FORCE TECHNOLOGIES LTD

128K x 32 EEPROM Module

TIGA 2E4001-12/15/20
TIGA 6E4001/A/B-12/15/20
TIGA 7E4001/A/B-12/15/20

Description

Available in PGA (TIGA 2), JLCC (TIGA 1/6) and Gullwing (TIGA 7) footprints, the TIGA **E4001 is a 4 Mbit EEPROM module user configurable as 128K x 32, 256K x 16 or 512K x 8. Available with access times of 120, 150 and 200ns, the device features hardware and software data protection, 10,000 cycle Write/Erase capability and 10 year data retention time.

Several pinout variants of the TIGA 6/7 are available

including single and multiple WE variants

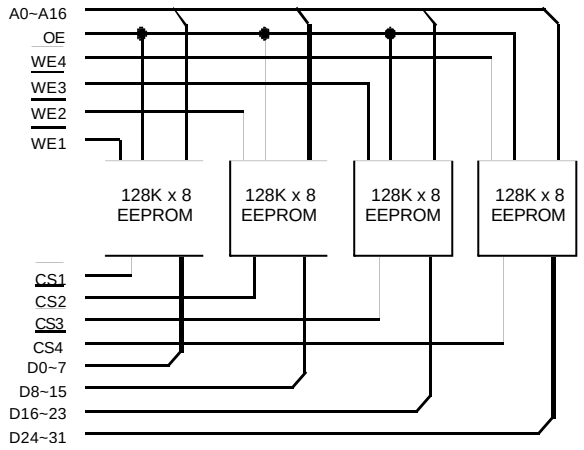
Parts may be screened in accordance with MIL-STD-883

Features

- 4 Megabit EEPROM module.
- Access Times of 120/150/200 ns.
- Output Configurable as 32/16/8 bit wide.
- Upgradeable footprint
- Operating Power 1600/ 830/ 445 mW (Max).
  Low Power Standby 2.2 mW (Max).
- Byte and Page Write (128 Bytes) in 5ms typical with DATA Polling and Toggle bit indication of end of Write.
- Hardware and Software Data Protection.
- TIGA 2 - 66 pin Ceramic PGA.
- TIGA 6 - 68 Lead Ceramic JLCC. TIGA 1-Plastic
- TIGA 7 - 68 Lead Ceramic Gullwing.
- May be screened in accordance with MIL-STD-883.
- 100,000 W/E cycle endurance option

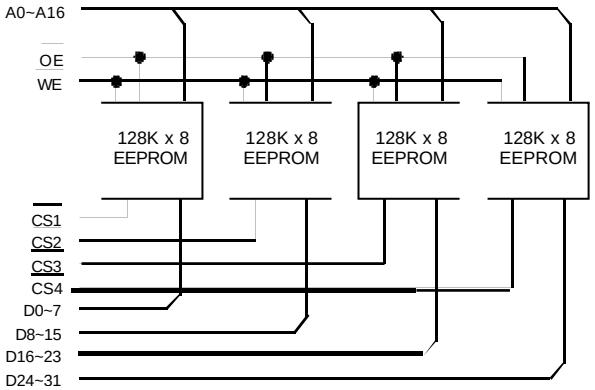
Block Diagram

TIGA 2E4001, 6E4001A /B and 7E4001A/B



Block Diagram

TIGA 6E4001 and 7E4001



Pin Functions

A0~A16	Address Input	D0~D31	Data Inputs/Outputs
CS1~4	Chip Select	WE1~4	Write Enables
OE	Output Enable	Vcc	Power (+5V)
GND	Ground		

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DC OPERATING CONDITIONS

Absolute Maximum Ratings (1)

Operating Temperature	T_{OPR}	-55 to +125	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Input voltages (including N.C. pins) with Respect to GND	V_{IN}	-0.6 to +6.25	V
Output voltages with respect to GND	V_{OUT}	-0.6 to V_{CC}+0.6	V

Notes: (1) Stresses above those listed may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

		min	*typ*	*max*	
DC Power Supply Voltage	V_{CC}	4.5	5.0	5.5	V
Input Low Voltage	V_{IL}	-1.0	-	0.8	V
Input High Voltage	V_{IH}	2.0	-	V_{CC}+1	V
Operating Temp Range	T_A	0	-	70	°C
	T_{AI}	-40	-	85	°C (**I** Suffix)
	T_{AM}	-55	-	125	°C (**M**, **MB** Suffix)

DC Electrical Characteristics (T_A=-55°C to +125°C, V_{CC}=5V ± 10%)

Parameter		*Symbol*	*Test Condition*	*min*	*max*	*Unit*
Input Leakage Current		I_{LI1}	V_{IN} = GND to V_{CC} +1	-	40	µA
Output Leakage Current	32 bit	I_{LO}	$V_{I/O}$ = GND to V_{CC}, $\overline{CS}$(1)=V_{IH}	-	40	µA
Operating Supply Current	32 bit	I_{CC32}	$\overline{CS}$(1)=$\overline{OE}$=V_{IL}, $\overline{WE}$=V_{IH}, I_{OUT}=0mA, f=5MHz(2)	-	320	mA
	16 bit	I_{CC16}	As above	-	166	mA
	8 bit	I_{CC8}	As above	-	89	mA
Standby Supply Current	TTL levels	I_{SB1}	$\overline{CS}$(1) = 2.0V to V_{CC}+1V	-	12	mA
	CMOS levels	I_{SB2}	$\overline{CS}$(1) = V_{CC}-0.3V to V_{CC}+1V	-	1.2	mA
Output Low Voltage		V_{OL}	I_{OL} = 2.1mA.	-	0.45	V
Output High Voltage		V_{OH}	I_{OH} = -400µA.	2.4	-	V

Notes (1) $\overline{CS}$ above are accessed through $\overline{CS1\sim4}$. These inputs must be operated simultaneously for 32 bit operation, in pairs in 16 bit mode and singly for 8 bit mode.

