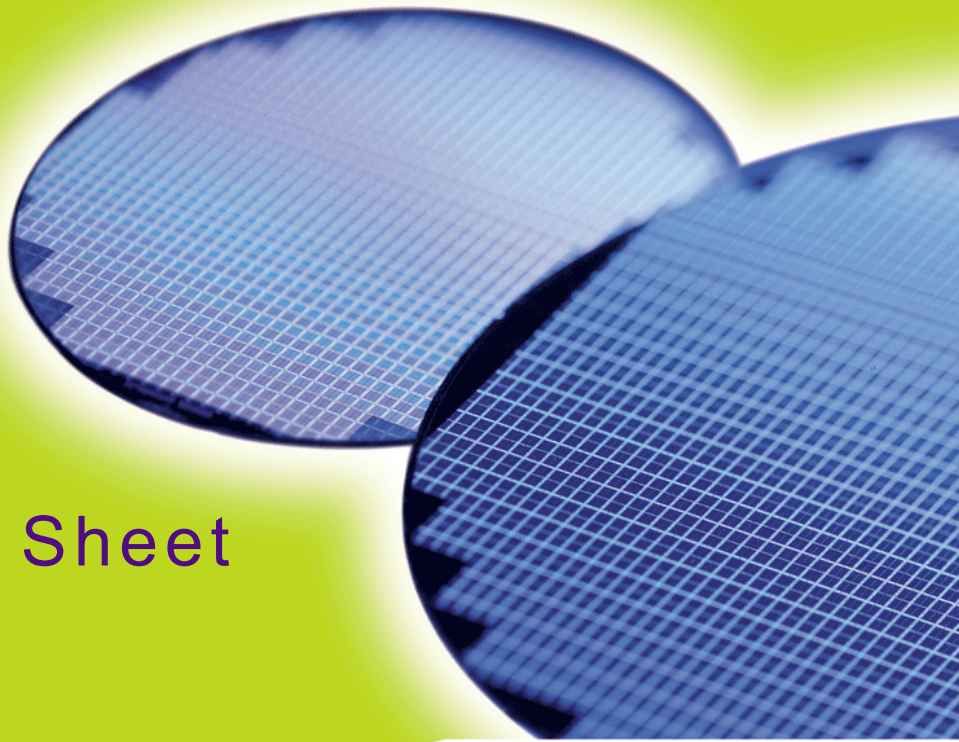


HYS64T128020EDL-[2.5/3S/3.7]-B

*200-Pin DDR2 SDRAM Modules
DDR2 SDRAM
SO-DIMM
RoHS Compliant Products*



Internet Data Sheet

Rev. 1.1

HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

HYS64T128020EDL-[2.5/3S/3.7]-B	
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1 Overview

This chapter gives an overview of the 200-pin small-outline DDR2 SDRAM modules product family and describes its main characteristics.

1.1 Features

- 200-Pin PC2-6400, PC2-5300 and PC2-4200 DDR2 SDRAM memory modules.
- 128Mx64 module organization, and 64Mx16 chip organization
- Standard Double-Data-Rate-Two Synchronous DRAMs (DDR2 SDRAM) with a single + 1.8 V (± 0.1 V) power supply
- 1GB Modules built with 1 Gbit DDR2 SDRAMs in PG-TFBGA-84-11 chipsize packages
- All speed grades faster than DDR2-400 comply with DDR2-400 timing specifications.
- Programmable CAS Latencies (3, 4, 5 and 6), Burst Length (8 & 4).
- Auto Refresh (CBR) and Self Refresh
- Auto Refresh for temperatures above 85 °C $t_{REFI} = 3.9 \mu s$.
- Programmable self refresh rate via EMRS2 setting.
- Programmable partial array refresh via EMRS2 settings.
- DCC enabling via EMRS2 setting.
- All inputs and outputs SSTL_1.8 compatible
- Off-Chip Driver Impedance Adjustment (OCD) and On-Die Termination (ODT)
- Serial Presence Detect with E²PROM
- SO-DIMM Dimensions (nominal): 30 mm high, 67.60 mm wide
- Based on standard reference layouts Raw Cards 'A'
- RoHS compliant products¹⁾

TABLE 1
Performance Table

QAG Speed Code			-2.5	-3S	-3.7	Unit
DRAM Speed Grade			DDR2-800E	DDR2-667D	DDR2-533C	
Module Speed Grade			PC2-6400E	PC2-5300D	PC2-4200C	
CAS-RCD-RP latencies			6-6-6	5-5-5	4-4-4	t_{CK}
Max. Clock Frequency	CL3	f_{CK3}	200	200	200	MHz
	CL4	f_{CK4}	266	266	266	MHz
	CL5	f_{CK5}	333	333	266	MHz
	CL6	f_{CK6}	400	-	-	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	45	ns
Min. Row Cycle Time		t_{RC}	60	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.



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

1.2 Description

The Qimonda HYS64T128020EDL-[2.5/3S/3.7]-B module family are small-outline DIMM modules "SO-DIMMs" with 30 mm height based on DDR2 technology. DIMMs are available as Non-ECC modules in 128Mx64 (1GB) in organization and density, intended for mounting into 200-pin connector sockets.

The memory array is designed with 1 Gbit Double-Data-Rate-Two (DDR2) Synchronous DRAMs. Decoupling capacitors are mounted on the PCB board. The DIMMs feature serial presence detect based on a serial E²PROM device using the 2-pin I²C protocol. The first 128 bytes are programmed with configuration data and are write protected; the second 128 bytes are available to the customer.

TABLE 2
Ordering Information for RoHS Compliant Products

Product Type ¹⁾	Compliance Code ²⁾	Description	SDRAM Technology
PC2-6400			
HYS64T128020EDL-2.5-B	1GB 2Rx16 PC2-6400S-666-12-A0	2 Ranks, Non-ECC	1 Gbit (x16)
PC2-5300			
HYS64T128020EDL-3S-B	1GB 2Rx16 PC2-5300S-555-12-A0	2 Ranks, Non-ECC	1 Gbit (x16)
PC2-4200			
HYS64T128020EDL-3.7-B	1GB 2Rx16 PC2-4200S-444-12-A0	2 Ranks, Non-ECC	1 Gbit (x16)

- 1) For detailed information regarding Product Type of Qimonda please see chapter "Product Type Nomenclature" of this datasheet.
- 2) The Compliance Code is printed on the module label and describes the speed grade, for example "PC2-6400S-666-12-A0" where 6400S means Small-Outline DIMM modules with 6.40 GB/sec Module Bandwidth and "666-12" means Column Address Strobe (CAS) latency =6, Row Column Delay (RCD) latency = 6 and Row Precharge (RP) latency = 6 using the latest JEDEC SPD Revision 1.2 and produced on the Raw Card "A".

