

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## Single Supply Quad Comparators

These comparators are designed for use in level detection, low-level sensing and memory applications in consumer, automotive, and industrial electronic applications.

- Single or Split Supply Operation
- Low Input Bias Current: 25 nA (Typ)
- Low Input Offset Current:  $\pm 5.0$  nA (Typ)
- Low Input Offset Voltage
- Input Common Mode Voltage Range to Gnd
- Low Output Saturation Voltage: 130 mV (Typ) @ 4.0 mA
- TTL and CMOS Compatible
- ESD Clamps on the Inputs Increase Reliability without Affecting Device Operation

### MAXIMUM RATINGS

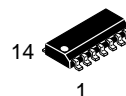
Rating	Symbol	Value	Unit
Power Supply Voltage LM239/LM339/LM2901, V MC3302	$V_{CC}$	+36 or $\pm 18$ +30 or $\pm 15$	Vdc
Input Differential Voltage Range LM239/LM339/LM2901, V MC3302	$V_{IDR}$	36 30	Vdc
Input Common Mode Voltage Range	$V_{ICMR}$	-0.3 to $V_{CC}$	Vdc
Output Short Circuit to Ground (Note 1)	$I_{SC}$	Continuous	
Power Dissipation @ $T_A = 25^\circ\text{C}$ Plastic Package Derate above $25^\circ\text{C}$	$P_D$ $1/R_{\theta JA}$	1.0 8.0	W mW/ $^\circ\text{C}$
Junction Temperature	$T_J$	150	$^\circ\text{C}$
Operating Ambient Temperature Range LM239 MC3302 LM2901 LM2901V, NCV2901 LM339	$T_A$	-25 to +85 -40 to +85 -40 to +105 -40 to +125 0 to +70	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
ESD Protection at any Pin Human Body Model Machine Model	$V_{esd}$	2000 200	V

1. The maximum output current may be as high as 20 mA, independent of the magnitude of  $V_{CC}$ . Output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.

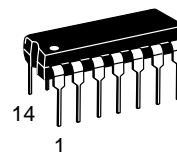


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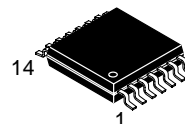
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SO-14  
D SUFFIX  
CASE 751A

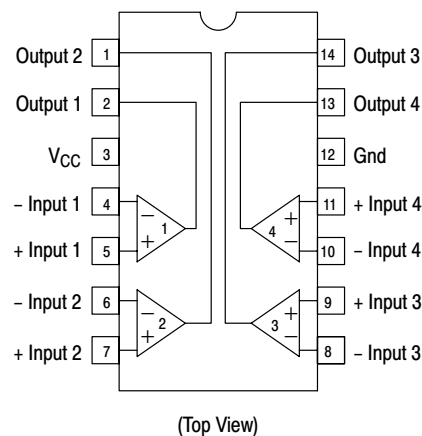


PDIP-14  
N, P SUFFIX  
CASE 646



TSSOP-14  
DTB SUFFIX  
CASE 948G

### PIN CONNECTIONS



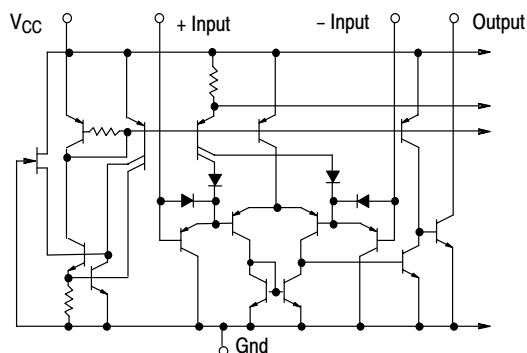
### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 6 of this data sheet.

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302



NOTE: Diagram shown is for 1 comparator.

