Features

- **Low-voltage and Standard-voltage Operation**
  - **2.7 (V_{CC} = 2.7V to 5.5V)**
  - **1.8 (V_{CC} = 1.8V to 5.5V)**
- **User Selectable Internal Organization**
  - **16K: 2048 x 8 or 1024 x 16**
- **Three-wire Serial Interface**
- **Sequential Read Operation**
- **Schmitt Trigger, Filtered Inputs for Noise Suppression**
- **2 MHz Clock Rate (5V) Compatibility**
- **Self-timed Write Cycle (10 ms max)**
- **High Reliability**
  - **Endurance: 1 Million Write Cycles**
  - **Data Retention: 100 Years**
- **Automotive Devices Available**
- **8-lead JEDEC PDIP, 8-lead JEDEC SOIC, 8-lead Ultra Thin Mini-MAP (MLP 2x3), and 8-lead TSSOP Packages**
- **Die Sales: Wafer Form, Waffle Pack and Bumped Wafers**

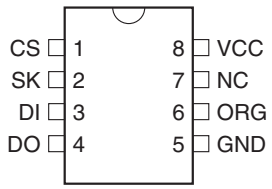
Description

The AT93C86A provides 16384 bits of serial electrically erasable programmable read only memory (EEPROM), organized as 1024 words of 16 bits each when the ORG pin is connected to V_{CC} and 2048 words of eight bits each when it is tied to ground. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operations are essential. The AT93C86A is available in space saving 8-lead PDIP, 8-lead JEDEC SOIC, 8-lead Ultra Thin Mini-MAP (MLP 2x3), and 8-lead TSSOP packages.

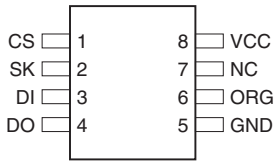
Table 1. Pin Configurations

Pin Name	Function
CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground
VCC	Power Supply
ORG	Internal Organization
NC	No Connect

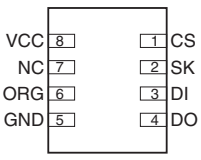
8-lead PDIP



8-lead SOIC

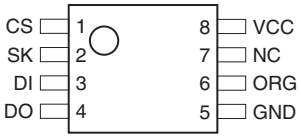


8-lead
Ultra Thin Mini-MAP (MLP 2x3)



Bottom View

8-lead TSSOP



Three-wire Serial EEPROM

16K (2048 x 8 or 1024 x 16)

AT93C86A

Rev. 3408H–SEEPR–1/07

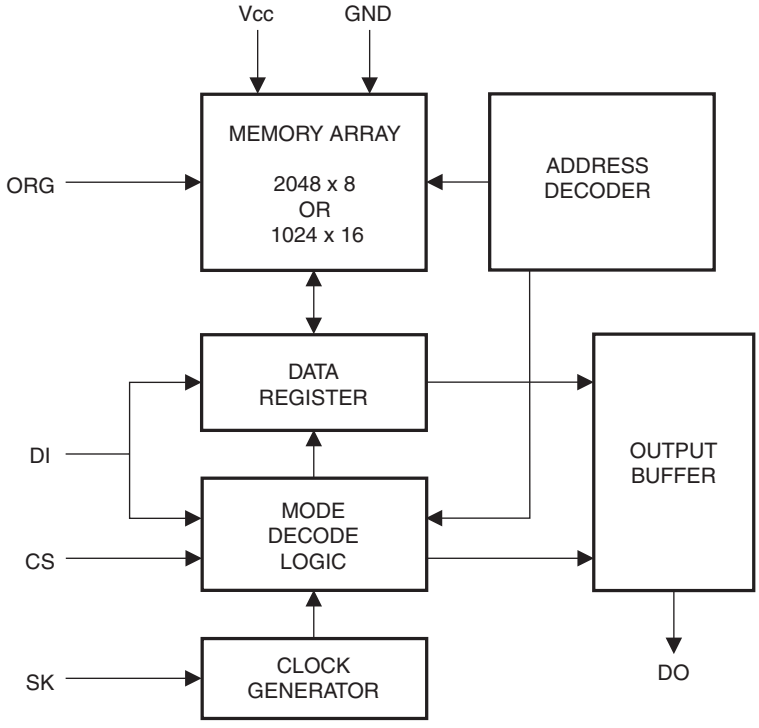
The AT93C86A is enabled through the Chip Select pin (CS), and accessed via a three-wire serial interface consisting of Data Input (DI), Data Output (DO), and Shift Clock (SK). Upon receiving a Read instruction at DI, the address is decoded and the data is clocked out serially on the data output pin DO. The Write cycle is completely self-timed and no separate Erase cycle is required before Write. The Write cycle is only enabled when the part is in the Erase/Write Enable state. When CS is brought "high" following the initiation of a Write cycle, the DO pin outputs the Ready/Busy status of the part. The AT93C86A is available in a 2.7V to 5.5V version.

Absolute Maximum Ratings*

Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C
Voltage on any Pin with Respect to Ground	–1.0V to +7.0V
Maximum Operating Voltage	6.25V
DC Output Current	5.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" 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 beyond 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

Figure 1. Block Diagram



Note: When the ORG pin is connected to Vcc, the x 16 organization is selected. When it is connected to ground, the x 8 organization is selected. If the ORG pin is left unconnected and the application does not load the input beyond the capability of the internal 1 Meg ohm pullup, then the x 16 organization is selected.

Table 2. Pin Capacitance[1]

Applicable over recommended operating range from T_A = 25°C, f = 1.0 MHz, V_{CC} = +5.0V (unless otherwise noted)

Symbol	Test Conditions	Max	Units	Conditions
C_{OUT}	Output Capacitance (DO)	5	pF	V_{OUT} = 0V
C_{IN}	Input Capacitance (CS, SK, DI)	5	pF	V_{IN} = 0V

Note: 1. This parameter is characterized and is not 100% tested.

