DATASHEET

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64 Megabit Pipelined SSRAM

UT8SP2M32

Features

- Synchronous SRAM organized as 2Meg words x 32bit
- Continuous Data Transfer (CDT) architecture eliminates wait states between read and write operations
- Supports 40MHz to 133MHz bus operations
- Internally self-timed output buffer control eliminates the need for synchronous output enable
- Registered inputs and outputs for pipelined operation
- Single 2.5V to 3.3V supply
- Clock-to-output time
  - Clk to Q = 7ns
- Clock Enable ($\overline{CEN}$) pin to enable clock and suspend operation
- Synchronous self-timed writes
- Three Chip Enables ($\overline{CS0}$, CS1, $\overline{CS2}$) for simple depth expansion
- "ZZ" Sleep Mode option for partial power-down
- "SHUTDOWN" Mode option for deep power-down
- Four Word Burst Capability--linear or interleaved
- Operational Environment
  - Total Dose: 100 krad(Si)
  - SEL Immune: ≤ 100MeV-cm^2/mg
  - SEU error rate: 1 x 10^{-15} errors/bit-day with internal error correction
- Package options:
  - 288-lead CLGA, CCGA, and CBGA
- Standard Microelectronics Drawing (SMD) 5962-15212
  - QMLQ and Q+

Introduction

The UT8SP2M32 is a high performance 67,108,864-bit synchronous static random access memory (SSRAM) device that is organized as 2M words of 32 bits. This device is equipped with three chip selects ($\overline{CS0}$, CS1, and $\overline{CS2}$), a write enable ($\overline{WE}$), and an output enable ($\overline{OE}$) pin, allowing for significant design flexibility without bus contention. The device supports a four word burst function using (ADV_$\overline{LD}$). The device achieves a very low error rate by employing SECDED (single error correction double error detection) EDAC (error detection and correction) scheme during read/write operations as well as additional autonomous data scrubbing. The data scrubbing is performed in the background and is invisible to the user.

All synchronous inputs are registered on the rising edge of the clock provided the Clock Enable ($\overline{CEN}$) input is enabled LOW. Operations are suspended when $\overline{CEN}$ is disabled HIGH and the previous operation is extended. Write operation control signals are $\overline{WE}$ and FLSH_PIPE. All write operations are performed by internal self-timed circuitry.

For easy bank selection, three synchronous Chip Enables ($\overline{CS0}$, CS1, $\overline{CS2}$) and an asynchronous Output Enable ($\overline{OE}$) provide for output tri-state control. The output drivers are synchronously tri-stated during the data portion of a write sequence to avoid bus contention.

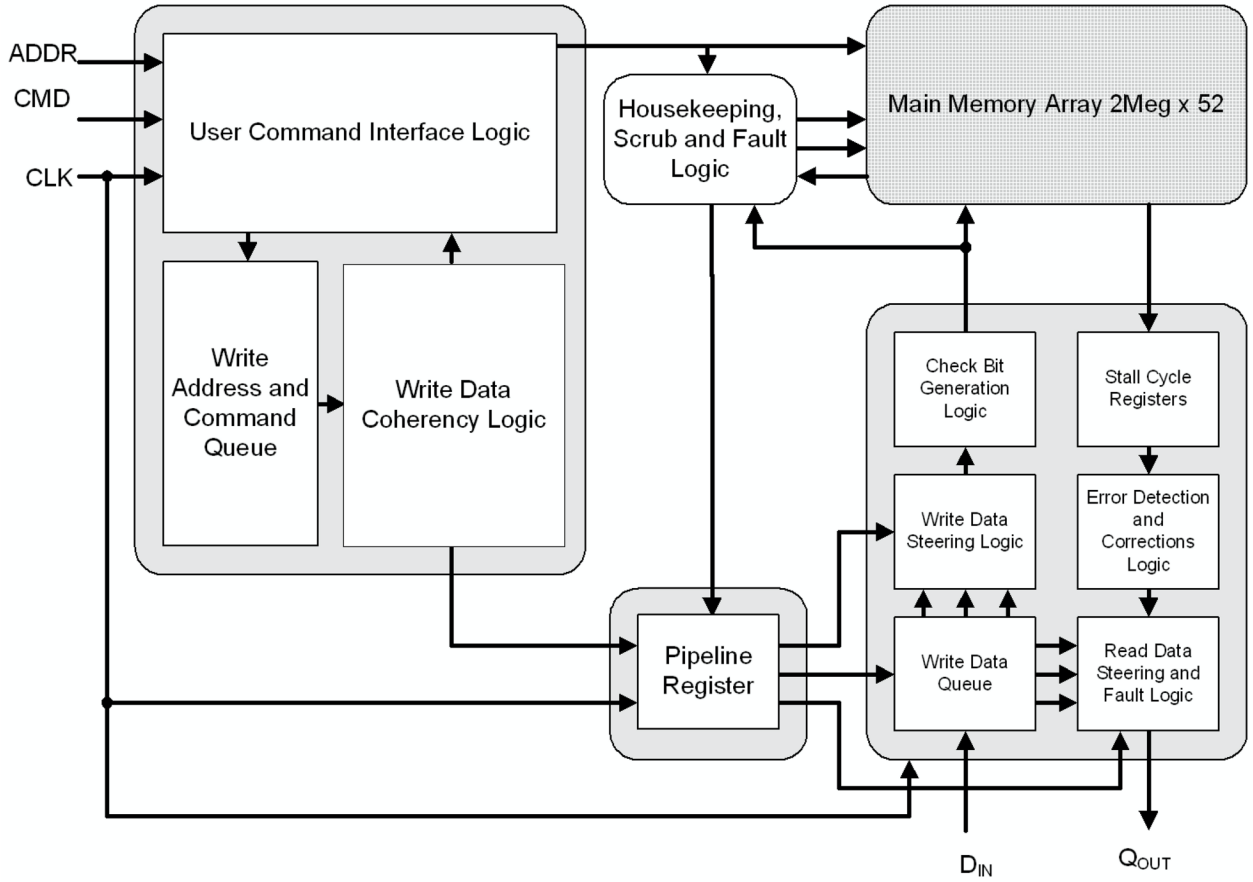

Figure 1. UT8SP2M32 Block Diagram

64 Megabit Pipelined SSRAM

UT8SP2M32

Table 1: Pin Definitions

Name	Description	Type
$\overline{CS0}$	**Chip Enable 0, Input, Active LOW:** Sampled on the rising edge of CLK. Used in conjunction with CS1 and $\overline{CS2}$ to select or deselect the device.	Input-Synchronous
CS1	**Chip Enable 1 Input, Active HIGH:** Sampled on the rising edge of CLK. Used in conjunction with $\overline{CS0}$ and $\overline{CS2}$ to select or deselect the device.	Input-Synchronous
$\overline{CS2}$	**Chip Enable 2 Input, Active LOW:** Sampled on the rising edge of CLK. Used in conjunction with $\overline{CS0}$ and CS1 to select or deselect the device.	Input-Synchronous
A[20:0]	**Address Inputs:** Sampled at the rising edge of the CLK. A[1:0] is fed to the two-bit burst counter.	Input-Synchronous
FLSH_PIPE	**Flush Pipeline Input, Active HIGH:** Qualified with $\overline{WE}$ to conduct dummy writes to flush pipeline. Must be LOW during normal write operation.	Input-Synchronous
$\overline{WE}$	**Write Enable Input, Active LOW:** Sampled on the rising edge of CLK if $\overline{CEN}$ is active LOW. This signal must be enabled LOW to initiate a write sequence.	Input-Synchronous
ADV_$\overline{LD}$	**Advance/Load Input:** Advances the on-chip address counter or loads a new address. When HIGH (and $\overline{CEN}$ is enabled LOW) the internal burst counter is advanced. When LOW, a new address can be loaded into the device for an access. After deselection, drive ADV_$\overline{LD}$ LOW to load a new address.	Input-Synchronous
CLK	**Clock Input:** Used to capture all synchronous inputs to the device. CLK is qualified with $\overline{CEN}$. CLK is only recognized if $\overline{CEN}$ is active LOW.	Input-Clock
$\overline{OE}$	**Output Enable, Asynchronous Input, Active LOW:** Combined with the synchronous logic block inside the device to control the direction of the I/O pins. When LOW, the I/O pins are enabled to behave as outputs. When disabled HIGH, I/O pins are tri-stated, and act as input data pins. $\overline{OE}$ is masked during the data portion of a write sequence, during the first clock when emerging from a deselected state and when the device is deselected.	Input-Asynchronous
$\overline{CEN}$	**Clock Enable Input, Active LOW:** When enabled LOW, the clock signal is recognized by the SSRAM. When deasserted HIGH, the clock signal is masked. Because deserting $\overline{CEN}$ does not deselect the device, $\overline{CEN}$ can be used to extend the previous cycle when required.	Input-Synchronous
DQ[51:0][1]	**Bidirectional Data I/Os:** As inputs, DQ[51:0] feed into an on-chip data register that is triggered by the rising edge of CLK. As outputs, DQ[51:0] delivers the data contained in the memory location specified by the addresses presented during the previous clock rise of the read cycle. The direction of the pins is controlled by $\overline{OE}$. When $\overline{OE}$ is enabled LOW, the pins behave as outputs. When HIGH, DQs are placed in a tri-state condition. The outputs are automatically tri-stated during the data portion of a write sequence, during the first clock when emerging from a deselected state, and when the device is deselected, regardless of the state of $\overline{OE}$. CAES recommends connecting all DQ pins to either VDDQ or VSS through a ≥10kΩ resistor.	I/O-Synchronous
$\overline{RESET}$	**Reset Input, Active Low:** Resets device to known configuration. Reset is required at initial power-up, after exiting shutdown mode, or after any power interruption.	Input-ASynchronous

