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## Viking Technology Single-Channel RDRAM NexMod™ Specification

### General Description

Viking VINRxxxETx0xCxx are high-density Direct Rambus NexMod™ Modules. The modules consist of up to eight, CMOS 16M x 18-bit Rambus DRAM in FBGA packages uniquely arranged in a PCB stacked module. The modules also include an EEPROM for Serial Presence Detect, VRM (voltage regulator module), DRCG (Direct Rambus Clock Generator), and end-of-channel termination. Decoupling capacitors are mounted on the circuit boards for each RDRAM. NexMod™ modules directly mount to motherboards using a BGA connection.

The NexMod™ product family addresses the needs of customers designing space-constrained systems. NexMod™ is a cost effective, small volumetric form factor solution that simplifies system layout and speeds time-to-market by providing virtually all the components needed for a complete Rambus channel.

Rambus Signaling Level (RSL) technology permits up to 1066 MHz transfer rates while using conventional system and board design technologies. RDRAM devices are capable of sustained data transfers at 938ps per two bytes (7.5ns 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 multi-bank architecture supports up to four simultaneous transactions per device.

### Features

- NexMod and Rambus compatible:
  - Fully compatible with NexMod
  - Simplifies system layout
  - Faster time-to-market
- Stacked PCB module design:
  - Improves signal integrity and margin
  - Shortens Rambus channel length by stacking PCBs and placing DRCG, VRM, RDRAM VREF and termination networks on module
  - BGA connectors to mainboard provide mounting and prototype flexibility
  - BGA connector to mainboard utilizes tin/lead paste for RoHS 5 applications
  - BGA interposers within module
- 200 pin interconnect pattern with 0.50" (1.27mm) pitch
- Module footprint: 1.1 inches x 2.0 inches
- Serial Presence Detect (SPD) support
- Operates from a 2.5 volt supply (±5%)
- Low power and powerdown self-refresh modes
- I/O Freq up to 1066 Mhz, tRAC up to 32 ns
- Separate RAS and CAS buses for higher efficiency
- RoHS 5 Compliant\* (see last page)

### Related Documents

Data sheets for the Rambus memory system components, including the Rambus DRAMs, Rambus standards, and SORIMM connector are available on the Rambus web site at <http://www.rambus.com>.

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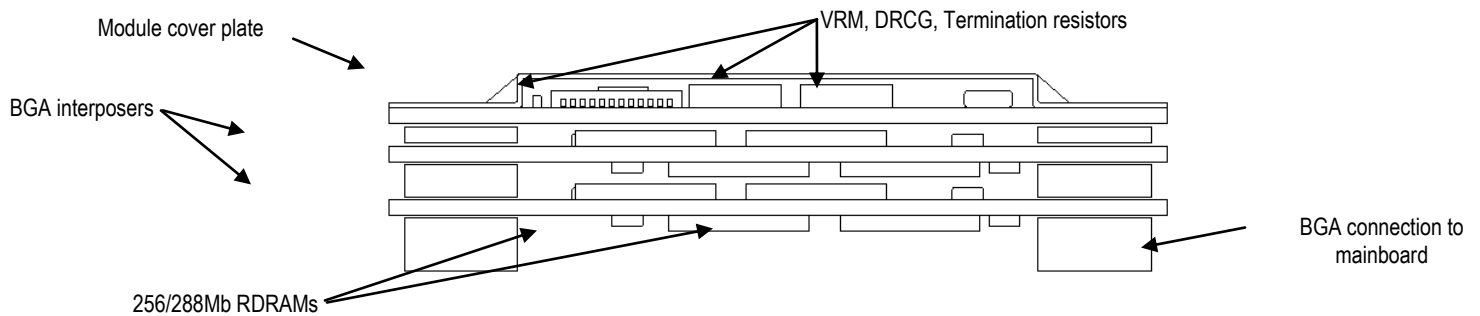
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**Part Numbers by Configuration**