Figure 1. Circuit Schematic

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +5.0$ Vdc, $T_A = +25^\circ\text{C}$ , unless otherwise noted)

Characteristic	Symbol	LM239/339			LM2901/2901V/ NCV2901			MC3302			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 3)	$V_{IO}$	-	$\pm 2.0$	$\pm 5.0$	-	$\pm 2.0$	$\pm 7.0$	-	$\pm 3.0$	$\pm 20$	mVdc
Input Bias Current (Notes 3, 4) (Output in Analog Range)	$I_{IB}$	-	25	250	-	25	250	-	25	500	nA
Input Offset Current (Note 3)	$I_{IO}$	-	$\pm 5.0$	$\pm 50$	-	$\pm 5.0$	$\pm 50$	-	$\pm 3.0$	$\pm 100$	nA
Input Common Mode Voltage Range	$V_{ICMR}$	0	-	$V_{CC} - 1.5$	0	-	$V_{CC} - 1.5$	0	-	$V_{CC} - 1.5$	V
Supply Current $R_L = \infty$ (For All Comparators) $R_L = \infty$ , $V_{CC} = 30$ Vdc	$I_{CC}$	-	0.8 1.0	2.0 2.5	-	0.8 1.0	2.0 2.5	-	0.8 1.0	2.0 2.5	mA
Voltage Gain $R_L \geq 15$ k $\Omega$ , $V_{CC} = 15$ Vdc	$A_{VOL}$	50	200	-	25	100	-	25	100	-	V/mV
Large Signal Response Time $V_I =$ TTL Logic Swing, $V_{ref} = 1.4$ Vdc, $V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k $\Omega$	-	-	300	-	-	300	-	-	300	-	ns
Response Time (Note 5) $V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k $\Omega$	-	-	1.3	-	-	1.3	-	-	1.3	-	$\mu\text{s}$
Output Sink Current $V_I(-) \geq +1.0$ Vdc, $V_I(+)=0$ , $V_O \leq 1.5$ Vdc	$I_{Sink}$	6.0	16	-	6.0	16	-	6.0	16	-	mA
Saturation Voltage $V_I(-) \geq +1.0$ Vdc, $V_I(+)=0$ , $I_{sink} \leq 4.0$ mA	$V_{sat}$	-	130	400	-	130	400	-	130	500	mV
Output Leakage Current $V_I(+)\geq +1.0$ Vdc, $V_I(-)=0$ , $V_O = +5.0$ Vdc	$I_{OL}$	-	0.1	-	-	0.1	-	-	0.1	-	nA

- (LM239)  $T_{low} = -25^\circ\text{C}$ ,  $T_{high} = +85^\circ\text{C}$   
(LM339)  $T_{low} = 0^\circ\text{C}$ ,  $T_{high} = +70^\circ\text{C}$   
(MC3302)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +85^\circ\text{C}$   
(LM2901)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +105^\circ\text{C}$   
(LM2901V & NCV2901)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +125^\circ\text{C}$   
*NCV2901 is qualified for automotive use.*

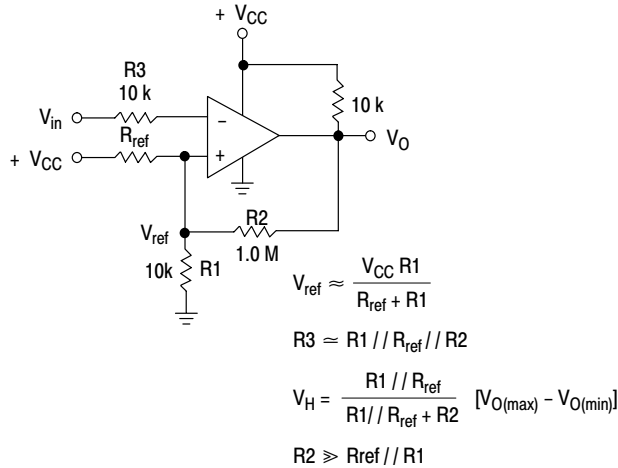
- At the output switch point,  $V_O = 1.4$  Vdc,  $R_S \leq 100 \Omega$   $5.0$  Vdc  $\leq V_{CC} \leq 30$  Vdc, with the inputs over the full common mode range (0 Vdc to  $V_{CC} - 1.5$  Vdc).
- The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
- The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