Table 1: Pin Definitions

Name	Description	Type
ZZ	**ZZ "Sleep" Input, Active HIGH:** When HIGH, places the device in a non-time critical "sleep" condition with data integrity preserved. During normal operation, this pin must be LOW.	Input-Synchronous
SHUTDOWN	**Shutdown Input, Active HIGH**: When HIGH, places device in shutdown mode. System clock can be stopped. Memory contents are not retained.	Input-Asynchronous
READY[2]	**Device Ready Output:** READY outputs a HIGH when device is available for normal operations. READY outputs a LOW when requesting an idle cycle or during power up initialization. The READY output is a pseudo open-drain to support multiple device READY outputs connected to a single controller input with minimal contention. The READY pin drives high for one user clock cycle then tri-states. The READY pin requires an external pull-up connection to V_{DDQ} through a ≥10kΩ±10% resistor to maintain the high logic state.	Output-Synchronous
MBE0 MBE1 MBEC	**Multiple Bit Error Flags:** When LOW data is valid, when HIGH data is corrupt. Users can monitor either MBE0 and MBE1 or MBEC (combined).	Output-Synchronous
MODE[3]	**Mode Input:** Established at power up. Selects the burst order of the device. When tied to V_{SS} selects linear burst sequence. When tied to V_{DDQ} selects interleaved burst sequence.	Input-DC
EDACEN	**EDAC Enable Input:** EDAC is enabled when HIGH. When LOW, allows for simple package pin disable of EDAC. Device pin internally connected through a 75kΩ±10% resistor to V_{DDQ}.	Input-DC
SCRUBEN	**SCRUB Enable Input:** Scrub mode is enabled when HIGH. When LOW, scrub mode is externally disabled. Device pin internally connected through a 75kΩ±10% resistor to V_{DDQ}.	Input-DC
EXTRES[3]	**Input Current Reference:** Provided for external precision current reference resister connection.	Input-DC
FREQSEL	**Operating Frequency Range Selection Input:** Input should be HIGH for CLK input above 80MHz, LOW for CLK input at 80MHz and below. DC input and CLK frequency can only be changed during sleep mode or established at power on.	Input-DC
V_{DD}	Power Supply Inputs to the core of the device.	Power Supply
V_{DDQ}	Power Supply for the I/O circuitry.	I/O Power Supply
V_{SS}	Ground inputs to the core of the device.	Ground
V_{SSQ}	Ground for I/O circuitry	I/O ground
NUIL	**Not used Input Low:** Pins designated as NUIL need to be externally connected by user to V_{SSQ} through a ≥10kΩ±10% resistor.	--
NUIH	**Not used Input High:** Pins designated as NUIH need to be externally connected by user to V_{DDQ} through a ≥10kΩ±10% resistor.	--
NC	**No Connects.** Not internally connected to the die.	---
TDO[4]	**JTAG Circuit Serial Data Output:** Package pin requires a pull-up through ≥10kΩ±10% resistor to V_{DDQ}.	JTAG Serial Output Synchronous

Name	Description	Type
TDI[4]	**JTAG Circuit Serial Data Input:** Device pin internally connected through a 75kΩ±10% resistor to V_{DDQ}.	JTAG Serial Input Synchronous
TMS[4]	**JTAG Controller Test Mode Select:** Device pin internally connected through a 75kΩ±10% resistor to V_{DDQ}.	Test Mode Select Synchronous
TCK[4]	**JTAG Circuit Clock Input:** Package pin requires a pull-up through ≥10kΩ±10% resistor to V_{DDQ}.	JTAG Clock

Note:

1) DQ[51:32] are ignore during write and tri-stated during read activities unless EDACEN is deselected. (See Read Access Error Correction and Detection page 6).
2) Reference application note AN-MEM-004 for additional READY signal information.
3) DC inputs are established at power up and cannot be switched while power is applied to the device.
4) Reference application note AN-MEM-005 for JTAG operations. JTAG operations are intended for terrestrial use and not guaranteed in radiation environment.

Device Operation

The UT8SP2M32 is synchronous-pipelined SSRAM designed specifically to eliminate wait states during Write/Read or Read/Write transitions. All synchronous inputs and outputs are registered on the rising edge of clock. The clock signal is enabled by the Clock Enable input ($\overline{CEN}$). When $\overline{CEN}$ is HIGH, the clock signal is disregarded and all internal states are maintained. All synchronous operations are qualified by $\overline{CEN}$. Once power-up requirements have been satisfied, the input clock may only be stopped during sleep (ZZ is HIGH) or shutdown mode (SHUTDOWN is HIGH). Maximum access delay from the rising edge of clock (t_{CQV}) is 6.7ns (133 MHz device).

Access is initiated by asserting all three Chip Enables ($\overline{CS0}$, CS1, $\overline{CS2}$) active at the rising edge of the clock with Clock Enable ($\overline{CEN}$) and ADV_$\overline{LD}$ asserted LOW. The address presented to the device will be registered. Access can be either a Read or Write operation, depending on the status of the Write Enable ($\overline{WE}$).

Write operations are initiated by the Write Enable ($\overline{WE}$) input. All write commands are controlled by built in synchronous self-timed circuitry.

Three synchronous Chip Enables ($\overline{CS0}$, CS1, $\overline{CS2}$) and an asynchronous Output Enable ($\overline{OE}$) simplify memory depth expansion. All operations (Reads, Writes, and Deselects) are pipelined. ADV_$\overline{LD}$ must be driven LOW once the device has been deselected in order to load a new address and command for the next operation.

Single Read Accesses

A read access is initiated when the following device inputs are present at rising clock edge: $\overline{CEN}$ is enabled LOW, $\overline{CS0}$, CS1, and $\overline{CS2}$ are all enabled, the Write Enable input signal $\overline{WE}$ is disabled HIGH and ADV_$\overline{LD}$ is asserted LOW. The addresses present at the address inputs A[20:0] are registered and presented to the memory. Data propagates to the input of the output register. Data will be available to the bus 7ns after the next rising clock edge provided $\overline{OE}$ is enabled LOW. After the first clock of the read access, the output buffers are controlled by $\overline{OE}$ and the internal control logic. $\overline{OE}$ must be enabled LOW to drive requested data. During the next rising clock, any operation (Read/Write/Deselect) may be initiated. Device deselection is also pipelined. If any of the chip enables are false at rising edge of clock, the device outputs will tri-state after the following rising clock edge.

Burst Read Accesses

The UT8SP2M32 has an internal burst counter allowing up to four reads to be performed from a single address input. A new address can only be loaded when ADV_$\overline{LD}$ is driven LOW. New addresses are loaded into the SSRAM, as described by the Single Read Access section. The burst counter operates in either linear or interleave and is controlled by the MODE input at power up. When MODE pin is LOW, the burst sequence is linear. The burst sequence is interleaved when MODE is HIGH. A0 and A1 are controlled by the burst counter. Burst counter will wrap around when needed. The burst counter increments anytime ADV_$\overline{LD}$ is HIGH and $\overline{CEN}$ is low. The operation selected by the state of $\overline{WE}$ is latched at the beginning of the sequence and maintained throughout.

Read Access Error Detection and Correction

The UT8SP2M32 device features an embedded single error correction double error detection (SECDED) CAES proprietary error correction scheme. Single bit errors are corrected during read accesses. Data corrections, to the core memory, occur during a separate data scrubbing activity. Double bit errors are detected and indicated by MBE0, MBE1 and MBEC. The MBE0 output is the multibit error indictor for the 16 even DQs. The MBE1 output is the multibit error indicator for 16 odd DQs. MBEC is the combined ORed result of MBE0 and MBE1. Either MBEC or MBE0 and MBE1 can be monitored to validate data. If all MBEx signals (MBEC, MBE0, MBE1) remain LOW during a data output cycle, the data is valid. If any of the MBE signal pins go active HIGH during a read activity, the data is invalid and contains an uncorrectable multibit error. CAES recommends that all DQ pins be commonly connected to either V_{DDQ} or V_{SSQ} through pull up/down resistors as DQ[51:0] must not be left floating. The upper 20 I/O pins DQ[51:32] are used for error code data storage, and need to be individually connected to soft pull ups or downs (refer to Table 4 external connections). When the EDAC is enabled via the EDACEN pin, the upper 20 data I/Os are ignored during write operations and tri-stated during read operations. When the EDAC is disabled, the upper 20 data I/Os may be written and read the same as DQ[31:0].

Single Write Accesses

A write access is initiated when the following device inputs are present at rising clock edge: $\overline{CEN}$ is enabled LOW, $\overline{CS0}$, CS1, and $\overline{CS2}$ are all enabled, the Write Enable input signal $\overline{WE}$ is enabled LOW and ADV_$\overline{LD}$ is asserted LOW. The addresses present at the address inputs A[20:0] are registered and presented to the memory core. Data I/Os are tri-stated after the next rising edge of clock regardless of state of $\overline{OE}$. This allows the external logic to present the data on all DQ. The write is completed after the next rising clock edge using data present on DQ lines. During a write operation, data is qualified by the FLSH_ PIPE input. Input data at DQ[51:0] is registered when FLSH_PIPE is LOW in conjunction with an active $\overline{WE}$, but ignored when FLSH_PIPE is HIGH with an active $\overline{WE}$. In either state of FLSH_PIPE, commands are shifted through the register pipeline.

To avoid bus contention data should not be driven to DQs when outputs are active. The Output Enable ($\overline{OE}$) may be disabled HIGH before applying data to the DQ lines. This will tri-state the DQ output drivers. As an additional feature DQ lines are automatically tri-stated during the data portion of a Write cycle, regardless of the state of $\overline{OE}$.

Burst Write Accesses

The UT8SP2M32 has an internal burst counter allowing up to four writes to be performed from a single address input. A new address can only be loaded when ADV_$\overline{LD}$ is driven LOW. New addresses are loaded into the SSRAM, as described in the Single Write Access section. When ADV_$\overline{LD}$ is driven HIGH on the subsequent clock rise, where $\overline{CEN}$ is LOW, the Chip Enables ($\overline{CS0}$, CS1, $\overline{CS2}$) and $\overline{WE}$ inputs are ignored and the burst counter is incremented. The FLSH_PIPE input must be LOW in each cycle of the burst write in order to write the correct data.

READY Status

The UT8SP2M32 device operates as a Synchronous SRAM device. Data integrity housekeeping activities are performed in the background during normal user activity. These housekeeping activities are performed on a regular basis. However, when a housekeeping activity sequence cannot be completed due to user conflict for memory space, the READY pin asserts signifying to the user that an idle cycle is required. Please reference applications note AN-MEM-004 for more information.

