

LM339, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302



ON Semiconductor®

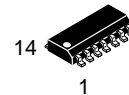
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Single Supply Quad Comparators

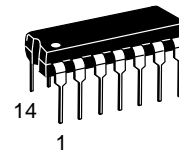
These comparators are designed for use in level detection, low-level sensing and memory applications in consumer, automotive, and industrial electronic applications.

Features

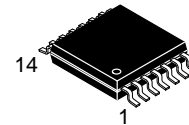
- Single Supply Operation: 3.0 V to 36 V
- Split Supply Operation: ± 1.5 V to ± 18 V
- Low Input Bias Current: 25 nA (Typ)
- Low Input Offset Current: ± 5.0 nA (Typ)
- Low Input Offset Voltage
- Input Common Mode Voltage Range to GND
- Low Output Saturation Voltage: 130 mV (Typ) @ 4.0 mA
- TTL and CMOS Compatible
- ESD Clamps on the Inputs Increase Reliability without Affecting Device Operation
- 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



SOIC-14
D SUFFIX
CASE 751A

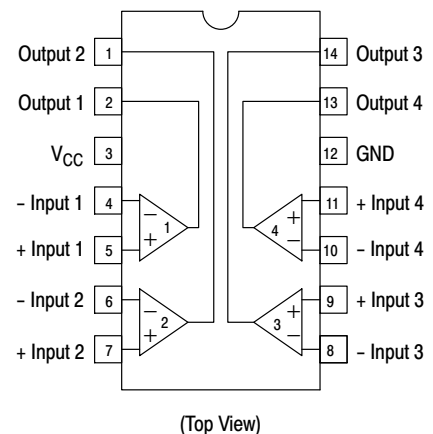


PDIP-14
N, P SUFFIX
CASE 646



TSSOP-14
DTB SUFFIX
CASE 948G

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

LM339, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302

MAXIMUM RATINGS

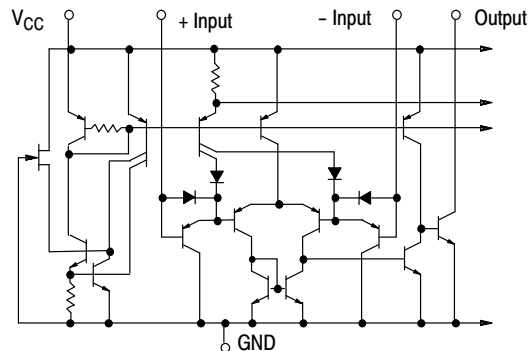
| Rating | Symbol | Value | Unit |
|--|----------------------------|--|---------------------------|
| Power Supply Voltage LM239/LM339, E/LM2901, E, V MC3302 | V_{CC} | +36 or ± 18 +30 or ± 15 | Vdc |
| Input Differential Voltage Range LM239/LM339, E/LM2901, E, V MC3302 | V_{IDR} | 36 30 | Vdc |
| Input 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°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, LM2901E LM2901V, NCV2901 LM339, LM339E | 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 | $^\circ\text{C}$ |

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.

- 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.

ESD RATINGS

| Rating | HBM | MM | Unit |
|---|------|-----|------|
| ESD Protection at any Pin (Human Body Model – HBM, Machine Model – MM) NCV2901 | 2000 | 200 | V |
| LM339E, LM2901E | 1500 | 200 | V |
| LM339DR2G, LM2901DR2G | 250 | 100 | V |
| All Other Devices | 1500 | 200 | V |



NOTE: Diagram shown is for 1 comparator.

Figure 1. Circuit Schematic

LM339, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302

ELECTRICAL CHARACTERISTICS (V_{CC} = +5.0 Vdc, T_A = +25°C, unless otherwise noted)

