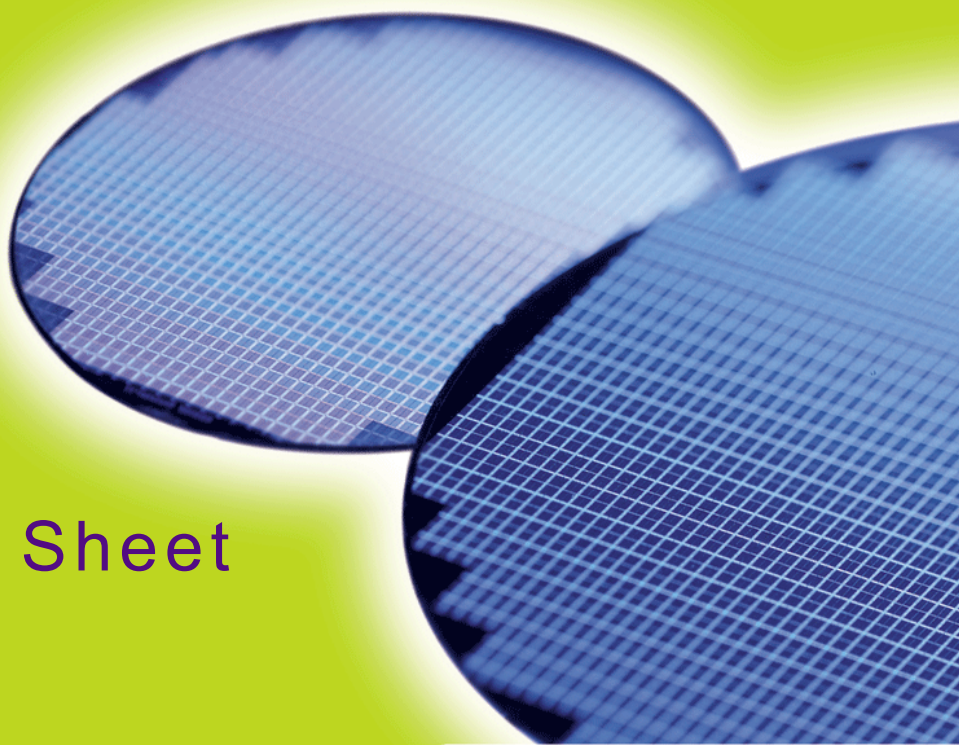


HYS72T1G242EP-[25F/2.5]-C HYS72T1G242EP-[3/3S/3.7]-C

*240-Pin Dual Die Registered DDR2 SDRAM Modules
RDIMM SDRAM
RoHS Compliant*



Internet Data Sheet

Rev. 1.0

**HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C**
Registered DDR2 SDRAM Module**HYS72T1G242EP-[25F/2.5]-C, HYS72T1G242EP-[3/3S/3.7]-C****Revision History: 2007-07, Rev. 1.0**

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HYS72T1G242EP-[25F/2.5/3S/3.7]-C Registered DDR2 SDRAM Module

1 Overview

This chapter gives an overview of the 1.8 V 240-Pin Dual Die Registered DDR2 SDRAM Modules with parity bit product family and describes its main characteristics.

1.1 Features

- 240-Pin PC2-6400, PC2-5300 and PC2-4200 DDR2 SDRAM memory modules.
- 1024M ×72 module organization and 512M ×4 chip organization
- Registered DIMM Parity bit for address and control bus
- 8 GByte modules built with stacked 2 Gbit (1Gbit Dual Dies) DDR2 SDRAMs in P-TFBGA-63 chipsize packages.
- Standard Double-Data-Rate-Two Synchronous DRAMs (DDR2 SDRAM) with a single + 1.8 V (± 0.1 V) power supply
- Programmable CAS Latencies (3, 4, 5, 6), Burst Length (4 & 8)
- 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_18 compatible
- Off-Chip Driver Impedance Adjustment (OCD) and On-Die Termination (ODT)
- Serial Presence Detect with E²PROM
- RDIMM Dimensions (nominal): 30 mm high, 133.35 mm wide
- Based on standard reference card layouts Raw Card "Z"
- All speed grades faster than DDR2-400 comply with DDR2-400 timing specifications.
- RoHS compliant products¹⁾

TABLE 1
Performance Table

Product Type Speed Code			-25F	-2.5	-3	-3S	-3.7	Unit
DRAM Speed Grade			DDR2-800D	DDR2-800E	DDR2-667C	DDR2-667D	DDR2-533C	
Speed Grade			PC2-6400	PC2-6400	PC2-5300	PC2-5300	PC2-4200	
CAS-RCD-RP latencies			5-5-5	6-6-6	4-4-4	5-5-5	4-4-4	t_{CK}
Max. Clock Frequency	@CL6	f_{CK6}	–	400	–	–	–	MHz
	@CL5	f_{CK5}	400	333	333	333	266	MHz
	@CL4	f_{CK4}	266	266	333	266	266	MHz
	@CL3	f_{CK3}	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	45	ns
Min. Row Cycle Time		t_{RC}	57.5	60	57	60	60	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.



HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C Registered DDR2 SDRAM Module

1.2 Description

The Qimonda HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C module family are Registered DIMM (with parity) modules with 30 mm height based on DDR2 technology.

DIMMs are available as ECC modules in 1024M × 72 (8 GB) organization and density, intended for mounting into 240-Pin connector sockets.

The memory array is designed with stacked 2 Gbit (1Gbit Dual Dies) 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 E2PROM device using the 2-pin I2C protocol. The first 128 bytes are programmed with configuration data and 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			
HYS72T1G242EP-2.5-C	8GB 4Rx4 PC2-6400P-666-12-ZZ	4 Rank, ECC	1Gbit (× 4)
HYS72T1G242EP-25F-C	8GB 4Rx4 PC2-6400P-555-12-ZZ	4 Rank, ECC	1Gbit (× 4)
PC2-5300			
HYS72T1G242EP-3-C	8GB 4Rx4 PC2-5300P-444-12-ZZ	4 Rank, ECC	1Gbit (× 4)
HYS72T1G242EP-3S-C	8GB 4Rx4 PC2-5300P-555-12-ZZ	4 Rank, ECC	1Gbit (× 4)
PC2-4200			
HYS72T1G242EP-3.7-C	8GB 4Rx4 PC2-4200P-444-12-ZZ	4 Rank, ECC	1Gbit (× 4)

- 1) All Product Type number end with a place code, designating the silicon die revision. Example: HYS72T1G242EP-3.7-C, indicating Rev. "C" 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 "PC2-4200P-444-12-ZZ", where 4200P means Registered DIMM modules (with Parity Bit) 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 "F"

TABLE 3
Address Format

DIMM Density	Module Organization	Memory Ranks	ECC/ Non-ECC	# of SDRAMs	# of row/bank/column bits	Raw Card
8 GByte	1024M × 72	4	ECC	36DDP ¹⁾	14/3/11	Z

- 1) DDP Dual Die Package

TABLE 4
Components on Modules

Product Type ¹⁾	DRAM Components	DRAM Density	DRAM Organization
HYS72T1G242EP	HYB18T2G402CF	1 Gbit	2 × 512M × 4

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



2 Pin Configuration and Block Diagrams

This chapter contains the pin configuration and block diagrams.