Part Number	Description	RDRAM Device	Module Speed	RDRAM die Rev.
VINR128ET004LCEB-C	144MB, ECC, BGA connector	Elpida EDR2518ABSE-AEP-E	1066MHz 32ns	B
VINR256ET008LCEB-C	288MB, ECC, BGA connector	Elpida EDR2518ABSE-AEP-E	1066MHz 32ns	B
VRNR512ET216LCEB	576MB, ECC, BGA connector	Elpida EDR2518ABSE-AEP-E	1066MHz 32ns	B

**Module arrangement**



*Module Stack-up Diagram*

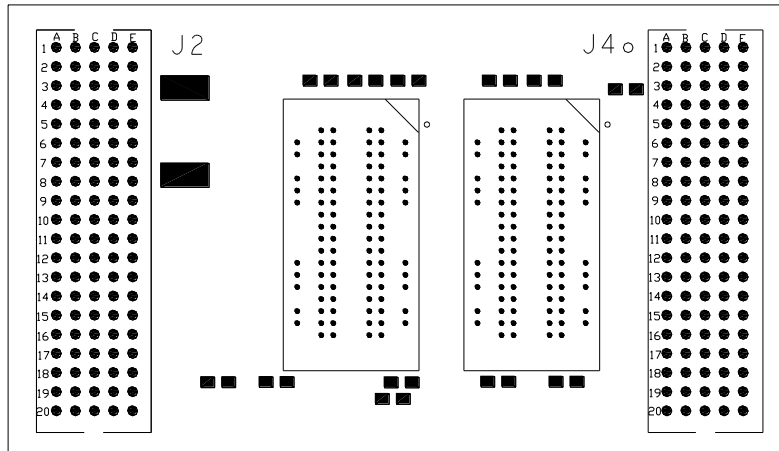
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**Module Pad Number and Signal Names**



Top View of NexMod Footprint, Indicating Pin Locations (Not in scale)

J2 Connector Pinout

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	VDD	B1	VDD	C1	VC MOS	D1	VC MOS	E1	VC MOS
A2	VDD	B2	SCK	C2	GND	D2	DQA8	E2	GND
A3	VDD	B3	DQA6	C3	GND	D3	CMD	E3	VTERM*
A4	VDD	B4	DQA4	C4	GND	D4	DQA7	E4	VTERM*
A5	VDD	B5	DQA2	C5	GND	D5	DQA5	E5	VTERM*
A6	VDD	B6	DQA0	C6	GND	D6	DQA3	E6	GND
A7	GND	B7	CFM	C7	GND	D7	DQA1	E7	GND
A8	GND	B8	CFMN	C8	GND	D8	CTMN	E8	CTMN-DRCG*
A9	GND	B9	ROW1	C9	GND	D9	CTM	E9	CTM-DRCG*
A10	GND	B10	COL4	C10	GND	D10	ROW2	E10	GND
A11	GND	B11	COL2	C11	GND	D11	ROW0	E11	VREF
A12	GND	B12	COL0	C12	GND	D12	COL3	E12	VREF
A13	GND	B13	DQB0	C13	GND	D13	COL1	E13	GND
A14	VDD	B14	DQB2	C14	GND	D14	DQB1	E14	SIN
A15	VDD	B15	DQB4	C15	GND	D15	DQB3	E15	GND
A16	VDD	B16	DQB6	C16	GND	D16	DQB5	E16	GND
A17	SA0	B17	GND	C17	GND	D17	DQB7	E17	GND
A18	SA1	B18	REFCLK	C18	GND	D18	DQB8	E18	VDD3.3
A19	SA2	B19	SDA	C19	SWP	D19	GND	E19	VDD3.3
A20	PCLK/M	B20	GND	C20	SYNCLK/N	D20	SVDD	E20	SCL

\*VTERM, CTMN-DRCG, and CTM DRCG pins are only used if internal VRM and DRCG options are not used on the NexMod.