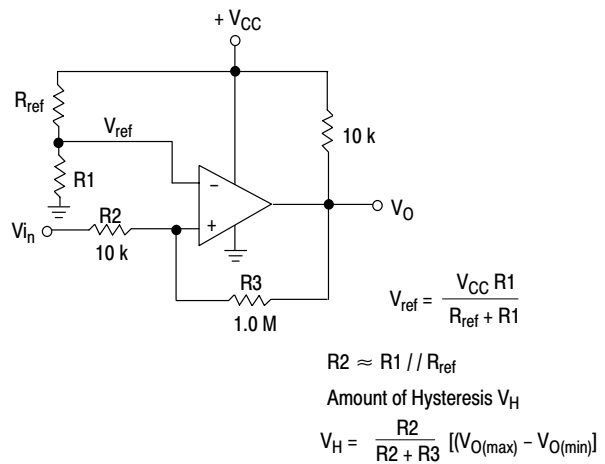
## PERFORMANCE CHARACTERISTICS (V<sub>CC</sub> = +5.0 Vdc, T<sub>A</sub> = T<sub>low</sub> to T<sub>high</sub> [Note 6])

Characteristic	Symbol	LM239/339			LM2901/2901V/ NCV2901			MC3302			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 7)	V <sub>IO</sub>	-	-	±9.0	-	-	±15	-	-	±40	mVdc
Input Bias Current (Notes 7, 8) (Output in Analog Range)	I <sub>IB</sub>	-	-	400	-	-	500	-	-	1000	nA
Input Offset Current (Note 7)	I <sub>IO</sub>	-	-	±150	-	-	±200	-	-	±300	nA
Input Common Mode Voltage Range	V <sub>ICMR</sub>	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	0	-	V <sub>CC</sub> -2.0	V
Saturation Voltage V <sub>I(-)</sub> ≥ +1.0 Vdc, V <sub>I(+)</sub> = 0, I <sub>sink</sub> ≤ 4.0 mA	V <sub>sat</sub>	-	-	700	-	-	700	-	-	700	mV
Output Leakage Current V <sub>I(+)</sub> ≥ +1.0 Vdc, V <sub>I(-)</sub> = 0, V <sub>O</sub> = 30 Vdc	I <sub>OL</sub>	-	-	1.0	-	-	1.0	-	-	1.0	μA
Differential Input Voltage All V <sub>I</sub> ≥ 0 Vdc	V <sub>ID</sub>	-	-	V <sub>CC</sub>	-	-	V <sub>CC</sub>	-	-	V <sub>CC</sub>	Vdc

6. (LM239) T<sub>low</sub> = -25°C, T<sub>high</sub> = +85°C  
 (LM339) T<sub>low</sub> = 0°C, T<sub>high</sub> = +70°C  
 (MC3302) T<sub>low</sub> = -40°C, T<sub>high</sub> = +85°C  
 (LM2901) T<sub>low</sub> = -40°C, T<sub>high</sub> = +105°C  
 (LM2901V & NCV2901) T<sub>low</sub> = -40°C, T<sub>high</sub> = +125°C  
*NCV2901 is qualified for automotive use.*
7. At the output switch point, V<sub>O</sub> ≈ 1.4 Vdc, R<sub>S</sub> ≤ 100 Ω 5.0 Vdc ≤ V<sub>CC</sub> ≤ 30 Vdc, with the inputs over the full common mode range (0 Vdc to V<sub>CC</sub> - 1.5 Vdc).
8. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
9. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.



**Figure 2. Inverting Comparator with Hysteresis**



**Figure 3. Noninverting Comparator with Hysteresis**

Typical Characteristics

( $V_{CC} = 15 \text{ Vdc}$ ,  $T_A = +25^\circ\text{C}$  (each comparator) unless otherwise noted.)

