

| Product Specifications | | |
|-------------------------------|--------------------------------|-----------------|
| PART NO.: | VL495T5669E-E7S/E6S/D5S | REV: 1.1 |

General Information

2GB 256Mx72 DDR2 SDRAM VLP ECC REGISTERED Mini-RDIMM 244-PIN

Description

The VL495T5669E is a 256Mx72 DDR2 SDRAM high density Mini-RDIMM. This memory module is dual rank, consists of nine stacked CMOS 256Mx8 bit with 8 banks DDR2 synchronous DRAMs in BGA packages, two 25-bit registered buffers in BGA package, a zero delay PLL clock in BGA package, and a 2K EEPROM in an 8-pin MLF package. This module is a 244-pin mini dual in-line memory module and is intended for mounting into an edge connector socket. Decoupling capacitors are mounted on the printed circuit board for each DDR2 SDRAM.

Features

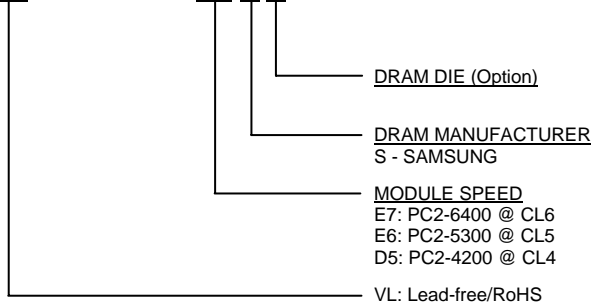
- 244-pin, registered mini dual in-line memory module (Mini-RDIMM)
- JEDEC pin out
- Supports ECC error detection and correction
- Fast data transfer rates: PC2-6400, PC2-5300, PC2-4200
- VDD = VDDQ = 1.8V
- JEDEC standard 1.8V (SSTL_18 compatible)
- VDDSPD = 1.7V to 3.6V
- Differential data strobe (DQS, DQS#) option
- Differential clock inputs (CK, CK#)
- Four-bit pre-fetch architecture
- DLL aligns DQ and DQS transition with CK
- Nominal and dynamic on-die termination (ODT)
- Programmable CAS# latency: 6 (DDR2-800), 5 (DDR2-667), 4 (DDR2-533)
- Write latency = Read latency - 1 tCK
- Eight internal component banks for concurrent operation
- Programmable burst; length (4, 8)
- Adjustable data-output drive strength
- Auto & self refresh, (8K/64ms refresh)
- Serial presence detect (SPD) with EEPROM
- Gold edge contacts
- Lead-free, RoHS compliant
- PCB: Height 18.29mm (0.720"), double sided components

Pin Description

| Pin Name | Function |
|-------------|---------------------------------|
| A0~A13 | Address Inputs |
| A10/AP | Address Input/ Autoprecharge |
| BA0~BA2 | Bank Address Inputs |
| DQ0~DQ63 | Data Input/Output |
| DQS0~DQS8 | Data Strobes |
| DQS0#~DQS8# | Data Strobes Complement |
| CB0~CB7 | Check Bits |
| DM0~DM8 | Data Masks |
| CK0, CK0# | Clock Input |
| ODT0, ODT1 | On-die Termination Control |
| CKE0, CKE1 | Clock Enables |
| CS0#, CS1# | Chip Selects |
| RAS# | Row Address Strobes |
| CAS# | Column Address Strobes |
| WE# | Write Enable |
| VDD | Voltage Supply 1.8V +/- 0.1V |
| VSS | Ground |
| SA0~SA2 | SPD Address |
| SDA | SPD Data Input/Output |
| SCL | SPD Clock Input |
| VDDSPD | SPD Voltage Supply 1.7V to 3.6V |
| VREF | SSTL_18 Reference Voltage |
| NC | No Connect |

Order Information:

VL495T5669E - E7 S X





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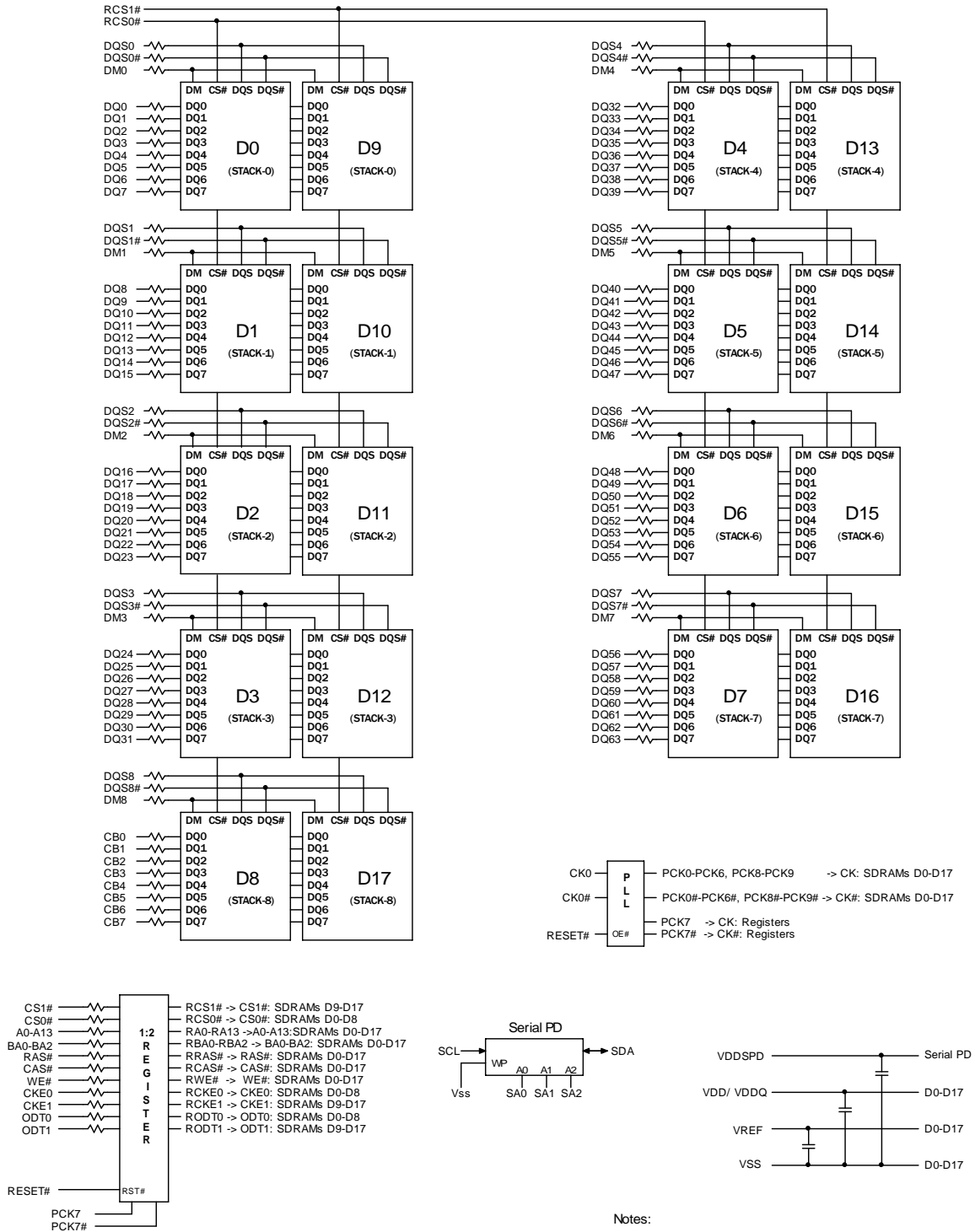
REV: 1.1

