

FEATURES:

- Four 512k x 8 SRAM architecture
- RAD-PAK® technology hardens against natural space radiation technology
- Total dose hardness:
 - > 100 krad (Si), depending upon space mission
- Excellent Single Event Effects:
 - SEL > 101MeV-cm²/mg
 - SEU threshold = 3 MeV-cm²/mg
 - SEU saturated cross section: 6E-9 cm²/bit
- Package: 68-pin quad flat package
- Fast access time: 20, 25 and 30 ns
- Completely static memory - no clock or timing strobe required
- Internal bypass capacitor
- High-speed silicon-gate CMOS technology
- 5V or 3V ± 10% power supply
- Equal address and chip enable access times
- Three-state outputs
- All inputs and outputs are TTL compatible

DESCRIPTION:

Maxwell Technologies' 89C1632 high-performance 16 Megabit Multi-Chip Module (MCM) Static Random Access Memory features a greater than 100 krad (Si) total dose tolerance, depending upon space mission. The four 4-Megabit SRAM die and bypass capacitors are incorporated into a high-reliable hermetic quad flat-pack ceramic package. With high-performance silicon-gate CMOS technology, the 89C1632 reduces power consumption and eliminates the need for external clocks or timing strobes. It is equipped with output enable (\overline{OE}) and four byte enable ($\overline{CS1} - \overline{CS4}$) inputs to allow greater system flexibility. When \overline{OE} input is high, the output is forced to high impedance.

Maxwell Technologies' patented RAD-PAK® packaging technology incorporates radiation shielding in the microcircuit package. In a GEO orbit, RAD-PAK provides true greater than 100 krad (Si) total radiation dose tolerance, dependent upon space mission. It eliminates the need for box shielding while providing the required radiation shielding for a lifetime in orbit or a space mission. This product is available with screening up to Maxwell Technologies self-defined Class K.

TABLE 1. PINOUT DESCRIPTION

| PIN | SYMBOL | DESCRIPTION |
|--|-----------------------------------|-------------------|
| 34-28, 42-36, 62-64, 7, 8 | A0-A18 | Address Enable |
| 65 | \overline{WE} | Write Enable |
| 66 | \overline{OE} | Output Enable |
| 3-6 | $\overline{CS1} - \overline{CS4}$ | Chip Enable |
| 43-46, 48-56, 58-61, 9-12, 14-17, 19-22, 24-27 | I/O0-I/O31 | Data Input/Output |
| 2, 67, 68 | NC | No Connection |
| 1, 18, 35, 52 | V _{CC} | +5V Power Supply |
| 13, 23, 47, 57 | V _{SS} | Ground |

TABLE 2. 89C1632 ABSOLUTE MAXIMUM RATINGS
(VOLTAGE REFERENCED TO V_{SS} = 0V)

| PARAMETER | SYMBOL | MIN | MAX | UNITS |
|--|------------------------------------|------|----------------------|-------|
| Power Supply Voltage Relative to V _{SS} | V _{CC} | -0.5 | +7.0 | V |
| Voltage Relative to V _{SS} for Any Pin Except V _{CC} | V _{IN} , V _{OUT} | -0.5 | V _{CC} +0.5 | V |
| Power Dissipation | P _D | -- | 4.0 | W |
| Operating Temperature | T _A | -55 | +125 | °C |
| Storage Temperature | T _S | -65 | +150 | °C |

TABLE 3. 89C1632 RECOMMENDED OPERATING CONDITIONS
(V_{CC} = 5.0 ± 10%, T_A = -55 TO +125 °C, UNLESS OTHERWISE NOTED)

| PARAMETER | SYMBOL | MIN | MAX | UNITS |
|---|-----------------|---------------------|--------------------------------------|-------|
| Supply Voltage, (Operating Voltage Range) | V _{CC} | 4.5 | 5.5 | V |
| Input High Voltage | V _{IH} | 2.2 | V _{CC} + 0.5 ⁽¹⁾ | V |
| Input Low Voltage | V _{IL} | -0.5 ⁽²⁾ | 0.8 | V |

1. V_{IH} (max) = V_{CC} + 2V ac (pulse width ≤ 10ns) for I ≤ 80 mA.

2. V_{IL} (min) = -2.0V ac; (pulse width ≤ 20 ns) for I ≤ 80 mA.

TABLE 4. 89C1632 DELTA LIMITS

| PARAMETER | VARIATION |
|-----------------|---------------------------------|
| I _{CC} | ±10% of stated value in table 5 |

TABLE 4. 89C1632 DELTA LIMITS

| PARAMETER | VARIATION |
|-----------|---------------------------------------|
| I_{SB} | $\pm 10\%$ of stated value in table 5 |
| I_{SB1} | $\pm 10\%$ of stated value in table 5 |
| I_{LI} | $\pm 10\%$ of stated value in table 5 |

