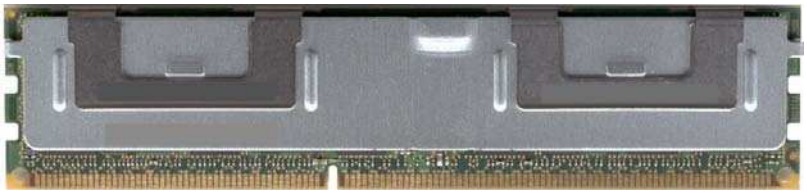
DTM64800A

32GB - 240-Pin 4Rx4 Buffered ECC DDR3 LRDIMM



Identification

DTM64800A 4Gx72

32GB 4Rx4 PC3L-10600L-9-11-C1

Performance range

Clock / Module Speed / CL-t_{RCD} -t_{RP}

667 MHz / PC3-10600 / 9-9-9

533 MHz / PC3-8500 / 8-8-8

533 MHz / PC3-8500 / 7-7-7

400 MHz / PC3-6400 / 6-6-6

Features

- 240-pin JEDEC-compliant DIMM, 133.35 mm wide by 30 mm high
- Operating Voltage: 1.35V (1.28V~1.45V)
  Backward compatible: 1.5V(1.425V~1.575V)
- I/O Type: SSTL_15
- On-board I^2C temperature sensor with integrated Serial Presence-Detect (SPD) EEPROM
- Data Transfer Rate: 10.6 Gigabytes/sec
- Data Bursts: 8 and burst chop 4 mode
- ZQ Calibration for Output Driver and On-Die Termination (ODT)
- Programmable ODT / Dynamic ODT during Writes
- Programmable CAS Latency: 6, 7, 8, and 9
- Bi-directional Differential Data Strobe signals
- SDRAM Addressing (Row/Col/Bank): 16/11/3
- Fully RoHS Compliant

Description

DTM64800A is a load reduced 4Gx72 memory module, which conforms to JEDEC's DDR3, PC3-10600L standard. The assembly is Quad-Rank. The ranks are comprised of eighteen 2Gx4 Samsung DDP (Dual Die Pack) DDR3 SDRAMs. One 2K-bit EEPROM is used for Serial Presence Detect and an Inphi Isolation Memory Buffer, which enables higher system memory bandwidth at DDR3 speeds up to 1333 MT/s are used.

Both output driver strength and input termination impedance are programmable to maintain signal integrity on the I/O signals in a Fly-by topology. A thermal sensor accurately monitors the DIMM module and can prevent exceeding the maximum operating temperature of 95C. A Heat Spreader is attached to improve the thermal characteristics of the module.

Pin Configuration

Front Side				Back Side			
1 V_{REFDQ}	31 DQ25	61 A2	91 DQ41	121 V_{SS}	151 V_{SS}	181 A1	211 V_{SS}
2 V_{SS}	32 V_{SS}	62 V_{DD}	92 V_{SS}	122 DQ4	152 DQS12	182 V_{DD}	212 DQS14
3 DQ0	33 /DQS3	63 CK1*	93 /DQS5	123 DQ5	153 /DQS12	183 V_{DD}	213 /DQS14
4 DQ1	34 DQS3	64 /CK1*	94 DQS5	124 V_{SS}	154 V_{SS}	184 CK0	214 V_{SS}
5 V_{SS}	35 V_{SS}	65 V_{DD}	95 V_{SS}	125 DQS9	155 DQ30	185 /CK0	215 DQ46
6 /DQS0	36 DQ26	66 V_{DD}	96 DQ42	126 /DQS9	156 DQ31	186 V_{DD}	216 DQ47
7 DQS0	37 DQ27	67 V_{REFCA}	97 DQ43	127 V_{SS}	157 V_{SS}	187 /Event	217 V_{SS}
8 V_{SS}	38 V_{SS}	68 P_{AR_IN}	98 V_{SS}	128 DQ6	158 CB4	188 A0	218 DQ52
9 DQ2	39 CB0	69 VDD	99 DQ48	129 DQ7	159 CB5	189 V_{DD}	219 DQ53
10 DQ3	40 CB1	70 A10/AP	100 DQ49	130 V_{SS}	160 V_{SS}	190 BA1	220 V_{SS}
11 V_{SS}	41 V_{SS}	71 BA0	101 V_{SS}	131 DQ12	161 DQS17	191 V_{DD}	221 DQS15
12 DQ8	42 /DQS8	72 V_{DD}	102 /DQS6	132 DQ13	162 /DQS17	192 /RAS	222 /DQS15
13 DQ9	43 DQS8	73 /WE	103 DQS6	133 V_{SS}	163 V_{SS}	193 /S0	223 V_{SS}
14 V_{SS}	44 V_{SS}	74 /CAS	104 V_{SS}	134 DQS10	164 CB6	194 V_{DD}	224 DQ54
15 /DQS1	45 CB2	75 V_{DD}	105 DQ50	135 /DQS10	165 CB7	195 ODT0	225 DQ55
16 DQS1	46 CB3	76 /S1	106 DQ51	136 V_{SS}	166 V_{SS}	196 A13	226 V_{SS}
17 V_{SS}	47 V_{SS}	77 ODT1	107 V_{SS}	137 DQ14	167 NC (TEST)	197 V_{DD}	227 DQ60
18 DQ10	48 V_{TT}	78 V_{DD}	108 DQ56	138 DQ15	168 /RESET	198 /S3	228 DQ61
19 DQ11	49 V_{TT}	79 /S2	109 DQ57	139 V_{SS}	169 CKE1	199 V_{SS}	229 V_{SS}
20 V_{SS}	50 CKE0	80 V_{SS}	110 V_{SS}	140 DQ20	170 V_{DD}	200 DQ36	230 DQS16
21 DQ16	51 V_{DD}	81 DQ32	111 /DQS7	141 DQ21	171 A15	201 DQ37	231 /DQS16
22 DQ17	52 BA2	82 DQ33	112 DQS7	142 V_{SS}	172 A14	202 V_{SS}	232 V_{SS}
23 V_{SS}	53 /E_{RR_OUT}	83 V_{SS}	113 V_{SS}	143 DQS11	173 V_{DD}	203 DQS13	233 DQ62
24 /DQS2	54 V_{DD}	84 /DQS4	114 DQ58	144 /DQS11	174 A12/ /BC	204 /DQS13	234 DQ63
25 DQS2	55 A11	85 DQS4	115 DQ59	145 V_{SS}	175 A9	205 V_{SS}	235 V_{SS}
26 V_{SS}	56 A7	86 V_{SS}	116 V_{SS}	146 DQ22	176 V_{DD}	206 DQ38	236 V_{DDSPD}
27 DQ18	57 V_{DD}	87 DQ34	117 SA0	147 DQ23	177 A8	207 DQ39	237 SA1
28 DQ19	58 A5	88 DQ35	118 SCL	148 V_{SS}	178 A6	208 V_{SS}	238 SDA
29 V_{SS}	59 A4	89 V_{SS}	119 SA2	149 DQ28	179 V_{DD}	209 DQ44	239 V_{SS}
30 DQ24	60 V_{DD}	90 DQ40	120 V_{TT}	150 DQ29	180 A3	210 DQ45	240 V_{TT}