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**Module Pad Number and Signal Names (cont'd)**

J4 Connector Pinout

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	VCMOS	B1	VCMOS	C1	VCMOS	D1	VDD	E1	VDD
A2	GND	B2	RESERVED*	C2	GND	D2	RESERVED*	E2	VDD
A3	VTERM	B3	RESERVED*	C3	GND	D3	RESERVED*	E3	VDD
A4	VTERM	B4	RESERVED*	C4	GND	D4	RESERVED*	E4	VDD
A5	VTERM	B5	RESERVED*	C5	GND	D5	RESERVED*	E5	VDD
A6	GND	B6	RESERVED*	C6	GND	D6	RESERVED*	E6	VDD
A7	GND	B7	RESERVED*	C7	GND	D7	RESERVED*	E7	GND
A8	GND	B8	RESERVED*	C8	GND	D8	RESERVED*	E8	GND
A9	GND	B9	RESERVED*	C9	GND	D9	RESERVED*	E9	GND
A10	GND	B10	RESERVED*	C10	GND	D10	RESERVED*	E10	GND
A11	VREF	B11	RESERVED*	C11	GND	D11	RESERVED*	E11	GND
A12	VREF	B12	RESERVED*	C12	GND	D12	RESERVED*	E12	GND
A13	GND	B13	RESERVED*	C13	GND	D13	RESERVED*	E13	GND
A14	RESERVED*	B14	RESERVED*	C14	GND	D14	RESERVED*	E14	GND
A15	GND	B15	RESERVED*	C15	GND	D15	RESERVED*	E15	VDD
A16	GND	B16	RESERVED*	C16	GND	D16	RESERVED*	E16	VDD
A17	GND	B17	RESERVED*	C17	GND	D17	GND	E17	VDD
A18	GND	B18	RESERVED*	C18	GND	D18	VDD	E18	VDD
A19	GND	B19	GND	C19	GND	D19	VDD	E19	VDD
A20	GND	B20	GND	C20	GND	D20	GND	E20	GND

\*Reserved pins are used during module assembly at the factory. Do NOT connect in system layout.

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## Module Connector Pad Description

Signal	I/O	Type	Description
GND			Ground reference for connector pads, RDRAM core, and interface.
CFM	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Positive polarity.
CFMN	I	RSL	Clock from master. Interface clock used for receiving RSL signals from the Channel. Negative polarity.
CMD	I	VCMOS	Serial Command used to read from and write to the control registers. Also used for power management.
COL4... COL0	I	RSL	Column bus. 5-bit bus containing control and address information for column accesses.
CTM	O	RSL	Clock from on-board DRCG to Master. Interface clock used for transmitting RSL signals to the Channel. Positive polarity.
CTMN	O	RSL	Clock from on-board DRCG to master. Interface clock used for transmitting RSL signals to the Channel. Negative polarity.
DQA8... DQA0	I/O	RSL	Data bus A. 9-bit bus carrying a byte of read or write data between the Channel and RDRAMs. DQA8 is not used on modules with x16 RDRAM devices.
DQB8... DQB0	I/O	RSL	Data bus B. 9-bit bus carrying a byte of read or write data between the Channel and RDRAMs. DQB8 is not used on modules with x16 RDRAM devices.
ROW2... ROW0	I	RSL	Row bus. 3-bit bus containing control and address information for row accesses.
SCK	I	VCMOS	Serial clock input. Clock source used to read from and write to the RDRAM control registers.
NC			Pads are not connected. Reserved for future use.

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

Signal	I/O	Type	Description
SA0	I	SVDD	Serial Presence Detect Address 0.
SA1	I	SVDD	Serial Presence Detect Address 1.
SA2	I	SVDD	Serial Presence Detect Address 2.
SCL	I	SVDD	Serial Presence Detect Clock.
SDA	I/O	SVDD	Serial Presence Detect Data (Open Collector I/O).
SIN	I/O	VC MOS	Serial I/O for reading from and writing to the control registers. Attaches to SIO0 of the first RDRAM on the module.
SVDD			SPD Voltage. Used for signals SCL, SDA, SWE, SA0, SA1 and SA2.
SWP	I	SVDD	Serial Presence Detect Write Protect (active high). When low, the SPD can be written as well as read.
PCLK/M		VDD3.3	Phase detector input (DRCG).
SYNCLK/N		VDD3.3	Phase detector input (DRCG).
REFCLK		VDD3.3	Reference clock (DRCG).
CTM-DRCG	I	RSL	Clock from external DRCG to master routed to last device in channel. Positive polarity.
CTMN-DRCG	I	RSL	Clock from external DRCG to master routed to last device in channel. Negative polarity.
VDD3.3			Supply voltage for DRCG
VC MOS			CMOS I/O Voltage. Used for signals CMD, SCK, SIN, SOUT.
VDD			Supply voltage for the RDRAM core and interface logic.
VREF			Logic threshold reference voltage for RSL signals.

