
12	Refresh Rate and Type	82	82	82
13	Primary SDRAM Width	10	10	08
14	Error Checking SDRAM Width	00	00	00
15	Not used	00	00	00
16	Burst Length Supported	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04
18	Supported CAS Latencies	70	70	70
19	DIMM Mechanical Characteristics	01	01	01
20	DIMM Type Information	04	04	04
21	DIMM Attributes	00	00	00
22	Component Attributes	07	07	07


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-2.5-B	HYS64T64020HDL-2.5-B	HYS64T128021HDL-2.5-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-666	PC2-6400S-666	PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30	30	30
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	45	45	45
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	3D	3D	3D
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	50	50	50
27	$t_{RP.MIN}$ [ns]	3C	3C	3C
28	$t_{RRD.MIN}$ [ns]	28	28	1E
29	$t_{RCD.MIN}$ [ns]	3C	3C	3C
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D
31	Module Density per Rank	40	40	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	17	17	17
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	25	25	25
34	$t_{DS.MIN}$ [ns]	05	05	05
35	$t_{DH.MIN}$ [ns]	12	12	12
36	$t_{WR.MIN}$ [ns]	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E
39	Analysis Characteristics	00	00	00
40	t_{RC} and t_{RFC} Extension	00	00	00
41	$t_{RC.MIN}$ [ns]	3C	3C	3C
42	$t_{RFC.MIN}$ [ns]	69	69	69
43	$t_{CK.MAX}$ [ns]	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	14	14	14
45	$t_{QHS.MAX}$ [ns]	1E	1E	1E
46	PLL Relock Time	00	00	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	55	55	50
48	Psi(T-A) DRAM	72	72	7A


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-2.5-B	HYS64T64020HDL-2.5-B	HYS64T128021HDL-2.5-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-666	PC2-6400S-666	PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
49	ΔT_0 (DT0)	6F	6F	5B
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	37	37	3B
51	ΔT_{2P} (DT2P)	33	33	36
52	ΔT_{3N} (DT3N)	2B	2B	2E
53	$\Delta T_{3P.fast}$ (DT3P fast)	54	54	5A
54	$\Delta T_{3P.slow}$ (DT3P slow)	27	27	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	62	62	5A
56	ΔT_{5B} (DT5B)	1F	1F	22
57	ΔT_7 (DT7)	37	37	25
58	Psi(ca) PLL	00	00	00
59	Psi(ca) REG	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00
62	SPD Revision	12	12	12
63	Checksum of Bytes 0-62	10	11	2B
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00
72	Module Manufacturer Location	xx	xx	xx
73	Product Type, Char 1	36	36	36
74	Product Type, Char 2	34	34	34


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-2.5-B	HYS64T64020HDL-2.5-B	HYS64T128021HDL-2.5-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-6400S-666	PC2-6400S-666	PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
75	Product Type, Char 3	54	54	54
76	Product Type, Char 4	33	36	31
77	Product Type, Char 5	32	34	32
78	Product Type, Char 6	30	30	38
79	Product Type, Char 7	30	32	30
80	Product Type, Char 8	30	30	32
81	Product Type, Char 9	48	48	31
82	Product Type, Char 10	44	44	48
83	Product Type, Char 11	4C	4C	44
84	Product Type, Char 12	32	32	4C
85	Product Type, Char 13	2E	2E	32
86	Product Type, Char 14	35	35	2E
87	Product Type, Char 15	42	42	35
88	Product Type, Char 16	20	20	42
89	Product Type, Char 17	20	20	20
90	Product Type, Char 18	20	20	20
91	Module Revision Code	4x	4x	4x
92	Test Program Revision Code	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx
99 - 127	Not used	00	00	00
128 - 255	Blank for customer use	FF	FF	FF


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

TABLE 29
SPD codes for PC2-5300 4-4-4

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80
1	Total number of Bytes in EEPROM	08	08	08
2	Memory Type (DDR2)	08	08	08
3	Number of Row Addresses	0D	0D	0E
4	Number of Column Addresses	0A	0A	0A
5	DIMM Rank and Stacking Information	60	61	61
6	Data Width	40	40	40
7	Not used	00	00	00
8	Interface Voltage Level	05	05	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	30	30	30
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	45	45	45
11	Error Correction Support (non-ECC, ECC)	00	00	00
12	Refresh Rate and Type	82	82	82
13	Primary SDRAM Width	10	10	08
14	Error Checking SDRAM Width	00	00	00
15	Not used	00	00	00
16	Burst Length Supported	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04
18	Supported CAS Latencies	38	38	38
19	DIMM Mechanical Characteristics	01	01	01
20	DIMM Type Information	04	04	04
21	DIMM Attributes	00	00	00
22	Component Attributes	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30	30	30


