CAT93C86B

16-Kb Microwire Serial EEPROM

Description

The CAT93C86B is a 16−Kb Serial EEPROM memory device which is configured as either registers of 16 bits (ORG pin at V_{CC}) or 8 bits (ORG pin at GND). Each register can be written (or read) serially by using the DI (or DO) pin. The CAT93C86B features a self−timed internal write with auto−clear. On−chip Power−On Reset circuit protects the internal logic against powering up in the wrong state.

Features

- High Speed Operation: 4 MHz (5 V), 2 MHz (1.8 V)
- 1.8 V (1.65 V*) to 5.5 V Supply Voltage Range
- Selectable x8 or x16 Memory Organization
- Self−timed Write Cycle with Auto−clear
- Sequential Read
- Hardware and Software Write Protection
- Power−up Inadvertent Write Protection
- Low Power CMOS Technology
- Program Enable (PE) Pin
- 1,000,000 Program/Erase Cycles
- 100 Year Data Retention
- Industrial and Extended Temperature Ranges
- 8−pin PDIP, SOIC, MSOP, TSSOP, 8−pad UDFN, and WLCSP 6−ball Packages
- This Device is Pb−Free, Halogen Free/BFR Free, and RoHS Compliant†

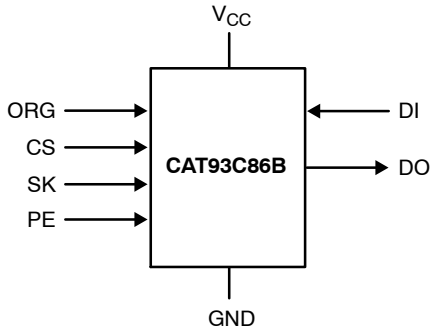


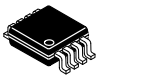
Figure 1. Functional Symbol

***CAT93C86Bxx−xxL (T_A = −20°C to +85°C)**

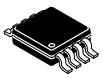
†For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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MSOP−8
Z SUFFIX
CASE 846AD



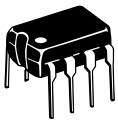
SOIC−8
X SUFFIX
CASE 751BE



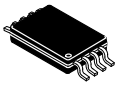
UDFN−8
HU4 SUFFIX
CASE 517AZ



WLCSP−6
C6A SUFFIX
PRELIMINARY



PDIP−8
L SUFFIX
CASE 646AA

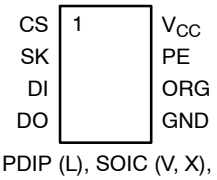


TSSOP−8
Y SUFFIX
CASE 948AL

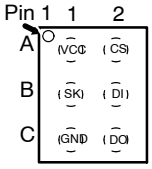


SOIC−8
V SUFFIX
CASE 751BD

PIN CONFIGURATION



PDIP (L), SOIC (V, X),
TSSOP (Y),
UDFN (HU4), MSOP (Z)



WLCSP*, ** (C6A)
*ORG internally connected to GND
**PE float

PIN FUNCTION

Pin Name	Function
CS	Chip Select
SK	Clock Input
DI	Serial Data Input
DO	Serial Data Output
V_{CC}	Power Supply
GND	Ground
ORG	Memory Organization
PE	Program Enable

Note: When the ORG pin is connected to V_{CC}, the x16 organization is selected. When it is connected to ground, the x8 pin is selected. If the ORG pin is left unconnected, then an internal pull−up device will select the x16 organization.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 14 of this data sheet.

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Table 1. ABSOLUTE MAXIMUM RATINGS

Parameters	Ratings	Units
Storage Temperature	−65 to +150	°C
Voltage on Any Pin with Respect to Ground (Note 1)	−0.5 to +6.5	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. The DC input voltage on any pin should not be lower than −0.5 V or higher than V_{CC} + 0.5 V. During transitions, the voltage on any pin may undershoot to no less than −1.5 V or overshoot to no more than V_{CC} + 1.5 V, for periods of less than 20 ns.

Table 2. RELIABILITY CHARACTERISTICS (Note 2)

Symbol	Parameter	Min	Units
N_{END} (Note 3)	Endurance	1,000,000	Program / Erase Cycles
T_{DR}	Data Retention	100	Years

2. These parameters are tested initially and after a design or process change that affects the parameter according to appropriate AEC−Q100 and JEDEC test methods.
3. Block Mode, V_{CC} = 5 V, 25°C.

Table 3. D.C. OPERATING CHARACTERISTICS
(V_{CC} = +1.8 V to +5.5 V, T_A = −40°C to +125°C, V_{CC} = +1.65 V to +5.5 V, T_A = −20°C to +85°C unless otherwise specified.)