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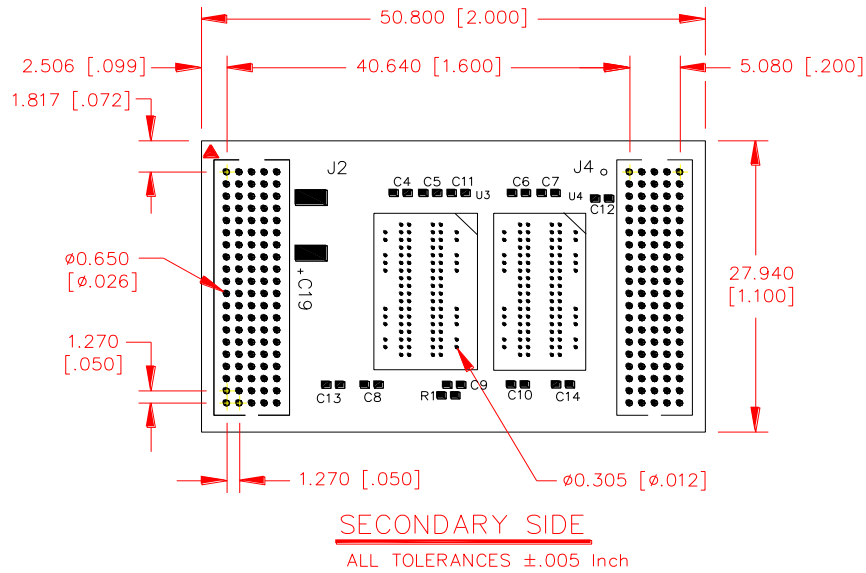
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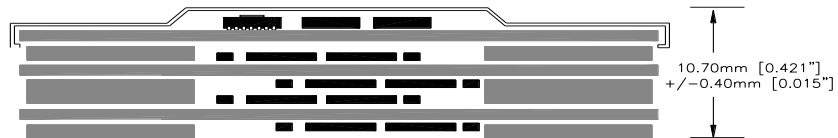
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**Physical Layout Dimensions**



*Top view layout dimensions (millimeters)*



*256MB NexMod with BGA connector vertical dimensions*

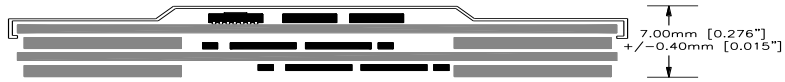
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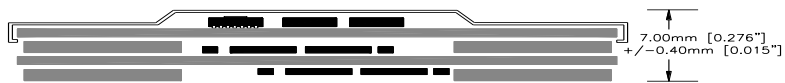
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**Physical Layout Dimensions (cont'd)**