(2) Also for $\overline{WE1\sim4}$ on the PUMA 2E4001, 67E4001A, 77E4001A versions. Additionally, $\overline{WE1\sim4}$ are accessed as in note (1) above.

Capacitance (T_A=25°C, f=1MHz) Note: These parameters are calculated, not measured.

Parameter		*Symbol*	*Test Condition*	*typ*	*max*	*Unit*
Input Capacitance	$\overline{CS1\sim4}$, $\overline{WE1\sim4}$(1)	C_{IN1}	V_{IN}=0V	-	20	pF
	Other Inputs	C_{IN2}	V_{IN}=0V	-	22	pF
Output Capacitance		C_{OUT}	V_{OUT}=0V	-	22	pF

Notes: (1) On the PUMA 2E4001, 67E4001A, 77E4001A versions only.

AC OPERATING CONDITIONS

Read Cycle

		12		15		20		
Parameter	*Symnbol*	*min*	*max*	*min*	*max*	*min*	*max*	*Unit*
Read Cycle Time	t_{RC}	120	-	150	-	200	-	ns
Address Access Time	t_{AA}	-	120	-	150	-	200	ns
Chip Select Access Time	t_{CS}	-	120	-	150	-	200	ns
Output Enable Access Time	t_{OE}	0	60	0	70	0	80	ns
$\overline{CS}$ or $\overline{OE}$ to Output Float (2)	t_{DF}	0	60	0	70	0	80	ns
Output Hold from Address Change	t_{OH}	0	-	0	-	0	-	ns

Notes:(1) t_{HZ} max. and t_{OLZ} max. are measured with CL = 5pF, from the point when Chip Select or Output Enable return high (whichever occurs first) to the time when the outputs are no longer driven. t_{HZ} and t_{OHZ} are shown for reference only: they are characterized and not tested.

(2) This parameter is characterised and is not 100% tested.

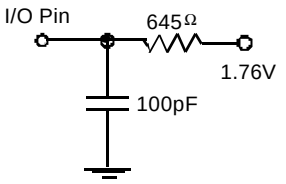
Write Cycle

Parameter	*Symbol*	*min*	*typ*	*max*	*Unit*
Write Cycle Time	t_{WC}	-	-	10	ms
Address Set-up Time	t_{AS}	0	-	-	ns
Address Hold Time	t_{AH}	50	-	-	ns
Output Enable Set-up Time	t_{OES}	0	-	-	ns
Output Enable Hold Time	t_{OEH}	0	-	-	ns
Chip Select Set-up Time	t_{CS}	0	-	-	ns
Chip Select Hold Time	t_{CH}	0	-	-	ns
Write Pulse Width	t_{WP}	100	-	-	ns
Write Enable High Recovery	t_{WPH}	50	-	-	ns
Data Set-up Time	t_{DS}	50	-	-	ns
Data Hold Time	t_{DH}	0	-	-	ns
Byte Load Cycle	t_{BLC}	-	-	150	µs

AC Test Conditions

* Input pulse levels: 0V to 3.0V
* Input rise and fall times: 10ns
* Input and Output timing reference levels: 1.5V
* Output load: 1 TTL gate + 100pF
* V_{CC}=5V±10%

Output Test Load



$\overline{\text{Data}}$ Polling Characterisitics (1)

Parameter	*Symbol*	*min*	*typ*	*max*	*Unit*
Data Hold Time	t_{DH}	10	-	-	ns
$\overline{\text{OE}}$ Hold Time	t_{OEH}	10	-	-	ns
$\overline{\text{OE}}$ to Output Delay (2)	t_{OE}	-	-	-	ns
Write Recovery Time	t_{WR}	0	-	-	ns

Notes:(1) These parameter are characterised and is not 100% tested.

(2) See AC Read Characteristics.

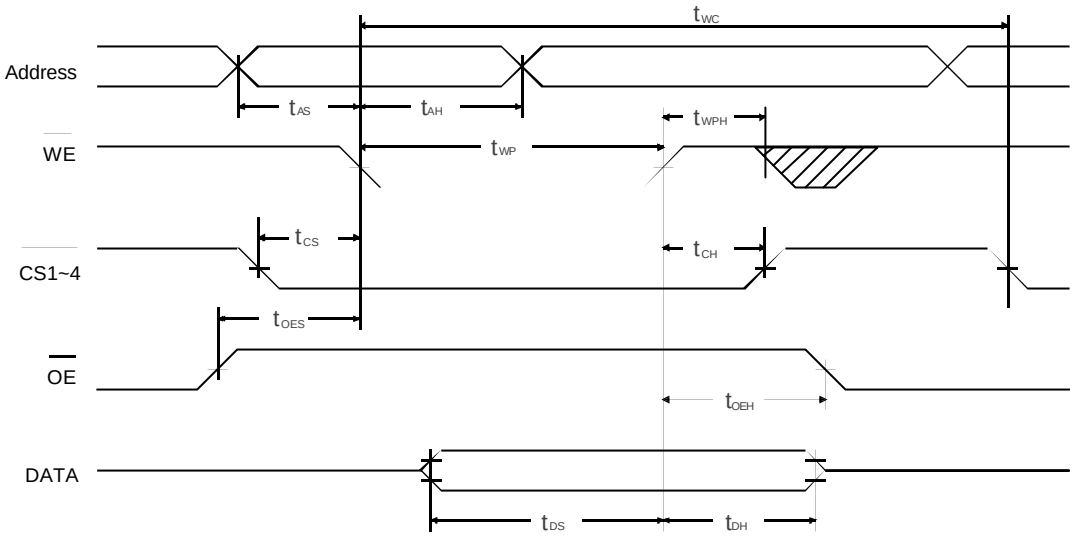
Toggle Bit Characteristics (1)