* Not used

Pin Description

Name	Function
CB[7:0]	Data Check Bits
DQ[63:0]	Data Bits
DQS[17:0], /DQS[17:0]	Differential Data Strobes
CK[1:0], /CK[1:0]	Differential Clock Inputs
CKE[1:0]	Clock Enables
/CAS	Column Address Strobe
/RAS	Row Address Strobe
/S[3:0]	Chip Selects
/WE	Write Enable
A[15:0]	Address Inputs
BA[2:0]	Bank Addresses
ODT[1:0]	On Die Termination Inputs
SA[2:0]	SPD Address
SCL	SPD Clock Input
SDA	SPD Data Input/Output
/Event	Temperature Sensing
/RESET	Reset for register and DRAMs
PAR_IN	Parity bit for Addr/Ctrl
/ERR_OUT	Error bit for Parity Error
A12/BC	Combination input: Addr12/Burst Chop
A10/AP	Combination input: Addr10/Auto-precharge
V_{SS}	Ground
V_{DD}	Power
V_{DDSPD}	SPD EEPROM Power
V_{REFDQ}	Reference Voltage for DQ
V_{REFCA}	Reference Voltage for CA
V_{TT}	Termination Voltage
NC	No Connection

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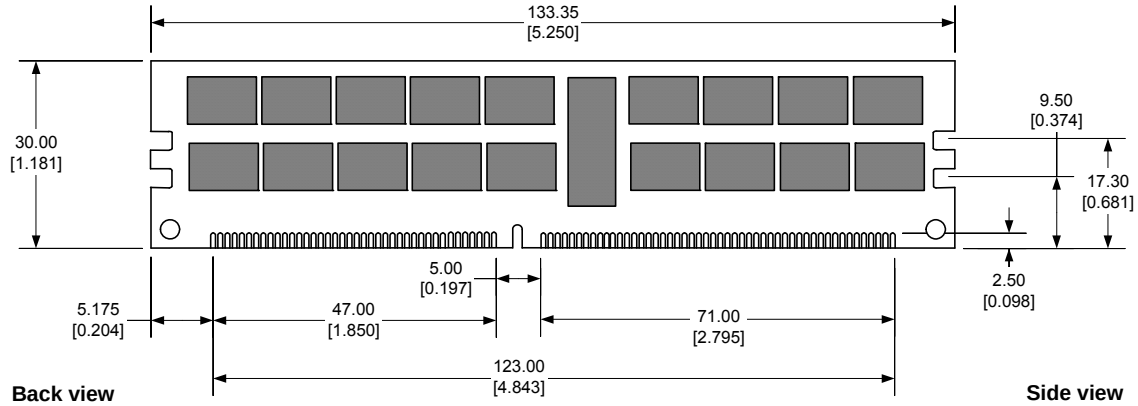
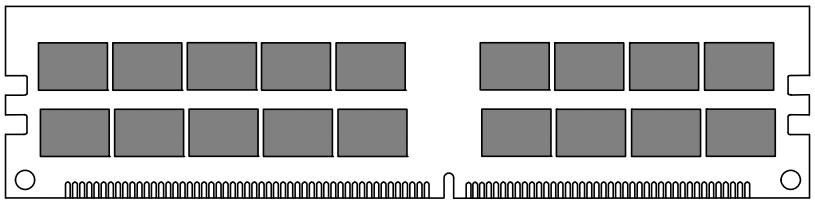
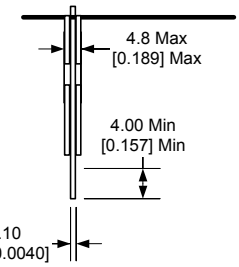
Front view



Back view

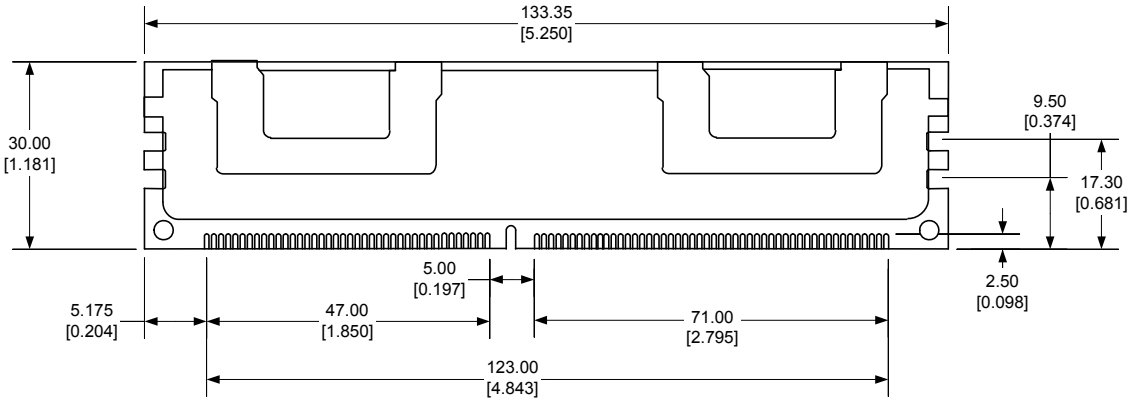


Side view

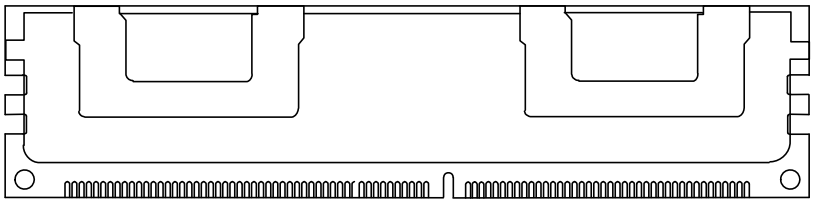


Note: Tolerances on all dimensions +/- .15 unless otherwise specified.