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
24	t_{AC} SDRAM @ CL_{MAX} -1 [ns]	45	45	45
25	t_{CK} @ CL_{MAX} -2 (Byte 18) [ns]	50	50	50
26	t_{AC} SDRAM @ CL_{MAX} -2 [ns]	60	60	60
27	$t_{RP.MIN}$ [ns]	30	30	30
28	$t_{RRD.MIN}$ [ns]	28	28	1E
29	$t_{RCD.MIN}$ [ns]	30	30	30
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D
31	Module Density per Rank	40	40	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	20	20	20
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	27	27	27
34	$t_{DS.MIN}$ [ns]	10	10	10
35	$t_{DH.MIN}$ [ns]	17	17	17
36	$t_{WR.MIN}$ [ns]	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E
39	Analysis Characteristics	00	00	00
40	t_{RC} and t_{RFC} Extension	00	00	00
41	$t_{RC.MIN}$ [ns]	39	39	39
42	$t_{RFC.MIN}$ [ns]	69	69	69
43	$t_{CK.MAX}$ [ns]	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	18	18	18
45	$t_{QHS.MAX}$ [ns]	22	22	22
46	PLL Relock Time	00	00	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	54	54	50
48	Psi(T-A) DRAM	72	72	7A
49	ΔT_0 (DT0)	67	67	53


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	31	31	34
51	ΔT_{2P} (DT2P)	33	33	36
52	ΔT_{3N} (DT3N)	24	24	27
53	$\Delta T_{3P.fast}$ (DT3P fast)	47	47	4C
54	$\Delta T_{3P.slow}$ (DT3P slow)	27	27	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	54	54	4C
56	ΔT_{5B} (DT5B)	1E	1E	20
57	ΔT_7 (DT7)	37	37	25
58	Psi(ca) PLL	00	00	00
59	Psi(ca) REG	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00
62	SPD Revision	12	12	12
63	Checksum of Bytes 0-62	E1	E2	FA
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00
72	Module Manufacturer Location	xx	xx	xx
73	Product Type, Char 1	36	36	36
74	Product Type, Char 2	34	34	34
75	Product Type, Char 3	54	54	54


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
76	Product Type, Char 4	33	36	31
77	Product Type, Char 5	32	34	32
78	Product Type, Char 6	30	30	38
79	Product Type, Char 7	30	32	30
80	Product Type, Char 8	30	30	32
81	Product Type, Char 9	48	48	31
82	Product Type, Char 10	44	44	48
83	Product Type, Char 11	4C	4C	44
84	Product Type, Char 12	33	33	4C
85	Product Type, Char 13	42	42	33
86	Product Type, Char 14	20	20	42
87	Product Type, Char 15	20	20	20
88	Product Type, Char 16	20	20	20
89	Product Type, Char 17	20	20	20
90	Product Type, Char 18	20	20	20
91	Module Revision Code	3x	3x	4x
92	Test Program Revision Code	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx
99 - 127	Not used	00	00	00
128 - 255	Blank for customer use	FF	FF	FF



HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

TABLE 30
SPD codes for PC2-5300 5-5-5

Product Type		HYS64T32000HDL-3S-B	HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B	HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B	HYS64T128921HDL-3S-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80	80	80	80
1	Total number of Bytes in EEPROM	08	08	08	08	08	08
2	Memory Type (DDR2)	08	08	08	08	08	08
3	Number of Row Addresses	0D	0D	0D	0D	0E	0E
4	Number of Column Addresses	0A	0A	0A	0A	0A	0A
5	DIMM Rank and Stacking Information	60	60	61	61	61	61
6	Data Width	40	40	40	40	40	40
7	Not used	00	00	00	00	00	00
8	Interface Voltage Level	05	05	05	05	05	05
9	t_{CK} @ CL_{MAX} (Byte 18) [ns]	30	30	30	30	30	30
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	45	45	45	45	45	45
11	Error Correction Support (non-ECC, ECC)	00	00	00	00	00	00
12	Refresh Rate and Type	82	82	82	82	82	82
13	Primary SDRAM Width	10	10	10	10	08	08
14	Error Checking SDRAM Width	00	00	00	00	00	00
15	Not used	00	00	00	00	00	00
16	Burst Length Supported	0C	0C	0C	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04	04	04	04
18	Supported CAS Latencies	38	38	38	38	38	38
19	DIMM Mechanical Characteristics	01	01	01	01	01	01