Symbol	Parameter	Test Conditions		Min	Max	Units
I_{CC1}	Supply Current (Write)	Write, V_{CC} = 5.0 V			2	mA
I_{CC2}	Supply Current (Read)	Read, DO open, f_{SK} = 2 MHz, V_{CC} = 5.0 V			500	μA
I_{SB1}	Standby Current (x8 Mode)	V_{IN} = GND or V_{CC} CS = GND, ORG = GND	T_A = −40°C to +85°C		2	μA
			T_A = −40°C to +125°C		5	
I_{SB2}	Standby Current (x16 Mode)	V_{IN} = GND or V_{CC} CS = GND, ORG = Float or V_{CC}	T_A = −40°C to +85°C		1	μA
			T_A = −40°C to +125°C		3	
I_{LI}	Input Leakage Current	V_{IN} = GND to V_{CC}	T_A = −40°C to +85°C		1	μA
			T_A = −40°C to +125°C		2	
I_{LO}	Output Leakage Current	V_{OUT} = GND to V_{CC} CS = GND	T_A = −40°C to +85°C		1	μA
			T_A = −40°C to +125°C		2	
V_{IL1}	Input Low Voltage	4.5 V ≤ V_{CC} < 5.5 V		−0.1	0.8	V
V_{IH1}	Input High Voltage	4.5 V ≤ V_{CC} < 5.5 V		2	V_{CC} + 1	V
V_{IL2}	Input Low Voltage	1.65 V ≤ V_{CC} < 4.5 V		0	V_{CC} x 0.2	V
V_{IH2}	Input High Voltage	1.65 V ≤ V_{CC} < 4.5 V		V_{CC} x 0.7	V_{CC} + 1	V
V_{OL1}	Output Low Voltage	4.5 V ≤ V_{CC} < 5.5 V, I_{OL} = 3 mA			0.4	V
V_{OH1}	Output High Voltage	4.5 V ≤ V_{CC} < 5.5 V, I_{OH} = −400 μA		2.4		V
V_{OL2}	Output Low Voltage	1.65 V ≤ V_{CC} < 4.5 V, I_{OL} = 1 mA			0.2	V
V_{OH2}	Output High Voltage	1.65 V ≤ V_{CC} < 4.5 V, I_{OH} = −100 μA		V_{CC} − 0.2		V

Table 4. PIN CAPACITANCE (Note 4)

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

Table 5. POWER−UP TIMING (Notes 4, 5)

Symbol	Parameter	Max	Units
t_{PUR}	Power−up to Read Operation	1	ms
t_{PUW}	Power−up to Write Operation	1	ms

Table 6. A.C. TEST CONDITIONS

Input Rise and Fall Times	≤ 50 ns	
Input Pulse Voltages	0.4 V to 2.4 V	4.5 V ≤ V_{CC} ≤ 5.5 V
Timing Reference Voltages	0.8 V, 2.0 V	4.5 V ≤ V_{CC} ≤ 5.5 V
Input Pulse Voltages	0.2 V_{CC} to 0.7 V_{CC}	1.65 V ≤ V_{CC} ≤ 4.5 V
Timing Reference Voltages	0.5 V_{CC}	1.65 V ≤ V_{CC} ≤ 4.5 V
Output Load	Current Source I_{OLmax}/I_{OHmax}; CL = 100 pF	

4. These parameters are tested initially and after a design or process change that affects the parameter.
5. t_{PUR} and t_{PUW} are the delays required from the time V_{CC} is stable until the specified operation can be initiated.

Table 7. A.C. CHARACTERISTICS

(V_{CC} = +1.8 V to +5.5 V, T_A = −40°C to +125°C, V_{CC} = +1.65 V to +5.5 V, T_A = −20°C to +85°C unless otherwise specified.)

		V_{CC} < 4.5 V		V_{CC} > 4.5 V		
Symbol	**Parameter**	**Min**	**Max**	**Min**	**Max**	**Units**
t_{CSS}	CS Setup Time	50		50		ns
t_{CSH}	CS Hold Time	0		0		ns
t_{DIS}	DI Setup Time	100		50		ns
t_{DIH}	DI Hold Time	100		50		ns
t_{PD1}	Output Delay to 1		0.25		0.1	μs
t_{PD0}	Output Delay to 0		0.25		0.1	μs
t_{HZ} (Note 6)	Output Delay to High−Z		100		100	ns
t_{EW}	Program/Erase Pulse Width		5		5	ms
t_{CSMIN}	Minimum CS Low Time	0.25		0.1		μs
t_{SKHI}	Minimum SK High Time	0.25		0.1		μs
t_{SKLOW}	Minimum SK Low Time	0.25		0.1		μs
t_{SV}	Output Delay to Status Valid		0.25		0.1	μs
SK_{MAX}	Maximum Clock Frequency	DC	2000	DC	4000	kHz

6. This parameter is tested initially and after a design or process change that affects the parameter.

Table 8. INSTRUCTION SET

			Address		Data		
Instruction	**Start Bit**	**Opcode**	**x8**	**x16**	**x8**	**x16**	**Comments**
READ	1	10	A10−A0	A9−A0			Read Address AN− A0
ERASE	1	11	A10−A0	A9−A0			Clear Address AN− A0
WRITE	1	01	A10−A0	A9−A0	D7−D0	D15−D0	Write Address AN− A0
EWEN	1	00	11XXXXXXXXX	11XXXXXXXX			Write Enable
EWDS	1	00	00XXXXXXXXX	00XXXXXXXX			Write Disable
ERAL*	1	00	10XXXXXXXXX	10XXXXXXXX			Clear All Addresses
WRAL*	1	00	01XXXXXXXXX	01XXXXXXXX	D7−D0	D15−D0	Write All Addresses

*Not available at V_{CC} < 1.8 V

Device Operation

The CAT93C86B is a 16,384−bit nonvolatile memory intended for use with industry standard microprocessors. The CAT93C86B can be organized as either registers of 16 bits or 8 bits. When organized as X16, seven 13−bit instructions control the reading, writing and erase operations of the device. When organized as X8, seven 14−bit instructions control the reading, writing and erase operations of the device. The CAT93C86B operates on a single power supply and will generate on chip, the high voltage required during any write operation.