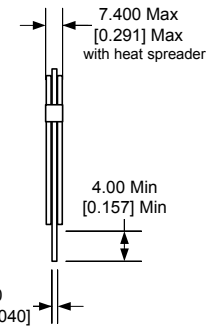
Front view

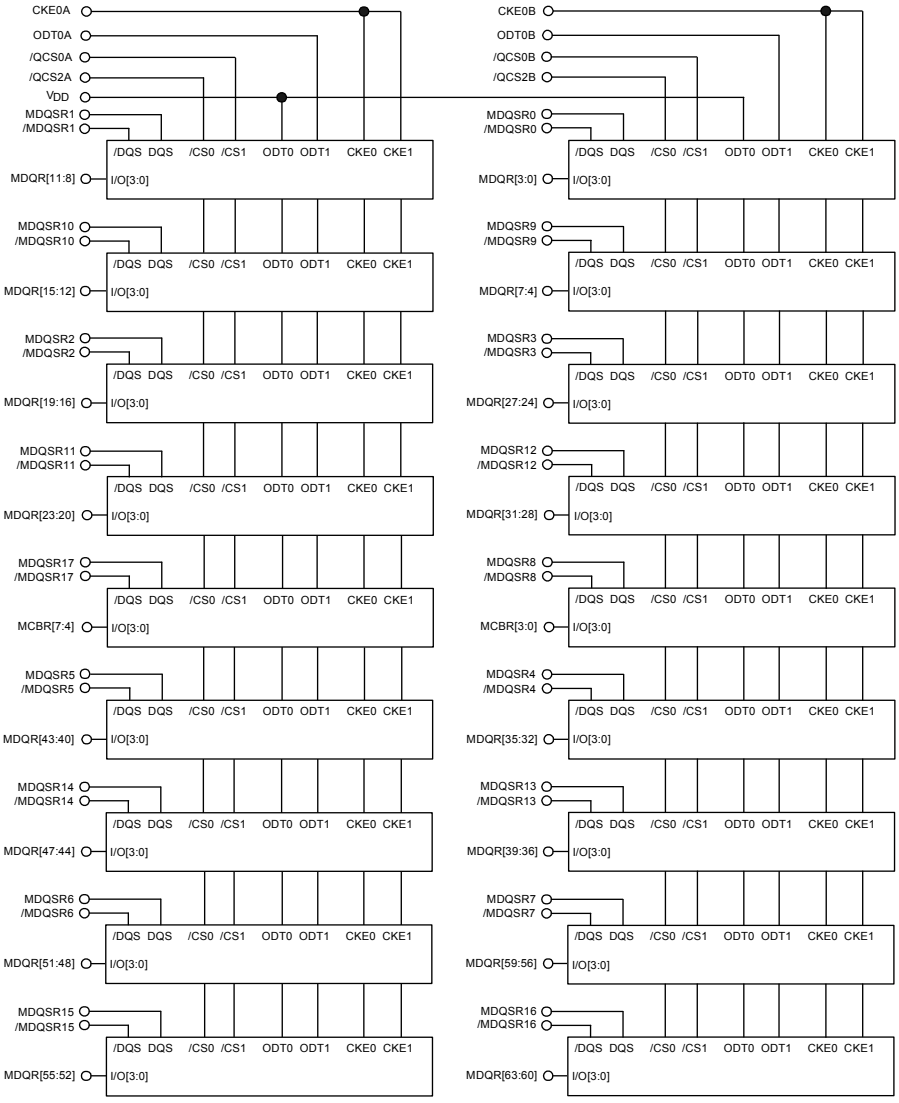


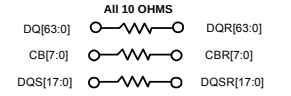
Back view



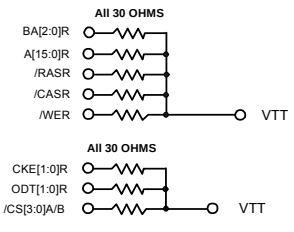
Side view

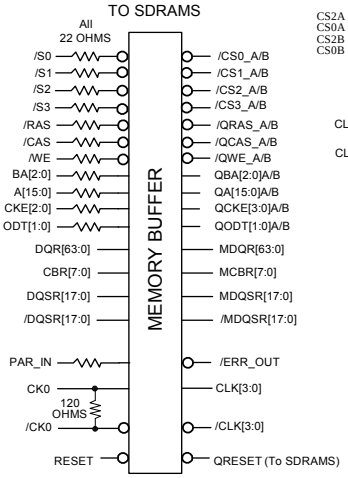




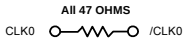


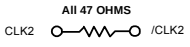
GLOBAL SDRAM CONNECTS

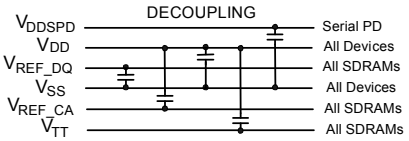


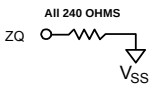


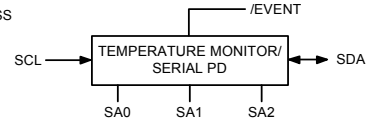
CS2A → CS0: Top row of DDP SDRAMs on front.
CS0A → CS1: Top row of DDP SDRAMs on front.
CS2B → CS0: Bottom row of DDP SDRAMs on front.
CS0B → CS1: Bottom row of DDP SDRAMs on front.
CS3A → CS0: Top row of DDP SDRAMs on back.
CS1A → CS1: Top row of DDP SDRAMs on back.
CS3B → CS0: Bottom row of DDP SDRAMs on back.
CS1B → CS1: Bottom row of DDP SDRAMs on back.

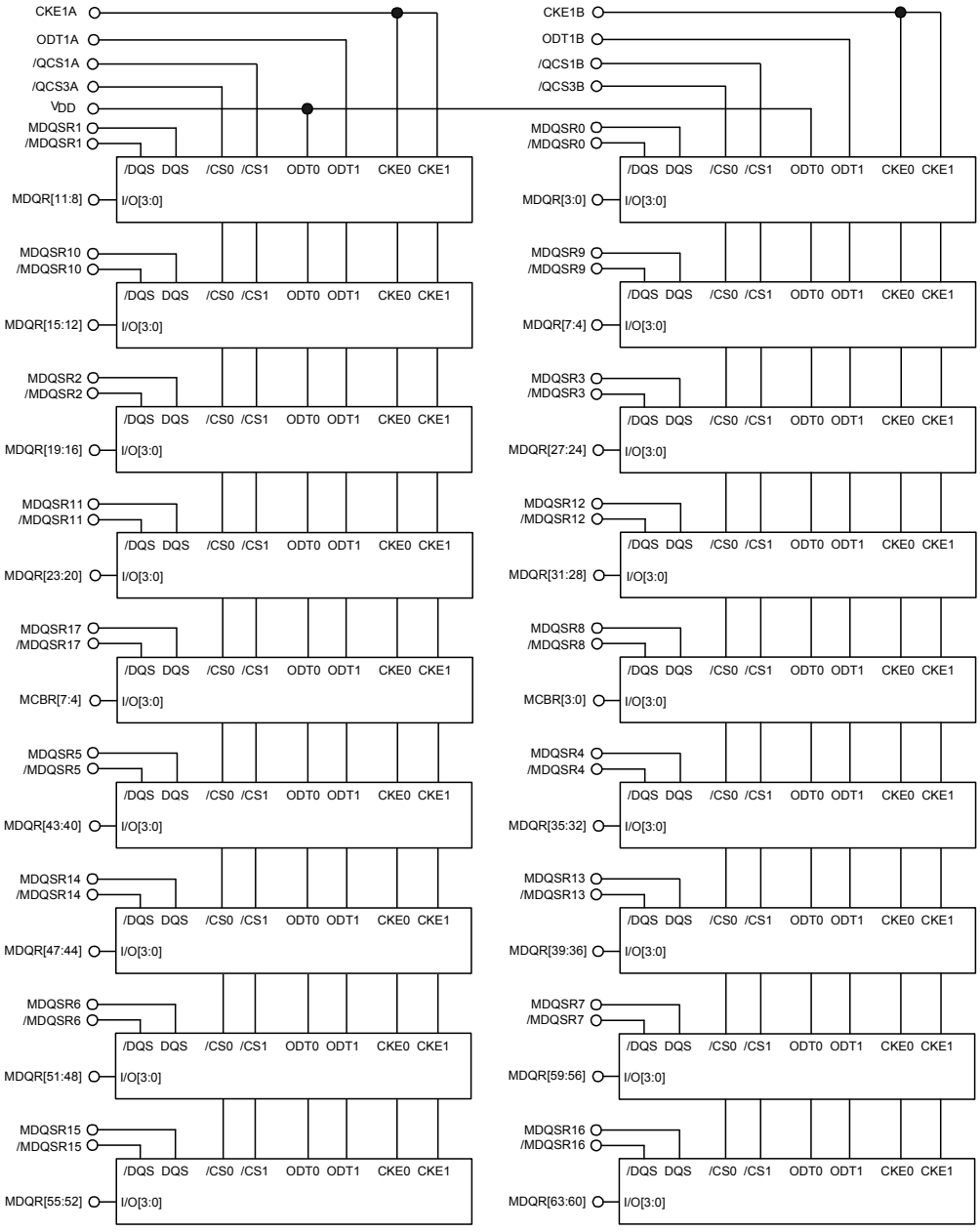











CKE1A
ODT1A
/QCS1A
/QCS3A
VDD
MDQSR1
/MDQSR1
/DQS DQS /CS0 /CS1 ODT0 ODT1 CKE0 CKE1
MDQR[11:8]
I/O[3:0]
MDQSR10
/MDQSR10
MDQR[15:12]
MDQSR2
/MDQSR2
MDQR[19:16]
MDQSR11
/MDQSR11
MDQR[23:20]
MDQSR17
/MDQSR17
MCBR[7:4]
MDQSR5
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MDQR[43:40]
MDQSR14
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MDQR[47:44]
MDQSR6
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MDQR[51:48]
MDQSR15
/MDQSR15
MDQR[55:52]
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ODT1B
/QCS1B
/QCS3B
MDQSR0
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MDQR[3:0]
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/MDQSR13
MDQR[39:36]
MDQSR7
/MDQSR7
MDQR[59:56]
MDQSR16
/MDQSR16
MDQR[63:60]