Pin Configuration

| 244-PIN DDR2 Mini-RDIMM FRONT SIDE | | | | | | | | 244-PIN DDR2 Mini-RDIMM BACK SIDE | | | | | | | |
|------------------------------------|--------|-----|-------|-----|---------|-----|-------|-----------------------------------|------|-----|-------|-----|------|-----|--------|
| Pin | Name | Pin | Name | Pin | Name | Pin | Name | Pin | Name | Pin | Name | Pin | Name | | |
| 1 | VREF | 32 | VSS | 63 | VDDQ | 93 | VSS | 123 | VSS | 154 | DQ28 | 185 | A3 | 215 | DM5 |
| 2 | VSS | 33 | DQ24 | 64 | A2 | 94 | DQS5# | 124 | DQ4 | 155 | DQ29 | 186 | A1 | 216 | NC |
| 3 | DQ0 | 34 | DQ25 | 65 | VDD | 95 | DQS5 | 125 | DQ5 | 156 | VSS | 187 | VDD | 217 | VSS |
| 4 | DQ1 | 35 | VSS | KEY | | 96 | VSS | 126 | VSS | 157 | DM3 | KEY | | 218 | DQ46 |
| 5 | VSS | 36 | DQS3# | 66 | VSS | 97 | DQ42 | 127 | DM0 | 158 | NC | 188 | CK0 | 219 | DQ47 |
| 6 | DQS0# | 37 | DQS3 | 67 | VSS | 98 | DQ43 | 128 | NC | 159 | VSS | 189 | CK0# | 220 | VSS |
| 7 | DQS0 | 38 | VSS | 68 | NC | 99 | VSS | 129 | VSS | 160 | DQ30 | 190 | VDD | 221 | DQ52 |
| 8 | VSS | 39 | DQ26 | 69 | VDD | 100 | DQ48 | 130 | DQ6 | 161 | DQ31 | 191 | A0 | 222 | DQ53 |
| 9 | DQ2 | 40 | DQ27 | 70 | A10/ AP | 101 | DQ49 | 131 | DQ7 | 162 | VSS | 192 | BA1 | 223 | VSS |
| 10 | DQ3 | 41 | VSS | 71 | BA0 | 102 | VSS | 132 | VSS | 163 | CB4 | 193 | VDD | 224 | NC |
| 11 | VSS | 42 | CB0 | 72 | VDD | 103 | SA2 | 133 | DQ12 | 164 | CB5 | 194 | RAS# | 225 | NC |
| 12 | DQ8 | 43 | CB1 | 73 | WE# | 104 | NC | 134 | DQ13 | 165 | VSS | 195 | VDDQ | 226 | VSS |
| 13 | DQ9 | 44 | VSS | 74 | VDDQ | 105 | VSS | 135 | VSS | 166 | DM8 | 196 | CS0# | 227 | DM6 |
| 14 | VSS | 45 | DQS8# | 75 | CAS# | 106 | DQS6# | 136 | DM1 | 167 | NC | 197 | VDDQ | 228 | NC |
| 15 | DQS1# | 46 | DQS8 | 76 | VDDQ | 107 | DQS6 | 137 | NC | 168 | VSS | 198 | ODT0 | 229 | VSS |
| 16 | DQS1 | 47 | VSS | 77 | CS1# | 108 | VSS | 138 | VSS | 169 | CB6 | 199 | A13 | 230 | DQ54 |
| 17 | VSS | 48 | CB2 | 78 | OTD1 | 109 | DQ50 | 139 | NC | 170 | CB7 | 200 | VDD | 231 | DQ55 |
| 18 | RESET# | 49 | CB3 | 79 | VDDQ | 110 | DQ51 | 140 | NC | 171 | VSS | 201 | NC | 232 | VSS |
| 19 | NC | 50 | VSS | 80 | NC | 111 | VSS | 141 | VSS | 172 | NC | 202 | VSS | 233 | DQ60 |
| 20 | VSS | 51 | NC | 81 | VSS | 112 | DQ56 | 142 | DQ14 | 173 | VDDQ | 203 | DQ36 | 234 | DQ61 |
| 21 | DQ10 | 52 | VDDQ | 82 | DQ32 | 113 | DQ57 | 143 | DQ15 | 174 | CKE1 | 204 | DQ37 | 235 | VSS |
| 22 | DQ11 | 53 | CKE0 | 83 | DQ33 | 114 | VSS | 144 | VSS | 175 | VDD | 205 | VSS | 236 | DM7 |
| 23 | VSS | 54 | VDD | 84 | VSS | 115 | DQS7# | 145 | DQ20 | 176 | A15 * | 206 | DM4 | 237 | NC |
| 24 | DQ16 | 55 | BA2 | 85 | DQS4# | 116 | DQS7 | 146 | DQ21 | 177 | A14 * | 207 | NC | 238 | VSS |
| 25 | DQ17 | 56 | NC | 86 | DQS4 | 117 | VSS | 147 | VSS | 178 | VDDQ | 208 | VSS | 239 | DQ62 |
| 26 | VSS | 57 | VDDQ | 87 | VSS | 118 | DQ58 | 148 | DM2 | 179 | A12 | 209 | DQ38 | 240 | DQ63 |
| 27 | DQS2# | 58 | A11 | 88 | DQ34 | 119 | DQ59 | 149 | NC | 180 | A9 | 210 | DQ39 | 241 | VSS |
| 28 | DQS2 | 59 | A7 | 89 | DQ35 | 120 | VSS | 150 | VSS | 181 | VDD | 211 | VSS | 242 | SDA |
| 29 | VSS | 60 | VDD | 90 | VSS | 121 | SA0 | 151 | DQ22 | 182 | A8 | 212 | DQ44 | 243 | SCL |
| 30 | DQ18 | 61 | A5 | 91 | DQ40 | 122 | SA1 | 152 | DQ23 | 183 | A6 | 213 | DQ45 | 244 | VDDSPD |
| 31 | DQ19 | 62 | A4 | 92 | DQ41 | | | 153 | VSS | 184 | VDDQ | 214 | VSS | | |

*: These pins are not used in this module.
RESET# (Pin 18) is connected to both OE of the PLL and RESET# of the register

Function Block Diagram





| Product Specifications | | |
|-------------------------------|--------------------------------|-----------------|
| PART NO.: | VL495T5669E-E7S/E6S/D5S | REV: 1.1 |

| Absolute Maximum Ratings | | | | | |
|---------------------------------|--|---------------------------------|------------|-------------|----|
| Symbol | Parameter | MIN | MAX | Unit | |
| VDD | Voltage on VDD pin relative to VSS | -1.0 | 2.3 | V | |
| VDDQ | Voltage on VDDQ pin relative to VSS | -0.5 | 2.3 | V | |
| VDDL | Voltage on VDDL pin relative to VSS | -0.5 | 2.3 | V | |
| VIN, VOUT | Voltage on any pin relative to VSS | -0.5 | 2.3 | V | |
| TSTG | Storage temperature | -55 | 100 | °C | |
| IL | Input leakage current; Any input 0V<VIN<VDD; VREF input 0V<VIN<0.95V; Other pins not under test = 0V | Address, BA, RAS#, CAS#, WE# | -5 | 5 | uA |
| | | CS#, CKE, ODT | -5 | 5 | uA |
| | | CK, CK# | -250 | +250 | uA |
| | | DM | -10 | 10 | uA |
| IOZ | Output leakage current; 0V<VOUT<VDDQ; DQs and ODT are disabled | DQ, DQS, DQS# | -10 | 10 | uA |
| IVREF | VREF supply leakage current; VREF = Valid VREF level | | -36 | 36 | uA |

