

## **Direct RDRAM RIMM Modules (with 288 Mbit RDRAMs)**

### **Overview**

The Direct Rambus™ RIMM™ module is a general purpose high-performance memory subsystem suitable for use in a broad range of applications including computer memory, personal computers, workstations, and other applications where high bandwidth and low latency are required.

The Direct Rambus RIMM module consists of 288 Mbit Direct Rambus DRAM (Direct RDRAM™) devices. These are extremely high-speed CMOS DRAMs organized as 16M words by 18 bits. The use of Rambus Signaling Level (RSL) technology permits 600 MHz to 800 MHz transfer rates while using conventional system and board design technologies. Direct RDRAM devices are capable of sustained data transfers at 1.25 ns per two bytes (10 ns per sixteen bytes).

The RDRAM architecture enables the highest sustained bandwidth for multiple, simultaneous, randomly addressed, memory transactions. The separate control and data buses with independent row and column control yield over 95% bus efficiency. The RDRAM's 32-bank architecture supports up to four simultaneous transactions per device.

### **Form Factor**

These family of 64MByte and 128MByte Rambus RIMM modules are offered in a 184-pad 1 mm edge connector pad pitch form factor suitable for 184 contact RIMM connectors. The RIMM module is suitable for desktop and other system applications. The next figure shows an eight device Rambus RIMM module without heat spreader.

### **Features**

- 64 MByte and 128 MByte non-ECC versions
- High speed 800 & 600 MHz RDRAM storage
- 184 edge connector pads with 1 mm pad spacing
- Maximum module PCB size:  
133.5 mm × 31.75 mm × 1.37 mm  
(5.25" × 1.25" × 0.05")
- Each RDRAM has 32 banks, for a total of 128 or 64 banks on each 128 MB or 64 MB module respectively.
- Gold plated edge connector pad contacts
- Serial Presence Detect (SPD) support
- Operates from a 2.5 V supply ( $\pm 5\%$ )
- Low power and powerdown self refresh modes
- Separate Row and Column buses for higher efficiency

**Part Number Designators**

<b>Organization</b>	<b>Capacity</b>	<b>I/O Frequency [MHz]</b>	<b>Part Designator</b>	<b># of RDRAMs</b>	<b>RDRAM Density</b>
<b>64 MB</b>					
32 MB × 16	64 MB	600	HYR163249G-653	2	288 Mbit
32 MB × 16	64 MB	800	HYR163249G-840	2	
<b>128 MB</b>					
64 MB × 16	128 MB	600	HYR166449G-653	4	288 Mbit
64 MB × 16	128 MB	800	HYR166449G-845	4	

**Pin Configuration**

<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>
A1	GND	B1	GND	A47	N.C.	B47	N.C.
A2	LDQA8	B2	LDQA7	A48	N.C.	B48	N.C.
A3	GND	B3	GND	A48	N.C.	B49	N.C.
A4	LDQA6	B4	LDQA5	A50	N.C.	B50	N.C.
A5	GND	B5	GND	A51	V <sub>REF</sub>	B51	V <sub>REF</sub>
A6	LDQA4	B6	LDQA3	A52	GND	B52	GND
A7	GND	B7	GND	A53	SCL	B53	SA0
A8	LDQA2	B8	LDQA1	A54	V <sub>DD</sub>	B54	V <sub>DD</sub>
A9	GND	B9	GND	A55	SDA	B55	SA1
A10	LDQA0	B10	LCFM	A56	SVdd	B56	SVdd
A11	GND	B11	GND	A57	SWP	B57	SA2
A12	LCTMN	B12	LCFMN	A58	V <sub>DD</sub>	B58	V <sub>DD</sub>
A13	GND	B13	GND	A59	RSCK	B59	RCMD
A14	LCTM	B14	N.C.	A60	GND	B60	GND
A15	GND	B15	GND	A61	RDQB7	B61	RDQB8
A16	N.C.	B16	LROW2	A62	GND	B62	GND
A17	GND	B17	GND	A63	RDQB5	B63	RDQB6
A18	LROW1	B18	LROW0	A64	GND	B64	GND
A19	GND	B19	GND	A65	RDQB3	B65	RDQB4
A20	LCOL4	B20	LCOL3	A66	GND	B66	GND
A21	GND	B21	GND	A67	RDQB1	B67	RDQB2
A22	LCOL2	B22	LCOL1	A68	GND	B68	GND
A23	GND	B23	GND	A69	RCOL0	B69	RDQB0
A24	LCOL0	B24	LDQB0	A70	GND	B70	GND
A25	GND	B25	GND	A71	RCOL2	B71	RCOL1
A26	LDQB1	B26	LDQB2	A72	GND	B72	GND
A27	GND	B27	GND	A73	RCOL4	B73	RCOL3
A28	LDQB3	B28	LDQB4	A74	GND	B74	GND
A29	GND	B29	GND	A75	RROW1	B75	RROW0
A30	LDQB5	B30	LDQB6	A76	GND	B76	GND
A31	GND	B31	GND	A77	N.C.	B77	RROW2
A32	LDQB7	B32	LDQB8	A78	GND	B78	GND
A33	GND	B33	GND	A79	RCTM	B79	N.C.