TABLE 3
Address Format

DIMM Density	Module Organization	Memory Ranks	ECC/ Non-ECC	# of SDRAMs	# of row/bank/column bits	Raw Card
1GB	128Mx64	2	Non-ECC	8	13/3/10	A

TABLE 4
Components on Modules

Product Type ¹⁾²⁾	DRAM Components ¹⁾	DRAM Density	DRAM Organisation
HYS64T128020EDL	HYB18T1G160BF	1 Gbit	64M x 16

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



2 Pin Configurations and Block Diagrams

2.1 Pin Configurations

The pin configuration of the Small Outline DDR2 SDRAM DIMM is listed by function in **Table 5** (200 pins). The abbreviations used in columns Pin Type 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 SO-DIMM

Pin No.	Name	Pin Type	Buffer Type	Function
Clock Signals				
30	CK0	I	SSTL	Clock Signals 2:0, Complement Clock Signals 2:0 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.
164	CK1	I	SSTL	
32	$\overline{\text{CK0}}$	I	SSTL	
166	$\overline{\text{CK1}}$	I	SSTL	
79	CKE0	I	SSTL	Clock Enable Rank 1:0 Activates the DDR2 SDRAM CK signal when HIGH and deactivates the CK signal when LOW. By deactivating the clocks, CKE LOW initiates the Power Down Mode or the Self Refresh Mode. <i>Note: 2 Ranks module</i>
80	CKE1	I	SSTL	
	NC	NC	—	Not Connected <i>Note: 1-rank module</i>
Control Signals				
110	$\overline{\text{S0}}$	I	SSTL	Chip Select Rank 1:0 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 $\overline{\text{S1}}$. Ranks are also called "Physical banks".2 Ranks module
115	$\overline{\text{S1}}$	I	SSTL	
	NC	NC	—	
108	$\overline{\text{RAS}}$	I	SSTL	Row Address Strobe When sampled at the cross point of the rising edge of CK, and falling edge of $\overline{\text{CK}}$, $\overline{\text{RAS}}$, $\overline{\text{CAS}}$ and $\overline{\text{WE}}$ define the operation to be executed by the SDRAM.
113	$\overline{\text{CAS}}$	I	SSTL	Column Address Strobe



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Small Outlined DDR2 SDRAM Modules

Pin No.	Name	Pin Type	Buffer Type	Function
109	$\overline{\text{WE}}$	I	SSTL	Write Enable
Address Signals				
107	BA0	I	SSTL	Bank Address Bus 2:0 Selects which DDR2 SDRAM internal bank of four or eight is activated.
106	BA1	I	SSTL	
85	BA2	I	SSTL	Bank Address Bus 2 Greater than 512Mb DDR2 SDRAMs
	NC	NC	SSTL	Less than 1Gb DDR2 SDRAMs
102	A0	I	SSTL	Address Bus 12:0 During a Bank Activate command cycle, defines the row address when sampled at the cross-point of the rising edge of CK and falling edge of $\overline{\text{CK}}$. During a Read or Write command cycle, defines the column address when sampled at the cross point of the rising edge of CK and falling edge of $\overline{\text{CK}}$. In addition to the column address, AP is used to invoke autoprecharge operation at the end of the burst read or write cycle. If AP is HIGH, autoprecharge is selected and BA0-BAn defines the bank to be precharged. If AP is LOW, autoprecharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA0-BAn to control which bank(s) to precharge. If AP is HIGH, all banks will be precharged regardless of the state of BA0-BAn inputs. If AP is LOW, then BA0-BAn are used to define which bank to precharge.
101	A1	I	SSTL	
100	A2	I	SSTL	
99	A3	I	SSTL	
98	A4	I	SSTL	
97	A5	I	SSTL	
94	A6	I	SSTL	
92	A7	I	SSTL	
93	A8	I	SSTL	
91	A9	I	SSTL	
105	A10	I	SSTL	
	AP	I	SSTL	
90	A11	I	SSTL	
89	A12	I	SSTL	Address Signal 12 <i>Note: Module based on 256 Mbit or larger dies</i>
116	A13	I	SSTL	Address Signal 13 <i>Note: 1 Gbit based module</i>
	NC	NC	—	Not Connected <i>Note: Module based on 512 Mbit or smaller dies</i>
Data Signals				
5	DQ0	I/O	SSTL	Data Bus 63:0 <i>Note: Data Input/Output pins</i>
7	DQ1	I/O	SSTL	
17	DQ2	I/O	SSTL	
19	DQ3	I/O	SSTL	
4	DQ4	I/O	SSTL	
6	DQ5	I/O	SSTL	
14	DQ6	I/O	SSTL	
16	DQ7	I/O	SSTL	
23	DQ8	I/O	SSTL	
25	DQ9	I/O	SSTL	
35	DQ10	I/O	SSTL	
37	DQ11	I/O	SSTL	



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

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



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Pin No.	Name	Pin Type	Buffer Type	Function
158	DQ52	I/O	SSTL	Data Bus 63:0
160	DQ53	I/O	SSTL	
174	DQ54	I/O	SSTL	
176	DQ55	I/O	SSTL	
179	DQ56	I/O	SSTL	
181	DQ57	I/O	SSTL	
189	DQ58	I/O	SSTL	
191	DQ59	I/O	SSTL	
180	DQ60	I/O	SSTL	
182	DQ61	I/O	SSTL	
192	DQ62	I/O	SSTL	
194	DQ63	I/O	SSTL	
Data Strobe Signals				
13	DQS0	I/O	SSTL	Data Strobe Bus 7:0 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. \overline{DQS} signals are complements, and timing is relative to the cross-point of respective DQS and \overline{DQS} . If the module is to be operated in single ended strobe mode, all \overline{DQS} signals must be tied on the system board to V_{SS} and DDR2 SDRAM mode registers programmed appropriately.
11	$\overline{DQS0}$	I/O	SSTL	
31	DQS1	I/O	SSTL	
29	$\overline{DQS1}$	I/O	SSTL	
51	DQS2	I/O	SSTL	
49	$\overline{DQS2}$	I/O	SSTL	
70	DQS3	I/O	SSTL	
68	$\overline{DQS3}$	I/O	SSTL	
131	DQS4	I/O	SSTL	
129	$\overline{DQS4}$	I/O	SSTL	
148	DQS5	I/O	SSTL	
146	$\overline{DQS5}$	I/O	SSTL	
169	DQS6	I/O	SSTL	
167	$\overline{DQS6}$	I/O	SSTL	
188	DQS7	I/O	SSTL	
186	$\overline{DQS7}$	I/O	SSTL	
Data Mask Signals				
10	DM0	I	SSTL	Data Mask Bus 7:0 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.
26	DM1	I	SSTL	
52	DM2	I	SSTL	
67	DM3	I	SSTL	
130	DM4	I	SSTL	
147	DM5	I	SSTL	
170	DM6	I	SSTL	
185	DM7	I	SSTL	
EEPROM				



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Small Outlined DDR2 SDRAM Modules