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3S-B	HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B	HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B	HYS64T128921HDL-3S-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
20	DIMM Type Information	04	04	04	04	04	04
21	DIMM Attributes	00	00	00	00	00	00
22	Component Attributes	07	07	07	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	3D	3D	3D	3D	3D	3D
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	50	50	50	50	50	50
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	50	50	50	50	50	50
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	60	60	60	60	60	60
27	$t_{RP.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
28	$t_{RRD.MIN}$ [ns]	28	28	28	28	1E	1E
29	$t_{RCD.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D	2D	2D	2D
31	Module Density per Rank	40	40	40	40	80	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	20	20	20	20	20	20
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	27	27	27	27	27	27
34	$t_{DS.MIN}$ [ns]	10	10	10	10	10	10
35	$t_{DH.MIN}$ [ns]	17	17	17	17	17	17
36	$t_{WR.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E	1E	1E	1E
39	Analysis Characteristics	00	00	00	00	00	00
40	t_{RC} and t_{RFC} Extension	00	00	00	00	00	00
41	$t_{RC.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
42	$t_{RFC.MIN}$ [ns]	69	69	69	69	69	69


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3S-B	HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B	HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B	HYS64T128921HDL-3S-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
43	$t_{CK,MAX}$ [ns]	80	80	80	80	80	80
44	$t_{DQSQ,MAX}$ [ns]	18	18	18	18	18	18
45	$t_{QHS,MAX}$ [ns]	22	22	22	22	22	22
46	PLL Relock Time	00	00	00	00	00	00
47	$T_{CASE,MAX}$ Delta / ΔT_{4R4W} Delta	54	54	54	54	50	50
48	Psi(T-A) DRAM	72	72	72	72	7A	7A
49	ΔT_0 (DT0)	5F	5F	5F	5F	4B	4B
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	31	31	31	31	34	34
51	ΔT_{2P} (DT2P)	33	33	33	33	36	36
52	ΔT_{3N} (DT3N)	24	24	24	24	27	27
53	$\Delta T_{3P,fast}$ (DT3P fast)	47	47	47	47	4C	4C
54	$\Delta T_{3P,slow}$ (DT3P slow)	27	27	27	27	2A	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	54	54	54	54	4C	4C
56	ΔT_{5B} (DT5B)	1E	1E	1E	1E	20	20
57	ΔT_7 (DT7)	34	34	34	34	23	23
58	Psi(ca) PLL	00	00	00	00	00	00
59	Psi(ca) REG	00	00	00	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00	00	00	00
62	SPD Revision	12	12	12	12	12	12
63	Checksum of Bytes 0-62	09	09	0A	0A	23	23
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F	7F	7F	7F


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3S-B	HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B	HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B	HYS64T128921HDL-3S-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00	00	00	00
72	Module Manufacturer Location	xx	xx	xx	xx	xx	xx
73	Product Type, Char 1	36	36	36	36	36	36
74	Product Type, Char 2	34	34	34	34	34	34
75	Product Type, Char 3	54	54	54	54	54	54
76	Product Type, Char 4	33	33	36	36	31	31
77	Product Type, Char 5	32	32	34	34	32	32
78	Product Type, Char 6	30	39	30	39	38	38
79	Product Type, Char 7	30	30	32	32	30	39
80	Product Type, Char 8	30	30	30	30	32	32
81	Product Type, Char 9	48	48	48	48	31	31
82	Product Type, Char 10	44	44	44	44	48	48
83	Product Type, Char 11	4C	4C	4C	4C	44	44
84	Product Type, Char 12	33	33	33	33	4C	4C
85	Product Type, Char 13	53	53	53	53	33	33
86	Product Type, Char 14	42	42	42	42	53	53
87	Product Type, Char 15	20	20	20	20	42	42
88	Product Type, Char 16	20	20	20	20	20	20


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3S-B	HYS64T32900HDL-3S-B	HYS64T64020HDL-3S-B	HYS64T64920HDL-3S-B	HYS64T128021HDL-3S-B	HYS64T128921HDL-3S-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555	PC2-5300S-555
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
89	Product Type, Char 17	20	20	20	20	20	20
90	Product Type, Char 18	20	20	20	20	20	20
91	Module Revision Code	4x	2x	4x	2x	4x	2x
92	Test Program Revision Code	xx	xx	xx	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx	xx	xx	xx
99 - 127	Not used	00	00	00	00	00	00
128 - 255	Blank for customer use	FF	FF	FF	FF	FF	FF


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

TABLE 31
SPD codes for PC2-4200 4-4-4

Product Type		HYS64T32000HDL-3.7-B	HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B	HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B	HYS64T128921HDL-3.7-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80	80	80	80
1	Total number of Bytes in EEPROM	08	08	08	08	08	08
2	Memory Type (DDR2)	08	08	08	08	08	08
3	Number of Row Addresses	0D	0D	0D	0D	0E	0E
4	Number of Column Addresses	0A	0A	0A	0A	0A	0A
5	DIMM Rank and Stacking Information	60	60	61	61	61	61
6	Data Width	40	40	40	40	40	40
7	Not used	00	00	00	00	00	00
8	Interface Voltage Level	05	05	05	05	05	05
9	t_{CK} @ CL_{MAX} (Byte 18) [ns]	3D	3D	3D	3D	3D	3D
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	50	50	50	50	50	50
11	Error Correction Support (non-ECC, ECC)	00	00	00	00	00	00
12	Refresh Rate and Type	82	82	82	82	82	82
13	Primary SDRAM Width	10	10	10	10	08	08
14	Error Checking SDRAM Width	00	00	00	00	00	00
15	Not used	00	00	00	00	00	00
16	Burst Length Supported	0C	0C	0C	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04	04	04	04
18	Supported CAS Latencies	38	38	38	38	38	38
19	DIMM Mechanical Characteristics	01	01	01	01	01	01