TABLE 5. 89C1632 DC ELECTRICAL CHARACTERISTICS
($V_{CC} = 5.0 \pm 10\%$, $T_A = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | SYMBOL | TEST CONDITIONS | SUBGROUPS | MIN | TYP | MAX | UNITS |
|--|-----------|--|--------------------|------|-----|-------------------|-------|
| Input Leakage Current | I_{LI} | $V_{IN} = 0$ to V_{CC} | 1, 2, 3 | -8.0 | -- | +8.0 | uA |
| Output Leakage Current | I_{LO} | $\overline{CS} = V_{IH}$, $V_{OUT} = V_{SS}$ to V_{CC} | 1, 2, 3 | -8.0 | -- | +8.0 | uA |
| Average Operating Current Cycle Time: 20 ns 25 ns 30 ns | I_{CC} | Min. Cycle, 100% Duty, $\overline{CS} = V_{IL}$, $I_{OUT} = 0$ mA $V_{IN} = V_{IH}$ or V_{IL} | 1, 2, 3 | -- | -- | 800 760 720 | mA |
| Standby Power Supply Current | I_{SB} | $\overline{CS} = V_{IH}$, cycle time ≥ 25 ns | 1, 2, 3 | -- | -- | 240 | mA |
| CMOS Standby Power Supply Current | I_{SB1} | $\overline{CS} \geq V_{CC} - 0.2V$, $f = 0$ MHz, $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} < 0.2V$ | 1, 2, 3 | -- | -- | 60 | mA |
| Output Low Voltage | V_{OL} | $I_{OL} = +8.0$ mA | 1, 2, 3 | -- | -- | 0.4 | V |
| Output High Voltage | V_{OH} | $I_{OH} = -4.0$ mA | 1, 2, 3 | 2.4 | -- | -- | V |
| Input Capacitance ¹ $\overline{CS1} - \overline{CS4}$, \overline{OE} , \overline{WE} I/O0-7, I/O8-15, I/O16-23, I/O24-31 | C_{IN} | $V_{IN} = 0$ V | 1, 2, 3 1, 2, 3 | | | 7 28 7 | pF |
| Input / Output Capacitance ¹ | C_{OUT} | $V_{I/O} = 0$ V | 4, 5, 6 | | | 8 | pF |

1. Guaranteed by design.

TABLE 6. 89C1632 AC OPERATING CONDITIONS AND CHARACTERISTICS
($V_{CC} = 5.0 \pm 10\%$, $T_A = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | MIN | TYP | MAX | UNITS |
|---|-----|-----|-----|-------|
| Input Pulse Level | 0.0 | -- | 3.0 | V |
| Output Timing Measurement Reference Level | -- | -- | 1.5 | V |
| Input Rise/Fall Time | -- | -- | 3.0 | ns |

TABLE 6. 89C1632 AC OPERATING CONDITIONS AND CHARACTERISTICS

($V_{CC} = 5.0 \pm 10\%$, $T_A = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | MIN | TYP | MAX | UNITS |
|--|-----|-----|-----|-------|
| Input Timing Measurement Reference Level | -- | -- | 1.5 | V |

TABLE 7. 89C1632 READ CYCLE

($V_{CC} = 5.0 \pm 10\%$, $T_A = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | SYMBOL | SUBGROUPS | MIN | TYP | MAX | UNITS |
|---------------------------------|-----------|-----------|-----|-----|-----|-------|
| Read Cycle Time | t_{RC} | 9, 10, 11 | | | | ns |
| -20 | | | 20 | -- | -- | |
| -25 | | | 25 | -- | -- | |
| -30 | | | 30 | -- | -- | |
| Address Access Time | t_{AA} | 9, 10, 11 | | | | ns |
| -20 | | | -- | -- | 20 | |
| -25 | | | -- | -- | 25 | |
| -30 | | | -- | -- | 30 | |
| Chip Select to Output | t_{CO} | 9, 10, 11 | | | | ns |
| -20 | | | -- | -- | 20 | |
| -25 | | | -- | -- | 25 | |
| -30 | | | -- | -- | 30 | |
| Output Enable to Output | t_{OE} | 9, 10, 11 | | | | ns |
| -20 | | | -- | -- | 10 | |
| -25 | | | -- | -- | 12 | |
| -30 | | | -- | -- | 14 | |
| Output Enable to Low-Z Output | t_{OLZ} | 9, 10, 11 | | | | ns |
| -20 | | | -- | 0 | -- | |
| -25 | | | -- | 0 | -- | |
| -30 | | | -- | 0 | -- | |
| Chip Enable to Low-Z Output | t_{LZ} | 9, 10, 11 | | | | ns |
| -20 | | | -- | 3 | -- | |
| -25 | | | -- | 3 | -- | |
| -30 | | | -- | 3 | -- | |
| Output Disable to High-Z Output | t_{OHZ} | 9, 10, 11 | | | | ns |
| -20 | | | -- | 5 | -- | |
| -25 | | | -- | 6 | -- | |
| -30 | | | -- | 8 | -- | |
| Chip Disable to High-Z Output | t_{HZ} | 9, 10, 11 | | | | ns |
| -20 | | | -- | 5 | -- | |
| -25 | | | -- | 6 | -- | |
| -30 | | | -- | 8 | -- | |
| Output Hold from Address Change | t_{OH} | 9, 10, 11 | | | | ns |
| -20 | | | 3 | -- | -- | |
| -25 | | | 3 | -- | -- | |
| -30 | | | 3 | -- | -- | |