Absolute Maximum Ratings
(Note: Operation at or above Absolute Maximum Ratings can adversely affect module reliability.)

PARAMETER	Symbol	Minimum	Maximum	Unit
Temperature, non-Operating	$T_{STORAGE}$	-55	100	C
Ambient Temperature, Operating	T_A	0	70	C
DRAM Case Temperature, Operating	T_{CASE}	0	95	C
Voltage on V_{DD} relative to V_{SS}	V_{DD}	-0.4	1.975	V
Voltage on Any Pin relative to V_{SS}	V_{IN},V_{OUT}	-0.4	1.975	V

Notes:
DRAM Operating Case Temperature above 85C requires 2X refresh.

Recommended DC Operating Conditions (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER	Symbol		Minimum	Typical	Maximum	Unit	Note
Power Supply Voltage	V_{DD}	1.35V	1.283	1.35	1.45	V	
		1.5V	1.425	1.5	1.575		
I/O Reference Voltage	V_{REFDQ}		0.49 V_{DD}	0.50 V_{DD}	0.51 V_{DD}	V	1
I/O Reference Voltage	V_{REFCA}		0.49 V_{DD}	0.50 V_{DD}	0.51 V_{DD}	V	1

Notes:
1) The value of V_{REF} is expected to equal one-half V_{DD} and to track variations in the V_{DD} DC level. Peak-to-peak noise on V_{REF} may not exceed ±1% of its DC value.

DC Input Logic Levels, Single-Ended for Command and Address (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.35V**	$V_{IH.CA(DC90)}$	V_{REF} + 90	V_{DD}	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.CA(DC90)}$	V_{SS}	V_{REF} - 90	mV
Logical High (Logic 1)	**1.5V**	$V_{IH.CA(DC100)}$	V_{REF} + 100	V_{DD}	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.CA(DC100)}$	V_{SS}	V_{REF} - 100	mV

AC Input Logic Levels, Single-Ended for Command and Address (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.35V**	$V_{IH.CA(AC160)}$	V_{REF} + 160	-	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.CA(AC160)}$	-	V_{REF} - 160	mV
Logical High (Logic 1)	**1.35V**	$V_{IH.CA(AC135)}$	V_{REF} + 135	-	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.CA(AC135)}$	-	V_{REF} - 135	mV

AC Input Logic Levels, Single-Ended for Command and Address (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.5V**	$V_{IH.CA(AC175)}$	V_{REF} + 175	-	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.CA(AC175)}$	-	V_{REF} – 175	mV
Logical High (Logic 1)	**1.5V**	$V_{IH.CA(AC150)}$	V_{REF} + 150	-	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.CA(AC150)}$	-	V_{REF} - 150	mV

DC Input Logic Levels, Single-Ended for DQ and DM (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.35V**	$V_{IH.DQ(DC90)}$	V_{REF} + 90	V_{DD}	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.DQ(DC90)}$	V_{SS}	V_{REF} - 90	mV
Logical High (Logic 1)	**1.5V**	$V_{IH.DQ(DC100)}$	V_{REF} + 100	V_{DD}	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.DQ(DC100)}$	V_{SS}	V_{REF} - 100	mV

AC Input Logic Levels, Single-Ended for DQ and DM (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.35V**	$V_{IH.DQ(AC160)}$	V_{REF} + 160	-	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.DQ(AC160)}$	-	V_{REF} - 160	mV
Logical High (Logic 1)	**1.35V**	$V_{IH.DQ(AC135)}$	V_{REF} + 135	-	mV
Logical Low (Logic 0)	**1.35V**	$V_{IL.DQ(AC135)}$	-	V_{REF} - 135	mV

AC Input Logic Levels, Single-Ended for DQ and DM (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER		Symbol	Minimum	Maximum	Unit
Logical High (Logic 1)	**1.5V**	$V_{IH.DQ(AC175)}$	V_{REF} + 175	-	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.DQ(AC175)}$	-	V_{REF} – 175	mV
Logical High (Logic 1)	**1.5V**	$V_{IH.DQ(AC150)}$	V_{REF} + 150	-	mV
Logical Low (Logic 0)	**1.5V**	$V_{IL.DQ(AC150)}$	-	V_{REF} - 150	mV

Capacitance (T_A = 25 C, f = 100 MHz)

PARAMETER	Pin	Symbol	Minimum	Maximum	Unit
Input Capacitance, Clock	CK0, /CK0	C_{CK}	.7	1.2	pF
Input Capacitance, Address	BA[2:0], A[15:0], /RAS, /CAS, /WE	C_I	.7	1.2	pF
Input Capacitance Control	/S[3:0], CKE[1:0], ODT[1:0]	C_I	.7	1.2	pF
Input/Output Capacitance	DQ[63:0], CB[7:0] DQS[17:0], /DQS[17:0]	C_{IO}	1.4	2.1	pF

DC Characteristics (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER	Symbol	Minimum	Maximum	Unit	Note
Input Leakage Current (Any input 0 V < VIN < VDD)	I_{IL}	-18	+18	µA	1,2
Output Leakage Current (0V < VOUT < VDDQ)	I_{OL}	-10	+10	µA	2,3

Notes:
1) All other pins not under test = 0 V
2) Values are shown per pin
3) DQ, DQS, DQS and ODT are disabled

I_{DD} Specifications and Conditions (T_A = 0 to 70 C, Voltage referenced to V_{ss} = 0 V)

PARAMETER	Symbol	Test Condition	Max Value		Unit
			1.35V	1.5V	
Operating One Bank Active-Precharge Current	$I_{DD}0$*	Operating current : One bank ACTIVATE-to-PRECHARGE	3200	3600	mA
Operating One Bank Active-Read-Precharge Current	$I_{DD}1$*	Operating current : One bank ACTIVATE-to-READ-to-PRECHARGE	3700	4300	mA
Precharge Power-Down Current	$I_{DD}2P$**	Precharge power down current: (Slow exit)	1300	1400	mA
Precharge Power-Down Current	$I_{DD}2P$**	Precharge power down current: (Fast exit)	1600	1900	mA
Precharge Standby Current	$I_{DD}2N$**	Precharge standby current	2800	3200	mA
Active Power-Down Current	$I_{DD}3P$**	Active power-down current	1700	2000	mA
Active Standby Current	$I_{DD}3N$**	Active standby current	2900	3300	mA
Operating Burst Write Current	$I_{DD}4W$*	Burst write operating current	6300	7200	mA
Operating Burst Read Current	$I_{DD}4R$*	Burst read operating current	6200	7200	mA
Burst Refresh Current	$I_{DD}5B$**	Refresh current	4500	4900	mA
Self Refresh Current	$I_{DD}6$**	Self-refresh temperature current: MAX T_C = 85°C	1500	1700	mA
Operating Bank Interleave Read Current	$I_{DD}7$*	All bank interleaved read current	7000	7900	mA

* One module rank in this operation, the rest in IDD2P slow exit.
** All module ranks in this operation.