Instructions, addresses, and write data are clocked into the DI pin on the rising edge of the clock (SK). The DO pin is normally in a high impedance state except when reading data from the device, or when checking the ready/busy status after a write operation.

The ready/busy status can be determined after the start of a write operation by selecting the device (CS high) and polling the DO pin; DO low indicates that the write operation is not completed, while DO high indicates that the device is ready for the next instruction. If necessary, the DO pin may be placed back into a high impedance state during chip select by shifting a dummy "1" into the DI pin. The DO pin will enter the high impedance state on the falling edge of the clock (SK). Placing the DO pin into the high impedance state is recommended in applications where the DI pin and the DO pin are to be tied together to form a common DI/O pin.

The format for all instructions sent to the device is a logical "1" start bit, a 2−bit (or 4−bit) opcode, 10−bit address (an additional bit when organized X8) and for write operations a 16−bit data field (8−bit for X8 organizations).

Note: *The Write, Erase, Write all and Erase all instructions require PE = 1. If PE is left floating, 93C86B is in Program Enabled mode. For Write Enable and Write Disable instruction PE = don't care.*

Read

Upon receiving a READ command and an address (clocked into the DI pin), the DO pin of the CAT93C86B will come out of the high impedance state and, after sending an initial dummy zero bit, will begin shifting out the data addressed (MSB first). The output data bits will toggle on the rising edge of the SK clock and are stable after the specified time delay (t_{PD0} or t_{PD1}).

After the initial data word has been shifted out and CS remains asserted with the SK clock continuing to toggle, the device will automatically increment to the next address and shift out the next data word in a sequential READ mode. As long as CS is continuously asserted and SK continues to toggle, the device will keep incrementing to the next address automatically until it reaches to the end of the address space, then loops back to address 0. In the sequential READ mode, only the initial data word is preceeded by a dummy zero bit. All subsequent data words will follow without a dummy zero bit.

Write

After receiving a WRITE command, address and the data, the CS (Chip Select) pin must be deselected for a minimum of t_{CSMIN}. The falling edge of CS will start the self clocking clear and data store cycle of the memory location specified in the instruction. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the CAT93C86B can be determined by selecting the device and polling the DO pin. Since this device features Auto−Clear before write, it is NOT necessary to erase a memory location before it is written into.