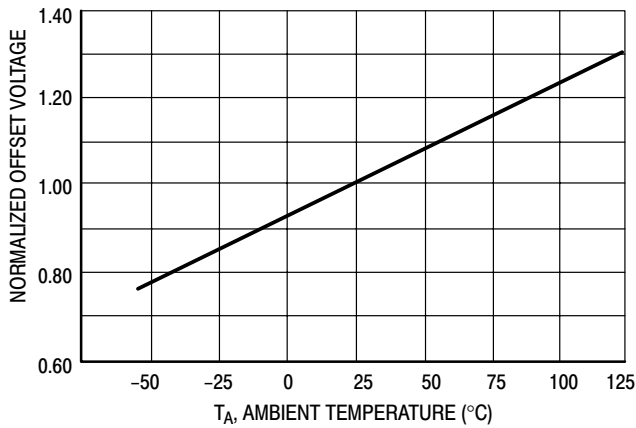


Figure 4. Normalized Input Offset Voltage

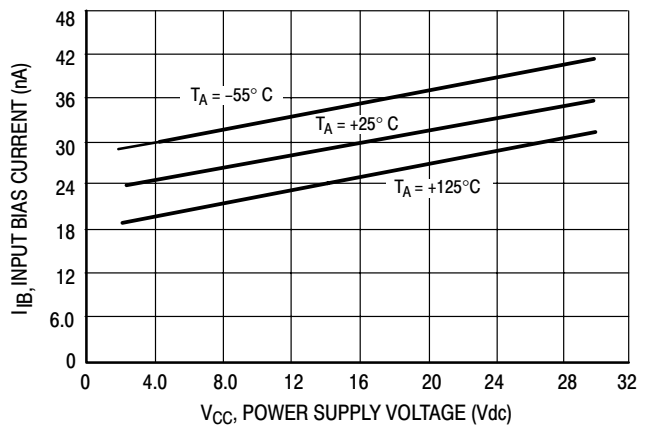


Figure 5. Input Bias Current

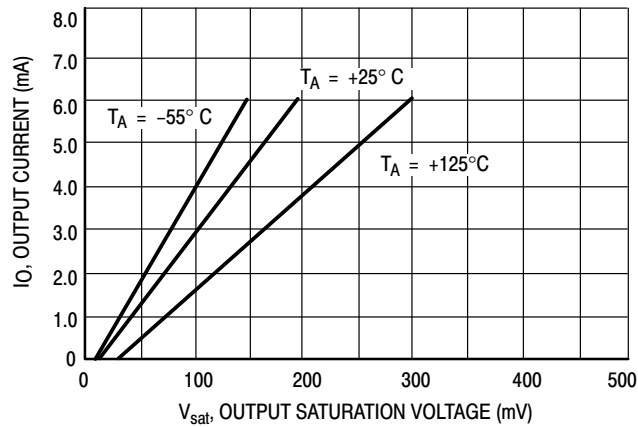
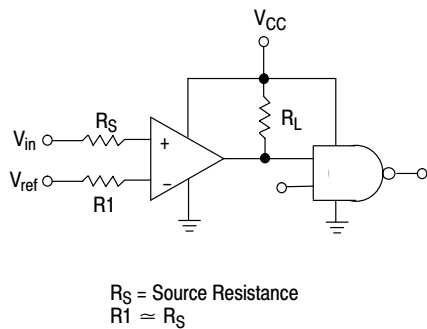


Figure 6. Output Sink Current versus Output Saturation Voltage



Logic	Device	$V_{CC}$ (V)	$R_L$ (k $\Omega$ )
CMOS	1/4 MC14001	+15	100
TTL	1/4 MC7400	+5.0	10