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

Pin No.	Name	Pin Type	Buffer Type	Function
Clock Signals				
185	CK0	I	SSTL	Clock Signal CK0, Complementary Clock Signal CK0 The system clock inputs. All address and command lines are sampled on the cross point of the rising edge of CK and the falling edge of CK. A Delay Locked Loop (DLL) circuit is driven from the clock inputs and output timing for read operations is synchronized to the input clock.
186	$\overline{\text{CK0}}$	I	SSTL	
52	CKE0	I	SSTL	Clock Enables 1:0 Activates the DDR2 SDRAM CK signal when HIGH and deactivates the CK signal when LOW. By deactivating the clocks, CKE0 initiates the Power Down Mode or the Self Refresh Mode. <i>Note: 2-Ranks module</i>
171	CKE1	I	SSTL	
	NC	NC	—	
				Not Connected <i>Note: 1-Rank module</i>
Control Signals				
193	$\overline{\text{S0}}$	I	SSTL	Chip Select Enables the associated DDR2 SDRAM command decoder when LOW and disables the command decoder when HIGH. When the command decoder is disabled, new commands are ignored but previous operations continue. Rank 0 is selected by $\overline{\text{S0}}$ Rank 1 is selected by $\overline{\text{S1}}$ The input signals also disable all outputs (except CKE and ODT) of the register(s) on the DIMM when both inputs are high. When $\overline{\text{S}}$ is HIGH, all register outputs (except CK, ODT and Chip select) remain in the previous state. <i>Note: 2-Ranks module</i>
76	$\overline{\text{S1}}$	I	SSTL	
	NC	NC	—	
				Not Connected <i>Note: 1-Rank module</i>


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Pin No.	Name	Pin Type	Buffer Type	Function
220	$\overline{S2}$	I	SSTL	Rank 2 is selected by $\overline{S2}$
	NC	NC	—	Not Connected <i>Note: 1-Rank, 2-Ranks module</i>
221	$\overline{S3}$	I	SSTL	Rank 3 is selected by $\overline{S3}$
	NC	NC	—	Not Connected <i>Note: 1-Rank, 2-Ranks module</i>
192	$\overline{RAS}$	I	SSTL	Row Address Strobe (RAS), Column Address Strobe (CAS), Write Enable (WE) When sampled at the cross point of the rising edge of CK, and falling edge of $\overline{CK}$, $\overline{RAS}$, $\overline{CAS}$ and $\overline{WE}$ define the operation to be executed by the SDRAM.
74	$\overline{CAS}$	I	SSTL	
73	$\overline{WE}$	I	SSTL	
18	$\overline{RESET}$	I	CMOS	Register Reset The RESET pin is connected to the RST pin on the register and to the OE pin on the PLL. When LOW, all register outputs will be driven LOW and the PLL clocks to the DRAMs and the register(s) will be set to low-level. The PLL will remain synchronized with the input clock.
Address Signals				
71	BA0	I	SSTL	Bank Address Bus 1:0 Selects internal SDRAM memory bank
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
188	A0	I	SSTL	Address Bus 12:0, Address Signal 10/AutoPrecharge During a Bank Activate command cycle, defines the row address when sampled at the crosspoint of the rising edge of CK and falling edge of $\overline{CK}$. During a Read or Write command cycle, defines the column address when sampled at the cross point of the rising edge of CK and falling edge of CK. In addition to the column address, AP is used to invoke autoprecharge operation at the end of the burst read or write cycle. If AP is HIGH, autoprecharge is selected and BA[2:0] defines the bank to be precharged. If AP is LOW, autoprecharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA[2:0] to control which bank(s) to precharge. If AP is HIGH, all banks will be precharged regardless of the state of BA[2:0] inputs. If AP is LOW, then BA[2:0] are used to define which bank to precharge.
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 <i>Note: Non CA parity modules based on 256 Mbit component</i>


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Pin No.	Name	Pin Type	Buffer Type	Function
174	A14	I	SSTL	Address Signal 14 <i>Note: CA Parity module</i>
	NC	NC	—	Not Connected <i>Note: Non CA parity module. Less than 1 GBit per DRAM die.</i>
173	A15	I	SSTL	Address Signal 14 <i>Note: CA Parity module</i>
	NC	NC	—	Not Connected <i>Note: Non CA parity module. Less than 1 GBit per DRAM die.</i>
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	

HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Pin No.	Name	Pin Type	Buffer Type	Function
159	DQ31	I/O	SSTL	Data Bus 63:0 Data Input/Output pins
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	
206	DQ39	I/O	SSTL	
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 <i>Note: NC on Non-ECC module</i>
43	CB1	I/O	SSTL	
48	CB2	I/O	SSTL	
49	CB3	I/O	SSTL	


HYS72T1G242EP–[25F/2.5/3/3S/3.7]–C
Registered DDR2 SDRAM Module

Pin No.	Name	Pin Type	Buffer Type	Function
161	CB4	I/O	SSTL	Check Bits 7:0 Check Bit Input / Output pins <i>Note: NC on Non-ECC module</i>
162	CB5	I/O	SSTL	
167	CB6	I/O	SSTL	
168	CB7	I/O	SSTL	
Data Strobe Bus				
7	DQS0	I/O	SSTL	Data Strobes 17:0 The data strobes, associated with one data byte, sourced with data transfers. In Write mode, the data strobe is sourced by the controller and is centered in the data window. In Read mode the data strobe is sourced by the DDR2 SDRAM and is sent at the leading edge of the data window. DQS signals are complements, and timing is relative to the crosspoint of respective DQS and $\overline{\text{DQS}}$. If the module is to be operated in single ended strobe mode, all DQS signals must be tied on the system board to V_{SS} through a 20 Ω to 10 k Ω resistor and DDR2 SDRAM mode registers programmed appropriately. <i>Note: See block diagram for corresponding DQ signals</i>
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	


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Pin No.	Name	Pin Type	Buffer Type	Function
233	DQS16	I/O	SSTL	Data Strobes 17:0
164	DQS17	I/O	SSTL	
165	DQS17	I/O	SSTL	
Data Mask				
125	DM0	I	SSTL	Data Masks 8:0 The data write masks, associated with one data byte. In Write mode, DM operates as a byte mask by allowing input data to be written if it is LOW but blocks the write operation if it is HIGH. In Read mode, DM lines have no effect. <i>Note: x8 based module</i>
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 This signal is used to clock data into and out of the SPD EEPROM.
119	SDA	I/O	OD	Serial Bus Data This is a bidirectional pin used to transfer data into or out of the SPD EEPROM. A resistor must be connected from SDA to V_{DDSPD} on the motherboard to act as a pull-up.
239	SA0	I	CMOS	Serial Address Select Bus 2:0 These signals are tied at the system planar to either V_{SS} or V_{DDSPD} to configure the serial SPD EEPROM address range
240	SA1	I	CMOS	
101	SA2	I	CMOS	
Parity				
55	ERR_OUT	O	CMOS	Parity bits <i>Note: Only for modules with parity bit for address and control bus. Not connected on non-parity registered modules.</i>
68	PAR_IN	I	CMOS	
Power Supplies				
1	V_{REF}	AI	—	I/O Reference Voltage Reference voltage for the SSTL-18 inputs.
238	V_{DDSPD}	PWR	—	EEPROM Power Supply Serial EEPROM positive power supply, wired to a separated power pin at the connector which supports from 1.7 Volt to 3.6 Volt.
51, 56, 62, 72, 75, 78, 170, 175, 181, 191, 194	V_{DDQ}	PWR	—	I/O Driver Power Supply Power and ground for the DDR SDRAM
53, 59, 64, 67, 69, 172, 178, 184, 187, 189, 197	V_{DD}	PWR	—	Power Supply Power and ground for the DDR SDRAM


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Pin 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 Power and ground for the DDR SDRAM
Other Pins				
19, 102, 137, 138,	NC	NC	—	Not connected Pins not connected on Qimonda RDIMM's
195	ODT0	I	SSTL	On-Die Termination Control 1:0 Asserts on-die termination for DQ, DM, DQS, and $\overline{DQS}$ signals if enabled via the DDR2 SDRAM mode register. <i>Note: 2-Ranks module</i>
77	ODT1	I	SSTL	
	NC	NC	—	<i>Note: 1-Rank modules</i>

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.

HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module**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

HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module**FIGURE 1**
Pin Configuration for RDIMM (240 pins)

VREF	- Pin 001	V _{SS}	- Pin 002	Pin 122	- DQ4	Pin 121	- V _{SS}
DQ0	- Pin 003	DQ1	- Pin 004	Pin 124	- V _{SS}	Pin 123	- DQ5
V _{SS}	- Pin 005	DQS0	- Pin 006	Pin 126	- NC/DQS9	Pin 125	- DM0/DQS9
DQS0	- Pin 007	V _{SS}	- Pin 008	Pin 128	- DQ6	Pin 127	- V _{SS}
DQ2	- Pin 009	DQ3	- Pin 010	Pin 130	- V _{SS}	Pin 129	- DQ7
V _{SS}	- Pin 011	DQ8	- Pin 012	Pin 132	- DQ13	Pin 131	- DQ12
DQ9	- Pin 013	V _{SS}	- Pin 014	Pin 134	- DM1/DQS10	Pin 133	- V _{SS}
DQS1	- Pin 015	DQS1	- Pin 016	Pin 136	- V _{SS}	Pin 135	- NC/DQS10
V _{SS}	- Pin 017	RESET	- Pin 018	Pin 138	- NC	Pin 137	- NC
NC	- Pin 019	V _{SS}	- Pin 020	Pin 140	- DQ14	Pin 139	- V _{SS}
DQ10	- Pin 021	DQ11	- Pin 022	Pin 142	- V _{SS}	Pin 141	- DQ15
V _{SS}	- Pin 023	DQ16	- Pin 024	Pin 144	- DQ21	Pin 143	- DQ20
DQ17	- Pin 025	V _{SS}	- Pin 026	Pin 146	- DM2/DQS11	Pin 145	- V _{SS}
DQS2	- Pin 027	DQS2	- Pin 028	Pin 148	- V _{SS}	Pin 147	- NC/DQS11
V _{SS}	- Pin 029	DQ18	- Pin 030	Pin 150	- DQ23	Pin 149	- DQ22
DQ19	- Pin 031	V _{SS}	- Pin 032	Pin 152	- DQ28	Pin 151	- V _{SS}
DQ24	- Pin 033	DQ25	- Pin 034	Pin 154	- V _{SS}	Pin 153	- DQ29
V _{SS}	- Pin 035	DQS3	- Pin 036	Pin 156	- NC/DQS12	Pin 155	- DM3/DQS12
DQS3	- Pin 037	V _{SS}	- Pin 038	Pin 158	- DQ30	Pin 157	- V _{SS}
DQ26	- Pin 039	DQ27	- Pin 040	Pin 160	- V _{SS}	Pin 159	- DQ31
V _{SS}	- Pin 041	CB0	- Pin 042	Pin 162	- CB5	Pin 161	- CB4
CB1	- Pin 043	V _{SS}	- Pin 044	Pin 164	- DM8/DQS17	Pin 163	- V _{SS}
DQS8	- Pin 045	DQS8	- Pin 046	Pin 166	- V _{SS}	Pin 165	- NC/DQS17
V _{SS}	- Pin 047	CB2	- Pin 048	Pin 168	- CB7	Pin 167	- CB6
CB3	- Pin 049	V _{SS}	- Pin 050	Pin 170	- V _{DDQ}	Pin 169	- V _{SS}
V _{DDQ}	- Pin 051	CKE0	- Pin 052	Pin 172	- V _{DD}	Pin 171	- NC/CKE1
V _{DD}	- Pin 053	NC/BA2	- Pin 054	Pin 174	- NC/A14	Pin 173	- NC / A15
NC/EP _R _OUT	- Pin 055	V _{DDQ}	- Pin 056	Pin 176	- A12	Pin 175	- V _{DDQ}
A11	- Pin 057	A7	- Pin 058	Pin 178	- V _{DD}	Pin 177	- A9
V _{DD}	- Pin 059	A5	- Pin 060	Pin 180	- A6	Pin 179	- A8
A4	- Pin 061	V _{DDQ}	- Pin 062	Pin 182	- A3	Pin 181	- V _{DDQ}
A2	- Pin 063	V _{DD}	- Pin 064	Pin 184	- V _{DD}	Pin 183	- A1
V _{SS}	- Pin 065	V _{SS}	- Pin 066	Pin 186	- CK0	Pin 185	- CK0
V _{DD}	- Pin 067	NC/PAR_IN	- Pin 068	Pin 188	- A0	Pin 187	- V _{DD}
V _{DD}	- Pin 069	A10/AP	- Pin 070	Pin 190	- BA1	Pin 189	- V _{DD}
BA0	- Pin 071	V _{DDQ}	- Pin 072	Pin 192	- RAS	Pin 191	- V _{DDQ}
WE	- Pin 073	CAS	- Pin 074	Pin 194	- V _{DDQ}	Pin 193	- S0
V _{DDQ}	- Pin 075	NC/S1	- Pin 076	Pin 196	- NC/A13	Pin 195	- ODT0
NC/ODT1	- Pin 077	V _{DDQ}	- Pin 078	Pin 198	- V _{SS}	Pin 197	- V _{DD}
V _{SS}	- Pin 079	DQ32	- Pin 080	Pin 200	- DQ37	Pin 199	- DQ36
DQ33	- Pin 081	V _{SS}	- Pin 082	Pin 202	- DM4/DQS13	Pin 201	- V _{SS}
DQS4	- Pin 083	DQS4	- Pin 084	Pin 204	- V _{SS}	Pin 203	- NC/DQS13
V _{SS}	- Pin 085	DQ34	- Pin 086	Pin 206	- DQ39	Pin 205	- DQ38
DQ35	- Pin 087	V _{SS}	- Pin 088	Pin 208	- DQ44	Pin 207	- V _{SS}
DQ40	- Pin 089	DQ41	- Pin 090	Pin 210	- V _{SS}	Pin 209	- DQ45
V _{SS}	- Pin 091	DQS5	- Pin 092	Pin 212	- NC/DQS14	Pin 211	- DM5/DQS14
DQS5	- Pin 093	V _{SS}	- Pin 094	Pin 214	- DQ46	Pin 213	- V _{SS}
DQ42	- Pin 095	DQ43	- Pin 096	Pin 216	- V _{SS}	Pin 215	- DQ47
V _{SS}	- Pin 097	DQ48	- Pin 098	Pin 218	- DQ53	Pin 217	- DQ52
DQ49	- Pin 099	V _{SS}	- Pin 100	Pin 220	- NC/S2	Pin 219	- V _{SS}
SA2	- Pin 101	NC	- Pin 102	Pin 222	- V _{SS}	Pin 221	- NC/S3
V _{SS}	- Pin 103	DQS6	- Pin 104	Pin 224	- NC/DQS15	Pin 223	- DM6/DQS15
DQS6	- Pin 105	V _{SS}	- Pin 106	Pin 226	- DQ54	Pin 225	- V _{SS}
DQ50	- Pin 107	DQ51	- Pin 108	Pin 228	- V _{SS}	Pin 227	- DQ55
V _{SS}	- Pin 109	DQ56	- Pin 110	Pin 230	- DQ61	Pin 229	- DQ60
DQ57	- Pin 111	V _{SS}	- Pin 112	Pin 232	- DM7/DQS16	Pin 231	- V _{SS}
DQS7	- Pin 113	DQS7	- Pin 114	Pin 234	- V _{SS}	Pin 233	- NC/DQS16
V _{SS}	- Pin 115	DQ58	- Pin 116	Pin 236	- DQ63	Pin 235	- DQ62
DQ59	- Pin 117	V _{SS}	- Pin 118	Pin 238	- VDDSPD	Pin 237	- V _{SS}
SDA	- Pin 119	SCL	- Pin 120	Pin 240	- SA1	Pin 239	- SA0

