

## SYNCHRONOUS DRAM

### Features:

- Intel PC-100 (3-3-3) or PC133 (3-3-3) compatible
- Fully synchronous; all signals registered on positive edge of system clock
- Internal pipelined operation; column address can be changed every clock cycle
- Internal banks for hiding row access precharge time
- Programmable burst lengths: 1, 2, or 4 using Interleaved Burst Addressing
- Auto Precharge and Auto Refresh modes
- 64ms, 4,096-cycle refresh quad-row refresh, (15.6μs/row)
- Self Refresh mode<sup>1</sup>
- LVTTTL-compatible inputs and outputs
- Single +3.3V ±0.3V power supply
- The x16 devices are optimized for both single and dual rank DIMM applications. The x8 devices are optimized for single rank DIMM applications.

**Options:**

**Designation:**

**Family:**

SpecTek Memory

SAA

**Configuration:**

|                                   |      |
|-----------------------------------|------|
| 32 Meg x 4 (8 Meg x 4 x 4 banks)  | 32M4 |
| 16 Meg x 8 (4 Meg x 8 x 4 banks)  | 16M8 |
| 8 Meg x 16 (2 Meg x 16 x 4 banks) | 8M16 |

## Design ID

SDRAM 128 Megabit Design  
(Call SpecTek Sales for details on  
availability of "x" placeholders)

$$Y \times 5x$$

**Voltage and Refresh:**

|                                                      |    |
|------------------------------------------------------|----|
| 3.3V, Auto Refresh, 4K refresh                       | L4 |
| 3.3V, Self or Auto Refresh <sup>1</sup> , 4K refresh | M4 |

### Package Types:

|                               |                 |
|-------------------------------|-----------------|
| 54-pin plastic TSOP (400 mil) | TK              |
| 60-ball FBGA (8mm x 16mm)     | FB <sup>2</sup> |
| 60-ball FBGA (11mm x 13mm)    | FC <sup>2</sup> |

### Timing Types:

|               |      |
|---------------|------|
| PC100 (3-3-3) | -8A  |
| PC133 (3-3-3) | -75A |

Part number example: SAA16M8Y95AL4TK-75A  
(For part numbers prior to December 2004, refer to [page 9](#) for decoding.)

### PIN ASSIGNMENT (Top View)

### 54-Pin TSOP

| x4  | x8  | x16  |    |    |      |     | x16 | x8 | x4 |
|-----|-----|------|----|----|------|-----|-----|----|----|
| -   | -   | Vss  | 1  | 54 | Vss  | -   | -   | -  | -  |
| NC  | DQ0 | DQ0  | 2  | 53 | DQ15 | DQ7 | NC  | -  | -  |
| -   | -   | VssQ | 3  | 52 | VssQ | -   | -   | -  | -  |
| NC  | NC  | DQ1  | 4  | 51 | DQ14 | NC  | NC  | -  | -  |
| DQ0 | DQ1 | DQ2  | 5  | 50 | DQ13 | DQ6 | DQ3 | -  | -  |
| -   | -   | VssQ | 6  | 49 | VssQ | -   | -   | -  | -  |
| NC  | NC  | DQ3  | 7  | 48 | DQ12 | NC  | NC  | -  | -  |
| NC  | DQ2 | DQ4  | 8  | 47 | DQ11 | DQ5 | NC  | -  | -  |
| -   | -   | VssQ | 9  | 46 | VssQ | -   | -   | -  | -  |
| NC  | NC  | DQ5  | 10 | 45 | DQ10 | NC  | NC  | -  | -  |
| DQ1 | DQ3 | DQ6  | 11 | 44 | DQ9  | DQ4 | DQ2 | -  | -  |
| -   | -   | VssQ | 12 | 43 | VssQ | -   | -   | -  | -  |
| NC  | NC  | DQ7  | 13 | 42 | DQ8  | NC  | NC  | -  | -  |
| -   | -   | Vss  | 14 | 41 | Vss  | -   | -   | -  | -  |
| NC  | NC  | DQML | 15 | 40 | NC   | -   | -   | -  | -  |
| -   | -   | WE#  | 16 | 39 | DQMH | DQM | DQM | -  | -  |
| -   | -   | CAS# | 17 | 38 | CLK  | -   | -   | -  | -  |
| -   | -   | RAS# | 18 | 37 | CKE  | -   | -   | -  | -  |
| -   | -   | CS#  | 19 | 36 | NC   | -   | -   | -  | -  |
| -   | -   | BA0  | 20 | 35 | A11  | -   | -   | -  | -  |
| -   | -   | BA1  | 21 | 34 | A9   | -   | -   | -  | -  |
| -   | -   | A10  | 22 | 33 | A8   | -   | -   | -  | -  |
| -   | -   | A0   | 23 | 32 | A7   | -   | -   | -  | -  |
| -   | -   | A1   | 24 | 31 | A6   | -   | -   | -  | -  |
| -   | -   | A2   | 25 | 30 | A5   | -   | -   | -  | -  |
| -   | -   | A3   | 26 | 29 | A4   | -   | -   | -  | -  |
| -   | -   | Vss  | 27 | 28 | Vss  | -   | -   | -  | -  |

