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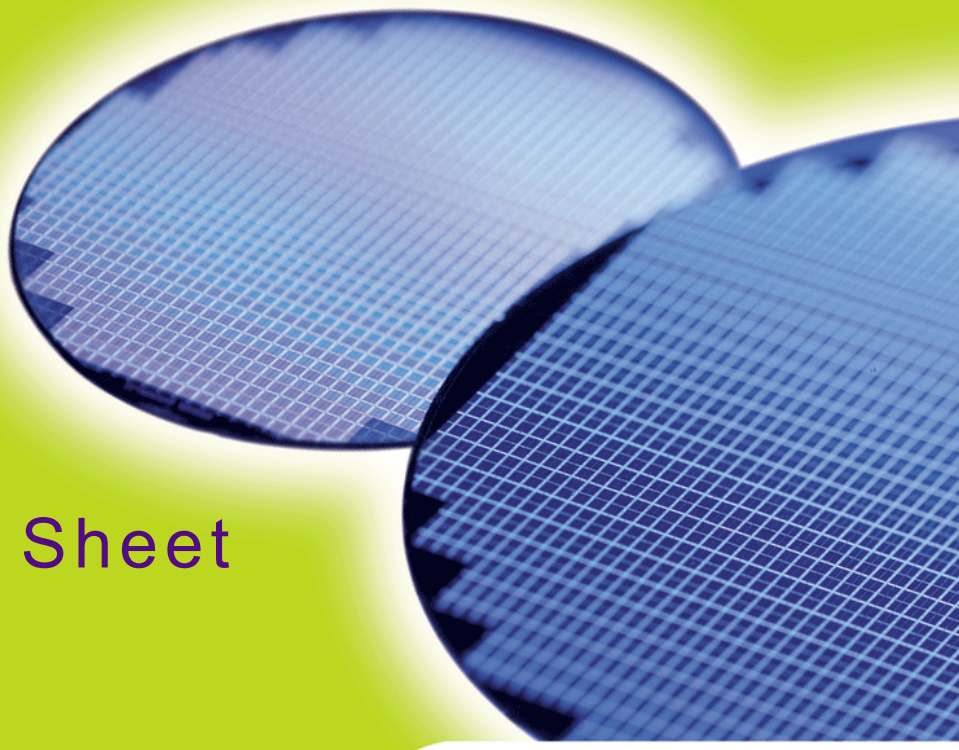
HYS72T256023HR–5–A
HYS72T512022HR–3S–A
HYS72T512022HR–3.7–A
HYS72T512022HR–5–A

240-Pin Registered DDR2 SDRAM Modules
DDR2 SDRAM
RDIMM SDRAM
RoHS compliant



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1 Overview

This chapter gives an overview of the 240-pin Registered DDR2 SDRAM Modules product family and describes its main characteristics.

1.1 Features

- 240-pin PC2–5300, PC2-4200 and PC2-3200 DDR2 SDRAM memory modules Workstation and Server main memory applications
- Two rank 256M × 72, 512M × 72 module organization and 2 × 128M × 8, 2 × 256M × 4 chip organization
- 2GByte, 4 GByte module built with stacked 1-Gbit DDR2 SDRAMs in P-TFBGA-71 chipsize packages
- Standard DDR2 Synchronous DRAMs (DDR2 SDRAM) with a single + 1.8 V (± 0.1 V) power supply
- All Speed grades faster than DDR2-400 can operate with DDR2-400 timing specifications aswell
- Programmable CAS Latencies (3, 4 & 5), Burst Length (4 & 8) and Burst Type
- Auto Refresh (CBR) and Self Refresh
- Average Refresh Period 7.8 µs at a T_{CASE} lower than 85 °C, 3.9µs between 85 °C and 95 °C.
- All inputs and outputs SSTL_1.8 compatible
- Off-Chip Driver Impedance Adjustment (OCD) and On-Die Termination (ODT)
- Serial Presence Detect with E^2PROM
- RDIMM Dimensions (nominal): 30 mm high, 133.35 mm wide
- Based on standard reference layouts Raw Card “D” and “Z“
- RoHS compliant products[1)]

TABLE 1
Performance Table

Product Type Speed Code			–3S	–3.7	–5	Unit
Speed Grade			**PC2–5300 5–5–5**	**PC2–4200 4–4–4**	**PC2–3200 4–4–4**	**—**
Max. Clock Frequency	@CL5	f_{CK5}	333	266	200	MHz
	@CL4	f_{CK4}	266	266	200	MHz
	@CL3	f_{CK3}	200	200	200	MHz
Min. RAS-CAS-Delay		t_{RCD}	15	15	15	ns
Min. Row Precharge Time		t_{RP}	15	15	15	ns
Min. Row Active Time		t_{RAS}	45	45	40	ns
Min. Row Cycle Time		t_{RC}	60	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.

1.2 Description

The QIMONDA HYS72T[512/256]02xHR–[3S/3.7/5]–A module family are Registered DIMM modules “RDIMMs” with 30 mm height based on DDR2 technology. DIMMs are available as ECC modules in 256M × 72 (2 GByte), 512M × 72 (4 GByte) organization and density, intended for mounting into 240-Pin connector sockets.

The memory array is designed with stacked 1-Gbit Double-Data-Rate-Two (DDR2) Synchronous DRAMs. All control and address signals are re-driven on the DIMM using register devices and a PLL for the clock distribution. This reduces capacitive loading to the system bus, but adds one cycle to the SDRAM timing. Decoupling capacitors are mounted on the PCB board. The DIMMs feature serial presence detect based on a serial E^2PROM device using the 2-pin I^2C protocol. The first 128 bytes are programmed with configuration data and the second 128 bytes are available to the customer.

green Product

TABLE 2
Ordering Information for RoHS Compliant Products

Product Type[1)]	Compliance Code[2)]	Description	SDRAM Technology
PC2–5300			
HYS72T512022HR–3S–A	4 GB 2R×4 PC2–5300R–555–12–D0	2 Ranks, ECC	1 Gbit (×4)
PC2–4200			
HYS72T512022HR–3.7–A	4 GB 2R×4 PC2–4200R–444–12–D0	2 Ranks, ECC	1 Gbit (×4)
PC2-3200			
HYS72T256023HR–5–A	2 GB 2R×8 PC2–3200R–333–12–ZZ	2 Ranks, ECC	1 Gbit (×8)
HYS72T512022HR–5–A	4 GB 2R×4 PC2–3200R–333–12–D0	2 Ranks, ECC	1 Gbit (×4)

1) All Product Type numbers end with a place code, designating the silicon die revision. Example: HYS72T512022HR–3.7–A, indicating Rev. “A” 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 “PC2–4200R–444–12–D0”, where 4200R means Registered DIMM modules with 4.26 GB/sec Module Bandwidth and “444-11” 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 “D”

TABLE 3
Address Format

DIMM Density	Module Organization	Memory Ranks	ECC/ Non-ECC	# of SDRAMs	# of row/bank/columns bits	Raw Card
2 GB	256M × 72	2	ECC	2 × 9	14/3/10	Z
4 GB	512M × 72	2	ECC	2 × 18	14/3/11	D

TABLE 4
Components on Modules

Product Type	DRAM Components	DRAM Density	DRAM Organization	Note[1)]
HYS72T256023HR	HYB18T2G802AF	2 Gbit	2 × 128M × 8	
HYS72T512022HR	HYB18T2G402AF	2 Gbit	2 × 256M × 4	

1) For a detailed description of all available functions of the DRAM components on these modules see the component data sheet.

2 Pin Configuration

This chapter contains the pin configuration.

2.1 Pin Configuration

The pin configuration of the Registered DDR2 SDRAM DIMM is listed by function in **Table 5** (240 pins). The abbreviations used in columns Pin and Buffer Type are explained in **Table 6** and **Table 7** respectively. The pin numbering is depicted in **Figure 1**.