Pin No.	Name	Pin Type	Buffer Type	Function
197	SCL	I	CMOS	Serial Bus Clock This signal is used to clock data into and out of the SPD EEPROM and Thermal sensor.
195	SDA	I/O	OD	Serial Bus Data This is a bidirectional pin use to transfer data into and out of the SPD EEPROM and Thermal sensor. A resistor must be connected from SDA to V_{DDSPD} on the motherboard to act as a pull-up.
198	SA0	I	CMOS	Serial Address Select Bus 2:0 Address pins used to select the SPD and Thermal sensor base address.
200	SA1	I	CMOS	
50	$\overline{\text{EVENT}}$	O	OD	EVENT The optional EVENT pin is reserved for use to flag critical module temperature and is used in conjunction with Thermal Sensor.
	NC	-	-	Not Connected Not connected on modules without temperature sensors.
Power Supplies				
1	V_{REF}	AI	—	I/O Reference Voltage Reference voltage for the SSTL-18 inputs.
199	V_{DDSPD}	PWR	—	EEPROM Power Supply Power supplies for Serial Presence Detect, Thermal Sensor and ground for the module.
81,82,87,88,95,96,103,104,111,112,117,118	V_{DD}	PWR	—	Power Supply Power supplies for core, I/O and ground for the module.
2,3,8,9,12,15,18,21,24,27,28,33,34,39,40,41,42,47,48,53,54,59,60,65,66,71,72,77,78,121,122,127,128,132,133,138,139,144,145,149,150,155,156,,161,162,165,171,172,177,178,183,184,187,190,193,196	V_{SS}	GND	—	Ground Plane Power supplies for core, I/O, Serial Presence Detect, Thermal Sensor and ground for the module.
Other pins				
114	ODT0	I	SSTL	On-Die Termination Control 1:0
119	ODT1	I	SSTL	On-Die Termination Control 1 Asserts on-die termination for DQ, DM, DQS, and $\overline{\text{DQS}}$ signals if enabled via the DDR2 SDRAM mode register. <i>Note: 2 Rank modules</i>
	NC	NC	—	Not Connected <i>Note: 1 Rank modules</i>
69,83,84,120,163,168	NC	NC	—	Not connected Pins not connected on Qimonda SO-DIMMs

HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules**TABLE 6**
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
NC	Not Connected

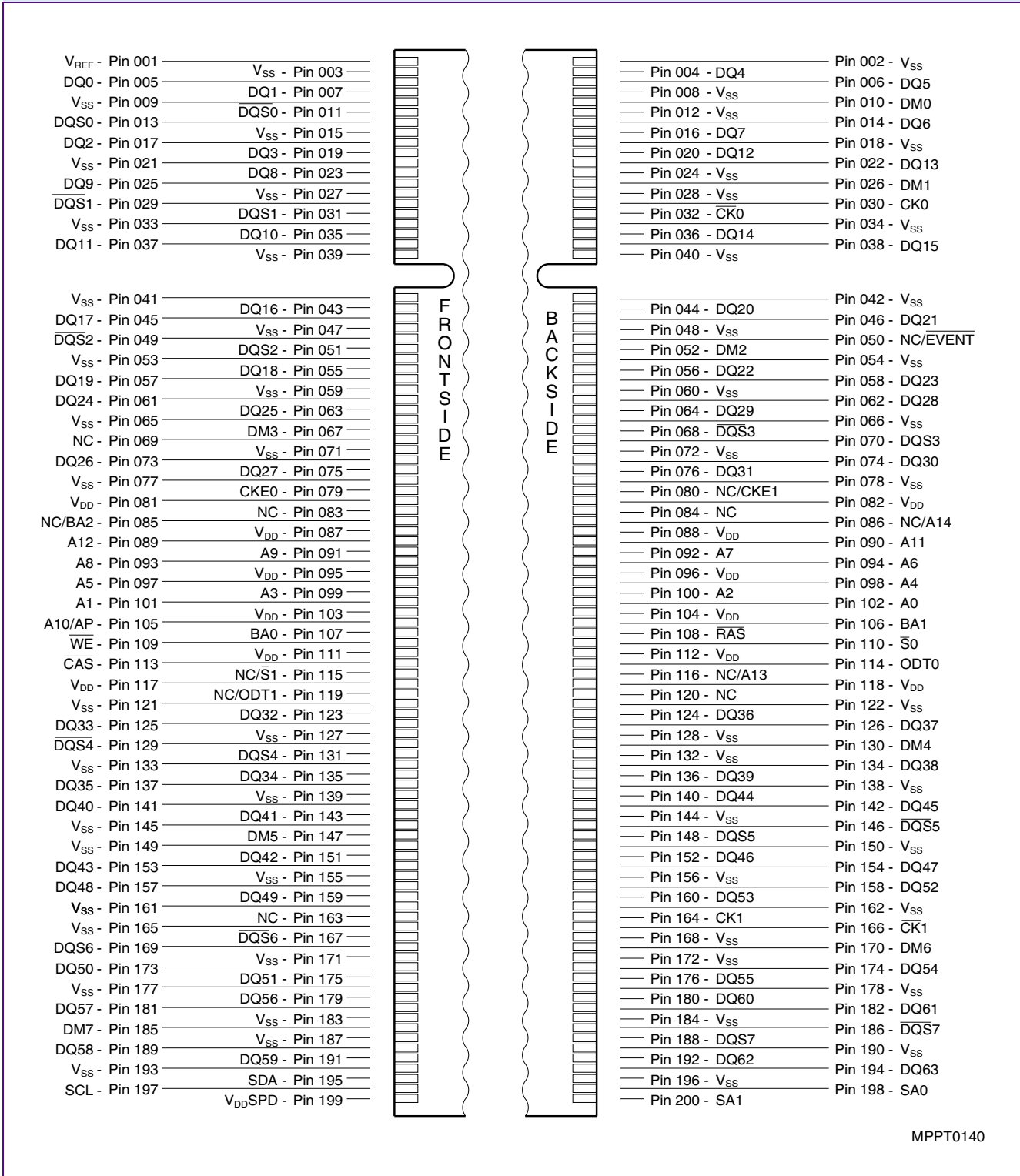
TABLE 7
Abbreviations for Buffer Type

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



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

FIGURE 1
Pin Configuration SO-DIMM (200 pin)



MPPT0140



3 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_{CASE}	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 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%



3.2 DC Operating Conditions

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

- 1) Under all conditions, V_{DDQ} must be less than or equal to V_{DD}
- 2) Peak to peak AC noise on V_{REF} may not exceed $\pm 2\% V_{REF(DC)}$. V_{REF} is also expected to track noise in V_{DDQ} .
- 3) Input voltage for any connector pin under test of $0 V \leq V_{IN} \leq V_{DDQ} + 0.3 V$; all other pins at 0 V. Current is per pin



