

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.

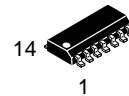
Features

- Single or Split Supply Operation
- 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 Site and Control Changes
- Pb-Free Packages are Available

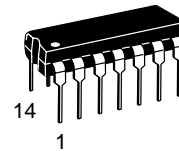


ON Semiconductor®

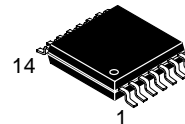
<http://onsemi.com>



SOIC-14
D SUFFIX
CASE 751A

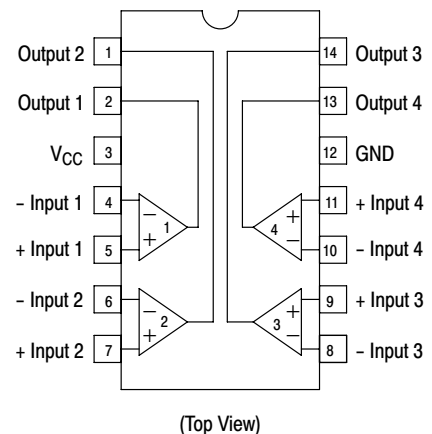


PDIP-14
N, P SUFFIX
CASE 646



TSSOP-14
DTB SUFFIX
CASE 948G

PIN CONNECTIONS



ORDERING INFORMATION

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

DEVICE MARKING INFORMATION

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

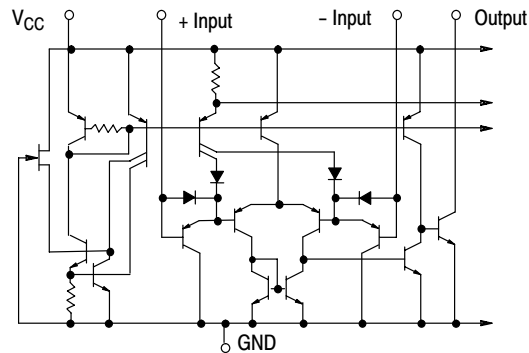
LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|--------------------------------|--|---------------------------|
| Power Supply Voltage LM239/LM339/LM2901, V MC3302 | V_{CC} | +36 or ± 18 +30 or ± 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°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 (Note 2) Human Body Model Machine Model | V_{ESD} | 1500 200 | 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.

- 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.
- V_{ESD} rating for NCV/SC devices is: Human Body Model – 2000 V; Machine Model – 200 V.



NOTE: Diagram shown is for 1 comparator.

Figure 1. Circuit Schematic

LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

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 4) | V_{IO} | – | ± 2.0 | ± 5.0 | – | ± 2.0 | ± 7.0 | – | ± 3.0 | ± 20 | mVdc |
| Input Bias Current (Notes 4, 5) (Output in Analog Range) | I_{IB} | – | 25 | 250 | – | 25 | 250 | – | 25 | 500 | nA |
| Input Offset Current (Note 4) | 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 $R_L = \infty$ (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 Ω , $V_{CC} = 15$ 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 Ω | – | – | 300 | – | – | 300 | – | – | 300 | – | ns |
| Response Time (Note 6) $V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k Ω | – | – | 1.3 | – | – | 1.3 | – | – | 1.3 | – | μs |
| 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 |

3. (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.
4. At the output switch point, $V_O \approx 1.4$ 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).
5. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
6. 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 $(V_{CC} = +5.0 \text{ Vdc}, T_A = T_{low} \text{ to } T_{high} \text{ [Note 7]})$