AC Operating Conditions

PARAMETER	Symbol	Min	Max	Unit
Internal read command to first data	t_{AA}	13.125	20	ns
CAS-to-CAS Command Delay	t_{CCD}	4	-	t_{CK}
Clock High Level Width	$t_{CH(avg)}$	0.47	0.53	t_{CK}
Clock Cycle Time	t_{CK}	1.5	2.500	ns
Clock Low Level Width	$t_{CL(avg)}$	0.47	0.53	t_{CK}
Data Input Hold Time after DQS Strobe	t_{DH}	65	-	ps
DQ Input Pulse Width	t_{DIPW}	400	-	ps
DQS Output Access Time from Clock	t_{DQSCK}	-255	+255	ps
Write DQS High Level Width	t_{DQSH}	0.45	0.55	$t_{CK(avg)}$
Write DQS Low Level Width	t_{DQSL}	0.45	0.55	$t_{CK(avg)}$
DQS-Out Edge to Data-Out Edge Skew	t_{DQSQ}	-	125	ps
Data Input Setup Time Before DQS Strobe	t_{DS}	30	-	ps
DQS Falling Edge from Clock, Hold Time	t_{DSH}	0.2	-	$t_{CK(avg)}$
DQS Falling Edge to Clock, Setup Time	t_{DSS}	0.2	-	$t_{CK(avg)}$
Address and Command Hold Time after Clock	t_{IH}	140	-	ps
Address and Command Setup Time before Clock	t_{IS}	65	-	ps
Load Mode Command Cycle Time	t_{MRD}	4	-	t_{CK}
DQ-to-DQS Hold	t_{QH}	0.38	-	$t_{CK(avg)}$
Active-to-Precharge Time	t_{RAS}	36	$9*t_{REFI}$	ns
Active-to-Active / Auto Refresh Time	t_{RC}	49.125	-	ns
RAS-to-CAS Delay	t_{RCD}	13.125	-	ns
Average Periodic Refresh Interval $0^o C \leq T_{CASE} < 85^o C$	t_{REFI}	-	7.8	µs
Average Periodic Refresh Interval $85^o C \leq T_{CASE} < 95^o C$	t_{REFI}	-	3.9	µs
Auto Refresh Row Cycle Time	t_{RFC}	260	-	ns
Row Precharge Time	t_{RP}	13.125	-	ns
Read DQS Preamble Time	t_{RPRE}	0.9	Note 1	$t_{CK(avg)}$
Read DQS Postamble Time	t_{RPST}	0.3	Note 2	$t_{CK(avg)}$
Row Active to Row Active Delay	t_{RRD}	Max(4nCK, 7.5ns)	-	ns
Internal Read to Precharge Command Delay	t_{RTP}	Max(4nCK, 7.5ns)	-	ns
Write DQS Preamble Setup Time	t_{WPRE}	0.9	-	$t_{CK(avg)}$
Write DQS Postamble Time	t_{WPST}	0.3	-	$t_{CK(avg)}$
Write Recovery Time	t_{WR}	15	-	ns
Internal Write to Read Command Delay	t_{WTR}	Max(4nCK, 7.5ns)	-	ns

Notes:
1. The maximum preamble is bound by tLZDQS(min)
2. The maximum postamble is bound by tHZDQS(max)

SERIAL PRESENCE DETECT MATRIX

Byte#	Function.	Value	Hex
0	Number of Bytes Used / Number of Bytes in SPD Device / CRC Coverage.		0x92
	Bit 3 ~ Bit 0. SPD Bytes Used -	176	
	Bit 6 ~ Bit 4. SPD Bytes Total -	256	
	Bit 7. CRC Coverage -	Bytes 0-116	
1	SPD Revision.	Rev. 1.1	0x11
2	Key Byte / DRAM Device Type.	DDR3 SDRAM	0x0B
3	Key Byte / Module Type.		0x0B
	Bit 3 ~ Bit 0. Module Type -	LRDIMM	
	Bit 7 ~ Bit 4. Reserved -	0	
4	SDRAM Density and Banks.		0x04
	Bit 3 ~ Bit 0. Total SDRAM capacity, in megabits -	4Gb	
	Bit 6 ~ Bit 4. Bank Address Bits -	8 banks	
	Bit 7. Reserved -	0	
5	SDRAM Addressing.		0x22
	Bit 2 ~ Bit 0. Column Address Bits -	11	
	Bit 5 ~ Bit 3. Row Address Bits -	16	
	Bit 7, 6. Reserved	0	
6	Module Nominal Voltage, VDD.		0x02
	Bit 0. NOT 1.5 V operable -		
	Bit 1. 1.35 V operable -	X	
	Bit 2. 1.2X V operable -		
	Bit 3. Reserved -		
	Bit 4. Reserved -		
	Bit 5. Reserved -		
	Bit 6. Reserved -		
	Bit 7. Reserved -		
7	Module Organization.		0x18
	Bit 2 ~ Bit 0. SDRAM Device Width -	4-Bits	
	Bit 5 ~ Bit 3. Number of Ranks -	4-Rank	
	Bit 7, 6. Reserved	0	
8	Module Memory Bus Width.		0x0B
	Bit 2 ~ Bit 0. Primary bus width, in bits -	64-Bits	
	Bit 4, Bit 3. Bus width extension, in bits -	8-Bits	
	Bit 7 ~ Bit 5. Reserved -	0	
9	Fine Timebase (FTB) Dividend / Divisor.		0x52
	Bit 3 ~ Bit 0. Fine Timebase (FTB) Divisor	2	
	Bit 7 ~ Bit 4. Fine Timebase (FTB) Dividend	5	
10	Medium Timebase (MTB) Dividend.	1 (MTB =	0x01

		0.125ns)	
11	Medium Timebase (MTB) Divisor.	8 (MTB = 0.125ns)	0x08
12	SDRAM Minimum Cycle Time (tCKmin).	1.5ns	0x0C
13	Reserved.	UNUSED	0x00
14	CAS Latencies Supported, Least Significant Byte.		0x3C
	Bit 0. CL = 4 -		
	Bit 1. CL = 5 -		
	Bit 2. CL = 6 -	X	
	Bit 3. CL = 7 -	X	
	Bit 4. CL = 8 -	X	
	Bit 5. CL = 9 -	X	
	Bit 6. CL = 10 -		
	Bit 7. CL = 11 -		
15	CAS Latencies Supported, Most Significant Byte.		0x00
	Bit 0. CL = 12 -		
	Bit 1. CL = 13 -		
	Bit 2. CL =14 -		
	Bit 3. CL = 15 -		
	Bit 4. CL = 16 -		
	Bit 5. CL = 17 -		
	Bit 6. CL = 18 -		
	Bit 7. Reserved.		
16	Minimum CAS Latency Time (tAAmin).	13.125ns	0x69
17	Minimum Write Recovery Time (tWRmin).	15.0ns	0x78
18	Minimum RAS# to CAS# Delay Time (tRCDmin).	13.125ns	0x69
19	Minimum Row Active to Row Active Delay Time (tRRDmin).	6.0ns	0x30
20	Minimum Row Precharge Delay Time (tRPmin).	13.125ns	0x69
21	Upper Nibbles for tRAS and tRC.		0x11
	Bit 3 ~ Bit 0. tRAS Most Significant Nibble -	1	
	Bit 7 ~ Bit 4. tRC Most Significant Nibble -	1	
22	Minimum Active to Precharge Delay Time (tRASmin), Least Significant Byte.	36.0ns	0x20
23	Minimum Active to Active/Refresh Delay Time (tRCmin), Least Significant Byte.	49.125ns	0x89
24	Minimum Refresh Recovery Delay Time (tRFCmin), Least Significant Byte.	260.0ns	0x20
25	Minimum Refresh Recovery Delay Time (tRFCmin), Most Significant Byte.	260.0ns	0x08
26	Minimum Internal Write to Read Command Delay Time (tWTRmin).	7.5ns	0x3C
27	Minimum Internal Read to Precharge Command Delay Time (tRTPmin).	7.5ns	0x3C
28	Upper Nibble for tFAW.		0x00

