

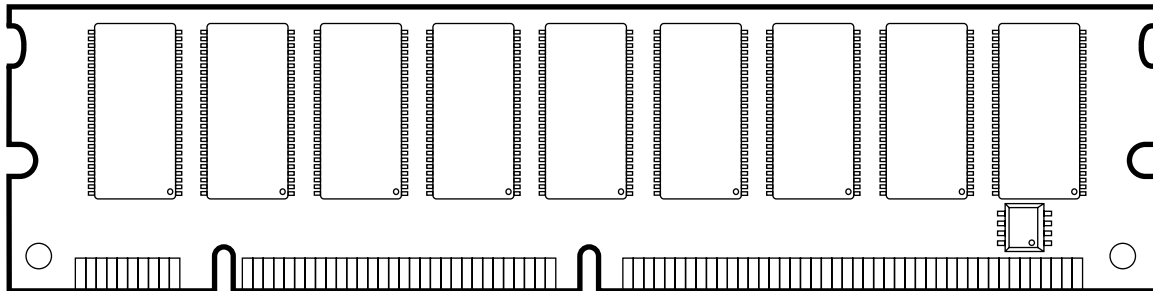
Features

- 168 Pin Unbuffered 8,388,608 x 72 bit Organization SDRAM ECC DIMMs
- Utilizes High Performance 8M x 8 SDRAM in TSOPII-54 Packages
- Fully PC Board Layout Compatible to INTEL'S Rev 1.0 Module Specification
- Single +3.3V (± 0.3V) Power Supply
- Programmable $\overline{\text{CAS}}$ Latency, Burst Length, and Wrap Sequence (Sequential & Interleave)
- Auto Refresh (CBR) and Self Refresh
- All Inputs, Outputs are LVTTTL Compatible
- 4096 Refresh Cycles every 64 ms
- Serial Present Detect (SPD)
- SDRAM Performance

Description

The V43728S04V(C)TG-75 memory module is organized 8,388,608 x 72 bits in a 168 pin memory module. The 8M x 72 memory module uses 9 Mosel-Vitelic 8M x 8 SDRAM. The x72 modules are ideal for use in high performance computer systems where increased memory density and fast access times are required.

| Key Component Timing Parameters | | -7 | Units |
|---------------------------------|--|-----|-------|
| t_{CK} | Clock Frequency (max.) | 143 | MHz |
| t_{AC} | Clock Access Time $\overline{\text{CAS}}$ Latency = 3 | 5.4 | ns |



V43728S04V(C)TG-75-01

■ Supported Latencies at 133 MHz Operation

| CL | t_{RCD} | t_{RP} | t_{RC} | |
|----|-----------|----------|----------|-----|
| 3 | 3 | 3 | 8 | CLK |

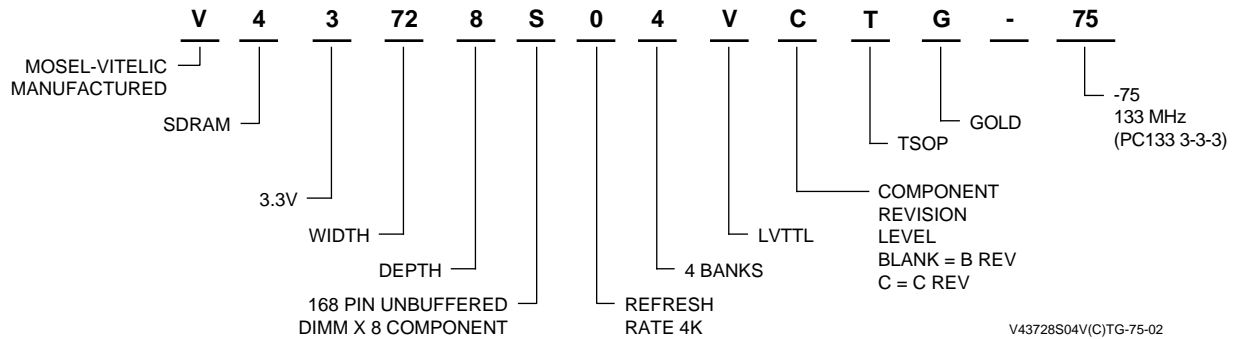
Pin Configurations (Front Side/Back Side)