| Characteristic | Symbol | LM239/339/339E | | | LM2901/2901E/2901V /NCV2901 | | | MC3302 | | | Unit |
|--|-------------------|----------------|------------|-------------------------|--------------------------------|------------|-------------------------|--------|------------|-------------------------|------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage (Note 3) | V _{IO} | – | ±2.0 | ±5.0 | – | ±2.0 | ±7.0 | – | ±3.0 | ±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} | – | ±5.0 | ±50 | – | ±5.0 | ±50 | – | ±3.0 | ±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 = ∞ (For All Comparators) R _L = ∞, 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 ≥ 15 kΩ, 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 kΩ | – | – | 300 | – | – | 300 | – | – | 300 | – | ns |
| Response Time (Note 5) V _{RL} = 5.0 Vdc, R _L = 5.1 kΩ | – | – | 1.3 | – | – | 1.3 | – | – | 1.3 | – | μs |
| Output Sink Current V _I (–) ≥ +1.0 Vdc, V _I (+) = 0, V _O ≤ 1.5 Vdc | I _{Sink} | 6.0 | 16 | – | 6.0 | 16 | – | 6.0 | 16 | – | mA |
| Saturation Voltage V _I (–) ≥ +1.0 Vdc, V _I (+) = 0, I _{sink} ≤ 4.0 mA | V _{sat} | – | 130 | 400 | – | 130 | 400 | – | 130 | 500 | mV |
| Output Leakage Current V _I (+) ≥ +1.0 Vdc, V _I (–) = 0, V _O = +5.0 Vdc | I _{OL} | – | 0.1 | – | – | 0.1 | – | – | 0.1 | – | nA |

- (LM239) T_{low} = –25°C, T_{high} = +85°C
(LM339, LM339E) T_{low} = 0°C, T_{high} = +70°C
(MC3302) T_{low} = –40°C, T_{high} = +85°C
(LM2901), LM2901E T_{low} = –40°C, T_{high} = +105°C
(LM2901V & NCV2901) T_{low} = –40°C, T_{high} = +125°C
NCV2901 is qualified for automotive use.
- At the output switch point, V_O ≈ 1.4 Vdc, R_S ≤ 100 Ω 5.0 Vdc ≤ V_{CC} ≤ 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, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302

PERFORMANCE CHARACTERISTICS ($V_{CC} = +5.0$ Vdc, $T_A = T_{low}$ to T_{high} [Note 6])

| Characteristic | Symbol | LM239/339/339E | | | LM2901/2901E/2901V /NCV2901 | | | MC3302 | | | Unit |
|--|------------|----------------|-----|----------------|--------------------------------|-----|----------------|--------|-----|----------------|---------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage (Note 7) | V_{IO} | - | - | ± 9.0 | - | - | ± 15 | - | - | ± 40 | mVdc |
| Input Bias Current (Notes 7, 8) (Output in Analog Range) | I_{IB} | - | - | 400 | - | - | 500 | - | - | 1000 | nA |
| Input Offset Current (Note 7) | I_{IO} | - | - | ± 150 | - | - | ± 200 | - | - | ± 300 | nA |
| Input Common Mode Voltage Range | V_{ICMR} | 0 | - | $V_{CC} - 2.0$ | 0 | - | $V_{CC} - 2.0$ | 0 | - | $V_{CC} - 2.0$ | V |
| Saturation Voltage $V_{I(-)} \geq +1.0$ Vdc, $V_{I(+)} = 0$, $I_{sink} \leq 4.0$ mA | V_{sat} | - | - | 700 | - | - | 700 | - | - | 700 | mV |
| Output Leakage Current $V_{I(+)} \geq +1.0$ Vdc, $V_{I(-)} = 0$, $V_O = 30$ Vdc | I_{OL} | - | - | 1.0 | - | - | 1.0 | - | - | 1.0 | μ A |
| Differential Input Voltage All $V_I \geq 0$ Vdc | V_{ID} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | Vdc |

- (LM239) $T_{low} = -25^\circ\text{C}$, $T_{high} = +85^\circ$
(LM339, LM339E) $T_{low} = 0^\circ\text{C}$, $T_{high} = +70^\circ\text{C}$
(MC3302) $T_{low} = -40^\circ\text{C}$, $T_{high} = +85^\circ\text{C}$
(LM2901, LM2901E) $T_{low} = -40^\circ\text{C}$, $T_{high} = +105^\circ$
(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.