	Bit 3 ~ Bit 0. tFAW Most Significant Nibble -	0	
	Bit 7 ~ Bit 4. Reserved -	0	
29	Minimum Four Activate Window Delay Time (tFAWmin), Least Significant Byte.	30.0ns	0xF0
30	SDRAM Optional Features.		0x83
	Bit 0. RZQ / 6 -	X	
	Bit 1. RZQ / 7 -	X	
	Bit 2. Reserved -		
	Bit 3. Reserved -		
	Bit 4. Reserved -		
	Bit 5. Reserved -		
	Bit 6. Reserved -		
	Bit 7. DLL-Off Mode Support -	X	
31	SDRAM Drivers Supported.		0x01
	Extended Temperature Range -	X	
	Extended Temperature Refresh Rate -		
	Auto Self Refresh (ASR) -		
	On-die Thermal Sensor (ODTS) Readout -		
	Reserved -		
	Reserved -		
	Reserved -		
	Partial Array Self Refresh (PASR) -		
32	Module Thermal Sensor.		0x80
	Bit 6 ~ Bit 0. Thermal Sensor Accuracy -	0	
	Bit 7. Thermal Sensor -	With TS	
33	SDRAM Device Type.		0x80
	Bit 1 ~ Bit 0. Signal Loading -	Not specified	
	Bit 3 ~ Bit 2. Reserved. 0-Undefined -	0	
	Bit 6 ~ Bit 4. Die Count. -	Not specified	
	Bit 7. SDRAM Device Type -	Non-Std	
34	Fine Offset for SDRAM Minimum Cycle Time (tCKmin) -	UNUSED	0x00
35	Fine Offset for Minimum CAS Latency Time (tAAmin) -	UNUSED	0x00
36,37	Fine Offset for Minimum RAS# to CAS# Delay Time (tRCDmin) -	UNUSED	0x00
38	Fine Offset for Minimum Active to Active/Refresh Delay Time (tRCmin) -	UNUSED	0x00
39-59	Reserved	UNUSED	0x00
60	(Load Reduced): Module Nominal Height.		0x10
	Bit 4 ~ Bit 0. Module Nominal Height max, in mm -	30<h<=31	
	Bit 7 ~ Bit5. Reserved -	0	
61	(Load Reduced): Module Maximum Thickness		0x33
	Bit 3 ~ Bit 0. Front, in mm (baseline thickness = 1 mm) -	3<th<=4	
	Bit 7 ~ Bit 4. Back, in mm (baseline thickness = 1 mm) -	3<th<=4	

62	(Load Reduced): Reference Raw Card Used.		0x22
	Bit 4 ~ Bit 0. Reference Raw Card -	R/C C	
	Bit 6, Bit 5. Reference Raw Card Revision -	Rev.1	
	Bit 7. Reference Raw Card Extension -	A-AL	
63	(Load Reduced): Module Attributes.		0x89
	Bit 1 ~ Bit 0. Mirroring -	Odd Mirr	
	Bit 3 ~ Bit 2. # of rows of DRAMs -	2	
	Bit 4. Orientation of Memory Buffer -	Vertical	
	Bit 5. Rank Numbering -	Contiguously	
	Bit 6. Reserved -		
	Bit 7. Heat Spreader -	With HS	
64	(Load Reduced): Memory Buffer Revision Number (Optional)	21	0x21
65	(Load Reduced):Register Manufacturer ID Code, Least Significant Byte (Optional)	INPHI	0x04
66	(Load Reduced): Register Manufacturer ID Code, Most Significant Byte (Optional).	INPHI	0xB3
67	(Load Reduced): F0RC3 / F0RC2 - Timing Control & Drive Strength, Address/Command & QxCS_n.		0x60
	Bit 0. DA3 value. Address/Command prelaunch -	Standard	
	Bit 1. DA4 value. Rank 1 and Rank 5 Swap -	Not Swapped	
	Bit 2. DBA0 value. Reserved -		
	Bit 3. 0 = Operation. 1 = Test Mode. Reserved -		
	Bit 5 ~ Bit 4. DA4/3 value. Address/Command Outputs -	Strong	
	Bit 7 ~ Bit 6. DBA1/0 value. QxCS[3:0]_n Outputs -	Moderate	
68	(Load Reduced): F0RC5 / F0RC4 - Drive Strength, QxODT & QxCKE and Clock		0x55
	Bit 1 ~ Bit 0. F0RC4/DA4,3 Value. QxODT[1:0] Outputs -	Moderate	
	Bit 3 ~ Bit 2. F0RC4/DBA1,0 Value. QxCKE[3:0] Outputs -	Moderate	
	Bit 5 ~ 4. F0RC5/DA4,3 Value. Y1_t/Y1_c and Y3_t/Y3_c Clock Outputs -	Moderate	
	Bit 7 ~ 6. F0RC5/DBA1,0 Value. Y0_t/Y10c and Y2_t/Y2_c Clock Outputs -	Moderate	
69	(Load Reduced): F1RC11 / F1RC8 - Extended Delay for Clocks, QxCS_n and QxODT & QxCKE.		0x00
	Bit 1 ~ Bit 0. F1RC8/DA3,4 Value. Y Extended Delay. -	0	
	Bit 3 ~ Bit 2. F1RC8/DBA0,1 Value. QxCS_n Extended Delay -	0	
	Bit 5 ~ Bit 4. F1RC11/DA4,3 value, QxODT Extended Delay. -	0	
	Bit 7 ~ Bit 6. F1RC11/DBA0,1 value, QxCKE Extended Delay -	0	
70	(Load Reduced): F1RC13 / F1RC12 - Additive Delay for QxCS_n and QxCA		0x00
	Bit 2 ~ Bit 0. F1RC12/DA3,4/DBA0 Value. Delay Y -	by (8/32)*tCK	
	Bit 3, F1RC12/DBA1 Value. RESERVED -	RESERVED	
	Bit 6 ~ Bit 4. F1RC13/DA3,4/DBA0 Value. QxCS_n Delay -	by (8/32)*tCK	
	Bit 7. F1RC13/DBA1 value. 0 = Disabled, 1 = Enabled -	Disabled	