| Pin | Front | Pin | Front | Pin | Front | Pin | Back | Pin | Back | Pin | Back |
|-----|-----------------|-----|------------------|-----|-------|-----|-------|-----|------------------|-----|-------|
| 1 | VSS | 29 | DQM1 | 57 | I/O19 | 85 | VSS | 113 | DQM5 | 141 | I/O51 |
| 2 | I/O1 | 30 | $\overline{CS0}$ | 58 | I/O20 | 86 | I/O33 | 114 | $\overline{CS1}$ | 142 | I/O52 |
| 3 | I/O2 | 31 | DU | 59 | VCC | 87 | I/O34 | 115 | RAS | 143 | VCC |
| 4 | I/O3 | 32 | VSS | 60 | I/O21 | 88 | I/O35 | 116 | VSS | 144 | I/O53 |
| 5 | I/O4 | 33 | A0 | 61 | NC | 89 | I/O36 | 117 | A1 | 145 | NC |
| 6 | VCC | 34 | A2 | 62 | DU | 90 | VCC | 118 | A3 | 146 | DU |
| 7 | I/O5 | 35 | A4 | 63 | CKE1 | 91 | I/O37 | 119 | A5 | 147 | NC |
| 8 | I/O6 | 36 | A6 | 64 | VSS | 92 | I/O38 | 120 | A7 | 148 | VSS |
| 9 | I/O7 | 37 | A8 | 65 | I/O22 | 93 | I/O39 | 121 | A9 | 149 | I/O54 |
| 10 | I/O8 | 38 | A10(AP) | 66 | I/O23 | 94 | I/O40 | 122 | BA0 | 150 | I/O55 |
| 11 | I/O9 | 39 | BA1 | 67 | I/O24 | 95 | I/O41 | 123 | A11 | 151 | I/O56 |
| 12 | VSS | 40 | VCC | 68 | VSS | 96 | VSS | 124 | VCC | 152 | VSS |
| 13 | I/O10 | 41 | VCC | 69 | I/O25 | 97 | I/O42 | 125 | CLK1 | 153 | I/O57 |
| 14 | I/O11 | 42 | CLK0 | 70 | I/O26 | 98 | I/O43 | 126 | NC | 154 | I/O58 |
| 15 | I/O12 | 43 | VSS | 71 | I/O27 | 99 | I/O44 | 127 | VSS | 155 | I/O59 |
| 16 | I/O13 | 44 | DU | 72 | I/O28 | 100 | I/O45 | 128 | CKE0 | 156 | I/O60 |
| 17 | I/O14 | 45 | $\overline{CS2}$ | 73 | VCC | 101 | I/O46 | 129 | $\overline{CS3}$ | 157 | VCC |
| 18 | VCC | 46 | DQM2 | 74 | I/O29 | 102 | VCC | 130 | DQM6 | 158 | I/O61 |
| 19 | I/O15 | 47 | DQM3 | 75 | I/O30 | 103 | I/O47 | 131 | DQM7 | 159 | I/O62 |
| 20 | I/O16 | 48 | DU | 76 | I/O31 | 104 | I/O48 | 132 | DU | 160 | I/O63 |
| 21 | CBO | 49 | VCC | 77 | I/O32 | 105 | CB4 | 133 | VCC | 161 | I/O64 |
| 22 | CB1 | 50 | NC | 78 | VSS | 106 | CB5 | 134 | NC | 162 | VSS |
| 23 | VSS | 51 | NC | 79 | CLK2 | 107 | VSS | 135 | NC | 163 | CLK3 |
| 24 | NC | 52 | CB2 | 80 | NC | 108 | NC | 136 | CB6 | 164 | NC |
| 25 | NC | 53 | CB3 | 81 | WP | 109 | NC | 137 | CB7 | 165 | SA0 |
| 26 | VCC | 54 | VSS | 82 | SDA | 110 | VCC | 138 | VSS | 166 | SA1 |
| 27 | \overline{WE} | 55 | I/O17 | 83 | SCL | 111 | CAS | 139 | I/O49 | 167 | SA2 |
| 28 | DQM0 | 56 | I/O18 | 84 | VCC | 112 | DQM4 | 140 | I/O50 | 168 | VCC |

