

# LMV331, NCV331, LMV393, LMV339

## Single, Dual, Quad General Purpose, Low Voltage Comparators

The LMV331 is a CMOS single channel, general purpose, low voltage comparator. The LMV393 and LMV339 are dual and quad channel versions, respectively. The LMV331/393/339 are specified for 2.7 V to 5 V performance, have excellent input common-mode range, low quiescent current, and are available in several space saving packages.

The LMV331 is available in 5-pin SC-70 and TSOP-5 packages. The LMV393 is available in a 8-pin Micro8™, SOIC-8, and a UDFN8 package, and the LMV339 is available in a SOIC-14 and a TSSOP-14 package.

The LMV331/393/339 are cost effective solutions for applications where space saving, low voltage operation, and low power are the primary specifications in circuit design for portable applications.

### Features

- Guaranteed 2.7 V and 5 V Performance
- Input Common-mode Voltage Range Extends to Ground
- Open Drain Output for Wired-OR Applications
- Low Quiescent Current: 60  $\mu$ A/channel TYP @ 5 V
- Low Saturation Voltage 200 mV TYP @ 5 V
- Propagation Delay 200 ns TYP @ 5 V
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Battery Monitors
- Notebooks and PDA's
- General Purpose Portable Devices
- General Purpose Low Voltage Applications

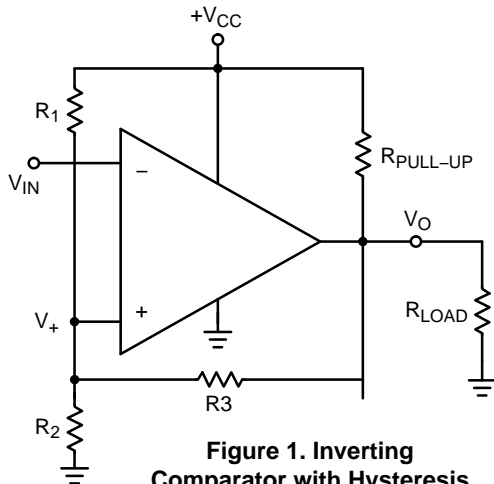


Figure 1. Inverting Comparator with Hysteresis

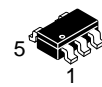


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SC-70  
CASE 419A



TSOP-5  
CASE 483



Micro8  
CASE 846A



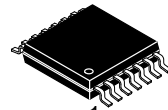
SOIC-8  
CASE 751



UDFN8  
CASE 517AJ



SOIC-14  
CASE 751A



TSSOP-14  
CASE 948G

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 13 of this data sheet.

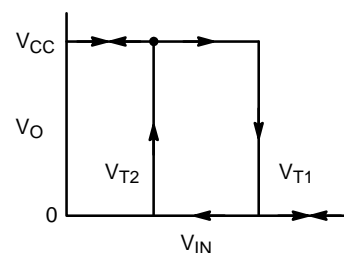
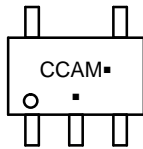


Figure 2. Hysteresis Curve

# LMV331, NCV331, LMV393, LMV339

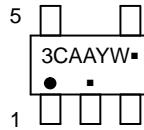
## MARKING DIAGRAMS

**SC-70  
CASE 419A**



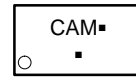
CCA = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

**TSOP-5  
CASE 483**



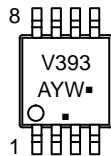
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

**UDFN8  
CASE 517AJ**



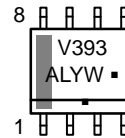
CA = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

**Micro8  
CASE 846A**



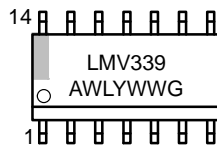
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

**SOIC-8  
CASE 751**



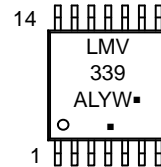
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

**SOIC-14  
CASE 751A**



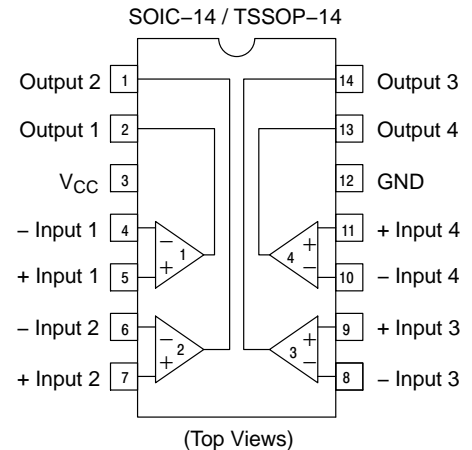
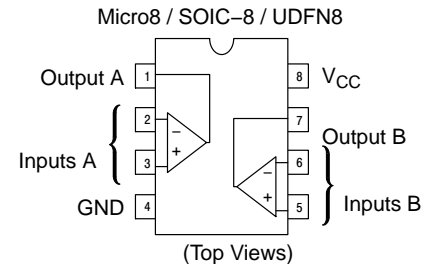
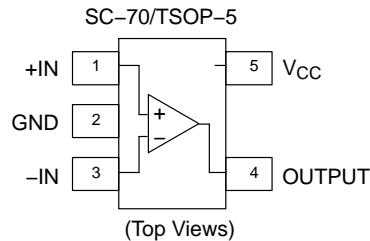
A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

**TSSOP-14  
CASE 948G**



A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

## PACKAGE PINOUTS



# LMV331, NCV331, LMV393, LMV339

## MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V <sub>S</sub>	Voltage on any Pin (referred to V <sup>-</sup> pin)	5.5	V
V <sub>IDR</sub>	Input Differential Voltage Range	±Supply Voltage	V
T <sub>J</sub>	Maximum Junction Temperature	150	°C
T <sub>A</sub>	Operating Ambient Temperature Range LMV331, LMV393, LMV339 NCV331 (Note 3)	-40 to 85 -40 to 125	°C
T <sub>stg</sub>	Storage Temperature Range	-65 to 150	°C
T <sub>L</sub>	Mounting Temperature (Infrared or Convection (1/16" From Case for 30 Seconds))	260	°C
V <sub>ESD</sub>	ESD Tolerance (Note 1) Machine Model Human Body Model	100 1000	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage Temperature Range (Note 2)	2.7 to 5.0	V
θ <sub>JA</sub>	Thermal Resistance SC-70 TSOP-5 Micro8 SOIC-8 UDFN8 SOIC-14 TSSOP-14	280 333 238 212 350 156 190	°C/W

- Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).
- The maximum power dissipation is a function of T<sub>J(MAX)</sub>, θ<sub>JA</sub>. The maximum allowable power dissipation at any ambient temperature is P<sub>D</sub> = (T<sub>J(MAX)</sub> - T<sub>A</sub>)/θ<sub>JA</sub>. All numbers apply for packages soldered directly onto a PC board.
- NCV prefix is qualified for automotive usage.

## LMV331, NCV331, LMV393, LMV339

**2.7 V DC ELECTRICAL CHARACTERISTICS** (All limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = 1.35\text{ V}$  unless otherwise noted.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Offset Voltage	$V_{IO}$			1.7	9	mV
Input Offset Voltage Average Drift	$T_C V_{IO}$			5		$\mu\text{V}/^\circ\text{C}$
Input Bias Current (Note 4)	$I_B$			< 1		nA
Input Offset Current (Note 4)	$I_{IO}$			< 1		nA
Input Voltage Range	$V_{CM}$			0 to 2		V
Saturation Voltage	$V_{SAT}$	$I_{SINK} \leq 1\text{ mA}$		120		mV
Output Sink Current	$I_O$	$V_O \leq 1.5\text{ V}$	5	23		mA
Supply Current	$I_{CC}$			40 40 70 140	100 100 140 200	$\mu\text{A}$
	LMV331 NCV331 LMV393 LMV339					

**2.7 V AC ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{ V}$ ,  $R_L = 5.1\text{ k}\Omega$ ,  $V^- = 0\text{ V}$  unless otherwise noted.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Propagation Delay – High to Low	$t_{PHL}$	Input Overdrive = 10 mV Input Overdrive = 100 mV		1000 500		ns
Propagation Delay – Low to High	$t_{PLH}$	Input Overdrive = 10 mV Input Overdrive = 100 mV		800 200		ns

4. Guaranteed by design and/or characterization.

## LMV331, NCV331, LMV393, LMV339

**5.0 V DC ELECTRICAL CHARACTERISTICS** (All limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = 2.5\text{ V}$  unless otherwise noted. Limits over temperature are guaranteed by design and/or characterization.)