**Note:** The # symbol indicates signal is active LOW. A dash (-) indicates x8 and x4 pin function is same as x16 pin function.

|                   | 32 Meg x 4          | 16 Meg x 8          | 8 Meg x 16           |
|-------------------|---------------------|---------------------|----------------------|
| Configuration     | 8 Meg x 4 x 4 banks | 4 Meg x 8 x 4 banks | 2 Meg x 16 x 4 banks |
| Refresh Count     | 4K                  | 4K                  | 4K                   |
| Row Addressing    | 4K (A0-A11)         | 4K (A0-A11)         | 4K (A0-A11)          |
| Bank Addressing   | 4 (BA0, BA1)        | 4 (BA0, BA1)        | 4 (BA0, BA1)         |
| Column Addressing | 2K (A0-A9, A11)     | 1K (A0-A9)          | 512 (A0-A8)          |

NOTES: 1. Only when specified. Consult Sales  
2. Not available in xl6 configuration

**General Description:**

The 128Mb SDRAM is a high-speed CMOS, dynamic random-access memory containing 134,217,728 bits. Each is internally configured as a quad-bank DRAM. Read and write accesses to the SDRAM are burst oriented; accesses start at a selected location and continue for a programmed number of locations in a programmed sequence. Accesses begin with the registration of an ACTIVE command, which is then followed by a READ or WRITE command. The address bits registered coincident with the ACTIVE command are used to select the bank and row to be accessed (BA0, BA1 select the bank; A0-A11 select the row). The address bits registered



## 128Mb: x4, x8, x16 SDRAM 3.3V

coincident with the READ or WRITE commands are used to select the starting column location for the burst access.

The SDRAM provides for programmable READ or WRITE burst lengths of 1, 2, or 4 locations with burst terminate option using the Burst Interleaved Addressing mode only. An AUTO PRECHARGE function may be enabled to provide a self-timed row precharge that is initiated at the end of the burst sequence.

The 128Mb SDRAM uses an internal pipelined architecture to achieve high-speed operation. This architecture is compatible with the 2n rule of prefetch architectures, but it also allows the column address to be changed on every clock cycle to achieve a high-speed, fully random access. Precharging one bank while accessing one of the other three banks will hide the precharge cycles and provide seamless high-speed, random-access operation.

The 128Mb SDRAM is designed to operate in 3.3V, low-power memory systems. An auto refresh mode is provided, along with a power-saving power-down mode. All inputs and outputs are LVTTTL-compatible. SDRAMs offer substantial advances in DRAM operating performance, including the abilities to synchronously burst data at a high data rate with automatic column-address generation, to interleave between internal banks in order to hide precharge time, and to randomly change column addresses on each clock cycle during a burst access.

The x8 devices are optimized for single bank DIMM applications. The x16 devices are available for both single and dual bank DIMM applications.

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### ABSOLUTE MAXIMUM RATINGS:

|                                                |                |
|------------------------------------------------|----------------|
| Voltage on Vdd Supply relative to Vss          | -1 to +4.6V    |
| Operating Temperature T <sub>A</sub> (Ambient) | 25° to +70 °C  |
| Storage Temperature                            | -55 to +150 °C |
| Power Dissipation                              | 1 W            |
| Short Circuit Output Current                   | 50 mA          |

Stresses beyond these may cause permanent damage to the device. This is a stress rating only and functional operation of the device at or beyond these conditions is not implied. Exposure to these conditions for extended periods may affect reliability.