*128MB NexMod with BGA connector vertical dimensions*



*64MB NexMod with BGA connector vertical dimensions*

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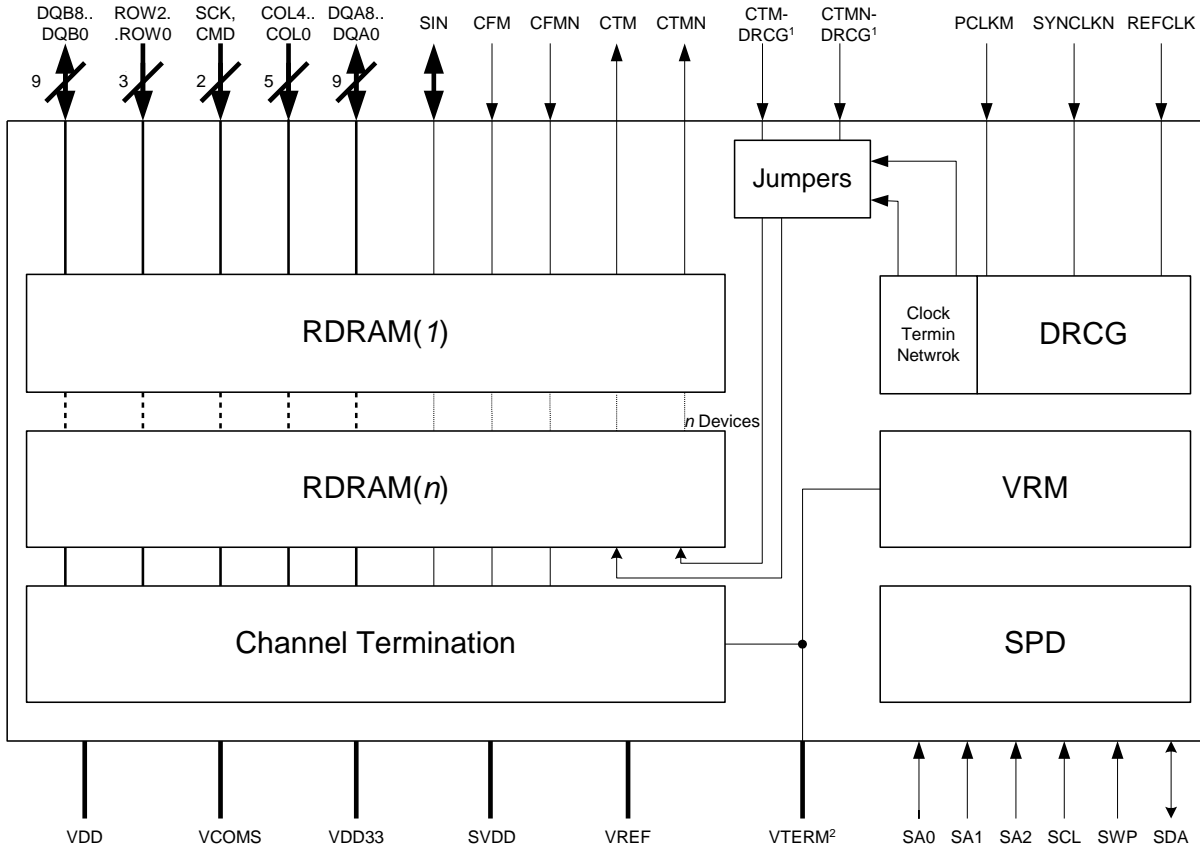
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**Functional Block Diagram**



1. Used if internal DRCG not used (contact Viking for ordering options and application notes)
2. Used if internal VRM not used (contact Viking for ordering options and application notes)

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### ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage applied to any RSL or CMOS signal pad with respect to Gnd	$V_{IABS}$	$-0.3 \sim V_{DD} + 0.3$	V
Voltage on VDD with respect to Gnd	$V_{DD,ABS}$	$-0.5 \sim V_{DD} + 1.0$	V
Storage temperature	$T_{STORE}$	$-50 \sim 100$	°C
Operating junction temperature	$T_{JMAX}$	100	°C
Operating heat spreader surface temperature	$T_{C_{MAX}}$	92	°C
Operating and storage humidity (non-condensing)	$RH_{STORE}, RH_{OP}$	95	%RH

**Note:** Permanent device damage may occur if 'ABSOLUTE MAXIMUM RATINGS' are exceeded. Functional operation should be restricted to recommended operating condition. Exposure to higher than recommended voltage for extended periods of time could affect device reliability.