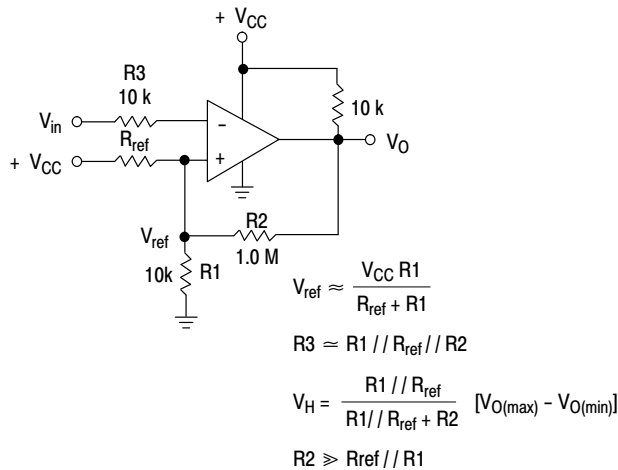


Figure 2. Inverting Comparator with Hysteresis

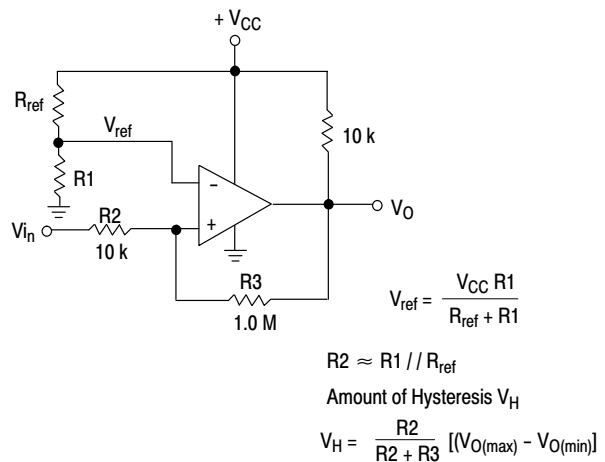


Figure 3. Noninverting Comparator with Hysteresis

Typical Characteristics

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

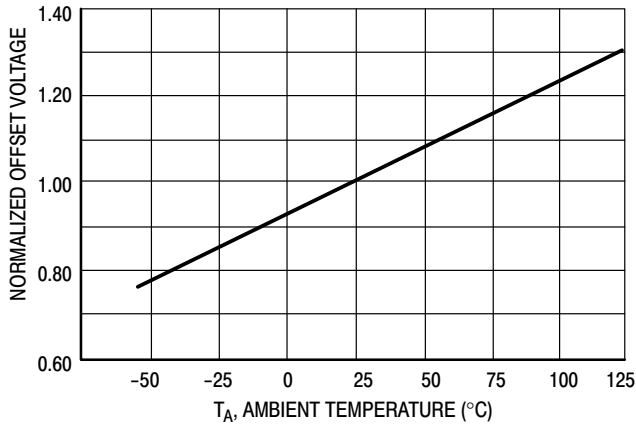


Figure 4. Normalized Input Offset Voltage

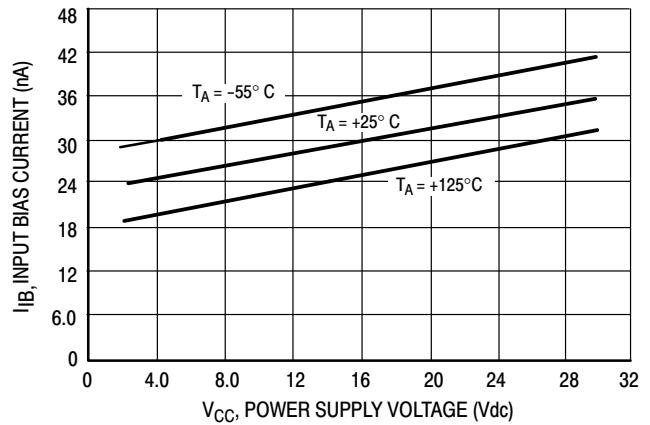


Figure 5. Input Bias Current

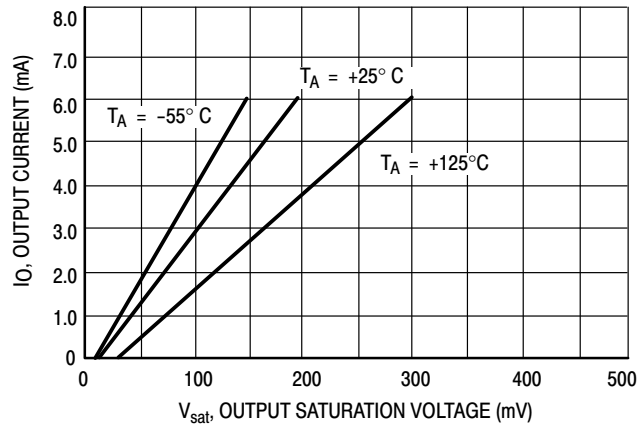
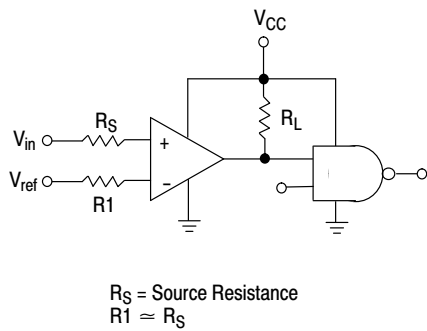


Figure 6. Output Sink Current versus Output Saturation Voltage



| Logic | Device | V_{CC} (V) | R_L k Ω |