3.3 Timing Characteristics

3.3.1 Speed Grade Definitions

TABLE 12
Speed Grade Definition

Speed Grade		-800E		-667D		-533C		Unit	Note	
QAG Sort Name		-2.5		-3S		-3.7				
CAS-RCD-RP latencies t_{CK}		6-6-6		5-5-5		4-4-4				
Parameter	Symbol	Min.	Max.	Min.	Max.	Min.	Max.	—		
Clock Period	@ 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	3.75	8	ns	1)2)3)4)
	@ CL = 5	t_{CK}	3	8	3	8	3.75	8	ns	1)2)3)4)
	@ CL = 6	t_{CK}	2.5	8	—	—	—	—	ns	1)2)3)4)
Row Active Time	t_{RAS}	45	70k	45	70k	45	70k	ns	1)2)3)4)5)	
Row Cycle Time	t_{RC}	60	—	60	—	60	—	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/CK differential Slew Rate of 2.0 V/ns. For DQS signals timings are guaranteed with a differential Slew Rate of 2.0 V/ns in differential strobe mode and a Slew Rate of 1 V/ns in single ended mode. Timings are further guaranteed for normal OCD drive strength (EMRS(1) A1 = 0)
- 2) The CK/CK input reference level (for timing reference to CK/CK) is the point at which CK and CK cross. The DQS / DQS, RDQS / RDQS, input reference level is the crosspoint when in differential strobe mode.
- 3) Inputs are not recognized as valid until V_{REF} stabilizes. During the period before V_{REF} stabilizes, $CKE = 0.2 \times V_{DDQ}$ is recognized as low.
- 4) The output timing reference voltage level is V_{TT} .
- 5) $t_{RAS,MAX}$ is calculated from the maximum amount of time a DDR2 device can operate without a refresh command which is equal to $9 \times t_{REFI}$.



3.3.2 Component AC Timing Parameters

TABLE 13

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{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{CK}	t_{DQSCK}	-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{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{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	35)
Mode register set command cycle time	t_{MRD}	2	—	nCK	
OCD drive mode output delay	t_{OIT}	0	12	ns	35)



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Parameter	Symbol	DDR2-800		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾⁸⁾
		Min.	Max.		
DQ/DQS output hold time from DQS	t_{QH}	$t_{HP} - t_{QHS}$	—	ps	26)
DQ hold skew factor	t_{QHS}	—	300	ps	27)
Average periodic refresh Interval	t_{REFI}	—	7.8	μ s	28)29)
		—	3.9	μ s	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) $V_{DDQ} = 1.8 V \pm 0.1V$; $V_{DD} = 1.8 V \pm 0.1 V$.
- 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 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, $CKE = 0.2 \times V_{DDQ}$ 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 $t_{DQSCK.MIN(DERATED)} = t_{DQSCK.MIN} - t_{ERR(6-10PER).MAX} = -400$ 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!)

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- 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 t_{WR} programmed to 4 clocks. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns})$ clocks = 4 + (4) clocks = 8 clocks.
- 14) $t_{DAL,nCK} = WR [nCK] + t_{nRP,nCK} = WR + RU\{t_{RP} [ps] / t_{CK,AVG}[ps]\}$, 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 $V_{i(DC),MAX}$ 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 / \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 been 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 $t_{JIT.PER}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT.PER.MIN} = -72$ ps and $t_{JIT.PER.MAX} = +93$ ps, then $t_{RPRE.MIN(DERATED)} = t_{RPRE.MIN} + t_{JIT.PER.MIN} = 0.9 \times t_{CK.AVG} - 72$ ps = + 2178 ps and $t_{RPRE.MAX(DERATED)} = t_{RPRE.MAX} + t_{JIT.PER.MAX} = 1.1 \times t_{CK.AVG} + 93$ ps = + 2843 ps. (Caution on the MIN/MAX usage!).
- 34) When the device is operated with input clock jitter, this parameter needs to be derated by the actual $t_{JIT.DUTY}$ of the input clock. (output deratings are relative to the SDRAM input clock.) For example, if the measured jitter into a DDR2-667 SDRAM has $t_{JIT.DUTY.MIN} = -72$ ps and $t_{JIT.DUTY.MAX} = +93$ ps, then $t_{RPST.MIN(DERATED)} = t_{RPST.MIN} + t_{JIT.DUTY.MIN} = 0.4 \times t_{CK.AVG} - 72$ ps = + 928 ps and $t_{RPST.MAX(DERATED)} = t_{RPST.MAX} + t_{JIT.DUTY.MAX} = 0.6 \times t_{CK.AVG} + 93$ ps = + 1592 ps. (Caution on the MIN/MAX usage!).
- 35) 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.
- 36) t_{WTR} is at least two clocks ($2 \times t_{CK}$) independent of operation frequency.

TABLE 14
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{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_{DQSK}	-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	35)
Four Activate Window for 2KB page size products	t_{FAW}	50	—	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{CK}	t_{HZ}	—	$t_{AC.MAX}$	ps	9)22)
Address and control input hold time	$t_{IH.BASE}$	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) $V_{DDQ} = 1.8 V \pm 0.1V$; $V_{DD} = 1.8 V \pm 0.1 V$.
- 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 $t_{DQSK,MIN(DERATED)} = t_{DQSK,MIN} - t_{ERR(6-10PER),MAX} = -400$ ps $- 293$ ps = -693 ps and $t_{DQSK,MAX(DERATED)} = t_{DQSK,MAX} - t_{ERR(6-10PER),MIN} = 400$ 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 t_{WR} 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. $t_{DAL} = 4 + (15 \text{ ns} / 3.75 \text{ ns})$ 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{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, \overline{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 / \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.



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- 28) 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.
- 29) $0\text{ }^{\circ}\text{C} \leq T_{\text{CASE}} \leq 85\text{ }^{\circ}\text{C}$
- 30) $85\text{ }^{\circ}\text{C} < T_{\text{CASE}} \leq 95\text{ }^{\circ}\text{C}$
- 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 least two clocks ($2 \times t_{\text{CK}}$) independent of operation frequency.