Pin Names

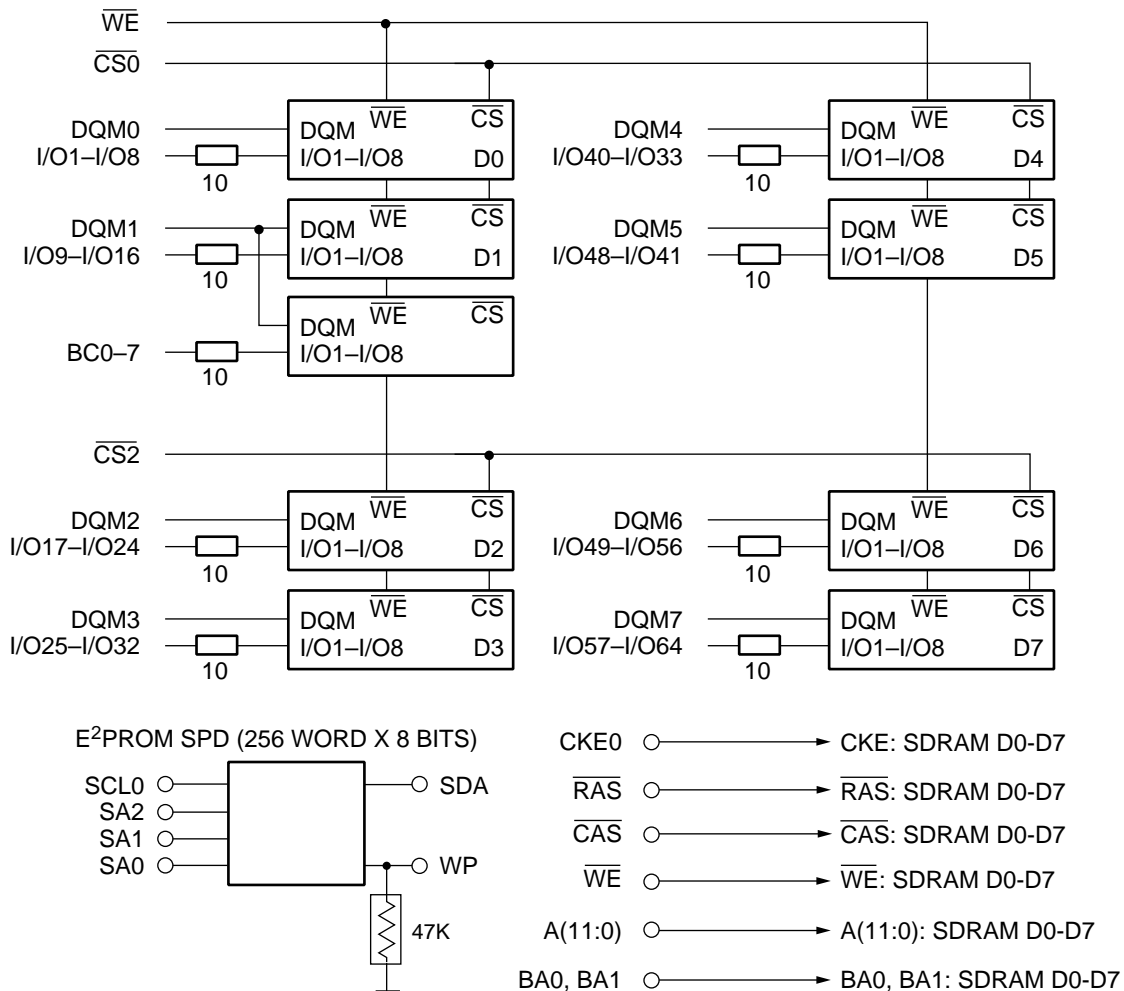
| | |
|---------------------------------------|-------------------------------------|
| A0–A11 | Address Inputs |
| I/O1–I/O64 | Data Inputs/Outputs |
| RAS | Row Address Strobe |
| \overline{CAS} | Column Address Strobe |
| \overline{WE} | Read/Write Input |
| BA0, BA1 | Bank Selects |
| $\overline{CKE0}$, $\overline{CKE1}$ | Clock Enable |
| $\overline{CS0}$ – $\overline{CS3}$ | Chip Select |
| CLK0–CLK3 | Clock Input |
| DQM0–DQM7 | Data Mask |
| VCC | Power (+3.3 Volts) |
| VSS | Ground |
| SCL | Clock for Presence Detect |
| SDA | Serial Data OUT for Presence Detect |
| SA0–A2 | Serial Data IN for Presence Detect |
| CB0–CB7 | Check Bits (x72 Organization) |
| NC | No Connection |
| DU | Don't Use |

Part Number Information

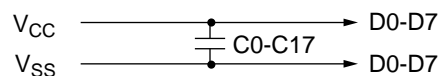


V43728S04V(C)TG-75-02

Block Diagram



| CLOCK WIRING | |
|--------------|---------------------|
| CLOCK INPUT | LOAD |
| CLK0 | 5 SDRAM |
| CLK1 | Termination |
| CLK2 | 4 SDRAMs +3.3pF Cap |
| CLK3 | Termination |