| Characteristic | Symbol | LM239/339 | | | LM2901/2901V/ NCV2901 | | | MC3302 | | | Unit |
|---|------------|-----------|-----|----------------|--------------------------|-----|----------------|--------|-----|----------------|---------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage (Note 8) | V_{IO} | - | - | ± 9.0 | - | - | ± 15 | - | - | ± 40 | mVdc |
| Input Bias Current (Notes 8, 9) (Output in Analog Range) | I_{IB} | - | - | 400 | - | - | 500 | - | - | 1000 | nA |
| Input Offset Current (Note 8) | 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 $V_{I(-)} \geq +1.0 \text{ Vdc}, V_{I(+)} = 0,$ $I_{sink} \leq 4.0 \text{ mA}$ | V_{sat} | - | - | 700 | - | - | 700 | - | - | 700 | mV |
| Output Leakage Current $V_{I(+)} \geq +1.0 \text{ Vdc}, V_{I(-)} = 0,$ $V_O = 30 \text{ Vdc}$ | I_{OL} | - | - | 1.0 | - | - | 1.0 | - | - | 1.0 | μA |
| Differential Input Voltage All $V_I \geq 0 \text{ Vdc}$ | V_{ID} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | Vdc |

7. (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.
8. At the output switch point, $V_O \approx 1.4 \text{ Vdc}, R_S \leq 100 \Omega, 5.0 \text{ Vdc} \leq V_{CC} \leq 30 \text{ Vdc}$, with the inputs over the full common mode range (0 Vdc to $V_{CC} - 1.5 \text{ Vdc}$).
9. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
10. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.