Parameter	Symbol	Condition (Note 6)	Min	Typ	Max	Unit
Input Offset Voltage	$V_{IO}$	$T_A = T_{LO}$ to $T_{HIGH}$		1.7	9	mV
Input Offset Voltage Average Drift		$T_A = T_{LO}$ to $T_{HIGH}$		5		$\mu\text{V}/^\circ\text{C}$
Input Bias Current (Note 5)	$I_B$	$T_A = T_{LO}$ to $T_{HIGH}$		< 1		nA
Input Offset Current (Note 5)	$I_{IO}$	$T_A = T_{LO}$ to $T_{HIGH}$		< 1		nA
Input Voltage Range	$V_{CM}$			0 to 4.2		V
Voltage Gain (Note 5)	$A_V$		20	50		V/mV
Saturation Voltage	$V_{SAT}$	$I_{SINK} = 10\text{ mA}$ $T_A = T_{LO}$ to $T_{HIGH}$		200	400 700	mV
Output Sink Current	$I_O$	$V_O \leq 1.5\text{ V}$	10	84		mA
Supply Current LMV331	$I_{CC}$	$T_A = T_{LO}$ to $T_{HIGH}$		60	120 150	$\mu\text{A}$
Supply Current LMV393	$I_{CC}$	$T_A = T_{LO}$ to $T_{HIGH}$		100	200 250	$\mu\text{A}$
Supply Current LMV339	$I_{CC}$	$T_A = T_{LO}$ to $T_{HIGH}$		170	300 350	$\mu\text{A}$
Output Leakage Current (Note 5)		$T_A = T_{LO}$ to $T_{HIGH}$		0.003	1	$\mu\text{A}$

**5.0 V AC ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{ V}$ ,  $R_L = 5.1\text{ k}\Omega$ ,  $V^- = 0\text{ V}$  unless otherwise noted.)

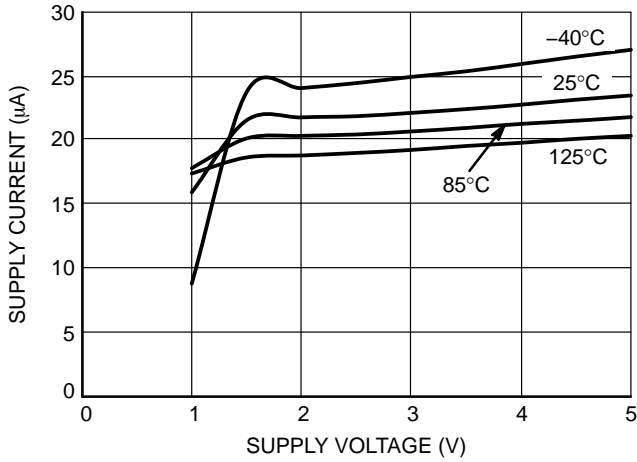
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Propagation Delay – High to Low	$t_{PHL}$	Input Overdrive = 10 mV Input Overdrive = 100 mV		1500 900		ns
Propagation Delay – Low to High	$t_{PLH}$	Input Overdrive = 10 mV Input Overdrive = 100 mV		800 200		ns

5. Guaranteed by design and/or characterization.
6. For LMV331, LMV393, LMV339:  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$   
For NCV331:  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$

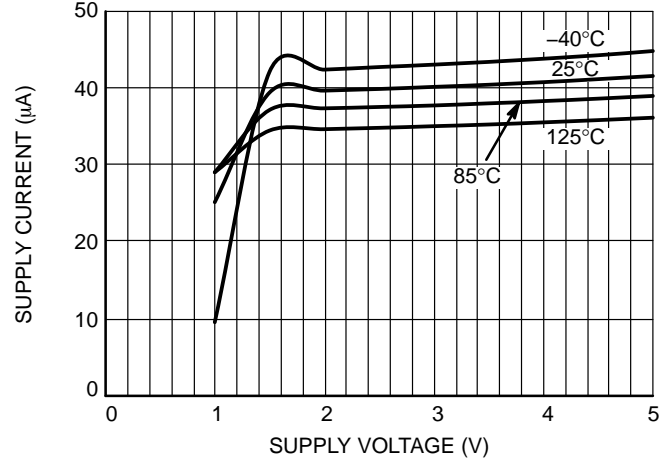
# LMV331, NCV331, LMV393, LMV339

## TYPICAL CHARACTERISTICS

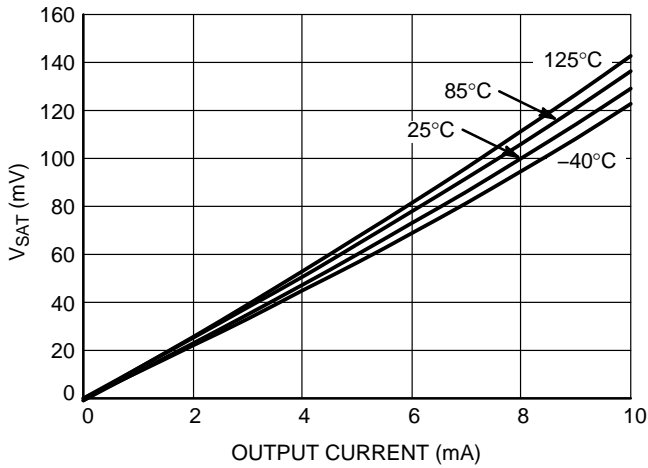
( $V_{CC} = 5.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 5\text{ k}\Omega$  unless otherwise specified)



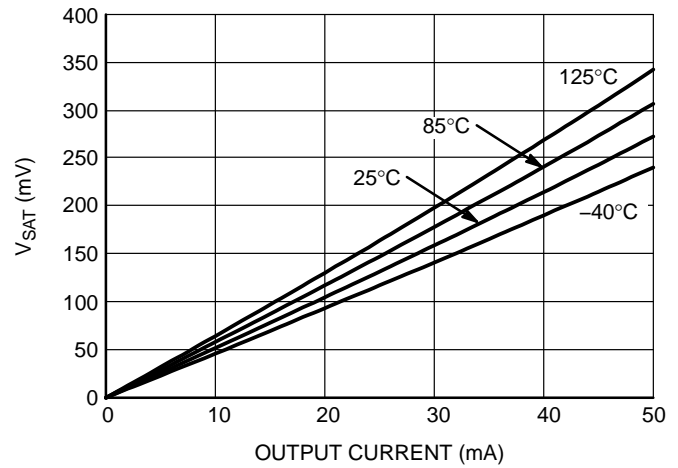
**Figure 3. Supply Current vs. Supply Voltage (Output High)**