Table 3. DC Characteristics

Applicable over recommended operating range from: T_{AI} = –40°C to +85°C, V_{CC} = +1.8V to +5.5V,
T_{AE} = –40°C to +125°C, V_{CC} = +1.8V to +5.5V (unless otherwise noted)

Symbol	Parameter	Test Condition		Min	Typ	Max	Unit
V_{CC1}	Supply Voltage			1.8		5.5	V
V_{CC2}	Supply Voltage			2.7		5.5	V
V_{CC3}	Supply Voltage			4.5		5.5	V
I_{CC}	Supply Current	V_{CC} = 5.0V	READ at 1.0 MHz		0.5	2.0	mA
			WRITE at 1.0 MHz		0.5	2.0	mA
I_{SB1}	Standby Current	V_{CC} = 1.8V	CS = 0V		0	0.1	µA
I_{SB2}	Standby Current	V_{CC} = 2.7V	CS = 0V		6.0	10.0	µA
I_{SB3}	Standby Current	V_{CC} = 5.0V	CS = 0V		17	30	µA
I_{IL}	Input Leakage	V_{IN} = 0V to V_{CC}			0.1	3.0	µA
I_{OL}	Output Leakage	V_{IN} = 0V to V_{CC}			0.1	3.0	µA
V_{IL1}[1] V_{IH1}[1]	Input Low Voltage Input High Voltage	2.7V ≤ V_{CC} ≤ 5.5V		---–0.6 2.0		0.8 V_{CC} + 1	V
V_{IL2}[1] V_{IH2}[1]	Input Low Voltage Input High Voltage	1.8V ≤ V_{CC} ≤ 2.7V		–0.6 V_{CC} x 0.7		V_{CC} x 0.3 V_{CC} + 1	V
V_{OL1} V_{OH1}	Output Low Voltage Output High Voltage	2.7V ≤ V_{CC} ≤ 5.5V	I_{OL} = 2.1 mA			0.4	V
			I_{OH} = –0.4 mA	2.4			V
V_{OL2} V_{OH2}	Output Low Voltage Output High Voltage	1.8V ≤ V_{CC} ≤ 2.7V	I_{OL} = 0.15 mA			0.2	V
			I_{OH} = –100 µA	V_{CC} – 0.2			V

Note: 1. V_{IL} min and V_{IH} max are reference only and are not tested.

Table 4. AC Characteristics

Applicable over recommended operating range from T_{AI} = –40°C to + 85°C, T_{AE} = –40°C to +125°C, V_{CC} = As Specified, CL = 1 TTL Gate and 100 pF (unless otherwise noted)

Symbol	Parameter	Test Condition		Min	Typ	Max	Units
f_{SK}	SK Clock Frequency	$4.5V \le V_{CC} \le 5.5V$ $2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$		0 0 0		2 1 0.25	MHz
t_{SKH}	SK High Time	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$		250 1000			ns
t_{SKL}	SK Low Time	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$		250 1000			ns
t_{CS}	Minimum CS Low Time	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$		250 1000			ns
t_{CSS}	CS Setup Time	Relative to SK	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$	50 200			ns
t_{DIS}	DI Setup Time	Relative to SK	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$	100 400			ns
t_{CSH}	CS Hold Time	Relative to SK		0			ns
t_{DIH}	DI Hold Time	Relative to SK	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$	100 400			ns
t_{PD1}	Output Delay to “1”	AC Test	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$			250 1000	ns
t_{PD0}	Output Delay to “0”	AC Test	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$			250 1000	ns
t_{SV}	CS to Status Valid	AC Test	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$			250 1000	ns
t_{DF}	CS to DO in High Impedance	AC Test CS = V_{IL}	$2.7V \le V_{CC} \le 5.5V$ $1.8V \le V_{CC} \le 5.5V$			150 400	ns
t_{WP}	Write Cycle Time		$1.8V \le V_{CC} \le 5.5V$	0.1	3	10	ms
							ms
Endurance(1)	5.0V, 25°C			1M			Write Cycles

Note: 1. This parameter is ensured by characterization.

Table 5. Instruction Set for the AT93C86A

Instruction	SB	Op Code	Address		Data		Comments
			x 8	x 16	x 8	x 16	
READ	1	10	$A_{10} – A_0$	$A_9 – A_0$			Reads data stored in memory, at specified address.
EWEN	1	00	11XXXXXXXXX	11XXXXXXXX			Write enable must precede all programming modes.
ERASE	1	11	$A_{10} – A_0$	$A_9 – A_0$			Erases memory location $A_n – A_0$.
WRITE	1	01	$A_{10} – A_0$	$A_9 – A_0$	$D_7 – D_0$	$D_{15} – D_0$	Writes memory location $A_n – A_0$.
ERAL	1	00	10XXXXXXXXX	10XXXXXXXX			Erases all memory locations. Valid only at V_{CC} = 4.5V to 5.5V.
WRAL	1	00	01XXXXXXXXX	01XXXXXXXX	$D_7 – D_0$	$D_{15} – D_0$	Writes all memory locations. Valid when V_{CC} = 4.5V to 5.5V and Disable Register cleared.
EWDS	1	00	00XXXXXXXXX	00XXXXXXXX			Disables all programming instructions.

Functional Description

The AT93C86A is accessed via a simple and versatile three-wire serial communication interface. Device operation is controlled by seven instructions issued by the host processor. ***A valid instruction starts with a rising edge of CS*** and consists of a Start Bit (logic “1”) followed by the appropriate Op Code and the desired memory address location.

READ (READ): The Read (READ) instruction contains the address code for the memory location to be read. After the instruction and address are decoded, data from the selected memory location is available at the serial output pin DO. Output data changes are synchronized with the rising edges of serial clock SK. It should be noted that a dummy bit (logic “0”) precedes the 8- or 16-bit data output string. The AT93C86A supports sequential read operations. The device will automatically increment the internal address pointer and clock out the next memory location as long as CS is held high. In this case, the dummy bit (logic “0”) will not be clocked out between memory locations, thus allowing for a continuous stream of data to be read.

ERASE/WRITE (EWEN): To assure data integrity, the part automatically goes into the Erase/Write Disable (EWDS) state when power is first applied. An Erase/Write Enable (EWEN) instruction must be executed first before any programming instructions can be carried out. Please note that once in the EWEN state, programming remains enabled until an EWDS instruction is executed or V_{CC} power is removed from the part.