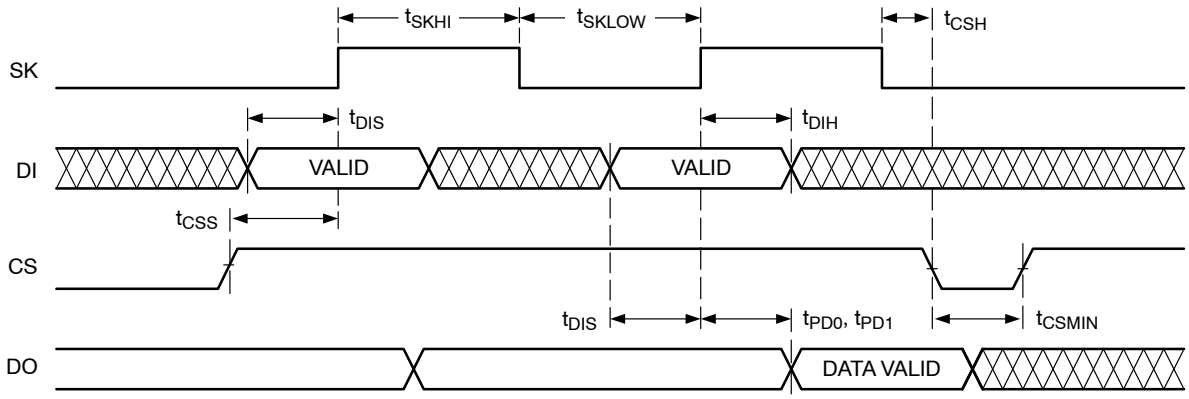


Figure 2. Synchronous Data Timing

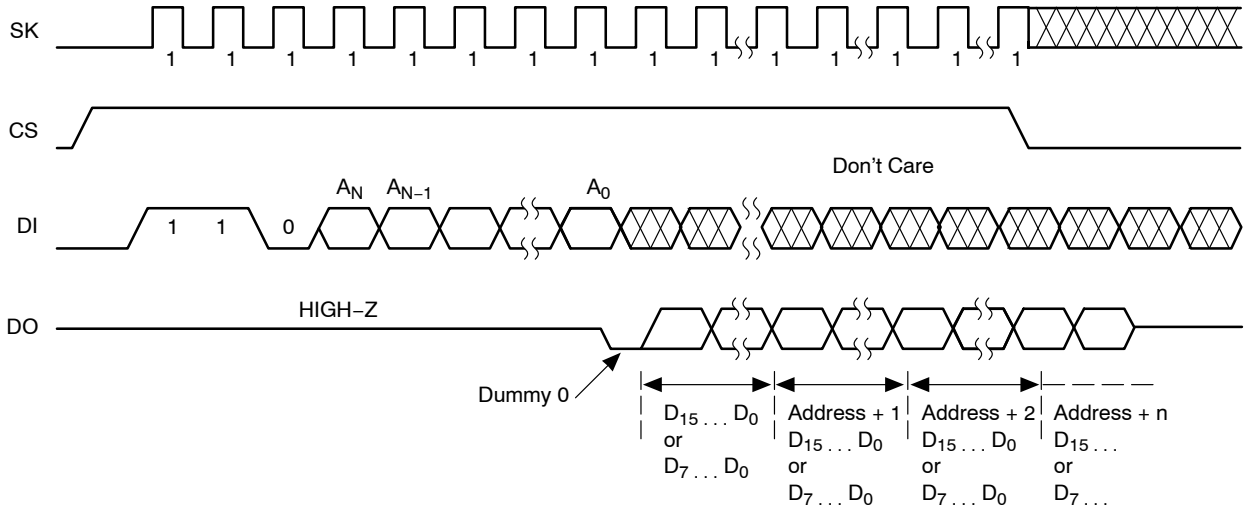


Figure 3. Read Instruction Timing

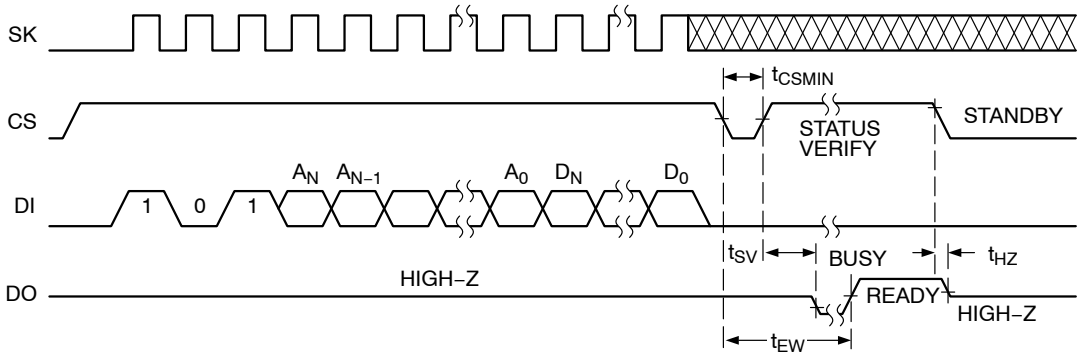


Figure 4. Write Instruction Timing

Erase

Upon receiving an ERASE command and address, the CS (Chip Select) pin must be deasserted for a minimum of t_{CSMIN}. The falling edge of CS will start the self clocking clear cycle of the selected memory location. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the CAT93C86B can be determined by selecting the device and polling the DO pin. Once cleared, the content of a cleared location returns to a logical “1” state.

Erase/Write Enable and Disable

The CAT93C86B powers up in the write disable state. Any writing after power−up or after an EWDS (write disable) instruction must first be preceded by the EWEN (write enable) instruction. Once the write instruction is enabled, it will remain enabled until power to the device is removed, or the EWDS instruction is sent. The EWDS instruction can be used to disable all CAT93C86B write and clear instructions, and will prevent any accidental writing or clearing of the device. Data can be read normally from the device regardless of the write enable/disable status.

Erase All

Upon receiving an ERAL command, the CS (Chip Select) pin must be deselected for a minimum of t_{CSMIN}. The falling edge of CS will start the self clocking clear cycle of all memory locations in the device. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the CAT93C86B can be determined by selecting the device and polling the DO pin. Once cleared, the contents of all memory bits return to a logical “1” state.

Write All

Upon receiving a WRAL command and data, the CS (Chip Select) pin must be deselected for a minimum of t_{CSMIN}. The falling edge of CS will start the self clocking data write to all memory locations in the device. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the CAT93C86B can be determined by selecting the device and polling the DO pin. It is not necessary for all memory locations to be cleared before the WRAL command is executed.

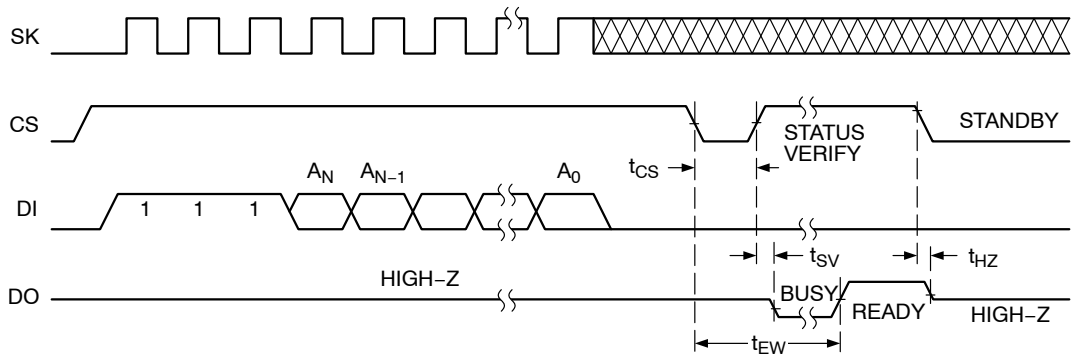
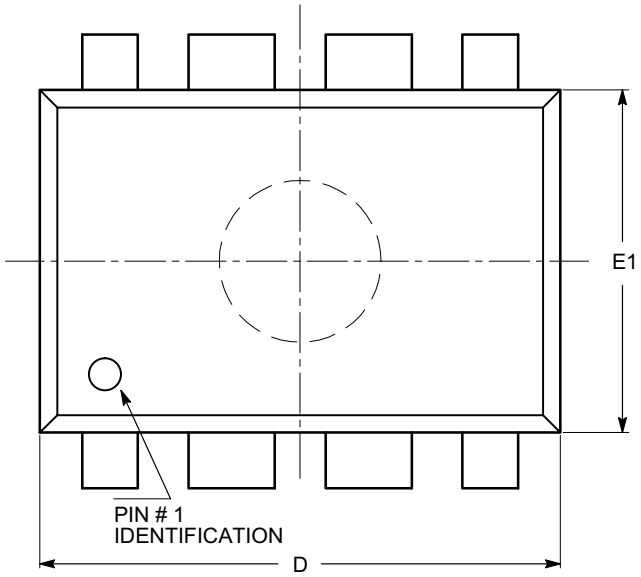