TABLE 8. 89C1632 FUNCTIONAL DESCRIPTION

| $\overline{\text{CS}}$ | $\overline{\text{WE}}$ | $\overline{\text{OE}}$ | MODE | I/O PIN | SUPPLY CURRENT |
|------------------------|------------------------|------------------------|----------------|------------------|---------------------------------|
| H | X ¹ | X ¹ | Not Select | High-Z | $I_{\text{SB}}, I_{\text{SB1}}$ |
| L | H | H | Output Disable | High-Z | I_{CC} |
| L | H | L | Read | D_{OUT} | I_{CC} |
| L | L | X ¹ | Write | D_{IN} | I_{CC} |

1. X = don't care.

TABLE 9. 89C1632 WRITE CYCLE
 ($V_{\text{CC}} = 5.0 \pm 10\%$, $T_{\text{A}} = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | SYMBOL | SUBGROUPS | MIN | TYP | MAX | UNITS |
|--|------------------|-----------|-----|-----|-----|-------|
| Write Cycle Time | t_{WC} | 9, 10, 11 | | | | ns |
| -20 | | | 20 | | -- | |
| -25 | | | 25 | | -- | |
| -30 | | | 30 | | -- | |
| Chip Select to End of Write | t_{CW} | 9, 10, 11 | | | | ns |
| -20 | | | 14 | | -- | |
| -25 | | | 17 | | -- | |
| -30 | | | 20 | | -- | |
| Address Set-up Time | t_{AS} | 9, 10, 11 | | | | ns |
| -20 | | | 0 | | -- | |
| -25 | | | 0 | | -- | |
| -30 | | | 0 | | -- | |
| Address Valid to End of Write | t_{AW} | 9, 10, 11 | | | | ns |
| -20 | | | 14 | | -- | |
| -25 | | | 17 | | -- | |
| -30 | | | 20 | | -- | |
| Write Pulse Width ($\overline{\text{OE}}$ High) | t_{WP} | 9, 10, 11 | | | | ns |
| -20 | | | 14 | | -- | |
| -25 | | | 17 | | -- | |
| -30 | | | 20 | | -- | |
| Write Pulse Width ($\overline{\text{OE}}$ Low) | t_{WP1} | 9, 10, 11 | | | | ns |
| -20 | | | 20 | | -- | |
| -25 | | | 25 | | -- | |
| -30 | | | 30 | | -- | |
| Write Recovery Time | t_{WR} | 9, 10, 11 | | | | ns |
| -20 | | | 0 | | -- | |
| -25 | | | 0 | | -- | |
| -30 | | | 0 | | -- | |

TABLE 9. 89C1632 WRITE CYCLE
 ($V_{CC} = 5.0 \pm 10\%$, $T_A = -55$ TO $+125$ °C, UNLESS OTHERWISE NOTED)

| PARAMETER | SYMBOL | SUBGROUPS | MIN | TYP | MAX | UNITS |
|--|-----------|-----------|----------------|-------------|----------------|-------|
| Write to Output High-Z -20 -25 -30 | t_{WHZ} | 9, 10, 11 | -- -- -- | 5 7 9 | -- -- -- | ns |
| Data to Write Time Overlap -25 -30 | t_{DW} | 9, 10, 11 | 10 12 14 | | -- -- -- | ns |
| Data Hold from Write Time -20 -25 -30 | t_{DH} | 9, 10, 11 | 0 0 0 | | -- -- -- | ns |
| End Write to Output Low-Z -20 -25 -30 | t_{OW} | 9, 10, 11 | -- -- -- | 3 3 3 | -- -- -- | ns |