**Figure 4. Supply Current vs. Supply Voltage (Output Low)**



**Figure 5.  $V_{SAT}$  vs. Output Current at  $V_{CC} = 2.7\text{ V}$**



**Figure 6.  $V_{SAT}$  vs. Output Current at  $V_{CC} = 5.0\text{ V}$**

# LMV331, NCV331, LMV393, LMV339

## NEGATIVE TRANSITION INPUT – $V_{CC} = 2.7\text{ V}$

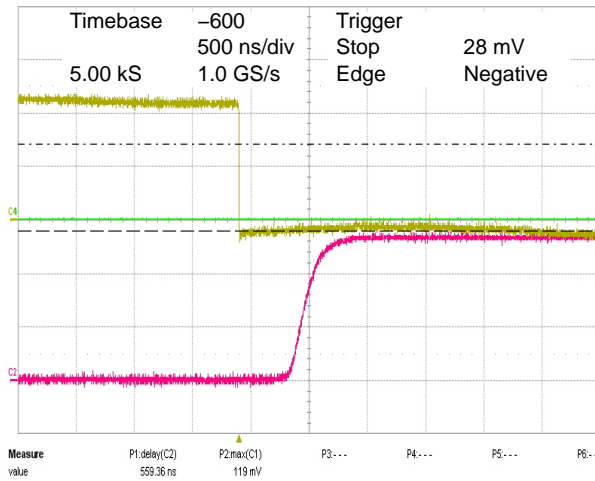


Figure 7. 10 mV Overdrive

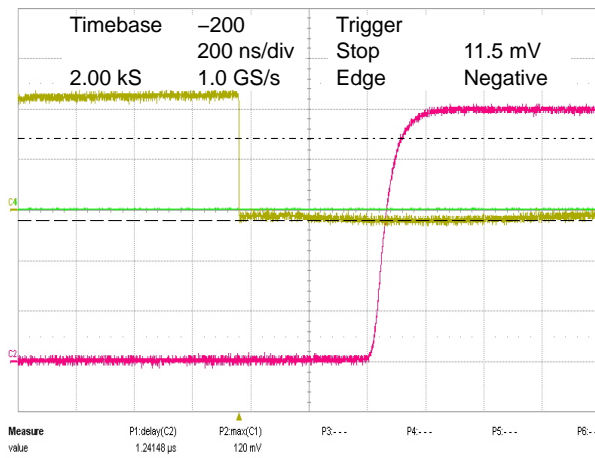


Figure 8. 20 mV Overdrive

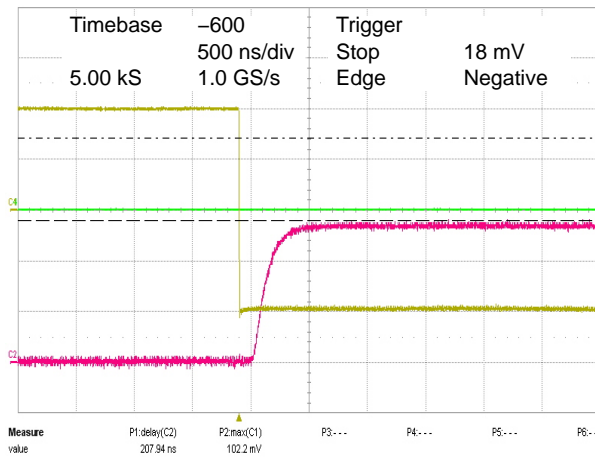


Figure 9. 100 mV Overdrive

# LMV331, NCV331, LMV393, LMV339

## POSITIVE TRANSITION INPUT - $V_{CC} = 2.7\text{ V}$

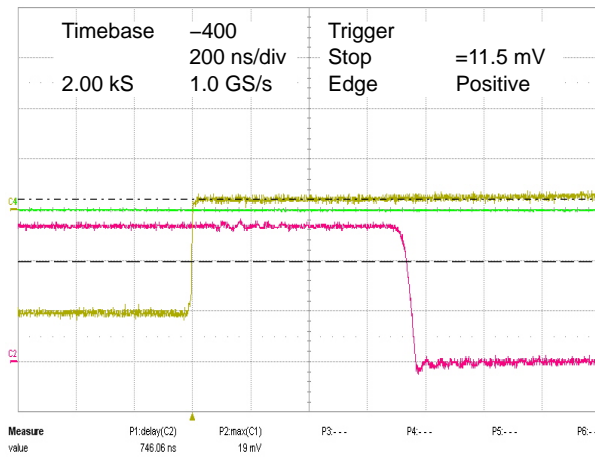


Figure 10. 10 mV Overdrive

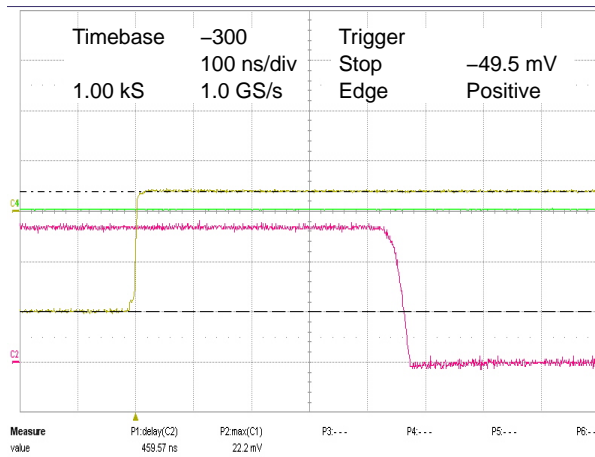


Figure 11. 20 mV Overdrive

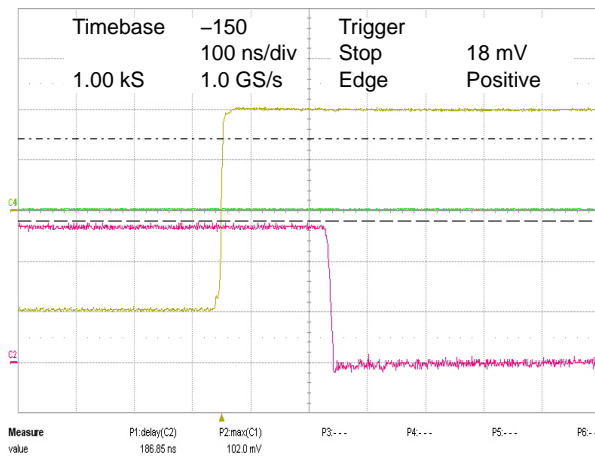


Figure 12. 100 mV Overdrive



# LMV331, NCV331, LMV393, LMV339

NEGATIVE TRANSITION INPUT –  $V_{CC} = 5.0\text{ V}$

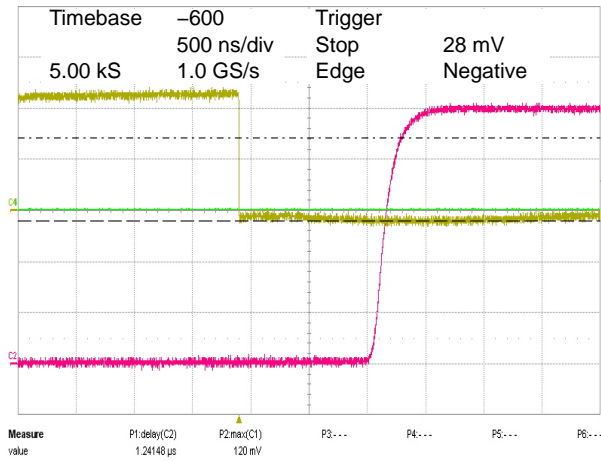


Figure 13. 10 mV Overdrive

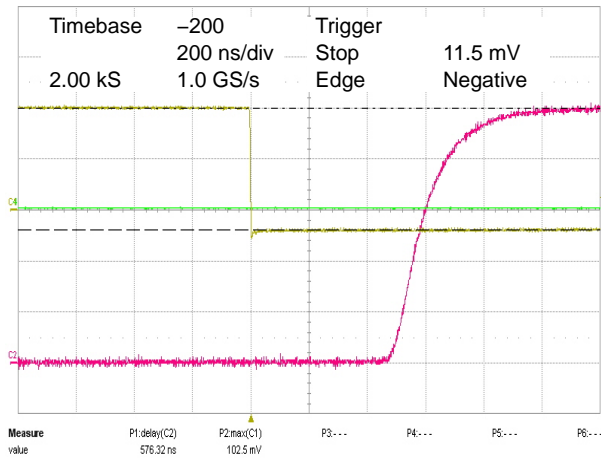


Figure 14. 20 mV Overdrive

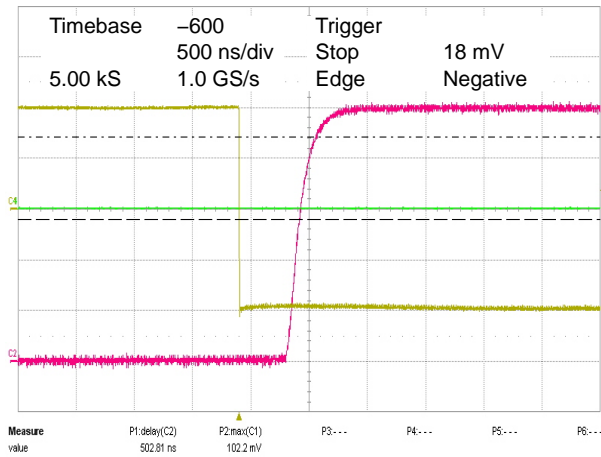


Figure 15. 100 mV Overdrive

# LMV331, NCV331, LMV393, LMV339

## POSITIVE TRANSITION INPUT – $V_{CC} = 5.0\text{ V}$

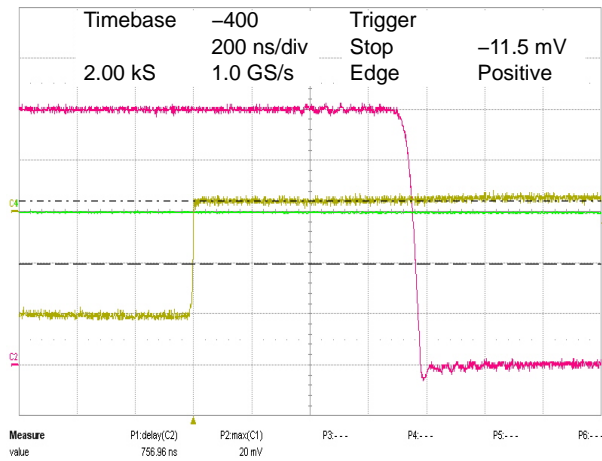


Figure 16. 10 mV Overdrive

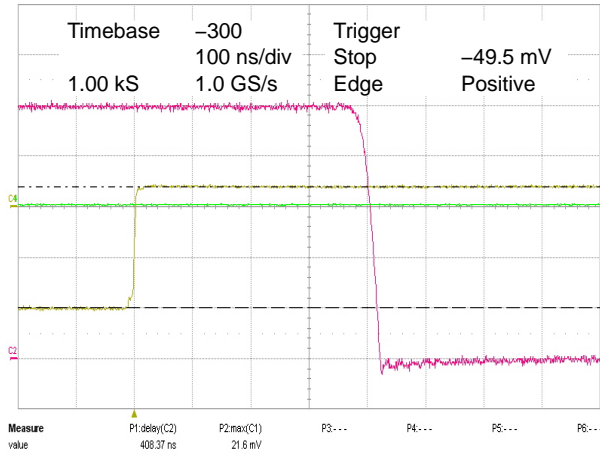


Figure 17. 20 mV Overdrive

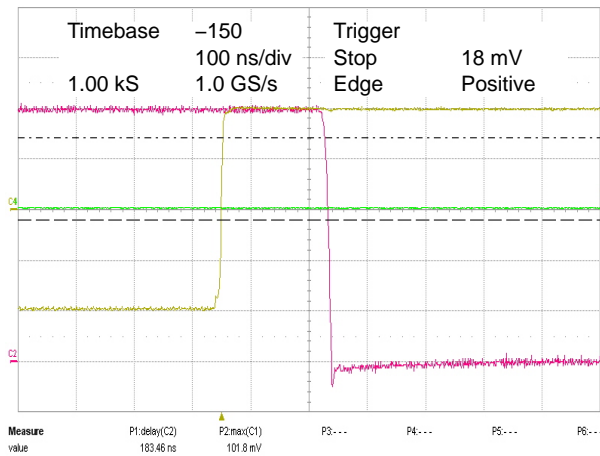


Figure 18. 100 mV Overdrive

APPLICATION CIRCUITS

Basic Comparator Operation

The basic operation of a comparator is to compare two input voltage signals, and produce a digital output signal by determining which input signal is higher. If the voltage on the non-inverting input is higher, then the internal output transistor is off and the output will be high. If the voltage on the inverting input is higher, then the output transistor will be on and the output will be low. The LMV331/393/339 has an open-drain output stage, so a pull-up resistor to a positive supply voltage is required for the output to switch properly.