Figure 5. Erase Instruction Timing

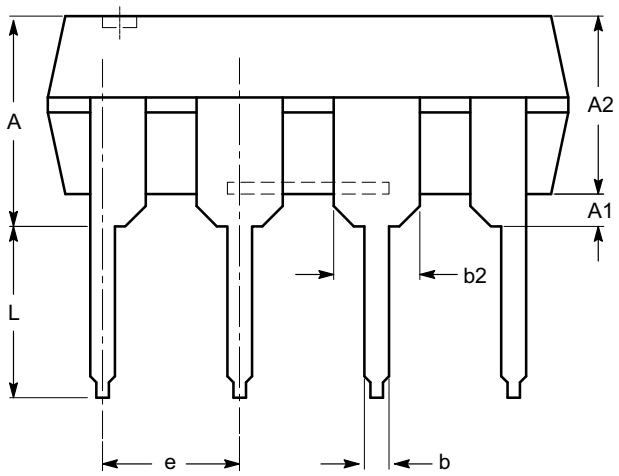
PACKAGE DIMENSIONS

PDIP−8, 300 mils
CASE 646AA−01
ISSUE A

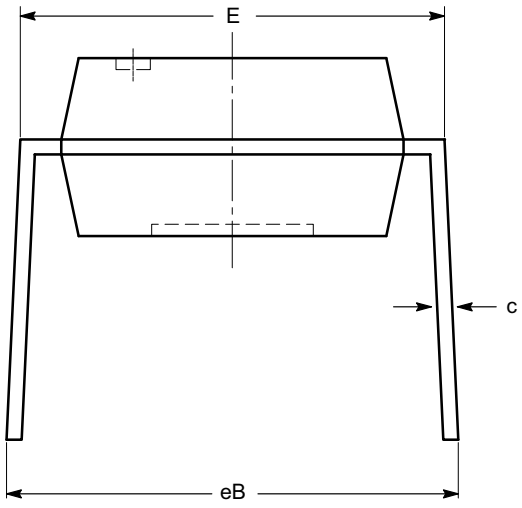


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			5.33
A1	0.38		
A2	2.92	3.30	4.95
b	0.36	0.46	0.56
b2	1.14	1.52	1.78
c	0.20	0.25	0.36
D	9.02	9.27	10.16
E	7.62	7.87	8.25
E1	6.10	6.35	7.11
e		2.54 BSC	
eB	7.87		10.92
L	2.92	3.30	3.80



SIDE VIEW

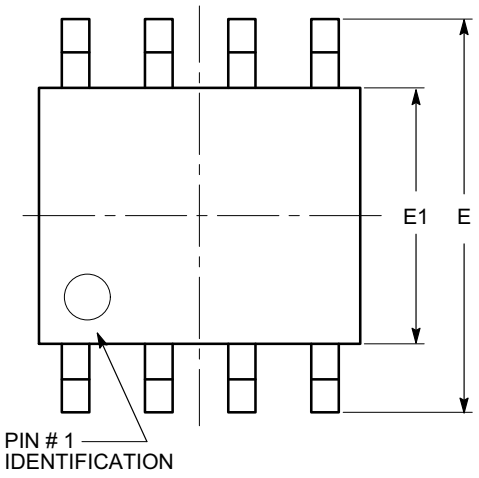


END VIEW

Notes:
(1) All dimensions are in millimeters.
(2) Complies with JEDEC MS-001.

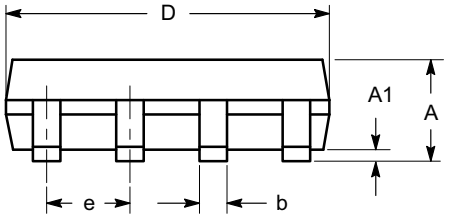
PACKAGE DIMENSIONS

SOIC 8, 150 mils
CASE 751BD−01
ISSUE O

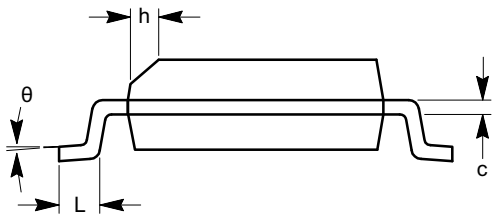


TOP VIEW

SYMBOL	MIN	NOM	MAX
A	1.35		1.75
A1	0.10		0.25
b	0.33		0.51
c	0.19		0.25
D	4.80		5.00
E	5.80		6.20
E1	3.80		4.00
e		1.27 BSC	
h	0.25		0.50
L	0.40		1.27
θ	0°		8°