|-------|-------------|--------------|------------------|
| CMOS | 1/4 MC14001 | +15 | 100 |
| TTL | 1/4 MC7400 | +5.0 | 10 |

Figure 7. Driving Logic

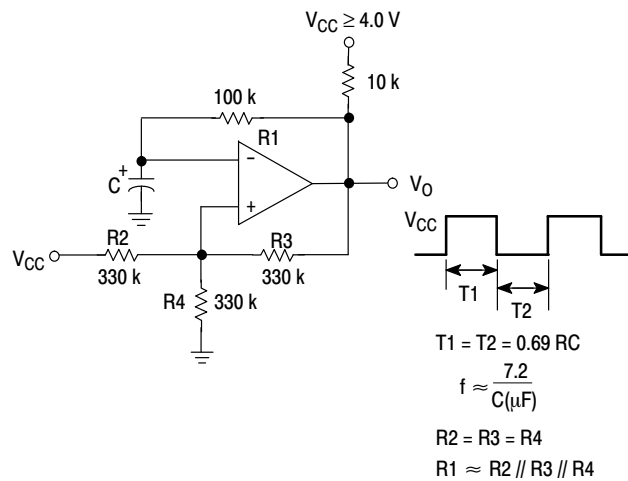


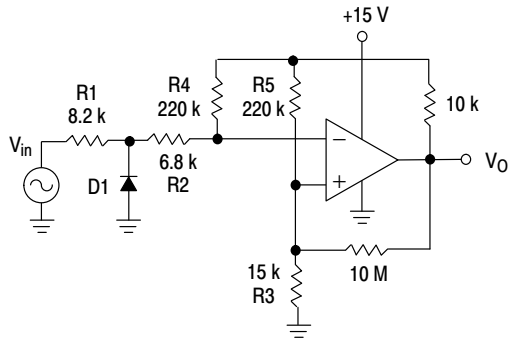
Figure 8. Squarewave Oscillator

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 mV should not be used.



D1 prevents input from going negative by more than 0.6 V.
 $R1 + R2 = R3$
 $R3 \leq \frac{R5}{10}$ for small error in zero crossing

Figure 9. Zero Crossing Detector (Single Supply)

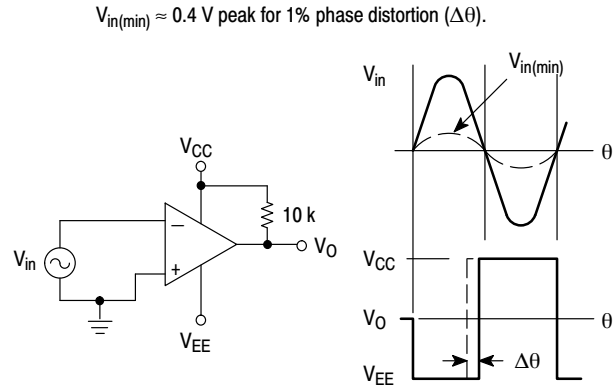


Figure 10. Zero Crossing Detector (Split Supplies)