The size of the pull-up resistor is recommended to be between 1 kΩ and 10 kΩ. This range of values will balance two key factors; i.e., power dissipation and drive capability for interface circuitry.

Figure 19 illustrates the basic operation of a comparator and assumes dual supplies. The comparator compares the input voltage ( $V_{IN}$ ) on the non-inverting input to the reference voltage ( $V_{REF}$ ) on the inverting input. If  $V_{IN}$  is less than  $V_{REF}$ , the output voltage ( $V_O$ ) will be low. If  $V_{IN}$  is greater than  $V_{REF}$ , then  $V_O$  will be high.

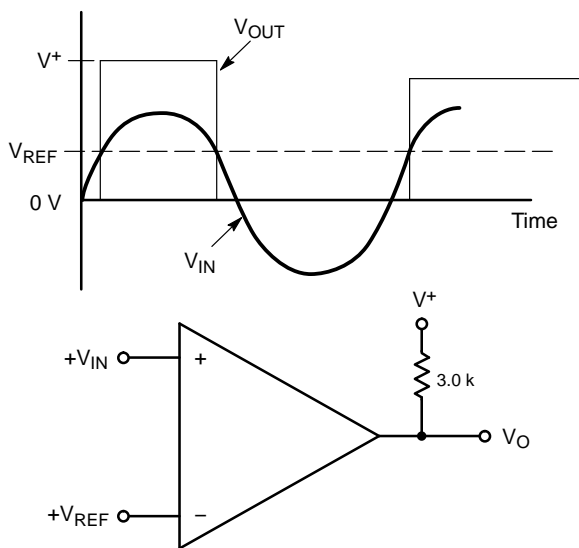


Figure 19.

Comparators and Stability

A common problem with comparators is oscillation due to their high gain. The basic comparator configuration in Figure 19 may oscillate if the differential voltage between the input pins is close to the device's offset voltage. This can happen if the input signal is moving slowly through the comparator's switching threshold or if unused channels are connected to the same potential for termination of unused channels. One way to eliminate output oscillations or 'chatter' is to include external hysteresis in the circuit design.

Inverting Configuration with Hysteresis

An inverting comparator with hysteresis is shown in Figure 20.

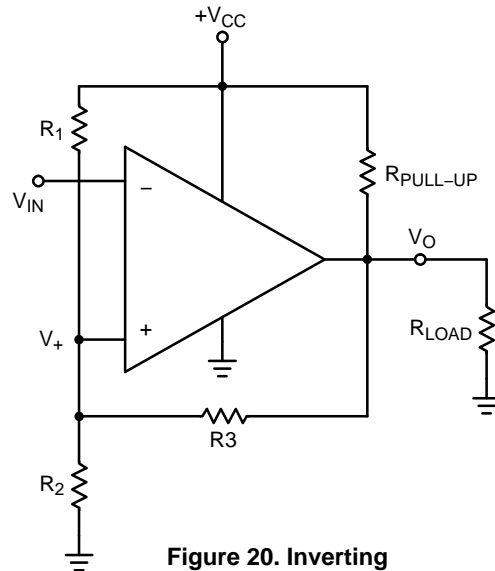


Figure 20. Inverting Comparator with Hysteresis

When  $V_{IN}$  is less than the voltage at the non-inverting node,  $V_+$ , the output voltage will be high. When  $V_{IN}$  is greater than the voltage at  $V_+$ , then the output will be low. The hysteresis band (Figure 21) created from the resistor network is defined as:

$$\Delta V_+ = V_{T1} - V_{T2}$$

where  $V_{T1}$  and  $V_{T2}$  are the lower and upper trip points, respectively.