Figure 7. Driving Logic

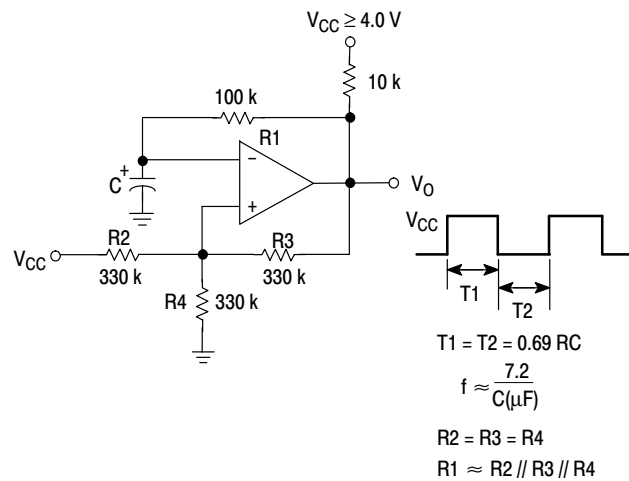


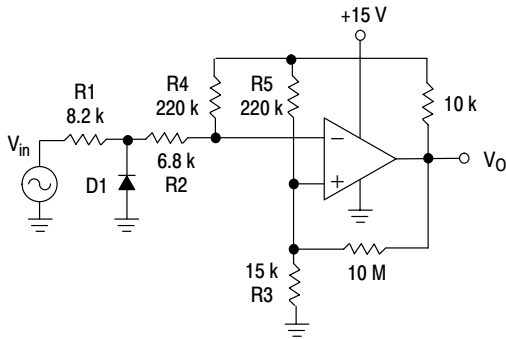
Figure 8. Squarewave Oscillator

APPLICATIONS INFORMATION

These quad comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions ( $V_{OL}$  to  $V_{OH}$ ). To alleviate this situation input resistors  $< 10\text{ k}\Omega$  should be used. The

addition of positive feedback ( $< 10\text{ mV}$ ) is also recommended. It is good design practice to ground all unused input pins.

Differential input voltages may be larger than supply voltages without damaging the comparator's inputs. Voltages more negative than  $-300\text{ mV}$  should not be used.

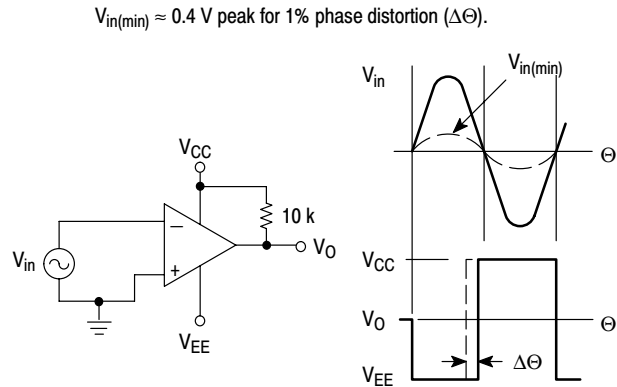


D1 prevents input from going negative by more than 0.6 V.

$$R1 + R2 = R3$$

$$R3 \leq \frac{R5}{10} \text{ for small error in zero crossing}$$

Figure 9. Zero Crossing Detector (Single Supply)



$V_{in(min)} \approx 0.4\text{ V}$  peak for 1% phase distortion ( $\Delta\theta$ ).

Figure 10. Zero Crossing Detector (Split Supplies)

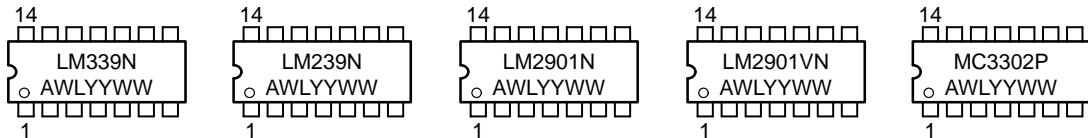
# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## ORDERING INFORMATION