FIGURE 1. AC TEST LOADS

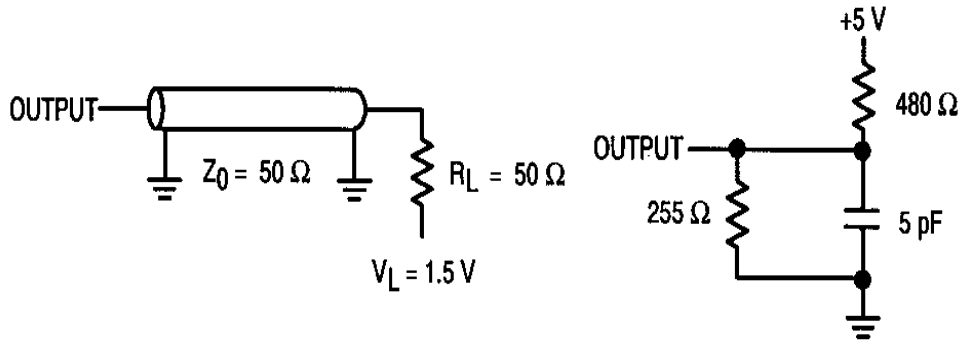


Figure 1A

Figure 1B

FIGURE 2. TIMING WAVEFORM OF READ CYCLE (1) (ADDRESS CONTROLLED)

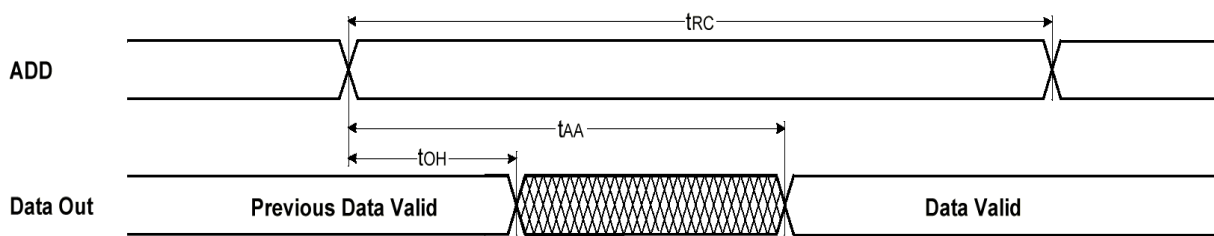
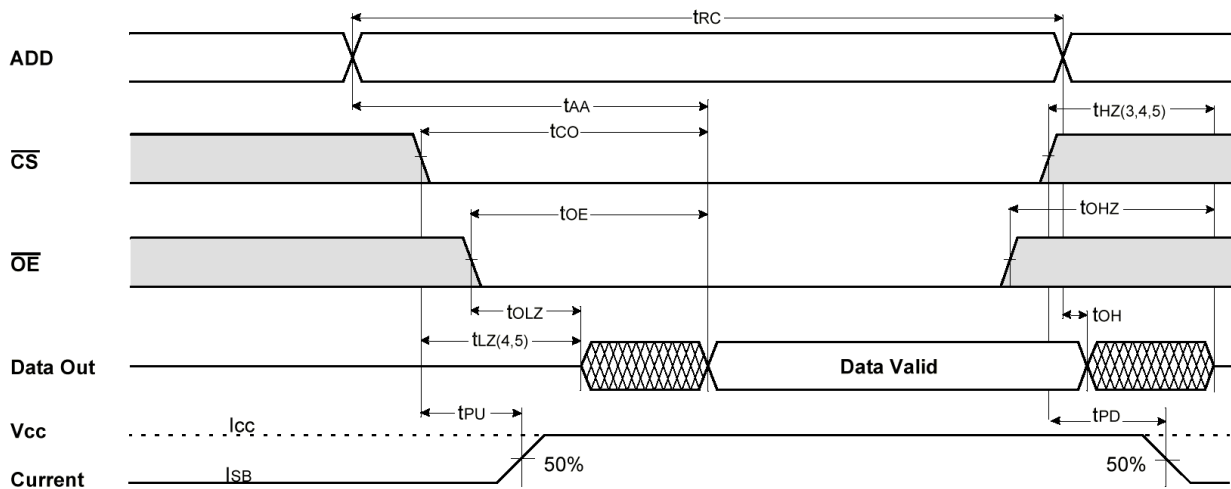


FIGURE 3. TIMING WAVEFORM OF READ CYCLE (2) ($\overline{WE} = V_{IH}$)



1. \overline{WE} is high for read cycle.
2. All read cycle timing is referenced from the last valid address to the first transition address.

3. t_{HZ} and t_{OHZ} are defined as the time at which the outputs achieve the open circuit condition and are not referenced to V_{OH} or V_{OL} levels.
4. At any given temperature and voltage conditions, t_{HZ} (max) is less than t_{LZ} (min) both for a given device and from device to device.
5. Transition is measured $\pm 200mV$ from steady state voltage with Load(B). This parameter is sampled and not 100% tested.
6. Device is continuously selected with $\overline{CS} = V_{IL}$.
7. Address valid prior to coincident with \overline{CS} transition low.
8. For common I/O applications, minimization or elimination of bus contention conditions is necessary during read and write cycle.