LM339, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302

ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|--------------------|--------------------|
| LM239DG | SOIC-14 (Pb-Free) | 55 Units/Tube |
| LM239DR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM239DTBR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| LM239NG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| LM339DG | SOIC-14 (Pb-Free) | 55 Units/Tube |
| LM339DR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM339EDR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM339DTBR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| LM339NG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| LM2901DG | SOIC-14 (Pb-Free) | 55 Units/Rail |
| LM2901DR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM2901EDR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM2901DTBR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| LM2901NG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| LM2901VDG | SOIC-14 (Pb-Free) | 55 Units/Tube |
| LM2901VDR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| LM2901VDTBR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| LM2901VNG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| NCV2901DR2G* | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| NCV2901DTBR2G* | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| NCV2901CTR* | Bare Die | 6000 / Tape & Reel |
| MC3302DG | SOIC-14 (Pb-Free) | 55 Units/Tube |
| MC3302DR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| MC3302DTBR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| MC3302PG | PDIP-14 (Pb-Free) | 25 Units/Rail |

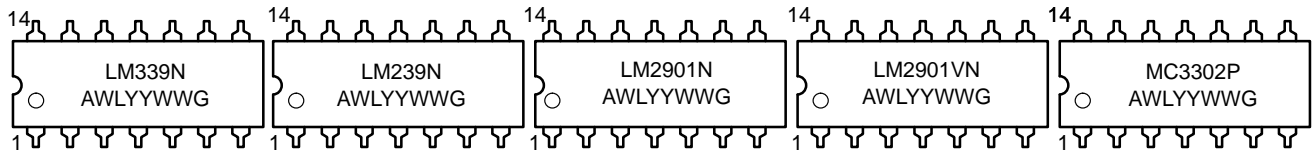
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

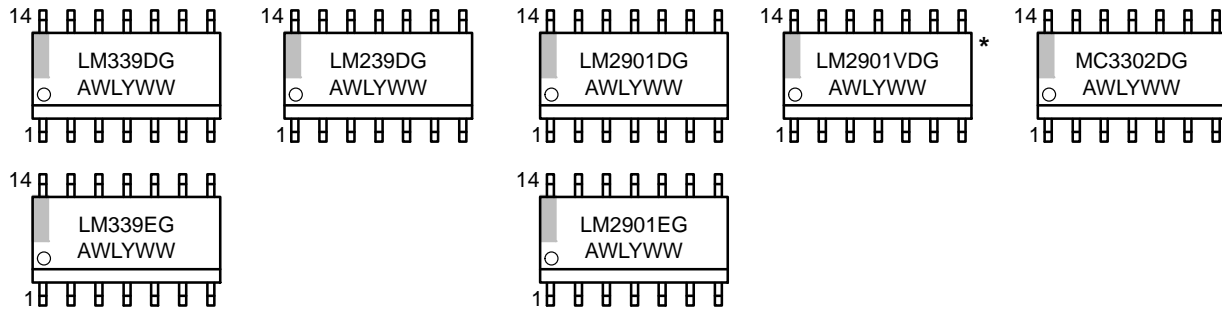
LM339, LM339E, LM239, LM2901, LM2901E, LM2901V, NCV2901, MC3302