SIDE VIEW

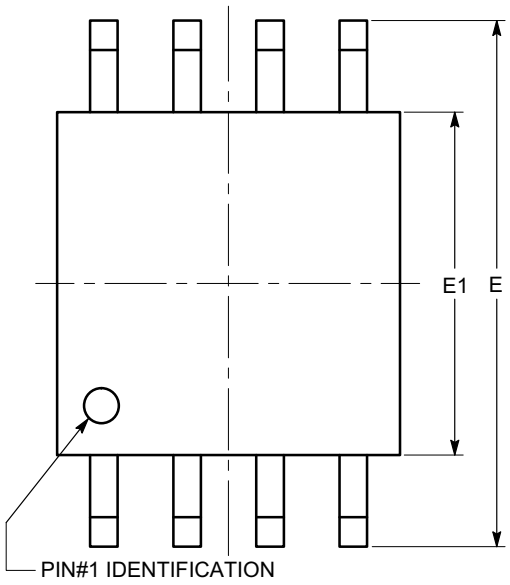


END VIEW

Notes:
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(2) Complies with JEDEC MS-012.

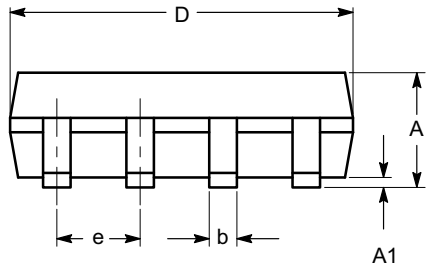
PACKAGE DIMENSIONS

SOIC−8, 208 mils
CASE 751BE−01
ISSUE O

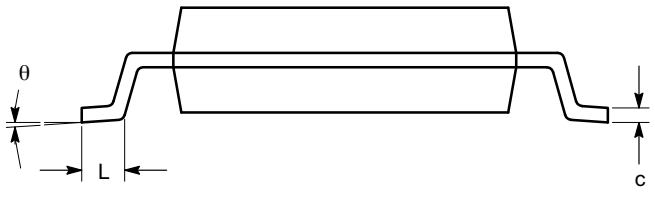


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			2.03
A1	0.05		0.25
b	0.36		0.48
c	0.19		0.25
D	5.13		5.33
E	7.75		8.26
E1	5.13		5.38
e	1.27 BSC		
L	0.51		0.76
θ	0°		8°



SIDE VIEW

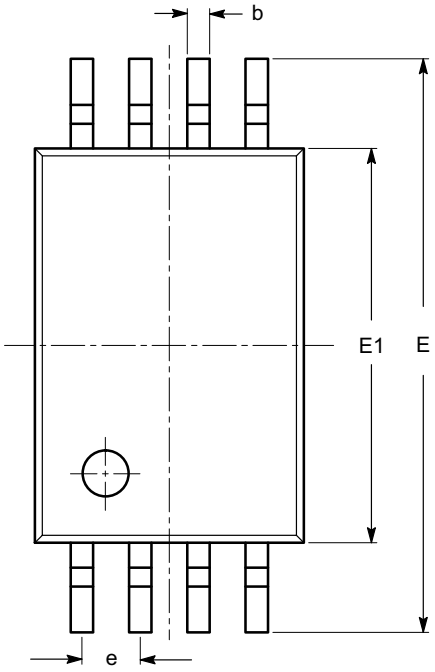


END VIEW

Notes:
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with EIAJ EDR-7320.

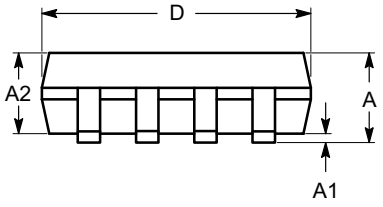
PACKAGE DIMENSIONS

TSSOP8, 4.4x3
CASE 948AL−01
ISSUE O

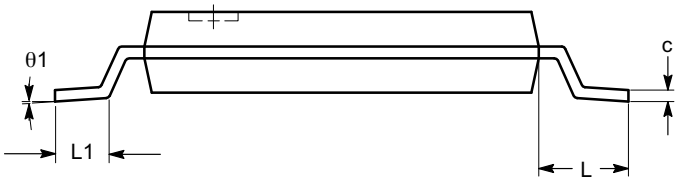


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			1.20
A1	0.05		0.15
A2	0.80	0.90	1.05
b	0.19		0.30
c	0.09		0.20
D	2.90	3.00	3.10
E	6.30	6.40	6.50
E1	4.30	4.40	4.50
e	0.65 BSC		
L	1.00 REF		
L1	0.50	0.60	0.75
θ	0°		8°



SIDE VIEW

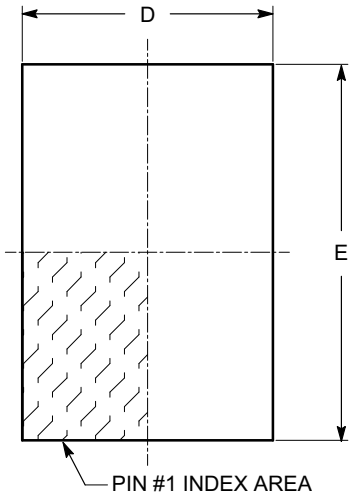


END VIEW

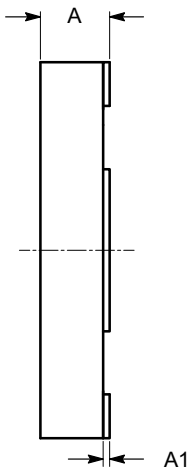
Notes:
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-153.