FIGURE 2

Method for calculating transitions and endpoint

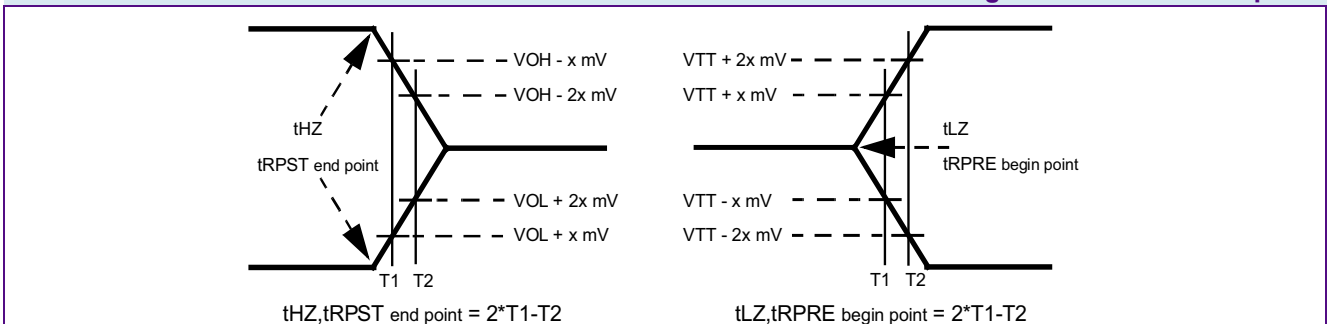


FIGURE 3

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

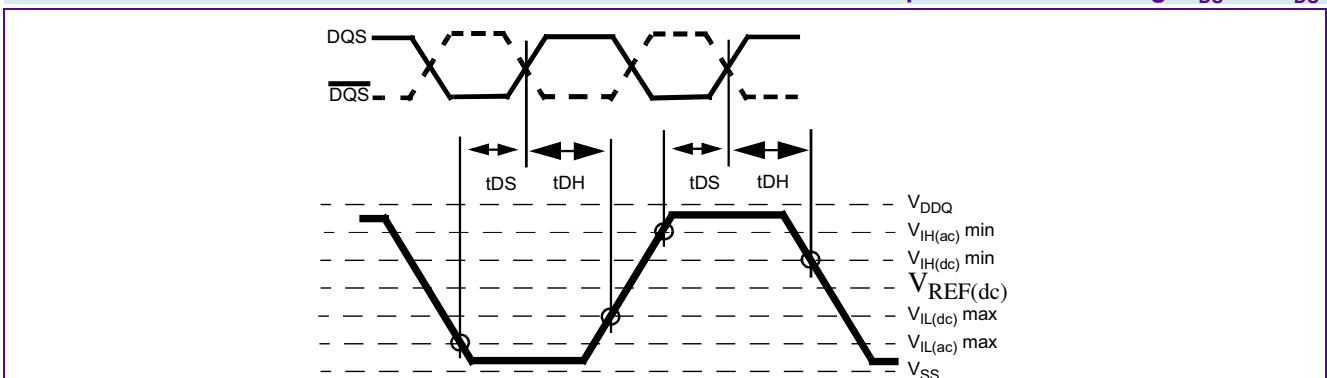




FIGURE 4

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

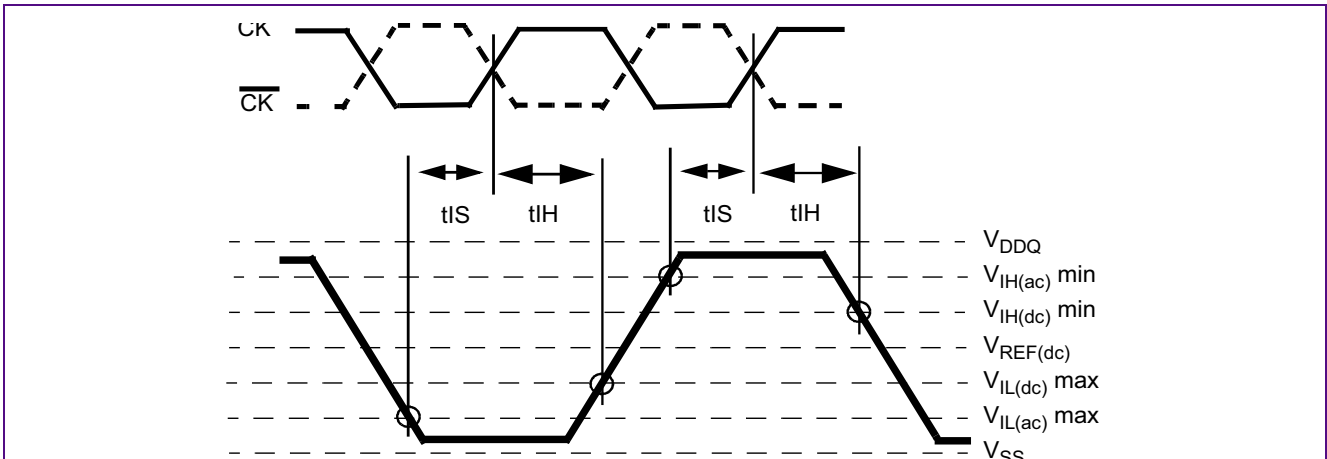


TABLE 15

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{CK}	t_{AC}	-500	+500	ps	
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)	$t_{DH}(\text{base})$	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{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)	$t_{DS}(\text{base})$	100	—	ps	11)
DQ and DM input setup time (single ended data strobe)	$t_{DS1}(\text{base})$	-25	—	ps	11)



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Parameter	Symbol	DDR2-533		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
DQS falling edge hold time from CK (write cycle)	t_{DSH}	0.2	—	t_{CK}	
DQS falling edge to CK setup time (write cycle)	t_{DSS}	0.2	—	t_{CK}	
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}	$t_{LZ}(DQ)$	$2 \times t_{AC.MIN}$	$t_{AC.MAX}$	ps	14)
DQS low-impedance from CK / \overline{CK}	$t_{LZ}(DQS)$	$t_{AC.MIN}$	$t_{AC.MAX}$	ps	14)
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	
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}	



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Parameter	Symbol	DDR2-533		Unit	Notes ¹⁾²⁾³⁾⁴⁾⁵⁾⁶⁾⁷⁾
		Min.	Max.		
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) $V_{DDQ} = 1.8 V \pm 0.1 V$; $V_{DD} = 1.8 V \pm 0.1 V$.
- 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 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, $CKE = 0.2 \times V_{DDQ}$ 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 / \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 been reduced to 3.9 μs when operating the DDR2 DRAM in a temperature range between 85 °C and 95 °C.
- 15) $0^\circ C \leq T_{CASE} \leq 85^\circ C$
- 16) $85^\circ C < T_{CASE} \leq 95^\circ C$
- 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 16
ODT AC Characteristics and Operating Conditions for 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.

TABLE 17
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 (= $2 \times 5 \text{ ns}$) after the clock edge that registered a first ODT HIGH if $t_{CK} = 5 \text{ ns}$.



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- 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 I_{DD} Specifications and Conditions

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

- **Table 18 “ I_{DD} Measurement Conditions” on Page 26**
- **Table 19 “Definitions for I_{DD} ” on Page 27**

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, $\underline{BL} = 4$, $t_{CK} = t_{CK.MIN}$, $t_{RC} = t_{RC.MIN}$, $t_{RAS} = t_{RAS.MIN}$, $t_{RCD} = t_{RCD.MIN}$, $\underline{AL} = 0$, $\underline{CL} = \underline{CL}_{MIN}$; 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; $\underline{BL} = 4$; $\underline{AL} = 0$, $\underline{CL} = \underline{CL}_{MIN}$; $t_{CK} = t_{CK.MIN}$; $t_{RAS} = t_{RAS.MAX}$, $t_{RP} = t_{RP.MIN}$; 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; $\underline{BL} = 4$; $\underline{AL} = 0$, $\underline{CL} = \underline{CL}_{MIN}$; $t_{CK} = t_{CKMIN}$; $t_{RAS} = t_{RASMAX}$; $t_{RP} = t_{RPMIN}$; 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; $\underline{BL} = 4$; $\underline{AL} = 0$, $\underline{CL} = \underline{CL}_{MIN}$; $t_{CK} = t_{CK.MIN}$; $t_{RAS} = t_{RAS.MAX}$, $t_{RP} = t_{RP.MAX}$; CKE is HIGH, \overline{CS} is HIGH between valid commands. Address inputs are SWITCHING; Data Bus inputs are SWITCHING;	I_{DD4W}	