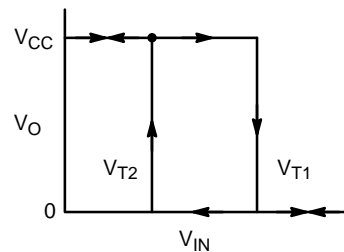


Figure 21.

$V_{T1}$  is calculated by assuming that the output of the comparator is pulled up to supply when high. The resistances  $R_1$  and  $R_3$  can be viewed as being in parallel which is in series with  $R_2$  (Figure 22). Therefore  $V_{T1}$  is:

$$V_{T1} = \frac{V_{CC} R_2}{(R_1 \parallel R_3) + R_2}$$

$V_{T2}$  is calculated by assuming that the output of the comparator is at ground potential when low. The resistances  $R_2$  and  $R_3$  can be viewed as being in parallel which is in series with  $R_1$  (Figure 23). Therefore  $V_{T2}$  is:

$$V_{T2} = \frac{V_{CC}(R_2 \parallel R_3)}{R_1 + (R_2 \parallel R_3)}$$

# LMV331, NCV331, LMV393, LMV339

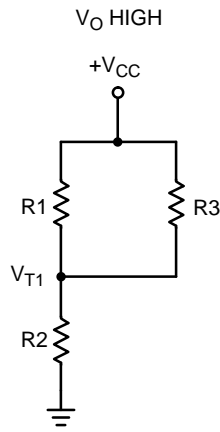


Figure 22.

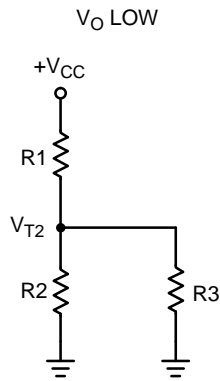


Figure 23.

When  $V_{IN}$  is much less than the voltage at the inverting input ( $V_{REF}$ ), then the output is low.  $R_2$  can then be viewed as being connected to ground (Figure 26). To calculate the voltage required at  $V_{IN}$  to trip the comparator high, the following equation is used:

$$V_{in1} = \frac{V_{ref} (R_1 + R_2)}{R_2}$$

When the output is high,  $V_{IN}$  must be less than or equal to  $V_{REF}$  ( $V_{IN} \leq V_{REF}$ ) before the output will be low again (Figure 27). The following equation is used to calculate the voltage at  $V_{IN}$  to switch the output back to the low state:

$$V_{in2} = \frac{V_{ref} (R_1 + R_2) - V_{CC} R_1}{R_2}$$

## Non-inverting Configuration with Hysteresis

A non-inverting comparator is shown in Figure 24.

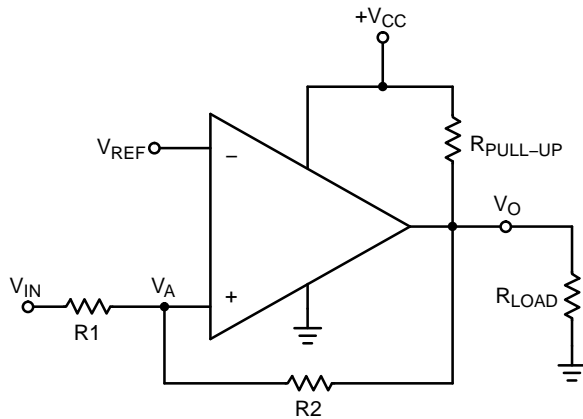


Figure 24.

The hysteresis band (Figure 25) of the non-inverting configuration is defined as follows:

$$\Delta V_{in} = V_{CC} R_1 / R_2$$

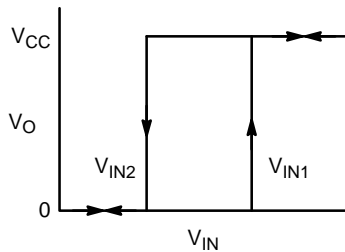


Figure 25.

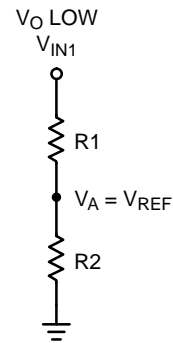


Figure 26.

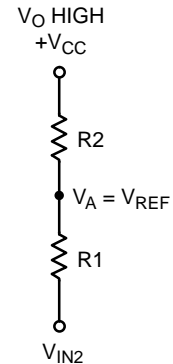


Figure 27.

## Termination of Unused Inputs

Proper termination of unused inputs is a good practice to keep the output from 'chattering.' For example, if one channel of a dual or quad package is not being used, then the inputs must be connected to a defined state. The recommended connections would be to tie one input to  $V_{CC}$  and the other input to ground.

## LMV331, NCV331, LMV393, LMV339

### ORDERING INFORMATION

Order Number	Number of Channels	Specific Device Marking	Package Type	Shipping†
LMV331SQ3T2G	Single	CCA	SC-70 (Pb-Free)	3000 / Tape & Reel
LMV331SN3T1G	Single	3CA	TSOP-5 (Pb-Free)	3000 / Tape & Reel
NCV331SN3T1G	Single	3CA	TSOP-5 (Pb-Free)	3000 / Tape & Reel
LMV393DMR2G	Dual	V393	Micro8 (Pb-Free)	4000 / Tape & Reel
LMV393DR2G	Dual	V393	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LMV393MUTAG	Dual	CA	UDFN8 (Pb-Free)	3000 / Tape & Reel
LMV339DR2G	Quad	LMV339	SOIC-14 (Pb-Free)	2500 / Tape & Reel
LMV339DTBR2G	Quad	LMV 339	TSSOP-14 (Pb-Free)	2500 / Tape & Reel

†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.

\*Contact factory.



SCALE 2:1

SC-88A (SC-70-5/SOT-353)  
CASE 419A-02  
ISSUE M

DATE 11 APR 2023



RECOMMENDED MOUNTING FOOTPRINT

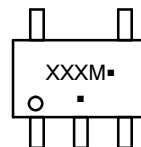
\* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.1016MM PER SIDE.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.80	0.95	1.10
A1	---	---	0.10
A3	0.20 REF		
b	0.10	0.20	0.30
c	0.10	---	0.25
D	1.80	2.00	2.20
E	2.00	2.10	2.20
E1	1.15	1.25	1.35
e	0.65 BSC		
L	0.10	0.15	0.30

GENERIC MARKING DIAGRAM\*



\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

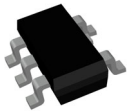
XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