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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	Notes
		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	Notes
		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%



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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)	PBar	+69	+105	kPa	5)
Operating Humidity (relative)	H_{OPR}	10	90	%	
Storage Humidity (without condensation)	H_{STG}	5	95	%	

- 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.

TABLE 11
Supply Voltage Levels and DC Operating Conditions

Parameter	Symbol	Values			Unit	Notes
		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



3.3 Timing Characteristics

This chapter describes the timing characteristics.

3.3.1 Speed Grade Definitions

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

Speed Grade Definitions: **Table 12** for DDR2-800E, **Table 13** for DDR2-667D, **Table 14** for DDR2-533C

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/ $\overline{CK}$ 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 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 $9 \times t_{REFI}$.

TABLE 13
Speed Grade Definition Speed Bins for DDR2-667

Speed Grade			DDR2-667C		DDR2-667D		Unit	Notes
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)


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Speed Grade		DDR2-667C		DDR2-667D		Unit	Notes
QAG Sort Name		-3		-3S			
CAS-RCD-RP latencies		4-4-4		5-5-5		t_{CK}	
Parameter	Symbol	Min.	Max.	Min.	Max.	—	
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 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 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 $9 \times t_{REFI}$.

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 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 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 $9 \times t_{REFI}$.



3.3.2 Component AC Timing Parameters

Timing Parameters: **Table 15** for DDR2-800E, **Table 16** for DDR2-667D, **Table 17** for DDR2-533C

TABLE 15
DRAM Component Timing Parameter by Speed Grade - DDR2-800

Parameter	Symbol	DDR2-800		Unit	Notes 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)
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	$t_{CK.AVG}$	2500	8000	ps	10)11)
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	$t_{DH.BASE}$	125	—	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 / $\overline{\text{CK}}$	t_{DQSK}	-350	+350	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}	—	200	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	$t_{DS.BASE}$	50	—	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}	35	—	ns	35)
Four Activate Window for 2KB page size products	t_{FAW}	45	—	ns	35)
CK half pulse width	t_{HP}	Min($t_{CH.ABS}$, $t_{CL.ABS}$)	—	ps	21)
Data-out high-impedance time from CK / $\overline{\text{CK}}$	t_{HZ}	—	$t_{AC.MAX}$	ps	9)22)
Address and control input hold time	$t_{IH.BASE}$	250	—	ps	23)25)
Control & address input pulse width for each input	t_{IPW}	0.6	—	$t_{CK.AVG}$	
Address and control input setup time	$t_{IS.BASE}$	175	—	ps	24)25)
DQ low impedance time from CK/ $\overline{\text{CK}}$	$t_{LZ.DQ}$	$2 \times t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
DQS/ $\overline{\text{DQS}}$ low-impedance time from CK / $\overline{\text{CK}}$	$t_{LZ.DQS}$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
MRS command to ODT update delay	t_{MOD}	0	12	ns	35)
Mode register set command cycle time	t_{MRD}	2	—	nCK	
OCD drive mode output delay	t_{OIT}	0	12	ns	35)
DQ/DQS output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—	ps	26)

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Parameter	Symbol	DDR2-800		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
DQ hold skew factor	t_{QHS}	—	300	ps	27)
Average periodic refresh Interval	t_{REFI}	—	7.8	μs	28)29)
		—	3.9	μs	29)30)
Auto-Refresh to Active/Auto-Refresh command period	t_{RFC}	127.5	—	ns	31)
Precharge-All (8 banks) command period	t_{RP}	$t_{RP} + 1 \times t_{CK}$	—	ns	
Read preamble	t_{RPRE}	0.9	1.1	$t_{CK,AVG}$	32)33)
Read postamble	t_{RPST}	0.4	0.6	$t_{CK,AVG}$	32)34)
Active to active command period for 1KB page size products	t_{RRD}	7.5	—	ns	35)
Active to active command period for 2KB page size products	t_{RRD}	10	—	ns	35)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	35)
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	35)
Internal write to read command delay	t_{WTR}	7.5	—	ns	35)36)
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	
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	35)
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) $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$.

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) 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 $2 \times t_{CK,AVG} + t_{ERR,2PER(MIN)}$.

9) 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 $t_{DQSCK,MIN(DERATED)} = t_{DQSCK,MIN} - t_{ERR(6-10PER),MAX} = -400 \text{ ps} - 293 \text{ ps} = -693 \text{ ps}$ and $t_{DQSCK,MAX(DERATED)} = t_{DQSCK,MAX} - t_{ERR(6-10PER),MIN} = 400 \text{ ps} + 272 \text{ ps} = +672 \text{ ps}$. 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!)

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.

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- 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 $t_{IS} + 2 \times t_{CK} + t_{IH}$.
- 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. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns}) \text{ clocks} = 4 + (4) \text{ clocks} = 8 \text{ clocks}$.
- 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 / $\overline{DQS}$ and associated DQ in any given cycle.
- 17) 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.
- 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 / $\overline{DQS}$) 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; $t_{HP} = \text{MIN}(t_{CH,ABS}, t_{CL,ABS})$, 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.
- 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 / $\overline{CK}$) 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) The Auto-Refresh command interval has be reduced to 3.9 μ s when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 29) $0^\circ\text{C} \leq T_{CASE} \leq 85^\circ\text{C}$
- 30) $85^\circ\text{C} < T_{CASE} \leq 95^\circ\text{C}$
- 31) A maximum of eight Auto-Refresh commands can be posted to any given DDR2 SDRAM device.
- 32) 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.