Parameter	*Symbol*	*min*	*typ*	*max*	*Unit*
Data Hold Time	t_{DH}	10	-	-	ns
$\overline{\text{OE}}$ Hold Time	t_{OEH}	10	-	-	ns
$\overline{\text{OE}}$ to Output Delay (2)	t_{OE}	-	-	-	ns
OE High Pulse	t_{OEHP}	150	-	-	ns
Write Recovery Time	t_{WR}	0	-	-	ns

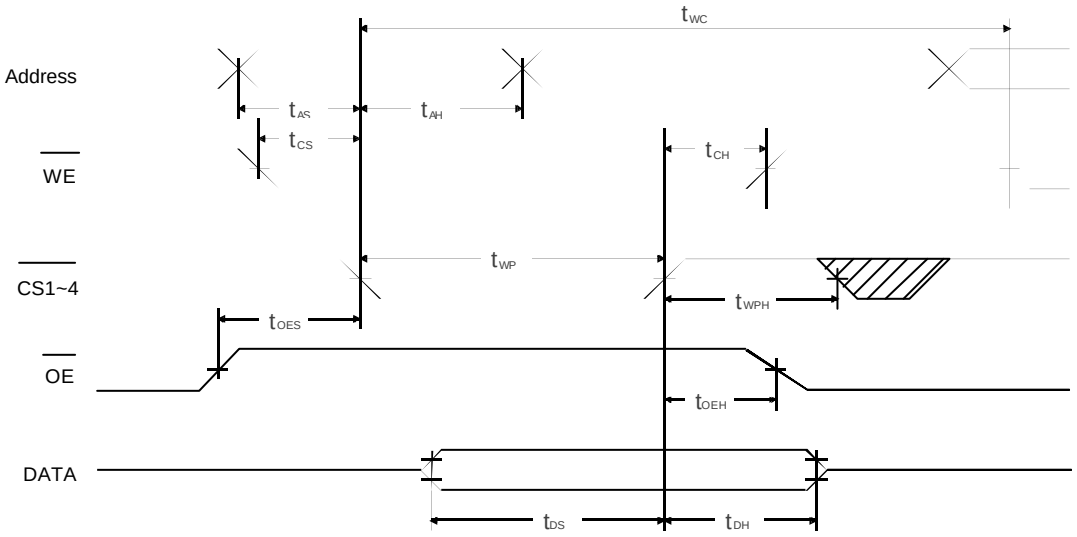
Notes:(1) These parameter are characterised and is not 100% tested.

(2) See AC Read Characteristics.

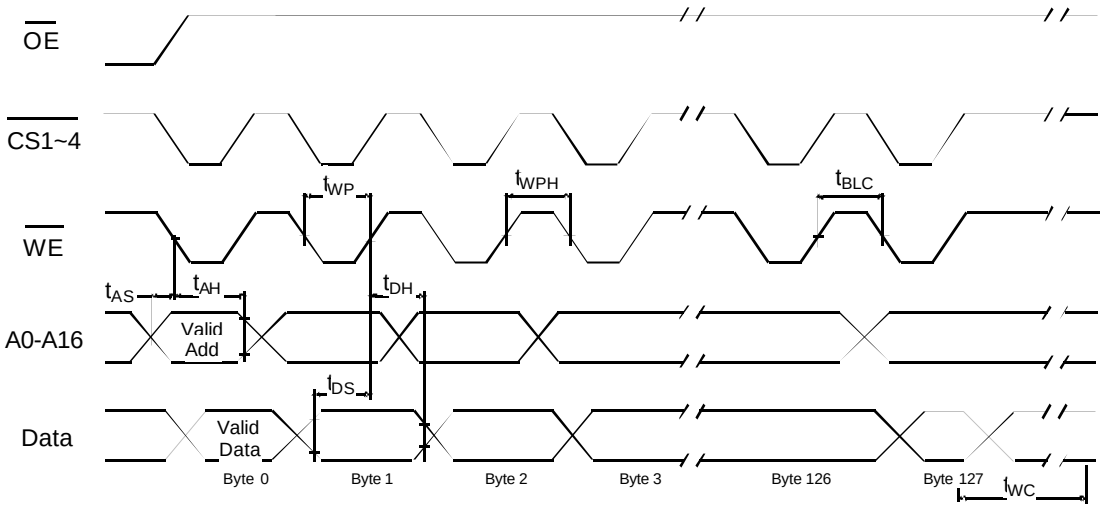
AC Write Waveform - $\overline{WE}$ Controlled