### CAPACITANCE:

| Parameter                                              | Symbol          | Min | Max | Units |
|--------------------------------------------------------|-----------------|-----|-----|-------|
| Input Capacitance: A0 - A11, BA0, BA1                  | C <sub>in</sub> | 1   | 5   | pF    |
| Input Capacitance: RAS#, CAS#, WE#, DQM, CLK, CKE, CS# | C <sub>in</sub> | 1   | 5   | pF    |
| Input/Output Capacitance: DQs                          | C <sub>io</sub> | 1   | 6   | pF    |

### DC ELECTRICAL CHARACTERISTICS AND RECOMMENDED OPERATING CONDITIONS:

| Parameter                                                                           | Symbol                            | Min  | Max                 | Units |
|-------------------------------------------------------------------------------------|-----------------------------------|------|---------------------|-------|
| Supply Voltage                                                                      | V <sub>dd</sub> /V <sub>ddq</sub> | 3.0  | 3.6                 | V     |
| Input High (Logic 1) Voltage, All inputs                                            | V <sub>ih</sub>                   | 2.2  | V <sub>dd</sub> + 3 | V     |
| Input Low (Logic 0) Voltage, All inputs                                             | V <sub>il</sub>                   | -0.3 | 0.8                 | V     |
| Input Leakage Current Any input = 0V ≤ VIN ≤ Vdd All other pins not under test = 0V | I <sub>i</sub>                    | -10  | 10                  | μA    |
| Output Leakage Current DQs are disabled; 0V ≤ VOUT ≤ VddQ                           | I <sub>oq</sub>                   | -10  | 10                  | μA    |
| Output High Voltage (I <sub>OUT</sub> = -4 mA)                                      | V <sub>oh</sub>                   | 2.4  |                     | V     |
| Output Low Voltage (I <sub>OUT</sub> = 4 mA)                                        | V <sub>ol</sub>                   |      | 0.4                 | V     |

**ICC OPERATING CONDITIONS AND MAXIMUM LIMITS:** Vdd = 3.3V ± 10%V, Temp. = 25° to 70 °C

| Supply Current                                                                                             |                    | Symbol | -75A | -8A | Units | Notes      |
|------------------------------------------------------------------------------------------------------------|--------------------|--------|------|-----|-------|------------|
| <b>OPERATING CURRENT:</b> ACTIVE mode, burst = 1, READ or WRITE, tRC ≥ tRC (MIN), one bank active, CL=3    |                    | Icc1   | 165  | 140 | mA    | 1, 2, 3, 4 |
| <b>STANDBY CURRENT:</b> POWER-DOWN mode, CKE = LOW, no accesses in progress                                | Standard parts     | Idd2   | 9    | 9   | mA    | 32         |
|                                                                                                            | Self refresh parts | Idd2   | 3    | 3   | mA    | 32         |
| <b>STANDBY CURRENT:</b> CS# = HIGH, CKE = HIGH, all banks idle                                             |                    | Icc3   | 75   | 60  | mA    | 1, 2, 3, 4 |
| <b>STANDBY CURRENT:</b> CS# = HIGH, CKE = HIGH, all banks active after tRCD met, no accesses in progress.  |                    | Icc4   | 75   | 50  | mA    | 1, 2, 3, 4 |
| <b>OPERATING CURRENT:</b> BURST mode after tRCD met, continuous burst, READ, WRITE, all banks active, CL=3 |                    | Icc5   | 165  | 145 | mA    | 1, 2, 3, 4 |
| <b>AUTO REFRESH CURRENT</b> tRC ≥ tRC (MIN) CL = 3                                                         |                    | Icc6   | 265  | 245 | mA    | 1, 2, 3, 4 |
| <b>AUTO REFRESH CURRENT</b> tRC=15.6us CL = 3                                                              |                    | Icc7   | 50   | 50  | mA    | 1, 2, 3, 4 |
| <b>SELF REFRESH CURRENT</b> (Self refresh parts only, part M)                                              |                    | Idd8   | 3    | 3   | mA    |            |

#### Notes

1. All voltages referenced to Vss.
2. An initial pause of 100 μs is required after power-up, followed by two AUTO REFRESH commands, before proper device operation is ensure. (Vdd and VddQ must be powered-up simultaneously Vss and VssQ must be at the same potential.) The two AUTO REFRESH command wake-ups should be repeated any time the 'REF refresh requirement is exceeded.
3. Icc specifications are tested after the device is properly initialized. tCK= 10ns for -8 and tCK=7.5ns for -75A.