**Pin Configuration (cont'd)**

<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>	<b>PIN</b>	<b>Pin Name</b>
A34	LCK	B34	LCMD	A80	GND	B80	GND
A35	V <sub>CMOS</sub>	B35	V <sub>CMOS</sub>	A81	RCTMN	B81	RCFMN
A36	SOUT	B36	SIN	A82	GND	B82	GND
A37	V <sub>CMOS</sub>	B37	V <sub>CMOS</sub>	A83	RDQA0	B83	RCFM
A38	N.C.	B38	N.C.	A84	GND	B84	GND
A39	GND	B39	GND	A85	RDQA2	B85	RDQA1
A40	N.C.	B40	N.C.	A86	GND	B86	GND
A41	V <sub>DD</sub>	B41	V <sub>DD</sub>	A87	RDQA4	B87	RDQA3
A42	V <sub>DD</sub>	B42	V <sub>DD</sub>	A88	GND	B88	GND
A43	N.C.	B43	N.C.	A89	RDQA6	B89	RDQA5
A44	N.C.	B44	N.C.	A90	GND	B90	GND
A45	N.C.	B45	N.C.	A91	RDQA8	B91	RDQA7
A46	N.C.	B46	N.C.	A92	GND	B92	GND

**Module Connector Pad Description**

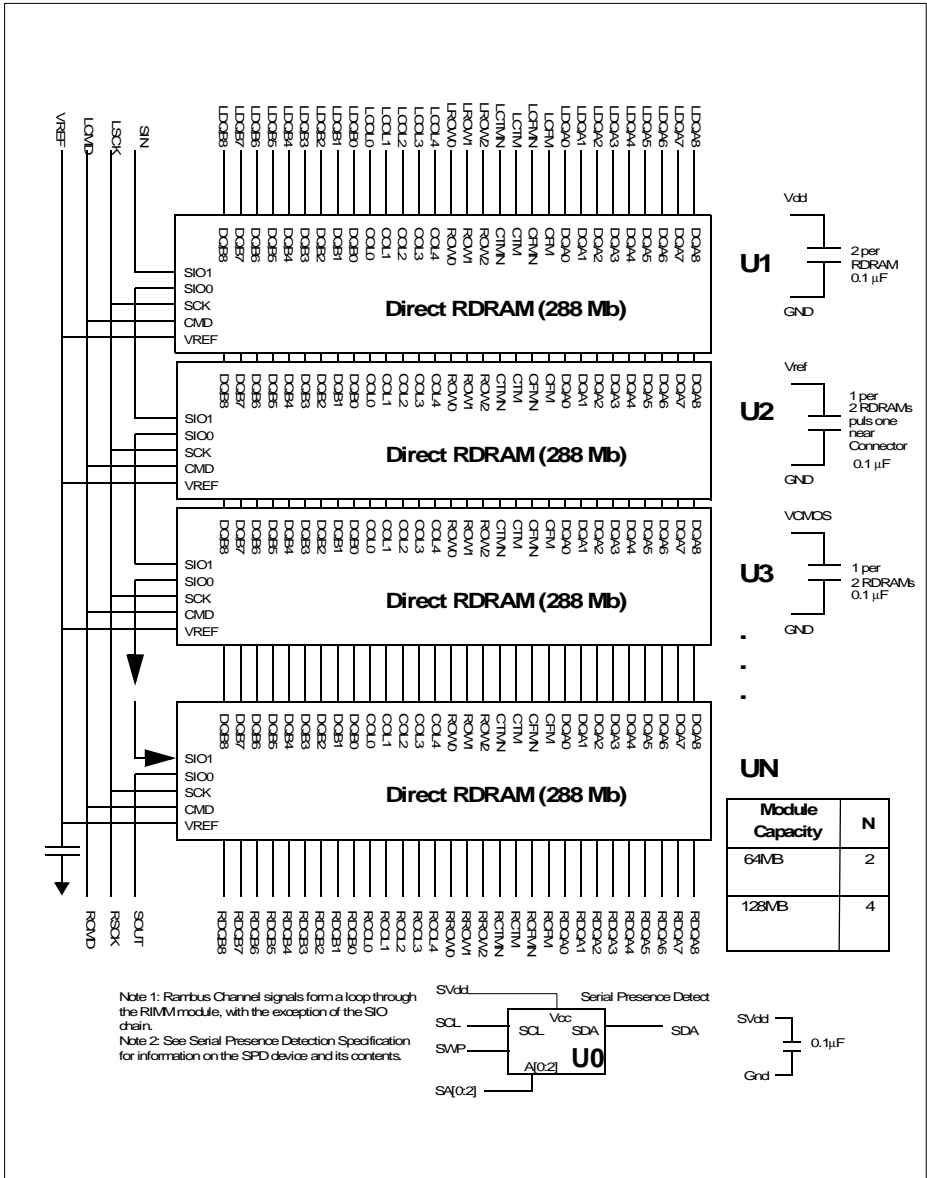
Signal	Module Connector Pads	I/O	Type	Description
GND	A1, A3, A5, A7, A9, A11, A13, A15, A17, A19, A21, A23, A25, A27, A29, A31, A33, A39, A52, A60, A62, A64, A66, A68, A70, A72, A74, A76, A78, A80, A82, A84, A86, A88, A90, A92, B1, B3, B5, B7, B9, B11, B13, B15, B17, B19, B21, B23, B25, B27, B29, B31, B33, B39, B52, B60, B62, B64, B66, B68, B70, B72, B74, B76, B78, B80, B82, B84, B86, B88, B90, B92	–	–	Ground reference for RDRAM core and interface. 72 PCB connector pads.
LCFM	B10	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Positive polarity.
LCFMN	B12	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Negative polarity.
LCMD	B34	I	$V_{CMOS}$	Serial Command used to read from and write to the control registers. Also used for power management.
LCOL4 ... LCOLO	A20, B20, A22, B22, A24	I	RSL	Column bus. 5-bit bus containing control and address information for column accesses.
LCTM	A14	I	RSL	Clock to master. Interface clock used for transmitting RSL signals to the Channel. Positive polarity.
LCTMN	A12	I	RSL	Clock to master. Interface clock used for transmitting RSL signals to the Channel. Negative polarity.
LDQA8 ... LDQA0	A2, B2, A4, B4, A6, B6, A8, B8, A10	I/O	RSL	Data bus A. A 9-bit bus carrying a byte of read or write data between the Channel and the RDRAM. LDQA8 is non-functional on modules with x16 RDRAM devices.