71	(Load Reduced): F1RC15 / F1RC14 - Additive Delay for QxODT and QxCKE.		0x00
	Bit 2 ~ Bit 0. F1RC14/DA3,4/DBA0 Value. QxODT Delay -	by (8/32)*tCK	
	Bit 3, F1RC14/DBA1 Value 0 = Disabled, 1 = Enabled -	Disabled	
	Bit 6 ~ Bit 4. F1RC15/DA3,4/DBA0 Value. QxCKE Delay -	by (8/32)*tCK	
	Bit 7. F1RC15/DBA1 value. 0 = Disabled, 1 = Enabled -	Disabled	
72	(Load Reduced): F3RC9 / F3RC8 - DRAM Interface MDQ Termination and Drive Strength for 800 & 1066		0x02
	Bit 2 ~ Bit 0. F3RC8/DA3,4/DBA0 Val. MDQ/ODT Strength -	RZQ/2 (120 Ohm)	
	Bit 3, Bit3. F3RC8/DBA1 Value. RESERVED -	RESERVED	
	Bit 6 ~ Bit 4. F3RC9/DA3,4/DBA0 Val. MDQ Drive Strength -	RZQ/6 (40 Ohm))	
	Bit 7. F3RC9/DBA1 value. RESERVED -	RESERVED	
73	(Load Reduced): F[3,4]RC11 / F[3,4]RC10 - Rank 0&1 Read and Write QxODT Control for 800 & 1066.		0x90
	Bit 0. DA3 value R0 (Read) -		
	Bit 1. DA4 value R0 (Read) -		
	Bit 2. DA3 value R1 (Read) -		
	Bit 3. DA4 value R1 (Read) -		
	Bit 4. DA3 value R0 (Write) -	X	
	Bit 5. DA4 value R0 (Write) -		
	Bit 6. DA3 value R1 (Write) -		
	Bit 7. DA4 value R1 (Write) -	X	
74	(Load Reduced): F[5,6]RC11 / F[5,6]RC10 - Rank 2&3 Read and Write QxODT Control for 800 & 1066.		0x00
	Bit 0. DA3 value R0 (Read) -		
	Bit 1. DA4 value R0 (Read) -		
	Bit 2. DA3 value R1 (Read) -		
	Bit 3. DA4 value R1 (Read) -		
	Bit 4. DA3 value R0 (Write) -		
	Bit 5. DA4 value R0 (Write) -		
	Bit 6. DA3 value R1 (Write) -		
	Bit 7. DA4 value R1 (Write) -		
75	(Load Reduced): F[7,8]RC11 / F[7,8]RC10 - Rank 4&5 Read and Write QxODT Control for 800 & 1066.		0x00
	Bit 0. DA3 value R0 (Read) -		
	Bit 1. DA4 value R0 (Read) -		
	Bit 2. DA3 value R1 (Read) -		
	Bit 3. DA4 value R1 (Read) -		
	Bit 4. DA3 value R0 (Write) -		
	Bit 5. DA4 value R0 (Write) -		
	Bit 6. DA3 value R1 (Write) -		
	Bit 7. DA4 value R1 (Write) -		
76	(Load Reduced): F[9,10]RC11 / F[9,10]RC10 - Rank 6&7 Read and Write QxODT Control for 800 & 1066.		0x00

	Bit 0. DA3 value R0 (Read) -		
	Bit 1. DA4 value R0 (Read) -		
	Bit 2. DA3 value R1 (Read) -		
	Bit 3. DA4 value R1 (Read) -		
	Bit 4. DA3 value R0 (Write) -		
	Bit 5. DA4 value R0 (Write) -		
	Bit 6. DA3 value R1 (Write) -		
	Bit 7. DA4 value R1 (Write) -		
77	(Load Reduced): MR1,2 for 800 & 1066.		0x81
	Bit 1 ~ Bit 0. DRAM Driver Impedance for all ranks -	RZQ/7 (34 Ohm)	
	Bit 4 ~ Bit2. DRAM Rtt_Nom for ranks 0 and 1 -	Rtt_Nom disabled	
	Bit 5. RESERVED -	RESERVED	
	Bit 7 ~ Bit 6. DRAM Rtt_WR for all ranks -	RZQ/2 (120 Ohm)	
78	(Load Reduced): F3RC9 / F3RC8 - DRAM Interface MDQ Termination and Drive Strength for 1333 & 1600.		0x11
	Bit 2 ~ Bit 0. F3RC8/DA3,4/DBA0 Val. MDQ/ODT Strength -	RZQ/4 (60 Ohm)	
	Bit 3, F3RC8/DBA1 Value. RESERVED -	RESERVED	
	Bit 6 ~ Bit 4. F3RC9/DA3,4/DBA0 Val. MDQ Drive Strength -	RZQ/7 (34 Ohm))	
	Bit 7. F3RC9/DBA1 value. RESERVED -	RESERVED	
79	(Load Reduced): F[3,4]RC11 / F[3,4]RC10 - Rank 0&1 Read and Write QxODT Control for 1333 & 1600.		0xF0
	Bit 0. DA3 value R0 (Read) -		
	Bit 1. DA4 value R0 (Read) -		
	Bit 2. DA3 value R1 (Read) -		
	Bit 3. DA4 value R1 (Read) -		
	Bit 4. DA3 value R0 (Write) -	X	
	Bit 5. DA4 value R0 (Write) -	X	
	Bit 6. DA3 value R1 (Write) -	X	
	Bit 7. DA4 value R1 (Write) -	X	
80	(Load Reduced): F[5,6]RC11 / F[5,6]RC10 - Rank 2&3 Read and Write QxODT Control for 1333 & 1600.		0x60
	Bit 0. DA3 value R2 (Read) -		
	Bit 1. DA4 value R2 (Read) -		
	Bit 2. DA3 value R3 (Read) -		
	Bit 3. DA4 value R3 (Read) -		
	Bit 4. DA3 value R2 (Write) -		
	Bit 5. DA4 value R2 (Write) -	X	
	Bit 6. DA3 value R3 (Write) -	X	
	Bit 7. DA4 value R3 (Write) -		
81	(Load Reduced): F[7,8]RC11 / F[7,8]RC10 - Rank 4&5 Read and Write QxODT Control for 1333 & 1600.		0x00
	Bit 0. DA3 value R4 (Read) -		
	Bit 1. DA4 value R4 (Read) -		
	Bit 2. DA3 value R5 (Read) -		