FIGURE 4. TIMING WAVEFORM OF WRITE CYCLE ⁽¹⁾ (\overline{OE} CLOCK)

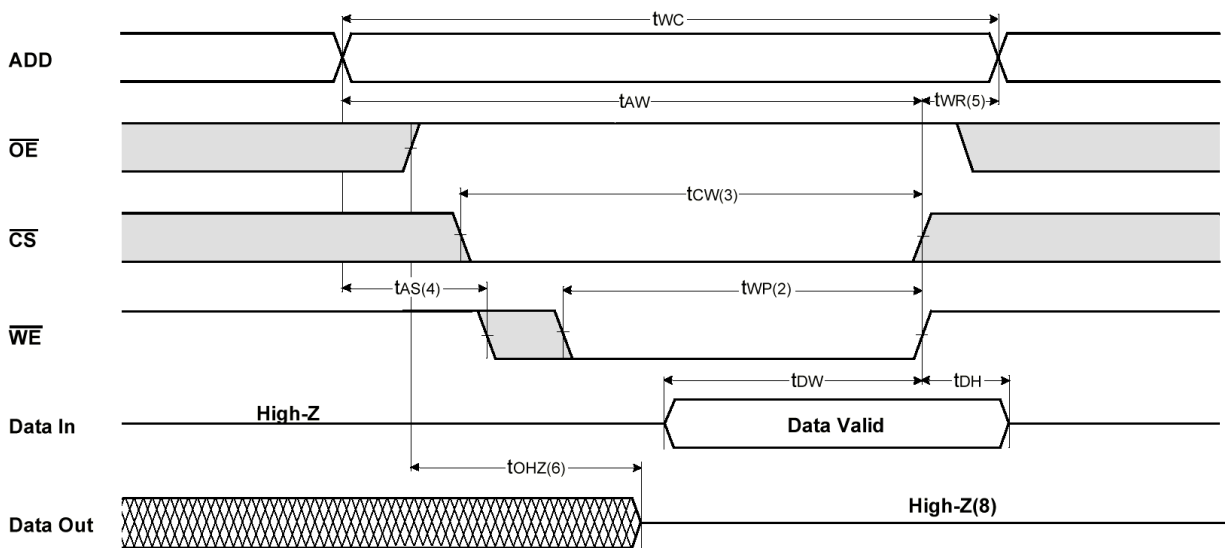


FIGURE 5. TIMING WAVEFORM OF WRITE CYCLE ⁽²⁾ (\overline{OE} LOW FIXED)

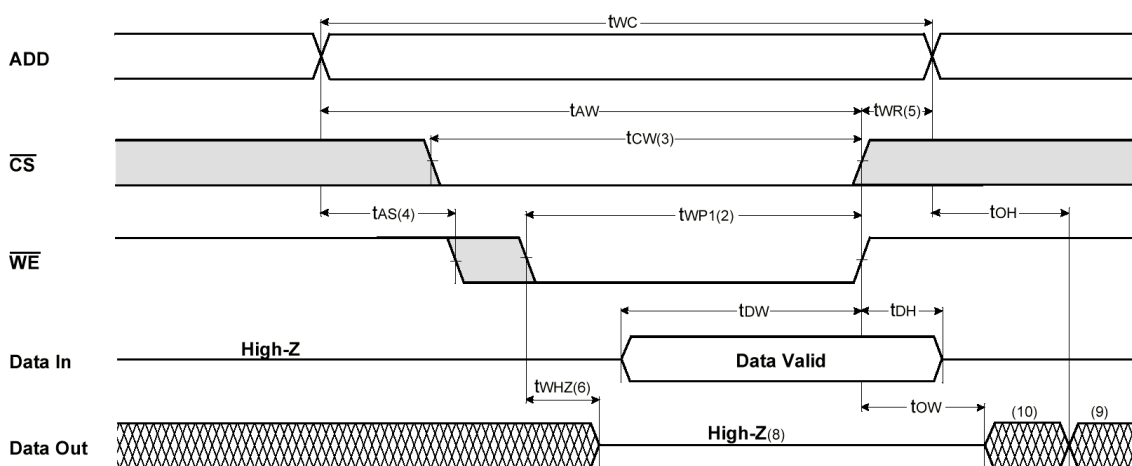
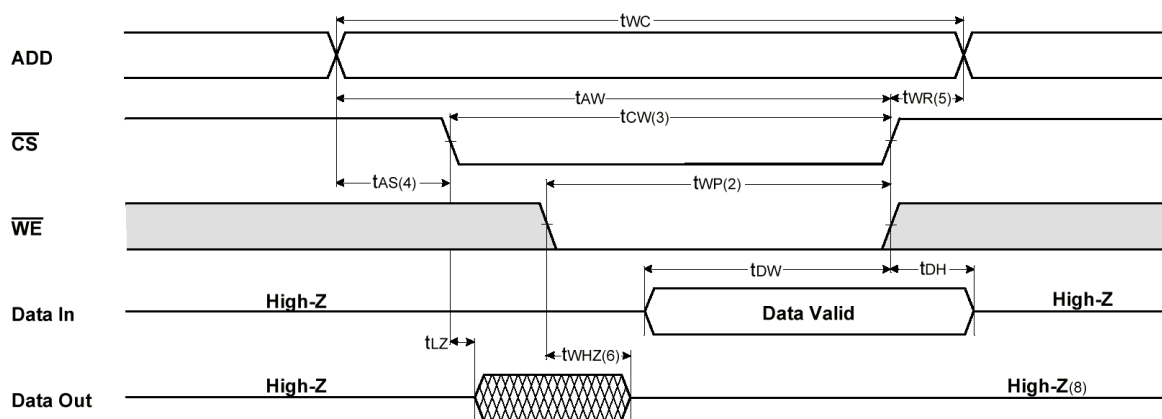