**AC ELECTRICAL CHARACTERISTICS:** Vdd = 3.3V ± 10%V, Temp. = 25° to 70°C

| AC CHARACTERISTICS                            |        | -75A | -75A | -8A | -8A |       |       |
|-----------------------------------------------|--------|------|------|-----|-----|-------|-------|
| PARAMETER                                     | SYMBOL | MIN  | MAX  | MIN | MAX | UNITS | NOTES |
| Access time from CLK (positive edge) CL = 3   | tAC    |      | 5.4  |     | 6   | ns    |       |
| Access time from CLK (positive edge) CL = 2   | tAC    |      | N/A  |     |     | ns    |       |
| Address hold time                             | tAH    | 0.8  |      | 1   |     | ns    |       |
| Address setup time                            | tAS    | 1.5  |      | 2   |     | ns    |       |
| CLK high level width                          | tCH    | 2.5  |      | 3   |     | ns    |       |
| CLK low level width                           | tCL    | 2.5  |      | 3   |     | ns    |       |
| Clock cycle time CL = 3                       | tCK    | 7.5  |      | 10  |     | ns    |       |
| Clock cycle time CL = 2                       | tCK    | N/A  |      |     |     | ns    |       |
| CKE hold time                                 | tCKH   | 0.8  |      | 1   |     | ns    |       |
| CKE setup time                                | tCKS   | 1.5  |      | 2   |     | ns    |       |
| CS#, RAS#, CAS#, WE#, DQM hold time           | tCMH   | 0.8  |      | 1   |     | ns    |       |
| CS#, RAS#, CAS#, WE#, DQM setup time          | tCMS   | 1.5  |      | 2   |     | ns    |       |
| Data-in hold time                             | tDH    | 0.8  |      | 1   |     | ns    |       |
| Data-in setup time                            | tDS    | 1.5  |      | 2   |     | ns    |       |
| Data-out high impedance time                  | tHZ    |      | 9    |     | 9   | ns    | 4     |
| Data-out low impedance time                   | tLZ    | 1    |      | 2   |     | ns    |       |
| Data-out hold time                            | tOH    | 2.7  |      | 3   |     | ns    |       |
| ACTIVE to PRECHARGE command period            | tRAS   | 44   | 16K  | 50  | 16K | ns    |       |
| AUTO REFRESH to ACTIVE command period         | tRC    | 60   |      | 80  |     | ns    |       |
| ACTIVE to READ or WRITE delay                 | tRCD   | 22.5 |      | 30  |     | ns    |       |
| Refresh period (4096 cycles)                  | tREF   |      | 64   |     | 64  | ms    |       |
| PRECHARGE command period                      | tRP    | 22.5 |      | 30  |     | ns    |       |
| ACTIVE bank A to bank B command period        | tRRD   | 15   |      | 20  |     | ns    |       |
| Transition time                               | tT     | 0.3  | 2    | 0.3 | 2   | ns    |       |
| Write recovery time                           | tWR    | 20   |      | 20  |     | ns    | 3     |
| Exit SELF REFRESH to ACTIVE command           | tXSR   | 8    |      | 8   |     | tCK   |       |
| READ/WRITE command to READ/WRITE command      | tCCD   | 1    |      | 1   |     | tCK   | 1     |
| CKE to clock disable or power down entry mode | tCKED  | 1    |      | 1   |     | tCK   | 2     |
| CKE to clock enable or power down exit setup  | tPED   | 1    |      | 1   |     | tCK   | 2     |