### DC OPERATING CONDITIONS AND CHARACTERISTICS

Recommended operating conditions (Voltages referenced to GND,  $T_A = 0$  to  $70^\circ\text{C}$ ,  $V_{DD} / V_{CMOS} = 2.5 \pm 0.13V$ )

Parameter and Conditions	Symbol	Min	Max	Unit
Supply voltage (Note 1)	$V_{DD}$	$2.50 - 0.13$	$2.50 + 0.13$	V
CMOS I/O power supply for 2.5V controllers (Note 2)	$V_{CMOS}$	$V_{DD}$	$V_{DD}$	V
CMOS I/O power supply for 1.8V controllers (Note 2)		$1.80 - 0.1$	$1.80 + 0.2$	
Reference voltage (Note 1)	$V_{REF}$	$1.4 - 0.2$	$1.4 + 0.2$	V
Serial Presence Detect- positive power supply	$V_{SPD}$	1.8	3.6	V
RSL input low voltage	$V_{DIL}$	$V_{REF} - 0.5$	$V_{REF} - 0.2$	V
			$V_{REF} - 0.15$	
RSL input high voltage	$V_{DIH}$	$V_{REF} + 0.2$	$V_{REF} + 0.5$	V
		$V_{REF} + 0.15$		
CMOS input low voltage (Note 3)	$V_{IL, CMOS}$	-0.3	$V_{CMOS} / 2 - 0.25$	V
CMOS input high voltage (Note 4)	$V_{IH, CMOS}$	$V_{CMOS} / 2 + 0.25$	$V_{CMOS} + 0.3$	V
CMOS output low voltage @ $I_{OL} = 1\text{mA}$	$V_{OL, CMOS}$	-	0.3	V
CMOS output high voltage @ $I_{OH} = -0.25\text{mA}$	$V_{OH, CMOS}$	$V_{CMOS} - 0.3$	-	V
Reference current @ $V_{REF} \text{ max}$	$I_{REF}$	$-10 \times \text{no.RDRAMs}^b$	$10 \times \text{no.RDRAMs}^b$	$\mu\text{A}$
RSL output low current (Note 5)	$I_{OL}$		90.0	mA
			90.0	
RSL output high current @ ( $0 \leq V_{OUT} \leq V_{DD}$ )	$I_{OH}$	-10	10	$\mu\text{A}$
CMOS input leakage current @ ( $0 \leq V_{CMOS} \leq V_{DD}$ )	$I_{L, CMOS}$	-160	160	$\mu\text{A}$

- Notes:**
1. See Direct RDRAM component datasheet for more details
  2.  $V_{CMOS}$  must be present at all times  $V_{DD}$  is applied.
  3. Undershoot is limited to  $-0.7V$  for a duration less than 5ns.
  4. Overshoot is limited to  $V_{CMOS} + 0.7V$  for a duration less than 5ns.
  5. Devices in manual current control mode, i.e. all output device legs of one device are sinking current.
  6. Number of RDRAM devices in a NexMod: 8 for 256/288MB; 4 for 128/144MB; 2 for 64/72MB

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**DC CHARACTERISTICS**

(Recommended operating conditions unless otherwise noted, TA = 0 to 70 °C)

Parameter	Symbol	Test Condition	Freq.	288MB	144MB	72MB	Unit	Note
				Max	Max	Max		
Read Current	I <sub>DD1</sub>	One RDRAM in Read, balance in NAP mode	800	628	612	604	mA	1, 2
			1066	778	762	754		
Read Current	I <sub>DD2</sub>	One RDRAM in Read, balance in Standby mode	800	1265	885	695	mA	1, 2
			1066	1485	1065	855		
Read Current	I <sub>DD3</sub>	One RDRAM in Read, balance in Active mode	800	1545	1005	735	mA	1, 2
			1066	1870	1230	910		
Write Current	I <sub>DD4</sub>	One RDRAM in Write, balance in NAP mode	800	608	592	584	mA	1, 2
			1066	768	752	74		
Write Current	I <sub>DD5</sub>	One RDRAM in Write, balance in Standby mode	800	1245	865	675	mA	1, 2
			1066	1475	1055	845		
Write Current	I <sub>DD6</sub>	One RDRAM in Write, balance in Active mode	800	1525	985	715	mA	1, 2
			1066	1860	1220	900		

**Notes:**

1. Actual power will depend on individual RDRAM component specifications, memory controller and usage patterns. Power does not include Refresh Current.
2. I/O current is a function of the number of bits=1. Add 290mA assuming 50% of data bits=1 and the following conditions: V<sub>DD</sub> = 2.5V, V<sub>TERM</sub> = 1.8V, V<sub>REF</sub> = 1.4V and V<sub>DIL</sub> = V<sub>REF</sub> - 0.5V.