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Parameter	Symbol	Note ¹⁾²⁾³⁾⁴⁾⁵⁾
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 $t_{RFC} = t_{REF1}$ interval, CKE is LOW and \overline{CS} is HIGH between valid commands, Other control and address inputs are SWITCHING, Data bus inputs are SWITCHING.	I_{DD5D}	
Self-Refresh Current CKE ≤ 0.2 V; external clock off, CK and \overline{CK} at 0 V; Other control and address inputs are FLOATING, Data bus inputs are FLOATING. I_{DD6} current values are guaranteed up to T_{CASE} of 85 °C max.	I_{DD6}	
All Bank Interleave Read Current All banks are being interleaved at minimum t_{RC} without violating t_{RRD} using a burst length of 4. Control and address bus inputs are STABLE during DESELECTS. $I_{out} = 0$ mA.	I_{DD7}	⁶⁾

- 1) $V_{DDQ} = 1.8\text{ V} \pm 0.1\text{ V}$; $V_{DD} = 1.8\text{ V} \pm 0.1\text{ V}$
- 2) I_{DD} specifications are tested after the device is properly initialized and I_{DD} parameter are specified with ODT disabled.
- 3) Definitions for I_{DD} see **Table 19**
- 4) For two rank modules: All active current measurements in the same I_{DD} current mode. The other rank is in I_{DD2P} Precharge Power-Down Mode
- 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



HYS64T128020EDL-[2.5/3S/3.7]-B
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TABLE 20

I_{DD} Specification for HYS64T128020EDL-[2.5/3S/3.7]-B

Product Type	HYS64T128020EDL-2.5-B	HYS64T128020EDL-3S-B	HYS64T128020EDL-3.7-B	Units	Note ¹⁾
Organization	1 GB	1 GB	1 GB		
	×64	×64	×64		
	2 Ranks	2 Ranks	2 Ranks		
	-2.5	-3S	-3.7		
I_{DD0}	648	588	548	mA	2)
I_{DD1}	688	628	568	mA	2)
I_{DD2N}	560	520	440	mA	3)
I_{DD2P}	96	96	96	mA	3)
I_{DD2Q}	520	480	400	mA	3)
I_{DD3N}	720	560	480	mA	3)
I_{DD3P_0} (fast)	384	360	304	mA	3)4)
I_{DD3P_1} (slow)	120	120	120	mA	3)5)
I_{DD4R}	1008	868	748	mA	2)
I_{DD4W}	1008	868	748	mA	2)
I_{DD5B}	948	888	848	mA	2)
I_{DD5D}	104	104	104	mA	3)6)
I_{DD6}	64	64	64	mA	3)6)
I_{DD7}	1408	1248	1168	mA	2)

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

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

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

4) Fast: MRS(12)=0

5) Slow: MRS(12)=1

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



4 SPD Codes

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

List of SPD Code Tables

- [Table 21 “PC2-6400-666” on Page 29](#)
- [Table 22 “PC2-5300-555” on Page 33](#)
- [Table 23 “PC2-4200-444” on Page 37](#)

TABLE 21
PC2-6400-666

Product Type		HYS64T128020EDL-2.5-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
0	Programmed SPD Bytes in EEPROM	80
1	Total number of Bytes in EEPROM	08
2	Memory Type (DDR2)	08
3	Number of Row Addresses	0D
4	Number of Column Addresses	0A
5	DIMM Rank and Stacking Information	61
6	Data Width	40
7	Not used	00
8	Interface Voltage Level	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	25
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	40
11	Error Correction Support (non-ECC, ECC)	00
12	Refresh Rate and Type	82
13	Primary SDRAM Width	10
14	Error Checking SDRAM Width	00
15	Not used	00
16	Burst Length Supported	0C
17	Number of Banks on SDRAM Device	08
18	Supported CAS Latencies	70
19	DIMM Mechanical Characteristics	01



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-2.5-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
20	DIMM Type Information	04
21	DIMM Attributes	00
22	Component Attributes	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	45
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	3D
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	50
27	$t_{RP.MIN}$ [ns]	3C
28	$t_{RRD.MIN}$ [ns]	28
29	$t_{RCD.MIN}$ [ns]	3C
30	$t_{RAS.MIN}$ [ns]	2D
31	Module Density per Rank	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	17
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	25
34	$t_{DS.MIN}$ [ns]	05
35	$t_{DH.MIN}$ [ns]	12
36	$t_{WR.MIN}$ [ns]	3C
37	$t_{WTR.MIN}$ [ns]	1E
38	$t_{RTP.MIN}$ [ns]	1E
39	Analysis Characteristics	00
40	t_{RC} and t_{RFC} Extension	06
41	$t_{RC.MIN}$ [ns]	3C
42	$t_{RFC.MIN}$ [ns]	7F
43	$t_{CK.MAX}$ [ns]	80
44	$t_{DQSQ.MAX}$ [ns]	14
45	$t_{QHS.MAX}$ [ns]	1E
46	PLL Relock Time	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	5F
48	Psi(T-A) DRAM	58
49	ΔT_0 (DT0)	53
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	3B
51	ΔT_{2P} (DT2P)	27
52	ΔT_{3N} (DT3N)	2A



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-2.5-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
53	$\Delta T_{3P.fast}$ (DT3P fast)	43
54	$\Delta T_{3P.slow}$ (DT3P slow)	1E
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	54
56	ΔT_{5B} (DT5B)	22
57	ΔT_7 (DT7)	42
58	Psi(ca) PLL	00
59	Psi(ca) REG	00
60	ΔT_{PLL} (DTPLL)	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00
62	SPD Revision	12
63	Checksum of Bytes 0-62	22
64	Manufacturer's JEDEC ID Code (1)	7F
65	Manufacturer's JEDEC ID Code (2)	7F
66	Manufacturer's JEDEC ID Code (3)	7F
67	Manufacturer's JEDEC ID Code (4)	7F
68	Manufacturer's JEDEC ID Code (5)	7F
69	Manufacturer's JEDEC ID Code (6)	51
70	Manufacturer's JEDEC ID Code (7)	00
71	Manufacturer's JEDEC ID Code (8)	00
72	Module Manufacturer Location	xx
73	Product Type, Char 1	36
74	Product Type, Char 2	34
75	Product Type, Char 3	54
76	Product Type, Char 4	31
77	Product Type, Char 5	32
78	Product Type, Char 6	38
79	Product Type, Char 7	30
80	Product Type, Char 8	32
81	Product Type, Char 9	30
82	Product Type, Char 10	45
83	Product Type, Char 11	44
84	Product Type, Char 12	4C
85	Product Type, Char 13	32



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-2.5-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-6400S-666
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
86	Product Type, Char 14	2E
87	Product Type, Char 15	35
88	Product Type, Char 16	42
89	Product Type, Char 17	20
90	Product Type, Char 18	20
91	Module Revision Code	0x
92	Test Program Revision Code	xx
93	Module Manufacturing Date Year	xx
94	Module Manufacturing Date Week	xx
95 - 98	Module Serial Number	xx
99 - 127	Not used	00
128 - 255	Blank for customer use	FF