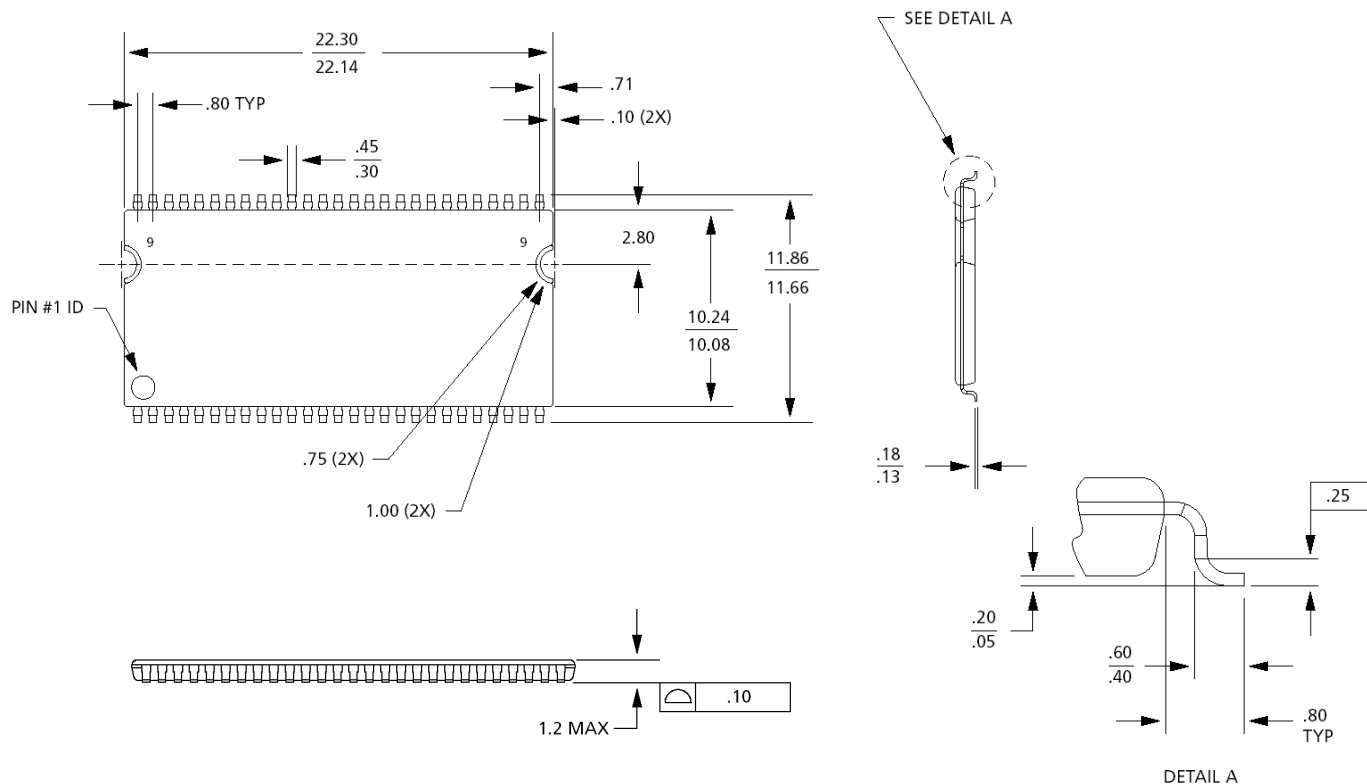
**AC ELECTRICAL CHARACTERISTICS:** Vdd = 3.3V ± 10%V, Temp. = 25° to 70°C

| AC CHARACTERISTICS                            |        | -75A | -75A | -8  | -8  |       |       |
|-----------------------------------------------|--------|------|------|-----|-----|-------|-------|
| PARAMETER                                     | SYMBOL | MIN  | MAX  | MIN | MAX | UNITS | NOTES |
| DQM to input data delay                       | tDQD   | 0    |      | 0   |     | tCK   | 1     |
| WRITE command to input data delay             | tDWD   | 0    |      | 0   |     | tCK   | 1     |
| Data-in to ACTIVATE command w/ Auto precharge | tDAL   | 5    |      | 5   |     | tCK   | 3     |
| Data-in to precharge                          | tDPL   | 2    |      | 2   |     | tCK   | 2, 3  |
| Last data-in to precharge command             | tRDL   | 2    |      | 2   |     | tCK   | 1     |
| LOAD MODE REGISTER command to command         | tMRD   | 2    |      | 2   |     | tCK   | 1     |
| Data-out to high impedance from precharge     | tROH   | 3    |      | 3   |     | tCK   | 1     |

**NOTES:**

1. Clocks required specified by JEDEC functionality and not dependent on any timing parameter.
2. Timing actually specified by tCKS, clock(s) specified as a reference only at a minimum cycle rate.
3. Timing actually specified by tWR plus tRP clock(s) specified as a reference only at a minimum cycle rate.
4. tHZ defines the time at which the output achieves the open circuit condition; it is not a reference to Voh or Vol. The last valid data element will meet tOH before going high-Z.
5. Based on tCK = 10ns for -8 and tCK = 7.5ns for -75a