**Module Connector Pad Description (cont'd)**

Signal	Module Connector Pads	I/O	Type	Description
LDQB8 ... LDQB0	B32, A32, B30, A30, B28, A28, B26, A26, B24	I/O	RSL	Data bus B. A 9-bit bus carrying a byte of read or write data between the Channel and the RDRAM. LDQB8 is non-functional on modules with x16 RDRAM devices.
LROW2 ... LROW0	B16, A18, B18	I	RSL	Row bus. 3-bit bus containing control and address information for row accesses.
LSCK	A34	I	$V_{CMOS}$	Serial Clock input. Clock source used to read from and write to the RDRAM control registers.
N.C.	A16, B14, A38, B38, A40, B40, A77, B79;A43, B43, A44, B44, A45, B45, A46, B46, A47, B47, A48, B48, A49, B49, A50, B50	–	–	These pads are not connected. These connector pads are reserved for future use.
RCFM	B83	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Positive polarity.
RCFMN	B81	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Negative polarity.
RCMD	B59	I	$V_{CMOS}$	Serial Command Input used to read from and write to the control registers. Also used for power management.
RCOL4 ... RCOLO	A73, B73, A71, B71, A69	I	RSL	Column bus. 5-bit bus containing control and address information for column accesses.
RCTM	A79	I	RSL	Clock to master. Interface clock used for transmitting RSL signals to the Channel. Positive polarity.
RCTMN	A81	I	RSL	Clock to master. Interface clock used for transmitting RSL signals to the Channel. Negative polarity.
RDQA8 ... RDQA0	A91, B91, A89, B89, A87, B87, A85, B85, A83	I/O	RSL	Data bus A. A 9-bit bus carrying a byte of read or write data between the Channel and the RDRAM. RDQA8 is non-functional on modules with x16 RDRAM devices.

**Module Connector Pad Description (cont'd)**

Signal	Module Connector Pads	I/O	Type	Description
RDQB8 ... RDQB0	B61, A61, B63, A63, B65, A65, B67, A67, B69	I/O	RSL	Data bus B. A 9-bit bus carrying a byte of read or write data between the Channel and the RDRAM. RDQB8 is non-functional on modules with x16 RDRAM devices.
RROW2 ... RROW0	B77, A75, B75	I	RSL	Row bus. 3-bit bus containing control and address information for row accesses.
RSCK	A59	I	$V_{CMOS}$	Serial Clock input. Clock source used to read from and write to the RDRAM control registers.
SA0	B53	I	SVDD	Serial Presence Detect Address 0.
SA1	B55	I	SVDD	Serial Presence Detect Address 1.
SA2	B57	I	SVDD	Serial Presence Detect Address 2.
SCL	A53	I	SVDD	Serial Presence Detect Clock.
SDA	A55	I/O	SVDD	Serial Presence Detect Data (Open Collector I/O).
SIN	B36	I/O	$V_{CMOS}$	Serial I/O for reading from and writing to the control registers. Attaches to SIO0 of the first RDRAM on the module.
SOUT	A36	I/O	$V_{CMOS}$	Serial I/O for reading from and writing to the control registers. Attaches to SIO1 of the last RDRAM on the module.
SVDD	A56, B56	–	–	SPD Voltage. Used for signals SCL, SDA, SWE, SA0, SA1 and SA2.
SWP	A57	I	SVDD	Serial Presence Detect Write Protect (active high). When low, the SPD can be written as well as read.
$V_{CMOS}$	A35, B35, A37, B37	–	–	CMOS I/O Voltage. Used for signals CMD, SCK, SIN, SOUT.
$V_{DD}$	A41, A42, A54, A58, B41, B42, B54, B58	–	–	Supply voltage for the RDRAM core and interface logic.
$V_{REF}$	A51, B51	–	–	Logic threshold reference voltage for RSL signals.



**RIMM Module Functional Diagram**



**Absolute Maximum Ratings**

Symbol	Parameter	Limit Values		Unit
		min.	max.	
$V_{I,ABS}$	Voltage applied to any RSL or CMOS signal pad with respect to GND	- 0.3	$V_{DD} + 0.3$	V
$V_{DD,ABS}$	Voltage on $V_{DD}$ with respect to GND	- 0.5	$V_{DD} + 1.0$	V
$T_{STORE}$	Storage temperature	- 50	100	°C