| DC Operating Conditions | | | | | | |
|--------------------------------|-------------------------|-------------|----------------|-------------|-------------|--------------|
| Symbol | Parameter | Min | Typical | Max | Unit | Notes |
| VDD | Supply voltage | 1.7 | 1.8 | 1.9 | V | 1 |
| VDDQ | I/O supply voltage | 1.7 | 1.8 | 1.9 | V | 4 |
| VDDL | VDDL supply voltage | 1.7 | 1.8 | 1.9 | V | 4 |
| VREF | I/O reference voltage | 0.49 x VDDQ | 0.50 x VDDQ | 0.51 x VDDQ | V | 2 |
| VTT | I/O termination voltage | VREF-0.04 | VREF | VREF+0.04 | V | 3 |

Note:

- VDD, VDDQ must track each other. VDDQ must be less than or equal to VDD.
- VREF is expected to equal VDDQ/2 of the transmitting device and to track variations in the DC level of the same. Peak-to-peak noise on VREF may not exceed +/-1percent of the DC value. Peak-to-peak AC noise on VREF may not exceed +/-2 percent of VREF. This measurement is to be taken at the nearest VREF bypass capacitor.
- VTT is not applied directly to the device. VTT is a system supply for signal termination resistors, is expected to be set equal to VREF and must track variations in the DC level of VREF.
- VDDQ tracks with VDD; VDDL tracks with VDD.

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| Operating Temperature Condition | | | | |
|---|-----------------------|--------|-------|-------|
| Symbol | Parameter | Rating | Units | Notes |
| TOPER | Operating temperature | 0 - 95 | °C | 1,2 |
| Notes: | | | | |
| 1. Operating temperature is the case surface temperature on the center/top side of the DRAM. For the measurement conditions, please refer to JEDEC JESD51-2. 2. At 0 – 85°C, operation temperature range, all DRAM specifications will be supported. The refresh rate is required to double when 85°C < TOPER <= 95°C. | | | | |

| Input DC Logic Level | | | | |
|--------------------------------|------------------------------|--------------|--------------|------|
| All voltages referenced to VSS | | | | |
| Symbol | Parameter | Min | Max | Unit |
| VIH(DC) | Input High (Logic 1) Voltage | VREF + 0.125 | VDDQ + 0.300 | V |
| VIL(DC) | Input Low (Logic 0) Voltage | -0.300 | VREF - 0.125 | V |

| Input AC Logic Level | | | | |
|--------------------------------|---|--------------|--------------|------|
| All voltages referenced to VSS | | | | |
| Symbol | Parameter | Min | Max | Unit |
| VIH(AC) | Input High (Logic 1) Voltage DDR2-533 | VREF + 0.250 | - | V |
| VIH(AC) | Input High (Logic 1) Voltage DDR2-800, DDR2-667 | VREF + 0.200 | - | V |
| VIL(AC) | Input Low (Logic 0) Voltage DDR2-533 | - | VREF - 0.250 | V |
| VIL(AC) | Input Low (Logic 0) Voltage DDR2-800, DDR2-667 | - | VREF - 0.200 | V |

| Input/Output Capacitance | | | | | | |
|--|--------|-------------------------|-----|------------------|-----|------|
| TA=25°C, f=100MHz | | | | | | |
| Parameter | Symbol | E7/E6 (DDR2-800/677) | | D5 (DDR2-533) | | Unit |
| | | Min | Max | Min | Max | |
| Input capacitance (A0–A13, BA0–BA2, RAS#, CAS#, WE#) | CIN1 | 6.5 | 7.5 | 6.5 | 7.5 | pF |
| Input capacitance (CKE0, CKE1), (ODT0, ODT1), (CS0#, CS1#) | CIN2 | 6.5 | 7.5 | 6.5 | 7.5 | pF |
| Input capacitance (CK0, CK0#) | CIN3 | 6 | 7 | 6 | 7 | pF |
| Input/Output capacitance (DQ, DQS, DQS#, DM, CB) | CIO | 9 | 11 | 9 | 12 | pF |