V43728S04V(C)TG-75-03

Serial Presence Detect Information

A serial presence detect storage device - E²PROM - is assembled onto the module. Information about the module configuration, speed,

etc. is written into the E²PROM device during module production using a serial presence detect protocol (I²C synchronous 2-wire bus)

SPD-Table for PC133 modules:

| Byte Number | Function Described | SPD Entry Value | Hex Value |
|-------------|---|-----------------------------|-----------|
| | | | 8Mx72 |
| 0 | Number of SPD bytes | 128 | 80 |
| 1 | Total bytes in Serial PD | 256 | 08 |
| 2 | Memory Type | SDRAM | 04 |
| 3 | Number of Row Addresses (without BS bits) | 12 | 0C |
| 4 | Number of Column Addresses (for x8 SDRAM) | 9 | 09 |
| 5 | Number of DIMM Banks | 1 | 01 |
| 6 | Module Data Width | 72 | 48 |
| 7 | Module Data Width (continued) | 0 | 00 |
| 8 | Module Interface Levels | LVTTTL | 01 |
| 9 | SDRAM Cycle Time at CL=3 | 7.5 ns | 75 |
| 10 | SDRAM Access Time from Clock at CL=3 | 5.4 ns | 54 |
| 11 | Dimm Config (Error Det/Corr.) | ECC | 02 |
| 12 | Refresh Rate/Type | Self-Refresh, 15.6µs | 80 |
| 13 | SDRAM width, Primary | x8 | 08 |
| 14 | Error Checking SDRAM Data Width | n/a / x8 | 08 |
| 15 | Minimum Clock Delay from Back to Back Random Column Address | t _{ccd} = 1 CLK | 01 |
| 16 | Burst Length Supported | 1, 2, 4, 8 & full Page | 8F |
| 17 | Number of SDRAM Banks | 4 | 04 |
| 18 | Supported \overline{CAS} Latencies | CL = 3 | 04 |
| 19 | \overline{CS} Latencies | \overline{CS} Latency = 0 | 01 |
| 20 | \overline{WE} Latencies | WL = 0 | 01 |
| 21 | SDRAM DIMM Module Attributes | Non Buffered/Non Reg. | 00 |
| 22 | SDRAM Device Attributes: General | V _{cc} tol ± 10% | 0E |
| 23 | Minimum Clock Cycle Time at \overline{CAS} Latency = 2 | Not Supported | 00 |
| 24 | Maximum Data Access Time from Clock for CL = 2 | Not Supported | 00 |
| 25 | Minimum Clock Cycle Time at CL = 1 | Not Supported | 00 |
| 26 | Maximum Data Access Time from Clock at CL = 1 | Not Supported | 00 |
| 27 | Minimum Row Precharge Time | 20 ns | 14 |
| 28 | Minimum Row Active to Row Active Delay t _{RRD} | 15 ns | 0F |
| 29 | Minimum RAS to \overline{CAS} Delay t _{RCD} | 20 ns | 14 |
| 30 | Minimum RAS Pulse Width t _{RAS} | 45 ns | 2D |

SPD-Table for PC133 modules: (Continued)

| Byte Number | Function Described | SPD Entry Value | Hex Value |
|-------------|--|--------------------|-----------|
| | | | 8Mx72 |
| 31 | Module Bank Density (Per Bank) | 64 MByte | 10 |
| 32 | SDRAM Input Setup Time | 1.5 ns | 15 |
| 33 | SDRAM Input Hold Time | 0.8 ns | 08 |
| 34 | SDRAM Data Input Setup Time | 1.5 ns | 15 |
| 35 | SDRAM Data Input Hold Time | 0.8 ns | 08 |
| 62-61 | Superset Information (May be used in Future) | | 00 |
| 62 | SPD Revision | Revision 2 | 02 |
| 63 | Checksum for Bytes 0 - 62 | | 9E |
| 64 | Manufacturer's JEDEC ID Code | Mosel Vitelic | 40 |
| 65-71 | Manufacturer's JEDEC ID Code (cont.) | | 00 |
| 72 | Manufacturing Location | | |
| 73-90 | Module Part Number (ASCII) | V43728S04V(C)TG-75 | |
| 91-92 | PCB Identification Code | | |
| 93 | Assembly Manufacturing Date (Year) | | |
| 94 | Assembly Manufacturing Date (Week) | | |
| 95-98 | Assembly Serial Number | | |
| 99-125 | Reserved | | 00 |
| 126 | Intel Specification for Frequency | | 64 |
| 127 | Reserved | | 00 |
| 128+ | Unused Storage Location | | 00 |