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- 33) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{\text{JIT.PER}}$ 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 $t_{\text{JIT.PER.MIN}} = -72$ ps and $t_{\text{JIT.PER.MAX}} = +93$ ps, then $t_{\text{RPRE.MIN(DERATED)}} = t_{\text{RPRE.MIN}} + t_{\text{JIT.PER.MIN}} = 0.9 \times t_{\text{CK.AVG}} - 72$ ps = + 2178 ps and $t_{\text{RPRE.MAX(DERATED)}} = t_{\text{RPRE.MAX}} + t_{\text{JIT.PER.MAX}} = 1.1 \times t_{\text{CK.AVG}} + 93$ ps = + 2843 ps. (Caution on the MIN/MAX usage!).
- 34) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{\text{JIT.DUTY}}$ 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 $t_{\text{JIT.DUTY.MIN}} = -72$ ps and $t_{\text{JIT.DUTY.MAX}} = +93$ ps, then $t_{\text{RPST.MIN(DERATED)}} = t_{\text{RPST.MIN}} + t_{\text{JIT.DUTY.MIN}} = 0.4 \times t_{\text{CK.AVG}} - 72$ ps = + 928 ps and $t_{\text{RPST.MAX(DERATED)}} = t_{\text{RPST.MAX}} + t_{\text{JIT.DUTY.MAX}} = 0.6 \times t_{\text{CK.AVG}} + 93$ ps = + 1592 ps. (Caution on the MIN/MAX usage!).
- 35) For these parameters, the DDR2 SDRAM device is characterized and verified to support $t_{\text{nPARAM}} = \text{RU}\{t_{\text{PARAM}} / t_{\text{CK.AVG}}\}$, which is in clock cycles, assuming all input clock jitter specifications are satisfied. For example, the device will support $t_{\text{nRP}} = \text{RU}\{t_{\text{RP}} / t_{\text{CK.AVG}}\}$, which is in clock cycles, if all input clock jitter specifications are met. This means: For DDR2-667 5-5-5, of which $t_{\text{RP}} = 15$ ns, the device will support $t_{\text{nRP}} = \text{RU}\{t_{\text{RP}} / t_{\text{CK.AVG}}\} = 5$, i.e. as long as the input clock jitter specifications are met, Precharge command at T_m and Active command at $T_m + 5$ is valid even if $(T_m + 5 - T_m)$ is less than 15 ns due to input clock jitter.
- 36) t_{WTR} is at least two clocks ($2 \times t_{\text{CK}}$) independent of operation frequency.

TABLE 16
DRAM Component Timing Parameter by Speed Grade - DDR2-667

Parameter	Symbol	DDR2-667		Unit	Notes 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)
CAS to CAS command delay	t_{CCD}	2	—	nCK	
Average clock high pulse width	$t_{\text{CH.AVG}}$	0.48	0.52	$t_{\text{CK.AVG}}$	10)11)
Average clock period	$t_{\text{CK.AVG}}$	3000	8000	ps	
CKE minimum pulse width (high and low pulse width)	t_{CKE}	3	—	nCK	12)
Average clock low pulse width	$t_{\text{CL.AVG}}$	0.48	0.52	$t_{\text{CK.AVG}}$	10)11)
Auto-Precharge write recovery + precharge time	t_{DAL}	$\text{WR} + t_{\text{nRP}}$	—	nCK	13)14)
Minimum time clocks remain ON after CKE asynchronously drops LOW	t_{DELAY}	$t_{\text{IS}} + t_{\text{CK.AVG}} + t_{\text{IH}}$	—	ns	
DQ and DM input hold time	$t_{\text{DH.BASE}}$	175	—	ps	19)20)15)
DQ and DM input pulse width for each input	t_{DIPW}	0.35	—	$t_{\text{CK.AVG}}$	
DQS output access time from CK / $\overline{\text{CK}}$	t_{DQSK}	-400	+400	ps	9)
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-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	$t_{\text{CK.AVG}}$	17)
DQ and DM input setup time	$t_{\text{DS.BASE}}$	100	—	ps	18)19)20)
DQS falling edge hold time from CK	t_{DSH}	0.2	—	$t_{\text{CK.AVG}}$	17)
DQS falling edge to CK setup time	t_{DSS}	0.2	—	$t_{\text{CK.AVG}}$	17)
Four Activate Window for 1KB page size products	t_{FAW}	37.5	—	ns	35)
Four Activate Window for 2KB page size products	t_{FAW}	50	—	ns	35)
CK half pulse width	t_{HP}	$\text{Min}(t_{\text{CH.ABS}}, t_{\text{CL.ABS}})$	—	ps	21)
Data-out high-impedance time from CK / $\overline{\text{CK}}$	t_{HZ}	—	$t_{\text{AC.MAX}}$	ps	9)22)
Address and control input hold time	$t_{\text{IH.BASE}}$	275	—	ps	25)23)


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Parameter	Symbol	DDR2-667		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
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 $\overline{CK}/\overline{CK}$	$t_{LZ.DQ}$	$2 \times t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
DQS/ $\overline{DQS}$ low-impedance time from $\overline{CK} / \overline{CK}$	$t_{LZ.DQS}$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	9)22)
MRS command to ODT update delay	t_{MOD}	0	12	ns	35)
Mode register set command cycle time	t_{MRD}	2	—	nCK	
OCD drive mode output delay	t_{OIT}	0	12	ns	35)
DQ/DQS output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—	ps	26)
DQ hold skew factor	t_{QHS}	—	340	ps	27)
Average periodic refresh Interval	t_{REFI}	—	7.8	μs	28)29)
		—	3.9	μs	29)30)
Auto-Refresh to Active/Auto-Refresh command period	t_{RFC}	127.5	—	ns	31)
Precharge-All (8 banks) command period	t_{RP}	$t_{RP} + 1 \times t_{CK}$	—	ns	
Read preamble	t_{RPRE}	0.9	1.1	$t_{CK.AVG}$	32)33)
Read postamble	t_{RPST}	0.4	0.6	$t_{CK.AVG}$	32)34)
Active to active command period for 1KB page size products	t_{RRD}	7.5	—	ns	35)
Active to active command period for 2KB page size products	t_{RRD}	10	—	ns	35)
Internal Read to Precharge command delay	t_{RTP}	7.5	—	ns	35)
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	35)
Internal write to read command delay	t_{WTR}	7.5	—	ns	35)36)
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	35)
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) $V_{DDQ} = 1.8 V \pm 0.1 V$; $V_{DD} = 1.8 V \pm 0.1 V$.

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 $\overline{CK}/\overline{CK}$ 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 $\overline{CK} / \overline{CK}$ 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.

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} .

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- 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 T_m , an Active command may be registered at $T_m + 2$, even if $(T_m + 2 - T_m)$ is $2 \times t_{CK,AVG} + t_{ERR,2PER(Min)}$.
- 9) 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!)
- 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 $t_{IS} + 2 \times t_{CK} + t_{IH}$.
- 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 tWR programmed to 4 clocks. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns})$ clocks = $4 + (4)$ clocks = 8 clocks.
- 14) $t_{DAL,nCK} = WR$ [nCK] $+ t_{nRP,nCK} = WR + RU\{t_{RP}[\text{ps}] / t_{CK,AVG}[\text{ps}]\}$, 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 / DQS and associated DQ in any given cycle.
- 17) These parameters are measured from a data strobe signal ((L/U/R)DQS / 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.
- 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 $V_{i(DC)MAX}$ and $V_{i(DC)MIN}$. 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 / 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; $t_{HP} = \text{MIN}(t_{CH,ABS}, t_{CL,ABS})$, 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.
- 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 / $\overline{CK}$) 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.