	Bit 3. DA4 value R5 (Read) -	
	Bit 4. DA3 value R4 (Write) -	
	Bit 5. DA4 value R4 (Write) -	
	Bit 6. DA3 value R5 (Write) -	
	Bit 7. DA4 value R5 (Write) -	
82	(Load Reduced): F[9,10]RC11 / F[9,10]RC10 - Rank 6&7 Read and Write QxODT Control for 1333 & 1600.	0x00
	Bit 0. DA3 value R6(Read) -	
	Bit 1. DA4 value R6 (Read) -	
	Bit 2. DA3 value R7 (Read) -	
	Bit 3. DA4 value R7 (Read) -	
	Bit 4. DA3 value R6 (Write) -	
	Bit 5. DA4 value R6 (Write) -	
	Bit 6. DA3 value R7 (Write) -	
	Bit 7. DA4 value R7 (Write) -	
83	(Load Reduced): MR1,2 for 1333 & 1600.	0x85
	Bit 1 ~ Bit 0. DRAM Driver Impedance for all ranks - RZQ/7 (34 Ohm)	
	Bit 4 ~ Bit2. DRAM Rtt_Nom for ranks 0 and 1 - RZQ/4 (60 Ohm)	
	Bit 5. RESERVED - RESERVED	
	Bit 7 ~ Bit 6. DRAM Rtt_WR for all ranks - RZQ/2 (120 Ohm)	
84	(Load Reduced): F3RC9 / F3RC8 - DRAM Interface MDQ Termination and Drive Strength for 1866 & 2133.	0x00
	Bit 2 ~ Bit 0. F3RC8/DA3,4/DBA0 Val. MDQ/ODT Strength - ODT disabled	
	Bit 3, F3RC8/DBA1 Value. RESERVED - RESERVED	
	Bit 6 ~ Bit 4. F3RC9/DA3,4/DBA0 Val. MDQ Drive Strength - RZQ/6 (40 Ohm))	
	Bit 7. F3RC9/DBA1 value. RESERVED - RESERVED	
85	(Load Reduced): F[3,4]RC11 / F[3,4]RC10 - Rank 0&1 Read and Write QxODT Control for 1866 & 2133.	0x00
	Bit 0. DA3 value R0 (Read) -	
	Bit 1. DA4 value R0 (Read) -	
	Bit 2. DA3 value R1 (Read) -	
	Bit 3. DA4 value R1 (Read) -	
	Bit 4. DA3 value R0 (Write) -	
	Bit 5. DA4 value R0 (Write) -	
	Bit 6. DA3 value R1 (Write) -	
	Bit 7. DA4 value R1 (Write) -	
86	(Load Reduced): F[5,6]RC11 / F[5,6]RC10 - Rank 2&3 Read and Write QxODT Control for 1866 & 2133.	0x00
	Bit 0. DA3 value R2 (Read) -	
	Bit 1. DA4 value R2 (Read) -	
	Bit 2. DA3 value R3 (Read) -	
	Bit 3. DA4 value R3 (Read) -	
	Bit 4. DA3 value R2 (Write) -	
	Bit 5. DA4 value R2 (Write) -	

	Bit 6. DA3 value R3 (Write) -		
	Bit 7. DA4 value R3 (Write) -		
87	(Load Reduced): F[7,8]RC11 / F[7,8]RC10 - Rank 4&5 Read and Write QxODT Control for 1866 & 2133.		0x00
	Bit 0. DA3 value R4 (Read) -		
	Bit 1. DA4 value R4 (Read) -		
	Bit 2. DA3 value R5 (Read) -		
	Bit 3. DA4 value R5 (Read) -		
	Bit 4. DA3 value R4 (Write) -		
	Bit 5. DA4 value R4 (Write) -		
	Bit 6. DA3 value R5 (Write) -		
	Bit 7. DA4 value R5 (Write) -		
88	(Load Reduced): F[9,10]RC11 / F[9,10]RC10 - Rank 6&7 Read and Write QxODT Control for 1866 & 2133.		0x00
	Bit 0. DA3 value R6(Read) -		
	Bit 1. DA4 value R6 (Read) -		
	Bit 2. DA3 value R7 (Read) -		
	Bit 3. DA4 value R7 (Read) -		
	Bit 4. DA3 value R6 (Write) -		
	Bit 5. DA4 value R6 (Write) -		
	Bit 6. DA3 value R7 (Write) -		
	Bit 7. DA4 value R7 (Write) -		
83	(Load Reduced): MR1,2 for 1866 & 2133.		0x00
	Bit 1 ~ Bit 0. DRAM Driver Impedance for all ranks -	RZQ/6 (40 Ohm)	
	Bit 4 ~ Bit2. DRAM Rtt_Nom for ranks 0 and 1 -	Rtt_Nom disabled	
	Bit 5. RESERVED -	RESERVED	
	Bit 7 ~ Bit 6. DRAM Rtt_WR for all ranks -	Dynamic ODT Off	
90	(Load Reduced): Minimum Module Delay Time for 1.5 V, ns. (Bit 7 RESERVED).	67	0x43
91	(Load Reduced): Maximum Module Delay for 1.5 V, ns. (Bit 7 RESERVED).	83	0x53
92	(Load Reduced): Minimum Module Delay for 1.35 V, ns. (Bit 7 RESERVED).	67	0x43
93	(Load Reduced): Maximum Module Delay Time for 1.35 V, ns. (Bit 7 RESERVED).	83	0x53
94	(Load Reduced): Minimum Module Delay Time for 1.25 V, ns. (Bit 7 RESERVED).	67	0x43
95	(Load Reduced): Maximum Module Delay Time for 1.25 V, ns. (Bit 7 RESERVED).	83	0x53
96-101	(Load Reduced): Reserved.	UNUSED	0x00
102	(Load Reduced): Memory Buffer Personality Bytes 0.	UNUSED	0x00
103	(Load Reduced): Memory Buffer Personality Bytes 1.	UNUSED	0x00
104	(Load Reduced): Memory Buffer Personality Bytes 2.	UNUSED	0x00
105	(Load Reduced): Memory Buffer Personality Bytes 3.	UNUSED	0x00
106	(Load Reduced): Memory Buffer Personality Bytes 4.	UNUSED	0x00

107	(Load Reduced): Memory Buffer Personality Bytes 5.	UNUSED	0x00
108	(Load Reduced): Memory Buffer Personality Bytes 6.	UNUSED	0x00
109	(Load Reduced): Memory Buffer Personality Bytes 7.	UNUSED	0x00
110	(Load Reduced): Memory Buffer Personality Bytes 8.	UNUSED	0x00
111	(Load Reduced): Memory Buffer Personality Bytes 9.	UNUSED	0x00
112	(Load Reduced): Memory Buffer Personality Bytes 10.	UNUSED	0x00
113	(Load Reduced): Memory Buffer Personality Bytes 11.	UNUSED	0x00
114	(Load Reduced): Memory Buffer Personality Bytes 12.	UNUSED	0x00
115	(Load Reduced): Memory Buffer Personality Bytes 13.	UNUSED	0x00
116	(Load Reduced): Memory Buffer Personality Bytes 14.	UNUSED	0x00
117	Module Manufacturer ID Code, Least Significant Byte	SAMSUNG	0x80
118	Module Manufacturer ID Code, Most Significant Byte	SAMSUNG	0xCE
119	Module Manufacturing Location		0x01
120	Module Manufacturing Date		0x12
121	Module Manufacturing Date		0x11
122	Module Serial Number		0x21
123	Module Serial Number		0x37
124	Module Serial Number		0xF4
125	Module Serial Number		0xD0
126	Cyclical Redundancy Code (CRC).	CRC	0x82
127	Cyclical Redundancy Code (CRC).	CRC	0x6C
128	Module Part Number	M	0x4D
129	Module Part Number	3	0x33
130	Module Part Number	8	0x38
131	Module Part Number	6	0x36
132	Module Part Number	B	0x42
133	Module Part Number	4	0x34
134	Module Part Number	G	0x47
135	Module Part Number	7	0x37
136	Module Part Number	0	0x30
137	Module Part Number	B	0x42
138	Module Part Number	M	0x4D
139	Module Part Number	0	0x30
140	Module Part Number	-	0x2D
141	Module Part Number	Y	0x59
142	Module Part Number	H	0x48
143	Module Part Number	9	0x39
144	Module Part Number	0	0x30

145	Module Part Number		0x20
146,147	Module Revision Code	UNUSED	0x00
148	DRAM Manufacturer ID Code, Least Significant Byte	SAMSUNG	0x80
149	DRAM Manufacturer ID Code, Most Significant Byte	SAMSUNG	0xCE
150-175	Manufacturer's Specific Data	UNUSED	0x00
176-255	Open for customer use	UNUSED	0x00

Bytes 119 – 125, 150 - 255 may change per DIMM.

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