RAMBUS®

Preliminary Information

Rambus® RIMM™ Module (with 64/72Mb RDRAMs)

Overview

The Rambus® RIMM™ module is a general purpose high-performance memory module 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 Rambus RIMM module consists of 64Mb / 72Mb Direct Rambus DRAM devices. These are extremely high-speed CMOS DRAMs organized as 4M words by 16 or 18 bits. The use of Rambus Signaling Level (RSL) technology permits 600 MHz, 711 MHz or 800 MHz transfer rates while using conventional system and board design technologies. RDRAM devices are capable of sustained data transfers at 1.25 ns per two bytes (10ns per 16 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 16-bank architecture supports up to four simultaneous transactions per device.

Features

- High speed 800, 711 and 600 MHz RDRAM storage
- 184 edge connector pads with 1mm pad spacing
- Maximum module PCB size: 133.5mm x 31.75mm x 1.37mm (5.25” x 1.25” x 0.05”)
- Each RDRAM has 16 banks, for a total of 256, 192, 128, 96, or 64 banks on each 128MB, 96MB, 64MB, 48MB, or 32MB module respectively
- Gold plated edge connector pad contacts
- Serial Presence Detect (SPD) support
- Operates from a 2.5 volt supply (±5%)
- Low power and powerdown self refresh modes
- Separate Row and Column buses for higher efficiency

Key Timing Parameters

The following table lists the frequency and latency bins available for RIMM modules.

Table 1: RIMM Module Frequency and Latency

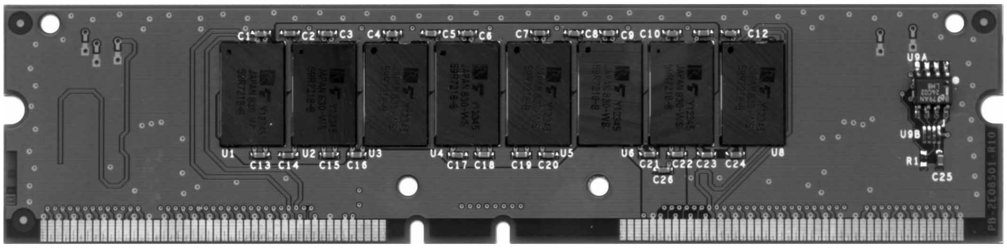
Organization	I/O Freq. MHz	t_{rac} (Row Access Time) ns
x 16	600	53
x 16	600	45
x 16	711	45
x 16	711	40
x 16	800	50
x 16	800	45
x 16	800	40
x 18	600	53
x 18	600	45
x 18	711	45
x 18	711	40
x 18	800	50
x 18	800	45
x 18	800	40

Related Documentation

Data sheets for the Rambus memory system components, including the Rambus DRAMs, RIMM Module, RIMM connector are available on the Rambus web site at http://www.rambus.com.

Form Factor

The Rambus RIMM modules are offered in 184-pad 1mm edge connector pad pitch suitable for either 184 or 168 contact RIMM connectors. Figure 1 below, shows an eight device Rambus RIMM module.



Note: On two sided modules, RDRAMs are also installed on bottom side of PCB.