DC Characteristics

$T_A = 0^{\circ}\text{C}$ to 70°C ; $V_{SS} = 0\text{ V}$; $V_{DD}, V_{DDQ} = 3.3\text{V} \pm 0.3\text{V}$

| Symbol | Parameter | Limit Values | | Unit |
|------------|---|--------------|--------------|---------------|
| | | Min. | Max. | |
| V_{IH} | Input High Voltage | 2.0 | $V_{CC}+0.3$ | V |
| V_{IL} | Input Low Voltage | -0.5 | 0.8 | V |
| V_{OH} | Output High Voltage ($I_{OUT} = -2.0\text{ mA}$) | 2.4 | — | V |
| V_{OL} | Output Low Voltage ($I_{OUT} = 2.0\text{ mA}$) | — | 0.4 | V |
| $I_{I(L)}$ | Input Leakage Current, any input ($0\text{ V} < V_{IN} < 3.6\text{ V}$, all other inputs = 0V) | -40 | 40 | μA |
| $I_{O(L)}$ | Output leakage current (DQ is disabled, $0\text{V} < V_{OUT} < V_{CC}$) | -40 | 40 | μA |

Capacitance

$T_A = 0^\circ\text{C}$ to 70°C ; $V_{DD} = 3.3\text{V} \pm 0.3\text{V}$, $f = 1\text{ MHz}$

| Symbol | Parameter | Limit Values | Unit |
|------------------|---|--------------|------|
| | | Max. 8M x 72 | |
| C _{I1} | Input Capacitance (A0 to A11, $\overline{\text{RAS}}$, CAS, $\overline{\text{WE}}$) | 65 | pF |
| C _{I2} | Input Capacitance ($\overline{\text{CS0}}$ - $\overline{\text{CS3}}$) | 40 | pF |
| C _{ICL} | Input Capacitance (CLK0-CLK3) | 40 | pF |
| C _{I3} | Input Capacitance (CKE0, CKE1) | 60 | pF |
| C _{I4} | Input Capacitance (DQM0-DQM7) | 15 | pF |
| C _{IO} | Input/Output Capacitance (I/O1-I/064) | 15 | pF |
| C _{SC} | Input Capacitance (SCL, SA0-2) | 8 | pF |
| C _{SD} | Input/Output Capacitance (SA0-SA2) | 10 | pF |

Standby and Refresh Currents¹

$T_A = 0^\circ\text{C}$ to 70°C , $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$

| Symbol | Parameter | Test Conditions | Max. x72 | Unit | Note |
|--------------------|---|--|----------|------|--------------------------------------|
| I _{CC1} | Operating Current | Burst length = 4, CL = 3 $t_{RC} > t_{RC}(\text{min})$, $t_{CK} > t_{CK}(\text{min})$, IO = 0 mA | 900 | mA | 1,2 |
| I _{CC2P} | Precharged Standby Current in Power Down Mode | CKE< = V _{IL} (max), $t_{CK} > t_{CK}(\text{min})$ | 27 | mA | |
| I _{CC2PS} | | CKE< = V _{IL} (max), $t_{CK} = \text{Infinite}$ | 18 | mA | |
| I _{CC2N} | Precharged Standby Current in Non-Power Down Mode | CKE> = V _{IH} (min), $t_{CK} > t_{CK}(\text{min})$, Input changed once in 3 cycles | 180 | mA | $\overline{\text{CS}} = \text{High}$ |
| I _{CC2NS} | | CKE> = V _{IH} (min), $t_{CK} = \text{Infinite}$, No Input change | 90 | mA | |
| I _{CC3P} | Active Standby Current in Power Down Mode | CKE< = V _{IL} (max), $t_{CK} > t_{CK}(\text{min})$ | 27 | mA | |
| I _{CC3PS} | | CKE< = V _{IL} (max), $t_{CK} = \text{Infinite}$ | 18 | mA | |
| I _{CC3N} | Active Standby Current in Non-Power Down Mode | CKE> = V _{IH} (min), $t_{CK} > t_{CK}(\text{min})$, Input changed one time | 225 | mA | $\overline{\text{CS}} = \text{High}$ |
| I _{CC3NS} | | CKE> = V _{IH} (min), $t_{CK} = \text{Infinite}$, No Input change | 135 | mA | |
| I _{CC4} | Burst Operating Current | Burst length = Full Page, $t_{RC} = \text{Infinite}$, CL = 3, $t_{CK} > t_{CK}(\text{min})$, IO = 0 mA | 900 | mA | 1, 2 |
| I _{CC5} | Auto Refresh Current | $t_{RC} > t_{RC}(\text{min})$ | 1100 | mA | 1,2 |
| I _{CC6} | Self Refresh Current | CKE = <0,2 V | 9 | mA | 1,2 |