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IDD Specification

| Condition | Symbol | E7 (DDR2-800) | E6 ⁽²⁾ (DDR2-667) | D5 ⁽²⁾ (DDR2-533) | Unit |
|--|------------------------------|------------------------------|---------------------------------|---------------------------------|------|
| Operating one bank active-pre-charge; $t_{CK} = t_{CK(IDD)}$; $t_{RC} = t_{RC(IDD)}$; $t_{RAS} = t_{RAS\ MIN(IDD)}$; CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are SWITCHING; Data bus inputs are SWITCHING | IDD0* | 895 | 877 | 877 | mA |
| Operating one bank active-read-pre-charge; IOU = 0mA; BL = 4; CL = CL(IDD); AL = 0; $t_{CK} = t_{CK(IDD)}$; $t_{RC} = t_{RC(IDD)}$; $t_{RAS} = t_{RAS\ MIN(IDD)}$; $t_{RCD} = t_{RCD(IDD)}$; CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are SWITCHING; Data pattern is same as IDD4W. | IDD1* | 949 | 922 | 922 | mA |
| Pre-charge power-down current; All banks idle; $t_{CK} = t_{CK(IDD)}$; CKE is LOW; Other control and address bus inputs are STABLE; Data bus inputs are FLOATING | IDD2P** | 580 | 580 | 580 | mA |
| Pre-charge quiet standby current; All banks idle; $t_{CK} = t_{CK(IDD)}$; CKE is HIGH; Other control and address bus inputs are STABLE; Data bus inputs are FLOATING | IDD2Q** | 760 | 760 | 760 | mA |
| Pre-charge standby current; All banks idle; $t_{CK} = t_{CK(IDD)}$; CKE is HIGH; Other control and address bus inputs are STABLE; Data bus inputs are SWITCHING. | IDD2N** | 850 | 832 | 832 | mA |
| Active power-down current; All banks open; $t_{CK} = t_{CK(IDD)}$; CKE is LOW; Other control and address bus inputs are STABLE; Data bus inputs are FLOATING. | Fast PDN Exit MRS(12) = 0 | 814 | 796 | 796 | mA |
| | | Slow PDN Exit MRS(12) = 1 | 670 | 670 | 670 |
| Active standby current; All banks open; $t_{CK} = t_{CK(IDD)}$; $t_{RP} = t_{RP(IDD)}$; $t_{RAS} = t_{RAS\ MAX(IDD)}$; CKE is HIGH, CS# is HIGH between valid commands; Other control and address bus inputs are SWITCHING; Data bus inputs are SWITCHING. | IDD3N** | 976 | 940 | 940 | mA |
| Operating burst write current; All banks open; Continuous burst writes; BL = 8; CL = CL(IDD); AL = 0; $t_{CK} = t_{CK(IDD)}$; $t_{RAS} = t_{RAS\ MAX(IDD)}$; $t_{RP} = t_{RP(IDD)}$; CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are SWITCHING; Data bus inputs are SWITCHING | IDD4W* | 1093 | 1030 | 1030 | mA |
| Operating burst read current; All banks open; Continuous burst reads; IOU = 0mA; BL = 4; CL = CL(IDD); AL = 0; $t_{CK} = t_{CK(IDD)}$; $t_{RAS} = t_{RAS\ MAX(IDD)}$; $t_{RP} = t_{RP(IDD)}$; CKE is HIGH, CS# is HIGH between valid commands; Address bus inputs are SWITCHING; Data pattern is same as IDD4W. | IDD4R* | 1210 | 1120 | 1120 | mA |
| Burst refresh current; $t_{CK} = t_{CK(IDD)}$; Refresh command at every $t_{RFC(IDD)}$ interval; CKE is HIGH; CS# is HIGH between valid commands; Other control and address bus inputs are SWITCHING; Data bus inputs are SWITCHING. | IDD5** | 2290 | 2200 | 2200 | mA |
| Self refresh current; CK and CK# at 0V; CKE < 0.2V; Other control and address bus inputs are FLOATING; Data bus inputs are FLOATING. | Normal | 180 | 180 | 180 | mA |
| Operating bank interleave read current; All bank interleaving reads; IOU = 0mA; BL = 8; CL = CL(IDD); AL = $t_{RCD(IDD)} - 1 * t_{CK(IDD)}$; $t_{CK} = t_{CK(IDD)}$; $t_{RC} = t_{RC(IDD)}$; $t_{RRD} = t_{RRD(IDD)}$; $t_{RCD} = 1 * t_{CK(IDD)}$; CKE is HIGH; CS# is HIGH between valid commands; Address bus inputs are STABLE during DESELECTs; Data bus inputs are SWITCHING. | IDD7* | 1930 | 1795 | 1795 | mA |

Notes: 1. IDD specification is based on Samsung F-die components.

2. The DRAM's speed DDR2-667 can support speed DDR2-533.

*: Value calculated as one module rank in this operating condition, and all other module ranks in IDD2P (CKE LOW) mode.