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### AC ELECTRICAL SPECIFICATIONS

Symbol	Parameter and Conditions	Min	Typ	Max	Unit	
Z <sub>L</sub>	Module Impedance of RSL Signals	25.2	28	30.8	Ω	
Z <sub>UL-CMOS</sub>	Module Impedance of SCK and CMD signals	23.8	28	32.2	Ω	
T <sub>PD</sub>	Propagation Delay, all RSL signals	-	2.5	3.0	ns	
ΔT <sub>PD</sub>	Propagation delay variation of RSL signals with respect to T <sub>PD a,b</sub>	-30		30	ps	
ΔT <sub>PD-CMOS</sub>	Propagation delay variation of SCK signal with respect to an average clock delay <b>a</b>	-250		250	ps	
ΔT <sub>PD-SCK,CMD</sub>	Propagation delay variation of CMD signal with respect to SCK signal	-200		200	ps	
V <sub>□</sub> /V <sub>IN</sub>	Attenuation Limit	800MHz	-	-	27	%
		1066MHz	-	-	35	
V <sub>XF</sub> /V <sub>IN</sub>	Forward crosstalk coefficient (300ps input rise time @ 20%-80%)	-	10.0	12.0	%	
V <sub>XB</sub> /V <sub>IN</sub>	Backward crosstalk coefficient (300ps input rise time @ 20%-80%)	-	2.0	4.0	%	
R <sub>DC</sub>	DC Resistance Limit	-	1.5	1.9	Ω	

**Notes:**

1. TPD or Average clock delay is defined as the average delay from finger to finger of all RSL clock nets (CTM, CTMN, CFM, and CFMN)
2. If the NexMod™ module meets the following specification, then it is compliant to the specification. If an actual NexMod™ module does not meet these specifications, the specification can be adjusted by using the "Adjusted ΔTPD Specification" table.

### ADJUSTED ΔTpd SPECIFICATION

(Note 1)

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

**Notes:**

1. Where: N = number of RDRAM devices installed on the NexMod™ module, ΔZ0 = delta Z0% = (max Z0 – min Z0)/(min Z0)  
Max Z0 and min Z0 are obtained from the loaded (high) impedance coupons of all RSL layers on the module

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**Viking NexMod™ Part Numbering Scheme**

**VR A B CCC D E F GG H I (J K) / (L M)**  
 (Example: VRNR512ET016LCSE)

	Form Factor	Technology	Capacity	Correction	Data Termination	Connector	IC Qty	Module Speed	Temp	Chip Manufacturer & Die Revision	Customer Specific
	A	B	CCC	D	E	F	GG	H	I	JK	LM
VI = Viking Tin Lead	N = NexMod™	R = RAMBUS	064 = 64MB	E = ECC	T = On board term	0 = BGA Interposer	02	A = 40ns/800MHz	C = Commercial	S = Samsung	As required
VR = Viking Lead Free			128 = 128Mb	N = Non ECC		2 = 2 PGA connectors	04	B = 45ns/800MHz	I = Industrial	E = Elpida	
			256 = 256MB				08	L = 32ns/1066MHz			
			512 = 512MB				16				

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REVISION HISTORY

Table with 4 columns: Revision, Release Date, Description of Change, Checked By (Full Name). Rows include revisions A through D with details on release dates and changes.

STATEMENT OF COMPLIANCE

Viking Technology(tm), Sanmina-SCI Corporation ("Viking") shall use commercially reasonable efforts to provide components, parts, materials, products and processes to Customer that do not contain: (i) lead, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE) above 0.1% by weight in homogeneous material or (ii) cadmium above 0.01% by weight of homogeneous material, except as provided in any exemption(s) from RoHS requirements...

All printed circuit boards (PCBs) have a flammability rating of UL94V-0.

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