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3.7-B	HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B	HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B	HYS64T128921HDL-3.7-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
20	DIMM Type Information	04	04	04	04	04	04
21	DIMM Attributes	00	00	00	00	00	00
22	Component Attributes	07	07	07	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	3D	3D	3D	3D	3D	3D
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	50	50	50	50	50	50
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	50	50	50	50	50	50
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	60	60	60	60	60	60
27	$t_{RP.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
28	$t_{RRD.MIN}$ [ns]	28	28	28	28	1E	1E
29	$t_{RCD.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D	2D	2D	2D
31	Module Density per Rank	40	40	40	40	80	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	25	25	25	25	25	25
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	37	37	37	37	37	37
34	$t_{DS.MIN}$ [ns]	10	10	10	10	10	10
35	$t_{DH.MIN}$ [ns]	22	22	22	22	22	22
36	$t_{WR.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E	1E	1E	1E
39	Analysis Characteristics	00	00	00	00	00	00
40	t_{RC} and t_{RFC} Extension	00	00	00	00	00	00
41	$t_{RC.MIN}$ [ns]	3C	3C	3C	3C	3C	3C
42	$t_{RFC.MIN}$ [ns]	69	69	69	69	69	69


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3.7-B	HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B	HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B	HYS64T128921HDL-3.7-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
43	$t_{CK,MAX}$ [ns]	80	80	80	80	80	80
44	$t_{DQSQ,MAX}$ [ns]	1E	1E	1E	1E	1E	1E
45	$t_{QHS,MAX}$ [ns]	28	28	28	28	28	28
46	PLL Relock Time	00	00	00	00	00	00
47	$T_{CASE,MAX}$ Delta / ΔT_{4R4W} Delta	54	54	54	54	50	50
48	Psi(T-A) DRAM	72	72	72	72	7A	7A
49	ΔT_0 (DT0)	53	53	53	53	43	43
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	29	29	29	29	2C	2C
51	ΔT_{2P} (DT2P)	33	33	33	33	36	36
52	ΔT_{3N} (DT3N)	1F	1F	1F	1F	21	21
53	$\Delta T_{3P,fast}$ (DT3P fast)	3D	3D	3D	3D	41	41
54	$\Delta T_{3P,slow}$ (DT3P slow)	27	27	27	27	2A	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	46	46	46	46	40	40
56	ΔT_{5B} (DT5B)	1C	1C	1C	1C	1E	1E
57	ΔT_7 (DT7)	32	32	32	32	22	22
58	Psi(ca) PLL	00	00	00	00	00	00
59	Psi(ca) REG	00	00	00	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00	00	00	00
62	SPD Revision	12	12	12	12	12	12
63	Checksum of Bytes 0-62	18	18	19	19	37	37
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F	7F	7F	7F


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3.7-B	HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B	HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B	HYS64T128921HDL-3.7-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444	PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00	00	00	00
72	Module Manufacturer Location	xx	xx	xx	xx	xx	xx
73	Product Type, Char 1	36	36	36	36	36	36
74	Product Type, Char 2	34	34	34	34	34	34
75	Product Type, Char 3	54	54	54	54	54	54
76	Product Type, Char 4	33	33	36	36	31	31
77	Product Type, Char 5	32	32	34	34	32	32
78	Product Type, Char 6	30	39	30	39	38	38
79	Product Type, Char 7	30	30	32	32	30	39
80	Product Type, Char 8	30	30	30	30	32	32
81	Product Type, Char 9	48	48	48	48	31	31
82	Product Type, Char 10	44	44	44	44	48	48
83	Product Type, Char 11	4C	4C	4C	4C	44	44
84	Product Type, Char 12	33	33	33	33	4C	4C
85	Product Type, Char 13	2E	2E	2E	2E	33	33
86	Product Type, Char 14	37	37	37	37	2E	2E
87	Product Type, Char 15	42	42	42	42	37	37
88	Product Type, Char 16	20	20	20	20	42	42