PACKAGE DIMENSIONS

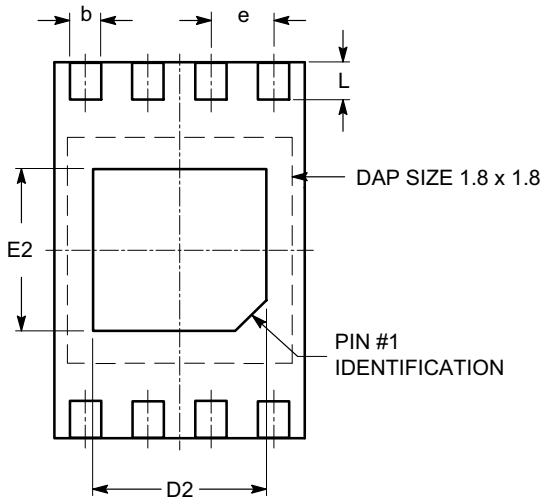
UDFN8, 2x3 EXTENDED PAD
CASE 517AZ−01
ISSUE O



TOP VIEW



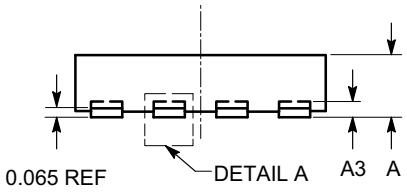
SIDE VIEW



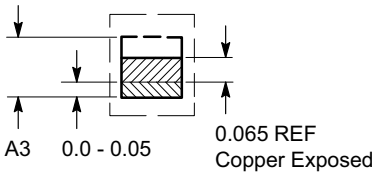
BOTTOM VIEW

SYMBOL	MIN	NOM	MAX
A	0.45	0.50	0.55
A1	0.00	0.02	0.05
A3		0.127 REF	
b	0.20	0.25	0.30
D	1.95	2.00	2.05
D2	1.35	1.40	1.45
E	2.95	3.00	3.05
E2	1.25	1.30	1.35
e		0.50 REF	
L	0.25	0.30	0.35

Notes:
(1) All dimensions are in millimeters.
(2) Refer JEDEC MO-236/MO-252.



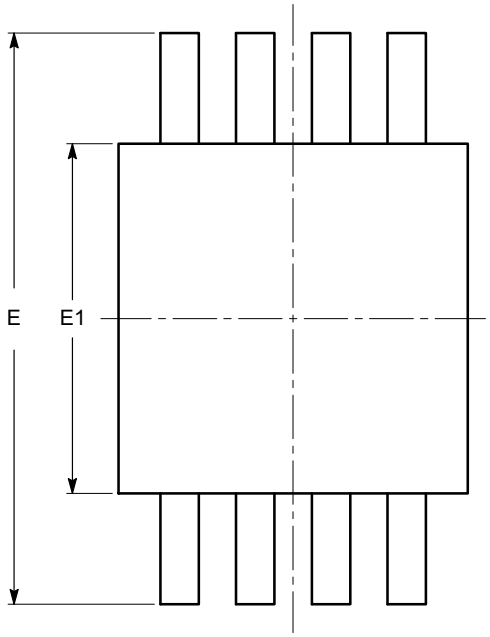
FRONT VIEW



DETAIL A

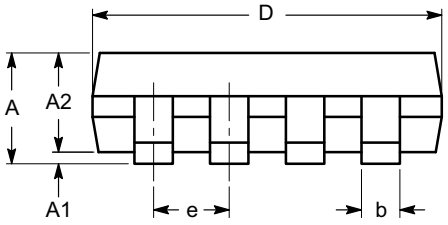
PACKAGE DIMENSIONS

MSOP 8, 3x3
CASE 846AD−01
ISSUE O

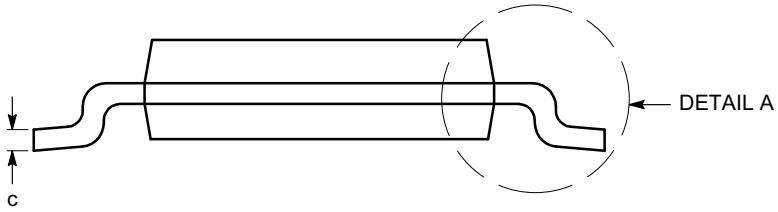


TOP VIEW

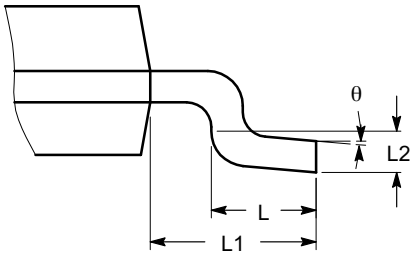
SYMBOL	MIN	NOM	MAX
A			1.10
A1	0.05	0.10	0.15
A2	0.75	0.85	0.95
b	0.22		0.38
c	0.13		0.23
D	2.90	3.00	3.10
E	4.80	4.90	5.00
E1	2.90	3.00	3.10
e		0.65 BSC	
L	0.40	0.60	0.80
L1		0.95 REF	
L2		0.25 BSC	
θ	0º		6º