TABLE 5
Pin Configuration of RDIMM

Ball No.	Name	Pin Type	Buffer Type	Function
Clock Signals				
185	CK0	I	SSTL	**Clock Signal CK0, Complementary Clock Signal CK0**
186	$\overline{\text{CK0}}$	I	SSTL	
52	CKE0	I	SSTL	**Clock Enables 1:0**
171	CKE1	I	SSTL	*Note: 2-Ranks module*
	NC	NC	—	**Not Connected** *Note: 1-Rank module*
Control Signals				
193	$\overline{\text{S0}}$	I	SSTL	**Chip Select Rank 1:0**
76	$\overline{\text{S1}}$	I	SSTL	*Note: 2-Ranks module*
	NC	NC	—	**Not Connected** *Note: 1-Rank module*
192	$\overline{\text{RAS}}$	I	SSTL	**Row Address Strobe (RAS), Column Address Strobe (CAS), Write Enable (WE)**
74	$\overline{\text{CAS}}$	I	SSTL	
73	$\overline{\text{WE}}$	I	SSTL	
18	$\overline{\text{RESET}}$	I	CMOS	**Register Reset**
Address Signals				
71	BA0	I	SSTL	**Bank Address Bus 1:0**
190	BA1	I	SSTL	
54	BA2	I	SSTL	**Bank Address Bus 2** Greater than 512Mb DDR2 SDRAMS
	NC	I	SSTL	**Not Connected** Less than 1Gb DDR2 SDRAMS

Ball No.	Name	Pin Type	Buffer Type	Function
188	A0	I	SSTL	**Address Bus 12:0, Address Signal 10/AutoPrecharge**
183	A1	I	SSTL	
63	A2	I	SSTL	
182	A3	I	SSTL	
61	A4	I	SSTL	
60	A5	I	SSTL	
180	A6	I	SSTL	
58	A7	I	SSTL	
179	A8	I	SSTL	
177	A9	I	SSTL	
70	A10	I	SSTL	
	AP	I	SSTL	
57	A11	I	SSTL	
176	A12	I	SSTL	
196	A13	I	SSTL	**Address Signal 13**
	NC	NC	—	**Not Connected** *Note: Non CA parity modules based on 256 Mbit component*
174	A14	I	SSTL	**Address Signal 14** *Note: CA Parity module*
	NC	NC	—	**Not Connected** *Note: Non CA parity module. Less than 1 GBit per DRAM die.*
173	A15	I	SSTL	**Address Signal 14** *Note: CA Parity module*
	NC	NC	—	**Not Connected** *Note: Non CA parity module. Less than 1 GBit per DRAM die.*

Ball No.	Name	Pin Type	Buffer Type	Function
Data Signals				
3	DQ0	I/O	SSTL	**Data Bus 63:0** Data Input/Output pins
4	DQ1	I/O	SSTL	
9	DQ2	I/O	SSTL	
10	DQ3	I/O	SSTL	
122	DQ4	I/O	SSTL	
123	DQ5	I/O	SSTL	
128	DQ6	I/O	SSTL	
129	DQ7	I/O	SSTL	
12	DQ8	I/O	SSTL	
13	DQ9	I/O	SSTL	
21	DQ10	I/O	SSTL	
22	DQ11	I/O	SSTL	
131	DQ12	I/O	SSTL	
132	DQ13	I/O	SSTL	
140	DQ14	I/O	SSTL	
141	DQ15	I/O	SSTL	
24	DQ16	I/O	SSTL	
25	DQ17	I/O	SSTL	
30	DQ18	I/O	SSTL	
31	DQ19	I/O	SSTL	
143	DQ20	I/O	SSTL	
144	DQ21	I/O	SSTL	
149	DQ22	I/O	SSTL	
150	DQ23	I/O	SSTL	
33	DQ24	I/O	SSTL	
34	DQ25	I/O	SSTL	
39	DQ26	I/O	SSTL	
40	DQ27	I/O	SSTL	
152	DQ28	I/O	SSTL	
153	DQ29	I/O	SSTL	
158	DQ30	I/O	SSTL	
159	DQ31	I/O	SSTL	
80	DQ32	I/O	SSTL	
81	DQ33	I/O	SSTL	
86	DQ34	I/O	SSTL	
87	DQ35	I/O	SSTL	
199	DQ36	I/O	SSTL	
200	DQ37	I/O	SSTL	
205	DQ38	I/O	SSTL	

Ball No.	Name	Pin Type	Buffer Type	Function
206	DQ39	I/O	SSTL	**Data Bus 63:0**
89	DQ40	I/O	SSTL	
90	DQ41	I/O	SSTL	
95	DQ42	I/O	SSTL	
96	DQ43	I/O	SSTL	
208	DQ44	I/O	SSTL	
209	DQ45	I/O	SSTL	
214	DQ46	I/O	SSTL	
215	DQ47	I/O	SSTL	
98	DQ48	I/O	SSTL	
99	DQ49	I/O	SSTL	
107	DQ50	I/O	SSTL	
108	DQ51	I/O	SSTL	
217	DQ52	I/O	SSTL	
218	DQ53	I/O	SSTL	
226	DQ54	I/O	SSTL	
227	DQ55	I/O	SSTL	
110	DQ56	I/O	SSTL	
111	DQ57	I/O	SSTL	
116	DQ58	I/O	SSTL	
117	DQ59	I/O	SSTL	
229	DQ60	I/O	SSTL	
230	DQ61	I/O	SSTL	
235	DQ62	I/O	SSTL	
236	DQ63	I/O	SSTL	
Check Bits				
42	CB0	I/O	SSTL	**Check Bits 7:0** Check Bit Input / Output pins *Note: NC on Non-ECC module*
43	CB1	I/O	SSTL	
48	CB2	I/O	SSTL	
49	CB3	I/O	SSTL	
161	CB4	I/O	SSTL	
162	CB5	I/O	SSTL	
167	CB6	I/O	SSTL	
168	CB7	I/O	SSTL	

Ball No.	Name	Pin Type	Buffer Type	Function
Data Strobe Bus				
7	DQS0	I/O	SSTL	**Data Strobes 17:0**
6	$\overline{\text{DQS0}}$	I/O	SSTL	
16	DQS1	I/O	SSTL	
15	$\overline{\text{DQS1}}$	I/O	SSTL	
28	DQS2	I/O	SSTL	
27	$\overline{\text{DQS2}}$	I/O	SSTL	
37	DQS3	I/O	SSTL	
36	$\overline{\text{DQS3}}$	I/O	SSTL	
84	DQS4	I/O	SSTL	
83	$\overline{\text{DQS4}}$	I/O	SSTL	
93	DQS5	I/O	SSTL	
92	$\overline{\text{DQS5}}$	I/O	SSTL	
105	DQS6	I/O	SSTL	
104	$\overline{\text{DQS6}}$	I/O	SSTL	
114	DQS7	I/O	SSTL	
113	$\overline{\text{DQS7}}$	I/O	SSTL	
46	DQS8	I/O	SSTL	
45	$\overline{\text{DQS8}}$	I/O	SSTL	
125	DQS9	I/O	SSTL	
126	$\overline{\text{DQS9}}$	I/O	SSTL	
134	DQS10	I/O	SSTL	
135	$\overline{\text{DQS10}}$	I/O	SSTL	
146	DQS11	I/O	SSTL	
147	$\overline{\text{DQS11}}$	I/O	SSTL	
155	DQS12	I/O	SSTL	
156	$\overline{\text{DQS12}}$	I/O	SSTL	
202	DQS13	I/O	SSTL	
203	$\overline{\text{DQS13}}$	I/O	SSTL	
211	DQS14	I/O	SSTL	
212	$\overline{\text{DQS14}}$	I/O	SSTL	
223	DQS15	I/O	SSTL	
224	$\overline{\text{DQS15}}$	I/O	SSTL	
232	DQS16	I/O	SSTL	
233	$\overline{\text{DQS16}}$	I/O	SSTL	
164	DQS17	I/O	SSTL	
165	$\overline{\text{DQS17}}$	I/O	SSTL	