FIGURE 6. TIMING WAVEFORM OF WRITE CYCLE ⁽³⁾ (\overline{CS} CONTROLLED)

1. All write cycle timing is referenced from the last valid address to the first transition address.
2. A write occurs during the overlap of a low \overline{CS} and \overline{WE} . A write begins at the latest transition \overline{CS} going low and \overline{WE} going low. A write ends at the earliest transition \overline{CS} going high or \overline{WE} going high. t_{WP} is measured from the beginning of write to the end of write.
3. t_{CW} is measured from the later of \overline{CS} going low to end of write.
4. t_{AS} is measured from the address valid to the beginning of write.
5. t_{WR} is measured from the end of write to the address change. t_{WR} applied in case a write ends as \overline{CS} or \overline{WE} going high.
6. If \overline{OE} , \overline{CS} and \overline{WE} are in the Read Mode during this period, the I/O pins are in the output low-Z state. Inputs of opposite phase of the output must not be applied because bus contention can occur.
7. For common I/O applications, minimization of elimination of bus contention conditions is necessary during read and write cycle.
8. If \overline{CS} goes low simultaneously with \overline{WE} going or after \overline{WE} going low, the outputs remain high impedance state.
9. D_{OUT} is the read data of the new address.
10. When \overline{CS} is low, I/O pins are in the output state. The input signals in the opposite phase leading to the output should not be applied.