Figure 1: Rambus RIMM Module shown with heat spreader removed

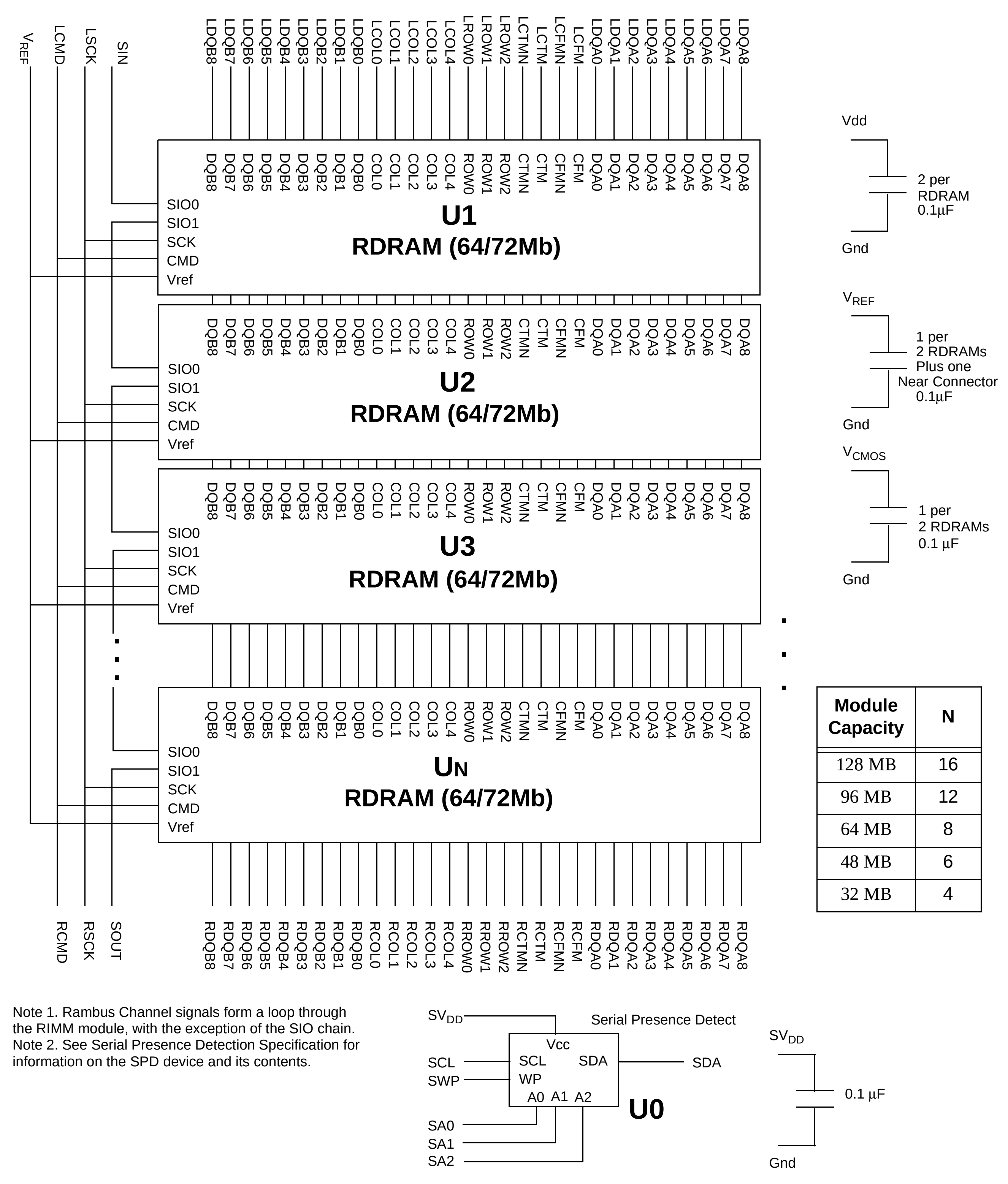
Table 2: Module Pad Number and Signal Names