AC Write Waveform - $\overline{CS}$ Controlled

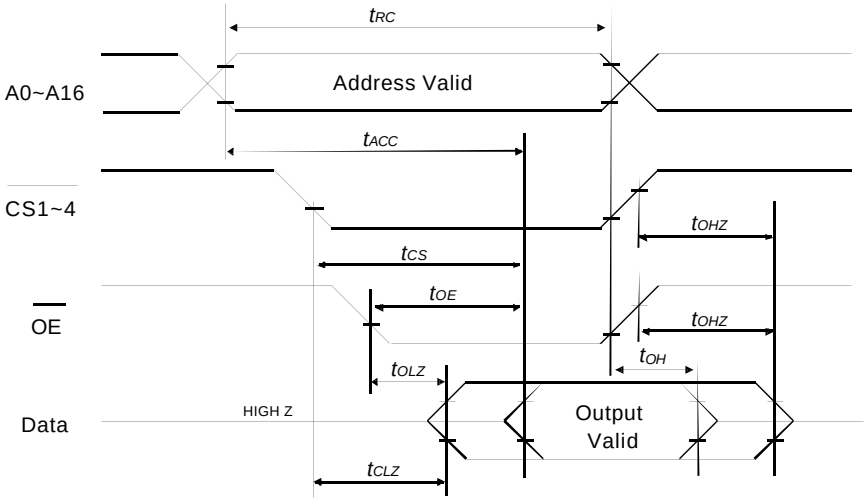


Page Mode Write Waveform

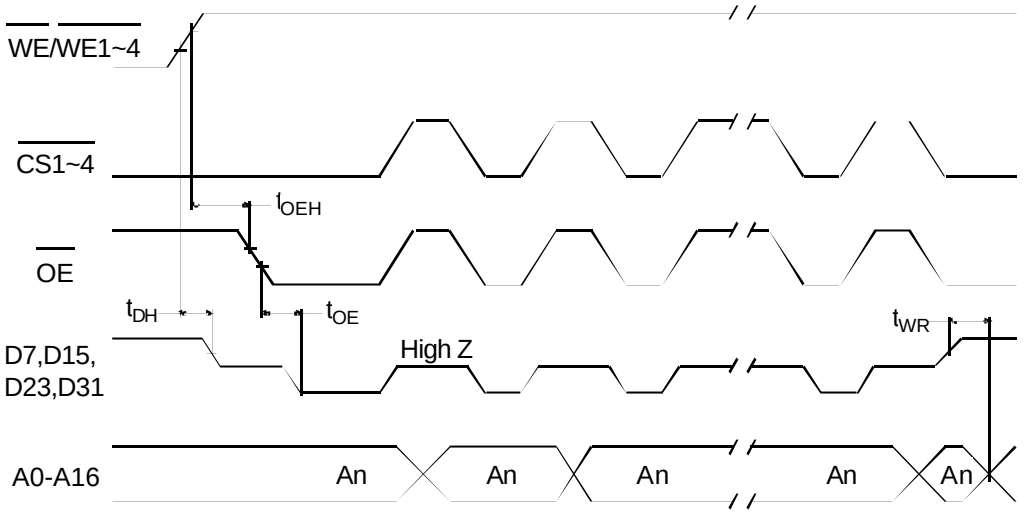


Note: A8 through A16 must specify the page address during each high to low transition of Write Enable (or Chip select). Output Enable must be high only when Write Enable and Chip Select are both low.

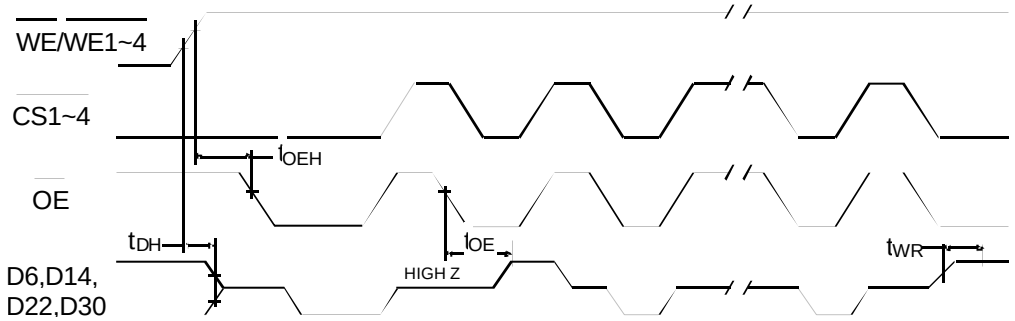
Read Cycle Timing Waveform



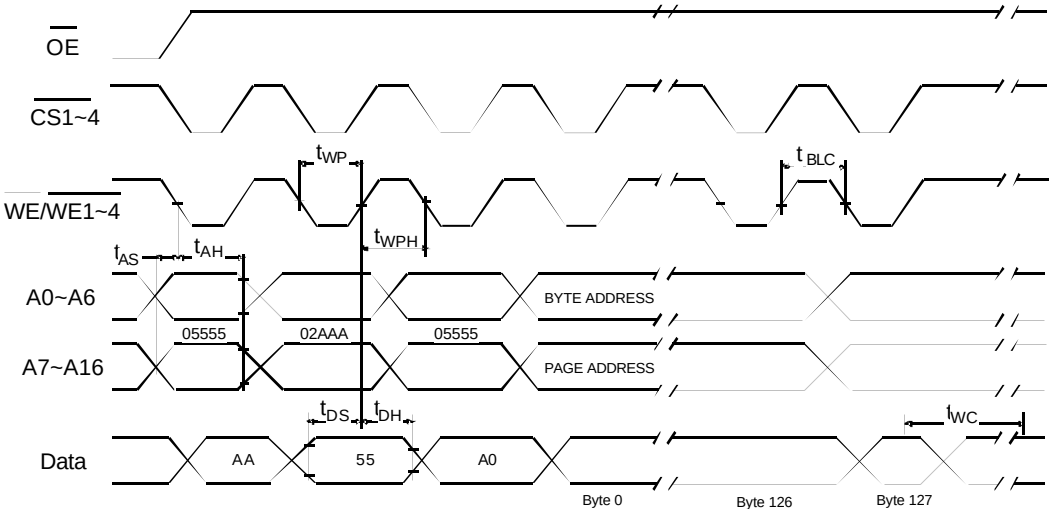
DATA Polling Waveform



Toggle Bit Waveform



Software Protected Write Waveform



Device Operation

The following description deals with the device, with the references to $\overline{WE}$ meaning $\overline{WE1{\sim}4}$ on the 'A' parts.