Ball No.	Name	Pin Type	Buffer Type	Function
Data Mask				
125	DM0	I	SSTL	**Data Masks 8:0** *Note: x8 based module*
134	DM1	I	SSTL	
146	DM2	I	SSTL	
155	DM3	I	SSTL	
202	DM4	I	SSTL	
211	DM5	I	SSTL	
223	DM6	I	SSTL	
232	DM7	I	SSTL	
164	DM8	I	SSTL	
EEPROM				
120	SCL	I	CMOS	**Serial Bus Clock**
119	SDA	I/O	OD	**Serial Bus Data**
239	SA0	I	CMOS	**Serial Address Select Bus 2:0**
240	SA1	I	CMOS	
101	SA2	I	CMOS	
Parity				
55	$\overline{\text{ERR_OUT}}$	O	CMOS	**Parity bits** *Note: Only for modules with parity bit for address and control bus.*
	NC	NC	—	**Not Connected** *Note: Not connected on non-parity registered modules*
68	PAR_IN	I	CMOS	**Parity bits** *Note: Only for modules with parity bit for address and control bus.*
	NC	NC	—	**Not Connected** *Note: Not connected on non-parity registered modules*
Power Supplies				
1	V_{REF}	AI	—	**I/O Reference Voltage**
238	V_{DDSPD}	PWR	—	**EEPROM Power Supply**
51, 56, 62, 72, 75, 78, 170, 175, 181, 191, 194	V_{DDQ}	PWR	—	**I/O Driver Power Supply**
53, 59, 64, 67, 69, 172, 178, 184, 187, 189, 197	V_{DD}	PWR	—	**Power Supply**

Ball No.	Name	Pin Type	Buffer Type	Function
2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, 50, 65, 66, 79, 82, 85, 88, 91, 94, 97, 100, 103, 106, 109, 112, 115, 118, 121, 124, 127, 130, 133, 136, 139, 142, 145, 148, 151, 154, 157, 160, 163, 166, 169, 198, 201, 204, 207, 210, 213, 216, 219, 222, 225, 228, 231, 234, 237	V_{SS}	GND	—	**Ground Plane**
Other Pins				
19,102, 137, 138, 220, 221	NC	NC	—	**Not connected**
195	ODT0	I	SSTL	**On-Die Termination Control 1:0**
77	ODT1	I	SSTL	*Note: 2-Ranks module*
	NC	NC	—	*Note: 1-Rank modules*

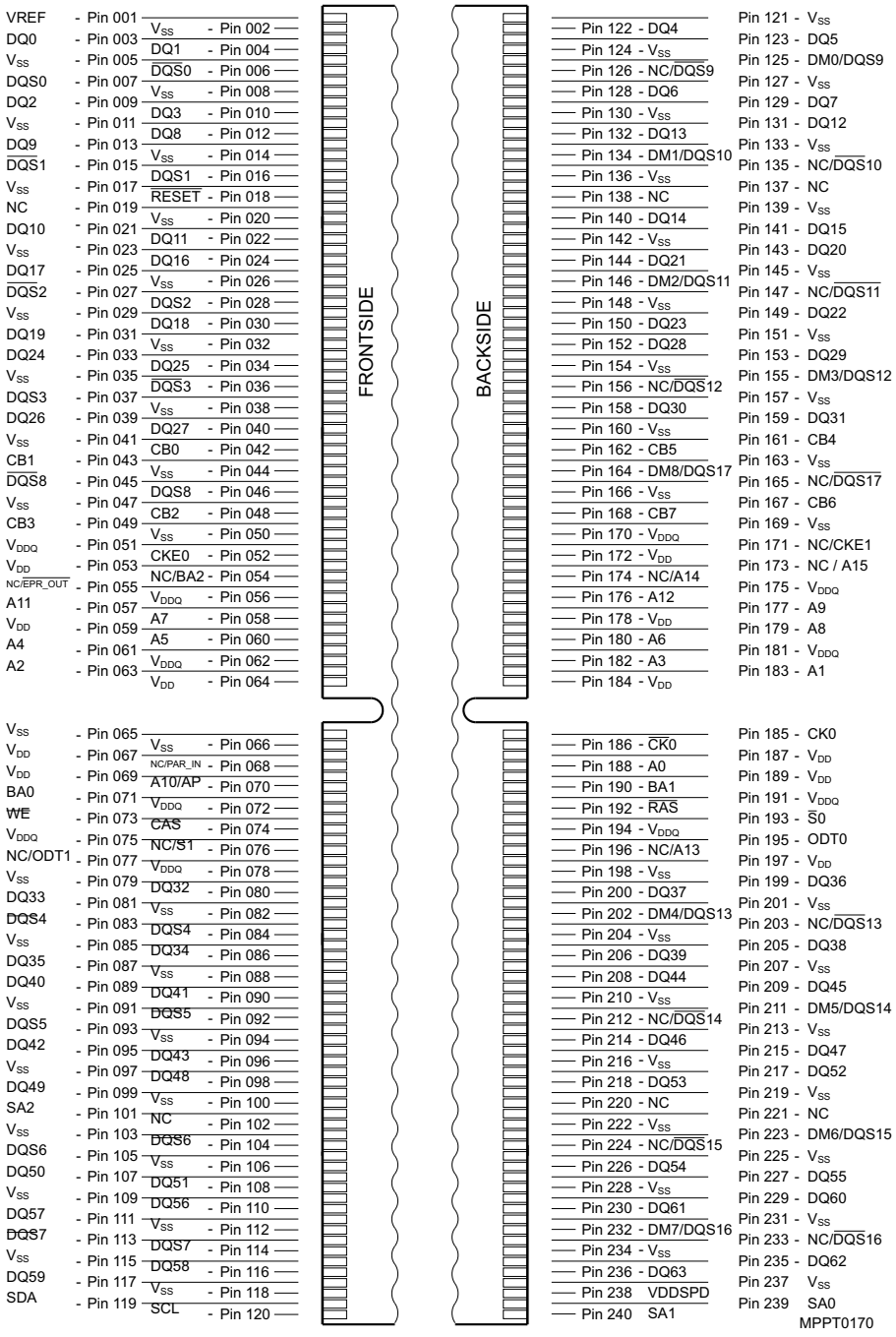
TABLE 6
Abbreviations for Buffer Type

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

TABLE 7
Abbreviations for Pin Type

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

FIGURE 1
Pin Configuration for RDIMM (240 pins)



3 Electrical Characteristics

This chapter describes 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 µs
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
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 µs
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.

TABLE 11
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 × V_{DDQ}	0.5 × V_{DDQ}	0.51 × 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 ± 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 ≤ V_{IN} ≤ V_{DDQ} + 0.3 V; all other pins at 0 V. Current is per pin

3.3 AC Characteristics

This chapter describes the AC characteristics.

3.3.1 Speed Grades Definitions

All Speed grades faster than DDR2-400B comply with DDR2-400B timing specifications (t_{CK} = 5ns with t_{RAS} = 40ns).