**: Value calculated reflects all module ranks in this operating condition.

Product Specifications

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REV: 1.1

AC TIMING PARAMETERS & SPECIFICATIONS

| Parameter | Symbol | E7 (DDR2-800) | | E6 (DDR2-667) | | D5 (DDR2-533) | | Unit | |
|--|--------|------------------|--------------------------------|------------------|--------------------------------|------------------|--------------------------------|---------------|----------|
| | | Min | Max | Min | Min | Max | Min | | |
| Clock Timing | | | | | | | | | |
| Clock Cycle Time | CL6 | $t_{CK(6)}$ | 2500 | 8000 | - | - | - | - | ps |
| | CL5 | $t_{CK(5)}$ | 3000 | 8000 | 3000 | 8000 | - | - | ps |
| | CL4 | $t_{CK(4)}$ | 3750 | 8000 | 3750 | 8000 | 3750 | 8000 | ps |
| CK high-level width | | $t_{CH(avg)}$ | 0.48 | 0.52 | 0.48 | 0.52 | 0.48 | 0.52 | t_{CK} |
| CK low-level width | | $t_{CL(avg)}$ | 0.48 | 0.52 | 0.48 | 0.52 | 0.48 | 0.52 | t_{CK} |
| Half clock period | | t_{HP} | MIN (t_{CH} , t_{CL}) | - | MIN (t_{CH} , t_{CL}) | - | MIN (t_{CH} , t_{CL}) | - | ps |
| Clock jitter | | t_{JIT} | -100 | 100 | -125 | 125 | -125 | 125 | ps |
| Data Timing | | | | | | | | | |
| DQ output access time from CK/CK# | | t_{AC} | -400 | 400 | -450 | +450 | -500 | 500 | ps |
| Data-out high impedance window from CK/CK# | | t_{HZ} | - | $t_{AC(MAX)}$ | - | $t_{AC(MAX)}$ | - | $t_{AC(MAX)}$ | ps |
| Data-out low impedance window from CK/CK# | | t_{LZ} | $t_{AC(MIN)}$ | $t_{AC(MAX)}$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}$ | ps |
| DQ and DM input setup time relative to DQS | | t_{DS} | 50 | - | 100 | - | 100 | - | ps |
| DQ and DM input hold time relative to DQS | | t_{DH} | 125 | - | 175 | - | 225 | - | ps |
| DQ and DM input pulse width (for each input) | | t_{DIPW} | 0.35 | - | 0.35 | - | 0.35 | - | t_{CK} |
| Data hold skew factor | | t_{QHS} | - | 300 | - | 340 | - | 400 | ps |
| DQ-DQS hold, DQS to first DQ to go non-valid, per access | | t_{QH} | $t_{HP} - t_{QHS}$ | - | $t_{HP} - t_{QHS}$ | - | $t_{HP} - t_{QHS}$ | - | ps |
| Data valid output window (DVW) | | t_{DVW} | $t_{QH} - t_{DQSQ}$ | - | $t_{QH} - t_{DQSQ}$ | - | $t_{QH} - t_{DQSQ}$ | - | ns |
| Data Strobe Timing | | | | | | | | | |
| DQS input high pulse width | | t_{DQSH} | 0.35 | - | 0.35 | - | 0.35 | - | t_{CK} |
| DQS input low pulse width | | t_{DQSL} | 0.35 | - | 0.35 | - | 0.35 | - | t_{CK} |
| DQS output access time from CK/CK# | | t_{DQSCK} | -350 | +350 | -400 | +400 | -450 | +450 | ps |
| DQS failing edge to CK rising-setup time | | t_{DSS} | 0.2 | - | 0.2 | - | 0.2 | - | t_{CK} |
| DQS failing edge from CK rising-hold time | | t_{DSH} | 0.2 | - | 0.2 | - | 0.2 | - | t_{CK} |
| DQS-DQ skew, DQS to last DQ valid, per group, per access | | t_{DQSQ} | - | 200 | - | 240 | - | 300 | ps |
| DQS read preamble | | t_{RPRE} | 0.9 | 1.1 | 0.9 | 1.1 | 0.9 | 1.1 | t_{CK} |
| DQS read preamble | | t_{RPST} | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | t_{CK} |
| DQS read preamble setup time | | t_{WPRES} | 0 | - | 0 | - | 0 | - | ps |
| DQS read preamble | | t_{WPRE} | 0.35 | - | 0.35 | - | 0.25 | - | t_{CK} |
| DQS read preamble | | t_{WPST} | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | t_{CK} |
| Write command to first DQS latching transition | | t_{DQSS} | WL-0.25 | WL+0.25 | WL-0.25 | WL+0.25 | WL-0.25 | WL+0.25 | t_{CK} |