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

TABLE 22
PC2-5300-555

Product Type		HYS64T128020EDL-3S-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
0	Programmed SPD Bytes in EEPROM	80
1	Total number of Bytes in EEPROM	08
2	Memory Type (DDR2)	08
3	Number of Row Addresses	0D
4	Number of Column Addresses	0A
5	DIMM Rank and Stacking Information	61
6	Data Width	40
7	Not used	00
8	Interface Voltage Level	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	30
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	45
11	Error Correction Support (non-ECC, ECC)	00
12	Refresh Rate and Type	82
13	Primary SDRAM Width	10
14	Error Checking SDRAM Width	00
15	Not used	00
16	Burst Length Supported	0C
17	Number of Banks on SDRAM Device	08
18	Supported CAS Latencies	38
19	DIMM Mechanical Characteristics	01
20	DIMM Type Information	04
21	DIMM Attributes	00
22	Component Attributes	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	30
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	45
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	50
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	60
27	$t_{RP,MIN}$ [ns]	30
28	$t_{RRD,MIN}$ [ns]	28
29	$t_{RCD,MIN}$ [ns]	30



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3S-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
30	$t_{RAS.MIN}$ [ns]	2D
31	Module Density per Rank	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	20
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	27
34	$t_{DS.MIN}$ [ns]	10
35	$t_{DH.MIN}$ [ns]	17
36	$t_{WR.MIN}$ [ns]	3C
37	$t_{WTR.MIN}$ [ns]	1E
38	$t_{RTP.MIN}$ [ns]	1E
39	Analysis Characteristics	00
40	t_{RC} and t_{RFC} Extension	06
41	$t_{RC.MIN}$ [ns]	39
42	$t_{RFC.MIN}$ [ns]	7F
43	$t_{CK.MAX}$ [ns]	80
44	$t_{DQSQ.MAX}$ [ns]	18
45	$t_{QHS.MAX}$ [ns]	22
46	PLL Relock Time	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	5D
48	Psi(T-A) DRAM	58
49	ΔT_0 (DT0)	47
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	32
51	ΔT_{2P} (DT2P)	27
52	ΔT_{3N} (DT3N)	24
53	$\Delta T_{3P.fast}$ (DT3P fast)	39
54	$\Delta T_{3P.slow}$ (DT3P slow)	1E
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	48
56	ΔT_{5B} (DT5B)	21
57	ΔT_7 (DT7)	37
58	Psi(ca) PLL	00
59	Psi(ca) REG	00
60	ΔT_{PLL} (DTPLL)	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00
62	SPD Revision	12



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3S-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
63	Checksum of Bytes 0-62	E6
64	Manufacturer's JEDEC ID Code (1)	7F
65	Manufacturer's JEDEC ID Code (2)	7F
66	Manufacturer's JEDEC ID Code (3)	7F
67	Manufacturer's JEDEC ID Code (4)	7F
68	Manufacturer's JEDEC ID Code (5)	7F
69	Manufacturer's JEDEC ID Code (6)	51
70	Manufacturer's JEDEC ID Code (7)	00
71	Manufacturer's JEDEC ID Code (8)	00
72	Module Manufacturer Location	xx
73	Product Type, Char 1	36
74	Product Type, Char 2	34
75	Product Type, Char 3	54
76	Product Type, Char 4	31
77	Product Type, Char 5	32
78	Product Type, Char 6	38
79	Product Type, Char 7	30
80	Product Type, Char 8	32
81	Product Type, Char 9	30
82	Product Type, Char 10	45
83	Product Type, Char 11	44
84	Product Type, Char 12	4C
85	Product Type, Char 13	33
86	Product Type, Char 14	53
87	Product Type, Char 15	42
88	Product Type, Char 16	20
89	Product Type, Char 17	20
90	Product Type, Char 18	20
91	Module Revision Code	0x
92	Test Program Revision Code	xx
93	Module Manufacturing Date Year	xx
94	Module Manufacturing Date Week	xx
95 - 98	Module Serial Number	xx

HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3S-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-5300S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
99 - 127	Not used	00
128 - 255	Blank for customer use	FF



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

TABLE 23
PC2-4200-444

Product Type		HYS64T128020EDL-3.7-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
0	Programmed SPD Bytes in EEPROM	80
1	Total number of Bytes in EEPROM	08
2	Memory Type (DDR2)	08
3	Number of Row Addresses	0D
4	Number of Column Addresses	0A
5	DIMM Rank and Stacking Information	61
6	Data Width	40
7	Not used	00
8	Interface Voltage Level	05
9	$t_{CK} @ CL_{MAX}$ (Byte 18) [ns]	3D
10	t_{AC} SDRAM @ CL_{MAX} (Byte 18) [ns]	50
11	Error Correction Support (non-ECC, ECC)	00
12	Refresh Rate and Type	82
13	Primary SDRAM Width	10
14	Error Checking SDRAM Width	00
15	Not used	00
16	Burst Length Supported	0C
17	Number of Banks on SDRAM Device	08
18	Supported CAS Latencies	38
19	DIMM Mechanical Characteristics	00
20	DIMM Type Information	04
21	DIMM Attributes	00
22	Component Attributes	07
23	$t_{CK} @ CL_{MAX} -1$ (Byte 18) [ns]	3D
24	t_{AC} SDRAM @ $CL_{MAX} -1$ [ns]	50
25	$t_{CK} @ CL_{MAX} -2$ (Byte 18) [ns]	50
26	t_{AC} SDRAM @ $CL_{MAX} -2$ [ns]	60
27	$t_{RP,MIN}$ [ns]	3C
28	$t_{RRD,MIN}$ [ns]	28
29	$t_{RCD,MIN}$ [ns]	3C



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3.7-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
30	$t_{RAS.MIN}$ [ns]	2D
31	Module Density per Rank	80
32	$t_{AS.MIN}$ and $t_{CS.MIN}$ [ns]	25
33	$t_{AH.MIN}$ and $t_{CH.MIN}$ [ns]	37
34	$t_{DS.MIN}$ [ns]	10
35	$t_{DH.MIN}$ [ns]	22
36	$t_{WR.MIN}$ [ns]	3C
37	$t_{WTR.MIN}$ [ns]	1E
38	$t_{RTP.MIN}$ [ns]	1E
39	Analysis Characteristics	00
40	t_{RC} and t_{RFC} Extension	06
41	$t_{RC.MIN}$ [ns]	3C
42	$t_{RFC.MIN}$ [ns]	7F
43	$t_{CK.MAX}$ [ns]	80
44	$t_{DQSQ.MAX}$ [ns]	1E
45	$t_{QHS.MAX}$ [ns]	28
46	PLL Relock Time	00
47	$T_{CASE.MAX}$ Delta / ΔT_{4R4W} Delta	59
48	Psi(T-A) DRAM	60
49	ΔT_0 (DT0)	3F
50	ΔT_{2N} (DT2N, UDIMM) or ΔT_{2Q} (DT2Q, RDIMM)	2A
51	ΔT_{2P} (DT2P)	2B
52	ΔT_{3N} (DT3N)	20
53	$\Delta T_{3P.fast}$ (DT3P fast)	35
54	$\Delta T_{3P.slow}$ (DT3P slow)	21
55	ΔT_{4R} (DT4R) / ΔT_{4R4W} Sign (DT4R4W)	40
56	ΔT_{5B} (DT5B)	22
57	ΔT_7 (DT7)	31
58	Psi(ca) PLL	00
59	Psi(ca) REG	00
60	ΔT_{PLL} (DTPLL)	00
61	ΔT_{REG} (DTREG) / Toggle Rate	00
62	SPD Revision	12