Read

The device read operations are initiated by both Output Enable and Chip Select LOW. The read operation is terminated by either Chip Select or Output Enable returning HIGH. This 2-line control architecture elimanates bus contention in a system environment. The data bus will be in a high impendence state when either Output Enable or Chip Select is HIGH.

Write

Write operations are initated when both Chip Select and Write Enable are LOW and Output Enable is HIGH. The device supports both a Chip Select and Write Enable controlled write cycle. That is, the address is latched by the falling edge of either Chip Select or Write Enable, whichever occurs last. Similarly, the data is latched internally by the rising edge of either Chip Select or Write Enable, whichever occurs first. A byte write operation, once initiated, will automatically continue to completion, typically within 5 ms.

Page Mode Write

The page write feature of the device allows the entire memory to be written in 5 seconds. Page Write allows 128 bytes of data to be written prior to the internal programming cycle. The host can fetch data from another location within the system during a page write operation (change the source address), but the page address (A8 through A16) for each subsequent valid write cycle to the part during this operation must be the same as the initial page address.

The page write mode can be initiated during any write operation. Following the initial byte write cycle, the host can write up to 128 bytes in the same manner as the first byte written. Each successive byte load cycle, started by the Write Enable HIGH to LOW transition, must begin within 150 µs of the falling edge of the preceding Write Enable. If a subsequent Write Enable HIGH to LOW transition is not detected within 150 µs, the internal automatic programming cycle will commence.

$\overline{DATA}$ Polling

The device features $\overline{DATA}$ Polling to indicate if the write cycle is completed. During the internal programming cycle, any attempt to read the last byte written will produce the compliment of that data on D7. Once the programming is complete, D7 will refect the true data. Note: If the the device is in a protected state and an illegal write operation is attempted $\overline{DATA}$ Polling will not operate.

TOGGLE bit

In addition to $\overline{DATA}$ polling, another method is provided to determine the end of a Write Cycle. During a write operation successive attempts to read data will result in D6 toggling between 1 and 0. Once a write is complete, this toggling will stop and valid data will be read.

Hardware Data Protection

The device provides three harware features to protect nonvololitile data from inadvertent writes.

- Noise Protection - A Write Enable pulse less than 15 ns will not inditiate a write cycle.
- Default V_{CC} Sence - All functions are inhabited when V_{CC} < 3.6 V.
- Write Inhibit - Holding either Output Enable LOW, Write Enable HIGH or Chip Select HIGH will prevent an inadvertent write cycle during power on or power off, maintaining data integrity.

Software Data Protection

The device can be automatically protected during power-up and power-down without the need for external circuits by employing the software data protect feature. The internal software data protection circuit is enabled after the first write operation utilizing the software algorithm. This circuit is nonvolatile and will remain set for the life of the device unless the reset command is issued.

Once the software protection is enabled, the device is also protected against inadvertent and accidental writes in that, the software algorithm must be issued prior to writing additional data to the device.

Operating Modes

The table below shows the logic inputs required to control the operation of the device.

MODE	$\overline{CS1\sim4}$	$\overline{OE}$	$\overline{WE}$	OUTPUTS
Read	0	0	1	Data Out
Write	0	I	0	Data in
Standby	1	X	X	Floating
Write Inhibit	X	X	1	
	X	0	X	

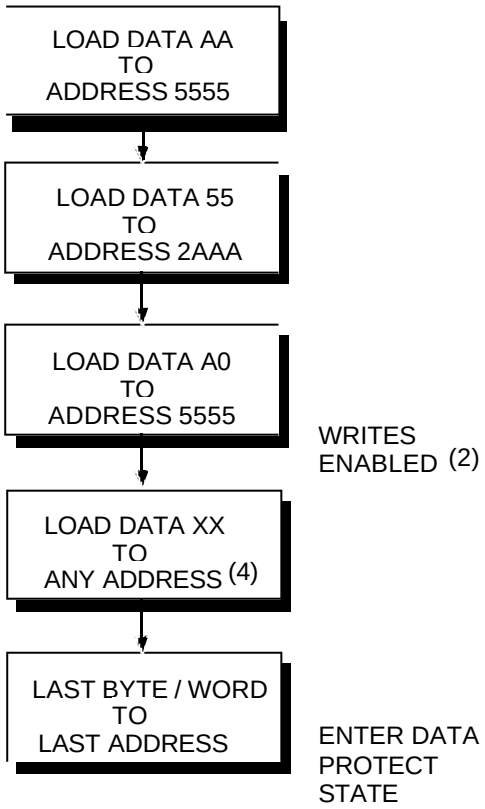
$0 = V_{IL}$: $1 = V_{IH}$: $X = V_{IH}$ or V_{IL}

Software Algorithms

Selecting the software data protection mode requires the host system to precede datawrite operations by a series of three write operations to three specfic addresses. The three byte sequence opens the page write window enabling the host to write from from 1 to 128 bytes of data. Once the page load cycle has been completed, the device will automatically be returned to the data protected state

Software Data Protection Algorithm

Regardless of wheather the device has been protected or not, once the software data protected aglorithm is used and the data is written, the device will automatically disable further writes unless another command is issued to cancel it. If no further commands are issued the device will be write protected during power-down and any subsequent power-up.