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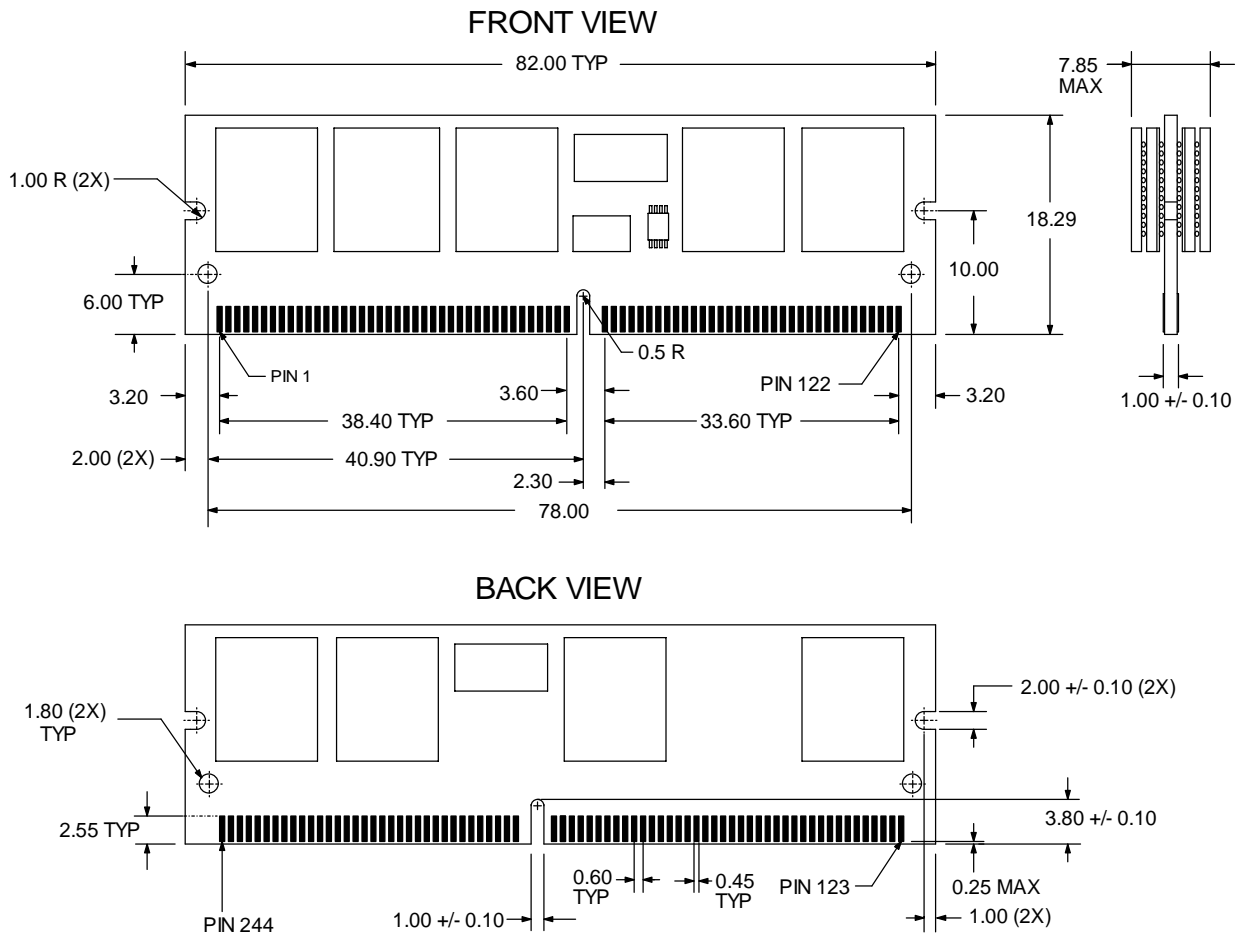
PART NO.:
VL495T5669E-E7S/E6S/D5S
REV: 1.1