TABLE 12
Speed Grade Definition

Speed Grade			DDR2–667		DDR2–533C		DDR2–400B		Unit	Note
QAG Sort Name			–3S		–3.7		–5			
CAS-RCD-RP latencies			5–5–5		4–4–4		3–3–3		t_{CK}	
Parameter		Symbol	Min.	Max.	Min.	Max.	Min.	Max.	—	
Clock Frequency	@ CL = 3	t_{CK}	5	8	5	8	5	8	ns	1)2)3)4)
	@ CL = 4	t_{CK}	3.75	8	3.75	8	5	8	ns	1)2)3)4)
	@ CL = 5	t_{CK}	3	8	3.75	8	5	8	ns	1)2)3)4)
Row Active Time		t_{RAS}	45	70000	45	70000	40	70000	ns	1)2)3)4)5)
Row Cycle Time		t_{RC}	60	—	60	—	55	—	ns	1)2)3)4)
RAS-CAS-Delay		t_{RCD}	15	—	15	—	15	—	ns	1)2)3)4)
Row Precharge Time		t_{RP}	15	—	15	—	15	—	ns	1)2)3)4)

1) Timings are guaranteed with 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) under the “Reference Load for Timing Measurements”
2) The CK/$\overline{CK}$ input reference level (for timing reference to CK/$\overline{CK}$) is the point at which CK and $\overline{CK}$ cross. The DQS / $\overline{DQS}$, 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 x 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 x t_{REFI}.

3.3.2 Component AC Timing Parameters

This chapter contains the AC Timing Parameters.

TABLE 13
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 / $\overline{CK}$	t_{AC}	–450	+450	ps	9)
CAS to CAS command delay	t_{CCD}	2	—	nCK	
Average clock high pulse width	$t_{CH.AVG}$	0.48	0.52	$t_{CK.AVG}$	10)11)
Average clock period	$t_{CK.AVG}$	3000	8000	ps	
CKE minimum pulse width (high and low pulse width)	t_{CKE}	3	—	nCK	12)
Average clock low pulse width	$t_{CL.AVG}$	0.48	0.52	$t_{CK.AVG}$	10)11)
Auto-Precharge write recovery + precharge time	t_{DAL}	WR + t_{nRP}	—	nCK	13)14)
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	t_{IS} + $t_{CK\ .AVG}$ + t_{IH}	—	ns	
DQ and DM input hold time	$t_{DH.BASE}$	175	—	ps	19)20)15)
DQ and DM input pulse width for each input	t_{DIPW}	0.35	—	$t_{CK.AVG}$	
DQS output access time from CK / $\overline{CK}$	t_{DQSCK}	–400	+400	ps	9)
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-DQ skew for DQS & associated DQ signals	t_{DQSQ}	—	240	ps	16)
DQS latching rising transition to associated clock edges	t_{DQSS}	– 0.25	+ 0.25	$t_{CK.AVG}$	17)
DQ and DM input setup time	$t_{DS.BASE}$	100	—	ps	18)19)20)
DQS falling edge hold time from CK	t_{DSH}	0.2	—	$t_{CK.AVG}$	17)
DQS falling edge to CK setup time	t_{DSS}	0.2	—	$t_{CK.AVG}$	17)
Four Activate Window for 1KB page size products	t_{FAW}	37.5	—	ns	31)
Four Activate Window for 2KB page size products	t_{FAW}	50	—	ns	31)
CK half pulse width	t_{HP}	Min($t_{CH.ABS}$, $t_{CL.ABS}$)	—	ps	21)
Data-out high-impedance time from CK / $\overline{CK}$	t_{HZ}	—	$t_{AC.MAX}$	ps	9)22)
Address and control input hold time	$t_{IH.BASE}$	275	—	ps	25)23)
Control & address input pulse width for each input	t_{IPW}	0.6	—	$t_{CK.AVG}$	
Address and control input setup time	$t_{IS.BASE}$	200	—	ps	24)25)
DQ low impedance time from CK/$\overline{CK}$	$t_{LZ.DQ}$	2 x $t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
DQS/$\overline{DQS}$ low-impedance time from CK / $\overline{CK}$	$t_{LZ.DQS}$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
MRS command to ODT update delay	t_{MOD}	0	12	ns	31)
Mode register set command cycle time	t_{MRD}	2	—	nCK	
OCD drive mode output delay	t_{OIT}	0	12	ns	31)
DQ/DQS output hold time from DQS	t_{QH}	t_{HP} – t_{QHS}	—	ps	26)

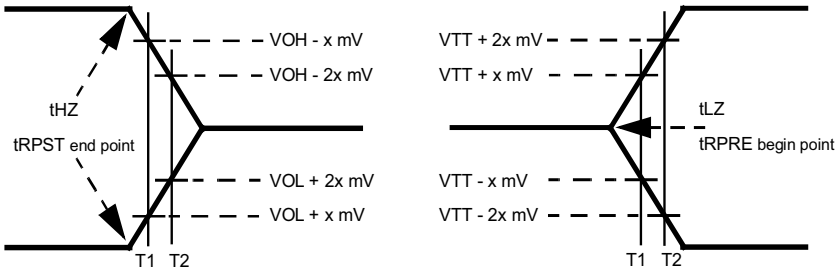
Parameter	Symbol	DDR2–667		Unit	Note 1)2)3)4)5)6)7)8)
		Min.	Max.		
DQ hold skew factor	t_{QHS}	—	340	ps	27)
Read preamble	t_{RPRE}	0.9	1.1	$t_{CK.AVG}$	28)29)
Read postamble	t_{RPST}	0.4	0.6	$t_{CK.AVG}$	28)30)
Active to active command period for 1KB page size products	t_{RRD}	7.5	—	ns	31)
Active to active command period for 2KB page size products	t_{RRD}	10	—	ns	31)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	31)
Write preamble	t_{WPRE}	0.35	—	$t_{CK.AVG}$	
Write postamble	t_{WPST}	0.4	0.6	$t_{CK.AVG}$	
Write recovery time	t_{WR}	15	—	ns	31)
Internal write to read command delay	t_{WTR}	7.5	—	ns	31)32)
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	
Exit precharge power-down to any valid command (other than NOP or Deselect)	t_{XP}	2	—	nCK	
Exit self-refresh to a non-read command	t_{XSNR}	t_{RFC} +10	—	ns	31)
Exit self-refresh to read command	t_{XSRD}	200	—	nCK	
Write command to DQS associated clock edges	WL	RL–1		nCK	

1) For details and notes see the relevant Qimonda component data sheet
2) V_{DDQ} = 1.8 V ± 0.1V; V_{DD} = 1.8 V ± 0.1 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/$\overline{CK}$ 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.
5) The CK / $\overline{CK}$ input reference level (for timing reference to CK / $\overline{CK}$) is the point at which CK and $\overline{CK}$ cross. The DQS / $\overline{DQS}$, RDQS / $\overline{RDQS}$, 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 x V_{DDQ} is recognized as low.
7) The output timing reference voltage level is V_{TT}.
8) 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 Tm, an Active command may be registered at Tm + 2, even if (Tm + 2 - Tm) is 2 x $t_{CK.AVG}$ + $t_{ERR.2PER(Min)}$.
9) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{ERR(6\text{-}10per)}$ 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 $t_{ERR(6\text{-}10PER).MIN}$ = – 272 ps and $t_{ERR(6\text{-}\ 10PER).MAX}$ = + 293 ps, then $t_{DQSCK.MIN(DERATED)}$ = $t_{DQSCK.MIN}$ – $t_{ERR(6\text{-}10PER).MAX}$ = – 400 ps – 293 ps = – 693 ps and $t_{DQSCK.MAX(DERATED)}$ = $t_{DQSCK.MAX}$ – $t_{ERR(6\text{-}10PER).MIN}$ = 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!)
10) 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.
11) 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).
12) $t_{CKE.MIN}$ 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 x t_{CK} + t_{IH}.