Notes:

(1) Data Format I/O7-I/O0 (Hex);
Once initiated, this sequence of write operations should not be interrupted.

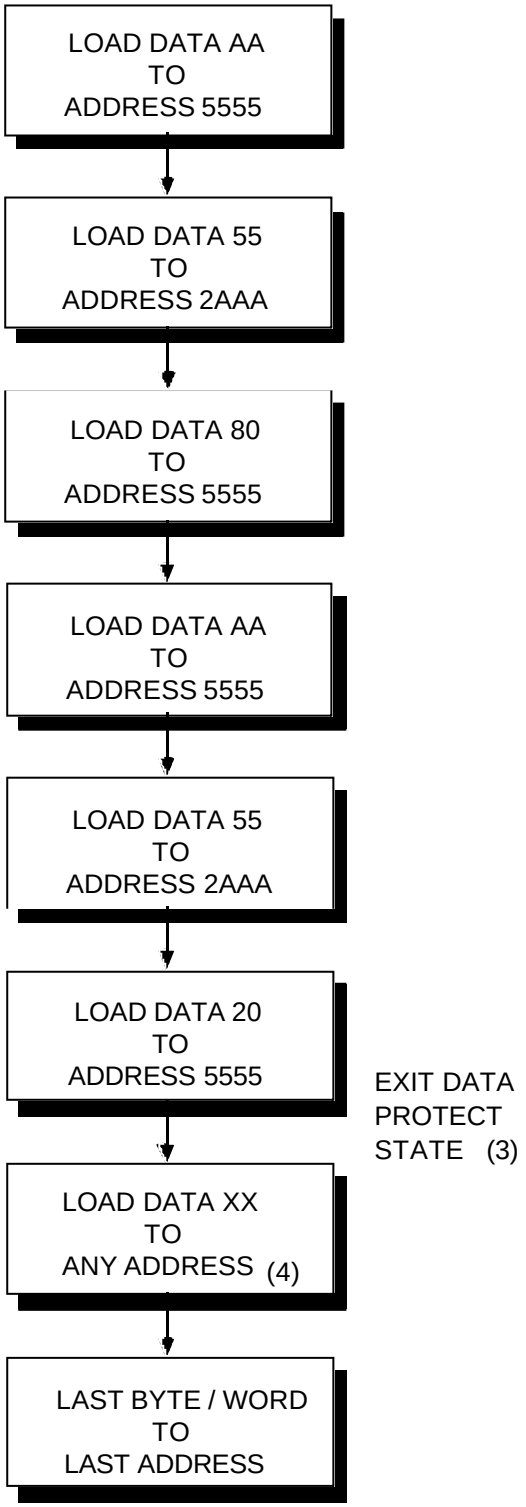
(2) Enable Write Protect state will be initiated at end of write even if no other data is loaded.

(3) Disable Write Protect state will be initiated at end of write period even if no other data is loaded.

(4) 1 to 128 bytes of data may be loaded.

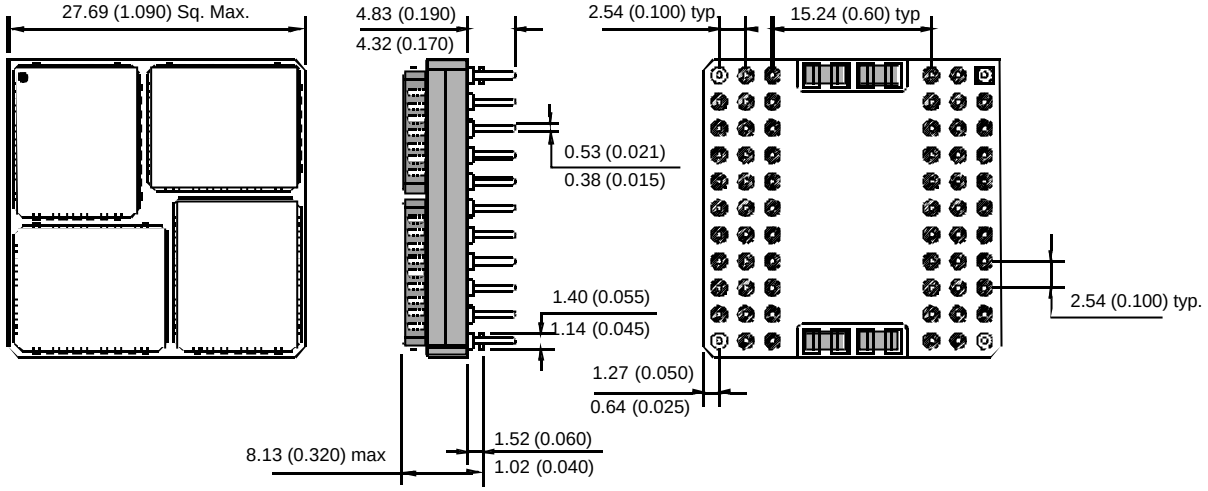
Software Data Protect Disable

In the event the user wants to deactivate the software data protection feature for testing or reprogramming in an E^2PROM programmer. The following six step algorithm will reset the internal protection circuit. After t_{WC}, the device will be in standard operating mode.