AC Characteristics
 $T_A = 0^\circ \text{ to } 70^\circ\text{C}; V_{SS} = 0\text{V}; V_{CC} = 3.3\text{V} \pm 0.3\text{V}, t_T = 1 \text{ ns}$

| # | Symbol | Parameter | Limit Values | | Unit | Note |
|-------------------------------|------------|--|--------------|------|------|------|
| | | | -75 | | | |
| | | | Min. | Max. | | |
| Clock and Clock Enable | | | | | | |
| 1 | t_{CK} | Clock Cycle Time CAS Latency = 3 CAS Latency = 2 | 7.5 | – | s | |
| | | | 10 | – | ns | |
| 2 | t_{CK} | Clock Frequency CAS Latency = 3 CAS Latency = 2 | – | 133 | MHz | |
| | | | – | 100 | MHz | |
| 3 | t_{AC} | Access Time from Clock CAS Latency = 3 CAS Latency = 2 | – | 5.4 | ns | 2, 4 |
| | | | – | 6 | ns | |
| 4 | t_{CH} | Clock High Pulse Width | 2.5 | – | ns | |
| 5 | t_{CL} | Clock Low Pulse Width | 2.5 | – | ns | |
| 6 | t_T | Transition Tim | 0.3 | 1.2 | ns | |
| Setup and Hold Times | | | | | | |
| 7 | t_{IS} | Input Setup Time | 1.5 | – | ns | 5 |
| 8 | t_{IH} | Input Hold Time | 0.8 | – | ns | 5 |
| 9 | t_{CKS} | Input Setup Time | 1.5 | – | ns | 5 |
| 10 | t_{CKH} | CKE Hold Time | 0.8 | – | ns | 5 |
| 11 | t_{RSC} | Mode Register Set-up Time | 15 | – | ns | |
| 12 | t_{SB} | Power Down Mode Entry Time | 0 | 7.5 | ns | |
| Common Parameters | | | | | | |
| 13 | t_{RCD} | Row to Column Delay Time | 20 | – | ns | 6 |
| 14 | t_{RP} | Row Precharge Time | 20 | – | ns | 6 |
| 15 | t_{RAS} | Row Active Time | 45 | 100K | ns | 6 |
| 16 | t_{RC} | Row Cycle Time | 60 | – | ns | 6 |
| 17 | t_{RRD} | Activate(a) to Activate(b) Command Period | 15 | – | ns | 6 |
| 18 | t_{CCD} | CAS(a) to CAS(b) Command Period | 1 | – | CLK | |
| Refresh Cycle | | | | | | |
| 19 | t_{REF} | Refresh Period (4096 cycles) | – | 64 | ms | |
| 20 | t_{SREX} | Self Refresh Exit Time | 10 | | ns | |

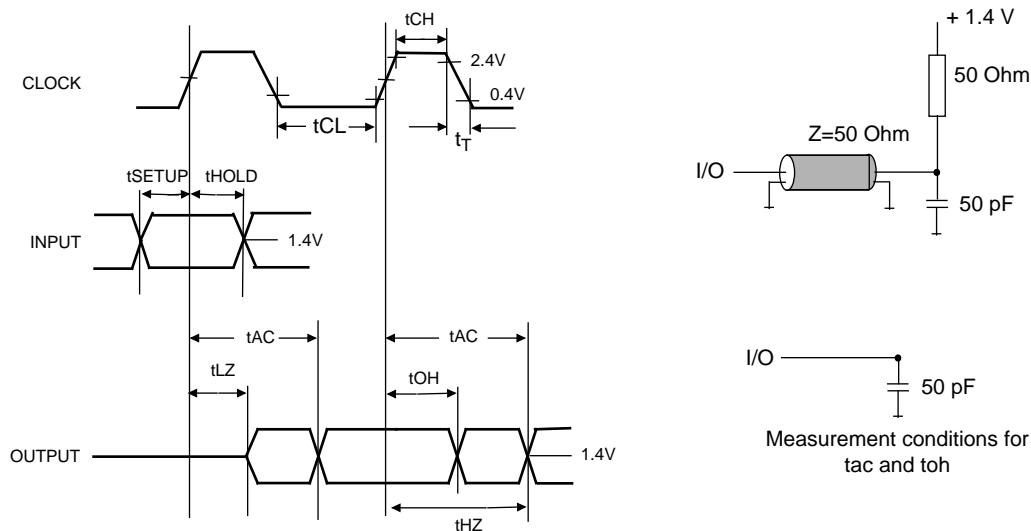
AC Characteristics

$T_A = 0^\circ$ to 70°C ; $V_{SS} = 0\text{V}$; $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$, $t_T = 1 \text{ ns}$ (Continued)