Data Scrubbing

The UT8SP2M32 device employs internal autonomous data scrubbing. The scrub circuit cycles through all address spaces typically once every 0.5 seconds. Scrub cycles occur anytime power is applied to the device provided SCRUBEN is HIGH. When the EDAC circuit is disabled via EDACEN input LOW, DQ[51:32] pins are available for read and write accesses. However, if the scrub is not additionally disabled, data written to DQ[51:32] could possibly be changed by the internal data scrubbing activity.

FLSH_PIPE

The write operation consists of three register stages. Writing data to the core memory requires three subsequent write operations. Dummy write operations can be performed using the FLSH_PIPE inputs. Because data coherency is always maintained and the SEU error rate includes the pipeline registers, flushing the pipeline is not necessary.

Sleep Mode

The ZZ input lead is a synchronous input. Asserting the ZZ pin HIGH places the SSRAM into a power conservative "sleep" mode. To assure the completion of previous commands through the pipeline prior to entering sleep mode, a minimum of two full clock cycles (t_{ZZS}) are required between the last operation command and asserting the ZZ input. While in sleep mode, data integrity is guaranteed. Changing the input clock frequency or halting the input clock may be executed during sleep mode. The device must be deselected prior to entering sleep mode and remain deselected for the duration of t_{ZZREC} after the ZZ input returns LOW.

Shutdown Mode

The SHUTDOWN input pin is an asynchronous input. Asserting SHUTDOWN places the device in a power saving shutdown mode. The system clock can be stopped. Memory contents are not maintained in shutdown mode. The SSRAM requires a reset upon exiting shutdown mode.

Table 3. Interleaved Burst Address Table (MODE=V_{SS})

Starting Address	Second Address	Third Address	Fourth Address
A1, A0	**A1, A0**	**A1, A0**	**A1, A0**
00	01	10	11
01	10	11	00
10	11	00	01
11	00	01	10

Table 3. Interleaved Burst Address Table (MODE=V_{DDQ})

Starting Address	Second Address	Third Address	Fourth Address
A1, A0	**A1, A0**	**A1, A0**	**A1, A0**
00	01	10	11
01	00	11	10
10	11	00	01
11	10	01	00

Power Up/ Down Requirements

The SSRAM requires that $V_{DD} \leq V_{DDQ}$ at all times. The SSRAM does require the user to provide an external reset after initial power application, exiting shutdown mode, or any power interruption to the device input voltage outside the specified limit. Performing a reset requires the assertion of the /RESET device input lead (LOW) for a minimum of 1us (t_{RLRH}). After the /RESET input is returned HIGH, the device requires 50us ($t_{SHTDWNREC}$) to complete the reset operation. Once the reset operation is complete, the device requires an additional 20us (t_{CR}) to synchronize the clock input, providing a stable input clock is present. The device READY output lead asserts HIGH once t_{CR} is satisfied at the next rising clock. The READY out lead HIGH indicates the device is available for normal operations. For power down it is required that V_{DD} and V_{DDQ} be powered down to ≤0.5V for a minimum of 100ms.

Clock Conditioning Requirements

The CLK signal input requirements are given in the Clock section of the AC Characterizations. AC Characterization performances listed herein are based on providing a clock input signal meeting these requirements.

Changing Clock Frequencies

In order to optimize the UT8SP2M32 device operation, users are required to establish the FREQSEL pin state to a logic HIGH for CLK input frequencies > 80MHz and a logic LOW for CLK input frequencies of ≤ 80MHz. The CLK input frequency and FREQSEL pin state are established at power on. Both may only be changed while in SLEEP mode (reference Table 5).

External Connections

A precision 25kohm +0.2% /-0.6% low TCR ≤ 25ppm/°C resistor is required to be connected between device pin EXTRES (R15) and V_{SS}.

In order to ensure proper operation in conjunction with JTAG boundary (reference applications note MEM-AN-005) and EDAC bypass capabilities, CAES requires that specific package pins be biased through soft connections to either V_{DD}, V_{DDQ} or V_{SS}. Table 4 below is a list of these required external biases.

Table 4. External Bias Conditions

Signal Name	Package Pin	Bias Condition
NUIL[1]	P13, R7, R8, R12, R16	≥10kΩ to V_{SSQ}
NUIH[2]	P16, R13	≥10kΩ to V_{DDQ}
TDO	R5	≥10kΩ to V_{DDQ}
TCK	R9	≥10kΩ to V_{SSQ}
DQ[51:0][3]	ref Table 6	≥10kΩ to V_{DDQ} or V_{SSQ}
READY	C4	≥10kΩ to V_{DDQ}

Notes:

1) NUIL = Not Used Input Low
2) NUIH = Not Used Input High
3) CAES recommends connecting all DQ[51:0] to either V_{DDQ} or V_{SSQ} through ≥10kΩ resistors.

Table 5: Truth Table for UT8SP2M32 [1,2,3,4,5,6,7]

Operation	Address Used	$\overline{CSx}$*	ZZ	SHUT DOWN	ADV _$\overline{LD}$	$\overline{WE}$	FLSH_ PIPE	$\overline{OE}$	$\overline{CEN}$	CLK	DQs
Standby Mode	None	H	L	L	L	X	X	X	L	L-H	3-State
Continue Deselect	None	X	L	L	H	X	X	X	L	L-H	3-State
Read Cycle (Start Burst)	External	L	L	L	L	H	X	L	L	L-H	Data Out
Read Cycle (Cont. Burst)	Next	X	L	L	H	X	X	L	L	L-H	Data Out
NOP/Dummy Read (Start)	External	L	L	L	L	H	X	H	L	L-H	3-State
NOP/Dummy Read (Cont.)	Next	X	L	L	H	X	X	H	L	L-H	3-State
Write Cycle (Start Burst)	External	L	L	L	L	L	L	X	L	L-H	Data In
Write Cycle (Cont. Burst)	Next	X	L	L	H	X	L	X	L	L-H	Data In
Dummy Write (Start)	None	L	L	L	L	L	H	X	L	L-H	3-State
Dummy Write (Cont. Burst)	Next	X	L	L	H	X	H	X	L	L-H	3-State
Clock Inhibit (Stall)	N/A	X	L	L	X	X	X	X	H	L-H	N/A
Sleep Mode	N/A	H	H	L	X	X	X	X	X	X	3-State
Shutdown Mode	None	X	X	H	X	X	X	X	X	X	3-State

Notes:

* All chip selects active when L, at least one chip selects inactive when H

1) X = "Don't Care", H = Logic HIGH, L = Logic LOW.
2) Write is defined by $\overline{WE}$ and FLSH_PIPE.
3) When a Write cycle is detected, all I/Os are tri-stated.
4) The DQ pins are controlled by the current cycle and the $\overline{OE}$ signal.
5) $\overline{CEN}$ = H inserts wait states.
6) Device will power-up deselected and the I/Os in a tri-state condition, regardless of $\overline{OE}$.
7) $\overline{OE}$ is asynchronous and is not sampled with the clock rise. It is masked internally during Write cycles. During a Read cycle DQs = tri-state when $\overline{OE}$ is inactive or when the device is deselected and DQs= data when $\overline{OE}$ is active.

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Table 6. 288-Lead Pipelined Signal Locations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A			VDDQ	$\overline{CS2}$	$\overline{WE}$	VSS	A10	A8	A4	A18	A19	A14	A15	A2	A0	$\overline{CS0}$	VSS	VSS		
B		VSS	VSS	$\overline{OE}$	VSS	A11	A9	A6	A17	VSS	A20	A16	A13	A12	A1	ZZ	VSS	SHUT DOWN	VSS	
C	VDDQ	VSSQ	VSS	READY[1]	FLSH_ PIPE	VSS	A7	A5	VSS	VDD	VSS	VSSQ	VDD	VDD	A3	ADV_$\overline{LD}$	CS1	VSS	VSSQ	VDD
D	DQ33	DQ35	VDD	VSS	VSS	VDDQ	VSSQ	VDD	VDD	VSS	VDD	VDD	VSSQ	VDDQ	VDD	VSS	VSS	VDD	VDDQ	DQ32
E	DQ37	DQ1	DQ39	VDD	VSSQ	VSS	VSSQ	VDDQ	VSS	VSS	VSS	VSSQ	VDDQ	VSS	VSS	VSSQ	VDD	DQ38	DQ36	DQ34
F	DQ3	DQ5	DQ7	VDDQ	VDDQ	VSSQ	VSS	VSS	VDD	VSS	VDD	VSS	VSS	VDDQ	VSSQ	VDDQ	VDDQ	DQ4	DQ0	DQ2
G	DQ9	DQ11	DQ13	VDD	VSSQ	VDD	VDDQ	VDD	VSS	VDD	VSS	VDD	VDDQ	VSSQ	VDD	VSSQ	VDD	DQ10	DQ6	DQ8
H	MBE1	DQ15	$\overline{CEN}$	VSS	VSS	VDD	VDD	VDD	VSS	VSS	VSS	VDD	VDD	VSS	VSS	VSS	VSS	CLK	DQ12	MBE0
J	DQ19	DQ17	DQ21	VDD	VSSQ	VDD	VSS	VDD	VSS	VDD	VSS	VDD	VSS	VSSQ	VDD	VSSQ	VDD	DQ14	DQ16	DQ18
K	DQ27	DQ25	DQ23	VDDQ	VDDQ	VSSQ	VSS	VDDQ	VDD	VSS	VDD	VDDQ	VSS	VDDQ	VSSQ	VDDQ	VDDQ	DQ20	DQ24	DQ22
L	DQ31	DQ41	DQ29	VDD	VSSQ	VSS	VSSQ	VDDQ	VSS	VSS	VSS	VSSQ	VDDQ	VSS	VSS	VSSQ	VDD	DQ26	DQ30	DQ28
M	DQ45	DQ47	DQ43	VDD	VSS	VSSQ	VDDQ	VSSQ	VDD	VSS	VDD	VDD	VSSQ	VDDQ	VSSQ	VSS	VDD	DQ40	DQ44	DQ42
N	DQ51	DQ49	VSS	VSS	VDD	VDDQ	VSSQ	VDD	VSS	VDD	VSS	VSS	VDD	VSSQ	VSSQ	VDD	VSS	DQ46	DQ48	DQ50
P		VSS	VSS	VDD	SCRUB EN	VSSQ	VSSQ	VSSQ	VSS	VSS	VDDQ	MODE	NUIL[3]	EDACEN	TMS	NUIH[4]	VSSQ	VSS	VSS	
R			VDD	TDI	TDO[1]	VDD	NUIL[3]	NUIL[3]	TCK[2]	MBEC	$\overline{RESET}$	NUIL[3]	NUIH[4]	FREQ SEL	EXTRES	NUIL[3]	VDDQ	VDD		

Notes:

1) Pin requires pull-up to V_{DDQ} of≥10kΩ±10%.
2) Pin requires pull-down to V_{SS} of≥10kΩ±10%.
3) NUIL = Not used Input Low. NUIL pins requires≥10kΩ±10% pull-down to V_{SSQ}.
4) NUIH = Not Used Input High. NUIH pins requires≥10kΩ ±10% pull-up to V_{DDQ}.