AC TIMING PARAMETERS & SPECIFICATIONS

| Parameter | Symbol | E7 (DDR2-800) | | E6 (DDR2-667) | | D5 (DDR2-533) | | Unit |
|--|-------------|------------------------|--|------------------------|--|------------------------|--|----------|
| | | Min | Max | Min | Max | Min | Max | |
| Command and Address Timing | | | | | | | | |
| Address and control input pulse width for each input | t_{IPW} | 0.6 | - | 0.6 | - | 0.6 | - | t_{CK} |
| Address and control input setup time | t_{IS} | 175 | - | 200 | - | 250 | - | ps |
| Address and control input hold time | t_{IH} | 250 | - | 275 | - | 375 | - | ps |
| CAS# to CAS# command delay | t_{CCD} | 2 | - | 2 | - | 2 | - | t_{CK} |
| ACTIVE to ACTIVE (same bank) command | t_{RC} | 60 | - | 60 | - | 60 | - | ns |
| ACTIVE bank a to ACTIVE bank b command | t_{RRD} | 7.5 | - | 7.5 | - | 7.5 | - | ns |
| ACTIVE to READ or WRITE delay | t_{RCD} | 15 | - | 15 | - | 15 | - | ns |
| Four Bank Activate period | t_{FAW} | 37.5 | - | 37.5 | - | 37.5 | - | ns |
| ACTIVE to PRECHARGE command | t_{RAS} | 45 | 70,000 | 45 | 70,000 | 45 | 70,000 | ns |
| Internal READ to precharge Command delay | t_{RTP} | 7.5 | - | 7.5 | - | 7.5 | - | ns |
| Write recovery time | t_{WR} | 15 | - | 15 | - | 15 | - | ns |
| Auto precharge write recovery + precharge time | t_{DAL} | $t_{WR}+t_{RP}$ | - | $t_{WR}+t_{RP}$ | - | $t_{WR}+t_{RP}$ | - | t_{CK} |
| Internal WRITE to READ Command delay | t_{WTR} | 7.5 | - | 7.5 | - | 7.5 | - | ns |
| PRECHARGE command period | t_{RP} | 15 | - | 15 | - | 15 | - | ns |
| PRECHARGE ALL command period | t_{RPA} | $t_{RP}+t_{CK}$ | - | $t_{RP}+t_{CK}$ | - | $t_{RP}+t_{CK}$ | - | ns |
| LOAD MODE command cycle time | t_{MRD} | 2 | - | 2 | - | 2 | - | t_{CK} |
| CKE low to CK, CK# uncertainty | t_{DELAY} | $t_{IS}+t_{CK}+t_{IH}$ | - | $t_{IS}+t_{CK}+t_{IH}$ | - | $t_{IS}+t_{CK}+t_{IH}$ | - | ns |
| Self Refresh | | | | | | | | |
| Refresh to Active or Refresh to Refresh command interval | t_{RFC} | 127.5 | - | 127.5 | - | 127.5 | - | ns |
| Average periodic Refresh interval | t_{REFI} | - | 7.8 | - | 7.8 | - | 7.8 | us |
| Exit Self Refresh to non-READ command | t_{XSNR} | $t_{RFC(MIN)}+10$ | - | $t_{RFC(MIN)}+10$ | - | $t_{RFC(MIN)}+10$ | - | ns |
| Exit Self Refresh to READ | t_{XSRD} | 200 | - | 200 | - | 200 | - | t_{CK} |
| Exit Self Refresh timing reference | t_{ISXR} | t_{IS} | - | t_{IS} | - | t_{IS} | - | ps |
| ODT | | | | | | | | |
| ODT turn-on delay | t_{AOND} | 2 | 2 | 2 | 2 | 2 | 2 | t_{CK} |
| ODT turn-on | t_{AON} | $t_{AC(MIN)}$ | $t_{AC(MAX)}+600$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}+700$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}+1000$ | ps |
| ODT turn-off delay | t_{AOFD} | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | t_{CK} |
| ODT turn-off | t_{AOF} | $t_{AC(MIN)}$ | $t_{AC(MAX)}+600$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}+600$ | $t_{AC(MIN)}$ | $t_{AC(MAX)}+600$ | ps |
| ODT turn-on(power-down mode) | t_{AONPD} | $t_{AC(MIN)}+2000$ | $2 \times t_{CK} + t_{AC(MAX)}+1000$ | $t_{AC(MIN)}+2000$ | $2 \times t_{CK} + t_{AC(MAX)}+1000$ | $t_{AC(MIN)}+2000$ | $2 \times t_{CK} + t_{AC(MAX)}+1000$ | ps |
| ODT turn-off (power-down mode) | t_{AOFPD} | $t_{AC(MIN)}+2000$ | $2.5 \times t_{CK} + t_{AC(MAX)}+1000$ | $t_{AC(MIN)}+2000$ | $2.5 \times t_{CK} + t_{AC(MAX)}+1000$ | $t_{AC(MIN)}+2000$ | $2.5 \times t_{CK} + t_{AC(MAX)}+1000$ | ps |
| ODT to power-down entry latency | t_{ANPD} | 3 | - | 3 | - | 3 | - | t_{CK} |
| ODT power-down exit latency | t_{AXPD} | 8 | - | 8 | - | 8 | - | t_{CK} |
| Power Down | | | | | | | | |
| Exit active power-down to READ command, MR[bit12=0] | t_{XARD} | 2 | - | 2 | - | 2 | - | t_{CK} |
| Exit active power-down to READ command, MR[bit12=1] | t_{XARDS} | 8-AL | - | 7-AL | - | 6-AL | - | t_{CK} |
| Exit precharge power-down to any non-READ command | t_{XP} | 2 | - | 2 | - | 2 | - | t_{CK} |
| CKE minimum high/low time | t_{CKE} | 3 | - | 3 | - | 3 | - | t_{CK} |

| Product Specifications | | |
|------------------------|-------------------------|----------|
| PART NO.: | VL495T5669E-E7S/E6S/D5S | REV: 1.1 |

Package Dimensions



Note: 1. All dimensions are in millimeters with tolerance +/- 0.15mm unless otherwise specified.
 2. The dimensional diagram is for reference only.



| Product Specifications | | |
|-------------------------------|--------------------------------|-----------------|
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Revision History:

| Date | Rev. | Page | Changes |
|------------|------|------|----------------------------|
| 10/28/2010 | 1.0 | All | Spec release |
| 12/22/2010 | 1.1 | 1 | Update General Information |
| | | | |