MARKING DIAGRAMS

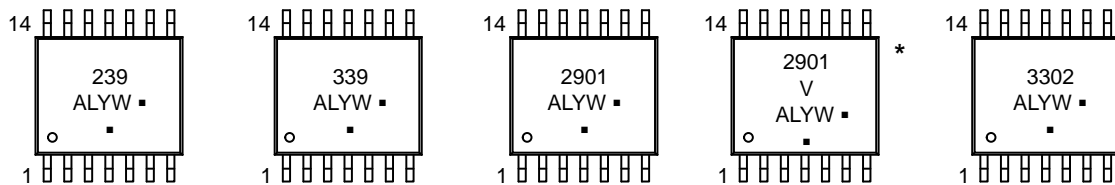
PDIP-14 N, P SUFFIX CASE 646



SOIC-14 D SUFFIX CASE 751A



TSSOP-14 DTB SUFFIX CASE 948G



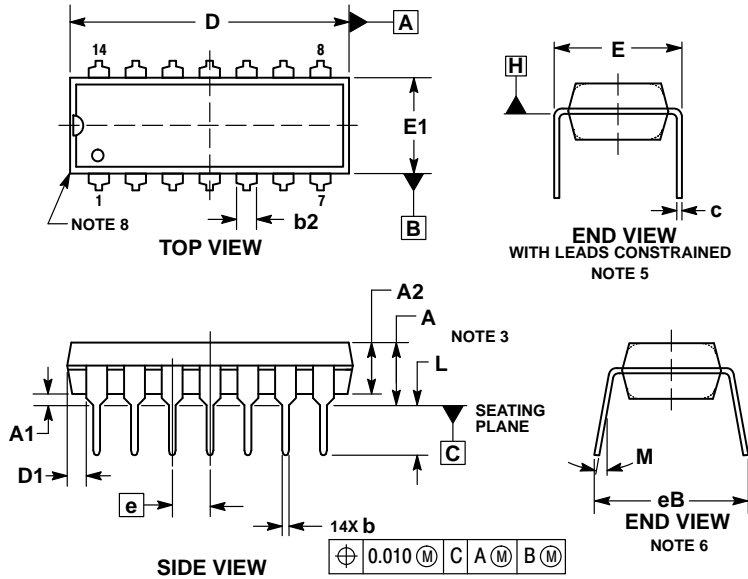
A = Assembly Location
 WL, L = Wafer Lot
 YY, Y = Year
 WW, W = Work Week
 G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

*This marking diagram also applies to NCV2901.

PACKAGE DIMENSIONS

PDIP-14
CASE 646-06
ISSUE S

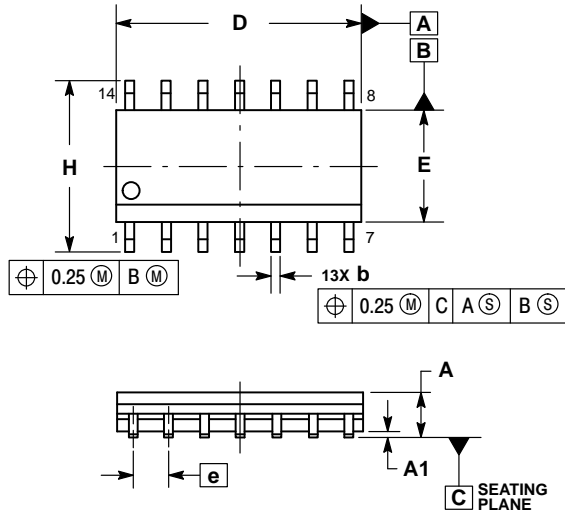


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
 2. CONTROLLING DIMENSION: INCHES.
 3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
 4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
 5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
 6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
 7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
 8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | ---- | 0.210 | ---- | 5.33 |
| A1 | 0.015 | ---- | 0.38 | ---- |
| A2 | 0.115 | 0.195 | 2.92 | 4.95 |
| b | 0.014 | 0.022 | 0.35 | 0.56 |
| b2 | 0.060 TYP | | 1.52 TYP | |
| C | 0.008 | 0.014 | 0.20 | 0.36 |
| D | 0.735 | 0.775 | 18.67 | 19.69 |
| D1 | 0.005 | ---- | 0.13 | ---- |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.280 | 6.10 | 7.11 |
| e | 0.100 BSC | | 2.54 BSC | |
| eB | ---- | 0.430 | ---- | 10.92 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |
| M | ---- | 10° | ---- | 10° |