ERASE (ERASE): The Erase (ERASE) instruction programs all bits in the specified memory location to the logical “1” state. The self-timed erase cycle starts once the ERASE instruction and address are decoded. The DO pin outputs the Ready/Busy status of the part if CS is brought high after being kept low for a minimum of 250 ns (t_{CS}). A logic “1” at pin DO indicates that the selected memory location has been erased, and the part is ready for another instruction.

WRITE (WRITE): The Write (WRITE) instruction contains the 8 or 16 bits of data to be written into the specified memory location. The self-timed programming cycle t_{WP} starts after the last bit of data is received at serial data input pin DI. The DO pin outputs the Ready/Busy status of the part if CS is brought high after being kept low for a minimum of

250 ns (t_{CS}). A logic “0” at DO indicates that programming is still in progress. A logic “1” indicates that the memory location at the specified address has been written with the data pattern contained in the instruction and the part is ready for further instructions. *A Ready/Busy status cannot be obtained if the CS is brought high after the end of the self-timed programming cycle t_{WP}.*

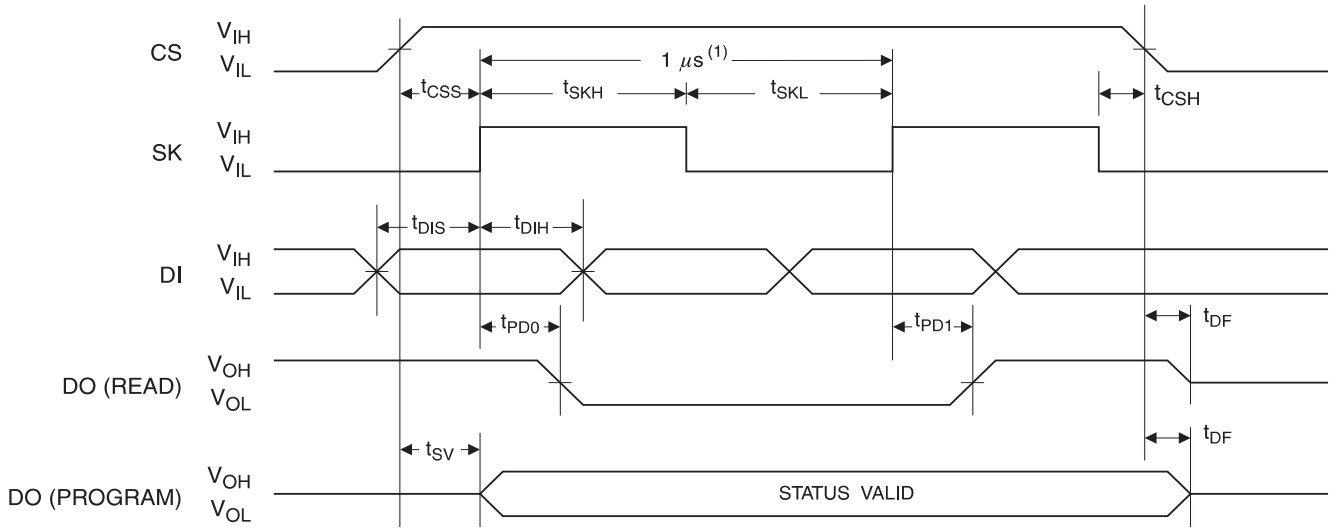
ERASE ALL (ERAL): The Erase All (ERAL) instruction programs every bit in the memory array to the logic “1” state and is primarily used for testing purposes. The DO pin outputs the Ready/Busy status of the part if CS is brought high after being kept low for a minimum of 250 ns (t_{CS}). The ERAL instruction is valid only at V_{CC} = 5.0V ± 10%.

WRITE ALL (WRAL): The Write All (WRAL) instruction programs all memory locations with the data patterns specified in the instruction. The DO pin outputs the Ready/Busy status of the part if CS is brought high after being kept low for a minimum of 250 ns (t_{CS}). The WRAL instruction is valid only at V_{CC} = 5.0V ± 10%.

ERASE/WRITE DISABLE (EWDS): To protect against accidental data disturbance, the Erase/Write Disable (EWDS) instruction disables all programming modes and should be executed after all programming operations. The operation of the READ instruction is independent of both the EWEN and EWDS instructions and can be executed at any time.

Timing Diagrams

Figure 2. Synchronous Data Timing



Note: 1. This is the minimum SK period.