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3.7-B	HYS64T32900HDL-3.7-B	HYS64T64020HDL-3.7-B	HYS64T64920HDL-3.7-B	HYS64T128021HDL-3.7-B	HYS64T128921HDL-3.7-B
Organization		256MB	256MB	512MB	512MB	1 GByte	1 GByte
		×64	×64	×64	×64	×64	×64
		1 Rank (×16)	1 Rank (×16)	2 Ranks (×16)	2 Ranks (×16)	2 Ranks (×8)	2 Ranks (×8)
Label Code		PC2- 4200S- 444	PC2- 4200S- 444	PC2- 4200S- 444	PC2- 4200S- 444	PC2- 4200S- 444	PC2- 4200S- 444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX	HEX
89	Product Type, Char 17	20	20	20	20	20	20
90	Product Type, Char 18	20	20	20	20	20	20
91	Module Revision Code	4x	2x	4x	2x	4x	2x
92	Test Program Revision Code	xx	xx	xx	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx	xx	xx	xx
99 - 127	Not used	00	00	00	00	00	00
128 - 255	Blank for customer use	FF	FF	FF	FF	FF	FF



HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

TABLE 32
SPD codes for PC2-5300 4-4-4

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80
1	Total number of Bytes in EEPROM	08	08	08
2	Memory Type (DDR2)	08	08	08
3	Number of Row Addresses	0D	0D	0E
4	Number of Column Addresses	0A	0A	0A
5	DIMM Rank and Stacking Information	60	61	61
6	Data Width	40	40	40
7	Not used	00	00	00
8	Interface Voltage Level	05	05	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	30	30	30
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	45	45	45
11	Error Correction Support (non-ECC, ECC)	00	00	00
12	Refresh Rate and Type	82	82	82
13	Primary SDRAM Width	10	10	08
14	Error Checking SDRAM Width	00	00	00
15	Not used	00	00	00
16	Burst Length Supported	0C	0C	0C
17	Number of Banks on SDRAM Device	04	04	04
18	Supported CAS Latencies	38	38	38
19	DIMM Mechanical Characteristics	01	01	01
20	DIMM Type Information	04	04	04
21	DIMM Attributes	00	00	00
22	Component Attributes	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30	30	30


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
24	t_{AC} SDRAM @ CL_{MAX} -1 [ns]	45	45	45
25	t_{CK} @ CL_{MAX} -2 (Byte 18) [ns]	50	50	50
26	t_{AC} SDRAM @ CL_{MAX} -2 [ns]	60	60	60
27	$t_{RP.MIN}$ [ns]	30	30	30
28	$t_{RRD.MIN}$ [ns]	28	28	1E
29	$t_{RCD.MIN}$ [ns]	30	30	30
30	$t_{RAS.MIN}$ [ns]	2D	2D	2D
31	Module Density per Rank	40	40	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	20	20	20
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	27	27	27
34	$t_{DS.MIN}$ [ns]	10	10	10
35	$t_{DH.MIN}$ [ns]	17	17	17
36	$t_{WR.MIN}$ [ns]	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E
39	Analysis Characteristics	00	00	00
40	t_{RC} and t_{RFC} Extension	00	00	00
41	$t_{RC.MIN}$ [ns]	39	39	39
42	$t_{RFC.MIN}$ [ns]	69	69	69
43	$t_{CK.MAX}$ [ns]	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	18	18	18
45	$t_{QHS.MAX}$ [ns]	22	22	22
46	PLL Relock Time	00	00	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	54	54	50
48	Psi(T-A) DRAM	72	72	7A
49	ΔT_0 (DT0)	67	67	53


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	31	31	34
51	ΔT_{2P} (DT2P)	33	33	36
52	ΔT_{3N} (DT3N)	24	24	27
53	$\Delta T_{3P.fast}$ (DT3P fast)	47	47	4C
54	$\Delta T_{3P.slow}$ (DT3P slow)	27	27	2A
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	54	54	4C
56	ΔT_{5B} (DT5B)	1E	1E	20
57	ΔT_7 (DT7)	37	37	25
58	Psi(ca) PLL	00	00	00
59	Psi(ca) REG	00	00	00
60	ΔT_{PLL} (DTPLL)	00	00	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00
62	SPD Revision	12	12	12
63	Checksum of Bytes 0-62	E1	E2	FA
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00
72	Module Manufacturer Location	xx	xx	xx
73	Product Type, Char 1	36	36	36
74	Product Type, Char 2	34	34	34
75	Product Type, Char 3	54	54	54