Pad	Signal Name	Pad	Signal Name
A1	Gnd	B1	Gnd
A2	LDQA8	B2	LDQA7
A3	Gnd	B3	Gnd
A4	LDQA6	B4	LDQA5
A5	Gnd	B5	Gnd
A6	LDQA4	B6	LDQA3
A7	Gnd	B7	Gnd
A8	LDQA2	B8	LDQA1
A9	Gnd	B9	Gnd
A10	LDQA0	B10	LCFM
A11	Gnd	B11	Gnd
A12	LCTMN	B12	LCFMN
A13	Gnd	B13	Gnd
A14	LCTM	B14	NC
A15	Gnd	B15	Gnd
A16	NC	B16	LROW2
A17	Gnd	B17	Gnd
A18	LROW1	B18	LROW0
A19	Gnd	B19	Gnd
A20	LCOL4	B20	LCOL3
A21	Gnd	B21	Gnd
A22	LCOL2	B22	LCOL1
A23	Gnd	B23	Gnd
A24	LCOL0	B24	LDQB0
A25	Gnd	B25	Gnd
A26	LDQB1	B26	LDQB2
A27	Gnd	B27	Gnd
A28	LDQB3	B28	LDQB4
A29	Gnd	B29	Gnd
A30	LDQB5	B30	LDQB6
A31	Gnd	B31	Gnd
A32	LDQB7	B32	LDQB8
A33	Gnd	B33	Gnd
A34	LSCK	B34	LCMD
A35	Vcmos	B35	Vcmos
A36	SOUT	B36	SIN
A37	Vcmos	B37	Vcmos
A38	NC	B38	NC
A39	Gnd	B39	Gnd
A40	NC	B40	NC
A41	Vdd	B41	Vdd
A42	Vdd	B42	Vdd
A43	NC	B43	NC
A44	NC	B44	NC
A45	NC	B45	NC
A46	NC	B46	NC
A47	NC	B47	NC
A48	NC	B48	NC
A49	NC	B49	NC
A50	NC	B50	NC
A51	Vref	B51	Vref
A52	Gnd	B52	Gnd
A53	SCL	B53	SA0
A54	Vdd	B54	Vdd
A55	SDA	B55	SA1
A56	SVdd	B56	SVdd
A57	SWP	B57	SA2
A58	Vdd	B58	Vdd
A59	RSCK	B59	RCMD
A60	Gnd	B60	Gnd
A61	RDQB7	B61	RDQB8
A62	Gnd	B62	Gnd
A63	RDQB5	B63	RDQB6
A64	Gnd	B64	Gnd
A65	RDQB3	B65	RDQB4
A66	Gnd	B66	Gnd
A67	RDQB1	B67	RDQB2
A68	Gnd	B68	Gnd
A69	RCOL0	B69	RDQB0
A70	Gnd	B70	Gnd
A71	RCOL2	B71	RCOL1
A72	Gnd	B72	Gnd
A73	RCOL4	B73	RCOL3
A74	Gnd	B74	Gnd
A75	RROW1	B75	RROW0
A76	Gnd	B76	Gnd
A77	NC	B77	RROW2
A78	Gnd	B78	Gnd
A79	RCTM	B79	NC
A80	Gnd	B80	Gnd
A81	RCTMN	B81	RCFMN
A82	Gnd	B82	Gnd
A83	RDQA0	B83	RCFM
A84	Gnd	B84	Gnd
A85	RDQA2	B85	RDQA1
A86	Gnd	B86	Gnd
A87	RDQA4	B87	RDQA3
A88	Gnd	B88	Gnd
A89	RDQA6	B89	RDQA5
A90	Gnd	B90	Gnd
A91	RDQA8	B91	RDQA7
A92	Gnd	B92	Gnd

Table 3: 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.. LCOL0	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
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.
NC	A16, B14, A38, B38, A40, B40, A77, B79			These pads are not connected. These 8 connector pads are reserved for future use.
NC	A43, B43, A44, B44, A45, B45, A46, B46, A47, B47, A48, B48, A49, B49, A50, B50			These pads are not connected. These 16 connector pads are reserved for future use. The 168 contact RIMM connector does not connect to these PCB pads
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.

Signal	Module Connector Pads	I/O	Type	Description
RCMD	B59	**I**	**V_{CMOS}**	Serial Command Input used to read from and write to the control registers. Also used for power management.
RCOL4.. RCOL0	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.
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**	**SV_{DD}**	Serial Presence Detect Address 0.
SA1	B55	**I**	**SV_{DD}**	Serial Presence Detect Address 1.
SA2	B57	**I**	**SV_{DD}**	Serial Presence Detect Address 2.
SCL	A53	**I**	**SV_{DD}**	Serial Presence Detect Clock.
SDA	A55	**I/O**	**SV_{DD}**	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.
SV_{DD}	A56, B56			SPD Voltage. Used for signals SCL, SDA, SWE, SA0, SA1 and SA2.
SWP	A57	**I**	**SV_{DD}**	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.
Vdd	A41, A42, A54, A58, B41, B42, B54, B58			Supply voltage for the RDRAM core and interface logic.
Vref	A51, B51			Logic threshold reference voltage for RSL signals.



Module Capacity	N
128 MB	16
96 MB	12
64 MB	8
48 MB	6
32 MB	4

Note 1. Rambus Channel signals form a loop through the RIMM module, with the exception of the SIO chain.
Note 2. See Serial Presence Detection Specification for information on the SPD device and its contents.