- |  |  |  |  |  |
|--|--|--|--|--|
| <p>STYLE 1:<br/>PIN 1. BASE<br/>2. EMITTER<br/>3. BASE<br/>4. COLLECTOR<br/>5. COLLECTOR</p>                   | <p>STYLE 2:<br/>PIN 1. ANODE<br/>2. EMITTER<br/>3. BASE<br/>4. COLLECTOR<br/>5. CATHODE</p>  | <p>STYLE 3:<br/>PIN 1. ANODE 1<br/>2. N/C<br/>3. ANODE 2<br/>4. CATHODE 2<br/>5. CATHODE 1</p> | <p>STYLE 4:<br/>PIN 1. SOURCE 1<br/>2. DRAIN 1/2<br/>3. SOURCE 1<br/>4. GATE 1<br/>5. GATE 2</p> | <p>STYLE 5:<br/>PIN 1. CATHODE<br/>2. COMMON ANODE<br/>3. CATHODE 2<br/>4. CATHODE 3<br/>5. CATHODE 4</p>  |
| <p>STYLE 6:<br/>PIN 1. EMITTER 2<br/>2. BASE 2<br/>3. EMITTER 1<br/>4. COLLECTOR<br/>5. COLLECTOR 2/BASE 1</p> | <p>STYLE 7:<br/>PIN 1. BASE<br/>2. EMITTER<br/>3. BASE<br/>4. COLLECTOR<br/>5. COLLECTOR</p> | <p>STYLE 8:<br/>PIN 1. CATHODE<br/>2. COLLECTOR<br/>3. N/C<br/>4. BASE<br/>5. EMITTER</p>      | <p>STYLE 9:<br/>PIN 1. ANODE<br/>2. CATHODE<br/>3. ANODE<br/>4. ANODE<br/>5. ANODE</p>           | <p>Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.</p> |

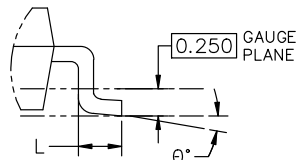
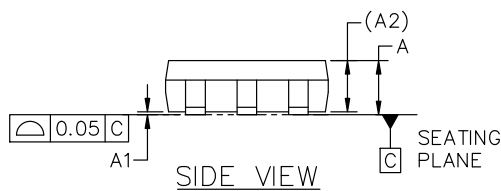
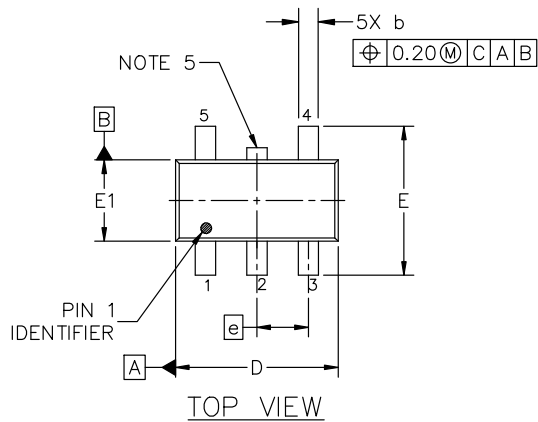
DOCUMENT NUMBER:	98ASB42984B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SC-88A (SC-70-5/SOT-353)	PAGE 1 OF 1

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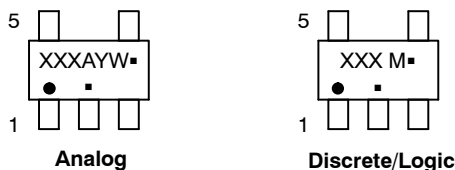
TSOP-5 3.00x1.50x0.95, 0.95P  
CASE 483  
ISSUE P

DATE 01 APR 2024



SCALE 2:1

GENERIC MARKING DIAGRAM\*



- XXX = Specific Device Code
- A = Assembly Location
- Y = Year
- W = Work Week
- = Pb-Free Package
- XXX = Specific Device Code
- M = Date Code
- = Pb-Free Package

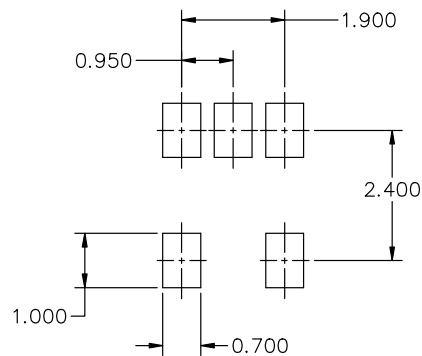
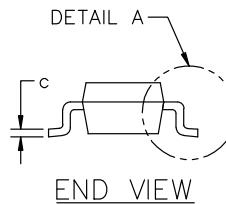
(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5-2018.
2. ALL DIMENSION ARE IN MILLIMETERS (ANGLES IN DEGREES).
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OF GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION D.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

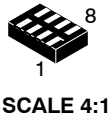
DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.900	1.000	1.100
A1	0.010	0.055	0.100
A2	0.950 REF.		
b	0.250	0.375	0.500
c	0.100	0.180	0.260
D	2.850	3.000	3.150
E	2.500	2.750	3.000
E1	1.350	1.500	1.650
e	0.950 BSC		
L	0.200	0.400	0.600
θ	0°	5°	10°



\* FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

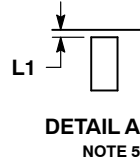
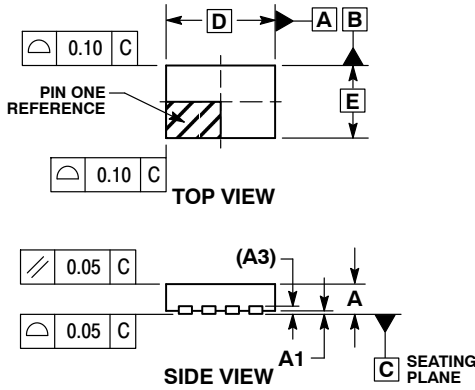
DOCUMENT NUMBER:	98ARB18753C	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	TSOP-5 3.00x1.50x0.95, 0.95P	PAGE 1 OF 1

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**UDFN8 1.8x1.2, 0.4P**  
CASE 517AJ  
ISSUE O

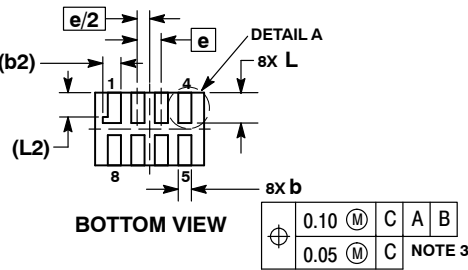
DATE 08 NOV 2006



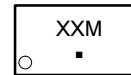
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm FROM TERMINAL TIP.
4. MOLD FLASH ALLOWED ON TERMINALS ALONG EDGE OF PACKAGE. FLASH MAY NOT EXCEED 0.03 ONTO BOTTOM SURFACE OF TERMINALS.
5. DETAIL A SHOWS OPTIONAL CONSTRUCTION FOR TERMINALS.

MILLIMETERS		
DIM	MIN	MAX
A	0.45	0.55
A1	0.00	0.05
A3	0.127	REF
b	0.15	0.25
b2	0.30	REF
D	1.80	BSC
E	1.20	BSC
e	0.40	BSC
L	0.45	0.55
L1	0.00	0.03
L2	0.40	REF

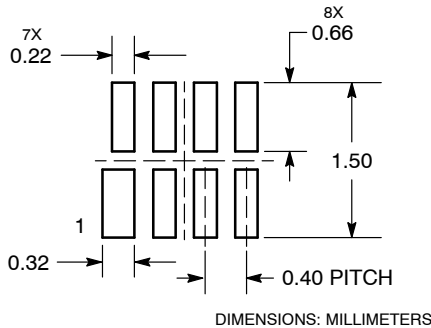


**GENERIC MARKING DIAGRAM\***



- XX = Specific Device Code
- M = Date Code
- = Pb-Free Package

**MOUNTING FOOTPRINT SOLDERMASK DEFINED**



\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present.