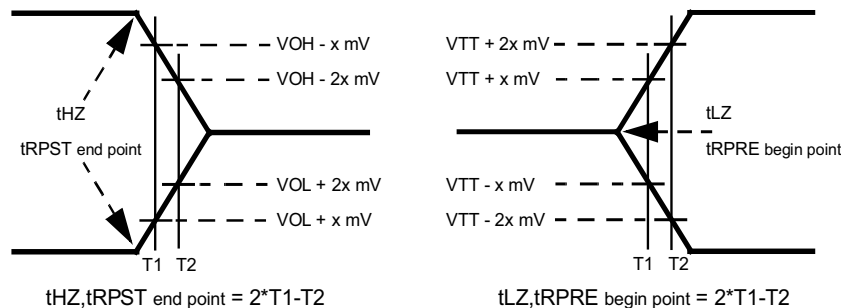


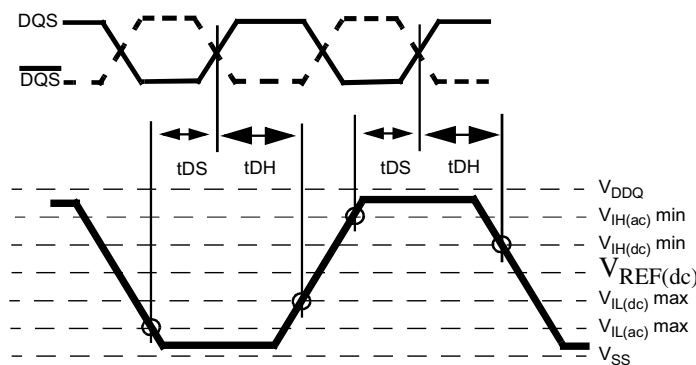
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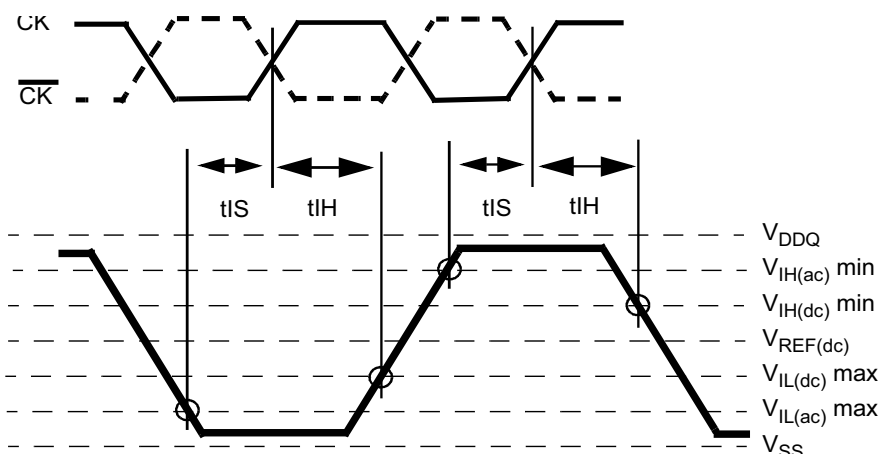
- 28) The Auto-Refresh command interval has be reduced to 3.9 μ s when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 29) $0^{\circ}\text{C} \leq T_{\text{CASE}} \leq 85^{\circ}\text{C}$
- 30) $85^{\circ}\text{C} < T_{\text{CASE}} \leq 95^{\circ}\text{C}$
- 31) A maximum of eight Auto-Refresh commands can be posted to any given DDR2 SDRAM device.
- 32) 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.
- 33) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{\text{JIT.PER}}$ 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 $t_{\text{JIT.PER.MIN}} = -72$ ps and $t_{\text{JIT.PER.MAX}} = +93$ ps, then $t_{\text{RPRE.MIN(DERATED)}} = t_{\text{RPRE.MIN}} + t_{\text{JIT.PER.MIN}} = 0.9 \times t_{\text{CK.AVG}} - 72$ ps = + 2178 ps and $t_{\text{RPRE.MAX(DERATED)}} = t_{\text{RPRE.MAX}} + t_{\text{JIT.PER.MAX}} = 1.1 \times t_{\text{CK.AVG}} + 93$ ps = + 2843 ps. (Caution on the MIN/MAX usage!).
- 34) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{\text{JIT.DUTY}}$ 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 $t_{\text{JIT.DUTY.MIN}} = -72$ ps and $t_{\text{JIT.DUTY.MAX}} = +93$ ps, then $t_{\text{RPST.MIN(DERATED)}} = t_{\text{RPST.MIN}} + t_{\text{JIT.DUTY.MIN}} = 0.4 \times t_{\text{CK.AVG}} - 72$ ps = + 928 ps and $t_{\text{RPST.MAX(DERATED)}} = t_{\text{RPST.MAX}} + t_{\text{JIT.DUTY.MAX}} = 0.6 \times t_{\text{CK.AVG}} + 93$ ps = + 1592 ps. (Caution on the MIN/MAX usage!).
- 35) For these parameters, the DDR2 SDRAM device is characterized and verified to support $t_{\text{nPARAM}} = \text{RU}\{t_{\text{PARAM}} / t_{\text{CK.AVG}}\}$, which is in clock cycles, assuming all input clock jitter specifications are satisfied. For example, the device will support $t_{\text{nRP}} = \text{RU}\{t_{\text{RP}} / t_{\text{CK.AVG}}\}$, which is in clock cycles, if all input clock jitter specifications are met. This means: For DDR2-667 5-5-5, of which $t_{\text{RP}} = 15$ ns, the device will support $t_{\text{nRP}} = \text{RU}\{t_{\text{RP}} / t_{\text{CK.AVG}}\} = 5$, 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.
- 36) t_{WTR} is at lease two clocks ($2 \times t_{\text{CK}}$) independent of operation frequency.

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}** 


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TABLE 17
DRAM Component Timing Parameter by Speed Grade - DDR2-533

Parameter	Symbol	DDR2-533		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
DQ output access time from CK / $\overline{\text{CK}}$	t_{AC}	-500	+500	ps	
CAS A to 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}	$t_{IS} + t_{CK} + t_{IH}$	—	ns	9)
DQ and DM input hold time (differential data strobe)	$t_{DH}(\text{base})$	225	—	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_{DQSK}	-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)	$t_{DS}(\text{base})$	100	—	ps	11)
DQ and DM input setup time (single ended data strobe)	$t_{DS1}(\text{base})$	-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}	
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 / $\overline{\text{CK}}$	t_{HZ}	—	$t_{AC,MAX}$	ps	13)
Address and control input hold time	$t_{IH}(\text{base})$	375	—	ps	11)
Address and control input pulse width (each input)	t_{IPW}	0.6	—	t_{CK}	
Address and control input setup time	$t_{IS}(\text{base})$	250	—	ps	11)
DQ low-impedance time from CK / $\overline{\text{CK}}$	$t_{LZ(DQ)}$	$2 \times t_{AC,MIN}$	$t_{AC,MAX}$	ps	14)
DQS low-impedance from CK / $\overline{\text{CK}}$	$t_{LZ(DQS)}$	$t_{AC,MIN}$	$t_{AC,MAX}$	ps	14)
MRS command to ODT update delay	t_{MOD}	0	12	ns	
Mode register set command cycle time	t_{MRD}	2	—	t_{CK}	
OCD drive mode output delay	t_{OIT}	0	12	ns	


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Parameter	Symbol	DDR2-533		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
Data output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—		
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 (8 banks) command period	t_{RP}	$t_{RP} + 1 \times t_{CK}$	—	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}	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) $V_{DDQ} = 1.8 \text{ V} \pm 0.1 \text{ V}$; $V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$.
- 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.