Absolute Maximum Ratings[1]

(Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}/V_{DDQ}	Supply Voltage[2]	-0.5 to 4.0	V
V_{IN}	Voltage on any pin[2]	-0.3 to V_{DDQ}+0.3	V
I_{IO}	DC I/O current per pin @ T_J = 135° for 15 years	±10	mA
P_D	Package power dissipation permitted @ T_C = 105°C[3]	15	W
T_J	Maximum junction temperature	+150	°C
Θ_{JC}	Thermal resistance junction to case	3	°C/W
T_{STG}	Storage temperature	-65 to +150	°C

Notes:

1) Permanent device damage may occur if absolute maximum ratings are exceeded. Functional operation should be restricted to recommended operating conditions.
2) All voltages are referenced to V_{SS}.
3) Per MIL-STD-883, Method 1012, Section 3.4.1 $P_D = \frac{(T_J(max) - T_C(max))}{\Theta_{JC}}$

Operational Environments[1]

Parameter	Limit	Units
Total Ionizing Dose (TID)	100K	rad(Si)
Heavy Ion Error Rate [3]	$1x10^{-15}$	Errors/Bit-Day
Single Event Latchup (SEL) immune[2]	≤ 100	MeV-cm²/mg

Notes:

1) Adams 90% worst case environment, Geosynchronous orbit, 100mils of aluminum
2) Temperature = 105°C; V_{DD} and V_{DDQ} = 3.6V
3) Error rate with EDAC and SCRUB enabled.

Recommended Operating Conditions

Symbol	Parameter	Limits
V_{DD}	Core supply voltage	2.3V to V_{DDQ}
V_{DDQ}	I/O power supply voltage	2.3V to 3.6V
T_C	Case temperature range	-55°C to +105°C
V_{IN}	DC input voltage	0V to V_{DDQ}
T_J	Junction Temperature	-55°C to +125°C

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DC Electrical Characteristics (Pre and Post-Radiation)*

(V_{DD}= 2.3V to V_{DDQ}, V_{DDQ} = 2.3 to 3.6V; Unless otherwise noted, Tc is per the temperature range ordered)

Parameter	Description	Condition		MIN	MAX	Unit
V_{DD}	Core Power Supply Voltage			2.3	V_{DDQ}	V
V_{DDQ}	I/O Power Supply Voltage			2.3	3.6	V
V_{OH}	Output HIGH Voltage	For 3.0V I/O, I_{OH}=-4mA		0.8 * V_{DDQ}		V
		For 2.3V I/O, I_{OH}=-1mA		2.0		V
V_{OL}	Output LOW Voltage	For 3.0V I/O, I_{OL}=8mA			0.4	V
		For 2.3V I/O, I_{OL}=1mA			0.4	V
V_{IH}	Input HIGH Voltage	For 3.0V I/O		2.0		V
		For 2.3V I/O		1.7		V
V_{IL}	Input LOW Voltage	For 3.0V I/O			0.8	V
		For 2.3V I/O			0.7	V
I_{IN1}	Input Leakage Current	V_{IN} = V_{DDQ} and V_{SS} Except device pins EDACEN, TDI, TMS, SCRUBEN		-2	2	µA
I_{IN2}	Input Leakage Current	V_{IN} = V_{DDQ} Device pins EDACEN, TDI, TMS, SCRUBEN			2	µA
		V_{IN} = V_{SS} Device pins EDACEN, TDI, TMS, SCRUBEN		-100		µA
I_{OZ}	Three-State Output Leakage Current	V_{DD}, V_{DDQ} = (Max), V_O = V_{DDQ} and V_{SS}, $\overline{OE}$ = V_{DDQ} (Max)		-2	2	µA
I_{OS}[1,2]	Short-Circuit Output Current	V_{DD}, V_{DDQ} = (Max), V_O = V_{DDQ} and V_{SS}		-100	100	mA
I_{DD}[3]	V_{DD} Supply Current in Active Mode	V_{DD}, V_{DDQ} = (Max), I_{OUT} = 0mA, f = f_{max}	105°C		900	mA
			-55°C and 25°C		750	mA
I_{DDQ}[3]	V_{DDQ} Supply Current in Active Mode	V_{DD}, V_{DDQ} = (Max), I_{OUT} = 0mA, f = f_{max}	105°C		100	mA
			-55°C and 25°C		100	mA
I_{SHTDWN}[3]	V_{DD} Supply Current in Shutdown Mode	V_{DD}, V_{DDQ} = (Max), V_{IN} ≥ V_{IH} or V_{IN} ≤ V_{IL}, SHUTDOWN ≥ V_{IH}	105°C		250	mA
			-55°C and 25°C		200	mA
$I_{SHTDWNQ}$[3]	V_{DDQ} Supply Current in Shutdown Mode	V_{DD}, V_{DDQ} = (Max), V_{IN} ≥ V_{IH} or V_{IN} ≤ V_{IL}, SHUTDOWN ≥ V_{IH}	105°C		15	mA
			-55°C and 25°C		15	mA
I_{STBY}[3]	V_{DD} Supply Current in Standby Mode	V_{DD}, V_{DDQ} = (Max) V_{IN} ≥ V_{IH} or V_{IN} ≤ V_{IL}, f = fmax, device deselected	105°C		650	mA
			-55°C and 25°C		500	mA
I_{STBYQ}[3]	V_{DDQ} Supply Current in Standby Mode	V_{DD}, V_{DDQ} = (Max) V_{IN} ≥ V_{IH} or V_{IN} < V_{IL}, f = fmax, device deselected	105°C		100	mA
			-55°C and 25°C		100	mA
I_{ZZ}[3]	V_{DD} Supply Current in Sleep Mode	V_{DD}, V_{DDQ} = (Max), V_{IN}≥V_{IH} or V_{IN} ≤ V_{IL}, ZZ ≥ V_{IH}, SHUTDOWN ≤ V_{IL}	105°C		500	mA
			-55°C and 25°C		350	mA
I_{ZZQ}[3]	V_{DDQ} Supply Current in Sleep Mode	V_{DD}, V_{DDQ} = (Max), V_{IN}≥V_{IH} or V_{IN} ≤ V_{IL}, ZZ ≥V_{IH}, SHUTDOWN ≤ V_{IL}	105°C		85	mA
			-55°C and 25°C		85	mA

DATASHEET

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Capacitance

Symbol	Parameter	MIN	MAX	Unit
C_{IN}[4]	Input Capacitance		15	pF
$C_{I/O}$[4]	I/O Capacitance		15	pF

Notes:

* For devices procured with a total ionizing dose tolerance guarantee, the post-irradiation performance is guaranteed at 25°C per MIL-STD-883 Method 1019, Condition A up to the maximum TID level procured.

1) Supplied as a design limit but not guaranteed nor tested.
2) Not more than one output may be shorted at a time for maximum duration of one second.
3) Post-irradiation limits are the 105°C limits when specified.
4) Measured only for initial qualification and after process or design changes that could affect this parameter.

AC Characteristics (Pre and Post-Radiation)*

(V_{DD}= 2.3V to V_{DDQ}, V_{DDQ} = 2.3 to 3.6V; Unless otherwise noted, Tc is per the temperature range ordered.)[1]

Parameter	Description	MIN	MAX	Unit
$t_{Powerup}$[2]	V_{DD} to first valid command (READ or WRITE)	100		ms
Clock				
t_{CYC}	Clock (CLK) cycle time	7.5	25.0	ns
t_{CH}	CLK HIGH time	0.4 * t_{CYC}	0.6 * t_{CYC}	ns
t_{CL}	CLK LOW time	0.4 * t_{CYC}	0.6 * t_{CYC}	ns
t_r, t_f[2]	Input clock rise/fall time (10-90%)	2.25		V/ns
t_{clkPJ}[3, 5]	Input clock period jitter	-100	100	ps
t_{clkCCJ}[3, 5]	Input clock cycle to cycle jitter		150	ps
Setup Times				
t_{AS}	Address setup time prior to CLK	2.5		ns
t_{DS}	Data setup time prior to CLK	1.5		ns
t_{CENS}	Clock enable ($\overline{CEN}$) setup time prior to CLK	3		ns
t_{WES}	Write enable ($\overline{WE}$) setup time prior to CLK	3		ns
t_{ADVLDS}	Advance load (ADV_$\overline{LD}$) setup time prior to CLK	2.5		ns
t_{CSS}	Chip select (CSx) setup time prior to CLK	3		ns
Hold Times				
t_{AH}	Address hold time after CLK	1.2		ns
t_{DH}	Data hold time after CLK	1.4		ns
t_{CENH}	$\overline{CEN}$ hold time after CLK	1.2		ns
t_{WEH}	$\overline{WE}$ hold time after CLK	1.5		ns
t_{ADVLDH}	ADV_$\overline{LD}$ hold time after CLK	0.9		ns
t_{CSH}	CSx hold time after CLK	1.8		ns
Output Times				
t_{CQV}[4]	Data valid after rising CLK		7	ns
t_{OEQV}[4]	Output enable ($\overline{OE}$) active to data valid		4.0	ns
t_{CQOH}	Data output hold time after rising CLK	2.0		ns
t_{CQZ}[5]	Rising CLK to output three-state time		5.0	ns
t_{CQX}[5]	Rising CLK to output enable time	1.3		ns
t_{OEQZ}[5]	$\overline{OE}$ inactive to output three-state time		4.5	ns
t_{OEQX}[5]	$\overline{OE}$ active to output enable time	0		ns
t_{CMV1}[4]	MBE0/MBE1 valid after rising clk		7	ns
t_{CMV2}[4]	MBEC valid after rising clk		9	ns
t_{OEMV1}[4]	$\overline{OE}$ active to MBE0/MBE1 valid		4.0	ns
t_{OEMV2}[4]	$\overline{OE}$ active to MBEC valid		4.5	ns
t_{CMZ1}[5]	Rising CLK to MBE0/MBE1 three-state time		4.5	ns
t_{CMZ2}[5]	Rising CLK to MBEC three-state time		4.5	ns