Organization Key for Timing Diagrams

	AT93C86A (16K)	
I/O	**x 8**	**x 16**
A_N	A_{10}	A_9
D_N	D_7	D_{15}

Figure 3. READ Timing

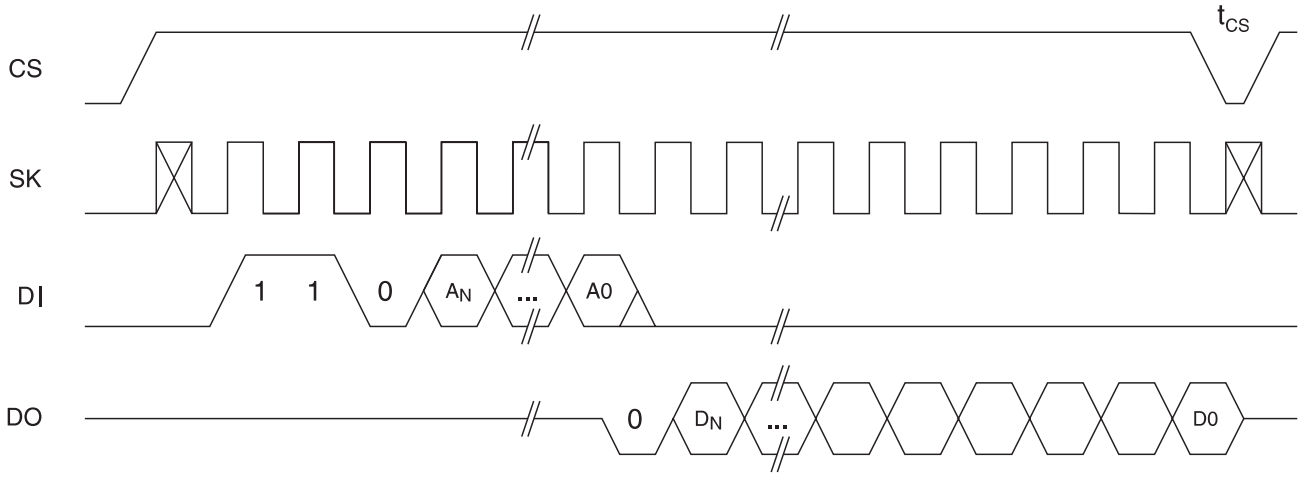


Figure 4. EWEN Timing

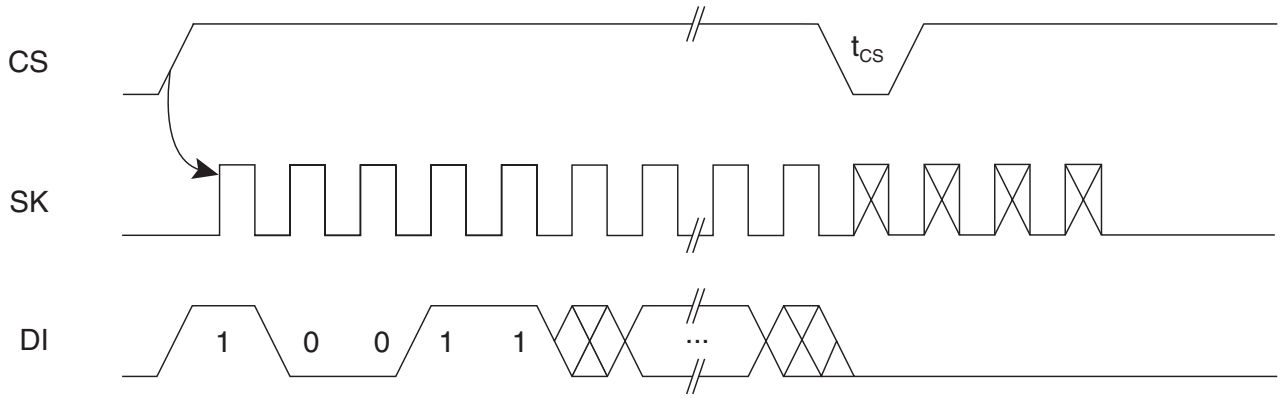


Figure 5. EWDS Timing

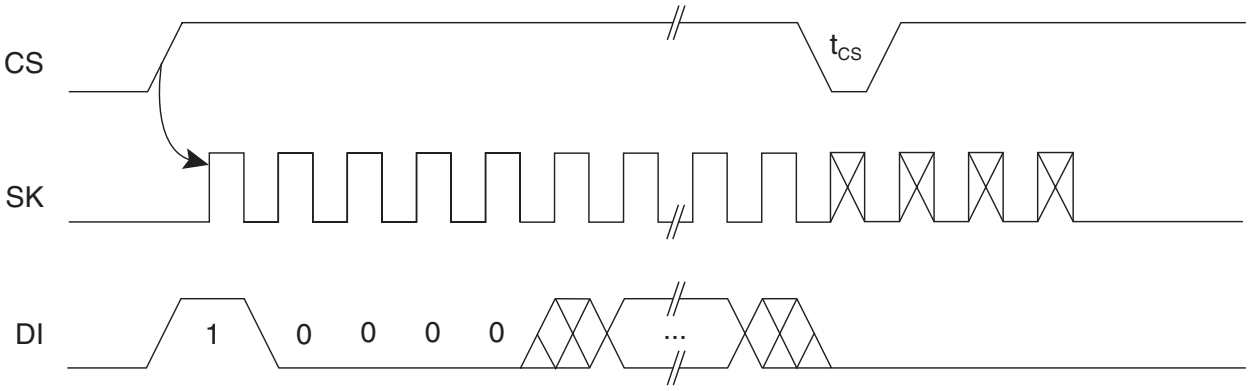


Figure 6. WRITE Timing