**DC Recommended Electrical Conditions**

Symbol	Parameter and Conditions	Limit Values		Unit
		min.	max.	
$V_{DD}$	Supply voltage	2.50 - 0.13	2.50 + 0.13	V
$V_{CMOS}$	CMOS I/O power supply at pad for 2.5 V controllers:	2.5 - 0.13	2.5 + 0.25	V
	CMOS I/O power supply at pad for 1.8 V controllers:	1.8 - 0.1	1.8 + 0.2	V
$V_{REF}$	Reference voltage	1.4 - 0.2	1.4 + 0.2	V
$V_{IL}$	RSL input low voltage	$V_{REF} - 0.5$	$V_{REF} - 0.2$	V
$V_{IH}$	RSL input high voltage	$V_{REF} + 0.2$	$V_{REF} + 0.5$	V
$V_{IL,CMOS}$	CMOS input low voltage	- 0.3	$0.5 V_{CMOS} - 0.25$	V
$V_{IH,CMOS}$	CMOS input high voltage	$0.5 V_{CMOS} + 0.25$	$V_{CMOS} + 0.7$	V
$V_{OL,CMOS}$	CMOS output low voltage @ $I_{OL,CMOS} = 1 \text{ mA}$	-	0.3	V
$V_{OH,CMOS}$	CMOS output high voltage @ $I_{OH,CMOS} = - 0.25 \text{ mA}$	$V_{CMOS} - 0.3$	-	V
$I_{REF}$	$V_{REF}$ current @ $V_{REF,MAX}$	- 10 × no. RDRAMs <sup>1)</sup>	10 × no. RDRAMs <sup>1)</sup>	μA
$I_{SCK,CMD}$	CMOS input leakage current @ ( $0 \leq V_{CMOS} \leq V_{DD}$ )	- 10 × no. RDRAMs <sup>1)</sup>	10 × no. RDRAMs <sup>1)</sup>	μA
$I_{SIN,SOUT}$	CMOS input leakage current @ ( $0 \leq V_{CMOS} \leq V_{DD}$ )	- 10.0	10.0	μA

1) The table below shows the number of 288 Mbit RDRAM devices contained in a RIMM module of listed memory storage capacity.

RIMM Module Capacity	64MB	128 MB
Number of 288 Mbit RDRAM devices	2	4

**AC Electrical Specifications**

Symbol	Parameter and Conditions	Limit Values			Unit
		min.	typ.	max.	
Z	Module Impedance	25.2	28	30.8	Ω
T <sub>PD</sub>	Average clock delay from finger of all RSL clock nets (CTM, CTMN, CFM and CFMN)	–	–	See Table <sup>1)</sup>	ns
ΔT <sub>PD</sub>	Propagation delay variation of RSL signals with respect to T <sub>PD</sub> <sup>2)3)</sup> for 4 and 8 device modules	– 21	–	21	ps
	Propagation delay variation of RSL signals with respect to T <sub>PD</sub> <sup>2)3)</sup> for 16 device modules	– 24	–	24	ps
ΔT <sub>PD-CMOS</sub>	Propagation delay variation of SCK and CMD signals with respect to an average clock delay <sup>2)</sup>	– 100	–	100	ps
V <sub>A</sub> /V <sub>IN</sub>	Attenuation Limit	–	–	See Table <sup>1)</sup>	%
V <sub>XF</sub> /V <sub>IN</sub>	Forward crosstalk coefficient (300 ps input rise time @ 20%-80%)	–	–	See Table <sup>1)</sup>	%
V <sub>XB</sub> /V <sub>IN</sub>	Backward crosstalk coefficient (300 ps input rise time @ 20%-80%)	–	–	See Table <sup>1)</sup>	%

- 1) Table below lists parameters and specifications for different storage capacity RIMM Modules that use 288 Mbit RDRAM devices.
- 2) Average clock delay is defined as the average delay from finger to finger of all RSL clock nets (CTM, CTMN, .....CFM and CFMN).
- 3.) If the RIMM module meets the following specifications, then it is compliant to the specification. If the RIMM .....module does not meet these specifications, then the specification can be adjusted by the "Adjusted ΔT<sub>PD</sub>- .....Specification" table.