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

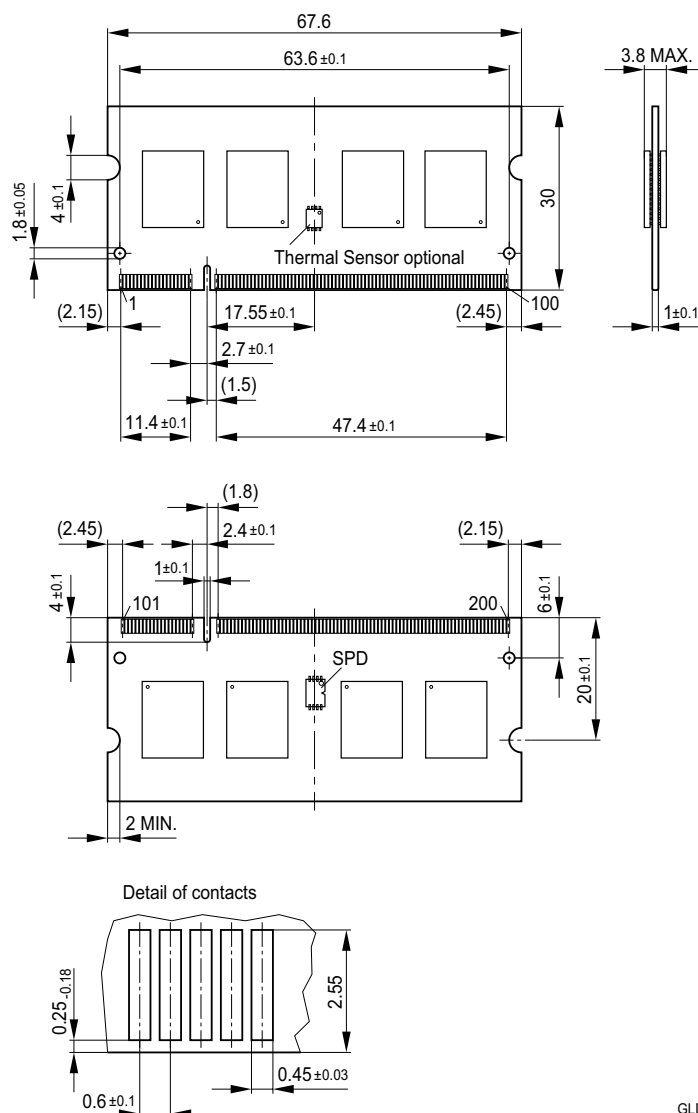
Product Type		HYS64T32000HDL-3-B	HYS64T64020HDL-3-B	HYS64T128021HDL-3-B
Organization		256MB	512MB	1 GByte
		×64	×64	×64
		1 Rank (×16)	2 Ranks (×16)	2 Ranks (×8)
Label Code		PC2-5300S-444	PC2-5300S-444	PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX
76	Product Type, Char 4	33	36	31
77	Product Type, Char 5	32	34	32
78	Product Type, Char 6	30	30	38
79	Product Type, Char 7	30	32	30
80	Product Type, Char 8	30	30	32
81	Product Type, Char 9	48	48	31
82	Product Type, Char 10	44	44	48
83	Product Type, Char 11	4C	4C	44
84	Product Type, Char 12	33	33	4C
85	Product Type, Char 13	42	42	33
86	Product Type, Char 14	20	20	42
87	Product Type, Char 15	20	20	20
88	Product Type, Char 16	20	20	20
89	Product Type, Char 17	20	20	20
90	Product Type, Char 18	20	20	20
91	Module Revision Code	3x	3x	4x
92	Test Program Revision Code	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx
99 - 127	Not used	00	00	00
128 - 255	Blank for customer use	FF	FF	FF