FIGURE 7. SRAM HEAVY ION CROSS SECTION

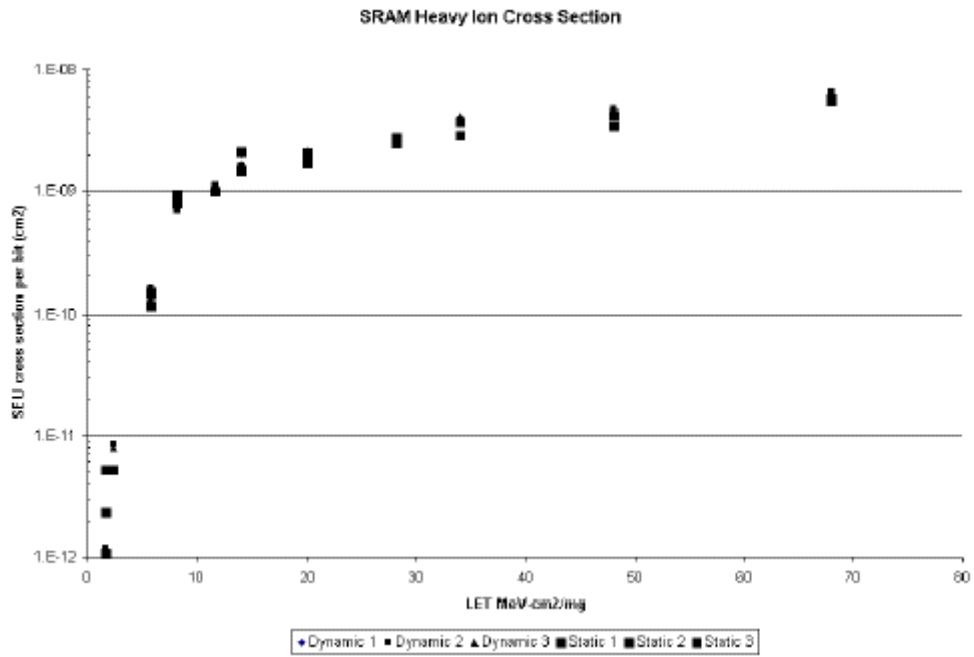
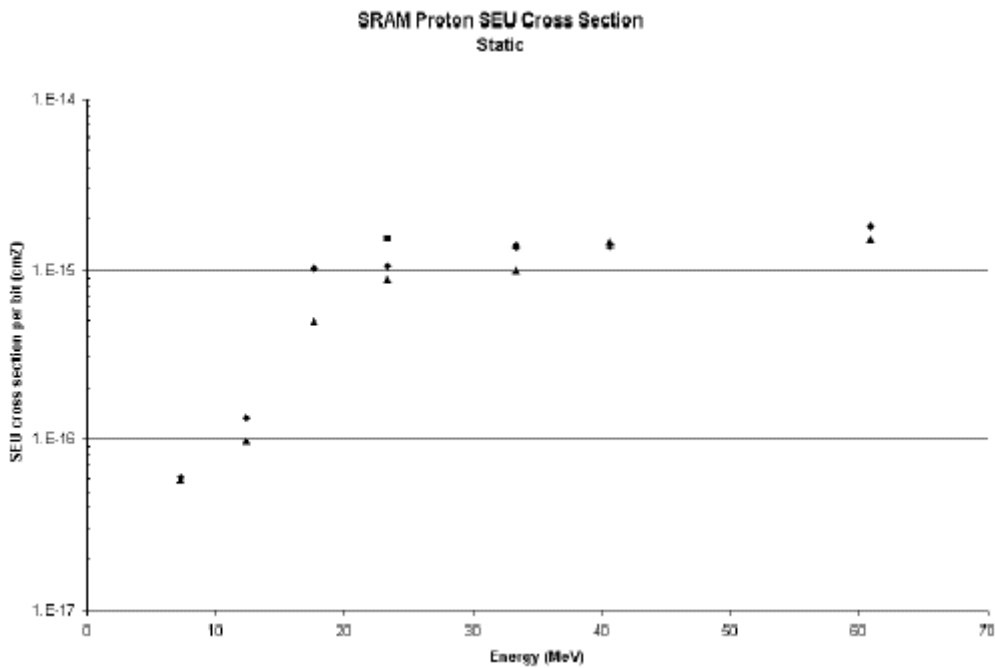
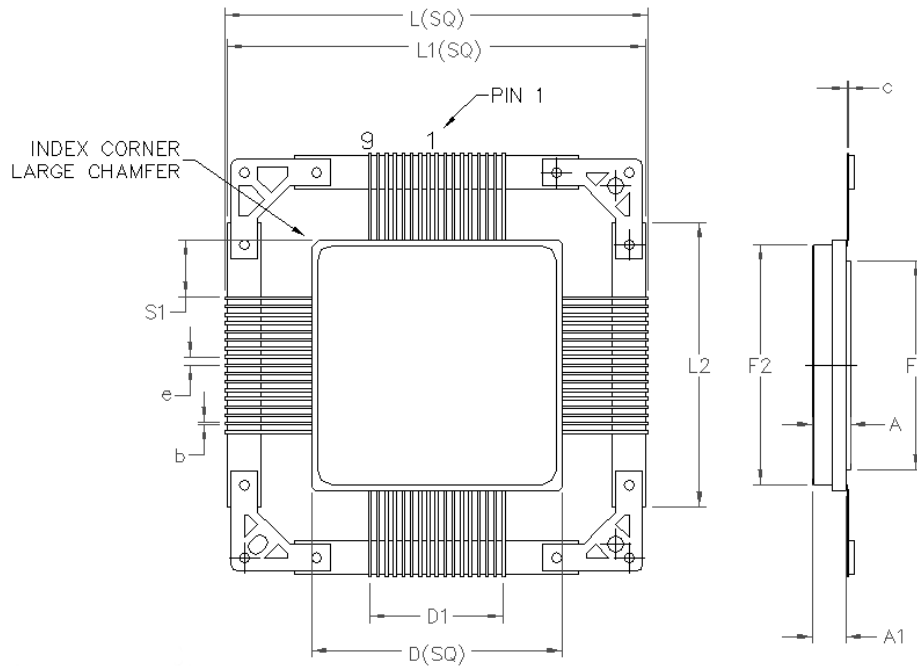