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- 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 been reduced to 3.9 μ s when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 15) $0\text{ }^{\circ}\text{C} \leq T_{CASE} \leq 85\text{ }^{\circ}\text{C}$
- 16) $85\text{ }^{\circ}\text{C} < T_{CASE} \leq 95\text{ }^{\circ}\text{C}$
- 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) 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 $WR_{MIN}[\text{cycles}] = t_{WR}(\text{ns})/t_{CK}(\text{ns})$ 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.



3.3.3 ODT AC Electrical Characteristics

This chapter describes the ODT AC electrical characteristics.

TABLE 18
ODT AC Characteristics and Operating Conditions for all bins DDR2-667 & DDR2-800

Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOND}	ODT turn-on delay	2	2	n_{CK}	1)
t_{AON}	ODT turn-on	$t_{AC.MIN}$	$t_{AC.MAX} + 0.7 \text{ ns}$	ns	1)2)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{AC.MIN} + 2 \text{ ns}$	$2 t_{CK} + t_{AC.MAX} + 1 \text{ ns}$	ns	1)
t_{AOFD}	ODT turn-off delay	2.5	2.5	n_{CK}	1)
t_{AOF}	ODT turn-off	$t_{AC.MIN}$	$t_{AC.MAX} + 0.6 \text{ ns}$	ns	1)3)
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{AC.MIN} + 2 \text{ ns}$	$2.5 t_{CK} + t_{AC.MAX} + 1 \text{ ns}$	ns	1)
t_{ANPD}	ODT to Power Down Mode Entry Latency	3	—	n_{CK}	1)
t_{AXPD}	ODT Power Down Exit Latency	8	—	n_{CK}	1)

- 1) New units, " $t_{CK.AVG}$ " and " n_{CK} ", 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 " n_{CK} " 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: $t_{XP} = 2 [n_{CK}]$ 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 $2 \times t_{CK.AVG} + t_{ERR.2PER(Min)}$.
- 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} , which is interpreted differently per speed bin. For DDR2-667/800, if $t_{CK(avg)} = 3 \text{ ns}$ is assumed, t_{AOFD} is 1.5 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 edges.



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TABLE 19
ODT AC Characteristics and Operating Conditions for DDR2-533

Symbol	Parameter / Condition	Values		Unit	Note
		Min.	Max.		
t_{AOND}	ODT turn-on delay	2	2	t_{CK}	
t_{AON}	ODT turn-on	$t_{AC.MIN}$	$t_{AC.MAX} + 1 \text{ ns}$	ns	1)
t_{AONPD}	ODT turn-on (Power-Down Modes)	$t_{AC.MIN} + 2 \text{ ns}$	$2 t_{CK} + t_{AC.MAX} + 1 \text{ ns}$	ns	
t_{AOFD}	ODT turn-off delay	2.5	2.5	t_{CK}	
t_{AOF}	ODT turn-off	$t_{AC.MIN}$	$t_{AC.MAX} + 0.6 \text{ ns}$	ns	2)
t_{AOFPD}	ODT turn-off (Power-Down Modes)	$t_{AC.MIN} + 2 \text{ ns}$	$2.5 t_{CK} + t_{AC.MAX} + 1 \text{ ns}$	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 x 5 ns) after the clock edge that registered a first ODT HIGH if $t_{CK} = 5 \text{ ns}$.
- 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 x 5 ns) after the clock edge that registered a first ODT HIGH if $t_{CK} = 5 \text{ ns}$.



3.4 Specifications and Conditions

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

- **Table 20 “IDD Measurement Conditions” on Page 31**
- **Table 21 “Definitions for IDD” on Page 32**
- **Table 22 “IDD Specification for HYS72T1G242EP-[2.5/25F/3/3S/3.7]-C” on Page 33**

TABLE 20
 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 $CKE \leq 0.2 V$; 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) $V_{DDQ} = 1.8 V \pm 0.1 V$; $V_{DD} = 1.8 V \pm 0.1 V$

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 21**

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 21
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 22
 I_{DD} Specification for HYS72T1G242EP-[2.5/25F/3/3S/3.7]-C

Product Type	HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C	Units	Note ¹⁾
Organization	8 GB	8 GB	8 GB	8 GB	8 GB		
	×72	×72	×72	×72	×72		
	4 Ranks	4 Ranks	4 Ranks	4 Ranks	4 Ranks		
	-2.5	-2.5F	-3	-3S	-3.7		
I_{DD0}	4030	4040	3620	3620	3210	mA	2)
I_{DD1}	4100	4120	3700	3700	3260	mA	2)
I_{DD2P}	2550	2550	2260	2260	1950	mA	3)
I_{DD2N}	6650	6650	6000	6000	5190	mA	3)
I_{DD2Q}	6290	6290	5640	5640	5120	mA	3)
I_{DD3P_0} (fast)	4350	4350	3910	3910	3390	mA	3)
I_{DD3P_1} (slow)	2910	2910	2620	2620	2310	mA	3)4)
I_{DD3N}	7010	7010	6220	6220	5410	mA	3)5)
I_{DD4R}	5110	5110	4520	4520	3930	mA	2)
I_{DD4W}	5200	5200	4610	4610	4020	mA	2)
I_{DD5B}	5900	5900	5460	5460	5100	mA	2)
I_{DD5D}	2690	2690	2400	2400	2090	mA	3)6)
I_{DD6}	720	720	720	720	720	mA	3)6)
I_{DD7}	6190	6190	5590	5550	5280	mA	2)

1) Module I_{DD} is calculated on the basis of component I_{DD} and includes currents of Registers and PLL. 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 23 “HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C” on Page 34

TABLE 23						
HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C						
Product Type		HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C
Organization		8 GByte	8 GByte	8 GByte	8 GByte	8 GByte
		×72	×72	×72	×72	×72
		4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)
Label Code		PC2-6400P-666	PC2-6400P-555	PC2-5300P-444	PC2-5300P-555	PC2-4200P-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX
0	Programmed SPD Bytes in EEPROM	80	80	80	80	80
1	Total number of Bytes in EEPROM	08	08	08	08	08
2	Memory Type (DDR2)	08	08	08	08	08
3	Number of Row Addresses	0E	0E	0E	0E	0E
4	Number of Column Addresses	0B	0B	0B	0B	0B
5	DIMM Rank and Stacking Information	73	73	73	73	73
6	Data Width	48	48	48	48	48
7	Not used	00	00	00	00	00
8	Interface Voltage Level	05	05	05	05	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	25	25	30	30	3D
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	40	40	45	45	50
11	Error Correction Support (non-ECC, ECC)	06	06	06	06	06
12	Refresh Rate and Type	82	82	82	82	82