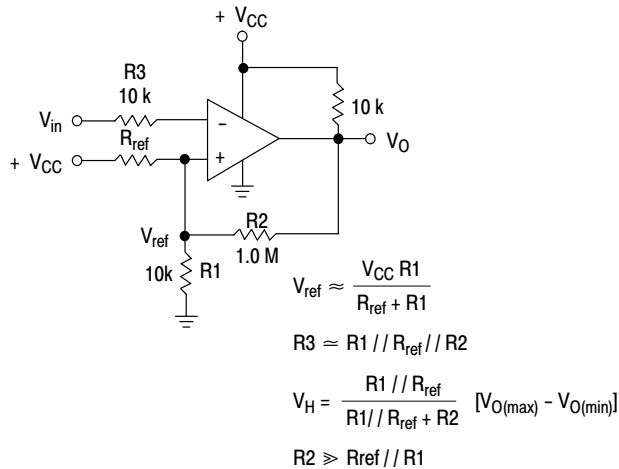


Figure 2. Inverting Comparator with Hysteresis

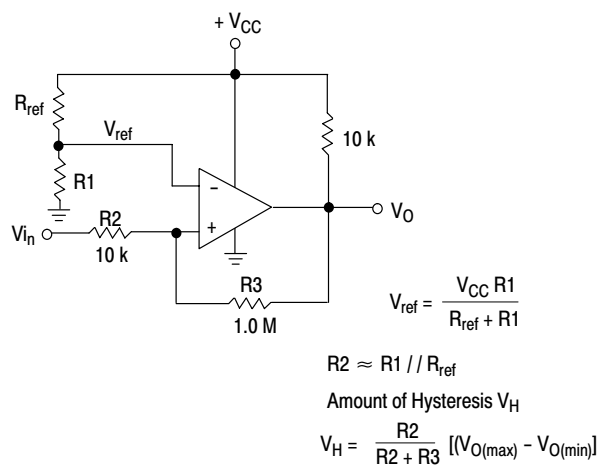


Figure 3. Noninverting Comparator with Hysteresis

Typical Characteristics

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

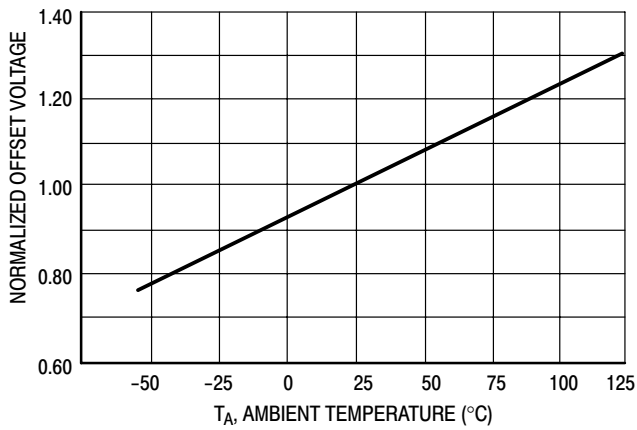


Figure 4. Normalized Input Offset Voltage

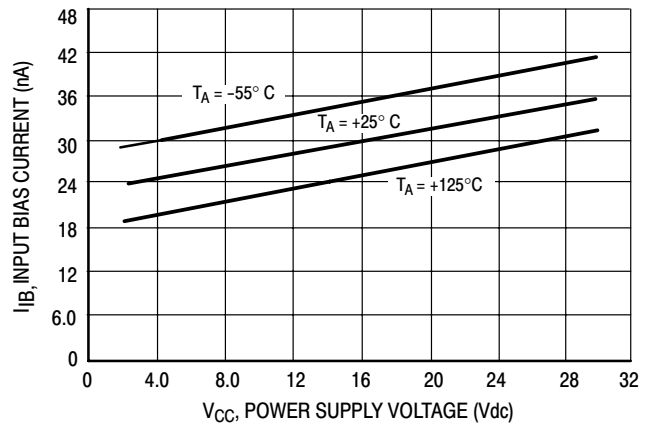


Figure 5. Input Bias Current

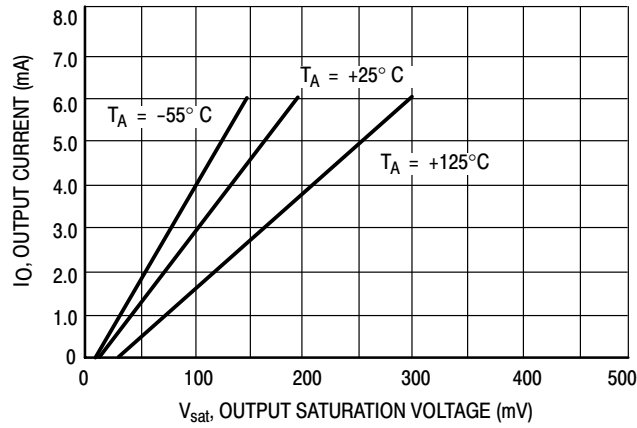
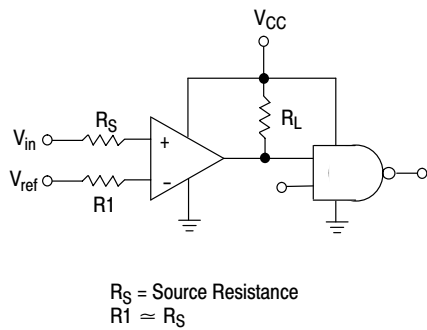


Figure 6. Output Sink Current versus Output Saturation Voltage



| 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

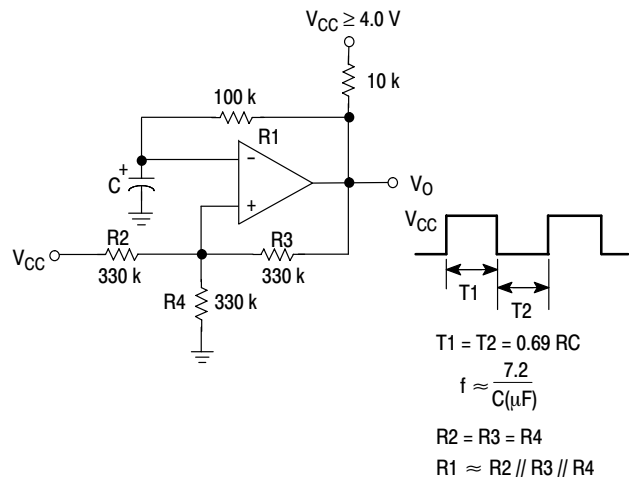


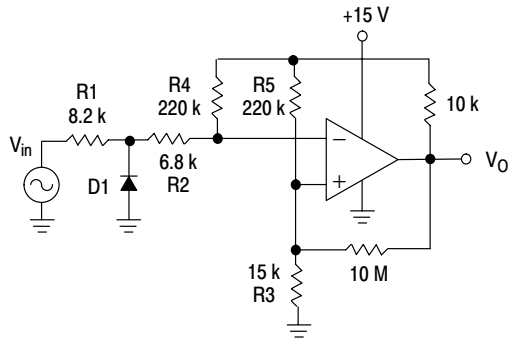
Figure 8. Squarewave Oscillator

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.