| # | Symbol | Parameter | Limit Values | | Unit | Note |
|--------------------|-----------|---------------------------------|--------------|------|------|------|
| | | | -75 | | | |
| | | | Min. | Max. | | |
| Read Cycle | | | | | | |
| 21 | t_{OH} | Data Out Hold Time | 2.7 | – | ns | 2 |
| 22 | t_{LZ} | Data Out to Low Impedance Time | 1 | – | ns | |
| 23 | t_{HZ} | Data Out to High Impedance Time | – | 5.4 | ns | 7 |
| 24 | t_{DQZ} | DQM Data Out Disable Latency | – | 2 | CLK | |
| Write Cycle | | | | | | |
| 25 | t_{WR} | Write Recovery Time | 1 | – | CLK | |
| 26 | t_{DQW} | DQM Write Mask Latency | 0 | – | CLK | |

Notes:

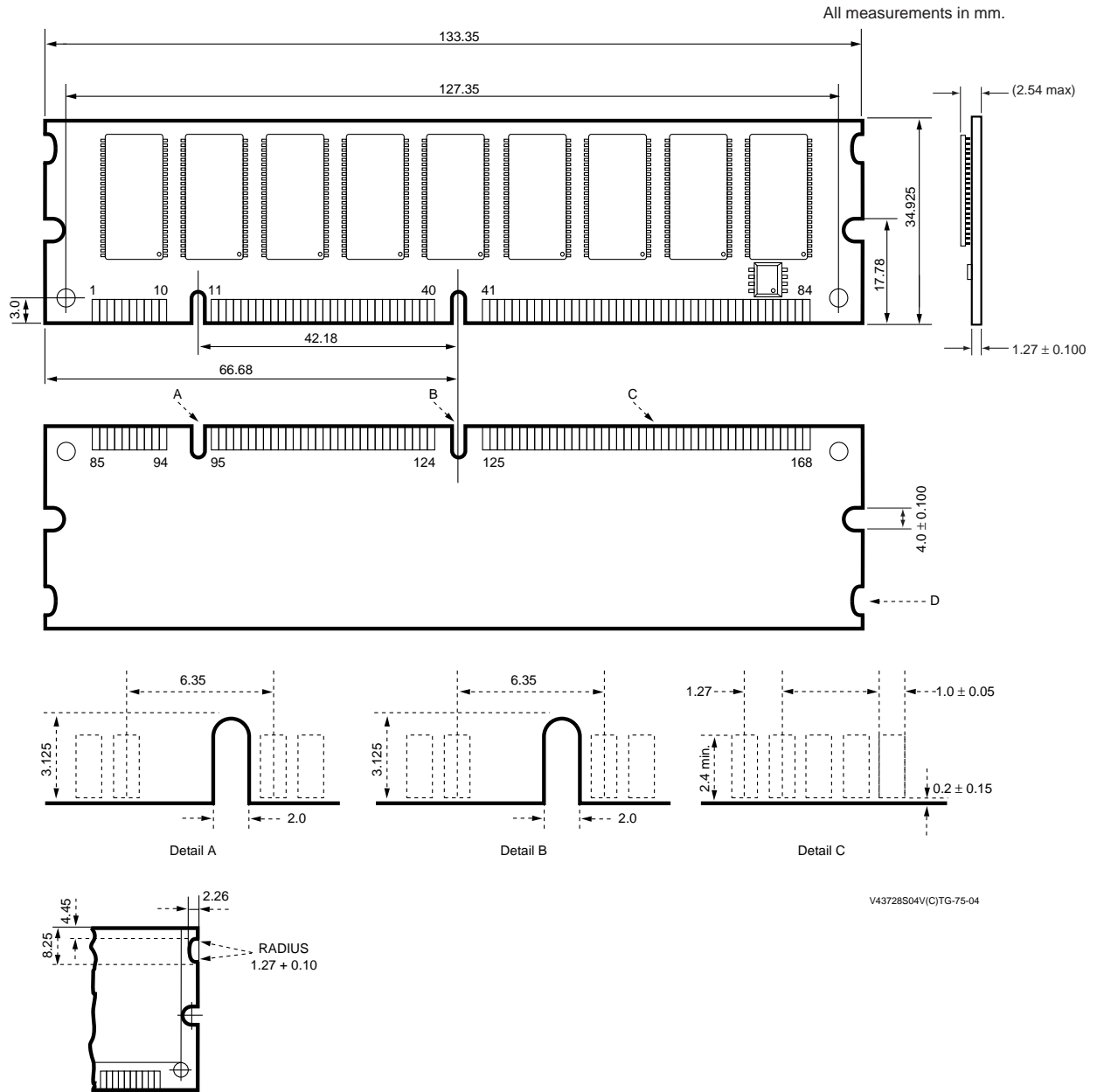
1. The specified values are valid when addresses are changed no more than once during $t_{CK}(\text{min.})$ and when No Operation commands are registered on every rising clock edge during $t_{RC}(\text{min.})$. Values are shown per module bank.
2. The specified values are valid when data inputs (DQ's) are stable during $t_{RC}(\text{min.})$.
3. All AC characteristics are shown for device level.
An initial pause of 100 μs is required after power-up, then a Precharge All Banks command must be given followed by 8 Auto Refresh (CBR) cycles before the Mode Register Set Operation can begin.
4. AC timing tests have $V_{IL} = 0.4\text{V}$ and $V_{IH} = 2.4\text{V}$ with the timing referenced to the 1.4V crossover point. The transition time is measured between V_{IH} and V_{IL} . All AC measurements assume $t_T = 1\text{ ns}$ with the AC output load circuit shown. Specific t_{ac} and t_{oh} parameters are measured with a 50 pF only, without any resistive termination and with a input signal of 1V / ns edge rate between 0.8V and 2.0V.