5 Package Outlines

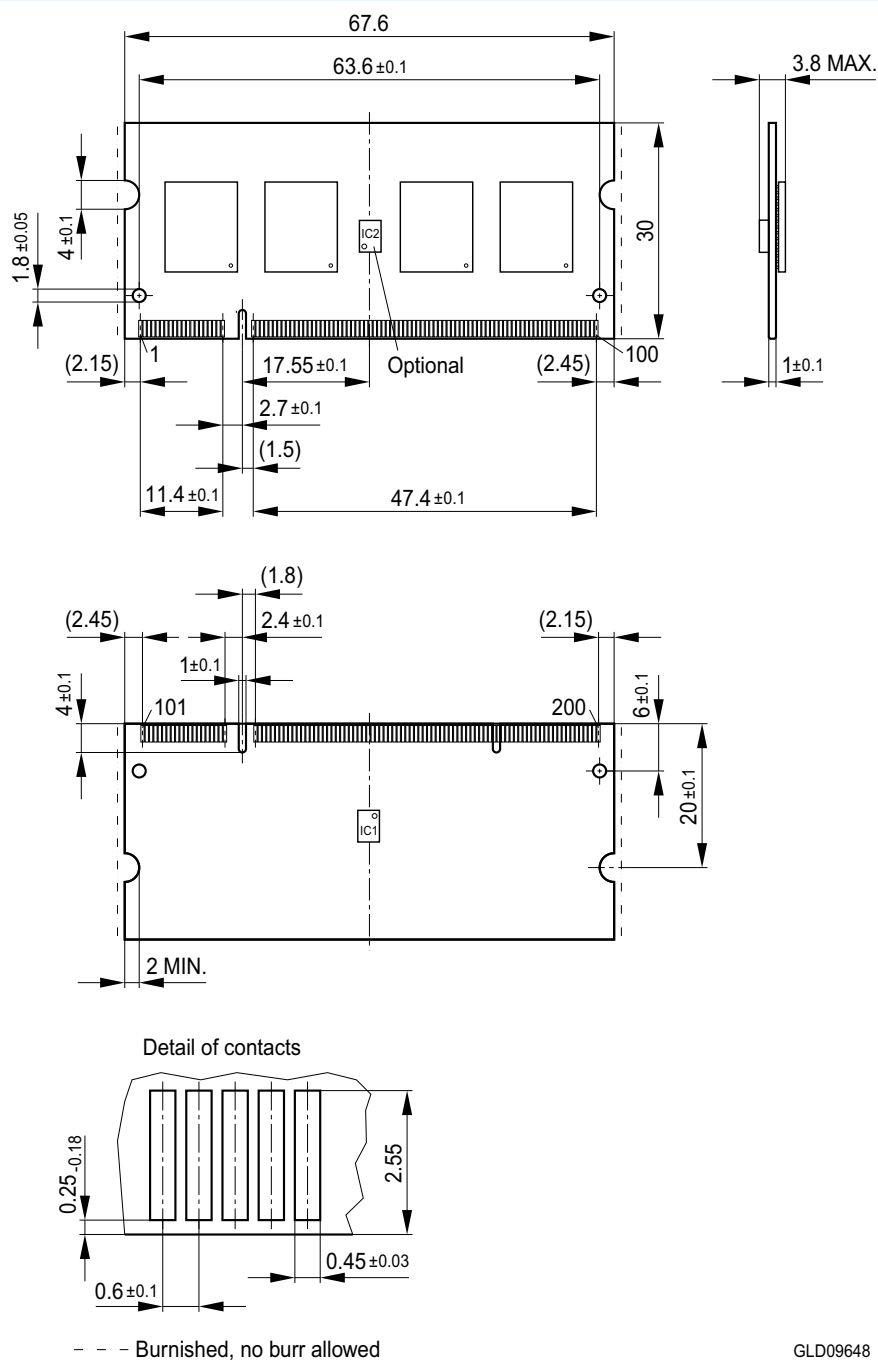
This chapter contains the package outlines of the products.

FIGURE 5
Package Outline Raw Card A L-DIM-200-31



Notes

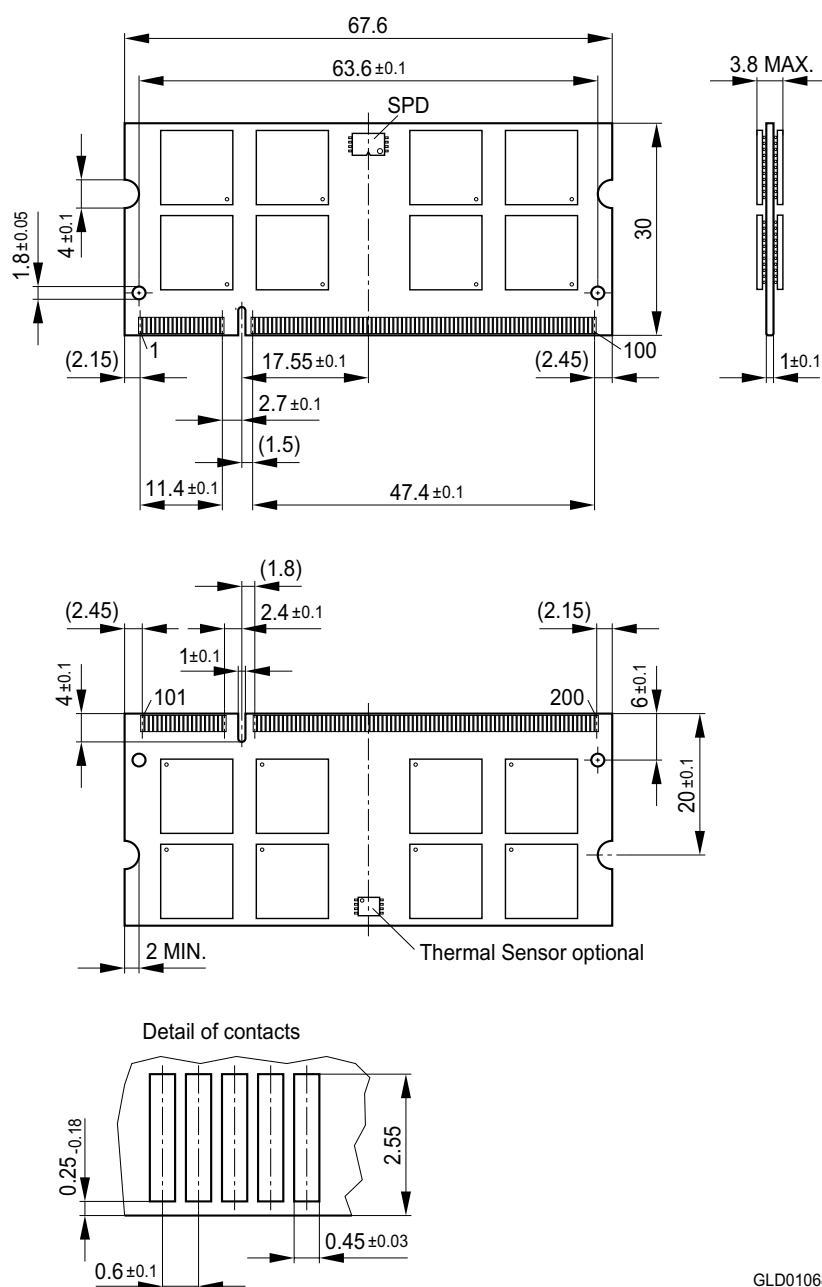
1. Drawing according to ISO 8015
2. Dimensions in mm
3. General tolerances ± 0.15

HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module**FIGURE 6**
Package Outline Raw Card C L-DIM-200-30

GLD09648

Notes

1. Drawing according to ISO 8015
2. Dimensions in mm
3. General tolerances +/- 0.15

HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module**FIGURE 7**
Package Outline L-DIM-200-36

GLD01068

Notes

1. Drawing according to ISO 8015
2. Dimensions in mm
3. General tolerances ± 0.15



6 Product Type Nomenclature

Qimonda's nomenclature uses simple coding combined with some proprietary coding. **Table 33** provides examples for module and component product type number as well as the

field number. The detailed field description together with possible values and coding explanation is listed for modules in **Table 34** and for components in **Table 35**.

TABLE 33
Nomenclature Fields and Examples

Example for	Field Number										
	1	2	3	4	5	6	7	8	9	10	11
Micro-DIMM	HYS	64	T	64/128	0	2	0	K	M	-5	-A
DDR2 DRAM	HYB	18	T	512/1G	16		0	A	C	-5	

TABLE 34
DDR2 DIMM Nomenclature

Field	Description	Values	Coding
1	Qimonda Module Prefix	HYS	Constant
2	Module Data Width [bit]	64	Non-ECC
		72	ECC
3	DRAM Technology	T	DDR2
4	Memory Density per I/O [Mbit]; Module Density ¹⁾	32	256 MByte
		64	512 MByte
		128	1 GByte
		256	2 GByte
		512	4 GByte
5	Raw Card Generation	0 .. 9	Look up table
6	Number of Module Ranks	0, 2, 4	1, 2, 4
7	Product Variations	0 .. 9	Look up table
8	Package, Lead-Free Status	A .. Z	Look up table
9	Module Type	D	SO-DIMM
		M	Micro-DIMM
		R	Registered
		U	Unbuffered
		F	Fully Buffered


HYS64T[32/64/128]xxxHDL-[25F/2.5/3/3S/3.7/5]-B
SO-DIMM DDR2 SDRAM Module

Field	Description	Values	Coding
10	Speed Grade	–2.5F	PC2–6400 5–5–5
		–2.5	PC2–6400 6–6–6
		–3	PC2–5300 4–4–4
		–3S	PC2–5300 5–5–5
		–3.7	PC2–4200 4–4–4
		–5	PC2–3200 3–3–3
11	Die Revision	–A	First
		–B	Second

1) Multiplying “Memory Density per I/O” with “Module Data Width” and dividing by 8 for Non-ECC and 9 for ECC modules gives the overall module memory density in MBytes as listed in column “Coding”.

TABLE 35
DDR2 DRAM Nomenclature

Field	Description	Values	Coding
1	Qimonda Component Prefix	HYB	Constant
2	Interface Voltage [V]	18	SSTL_18
3	DRAM Technology	T	DDR2
4	Component Density [Mbit]	256	256 Mbit
		512	512 Mbit
		1G	1 Gbit
		2G	2 Gbit
5+6	Number of I/Os	40	×4
		80	×8
		16	×16
7	Product Variations	0 .. 9	Look up table
8	Die Revision	A	First
		B	Second
9	Package, Lead-Free Status	C	FBGA, lead-containing
		F	FBGA, lead-free
10	Speed Grade	–25F	DDR2-800 5-5-5
		–2.5	DDR2-800 6-6-6
		–3	DDR2-667 4-4-4
		–3S	DDR2-667 5-5-5
		–3.7	DDR2-533 4-4-4
		–5	DDR2-400 3-3-3



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