13) 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 ns / 3.75 ns) clocks = 4 + (4) clocks = 8 clocks.
14) $t_{DAL.nCK}$ = WR [nCK] + $t_{nRP.nCK}$ = WR + RU{t_{RP} [ps] / $t_{CK.AVG}$[ps] }, where WR is the value programmed in the EMR.
15) 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**.
16) 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.
17) These parameters are measured from a data strobe signal ((L/U/R)DQS / $\overline{\text{DQS}}$) crossing to its respective clock signal (CK / $\overline{\text{CK}}$) 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.
18) 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**.
19) 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.
20) 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.
21) 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} = 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.
22) 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}) .
23) 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**.
24) 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**.
25) 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 / $\overline{\text{CK}}$) 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.
26) 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.
27) 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.
28) 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.
29) 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 x $t_{CK.AVG}$ – 72 ps = + 2178 ps and $t_{RPRE.MAX(DERATED)}$ = $t_{RPRE.MAX}$ + $t_{JIT.PER.MAX}$ = 1.1 x $t_{CK.AVG}$ + 93 ps = + 2843 ps. (Caution on the MIN/MAX usage!).
30) 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 x $t_{CK.AVG}$ – 72 ps = + 928 ps and $t_{RPST.MAX(DERATED)}$ = $t_{RPST.MAX}$ + $t_{JIT.DUTY.MAX}$ = 0.6 x $t_{CK.AVG}$ + 93 ps = + 1592 ps. (Caution on the MIN/MAX usage!).
31) For these parameters, the DDR2 SDRAM device is characterized and verified to support t_{nPARAM} = RU{t_{PARAM} / $t_{CK.AVG}$}, which is in clock cycles, assuming all input clock jitter specifications are satisfied. For example, the device will support t_{nRP} = RU{t_{RP} / $t_{CK.AVG}$}, which is in clock cycles, if all input clock jitter specifications are met. This means: For DDR2–667 5–5–5, of which t_{RP} = 15 ns, the device will support t_{nRP} = RU{t_{RP} / $t_{CK.AVG}$} = 5, i.e. as long as the input clock jitter specifications are met, Precharge command at Tm and Active command at Tm + 5 is valid even if (Tm + 5 - Tm) is less than 15 ns due to input clock jitter.

32) t_{WTR} is at lease two clocks (2 x t_{CK}) independent of operation frequency.

FIGURE 2
Method for calculating transitions and endpoint



tHZ,tRPST end point = 2*T1-T2

tLZ,tRPRE begin point = 2*T1-T2

FIGURE 3
Differential input waveform timing - t_{DS} and t_{DS}

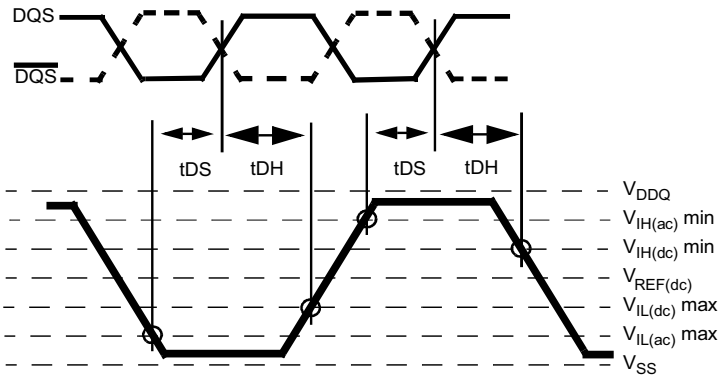


FIGURE 4
Differential input waveform timing - t_{IS} and t_{IH}

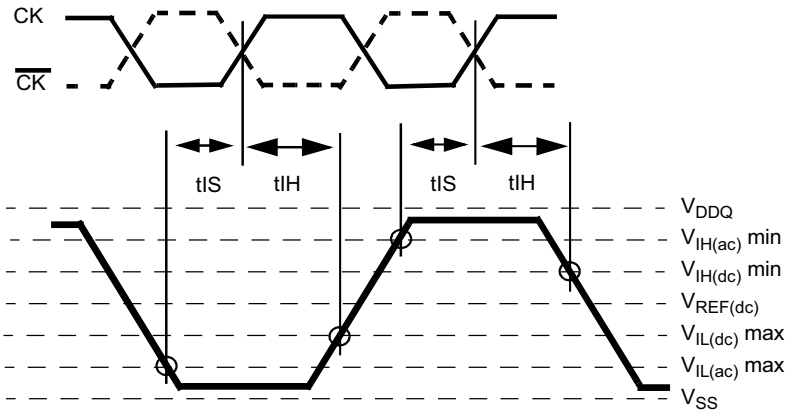


TABLE 14
DRAM Component Timing Parameter by Speed Grade - DDR2–533

Parameter	Symbol	DDR2–533		Unit	Note 1)2)3)4)5)6)7)
		Min.	Max.		
DQ output access time from CK / $\overline{CK}$	t_{AC}	–500	+500	ps	
$\overline{CAS}$ A to $\overline{CAS}$ B command period	t_{CCD}	2	—	t_{CK}	
CK, $\overline{CK}$ high-level width	t_{CH}	0.45	0.55	t_{CK}	
CKE minimum high and low pulse width	t_{CKE}	3	—	t_{CK}	
CK, $\overline{CK}$ 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_{IS} + t_{CK} + t_{IH}	—	ns	9)
DQ and DM input hold time (differential data strobe)	t_{DH}(base)	225	—	ps	10)
DQ and DM input hold time (single ended data strobe)	t_{DH1}(base)	–25	—	ps	11)
DQ and DM input pulse width (each input)	t_{DIPW}	0.35	—	t_{CK}	
DQS output access time from CK / $\overline{CK}$	t_{DQSCK}	–450	+450	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}	—	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_{DS}(base)	100	—	ps	11)
DQ and DM input setup time (single ended data strobe)	t_{DS1}(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}	
Four Activate Window period	t_{FAW}	37.5	—	ns	
Four Activate Window period	t_{FAW}	50	—	ns	13)
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)	375	—	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)	250	—	ps	11)
DQ low-impedance time from CK / $\overline{CK}$	$t_{LZ(DQ)}$	2 × $t_{AC.MIN}$	$t_{AC.MAX}$	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}	—	—	

Parameter	Symbol	DDR2–533		Unit	Note 1)2)3)4)5)6)7)
		Min.	Max.		
Data hold skew factor	t_{QHS}	—	400	ps	
Average periodic refresh Interval	t_{REFI}	—	7.8	µs	14)15)
Average periodic refresh Interval	t_{REFI}	—	3.9	µs	16)18)
Auto-Refresh to Active/Auto-Refresh command period	t_{RFC}	127.5	—	ns	17)
Precharge-All (4 banks) command period	t_{RP}	t_{RP} + 1t_{CK}	—	ns	
Precharge-All (8 banks) command period	t_{RP}	15 + 1tCK	—	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)
Active bank A to Active bank B command period	t_{RRD}	10	—	ns	16)22)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	
Write preamble	t_{WPRE}	0.25	—	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	
Internal Write to Read command delay	t_{WTR}	7.5	—	ns	20)
Exit power down to any valid command (other than NOP or Deselect)	t_{XARD}	2	—	t_{CK}	21)
Exit active power-down mode to Read command (slow exit, lower power)	t_{XARDS}	6 – AL	—	t_{CK}	21)
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}	
Write recovery time for write with Auto-Precharge	WR	t_{WR}/t_{CK}	—	t_{CK}	22)

1) For details and notes see the relevant Qimonda component data sheet
2) V_{DDQ} = 1.8 V ± 0.1 V; V_{DD} = 1.8 V ±0.1 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/$\overline{CK}$ 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.
5) The CK / $\overline{CK}$ input reference level (for timing reference to CK / $\overline{CK}$) is the point at which CK and $\overline{CK}$ cross. The DQS / $\overline{DQS}$, RDQS/ $\overline{RDQS}$, 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 x 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 / $\overline{DQS}$ 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}).
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 °C≤ T_{CASE} ≤ 85 °C
16) 85 °C < T_{CASE} ≤ 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) Minimum t_{WTR} is two clocks when operating the DDR2-SDRAM at frequencies ≤ 200 MHz.
21) 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.
22) WR must be programmed to fulfill the minimum requirement for the t_{WR} timing parameter, where WR_{MIN}[cycles] = t_{WR}(ns)/t_{CK}(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.