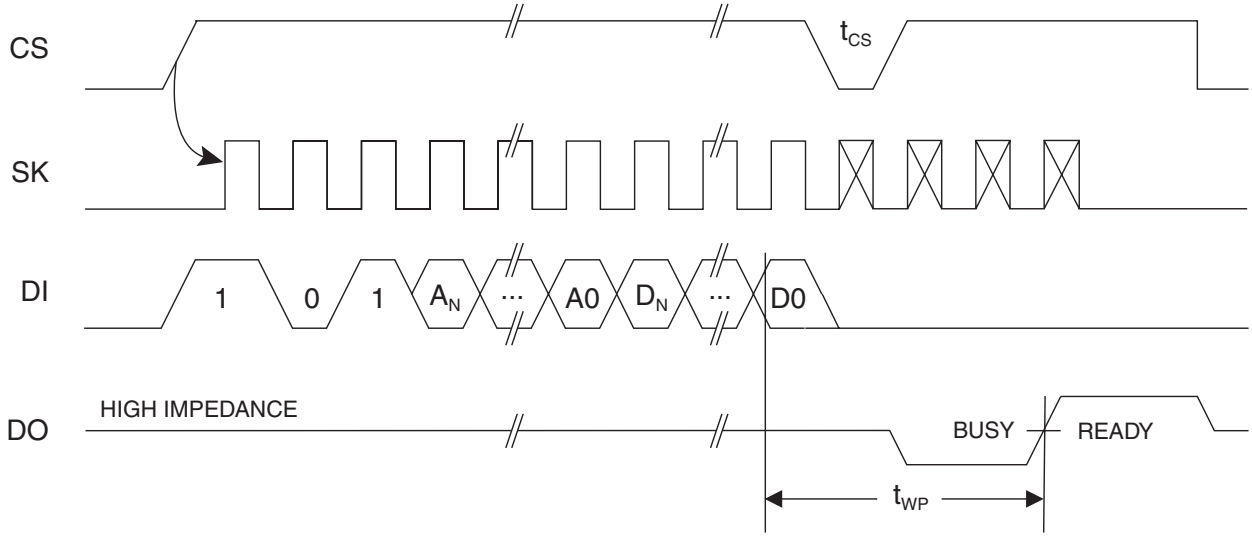
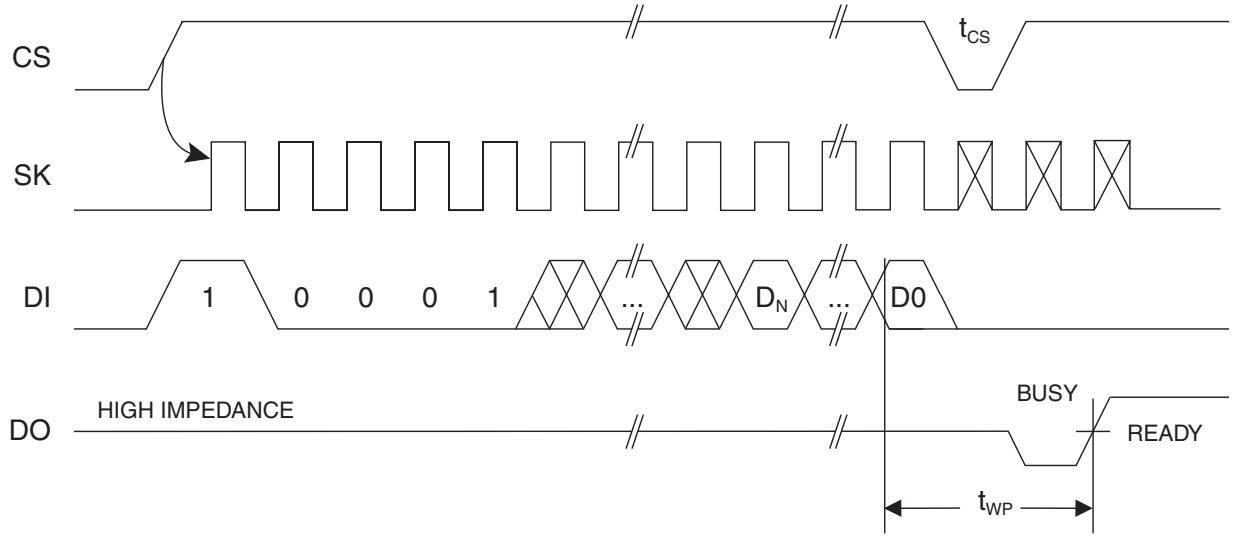


Figure 7. WRAL Timing[1]



Note: 1. Valid only at V_{CC} = 4.5V to 5.5V.

Figure 8. ERASE Timing

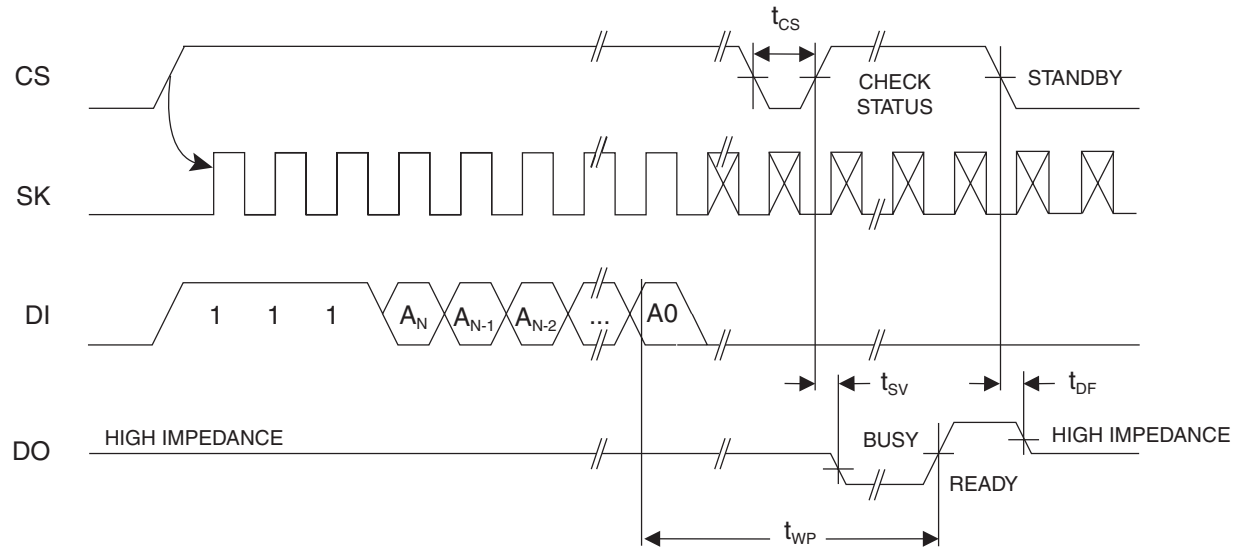
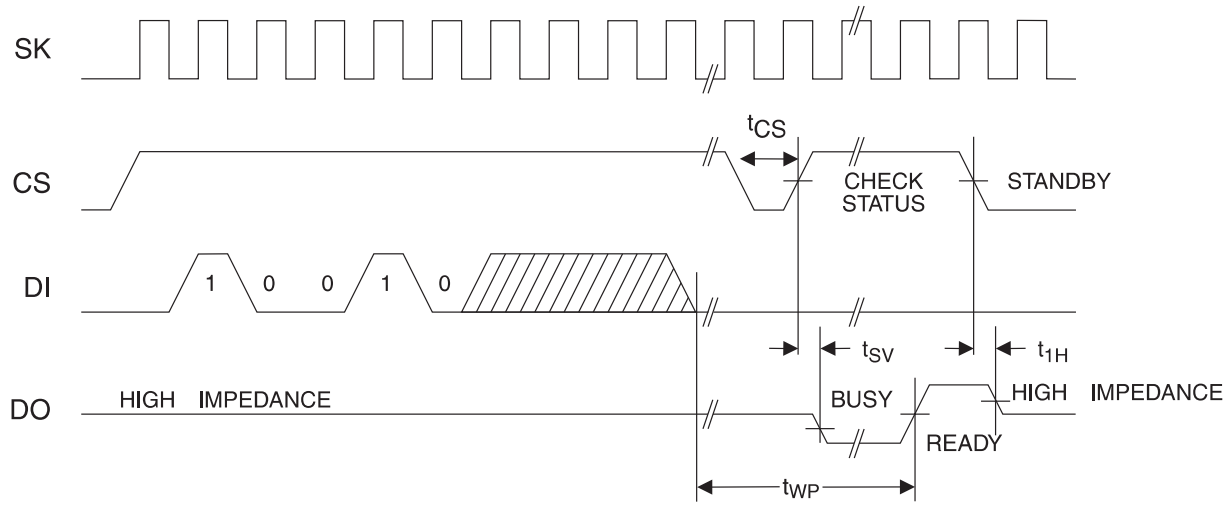


Figure 9. ERAL Timing[1]



Note: 1. Valid only at V_{CC} = 4.5V to 5.5V.