5. If clock rising time is longer than 1 ns, a time $(t_T/2 - 0.5)$ ns has to be added to this parameter.
6. Rated at 1.5V
7. If t_T is longer than 1 ns, a time $(t_T - 1)$ ns has to be added to this parameter.
8. Any time that the refresh Period has been exceeded, a minimum of two Auto (CBR) Refresh commands must be given to "wake-up" the device.
9. Self Refresh Exit is a synchronous operation and begins on the 2nd positive clock edge after CKE returns high. Self Refresh Exit is not complete until a time period equal to t_{RC} is satisfied once the Self Refresh Exit command is registered.
10. Referenced to the time which the output achieves the open circuit condition, not to output voltage levels.
11. t_{DAL} is equivalent to $t_{DPL} + t_{RP}$.

Package Diagram

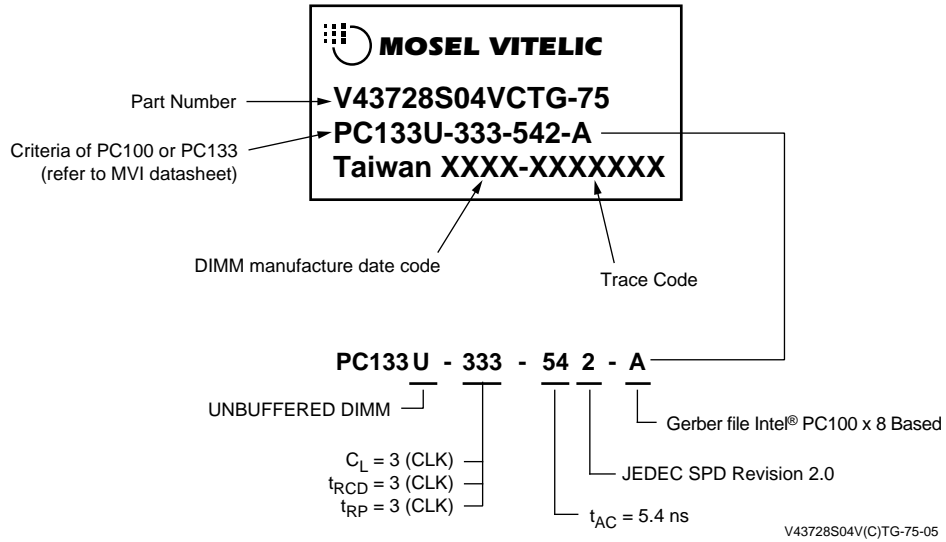
SDRAM DIMM Module Package



V43728S04V(C)TG-75-04

Tolerances: ± (0.13) unless otherwise specified.

Label Information



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