Figure 2: RIMM Module Functional Diagram

Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
$V_{I,ABS}$	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 VDD 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	Min	Max	Unit
V_{DD}	Supply voltage	2.50 - 0.13	2.50 + 0.13	**V**
V_{CMOS}	CMOS I/O power supply at pad for 2.5V controllers: CMOS I/O power supply at pad for 1.8V controllers:	2.5 - 0.13 1.8 - 0.1	2.5 + 0.25 1.8 + 0.2	**V** **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	0.5V_{CMOS} - 0.25	**V**
$V_{IH,CMOS}$	CMOS input high voltage	0.5V_{CMOS} + 0.25	V_{CMOS} + 0.3	**V**
$V_{OL,CMOS}$	CMOS output low voltage @ $I_{OL,CMOS}$ = 1mA		0.3	**V**
$V_{OH,CMOS}$	CMOS output high voltage @ $I_{OH,CMOS}$ = -0.25mA	V_{CMOS} - 0.3		**V**
I_{REF}	V_{REF} current @ $V_{REF,MAX}$	-10 x no. RDRAMs[a]	10 x no. RDRAMs[a]	**µA**
$I_{SCK,CMD}$	CMOS input leakage current @ $(0 \le V_{CMOS} \le V_{DD})$	-10 x no. RDRAMs[a]	10 x no. RDRAMs[a]	**µA**
$I_{SIN,SOUT}$	CMOS input leakage current @ $(0 \le V_{CMOS} \le V_{DD})$	-10.0	10.0	**µA**

[a] The table below shows the number of 64Mb or 72Mb RDRAM devices contained in a RIMM module of listed memory storage capacity.

RIMM Module Capacity:	**128MB**	**96MB**	**64MB**	**48MB**	**32MB**
Number of 64 Mb or 72Mb RDRAM devices:	16	12	8	6	4

RIMM Module Current Profile

I_{DD}	RIMM Module Capacity: No. of 64/72Mb RDRAMs:	128MB 16	96MB 12	64MB 8	48MB 6	32MB 4	Unit
	RIMM module power conditions [a]	**Max**	**Max**	**Max**	**Max**	**Max**	
I_{DD1}	One RDRAM in Read[b], balance in NAP mode	630	613	596	588	580	mA
I_{DD2}	One RDRAM in Read[b], balance in Standby mode	2082	1678	1274	1072	870	mA
I_{DD3}	One RDRAM in Read[b], balance in Active mode	2787	2195	1603	1307	1011	mA
I_{DD4}	One RDRAM in Write, balance in NAP mode	638	621	604	596	588	mA
I_{DD5}	One RDRAM in Write, balance in Standby mode	2090	1686	1282	1080	878	mA
I_{DD6}	One RDRAM in Write, balance in Active mode	2795	2203	1611	1315	1019	mA

a. Actual power will depend on individual RDRAM component specifications, memory controller and usage patterns. Please refer to specific RIMM module vendor data sheets for additional information. Power does not include Refresh Current. Max current computed for x16 64Mb RDRAMs. x18 72Mb RDRAMs use 8 mA more current per RDRAM in Read and 60mA more current per RDRAM in Write.

b. I/O current is a function of the % of 1's, to add I/O power for 50% 1's for a X16 need to add 257mA or 290mA for X18 ECC module for the following: V_{DD} = 2.5V, V_{TERM} = 1.8V, V_{REF} = 1.4V and V_{DIL} = V_{REF} - 0.5V.

AC Electrical Specifications

Symbol	Parameter and Conditions	Min	Typ	Max	Unit
Z	Module Impedance	25.2	28	30.8	Ω
T_{PD}	Average clock delay from finger to finger of all RSL clock nets (CTM, CTMN, CFM, and CFMN)	-		See Table[a]	**ns**
ΔT_{PD}	Propagation delay variation of RSL signals with respect to T_{PD} [b,c] for 4, 6, 8, and 12 device modules	-21		21	**ps**
	Propagation delay variation of RSL signals with respect to T_{PD} [b,c] for 16 device modules	-24		24	**ps**
$\Delta T_{PD\text{-}CMOS}$	Propagation delay variation of SCK and CMD signals with respect to an average clock delay [b]	-100		100	**ps**
V_{α}/V_{IN}	Attenuation Limit			See Table[a]	**%**
V_{XF}/V_{IN}	Forward crosstalk coefficient (300ps input rise time @ 20%-80%)			See Table[a]	**%**
V_{XB}/V_{IN}	Backward crosstalk coefficient (300ps input rise time @ 20%-80%)			See Table[a]	**%**

a. Table below lists parameters and specifications for different storage capacity RIMM Modules that use 64Mb or 72Mb RDRAM devices.

b. T_{PD} or Average clock delay is defined as the average delay from finger to finger of all RSL clock nets (CTM, CTMN, CFM, and CFMN).

c. If the RIMM module meets the following specification, 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_{PD} Specification" table.