Parameter	Description	MIN	MAX	Unit
t_{CMX1}[5]	Rising CLK to MBE0/MBE1 enable time	1.4		ns
t_{CMX2}[5]	Rising CLK to MBEC enable time	1.4		ns
t_{OEMZ1}[5]	$\overline{OE}$ inactive to MBE0/MBE1 three-state time		4.5	ns
t_{OEMZ2}[5]	$\overline{OE}$ inactive to MBEC three-state time		5.5	ns
t_{OEMX1}[5]	$\overline{OE}$ active to MBE0/MBE1 enable time	0		ns
t_{OEMX2}[5]	$\overline{OE}$ active to MBEC enable time	0		ns

Notes:
* For devices procured with a total ionizing dose tolerance guarantee, the post-irradiation performance is guaranteed at 25°C per MIL-STD-883 Method 1019, Condition A up to the maximum TID level procured

1) AC Characteristics based on compliance with CLOCK input specifications
2) Supplied as a design guideline, not tested or guaranteed.
3) Period and Cycle to Cycle jitter is defined by JEDEC Standard 65B
4) Maximum data output valid times guaranteed up to 25pf load capacitance. For loads >25pf, a derating factor of parameter = [specification max(ns) + (C_{Load} - 25pF)(44.2ps/pF].
5) Guaranteed by design.

Shutdown and Sleep Mode Characteristics (Pre and Post-Radiation)*

(V_{DD}= 2.3V to V_{DDQ}, V_{DDQ} = 2.3 to 3.6V; Unless otherwise noted Tc is for temperature range ordered.)

Parameter	Description	Condition	MIN	MAX	Unit
t_{ZZS}[3]	Device operation to SLEEP mode	ZZ ≥ V_{IH}	2 t_{CYC}		ns
t_{ZZH}[3]	SLEEP high pulse width	ZZ ≥ V_{IH}	100		µs
t_{ZZL}[3]	SLEEP low pulse width	ZZ ≤ V_{IH}	100		µs
$t_{SHTDWNS}$[3]	Device operation to SHUTDOWN	SHUTDOWN ≥ V_{IH}	2 t_{CYC}		ns
t_{ZZREC}[3]	SLEEP recovery time	STANDBY ≤ V_{IL}	100 + (3*t_{CYC})		ns
$t_{SHTDWNREC}$[1,3]	SHUTDOWN recovery time	SHUTDOWN ≤ V_{IL}		50	us
t_{ZZI}[4]	Active to SLEEP current	ZZ ≥ V_{IH}		100 + (3*t_{CYC})	ns
$t_{SHTDWNI}$[4]	Active to SHUTDOWN current	SHUTDOWN ≥ V_{IH}		250	ns
t_{RZZI}[4]	Time to exit SLEEP current mode	STANDBY ≤ V_{IL} Notes	0		ns
$t_{RSHTDWNI}$[4]	Time to exit SHUDOWN current mode	SHUTDOWN ≤ V_{IL}	0		ns
t_{CR}[1, 2, 3]	Clock recovery prior to exiting ZZ	ZZ ≥ V_{IH}		20	µs
t_{RLRH}	$\overline{RESET}$ low to high time	Shutdown ≤ V_{IL}	1		µs
t_{PDS}[3]	SLEEP setup time prior to CLK		2.0		ns
t_{PDH}[3]	SLEEP hold time after CLK		0.5		ns

Notes:
* For devices procured with a total ionizing dose tolerance guarantee, the post-irradiation performance is guaranteed at 25°C per MIL-STD-883 Method 1019, Condition A up to the maximum TID level procured.

1) The clock must start up prior to exiting sleep or shutdown modes. Parameter is guaranteed by design.
2) T_{CR} is necessary anytime the clock is stopped, after initial power on, or exiting shutdown mode.
3) Tested functionally.
4) Guaranteed by design.