TABLE 15
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 / $\overline{CK}$	t_{AC}	–600	+600	ps	
$\overline{CAS}$ A to $\overline{CAS}$ B command period	t_{CCD}	2	—	t_{CK}	
CK, $\overline{CK}$ high-level width	t_{CH}	0.45	0.55	t_{CK}	
CKE minimum high and low pulse width	t_{CKE}	3	—	t_{CK}	
CK, $\overline{CK}$ 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)21)
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}(base)	275	—	ps	10)
DQ and DM input hold time (single ended data strobe)	t_{DH1}(base)	–25	—	ps	11)
DQ and DM input pulse width (each input)	t_{DIPW}	0.35	—	t_{CK}	
DQS output access time from CK / $\overline{CK}$	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}(base)	150	—	ps	11)

Parameter	Symbol	DDR2–400		Unit	Note 1)2)3)4)5)6)7)
		Min.	Max.		
DQ and DM input setup time (single ended data strobe)	t_{DS1}(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}	
Four Activate Window period	t_{FAW}	37.5	—	ns	
Four Activate Window period	t_{FAW}	50	—	ns	13)
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 × $t_{AC.MIN}$	$t_{AC.MAX}$	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)
Average periodic refresh Interval	t_{REFI}	—	3.9	µs	16)18)
Auto-Refresh to Active/Auto-Refresh command period		127.5	—	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)
Active bank A to Active bank B command period	t_{RRD}	10	—	ns	16)22)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	
Write preamble	t_{WPRE}	0.25	—	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	
Internal Write to Read command delay	t_{WTR}	10	—	ns	20)
Exit power down to any valid command (other than NOP or Deselect)	t_{XARD}	2	—	t_{CK}	21)
Exit active power-down mode to Read command (slow exit, lower power)	t_{XARDS}	6 – AL	—	t_{CK}	21)

Parameter	Symbol	DDR2–400		Unit	Note 1)2)3)4)5)6)7)
		Min.	Max.		
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}	
Write recovery time for write with Auto-Precharge	WR	t_{WR}/t_{CK}	—	t_{CK}	22)

1) For details and notes see the relevant Qimonda component data sheet
2) V_{DDQ} = 1.8 V ± 0.1 V; V_{DD} = 1.8 V ±0.1 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/$\overline{CK}$ 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.
5) The CK / $\overline{CK}$ input reference level (for timing reference to CK / $\overline{CK}$) is the point at which CK and $\overline{CK}$ cross. The DQS / $\overline{DQS}$, RDQS/ $\overline{RDQS}$, 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 x 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 / $\overline{DQS}$ 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}).
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 °C≤ T_{CASE} ≤ 85 °C
16) 85 °C < T_{CASE} ≤ 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) Minimum t_{WTR} is two clocks when operating the DDR2-SDRAM at frequencies ≤ 200 MHz.
21) 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.
22) WR must be programmed to fulfill the minimum requirement for the t_{WR} timing parameter, where WR_{MIN}[cycles] = t_{WR}(ns)/t_{CK}(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.

3.3.3 ODT AC Electrical Characteristics

This chapter contains the ODT AC electrical characteristics tables.

TABLE 16
ODT AC Character. and Operating Conditions for DDR2-667

Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOND}	ODT turn-on delay	2	2	nCK	1)
t_{AON}	ODT turn-on	$t_{AC.MIN}$	$t_{AC.MAX}$ + 0.7 ns	ns	1)2)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{AC.MIN}$ + 2 ns	2 t_{CK} + $t_{AC.MAX}$ + 1 ns	ns	1)
t_{AOFD}	ODT turn-off delay	2.5	2.5	nCK	1)
t_{AOF}	ODT turn-off	$t_{AC.MIN}$	$t_{AC.MAX}$ + 0.6 ns	ns	1)3)
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{AC.MIN}$ + 2 ns	2.5 t_{CK} + $t_{AC.MAX}$ + 1 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, '$t_{CK.AVG}$' 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 Tm, an Active command may be registered at Tm + 2, even if (Tm + 2 - Tm) is 2 × $t_{CK.AVG}$+ $t_{EPR.2PER(MIN)}$.

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 $t_{CK.AVG}$ = 3 ns is assumed, t_{AOFD}= 1.5 ns (0.5 × 3 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 17
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	$t_{AC.MIN}$	$t_{AC.MAX}$ + 1 ns	ns	1)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{AC.MIN}$ + 2 ns	2 t_{CK} + $t_{AC.MAX}$ + 1 ns	ns	
t_{AOFD}	ODT turn-off delay	2.5	2.5	t_{CK}	
t_{AOF}	ODT turn-off	$t_{AC.MIN}$	$t_{AC.MAX}$ + 0.6 ns	ns	2)
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{AC.MIN}$ + 2 ns	2.5 t_{CK} + $t_{AC.MAX}$ + 1 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 x 5 ns) after the clock edge that registered a first ODT HIGH if t_{CK} = 5 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 x 5 ns) after the clock edge that registered a first ODT HIGH if t_{CK} = 5 ns.

3.4 Currents Specifications and Conditions

This chapter contains the Current Specification and Condition tables.

TABLE 18
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}; $t_{CK} = t_{CKMIN}$; $t_{RAS} = t_{RASMAX}$; $t_{RP} = t_{RPMIN}$; CKE is HIGH, CS is HIGH between valid commands; Address inputs are SWITCHING; Data bus inputs are SWITCHING; I_{OUT} = 0mA.	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}	
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}	

Parameter	Symbol	Note 1)2)3)4)5)
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 V ± 0.1 V; V_{DD} = 1.8 V ± 0.1 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 19**
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 19
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

TABLE 20

I_{DD} Specification for HYS72T[512/256]02xHR–[3S/3.7/5]–A

Product Type	HYS72T512022HR-3S-A	HYS72T512022HR-3.7-A	HYS72T512022HR-5-A	HYS72T512022HR-5-A	Unit	Note[1)]
Organization	4 GB	4 GB	4 GB	2 GB		
	2 Ranks	2 Ranks	2 Ranks	2 Ranks		
	×72	×72	×72	×72		
	-3S	-3.7	-5	-5		
Symbol		Max.	Max.	Max.		
I_{DD0}	2180	1980	1790	1100	mA	2)
I_{DD1}	2520	2160	1970	1190	mA	2)
I_{DD2N}	2760	2160	1670	1040	mA	3)
I_{DD2P}	850	750	660	530	mA	3)
I_{DD2Q}	2000	1330	1410	910	mA	3)
I_{DD3N}	2940	2300	1850	1130	mA	3)
$I_{DD3P.MRS=0}$	1390	1220	1050	730	mA	3)4)
$I_{DD3P.MRS=1}$	920	820	730	570	mA	3)5)
I_{DD4R}	4320	3240	2600	1500	mA	2)
I_{DD4W}	4320	3150	2510	1460	mA	2)
I_{DD5B}	4320	3960	3770	2090	mA	2)
I_{DD5D}	960	860	770	590	mA	3)6)
I_{DD6}	288	288	288	144	mA	3)6)
I_{DD7}	5080	4770	4220	2310	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 $0°C \leq T_{Case} \leq 85°C$

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.