SIDE VIEW



END VIEW

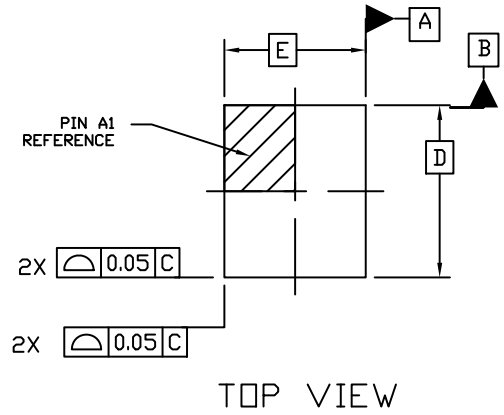


DETAIL A

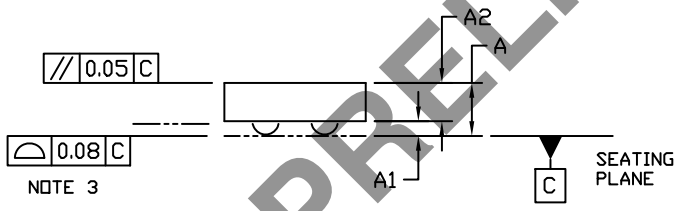
Notes:
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-187.

PACKAGE DIMENSIONS

WLCSP 6, 0.96 x 1.17
CASE TBD
ISSUE O



TOP VIEW



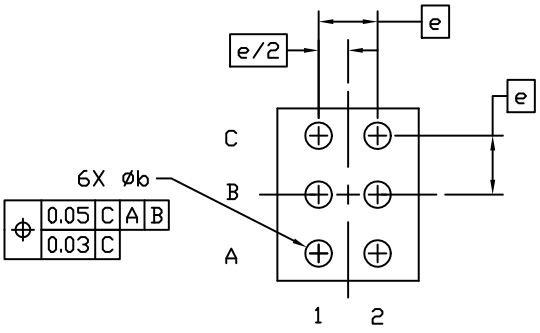
SIDE VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.

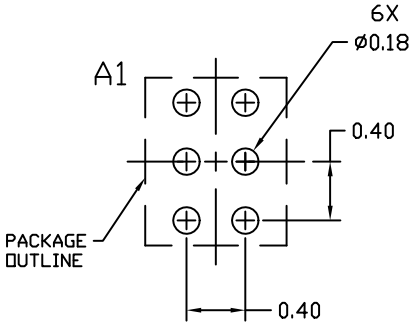
DIM	MILLIMETERS	
	MIN.	MAX.
A	---	0.41
A1	0.08	0.12
A2	0.26 REF	
b	0.16	0.20
D	1.17 BSC	
E	0.96 BSC	
e	0.40 BSC	

PRELIMINARY



BOTTOM VIEW

RECOMMENDED
MOUNTING FOOTPRINT



ORDERING INFORMATION

Order Number	Specific Device Marking	Package Type	Temperature Range	Lead Finish	Shipping
CAT93C86BLI−G	93C86D	PDIP−8	I = Industrial (−40°C to +85°C)	NiPdAu	Tube, 50 Units / Tube
CAT93C86BLE−G	93C86D	PDIP−8	E = Extended (−40°C to +125°C)	NiPdAu	Tube, 50 Units / Tube
CAT93C86BVI−GT3	93C86D	SOIC−8, JEDEC	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BVI−GT3L	93C86D	SOIC−8, JEDEC	I = Industrial −20°C to +85°C	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BVE−GT3	93C86D	SOIC−8, JEDEC	E = Extended (−40°C to +125°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BYI−GT3	M86D	TSSOP−8	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BYI−GT3L	M86D	TSSOP−8	I = Industrial (−20°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BYE−GT3	M86D	TSSOP−8	E = Extended (−40°C to +125°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BHU4I−GT3	M4U	UDFN−8	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BHU4E−GT3	M4U	UDFN−8	E = Extended (−40°C to +125°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BC6ATR (Note 9)	M4	WLCSP−6	I = Industrial (−40°C to +85°C)	SnAgCu	Tape & Reel, 5,000 Units / Reel
CAT93C86BZI−GT3	M4	MSOP−8	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BZE−GT3	M4	MSOP−8	E = Extended (−40°C to +125°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT93C86BXI−T2	93C86D	SOIC−8, EIAJ	I = Industrial (−40°C to +85°C)	Matte−Tin	Tape & Reel, 2,000 Units / Reel
CAT93C86BXE−T2	93C86D	SOIC−8, EIAJ	E = Extended (−40°C to +125°C)	Matte−Tin	Tape & Reel, 2,000 Units / Reel

7. All packages are RoHS−compliant (Lead−free, Halogen−free).
8. The standard lead finish is NiPdAu.
9. Preliminary. Please contact factory for availability.
10. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.
11. For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
12. For detailed information and a breakdown of device nomenclature and numbering systems, please see the ON Semiconductor Device Nomenclature document, TND310/D, available at www.onsemi.com

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