PACKAGE DIMENSIONS

SOIC-14
CASE 751A-03
ISSUE K

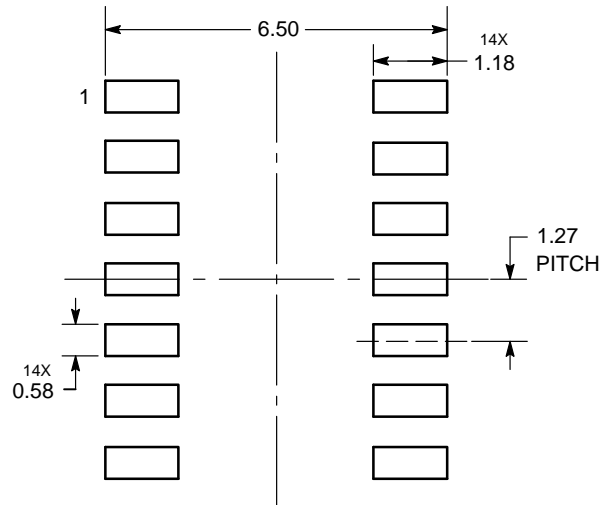


NOTES:

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° | |

SOLDERING FOOTPRINT*

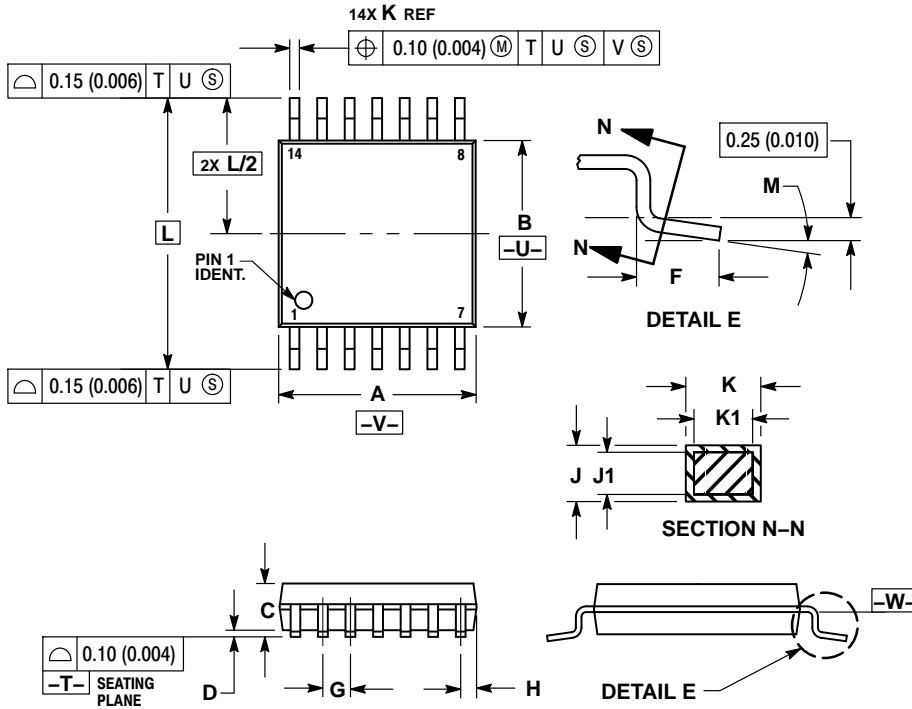


DIMENSIONS: MILLIMETERS

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

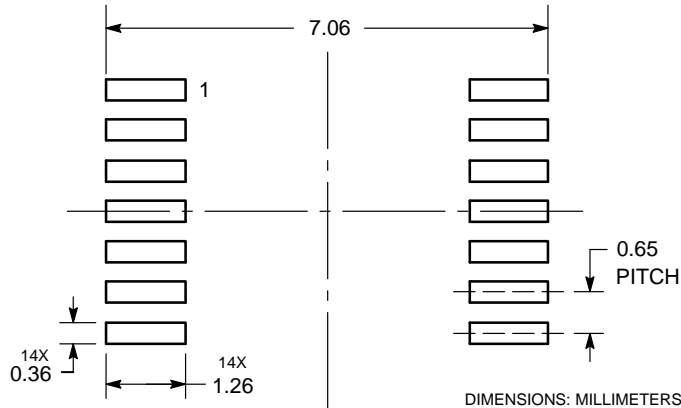
PACKAGE DIMENSIONS

TSSOP-14
CASE 948G
ISSUE B



- 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-.

SOLDERING FOOTPRINT



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