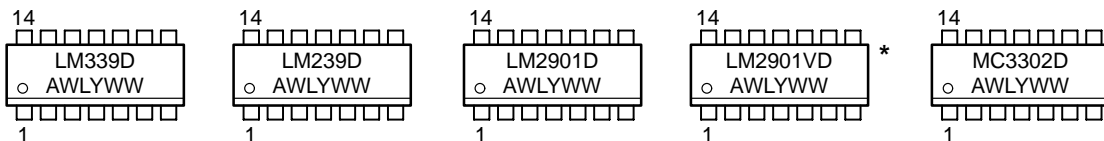
Device	Package	Shipping
LM239D	SO-14	55 Units/Rail
LM239DR2	SO-14	2500 Units/Tape & Reel
LM239DTBR2	TSSOP-14	2500 Units/Tape & Reel
LM239N	PDIP-14	25 Units/Rail
LM339D	SO-14	55 Units/Rail
LM339DR2	SO-14	2500 Units/Tape & Reel
LM339DTBR2	TSSOP-14	2500 Units/Tape & Reel
LM339N	PDIP-14	25 Units/Rail
LM2901D	SO-14	55 Units/Rail
LM2901DR2	SO-14	2500 Units/Tape & Reel
LM2901DTBR2	TSSOP-14	2500 Units/Tape & Reel
LM2901N	PDIP-14	25 Units/Rail
LM2901VD	SO-14	55 Units/Rail
LM2901VDR2	SO-14	2500 Units/Tape & Reel
LM2901VDTBR2	TSSOP-14	2500 Units/Tape & Reel
LM2901VN	PDIP-14	25 Units/Rail
NCV2901DR2	SO-14	2500 Units/Tape & Reel
MC3302D	SO-14	55 Units/Rail
MC3302DR2	SO-14	2500 Units/Tape & Reel
MC3302DTBR2	TSSOP-14	2500 Units/Tape & Reel
MC3302P	PDIP-14	25 Units/Rail

## MARKING DIAGRAMS

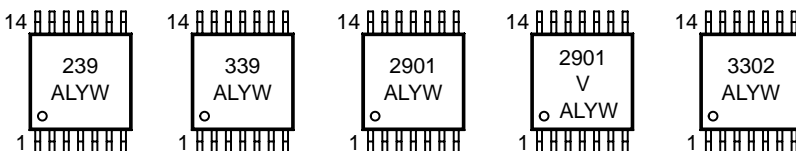
### PDIP-14 N, P SUFFIX CASE 646



### SO-14 D SUFFIX CASE 751A



### TSSOP-14 DTB SUFFIX CASE 948G



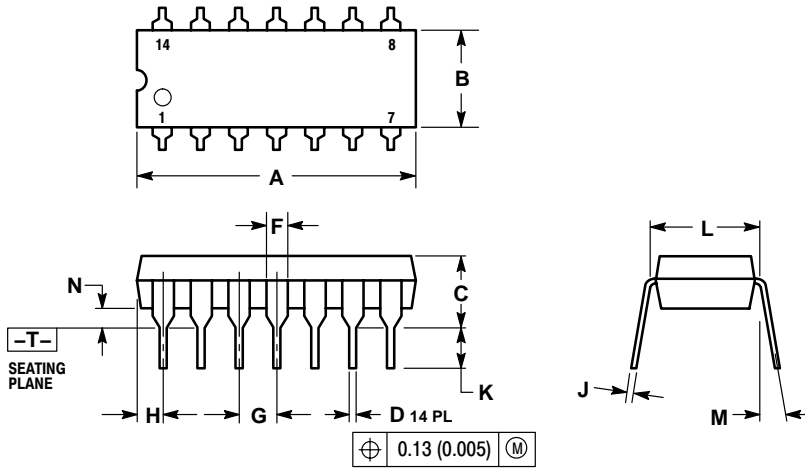
A = Assembly Location  
 WL, L = Wafer Lot  
 YY, Y = Year  
 WW, W = Work Week

\*This marking diagram also applies to NCV2901.