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3.7-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
63	Checksum of Bytes 0-62	42
64	Manufacturer's JEDEC ID Code (1)	7F
65	Manufacturer's JEDEC ID Code (2)	7F
66	Manufacturer's JEDEC ID Code (3)	7F
67	Manufacturer's JEDEC ID Code (4)	7F
68	Manufacturer's JEDEC ID Code (5)	7F
69	Manufacturer's JEDEC ID Code (6)	51
70	Manufacturer's JEDEC ID Code (7)	00
71	Manufacturer's JEDEC ID Code (8)	00
72	Module Manufacturer Location	xx
73	Product Type, Char 1	36
74	Product Type, Char 2	34
75	Product Type, Char 3	54
76	Product Type, Char 4	31
77	Product Type, Char 5	32
78	Product Type, Char 6	38
79	Product Type, Char 7	30
80	Product Type, Char 8	32
81	Product Type, Char 9	30
82	Product Type, Char 10	45
83	Product Type, Char 11	44
84	Product Type, Char 12	4C
85	Product Type, Char 13	33
86	Product Type, Char 14	2E
87	Product Type, Char 15	37
88	Product Type, Char 16	42
89	Product Type, Char 17	20
90	Product Type, Char 18	20
91	Module Revision Code	3x
92	Test Program Revision Code	xx
93	Module Manufacturing Date Year	xx
94	Module Manufacturing Date Week	xx
95 - 98	Module Serial Number	xx

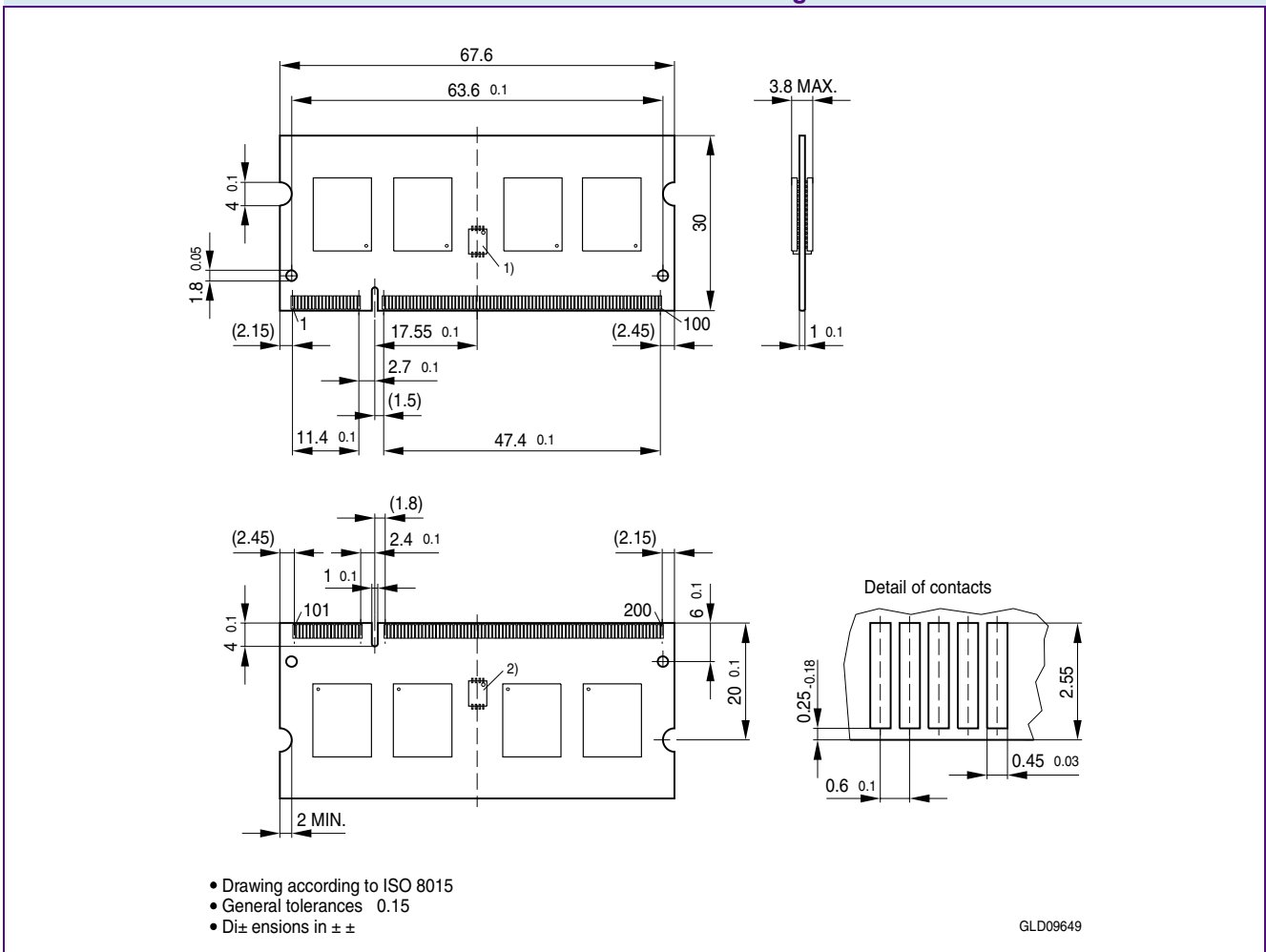
HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Product Type		HYS64T128020EDL-3.7-B
Organization		1 GByte
		×64
		2 Ranks (×16)
Label Code		PC2-4200S-444
JEDEC SPD Revision		Rev. 1.2
Byte#	Description	HEX
99 - 127	Not used	00
128 - 255	Blank for customer use	FF



5 Package Outlines

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



Notes

1. Thermal Sensor (Optional)
2. SPD or Combidevice (if used then no Thermal Sensor needed)



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



HYS64T128020EDL-[2.5/3S/3.7]-B
Small Outlined DDR2 SDRAM Modules

Field	Description	Values	Coding
10	Speed Grade	-19F	PC2-8500 6-6-6
		-1.9	PC2-8500 7-7-7
		-25F	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	-19F	PC2-8500 6-6-6
		-1.9	PC2-8500 7-7-7
		-25F	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



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