AT93C86A Ordering Information[1]

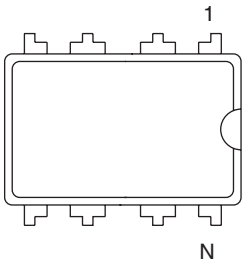
Ordering Code	Package	Operation Range
AT93C86A-10PU-2.7[2] AT93C86A-10PU-1.8[2] AT93C86A-10SU-2.7[2] AT93C86A-10SU-1.8[2] AT93C86A-10TU-2.7[2] AT93C86A-10TU-1.8[2] AT93C86AY1-10YU-1.8[2](Not recommended for new design) AT93C86AY6-10YH-1.8[3]	8P3 8P3 8S1 8S1 8A2 8A2 8Y1 8Y6	Lead-Free/Halogen-Free/ Industrial Temperature (–40°C to 85°C)
AT93C86A-W1.8-11[4]	Die Sale	Industrial Temperature (–40°C to 85°C)

Notes:
1. For 2.7V devices used in a 4.5V to 5.5V range, please refer to performance values in the AC and DC characteristics tables.
2. “U” designates Green package + RoHS compliant.
3. “H” designates Green Package + RoHS compliant, with NiPdAu Lead Finish.
4. Available in Waffle pack and Wafer form; order as SL788 for inkless Wafer form. Bumped die available upon request. Please contact Serial EEPROM marketing.

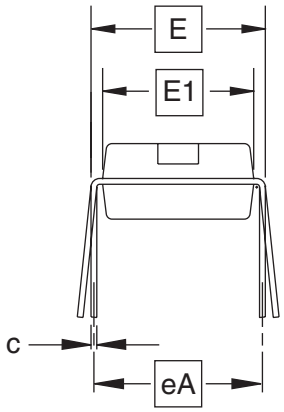
Package Type	
8P3	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
8S1	8-lead, 0.150" Wide, Plastic Gull Wing Small Outline (JEDEC SOIC)
8A2	8-lead, 0.170" Wide, Thin Shrink Small Outline Package (TSSOP)
8Y1	8-lead, 4.90 mm x 3.00 mm Body, Dual Footprint, Non-leaded, Miniature Array Package (MAP)
8Y6	8-lead, 2.00 mm x 3.00 mm Body, 0.50 mm Pitch, Ultra Thin Mini-MAP, Dual No Lead Package (DFN), (MLP 2x3 mm)
Options	
–**2.7**	Low Voltage (2.7V to 5.5V)
–**1.8**	Low Voltage (1.8V to 5.5V)

Packaging Information

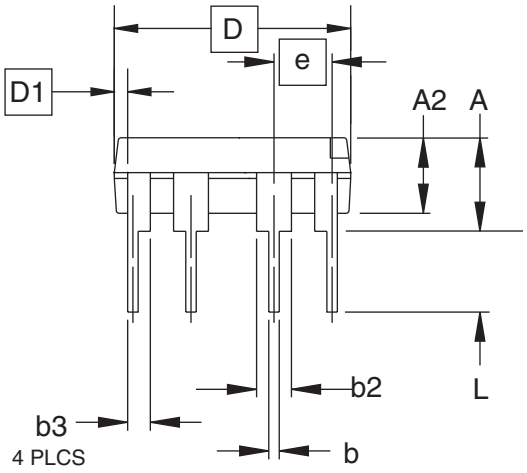
8P3 – PDIP



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = inches)

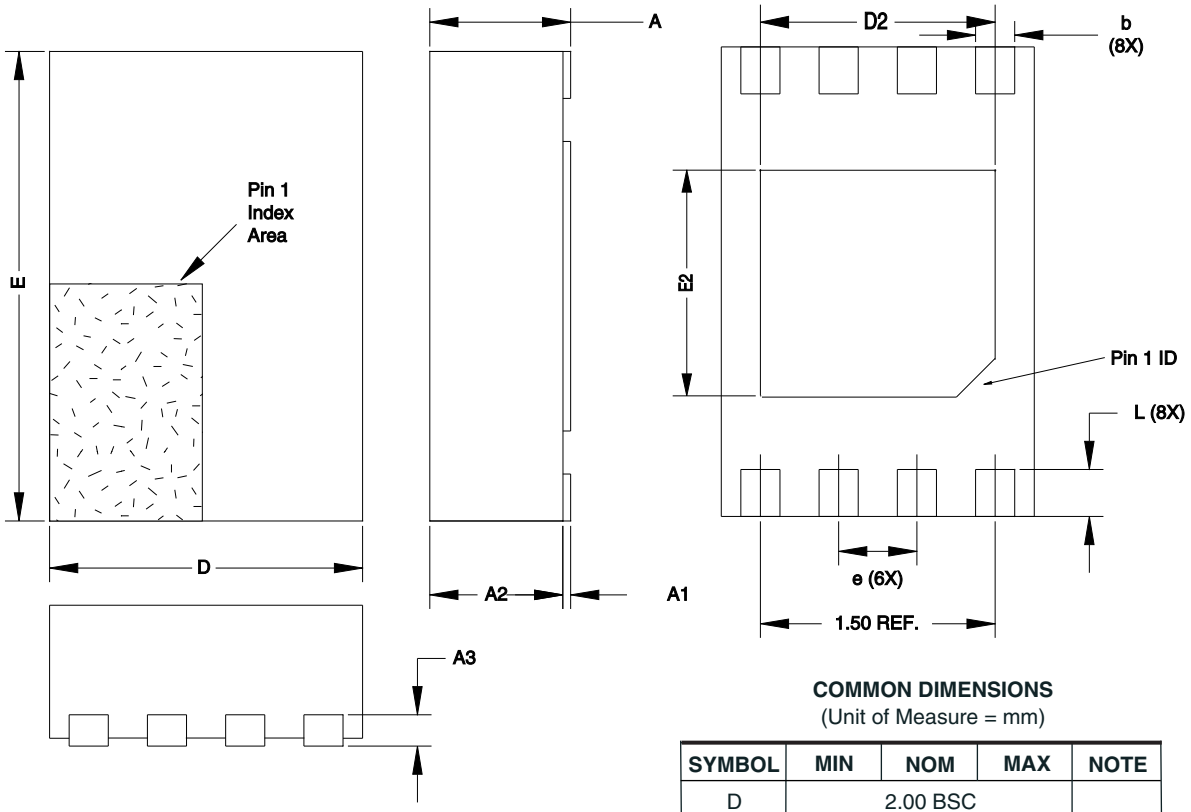
SYMBOL	MIN	NOM	MAX	NOTE
A			0.210	2
A2	0.115	0.130	0.195	
b	0.014	0.018	0.022	5
b2	0.045	0.060	0.070	6
b3	0.030	0.039	0.045	6
c	0.008	0.010	0.014	
D	0.355	0.365	0.400	3
D1	0.005			3
E	0.300	0.310	0.325	4
E1	0.240	0.250	0.280	3
e	0.100 BSC			
eA	0.300 BSC			4
L	0.115	0.130	0.150	2

Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-001, Variation BA for additional information.
2. Dimensions A and L are measured with the package seated in JEDEC seating plane Gauge GS-3.
3. D, D1 and E1 dimensions do not include mold Flash or protrusions. Mold Flash or protrusions shall not exceed 0.010 inch.
4. E and eA measured with the leads constrained to be perpendicular to datum.
5. Pointed or rounded lead tips are preferred to ease insertion.
6. b2 and b3 maximum dimensions do not include Dambar protrusions. Dambar protrusions shall not exceed 0.010 (0.25 mm).

01/09/02

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**8P3**, 8-lead, 0.300" Wide Body, Plastic Dual In-line Package (PDIP)	8P3	B

8Y6 - MLP 2x3 mm



COMMON DIMENSIONS
(Unit of Measure = mm)

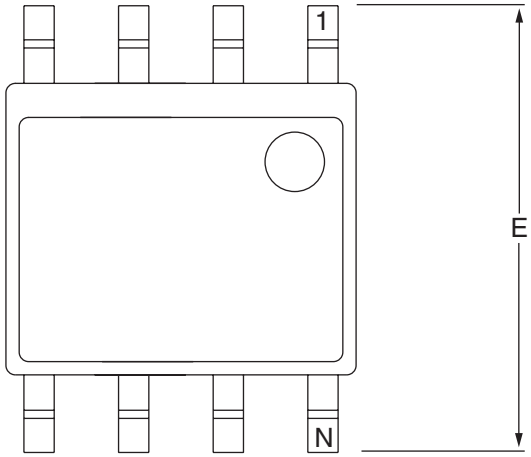
SYMBOL	MIN	NOM	MAX	NOTE
D		2.00 BSC		
E		3.00 BSC		
D2	1.40	1.50	1.60	
E2	-	-	1.40	
A	-	-	0.60	
A1	0.0	0.02	0.05	
A2	-	-	0.55	
A3		0.20 REF		
L	0.20	0.30	0.40	
e		0.50 BSC		
b	0.20	0.25	0.30	2

Notes:
1. This drawing is for general information only. Refer to JEDEC Drawing MO-229, for proper dimensions, tolerances, datums, etc.
2. Dimension b applies to metallized terminal and is measured between 0.15 mm and 0.30 mm from the terminal tip. If the terminal has the optional radius on the other end of the terminal, the dimension should not be measured in that radius area.

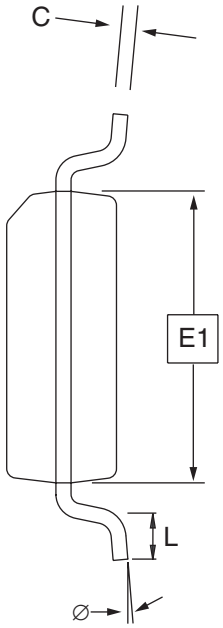
8/26/05

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**8Y6**, 8-lead 2.0 x 3.0 mm Body, 0.50 mm Pitch, Utlra Thin Mini-Map, Dual No Lead Package (DFN) ,(MLP 2x3)	8Y6	C

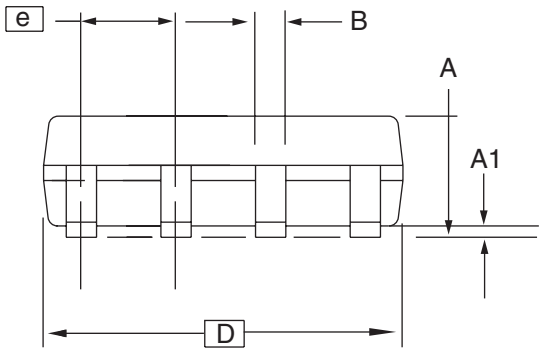
8S1 – JEDEC SOIC



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = mm)

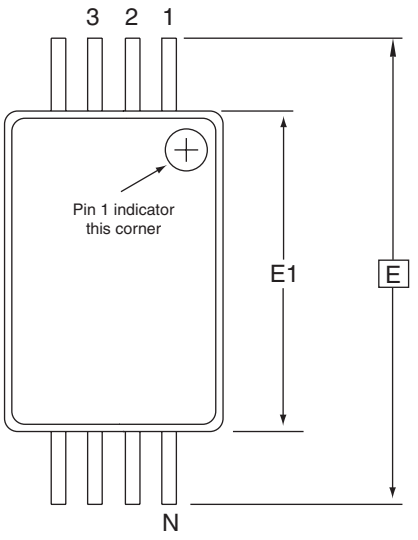
SYMBOL	MIN	NOM	MAX	NOTE
A	1.35	–	1.75	
A1	0.10	–	0.25	
B	0.31	–	0.51	
C	0.17	–	0.25	
D	4.80	–	5.00	
E1	3.81	–	3.99	
E	5.79	–	6.20	
e	1.27 BSC			
L	0.40	–	1.27	
∅	0°	–	8°	

Note: These drawings are for general information only. Refer to JEDEC Drawing MS-012, Variation AA for proper dimensions, tolerances, datums, etc.