### 54-PIN PLASTIC TSOP (400 mil) (Package TK)

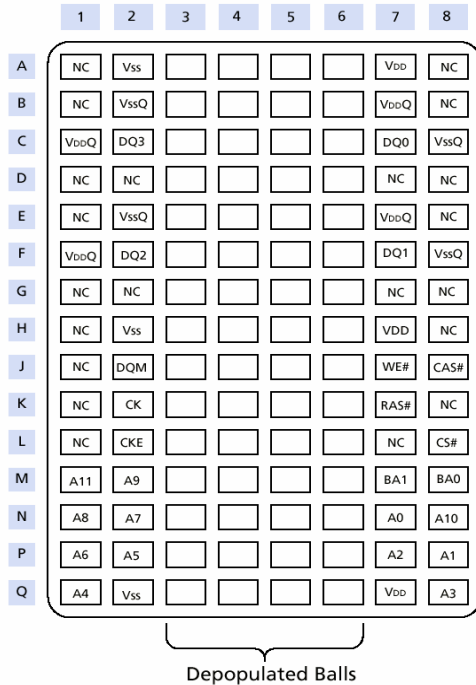


- NOTE:**
1. All dimensions in millimeters MAX/MIN or typical where noted.
  2. Package width and length do not include mold protrusion; allowable mold protrusion is 0.25mm per side.