**Adjusted ΔT<sub>PD</sub> Specification**

Symbol	Parameter and Conditions	Adjusted Min/Max	Absolute Min /Max		Unit
ΔT <sub>PD</sub>	Propagation delay variation of RSL signals with respect to T <sub>PD</sub> for 4 and 8 device modules	+/-[17+(18*N*ΔZ0)] <sup>a</sup>	-30	30	ps
	Propagation delay variation of RSL signals with respect to T <sub>PD</sub> for 16 device modules	+/-[24+(18*N*ΔZ0)]	-50	50	ps

a) Where:  
N = Nuber of RDRAM devices installed on the RIMm module  
ΔZ0 = delta Z0% =(max Z0 - minZ0)/(min Z0)  
(max Z= and min Z0 are obtained from the loaded (high impedance) impedance coupons of all RSL layers on the modules)

**AC Electrical Specifications for RIMM Modules**

Symbol	RIMM Module Capacity: No. of 288 Mbit RDRAMs:	64 MB 2	128 MB 4	Unit
	Parameter and Conditions for -800, 711 & -600 RIMM Modules	max.	max.	
$T_{PD}$	Propagation Delay, all RSL signals -800	1.28	1.28	ns
	Propagation Delay, all RSL signals -600	1.28	1.28	ns
$V_A/V_{IN}$	Attenuation Limit -800	12	12	%
	Attenuation Limit -600	10.5	10.5	%
$V_{XF}/V_{IN}$	Forward crosstalk coefficient (300 ps input rise time @ 20% - 80%) -800, -600	2	2	%
$V_{XB}/V_{IN}$	Backward crosstalk coefficient (300 ps input rise time @ 20%-80%) -800, -600	1.5	1.5	%
$R_{DC}$	DC Resistance Limit -800, -600	0.6	0.6	$\Omega$

**RIMM Module Current Profile**

$I_{DD}$	RIMM Module Capacity: No. of 288 Mbit RDRAMs:		64 MB 2	128 MB 4	Unit
	RIMM Modules Power Conditions <sup>a)</sup>	Freq.	max.	max.	
$I_{DD1}$	One RDRAM in Read <sup>b</sup> , balance in NAP mode	-800	932	940	mA
		-600	794	812	mA
$I_{DD2}$	One RDRAM in Read <sup>b</sup> , balance in Standby mode	-800	1038	1257	mA
		-600	764	974	mA
$I_{DD3}$	One RDRAM in Read <sup>b</sup> , balance in Active mode	-800	1107	1465	mA
		-600	946	1258	mA
$I_{DD4}$	One RDRAM in Write, balance in Active mode	-800	932	940	mA
		-600	794	812	mA
$I_{DD5}$	One RDRAM in Write, balance in Standby mode	-800	1038	1257	mA
		-600	764	974	mA
$I_{DD6}$	One RDRAM in Write, balance in Active mode	-800	1107	1465	mA
		-600	946	1258	mA

a) Actual power will depend on individual memory controller and usage pattern. Power does not include Refresh Current.

b) I/O power is a function of the percentage of 1's, to add I/O power for 50% 1's for a x 16 need to add 257mA per module for the following:  $V_{DD} = 2.5V$ ,  $V_{TERM} = 1.8V$ ,  $V_{REF} = 1.4V$  and  $V_{DIL} = V_{REF} = 0.5V$ .

The following defines the RIMM module dimensions. All units are in millimeters.