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Product Type		HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C
Organization		8 GByte	8 GByte	8 GByte	8 GByte	8 GByte
		×72	×72	×72	×72	×72
		4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)
Label Code		PC2-6400P-666	PC2-6400P-555	PC2-5300P-444	PC2-5300P-555	PC2-4200P-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX
13	Primary SDRAM Width	04	04	04	04	04
14	Error Checking SDRAM Width	04	04	04	04	04
15	Not used	00	00	00	00	00
16	Burst Length Supported	0C	0C	0C	0C	0C
17	Number of Banks on SDRAM Device	08	08	08	08	08
18	Supported CAS Latencies	70	70	38	38	38
19	DIMM Mechanical Characteristics	01	01	01	01	01
20	DIMM Type Information	01	01	01	01	01
21	DIMM Attributes	07	07	07	07	07
22	Component Attributes	07	07	07	07	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30	25	30	3D	3D
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	45	40	45	50	50
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	3D	3D	50	50	50
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	50	50	60	60	60
27	$t_{RP,MIN}$ [ns]	3C	32	30	3C	3C
28	$t_{RRD,MIN}$ [ns]	1E	1E	1E	1E	1E
29	$t_{RCD,MIN}$ [ns]	3C	32	30	3C	3C
30	$t_{RAS,MIN}$ [ns]	2D	2D	2D	2D	2D
31	Module Density per Rank	02	02	02	02	02
32	$t_{AS,MIN}$ and $t_{CS,MIN}$ [ns]	17	17	20	20	25
33	$t_{AH,MIN}$ and $t_{CH,MIN}$ [ns]	25	25	27	27	37
34	$t_{DS,MIN}$ [ns]	05	05	10	10	10
35	$t_{DH,MIN}$ [ns]	12	12	17	17	22
36	$t_{WR,MIN}$ [ns]	3C	3C	3C	3C	3C


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Product Type		HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C
Organization		8 GByte	8 GByte	8 GByte	8 GByte	8 GByte
		×72	×72	×72	×72	×72
		4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)
Label Code		PC2-6400P-666	PC2-6400P-555	PC2-5300P-444	PC2-5300P-555	PC2-4200P-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX
37	$t_{WTR.MIN}$ [ns]	1E	1E	1E	1E	1E
38	$t_{RTP.MIN}$ [ns]	1E	1E	1E	1E	1E
39	Analysis Characteristics	00	00	00	00	00
40	t_{RC} and t_{RFC} Extension	06	36	06	06	06
41	$t_{RC.MIN}$ [ns]	3C	39	39	3C	3C
42	$t_{RFC.MIN}$ [ns]	7F	7F	7F	7F	7F
43	$t_{CK.MAX}$ [ns]	80	80	80	80	80
44	$t_{DQSQ.MAX}$ [ns]	14	14	18	18	1E
45	$t_{QHS.MAX}$ [ns]	1E	1E	22	22	28
46	PLL Relock Time	0F	0F	0F	0F	0F
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	51	51	51	51	51
48	Psi(T-A) DRAM	60	60	60	60	60
49	ΔT_0 (DT0)	4F	4F	47	47	3F
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	39	39	34	34	31
51	ΔT_{2P} (DT2P)	3D	3D	3D	3D	3D
52	ΔT_{3N} (DT3N)	2C	2C	28	28	23
53	$\Delta T_{3P.fast}$ (DT3P fast)	35	35	31	31	2C
54	$\Delta T_{3P.slow}$ (DT3P slow)	24	24	24	24	24
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	46	46	3E	3E	36
56	ΔT_{5B} (DT5B)	24	24	22	22	22
57	ΔT_7 (DT7)	27	27	24	23	24
58	Psi(ca) PLL	C4	C4	C4	C4	C4
59	Psi(ca) REG	8C	8C	8C	8C	8C
60	ΔT_{PLL} (DTPLL)	70	70	68	68	61


HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Product Type		HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C
Organization		8 GByte	8 GByte	8 GByte	8 GByte	8 GByte
		×72	×72	×72	×72	×72
		4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)
Label Code		PC2-6400P-666	PC2-6400P-555	PC2-5300P-444	PC2-5300P-555	PC2-4200P-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX
61	ΔT_{REG} (DTREG) / Toggle Rate	B0	B0	94	94	78
62	SPD Revision	12	12	12	12	12
63	Checksum of Bytes 0-62	14	1D	D1	03	08
64	Manufacturer's JEDEC ID Code (1)	7F	7F	7F	7F	7F
65	Manufacturer's JEDEC ID Code (2)	7F	7F	7F	7F	7F
66	Manufacturer's JEDEC ID Code (3)	7F	7F	7F	7F	7F
67	Manufacturer's JEDEC ID Code (4)	7F	7F	7F	7F	7F
68	Manufacturer's JEDEC ID Code (5)	7F	7F	7F	7F	7F
69	Manufacturer's JEDEC ID Code (6)	51	51	51	51	51
70	Manufacturer's JEDEC ID Code (7)	00	00	00	00	00
71	Manufacturer's JEDEC ID Code (8)	00	00	00	00	00
72	Module Manufacturer Location	xx	xx	xx	xx	xx
73	Product Type, Char 1	37	37	37	37	37
74	Product Type, Char 2	32	32	32	32	32
75	Product Type, Char 3	54	54	54	54	54
76	Product Type, Char 4	31	31	31	31	31
77	Product Type, Char 5	47	47	47	47	47
78	Product Type, Char 6	32	32	32	32	32
79	Product Type, Char 7	34	34	34	34	34
80	Product Type, Char 8	32	32	32	32	32
81	Product Type, Char 9	45	45	45	45	45
82	Product Type, Char 10	50	50	50	50	50
83	Product Type, Char 11	32	32	33	33	33
84	Product Type, Char 12	2E	35	43	53	2E

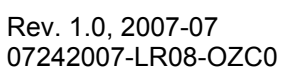

HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered DDR2 SDRAM Module

Product Type		HYS72T1G242EP-2.5-C	HYS72T1G242EP-25F-C	HYS72T1G242EP-3-C	HYS72T1G242EP-3S-C	HYS72T1G242EP-3.7-C
Organization		8 GByte	8 GByte	8 GByte	8 GByte	8 GByte
		×72	×72	×72	×72	×72
		4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)	4 Ranks (×4)
Label Code		PC2-6400P-666	PC2-6400P-555	PC2-5300P-444	PC2-5300P-555	PC2-4200P-444
JEDEC SPD Revision		Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2	Rev. 1.2
Byte#	Description	HEX	HEX	HEX	HEX	HEX
85	Product Type, Char 13	35	46	20	43	37
86	Product Type, Char 14	43	43	20	20	43
87	Product Type, Char 15	20	20	20	20	20
88	Product Type, Char 16	20	20	20	20	20
89	Product Type, Char 17	20	20	20	20	20
90	Product Type, Char 18	20	20	20	20	20
91	Module Revision Code	0x	0x	0x	0x	0x
92	Test Program Revision Code	xx	xx	xx	xx	xx
93	Module Manufacturing Date Year	xx	xx	xx	xx	xx
94	Module Manufacturing Date Week	xx	xx	xx	xx	xx
95 - 98	Module Serial Number	xx	xx	xx	xx	xx
99 - 127	Not used	00	00	00	00	00
128 - 255	Blank for customer use	FF	FF	FF	FF	FF



5 Package Outlines

FIGURE 5
Package Outline Raw Card Z L-DIM-240-49





6 Product Type Nomenclature

Qimonda's nomenclature uses simple coding combined with some proprietary coding. **Table 24** 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 25** and for components in **Table 26**.

TABLE 24
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 25
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



HYS72T1G242EP-[25F/2.5/3/3S/3.7]-C
Registered 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 26
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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