<b>DOCUMENT NUMBER:</b>	<b>98AON23417D</b>	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
<b>DESCRIPTION:</b>	<b>UDFN8 1.8X1.2, 0.4P</b>	<b>PAGE 1 OF 1</b>

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SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC MARKING DIAGRAM\*



XXXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

XXXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
▪ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

DOCUMENT NUMBER:	98ASB42564B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SOIC-8 NB	PAGE 1 OF 2

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**SOIC-8 NB**  
**CASE 751-07**  
**ISSUE AK**

DATE 16 FEB 2011

- |  |   |   |   |
|--|---|---|---|
| <p><b>STYLE 1:</b><br/>         PIN 1. EMITTER<br/>         2. COLLECTOR<br/>         3. COLLECTOR<br/>         4. EMITTER<br/>         5. EMITTER<br/>         6. BASE<br/>         7. BASE<br/>         8. EMITTER</p>   | <p><b>STYLE 2:</b><br/>         PIN 1. COLLECTOR, DIE, #1<br/>         2. COLLECTOR, #1<br/>         3. COLLECTOR, #2<br/>         4. COLLECTOR, #2<br/>         5. BASE, #2<br/>         6. EMITTER, #2<br/>         7. BASE, #1<br/>         8. EMITTER, #1</p>               | <p><b>STYLE 3:</b><br/>         PIN 1. DRAIN, DIE #1<br/>         2. DRAIN, #1<br/>         3. DRAIN, #2<br/>         4. DRAIN, #2<br/>         5. GATE, #2<br/>         6. SOURCE, #2<br/>         7. GATE, #1<br/>         8. SOURCE, #1</p>                            | <p><b>STYLE 4:</b><br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. ANODE<br/>         4. ANODE<br/>         5. ANODE<br/>         6. ANODE<br/>         7. ANODE<br/>         8. COMMON CATHODE</p>   |
| <p><b>STYLE 5:</b><br/>         PIN 1. DRAIN<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. DRAIN<br/>         5. GATE<br/>         6. GATE<br/>         7. SOURCE<br/>         8. SOURCE</p>   | <p><b>STYLE 6:</b><br/>         PIN 1. SOURCE<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. SOURCE<br/>         5. SOURCE<br/>         6. GATE<br/>         7. GATE<br/>         8. SOURCE</p>  | <p><b>STYLE 7:</b><br/>         PIN 1. INPUT<br/>         2. EXTERNAL BYPASS<br/>         3. THIRD STAGE SOURCE<br/>         4. GROUND<br/>         5. DRAIN<br/>         6. GATE 3<br/>         7. SECOND STAGE Vd<br/>         8. FIRST STAGE Vd</p>                    | <p><b>STYLE 8:</b><br/>         PIN 1. COLLECTOR, DIE #1<br/>         2. BASE, #1<br/>         3. BASE, #2<br/>         4. COLLECTOR, #2<br/>         5. COLLECTOR, #2<br/>         6. EMITTER, #2<br/>         7. EMITTER, #1<br/>         8. COLLECTOR, #1</p>                              |
| <p><b>STYLE 9:</b><br/>         PIN 1. EMITTER, COMMON<br/>         2. COLLECTOR, DIE #1<br/>         3. COLLECTOR, DIE #2<br/>         4. EMITTER, COMMON<br/>         5. EMITTER, COMMON<br/>         6. BASE, DIE #2<br/>         7. BASE, DIE #1<br/>         8. EMITTER, COMMON</p> | <p><b>STYLE 10:</b><br/>         PIN 1. GROUND<br/>         2. BIAS 1<br/>         3. OUTPUT<br/>         4. GROUND<br/>         5. GROUND<br/>         6. BIAS 2<br/>         7. INPUT<br/>         8. GROUND</p>  | <p><b>STYLE 11:</b><br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. DRAIN 2<br/>         7. DRAIN 1<br/>         8. DRAIN 1</p>   | <p><b>STYLE 12:</b><br/>         PIN 1. SOURCE<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p><b>STYLE 13:</b><br/>         PIN 1. N.C.<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>  | <p><b>STYLE 14:</b><br/>         PIN 1. N-SOURCE<br/>         2. N-GATE<br/>         3. P-SOURCE<br/>         4. P-GATE<br/>         5. P-DRAIN<br/>         6. P-DRAIN<br/>         7. N-DRAIN<br/>         8. N-DRAIN</p>   | <p><b>STYLE 15:</b><br/>         PIN 1. ANODE 1<br/>         2. ANODE 1<br/>         3. ANODE 1<br/>         4. ANODE 1<br/>         5. CATHODE, COMMON<br/>         6. CATHODE, COMMON<br/>         7. CATHODE, COMMON<br/>         8. CATHODE, COMMON</p>               | <p><b>STYLE 16:</b><br/>         PIN 1. EMITTER, DIE #1<br/>         2. BASE, DIE #1<br/>         3. EMITTER, DIE #2<br/>         4. BASE, DIE #2<br/>         5. COLLECTOR, DIE #2<br/>         6. COLLECTOR, DIE #2<br/>         7. COLLECTOR, DIE #1<br/>         8. COLLECTOR, DIE #1</p> |
| <p><b>STYLE 17:</b><br/>         PIN 1. VCC<br/>         2. V2OUT<br/>         3. V1OUT<br/>         4. TXE<br/>         5. RXE<br/>         6. VEE<br/>         7. GND<br/>         8. ACC</p>  | <p><b>STYLE 18:</b><br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. CATHODE<br/>         8. CATHODE</p>   | <p><b>STYLE 19:</b><br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. MIRROR 2<br/>         7. DRAIN 1<br/>         8. MIRROR 1</p>   | <p><b>STYLE 20:</b><br/>         PIN 1. SOURCE (N)<br/>         2. GATE (N)<br/>         3. SOURCE (P)<br/>         4. GATE (P)<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p><b>STYLE 21:</b><br/>         PIN 1. CATHODE 1<br/>         2. CATHODE 2<br/>         3. CATHODE 3<br/>         4. CATHODE 4<br/>         5. CATHODE 5<br/>         6. COMMON ANODE<br/>         7. COMMON ANODE<br/>         8. CATHODE 6</p>  | <p><b>STYLE 22:</b><br/>         PIN 1. I/O LINE 1<br/>         2. COMMON CATHODE/VCC<br/>         3. COMMON CATHODE/VCC<br/>         4. I/O LINE 3<br/>         5. COMMON ANODE/GND<br/>         6. I/O LINE 4<br/>         7. I/O LINE 5<br/>         8. COMMON ANODE/GND</p> | <p><b>STYLE 23:</b><br/>         PIN 1. LINE 1 IN<br/>         2. COMMON ANODE/GND<br/>         3. COMMON ANODE/GND<br/>         4. LINE 2 IN<br/>         5. LINE 2 OUT<br/>         6. COMMON ANODE/GND<br/>         7. COMMON ANODE/GND<br/>         8. LINE 1 OUT</p> | <p><b>STYLE 24:</b><br/>         PIN 1. BASE<br/>         2. EMITTER<br/>         3. COLLECTOR/ANODE<br/>         4. COLLECTOR/ANODE<br/>         5. CATHODE<br/>         6. CATHODE<br/>         7. COLLECTOR/ANODE<br/>         8. COLLECTOR/ANODE</p>                                      |
| <p><b>STYLE 25:</b><br/>         PIN 1. VIN<br/>         2. N/C<br/>         3. REXT<br/>         4. GND<br/>         5. IOUT<br/>         6. IOUT<br/>         7. IOUT<br/>         8. IOUT</p>   | <p><b>STYLE 26:</b><br/>         PIN 1. GND<br/>         2. dv/dt<br/>         3. ENABLE<br/>         4. ILIMIT<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. VCC</p>  | <p><b>STYLE 27:</b><br/>         PIN 1. ILIMIT<br/>         2. OVLO<br/>         3. UVLO<br/>         4. INPUT+<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. DRAIN</p>  | <p><b>STYLE 28:</b><br/>         PIN 1. SW_TO_GND<br/>         2. DASIC OFF<br/>         3. DASIC_SW_DET<br/>         4. GND<br/>         5. V_MON<br/>         6. VBULK<br/>         7. VBULK<br/>         8. VIN</p>  |
| <p><b>STYLE 29:</b><br/>         PIN 1. BASE, DIE #1<br/>         2. EMITTER, #1<br/>         3. BASE, #2<br/>         4. EMITTER, #2<br/>         5. COLLECTOR, #2<br/>         6. COLLECTOR, #2<br/>         7. COLLECTOR, #1<br/>         8. COLLECTOR, #1</p>                        | <p><b>STYLE 30:</b><br/>         PIN 1. DRAIN 1<br/>         2. DRAIN 1<br/>         3. GATE 2<br/>         4. SOURCE 2<br/>         5. SOURCE 1/DRAIN 2<br/>         6. SOURCE 1/DRAIN 2<br/>         7. SOURCE 1/DRAIN 2<br/>         8. GATE 1</p>                           |   |   |