TABLE 21
SPD Codes HYS72T[512/256]02xHR–[3S/3.7/5]–A

Product Type		HYS72T512022HR–3S–A	HYS72T512022HR–3.7–A	HYS72T512022HR–5–A	HYS72T256023HR–5–A
Organization		4 GByte	4 GByte	4 GByte	2 GByte
		×72	×72	×72	×72
		2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×8)
Label Code		PC2–5300R–555	PC2–4200R–444	PC2–3200R–333	PC2–3200R–333
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80	80
1	Total number of Bytes in EEPROM	08	08	08	08
2	Memory Type (DDR2)	08	08	08	08
3	Number of Row Addresses	0E	0E	0E	0E
4	Number of Column Addresses	0B	0B	0B	0A
5	DIMM Rank and Stacking Information	71	71	71	71
6	Data Width	48	48	48	48
7	Not used	00	00	00	00
8	Interface Voltage Level	05	05	05	05
9	t_{CK} @ CL_{MAX} (Byte 18) [ns]	30	3D	50	50
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	45	50	60	60
11	Error Correction Support (non-ECC, ECC)	02	02	02	02
12	Refresh Rate and Type	82	82	82	82
13	Primary SDRAM Width	04	04	04	08
14	Error Checking SDRAM Width	04	04	04	08
15	Not used	00	00	00	00
16	Burst Length Supported	0C	0C	0C	0C

Product Type		HYS72T512022HR–3S–A	HYS72T512022HR–3.7–A	HYS72T512022HR–5–A	HYS72T256023HR–5–A
Organization		4 GByte	4 GByte	4 GByte	2 GByte
		×72	×72	×72	×72
		2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×8)
Label Code		PC2–5300R–555	PC2–4200R–444	PC2–3200R–333	PC2–3200R–333
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX
17	Number of Banks on SDRAM Device	08	08	08	08
18	Supported CAS Latencies	38	38	38	38
19	DIMM Mechanical Characteristics	01	01	01	01
20	DIMM Type Information	01	01	01	01
21	DIMM Attributes	05	05	05	04
22	Component Attributes	03	01	01	01
23	t_{CK} @ CL_{MAX} -1 (Byte 18) [ns]	3D	3D	50	50
24	t_{AC} SDRAM @ CL_{MAX} -1 [ns]	50	50	60	60
25	t_{CK} @ CL_{MAX} -2 (Byte 18) [ns]	50	50	50	50
26	t_{AC} SDRAM @ CL_{MAX} -2 [ns]	60	60	60	60
27	$t_{RP.MIN}$ [ns]	3C	3C	3C	3C
28	$t_{RRD.MIN}$ [ns]	1E	1E	1E	1E
29	$t_{RCD.MIN}$ [ns]	3C	3C	3C	3C
30	$t_{RAS.MIN}$ [ns]	2D	2D	28	28
31	Module Density per Rank	02	02	02	01
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	20	25	35	35
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	27	37	47	47
34	$t_{DS.MIN}$ [ns]	10	10	15	15
35	$t_{DH.MIN}$ [ns]	17	22	27	27
36	$t_{WR.MIN}$ [ns]	3C	3C	3C	3C
37	$t_{WTR.MIN}$ [ns]	1E	1E	28	28
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E	1E
39	Analysis Characteristics	00	00	00	00
40	t_{RC} and t_{RFC} Extension	06	06	06	06
41	$t_{RC.MIN}$ [ns]	3C	3C	37	37
42	$t_{RFC.MIN}$ [ns]	7F	7F	7F	7F

Product Type		HYS72T512022HR–3S–A	HYS72T512022HR–3.7–A	HYS72T512022HR–5–A	HYS72T256023HR–5–A
Organization		4 GByte	4 GByte	4 GByte	2 GByte
		×72	×72	×72	×72
		2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×8)
Label Code		PC2–5300R–555	PC2–4200R–444	PC2–3200R–333	PC2–3200R–333
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX
43	$t_{CK.MAX}$ [ns]	80	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	18	1E	23	23
45	$t_{QHS.MAX}$ [ns]	22	28	2D	2D
46	PLL Relock Time	0F	0F	0F	0F
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	50	50	50	51
48	Psi(T-A) DRAM	58	00	00	60
49	ΔT_0 (DT0)	37	00	00	33
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	21	00	00	1A
51	ΔT_{2P} (DT2P)	21	00	00	23
52	ΔT_{3N} (DT3N)	24	00	00	18
53	$\Delta T_{3P.fast}$ (DT3P fast)	23	00	00	18
54	$\Delta T_{3P.slow}$ (DT3P slow)	17	00	00	16
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	4A	00	00	35
56	ΔT_{5B} (DT5B)	21	00	00	21
57	ΔT_7 (DT7)	28	00	00	25
58	Psi(ca) PLL	00	00	00	C4
59	Psi(ca) REG	00	00	00	8C
60	ΔT_{PLL} (DTPLL)	00	00	00	59
61	ΔT_{REG} (DTREG) / Toggle Rate	00	00	00	5C
62	SPD Revision	12	12	12	12
63	Checksum of Bytes 0-62	54	D4	4E	EA
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F	7F

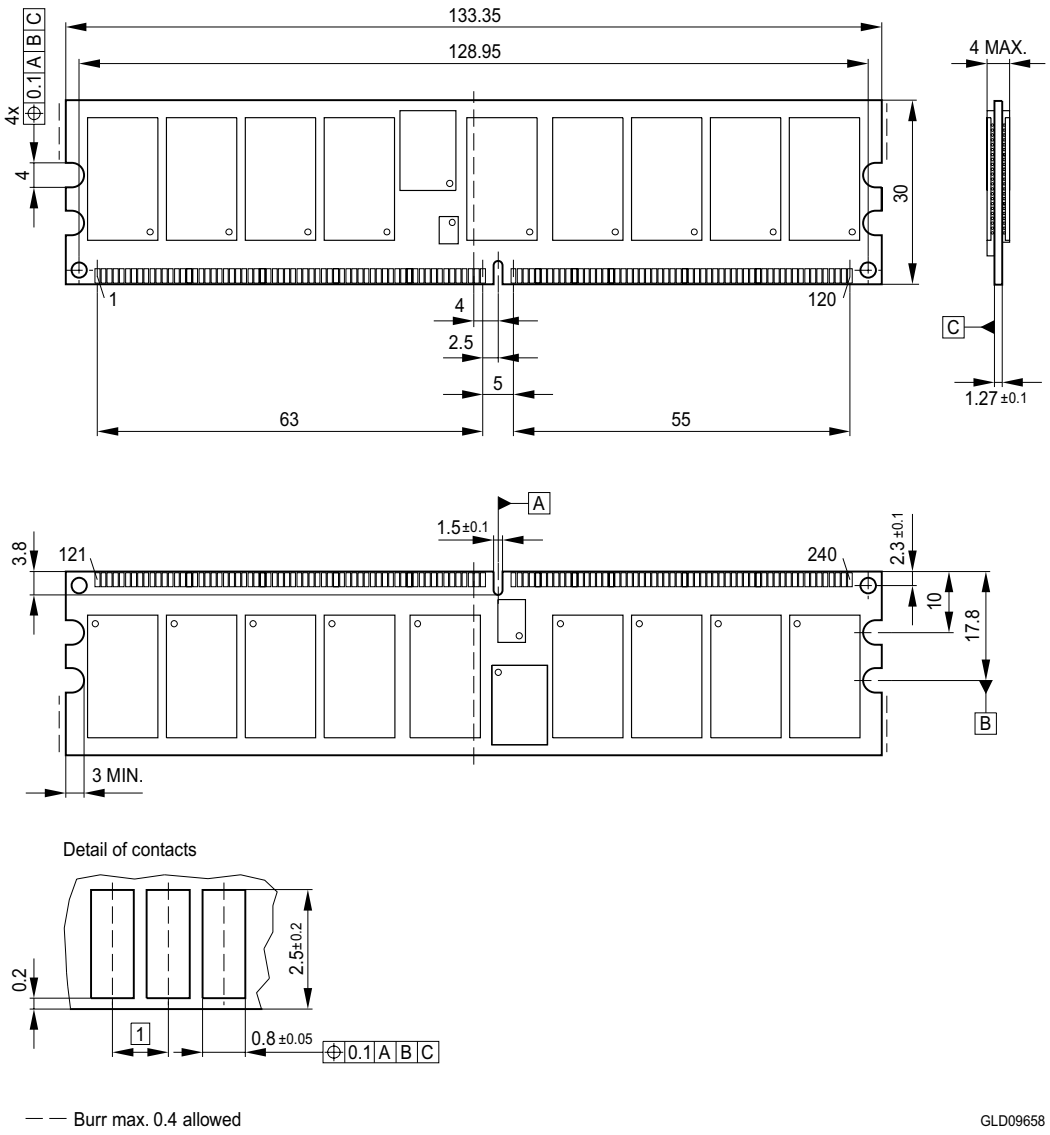
Product Type		HYS72T512022HR–3S–A	HYS72T512022HR–3.7–A	HYS72T512022HR–5–A	HYS72T256023HR–5–A
Organization		4 GByte	4 GByte	4 GByte	2 GByte
		×72	×72	×72	×72
		2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×4)	2 Ranks (×8)
Label Code		PC2–5300R–555	PC2–4200R–444	PC2–3200R–333	PC2–3200R–333
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX
69	Manufacturer's JEDEC ID Code (6)	51	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00	00
72	Module Manufacturer Location	xx	xx	xx	xx
73	Product Type, Char 1	37	37	37	37
74	Product Type, Char 2	32	32	32	32
75	Product Type, Char 3	54	54	54	54
76	Product Type, Char 4	35	35	35	32
77	Product Type, Char 5	31	31	31	35
78	Product Type, Char 6	32	32	32	36
79	Product Type, Char 7	30	30	30	30
80	Product Type, Char 8	32	32	32	32
81	Product Type, Char 9	32	32	32	33
82	Product Type, Char 10	48	48	48	48
83	Product Type, Char 11	52	52	52	52
84	Product Type, Char 12	33	33	35	35
85	Product Type, Char 13	53	2E	41	41
86	Product Type, Char 14	41	37	20	20
87	Product Type, Char 15	20	41	20	20
88	Product Type, Char 16	20	20	20	20
89	Product Type, Char 17	20	20	20	20
90	Product Type, Char 18	20	20	20	20
91	Module Revision Code	5x	5x	5x	0x
92	Test Program Revision Code	xx	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx	xx