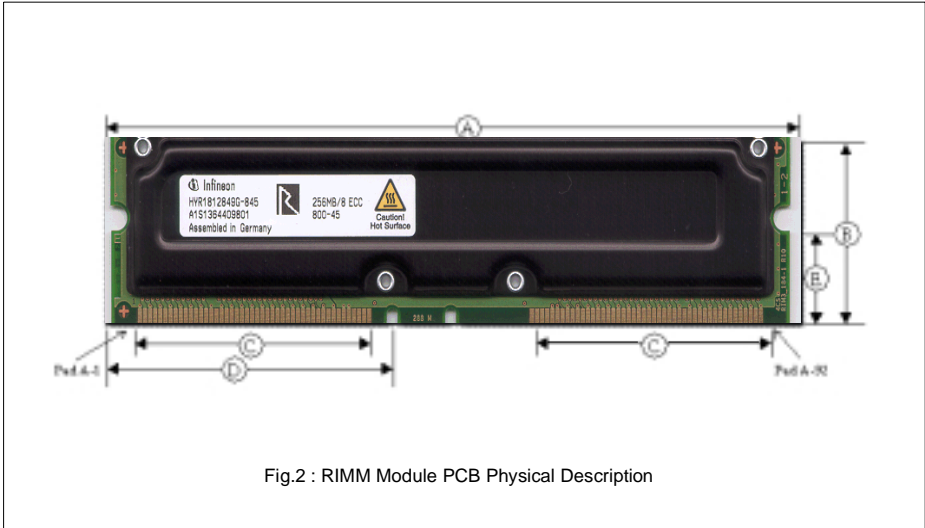


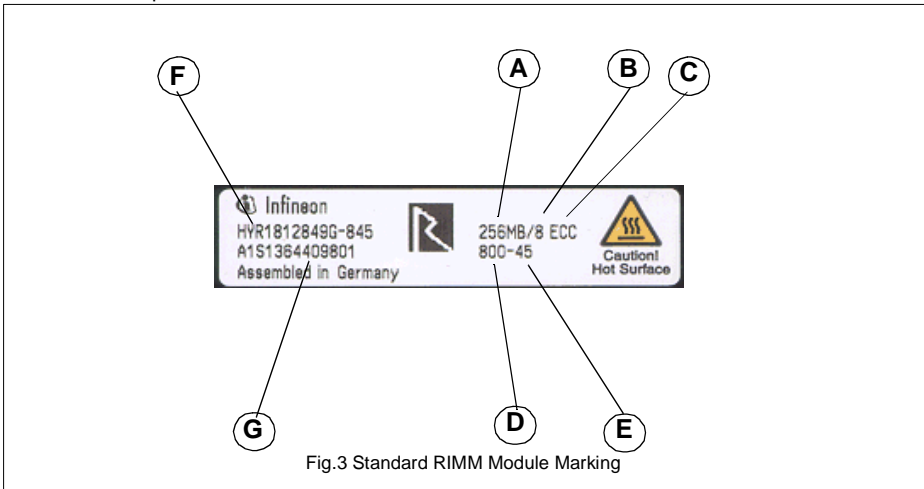
Fig.2 : RIMM Module PCB Physical Description

### RIMM Module PCB Physical Description

Dimension	Description	Limit Values			Unit
		min.	nom.	max.	
A	PCB length	133.20 5.244	133.35 5.250	133.50 5.256	mm in
B	PCB height	–	–	31.75 1.25	mm in
C	Center-center pad width from pad A1 to A46, A47 to A92, B1 to B46 or B47 to B92	–	–	45.00 1.770	mm in
D	Spacing from PCB left edge to connector key notch	55.10 2.169	55.175 2.172	55.25 2.175	mm in
E	Spacing from contact pad PCB edge to side edge retainer notch	–	–	17.78 0.700	mm in
F	PCB thickness	1.17 0.046	1.27 0.050	1.37 0.054	mm in
G	Heat spreader thickness from PCB surface (one side) to heat spreader top surface	–	–	3.02 0.119	mm in

**Standard RIMM Module Marking**

The RIMM modules available from INFINEON Technologies will be marked per Figure 3 below. This marking will help OEMs and users identify the Rambus RIMM modules when used in specific system applications. This will assist OEMs or users to specify and correctly verify if the correct RIMM modules are installed in their systems. In the diagram, a label is shown attached to the RIMM module's heat spreader.



	<b>Label Field</b>	<b>Description</b>	<b>Marked Text</b>	<b>Unit</b>
A	Module Memory Capacity	Number of 8-bit MBytes of RDRAM storage in RIMM module	128MB, 64MB	MB
B	Number of RDRAMs	Number of RDRAM devices contained in the RIMM module	4, 2	RDRAM devices
C	ECC Support	Indicates whether the RIMM module supports 8-bit (no ECC) or 9-bit (ECC) Bytes	blank = 8-bit Byte	-
D	Memory Speed	Data transfer speed for RDRAM RIMM module	800, 600	MHz
E	$t_{RAC}$	Row Access Time	-45, -53	ns
F	Part Number	INFINEON part number		
G	Manufacturing Code	Date Code etc.		