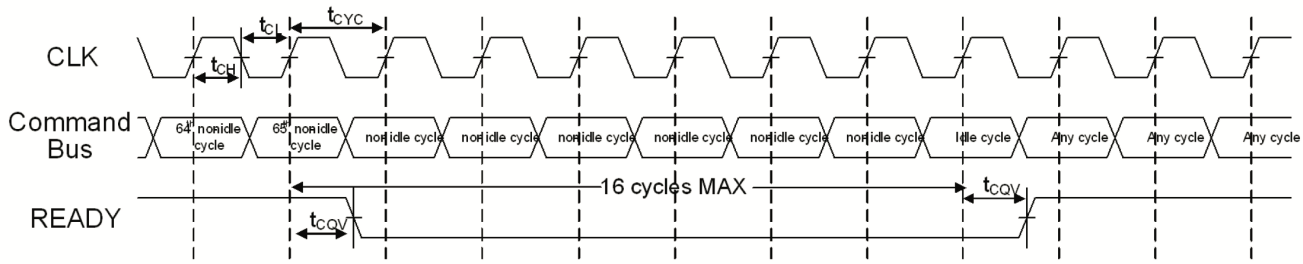

Figure 3. Switching Waveform for Internal Housekeeping

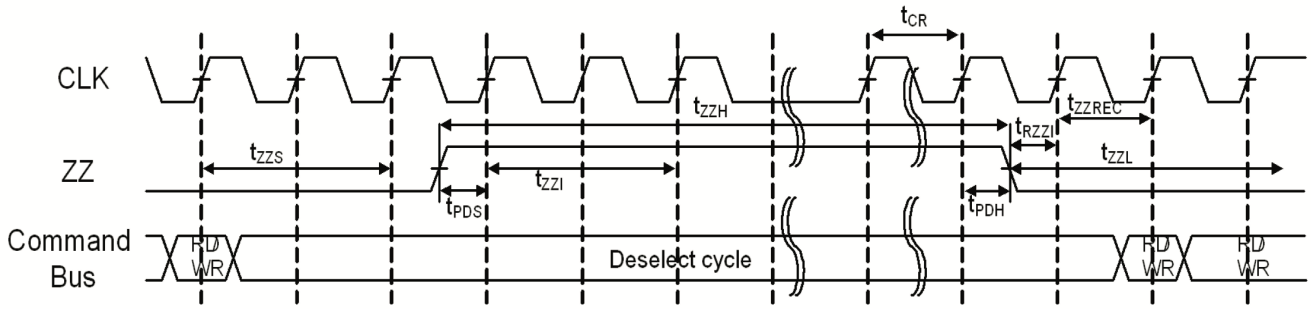

Figure 4. Switching Waveform for SLEEP Mode

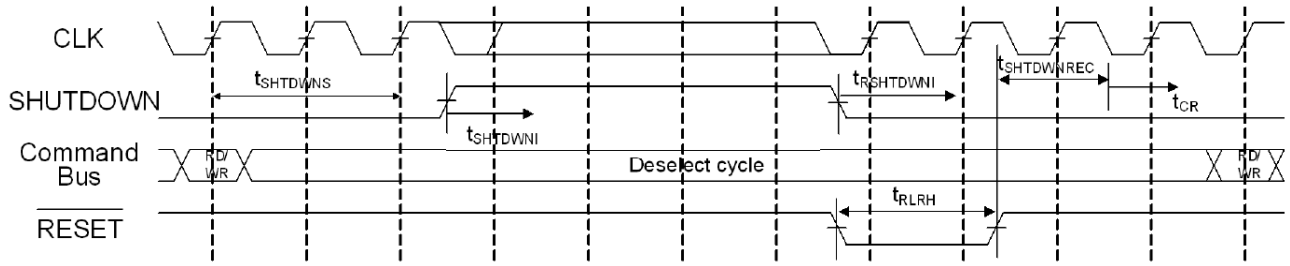

Figure 5. Switching Waveform for SHUTDOWN Mode

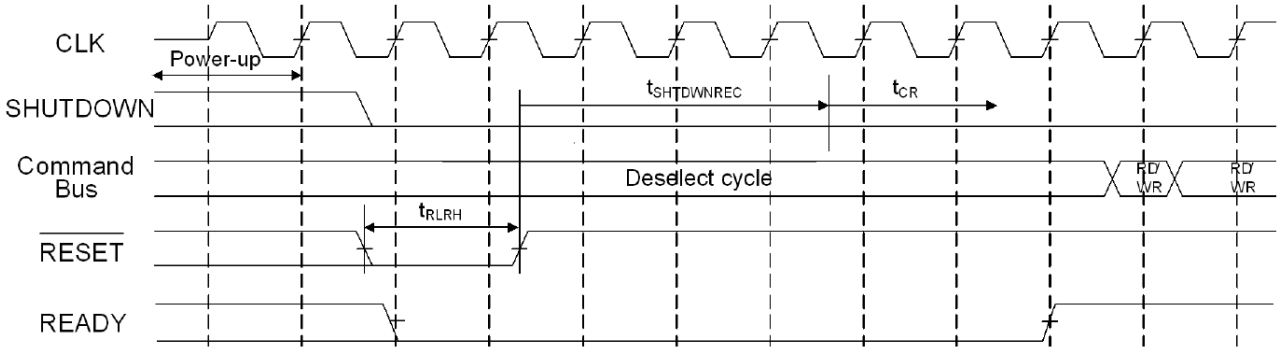

Figure 6. Switching Waveform for Power-Up

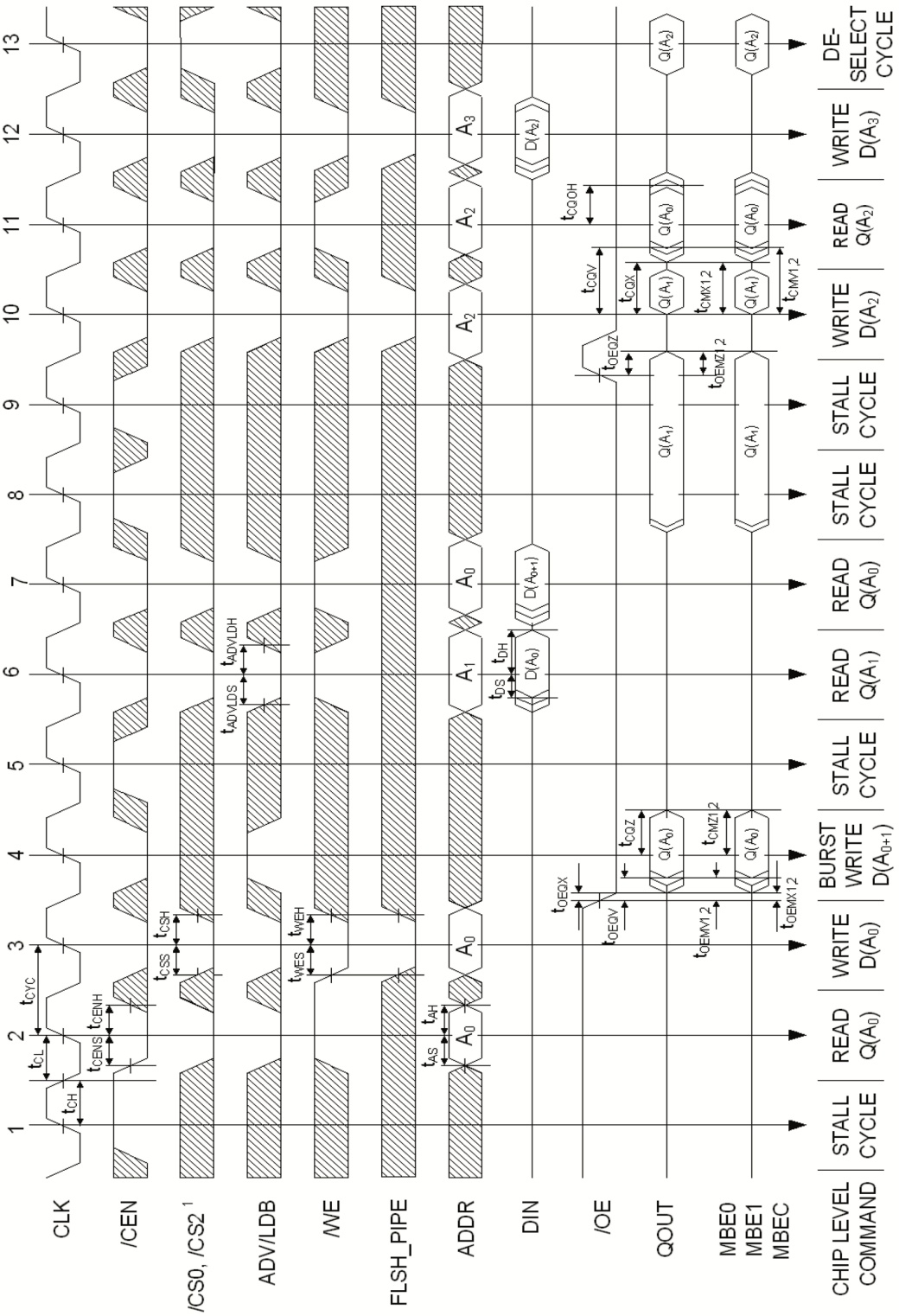

Figure 7. Switching Waveforms for Pipelined Cycle Operations

Notes:

1) CS1 has timing transitions identical to CS0b and CS2b, but is inverted logically. For example, when CS0b and CS2b are LOW, CS1 is High.

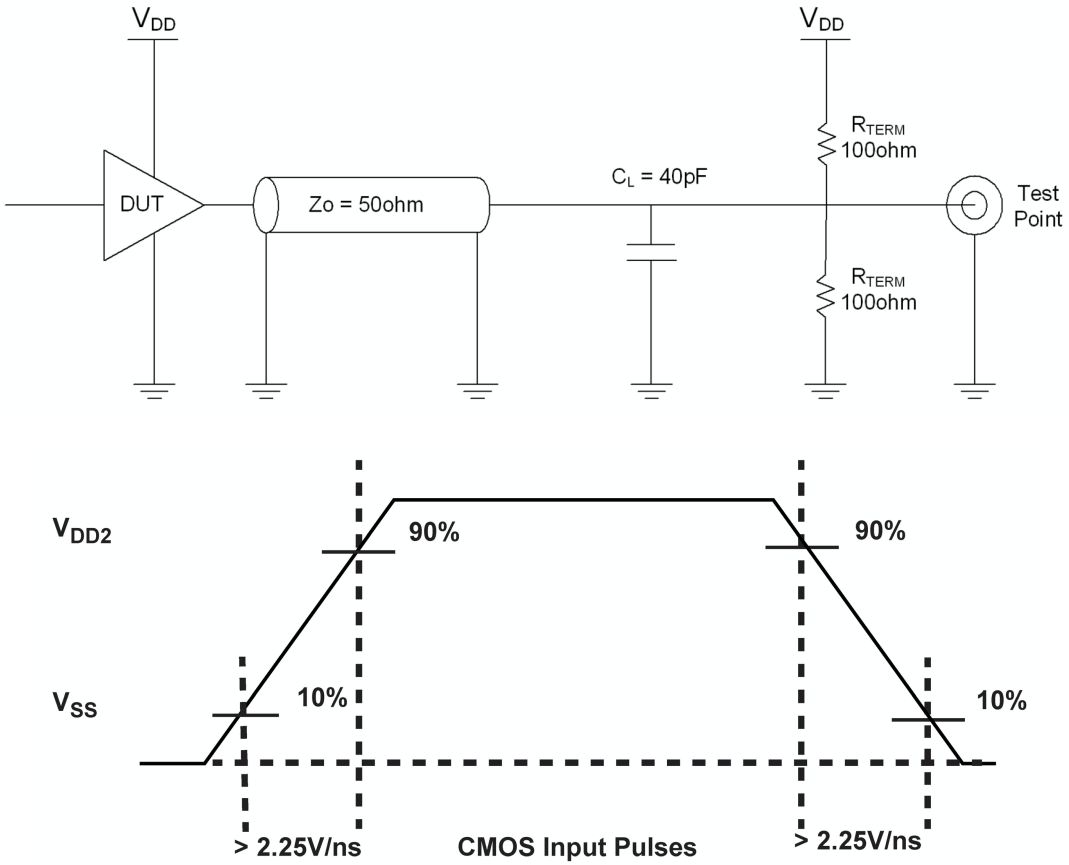

Figure 8. AC Test Loads and Input Waveforms

Notes:

1) Measurement of data output occurs at the low to high or high to low transition mid-point (i.e., CMOS input = $V_{DD2}/2$

Packaging

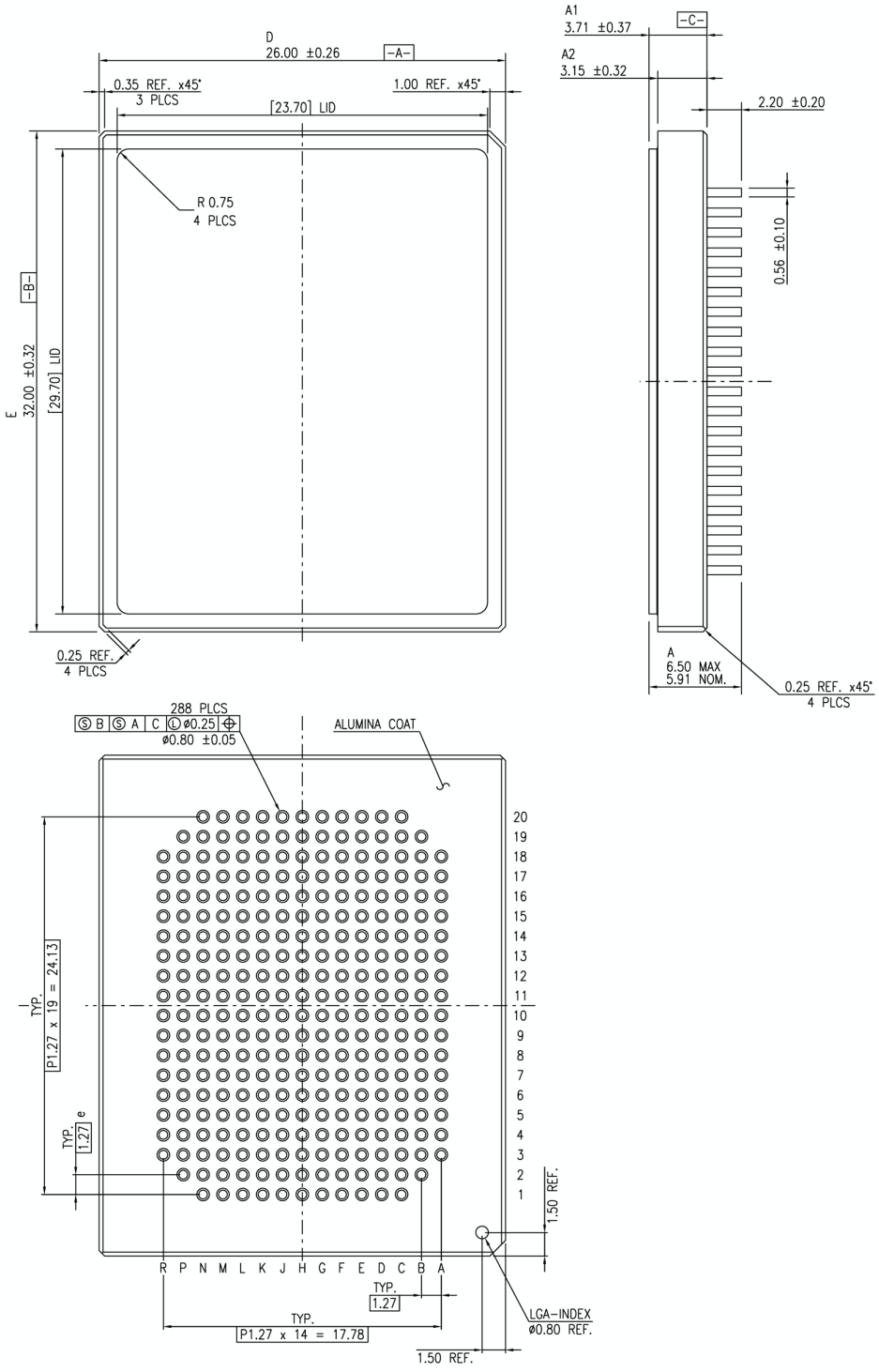

Figure 9. 288-Lead CCGA

Notes:

1) Package material: opaque 90% minimum alumina ceramic.
2) All exposed metal areas are gold plated over electroplated nickel undercoating per MIL-PRF-38535.
3) Lid is connected to VSS.