## FBGA PIN ASSIGNMENT (Top View)

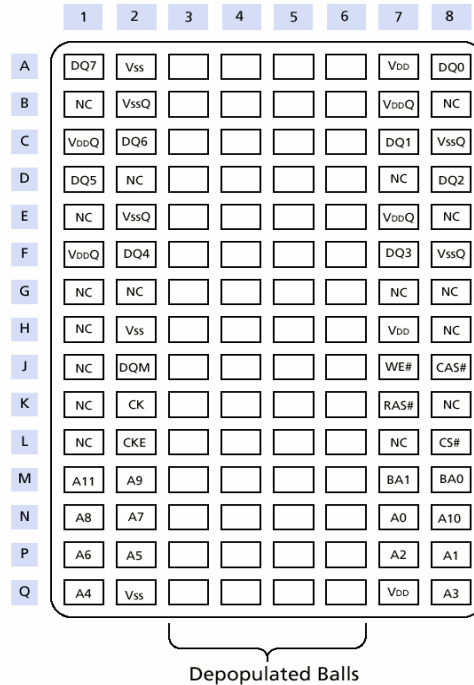
### 32 Meg x 4 SDRAM

11 x 13mm



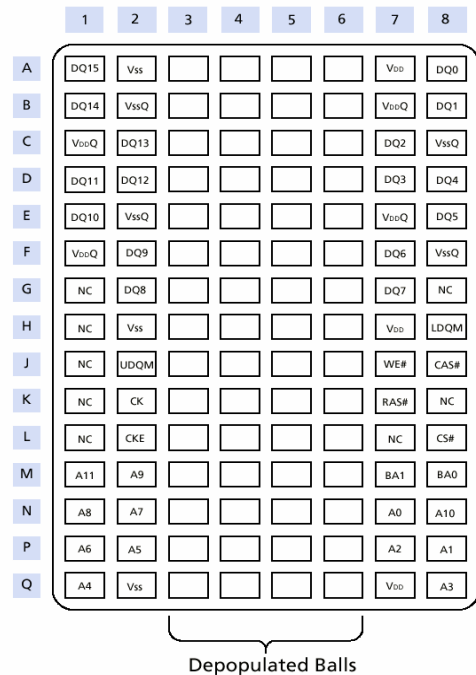
### 16 Meg x 8 SDRAM

11 x 13mm

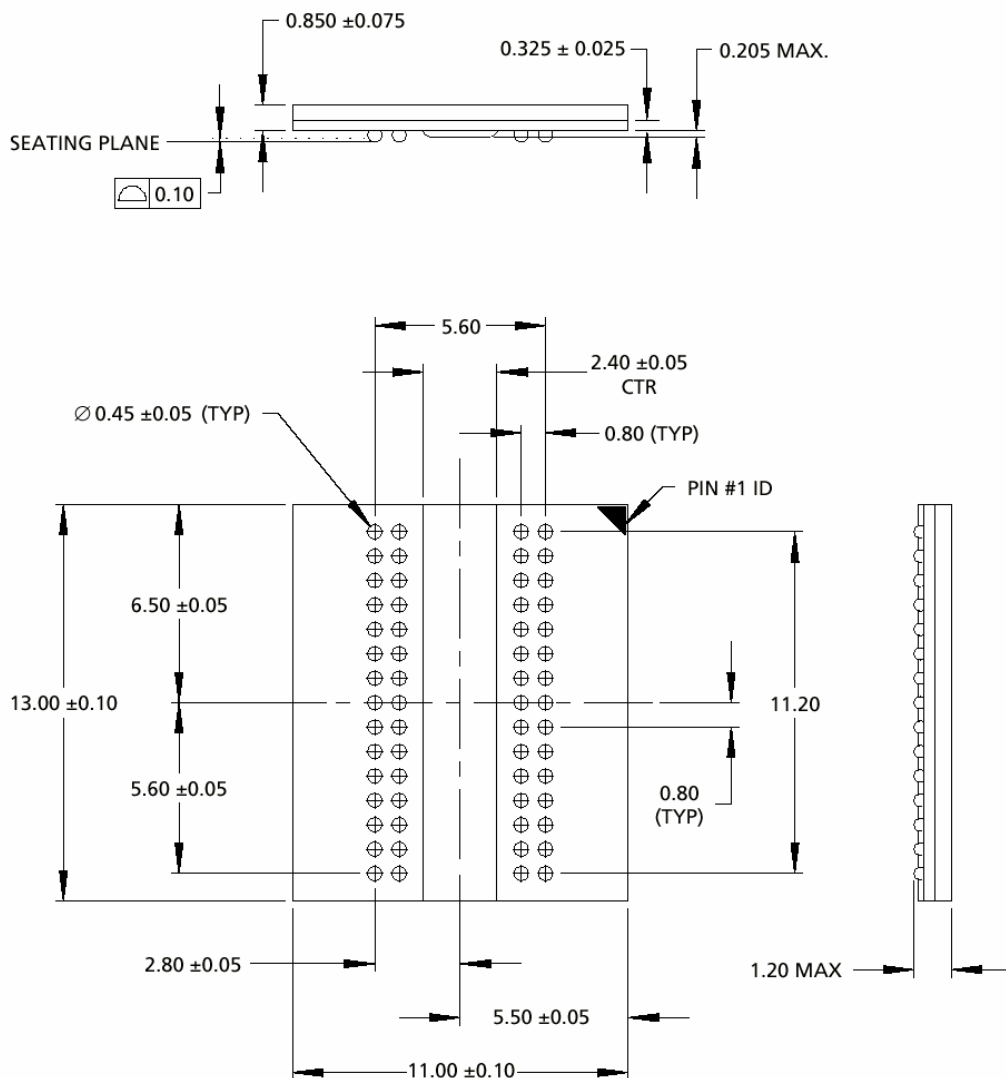


### 8 Meg x 16 SDRAM

11 x 13mm

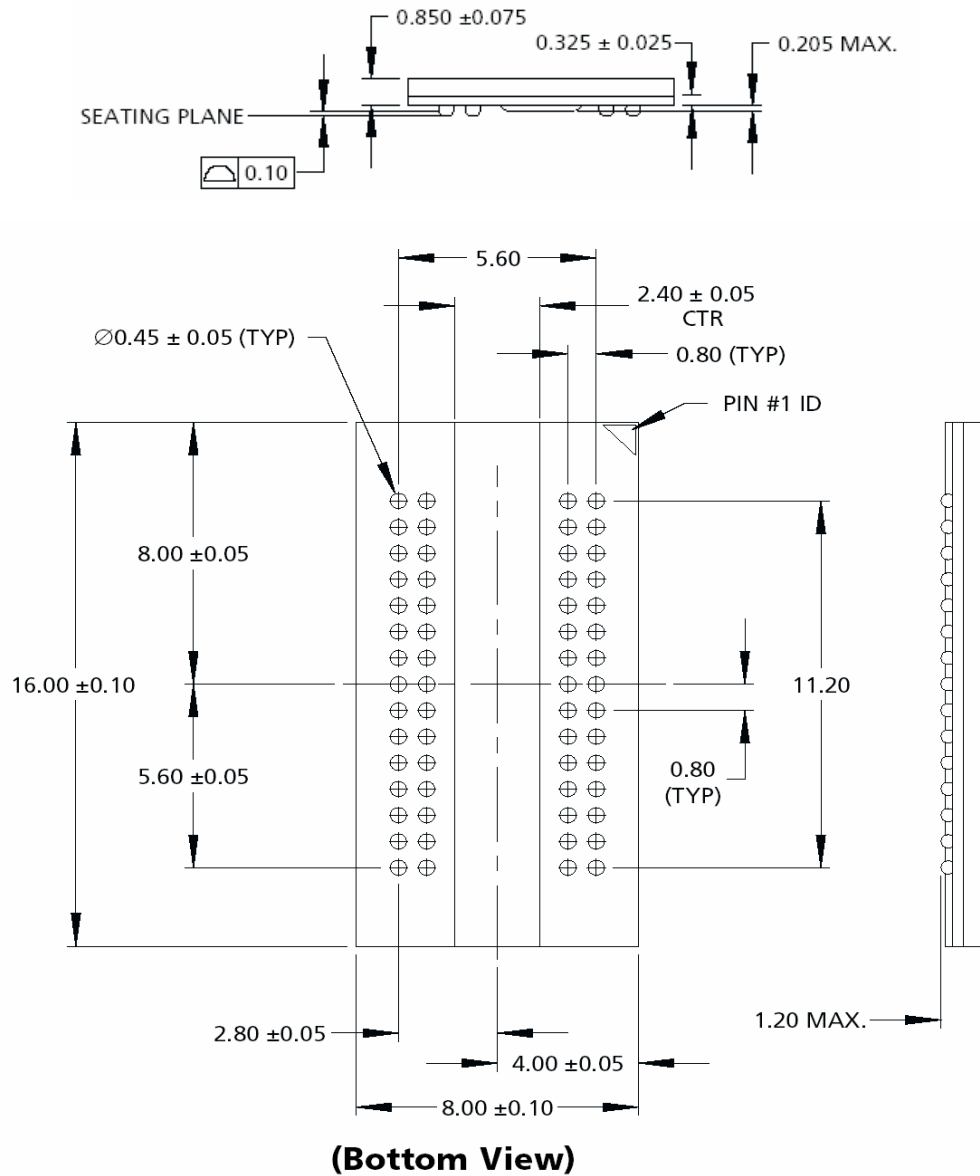


### FBGA "FC" PACKAGE 60-pin, 11mm x 13mm



**(Bottom View)**

- NOTE:** 1. All dimensions in millimeters.  
2. Recommended Pad size for PCB is 0.33mm±0.025mm.

**FBGA “FB” PACKAGE**  
60-pin, 8mm x 16mm


- NOTE:**
1. All dimensions in millimeters.
  2. Recommended Pad size for PCB is 0.33mm±0.025mm.

**PART NUMBERS FOR PRODUCT PRIOR TO DECEMBER 2004****Options:****Marking:****Architecture:**

|                                   |           |
|-----------------------------------|-----------|
| 32 Meg x 4 (8 Meg x 4 x 4 banks)  | S40032LK8 |
| 16 Meg x 8 (4 Meg x 8 x 4 banks)  | S80016LK7 |
| 8 Meg x 16 (2 Meg x 16 x 4 banks) | S16008LK9 |

**Voltage and Refresh:**

|                                         |    |
|-----------------------------------------|----|
| 3.3V, Auto Refresh                      | LK |
| 3.3V, Self or Auto Refresh <sup>1</sup> | MK |

**Device Configuration:**

|            |   |
|------------|---|
| 32 Meg x 4 | 8 |
| 16 Meg x 8 | 7 |
| 8 Meg x 16 | 9 |

**Package Types:**

|                               |                 |
|-------------------------------|-----------------|
| 54-pin plastic TSOP (400 mil) | TW              |
| 60-ball FBGA (8mm x 16mm)     | FB <sup>2</sup> |
| 60-ball FBGA (11mm x 13mm)    | FC <sup>2</sup> |

**Timing Types:**

|               |      |
|---------------|------|
| PC100 (3-3-3) | -8A  |
| PC133 (3-3-3) | -75A |

Part number example: S80016LK7TW-8A

NOTES: 1. Only when specified. Consult Sales  
2. Not available in x16 configuration

[http://www.spectek.com/menus/part\\_guides.asp](http://www.spectek.com/menus/part_guides.asp)

## Данный компонент на территории Российской Федерации

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