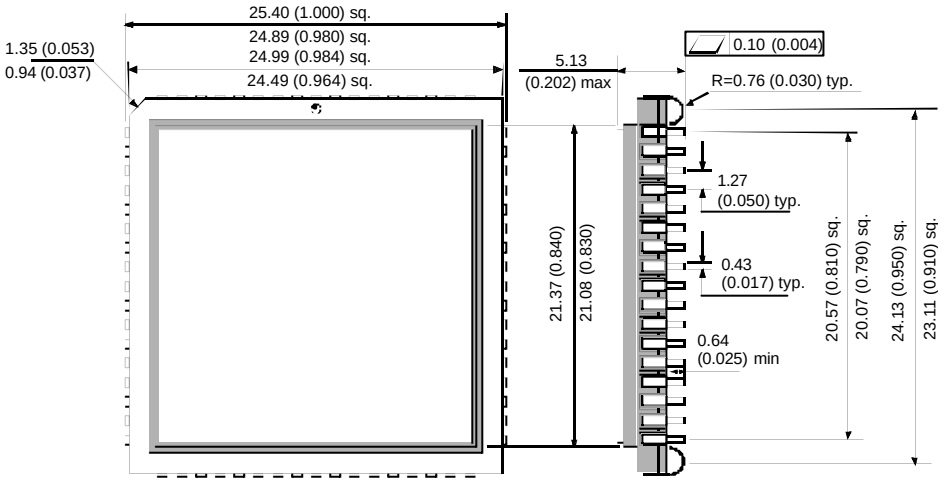


Package Details

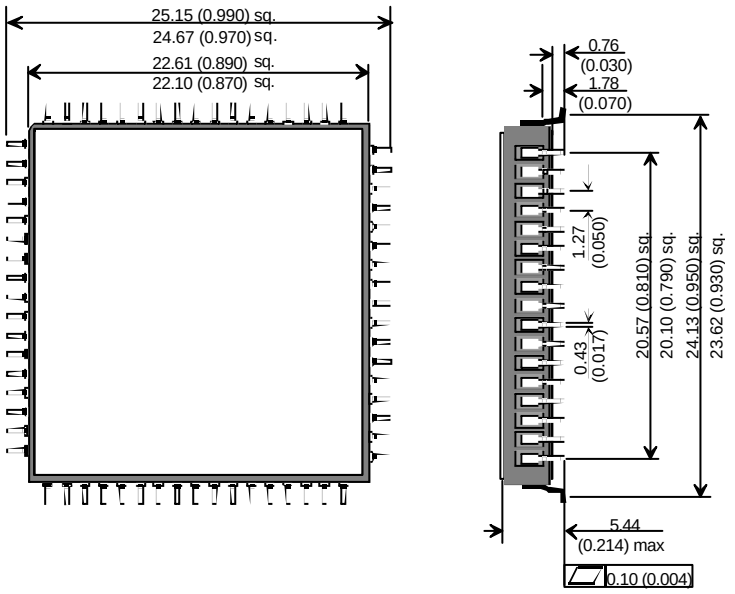
PUMA 2E4001



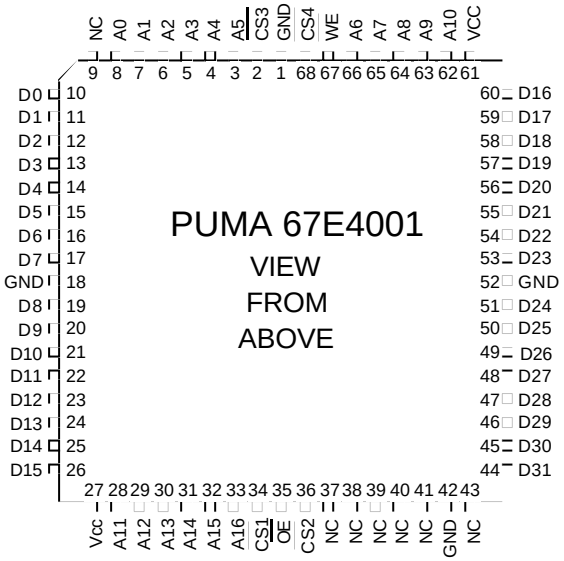
PUMA 67E4001



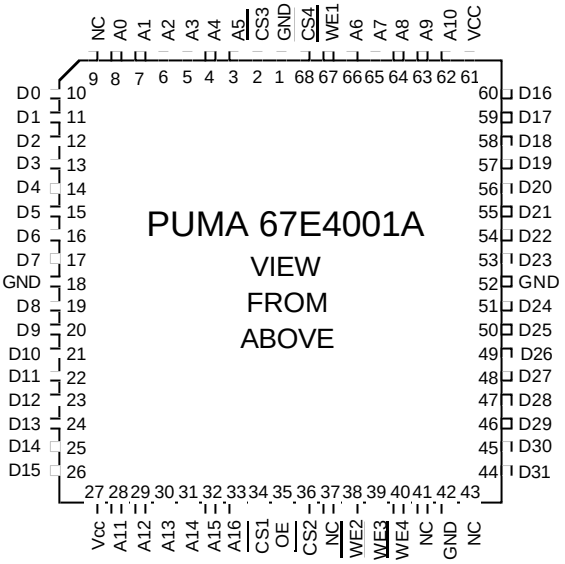
PUMA 77E4001



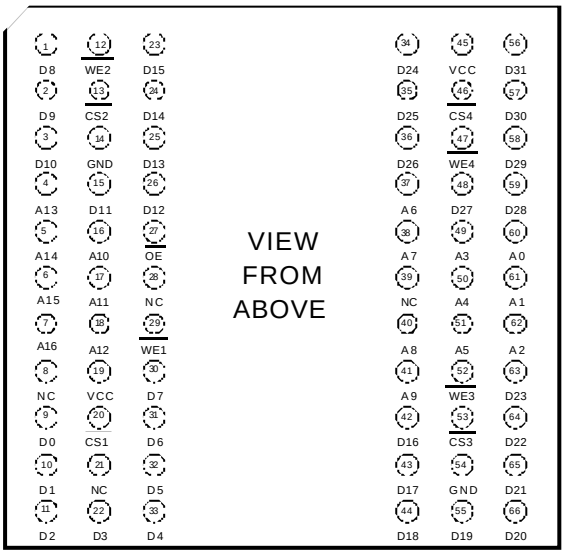
PUMA 67E4001 / PUMA 77E4001



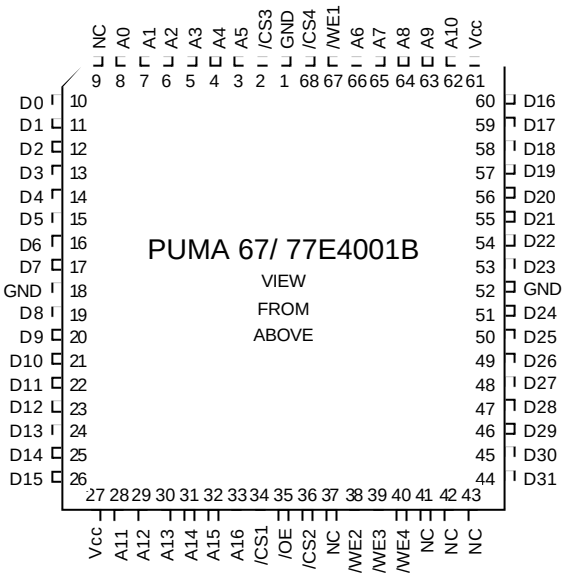
PUMA 67E4001A / PUMA 77E4001A



PUMA 2E4001



PUMA 67E4001B / PUMA 77E4001B



Military Screening Procedure

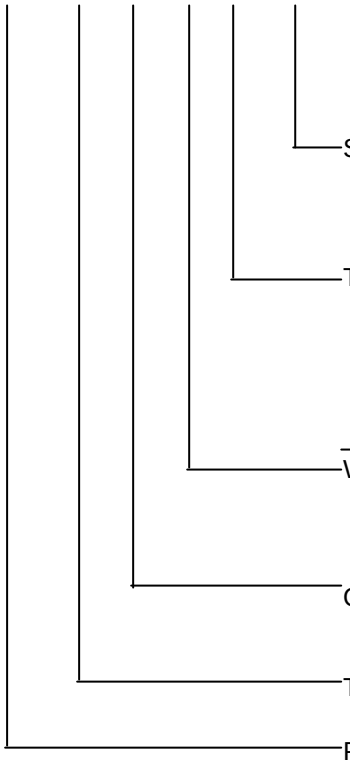
MultiChip Screening Flow for high reliability product is in accordance with Mil-883 method 5004 .

MB MULTICHIP MODULE SCREENING FLOW

SCREEN	*TEST METHOD*	*LEVEL*
Visual and Mechanical		
Internal visual	2010 Condition B or manufacturers equivalent	100%
Temperature cycle	1010 Condition C (10 Cycles,-65°C to +150°C)	100%
Constant acceleration	2001 Condition B (Y1 & Y2) (10,000g)	100%
Endurance		
Write Cycle endurance and Data Retention performance	As per Internal Specification.	
Burn-In		
Pre-Burn-in electrical	Per applicable device specifications at T_A=+25°C	100%
Burn-in	T_A=+125°C,160hrs min	100%
Final Electrical Tests	Per applicable Device Specification	
Static (DC)	a) @ T_A=+25°C and power supply extremes	100%