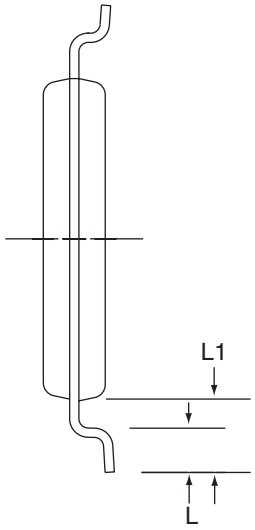
10/7/03

1150 E. Cheyenne Mtn. Blvd. Colorado Springs, CO 80906	**TITLE** **8S1**, 8-lead (0.150" Wide Body), Plastic Gull Wing Small Outline (JEDEC SOIC)	**DRAWING NO.** 8S1	**REV.** B

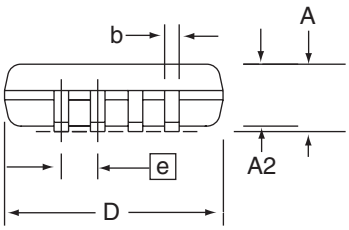
8A2 – TSSOP



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = mm)

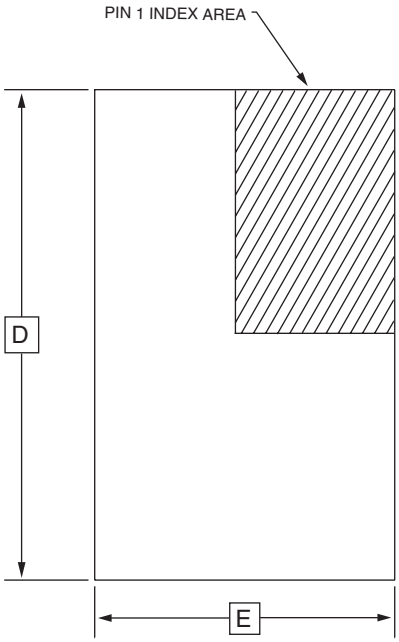
SYMBOL	MIN	NOM	MAX	NOTE
D	2.90	3.00	3.10	2, 5
E		6.40 BSC		
E1	4.30	4.40	4.50	3, 5
A	–	–	1.20	
A2	0.80	1.00	1.05	
b	0.19	–	0.30	4
e		0.65 BSC		
L	0.45	0.60	0.75	
L1		1.00 REF		

Notes:
1. This drawing is for general information only. Refer to JEDEC Drawing MO-153, Variation AA, for proper dimensions, tolerances, datums, etc.
2. Dimension D does not include mold Flash, protrusions or gate burrs. Mold Flash, protrusions and gate burrs shall not exceed 0.15 mm (0.006 in) per side.
3. Dimension E1 does not include inter-lead Flash or protrusions. Inter-lead Flash and protrusions shall not exceed 0.25 mm (0.010 in) per side.
4. Dimension b does not include Dambar protrusion. Allowable Dambar protrusion shall be 0.08 mm total in excess of the b dimension at maximum material condition. Dambar cannot be located on the lower radius of the foot. Minimum space between protrusion and adjacent lead is 0.07 mm.
5. Dimension D and E1 to be determined at Datum Plane H.

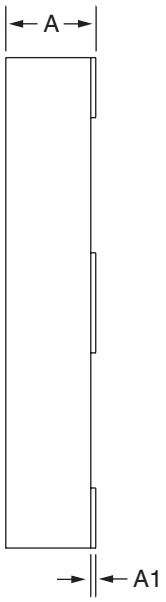
5/30/02

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**8A2**, 8-lead, 4.4 mm Body, Plastic Thin Shrink Small Outline Package (TSSOP)	8A2	B

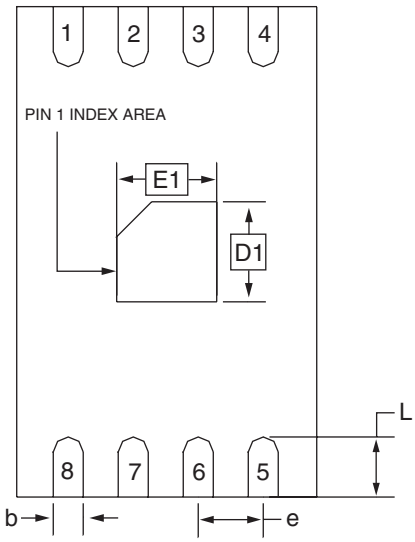
8Y1 - MAP



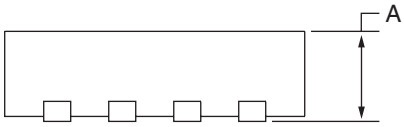
Top View



End View



Bottom View



Side View

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	0.90	
A1	0.00	–	0.05	
D	4.70	4.90	5.10	
E	2.80	3.00	3.20	
D1	0.85	1.00	1.15	
E1	0.85	1.00	1.15	
b	0.25	0.30	0.35	
e	0.65 TYP			
L	0.50	0.60	0.70	

2/28/03

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**8Y1,** 8-lead (4.90 x 3.00 mm Body) MSOP Array Package (MAP) Y1	8Y1	C

Revision History

Doc. Rev.	Date	Comments
3408H	1/2007	Add “Bottom View” to pg 1 Ultra Thin MiniMap package drawing pg 4 revise Note 1 added “ensured by characterization”
3408G	7/2006	Revision history implemented. Deleted ‘Preliminary’ status from datasheet; Added ‘Ultra Thin’ description to MLP 2x3 package; Deleted ‘1.8V not available’ on Figure 1 Note; Added 1.8V range on Table 4 under Write Cycle Time.

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