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## PACKAGE DIMENSIONS

PDIP-14  
P SUFFIX  
CASE 646-06  
ISSUE M

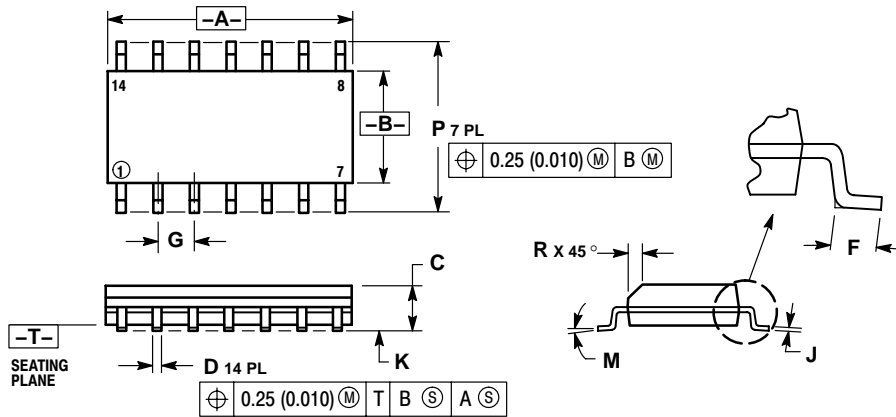


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	18.80
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.290	0.310	7.37	7.87
M	---	10°	---	10°
N	0.015	0.039	0.38	1.01

SO-14  
D SUFFIX  
CASE 751A-03  
ISSUE F



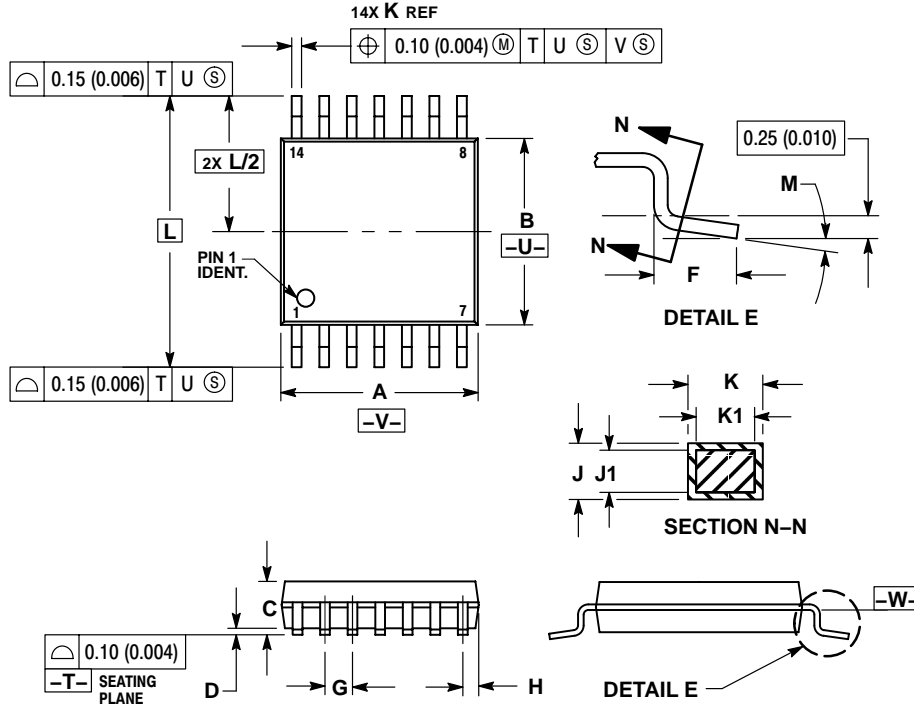
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS 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.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

PACKAGE DIMENSIONS

TSSOP-14  
DTB SUFFIX  
CASE 948G-01  
ISSUE O



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.50	0.60	0.020	0.024
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

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