	b) @ temperature and power supply extremes	100%
Functional	a) @ T_A=+25°C and power supply extremes	100%
	b) @ temperature and power supply extremes	100%
Switching (AC)	a) @ T_A=+25°C and power supply extremes	100%
	b) @ temperature and power supply extremes	100%
Percent Defective allowable (PDA)	Calculated at post-burn-in at T_A=+25°C	10%
Hermeticity	1014	
Fine	Condition A	100%
Gross	Condition C	100%
Quality Conformance	Per Applicable Device Specification	Sample
External Visual	2009 Per vendor or customer specification	100%

Ordering Information

PUMA2E4001AMB-12



Speed	12	=	120 ns
	15	=	150 ns
	20	=	200 ns
Temp. range/screening	Blank	=	Commercial Temperature
	I	=	Industrial Temperature
	M	=	Military Temperature
	MB	=	Processed in accordance with MIL-STD-883
$\overline{WE}$ Option	Blank	=	Single $\overline{WE}$ (PUMA 67 / 77 only) $\overline{WE1\sim4}$ (PUMA 2 only)
	A	=	$\overline{WE1\sim4}$ (PUMA 67 / 77 only)
	B	=	Pinout variant
Organisation	4001	=	128Kx 32, user confiurable as 256K x 16 and 512K x 8
Technology	E	=	EEPROM MEMORY
Package	PUMA 2	=	JEDEC 66 Pin Ceramic PGA package
	PUMA 67	=	JEDEC 68 J-Leaded Ceramic Surface Mount package
	PUMA 77	=	JEDEC 68 Leaded Gull Wing Ceramic Surface Mount package