FIGURE 8. SRAM PROTON SEU CROSS SECTION STATIC





68 PIN RAD-PAK® QUAD FLAT PACKAGE

| SYMBOL | DIMENSION | | |
|--------|-----------|-------|-------|
| | MIN | NOM | MAX |
| A | 0.206 | 0.225 | 0.244 |
| b | 0.015 | 0.017 | 0.018 |
| c | 0.008 | 0.009 | 0.12 |
| D | 1.479 | 1.494 | 1.509 |
| D1 | 0.800 | | |
| e | 0.050 BSC | | |
| S1 | -- | 0.339 | -- |
| F1 | 1.239 | 1.244 | 1.249 |
| F2 | 1.429 | 1.434 | 1.439 |
| L | 2.485 | 2.510 | 2.545 |
| L1 | 2.485 | 2.500 | 2.505 |
| L2 | 1.690 | 1.700 | 1.710 |
| A1 | 0.180 | 0.195 | 0.210 |
| N | 68 | | |

Q68-04

Note: All dimensions in inches

Important Notice:

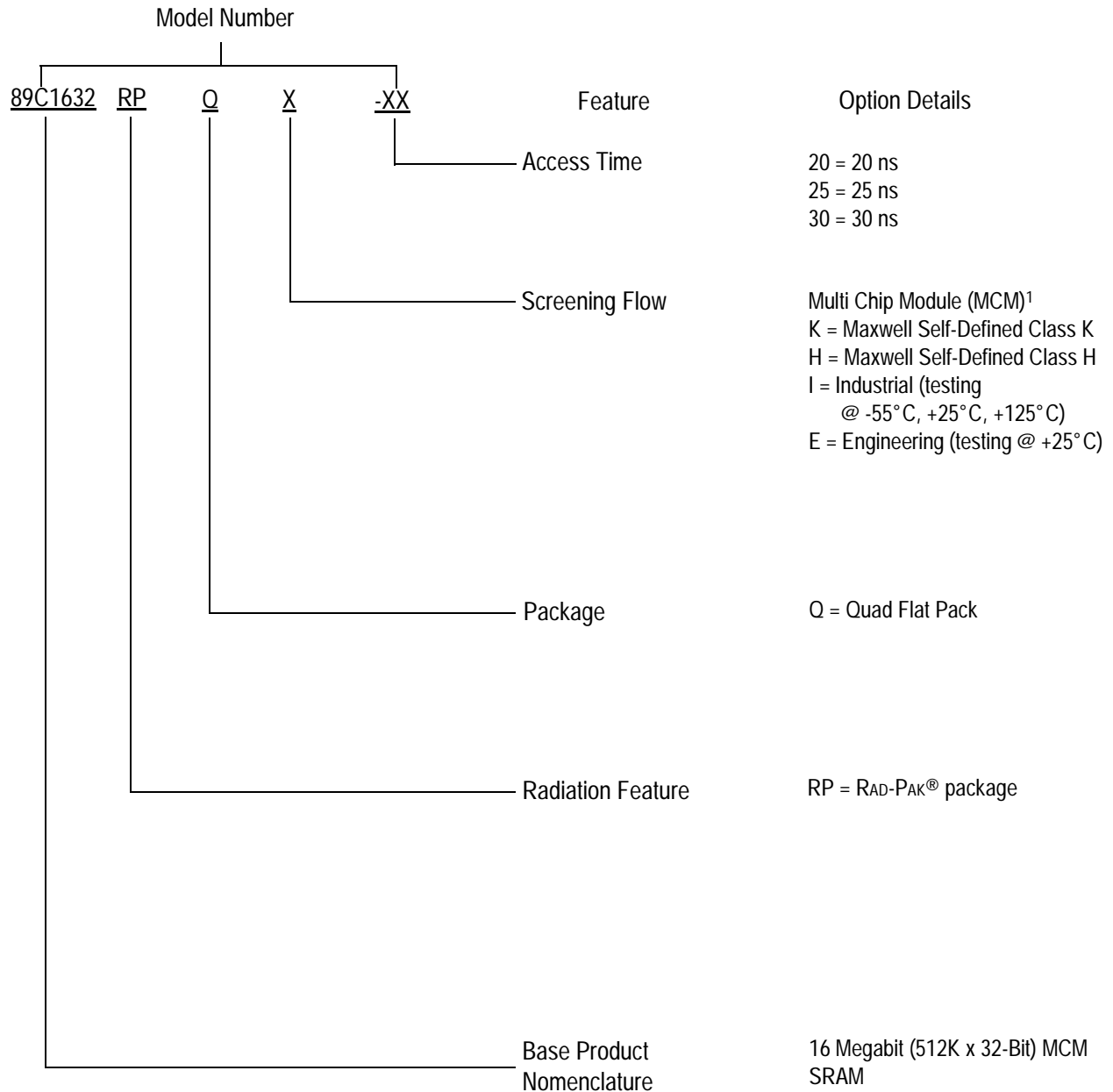
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The specifications presented within these data sheets represent the latest and most accurate information available to date. However, these specifications are subject to change without notice and Maxwell Technologies assumes no responsibility for the use of this information.

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