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<b>DESCRIPTION:</b>	<b>SOIC-8 NB</b>	<b>PAGE 2 OF 2</b>

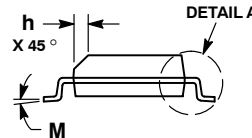
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SCALE 1:1

SOIC-14 NB  
CASE 751A-03  
ISSUE L

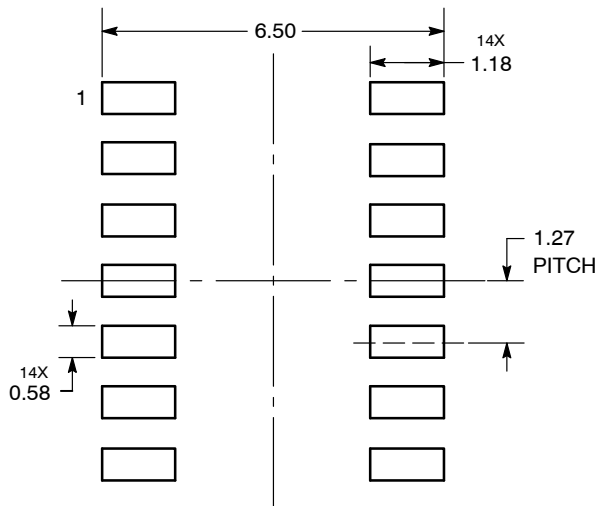
DATE 03 FEB 2016



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
  4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
  5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.054	0.068
A1	0.10	0.25	0.004	0.010
A3	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
M	0°	7°	0°	7°

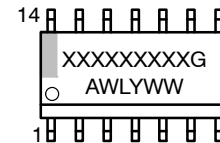
SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC MARKING DIAGRAM\*



- XXXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- WW = Work Week
- G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

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**SOIC-14**  
**CASE 751A-03**  
**ISSUE L**

DATE 03 FEB 2016

STYLE 1:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. NO CONNECTION  
 5. ANODE/CATHODE  
 6. NO CONNECTION  
 7. ANODE/CATHODE  
 8. ANODE/CATHODE  
 9. ANODE/CATHODE  
 10. NO CONNECTION  
 11. ANODE/CATHODE  
 12. ANODE/CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 2:  
 CANCELLED

STYLE 3:  
 PIN 1. NO CONNECTION  
 2. ANODE  
 3. ANODE  
 4. NO CONNECTION  
 5. ANODE  
 6. NO CONNECTION  
 7. ANODE  
 8. ANODE  
 9. ANODE  
 10. NO CONNECTION  
 11. ANODE  
 12. ANODE  
 13. NO CONNECTION  
 14. COMMON CATHODE

STYLE 4:  
 PIN 1. NO CONNECTION  
 2. CATHODE  
 3. CATHODE  
 4. NO CONNECTION  
 5. CATHODE  
 6. NO CONNECTION  
 7. CATHODE  
 8. CATHODE  
 9. CATHODE  
 10. NO CONNECTION  
 11. CATHODE  
 12. CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 5:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. ANODE/CATHODE  
 5. ANODE/CATHODE  
 6. NO CONNECTION  
 7. COMMON ANODE  
 8. COMMON CATHODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. ANODE/CATHODE  
 12. ANODE/CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 6:  
 PIN 1. CATHODE  
 2. CATHODE  
 3. CATHODE  
 4. CATHODE  
 5. CATHODE  
 6. CATHODE  
 7. CATHODE  
 8. ANODE  
 9. ANODE  
 10. ANODE  
 11. ANODE  
 12. ANODE  
 13. ANODE  
 14. ANODE

STYLE 7:  
 PIN 1. ANODE/CATHODE  
 2. COMMON ANODE  
 3. COMMON CATHODE  
 4. ANODE/CATHODE  
 5. ANODE/CATHODE  
 6. ANODE/CATHODE  
 7. ANODE/CATHODE  
 8. ANODE/CATHODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. COMMON CATHODE  
 12. COMMON ANODE  
 13. ANODE/CATHODE  
 14. ANODE/CATHODE

STYLE 8:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. NO CONNECTION  
 5. ANODE/CATHODE  
 6. ANODE/CATHODE  
 7. COMMON ANODE  
 8. COMMON ANODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. NO CONNECTION  
 12. ANODE/CATHODE  
 13. ANODE/CATHODE  
 14. COMMON CATHODE

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<b>DESCRIPTION:</b>	<b>SOIC-14 NB</b>	<b>PAGE 2 OF 2</b>

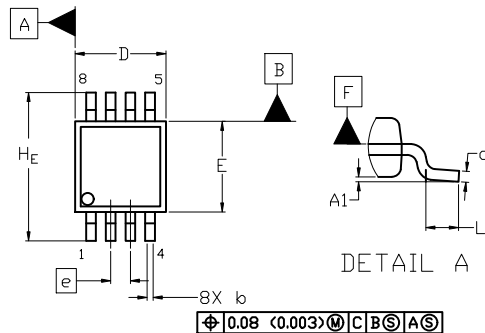
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SCALE 2:1

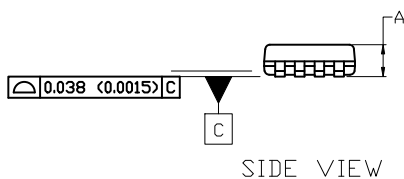
Micro8  
CASE 846A-02  
ISSUE K

DATE 16 JUL 2020

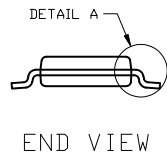


TOP VIEW

NOTE 3



SIDE VIEW

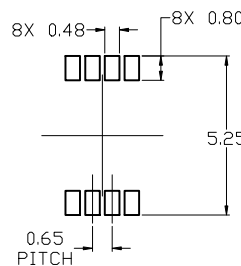


END VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION *b* DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS *D* AND *E* DO NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSION *E* DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE. DIMENSIONS *D* AND *E* ARE DETERMINED AT DATUM *F*.
5. DATUMS *A* AND *B* ARE TO BE DETERMINED AT DATUM *F*.
6. *A1* IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

$\phi 0.08$  (0.003) M C B S A S

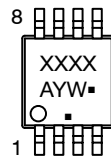


RECOMMENDED MOUNTING FOOTPRINT

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	---	---	1.10
A1	0.05	0.08	0.15
<i>b</i>	0.25	0.33	0.40
<i>c</i>	0.13	0.18	0.23
<i>D</i>	2.90	3.00	3.10
<i>E</i>	2.90	3.00	3.10
<i>e</i>	0.65 BSC		
<i>H<sub>E</sub></i>	4.75	4.90	5.05
<i>L</i>	0.40	0.55	0.70

For additional information on our Pb-Free strategy and soldering details, please download the [DN Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D](#).

GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLE 1:

1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 2:

1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 3:

1. N-SOURCE
2. N-GATE
3. P-SOURCE
4. P-GATE
5. P-DRAIN
6. P-DRAIN
7. N-DRAIN
8. N-DRAIN

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DESCRIPTION:	MICRO8	PAGE 1 OF 1

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