Adjusted ΔT_{PD} Specification

Symbol	Parameter and Conditions	Adjusted Min/Max	Absolute Min / Max		Unit
ΔT_{PD}	Propagation delay variation of RSL signals with respect to T_{PD} for 4, 6, and 8 device modules	+/-[17+(18*N*ΔZ0)][a]	-30	30	**ps**
	Propagation delay variation of RSL signals with respect to T_{PD} for 12 device modules	+/-[20+(18*N*ΔZ0)][a]	-40	40	**ps**
	Propagation delay variation of RSL signals with respect T_{PD} for 16 device modules	+/-[24+(18*N*ΔZ0)][a]	-50	50	**ps**

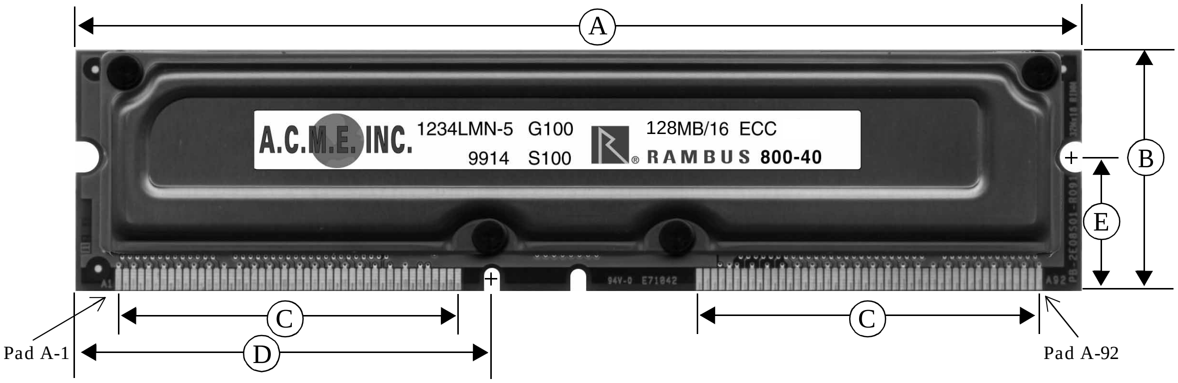
a. Where: N = Number of RDRAM devices installed on the RIMM module
ΔZ0 = delta Z0% = (max Z0 - min Z0)/(min Z0)
(max Z0 and min Z0 are obtained from the loaded (high impedance) impedance coupons of all RSL layers on the modules)

AC Electrical Specifications for RIMM Modules

Symbol	RIMM Module Capacity: No. of 64/72Mb RDRAMs:	128MB 16	96MB 12	64MB 8	48MB 6	32MB 4	Unit
	Parameter and Condition for -800, -711 & -600 RIMM modules	**Max**	**Max**	**Max**	**Max**	**Max**	
T_{PD}	Propagation Delay, all RSL signals -800, -711	2.06	1.76	1.50	1.40	1.25	ns
	Propagation Delay, all RSL signals -600	2.10	1.76	1.60	1.40	1.25	ns
V_{α}/V_{IN}	Attenuation Limit -800, -711	25	20	16	14	12	%
	Attenuation Limit -600	21	18	10	9	8	%
V_{XF}/V_{IN}	Forward crosstalk coefficient (300ps input rise time @ 20%-80%) -800, -711	8	6	4	3	2	%
	Forward crosstalk coefficient (300ps input rise time @ 20%-80%) -600	8	6	4	3	2	%
V_{XB}/V_{IN}	Backward crosstalk coefficient (300ps input rise time @ 20%-80%) -800, -711	2.5	2.3	2.0	1.8	1.5	%
	Backward crosstalk coefficient (300ps input rise time @ 20%-80%) -600	2.5	2.3	2.0	1.8	1.5	%
R_{DC}	DC Resistance Limit -800, -711	1.2	1.1	0.8	0.7	0.6	Ω
	DC Resistance Limit -600	1.2	1.1	0.8	0.7	0.6	Ω

Physical Dimensions

Figure 3 defines the RIMM module dimensions. All units are in millimeters / inches.