Packaging

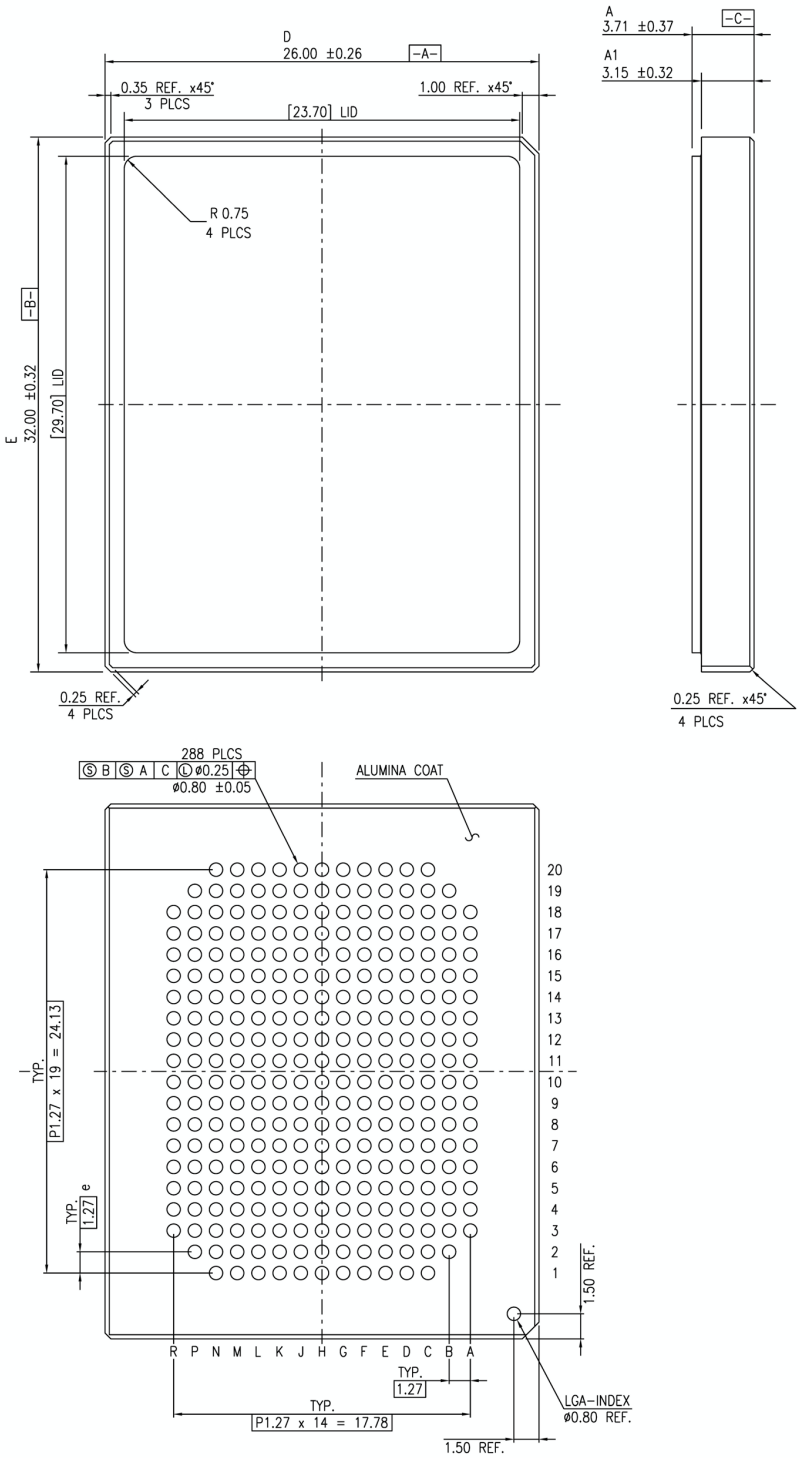

Figure 10. 288-Lead CLGA

Notes:

1) Package Material: Opaque 90% Minimum Alumina Ceramic.
2) All exposed metal areas are gold plated over electroplated nickel undercoating per MIL-PRF-38535.
3) Lid Is Connected to VSS.

Packaging

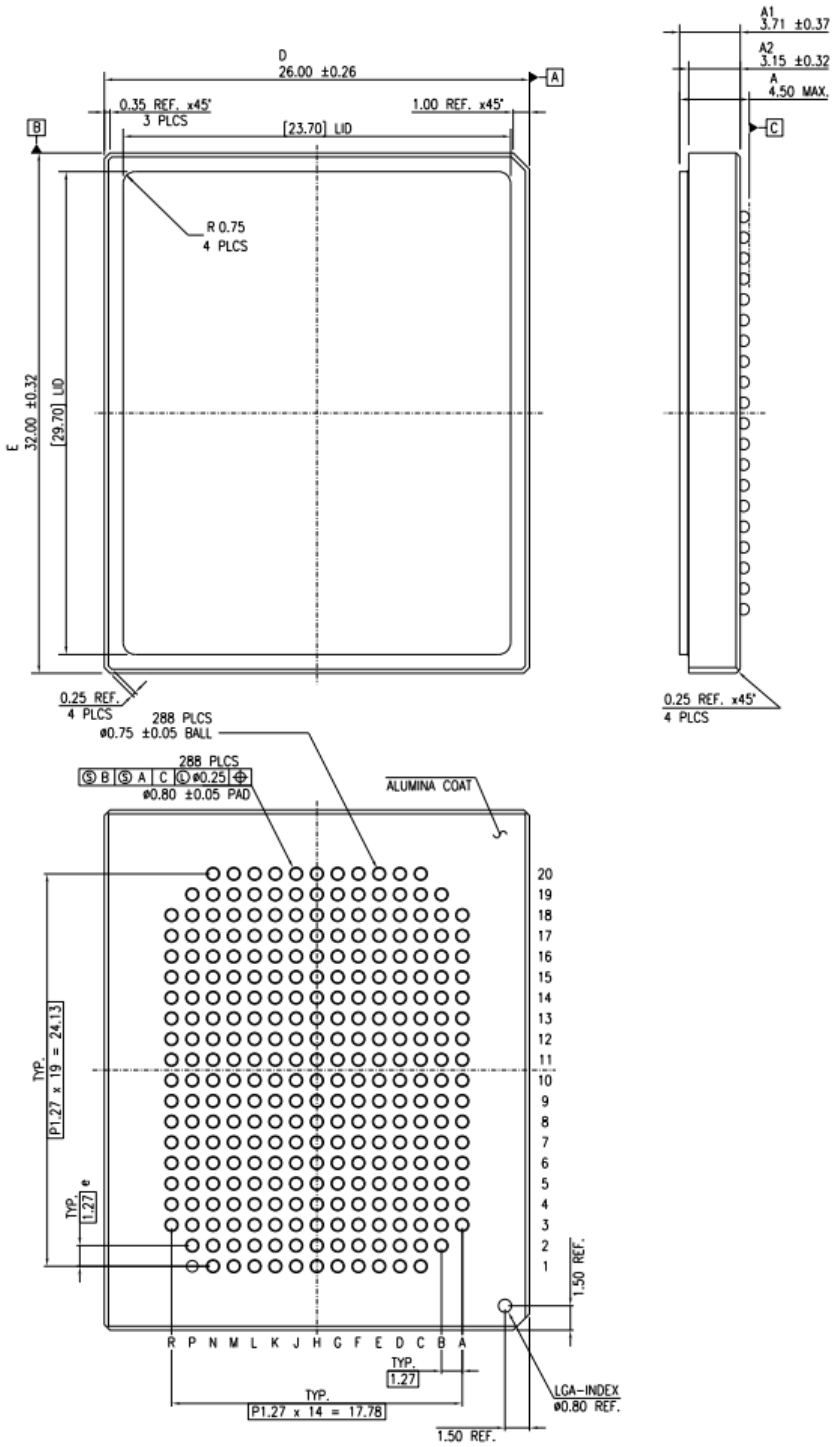

Figure 11. Advanced 288-lead CBGA, ball dimensions (A, A1, A2) are subject to change

Notes:

1) Package material: opaque 90% minimum alumina ceramic.
2) All exposed metal areas are gold plated over electroplated nickel undercoating per MIL-PRF-38535.
3) Lid is connected to VSS.
4) Ball drop size is 0.75mm.