Product Type		HYS72T512022HR–3S–A	HYS72T512022HR–3.7–A	HYS72T512022HR–5–A	HYS72T256023HR–5–A
Organization		**4 GByte**	**4 GByte**	**4 GByte**	**2 GByte**
		×72	**×72**	**×72**	**×72**
		2 Ranks (×4)	**2 Ranks (×4)**	**2 Ranks (×4)**	**2 Ranks (×8)**
Label Code		**PC2–5300R–555**	**PC2–4200R–444**	**PC2–3200R–333**	**PC2–3200R–333**
JEDEC SPD Revision		**Rev. 1.2**	**Rev. 1.2**	**Rev. 1.2**	**Rev. 1.2**
Byte#	**Description**	**HEX**	**HEX**	**HEX**	**HEX**
95 - 98	Module Serial Number	xx	xx	xx	xx
99 - 127	Not used	00	00	00	00
128 - 255	Blank for customer use	FF	FF	FF	FF

5 Package Outlines

This chapter contains the package outlines of the products.

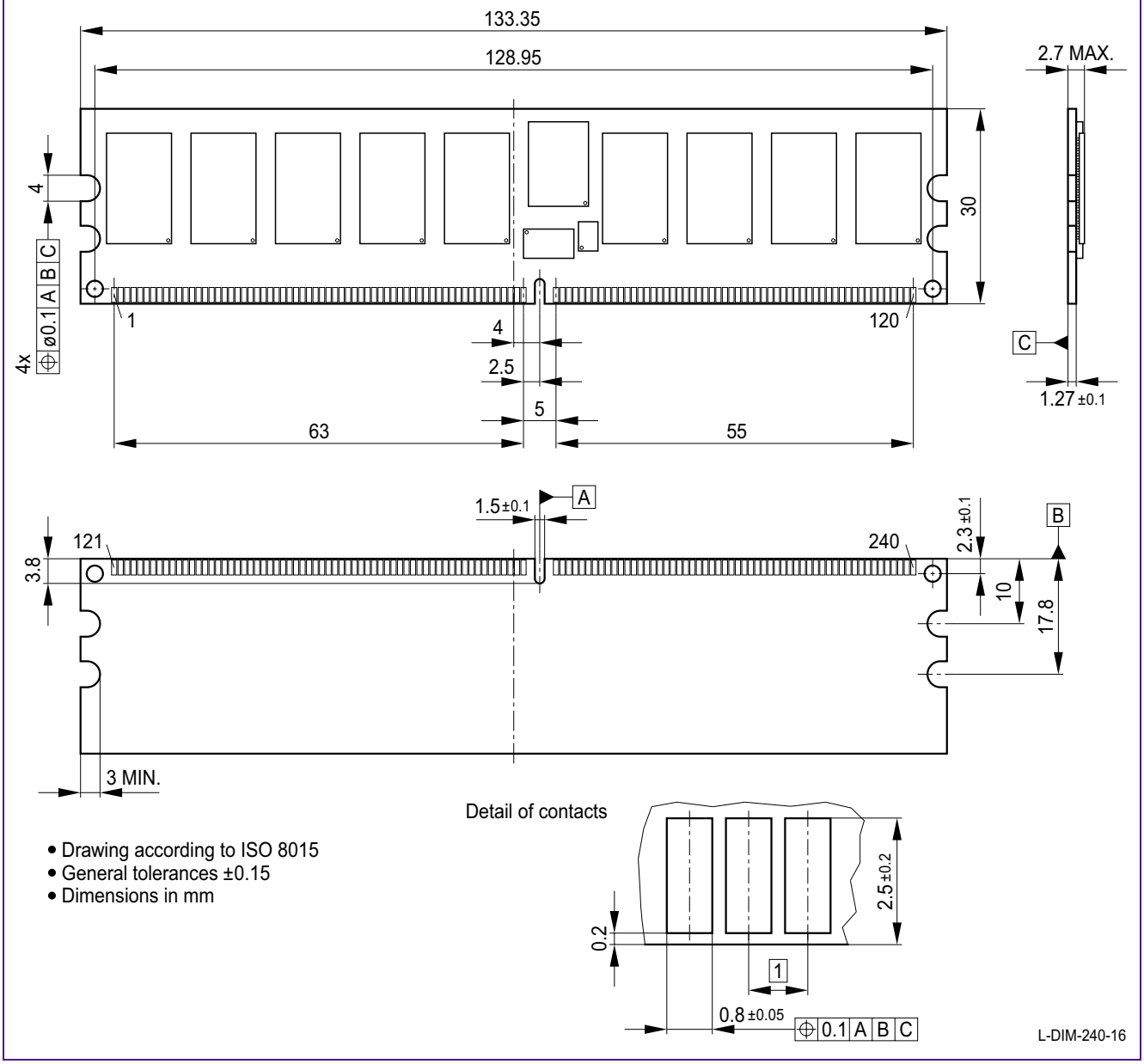
FIGURE 5
Package Outline Raw Card D L-DIM-240-15



Notes

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

FIGURE 6
Package Outline Raw Card Z L-DIM-240-16



6 Product Type Nomenclature

Qiomonda's nomenclature uses simple coding combined with some propriatory coding. **Table 22** 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 23** and for components in **Table 24**.

TABLE 22
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 23
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-**D**IMM
		M	**M**icro-DIMM
		R	**R**egistered
		U	**U**nbuffered
		F	**F**ully Buffered

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 24
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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