Dimension	Description	Min	Nom	Max	Unit
A	PCB length	133.20 5.244	133.35 5.250	133.50 5.256	mm in
B	PCB height for 1.25” RIMM Module			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	55.100 2.169	55.175 2.172	55.250 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			3.00 0.118	mm in

Figure 3: RIMM Module PCB Physical Description

Serial Presence Detect

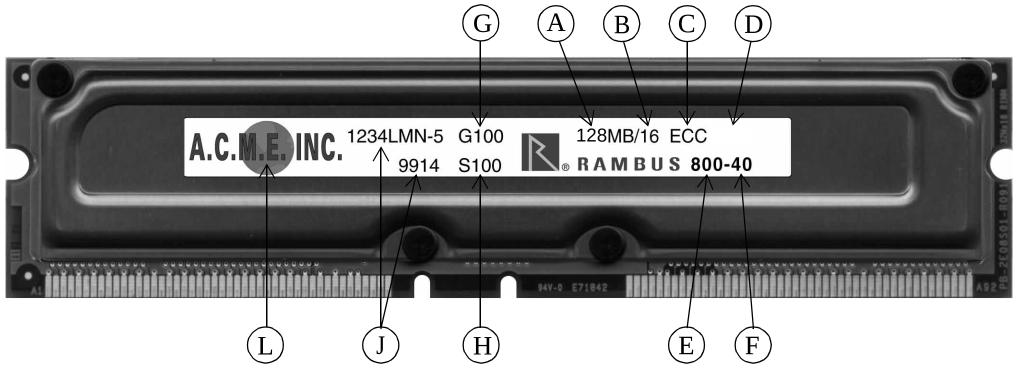
The RIMM Module supports the use of a Serial Presence Detect EEPROM. The specification and definition of the contents of this function are documented in the Serial Presence Detect Specification (DL-0066).

Module Weight

The maximum RIMM Module weight is 75 gm (2.625 oz) with a center of mass 35mm (1.378 in.) upwards from bottom edge.

Standard RIMM Module Marking

The RIMM modules available from RIMM module manufacturers will be marked per Figure 4 below. This industry standard marking will help OEMs and users identify the Rambus RIMM modules for use in specific system applications. This marking also assists OEMs or users to specify and 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. This label contains suggested vendor specific information. Information contained on the label is specific to the RIMM module and provides RDRAM information without requiring removal of the RIMM module's heat spreader.



	Label Field	**Description**	Marked Text	**Unit**
A	Module Memory Capacity	Number of 8-bit or 9-bit MBytes of RDRAM storage in RIMM module	128MB, 96MB, 64MB, 48MB, 32MB	MBytes
B	Number of RDRAMs	Number of RDRAM devices contained in the RIMM module	/16, /12, /8, /6, /4	RDRAM devices
C	ECC Support	Indicates whether the RIMM module supports 8-bit (no ECC) or 9-bit (ECC) Bytes	blank = 8-bit Byte ECC = 9-bit Byte	
D	Reserved	Reserved for future use	blank	
E	Memory Speed	Data transfer speed for RDRAM RIMM module	800, 711, 600	MHz
F	t_{RAC}	Row Access Time (Optional field)	-40, -45, -50, -53 or blank	ns
G	Gerber Version	PCB Gerber file revision used on RIMM Module (Optional field)	Rev 1.00 = G100 or blank	-
H	SPD Version	SPD code version (Optional field)	Rev 1.00 = S100 or blank	-
J	Vendor	Vendor specific part no., date code, mfg codes		
K	Vendor	Vendor specific barcode information (Optional field)		
L	Vendor	Vendor Logo Area, country of origin		

Figure 4: Standard RIMM Module Marking

Table Of Contents

This Rambus document is for design evaluation purposes only. Rambus devices and modules are manufactured and sold by Rambus partners. Rambus partners provide data sheets specific to their products. For a list of companies who are providing Rambus products, see the internet address listed below.

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