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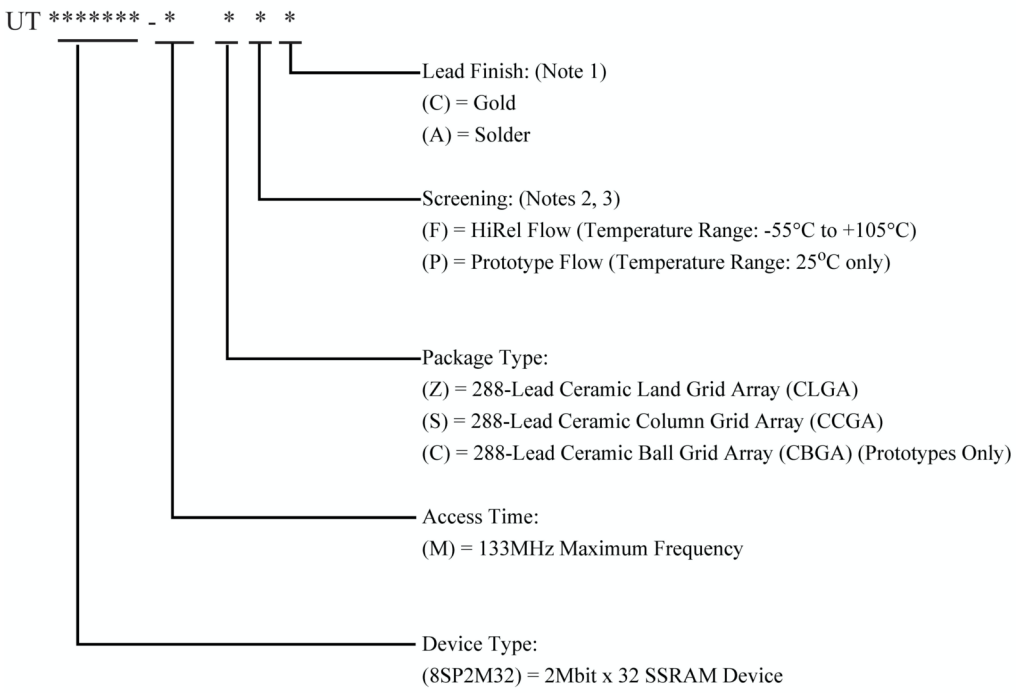
Ordering Information

2M x 32 SSRAM



Notes:

1) Lead finish is per the table below.
2) Prototype Flow per CAES Manufacturing Flows Document. Devices are tested at 25°C only. Radiation is neither tested nor guaranteed.
3) HiRel flow per CAES Manufacturing Flows Document. Radiation is neither tested nor guaranteed.

Package Option	Associated Lead Finish Option
(Z) 288-CLGA	(C) Gold
(S) 288-CCGA	(A) Hot Solder Dipped
(C) 288-CBGA	(A) Hot Solder Dipped

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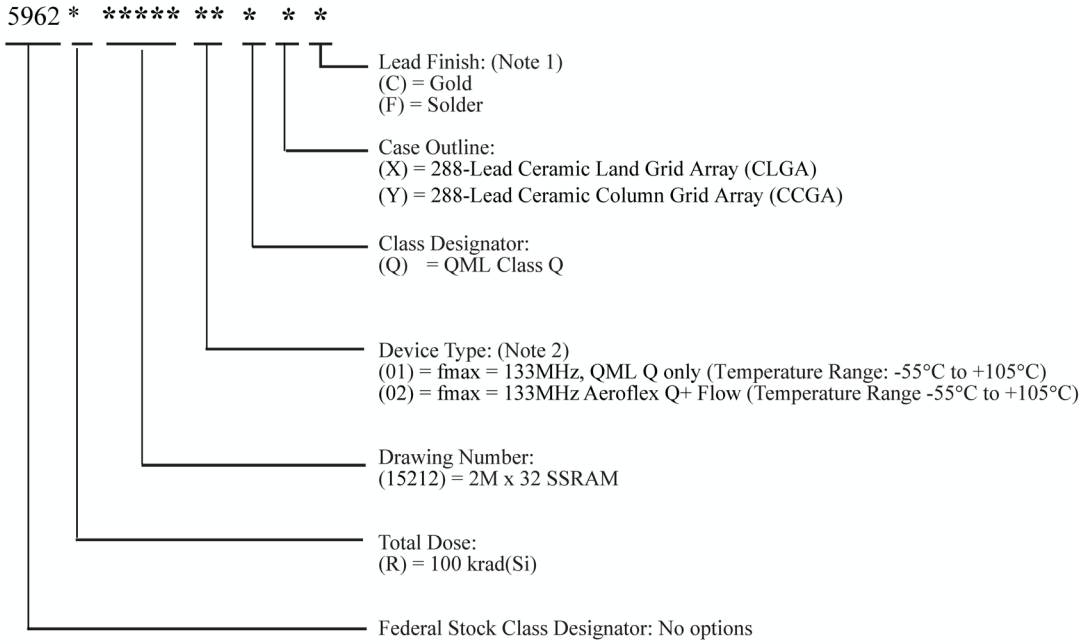
2M x 32 SSRAM: SMD



Notes:

1) Lead finish is per the table below.
2) CAES Q+ assembly flow, as defined in section 4.2.2.d of the SMD, provides QML-Q product through the SMD that is manufactured with CAES QML-V flow.

Package Option	Associated Lead Finish Option
(X) 288-CLGA	(C) Gold
(Y) 288-CCGA	(F) Hot Solder Dipped

Datasheet Revision History

Revision Date	Description of Change	Author
9/16/13	Release of Preliminary Data Sheet	MJL
10/1/13	Page 3: DQ[51:0] added CAES pull-up/down recommendation Page 9: Table 4 revised Page 9: Corrected $\overline{CSx}$ state for Sleep Mode from X to H	MJL
11/4/13	Page 3: Added manual $\overline{RESET}$ pin to Table 1. Page 10: Pull-up/down requirements changed from 75kΩ to 10kΩ R17 bias from V_{SSQ} to V_{DDQ} P16 from V_{SSQ} to NUIH P11 bias from V_{SS} to V_{DDQ} P6 from NUIL to V_{SSQ} R11 from V_{DDQ} to $\overline{RESET}$ Page 16: Shutdown and Sleep Mode Characterization table revised: $t_{SHTDWNREC}$ corrected from 100ms max to 50us min t_{CR} corrected from 10us to 20us max Page 16: Corrected Figures 4-6	MJL
1-10-14	Page 8: Added SSRAM requires $V_{DD} \leq V_{DDQ}$. Clarified clock conditioning paragraph. Page 12, 14, 15: Added V_{DDQ} voltage range to top of tables. Page 12: Changed IDDQ specification for all modes. Adjusted current specifications. Page 13: Added Note 3 for 105°C post-irradiation specifications. Page 15: Changed Note 5 to guaranteed by design and added note reference to all X and Z specifications. Page 22, 23: Corrected pin count for CLGA to 288 and corrected package designators to (Z) (S).	MJL
1/23/14	Page 1: Edits to Features bullets 2,3,5 and 13	MJL
4/24/14	Page 1: SEU changed to $1x10^{-15}$ Page 6, 7: Multiple wording typo corrections Page 11: Θ_{JC} changed to 3°C/W Page 13: CIN and CI/O change to 15pF. Page 14,1 5: Standardized signal names in descriptions and added note numbers to some parameters. Reworded note 4. Page 15: Added notes 3 and 4. Page 16: Added SHUTDOWN to signal in Figure 5. Page 21: Added advanced to Figure 11 title.	MJL
8/19/14	Page 12: Added IDDQ parameters for Stby, Shutdown, and Sleep modes. Finalized all current limits per characterization data. Page 14, 15: Finalized AC Setup, Hold, and Output limits per characterization data.	MJL
8/19/14	Page 12: Added IDDQ parameters for Stby, Shutdown, and Sleep modes. Finalized all current limits per characterization data. Page 14, 15: Finalized AC Setup, Hold, and Output limits per characterization data.	MJL
10/2/2014	Page 11: Added Operational Environment table. Page 12: Added I_{IN} paramter for EDACEN, TDI, and TMS pins. DC ELECTRICAL CHARACTERISTICS table Page 16: Corrected min t_{CYC} in Shutdown and Sleep Mode Characteristics table Page 22 and 23: Updated SMD and Ordering Info sections.	MJL

Revision Date	Description of Change	Author
3/18/2015	Page 1: Clock-to-ouput time changed from 11.5ns to 12ns. Added SMD Designator. Page 9: Added pinout R7 and R8 to Table 4. Page 10: Changed pinout R7 and R8 from VSS to NUIL Page 11: Changed P_D from 10 W to 15 W Page 12: SCRUBEN Device Pin added to Condition column of parameters I_{IN1} and I_{IN2} in the DC ELECTRICAL CHARACTERISTICS table Page 14: The minimum setup times for parameters t_{CENS}, t_{WES}, and t_{CSS} have changed from 2.5ns to 3ns, and the maximum output time for t_{CQV} and t_{CMV1} changed from 11.5ns to 12ns and t_{CMV2} changed from 12.5ns to 13ns in the AC ELECTRICAL CHARACTERISTICS table. Page 15: Minimum number of t_{CYC} changed from 1 t_{CYC} to 2 t_{CYC} for $t_{SHTDWNS}$ parameter in the SHUTDOWN AND SLEEP MODE CHARACTERISTICS TABLE Pages 19 and 20: Corrected bottom view orientation of package diagram. Page 23: A correction the Lead Finish section of the SMD ordering encoder page. The Solder lead finish designator was changed from "A" to "F". Added SMD designator	MJL
4-15	Page 9: Added pinout R13, R14, and R16 to Table 4. Page 10: Changed pinout R13, R14, and R16 from VSS to NUIL, and P8 from VSS to VSSQ	
9-17	Page 1: Datasheet Released Page 4 and 8: READY pin 10K ohm pull-up requirement added to datasheet	ML
11-17	Page 22-23: Updated Order Information	ML
10-18	Page 4: Corrected formatting of Table 1 Page 11: Added note 3 for EDAC error rate Page 12: Corrected Condition for I_{STBYQ} $V_{IN} \leq V_{IL}$	ML

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Datasheet Definitions

	DEFINITION
Advanced Datasheet	CAES reserves the right to make changes to any products and services described herein at any time without notice. The product is still in the development stage and the datasheet **is subject to change**. Specifications can be **TBD** and the part package and pinout are **not final**.
Preliminary Datasheet	CAES reserves the right to make changes to any products and services described herein at any time without notice. The product is in the characterization stage and prototypes are available.
Datasheet	Product is in production and any changes to the product and services described herein will follow a formal customer notification process for form, fit or function changes.

The following United States (U.S.) Department of Commerce statement shall be applicable if these commodities, technology, or software are exported from the U.S.: These commodities, technology, or software were exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law is prohibited.