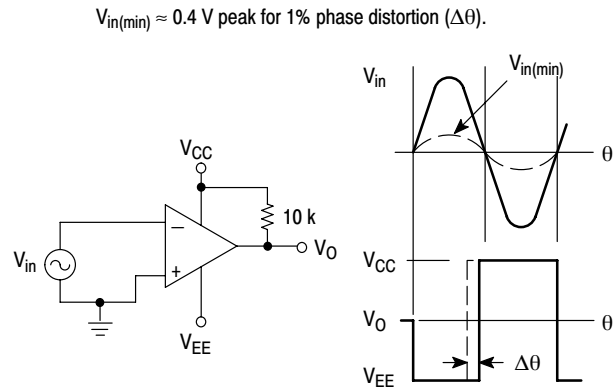


D1 prevents input from going negative by more than 0.6 V.

$$R1 + R2 = R3$$

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

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)

ORDERING INFORMATION

| Device | Package | Shipping† |
|-------------|-------------------|--------------------|
| LM239D | SOIC-14 | 55 Units/Tube |
| LM239DG | SOIC-14 (Pb-Free) | |
| LM239DR2 | SOIC-14 | 2500 / Tape & Reel |
| LM239DR2G | SOIC-14 (Pb-Free) | |
| LM239DTBR2 | TSSOP-14* | |
| LM239DTBR2G | TSSOP-14* | |
| LM239N | PDIP-14 | 25 Units/Rail |
| LM239NG | PDIP-14 (Pb-Free) | |
| LM339D | SOIC-14 | 55 Units/Tube |
| LM339DG | SOIC-14 (Pb-Free) | |
| LM339DR2 | SOIC-14 | 2500 / Tape & Reel |
| LM339DR2G | SOIC-14 (Pb-Free) | |
| LM339DTBR2 | TSSOP-14* | |
| LM339DTBR2G | TSSOP-14* | |

†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.

*This package is inherently Pb-Free.

LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

ORDERING INFORMATION

| Device | Package | Shipping† |
|---------------|----------------------|--------------------|
| LM339N | PDIP-14 | 25 Units/Rail |
| LM339NG | PDIP-14 (Pb-Free) | |
| LM2901D | SOIC-14 | 55 Units/Rail |
| LM2901DG | SOIC-14 (Pb-Free) | |
| LM2901DR2 | SOIC-14 | 2500 / Tape & Reel |
| LM2901DR2G | SOIC-14 (Pb-Free) | |
| LM2901DTBR2 | TSSOP-14* | |
| LM2901DTBR2G | TSSOP-14* | |
| LM2901N | PDIP-14 | |
| LM2901NG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| LM2901VD | SOIC-14 | 55 Units/Tube |
| LM2901VDG | SOIC-14 (Pb-Free) | |
| LM2901VDR2 | SOIC-14 | 2500 / Tape & Reel |
| LM2901VDR2G | SOIC-14 (Pb-Free) | |
| LM2901VDTBR2 | TSSOP-14* | |
| LM2901VDTBR2G | TSSOP-14* | |
| LM2901VN | PDIP-14 | |
| LM2901VNG | PDIP-14 (Pb-Free) | 25 Units/Rail |
| NCV2901DR2 | SOIC-14 | 2500 / Tape & Reel |
| NCV2901DR2G | SOIC-14 (Pb-Free) | |
| NCV2901DTBR2G | TSSOP-14* | |
| NCV2901CTR | Bare Die | 6000 / Tape & Reel |
| MC3302D | SOIC-14 | 55 Units/Tube |
| MC3302DG | SOIC-14 (Pb-Free) | |
| MC3302DR2 | SOIC-14 | 2500 / Tape & Reel |
| MC3302DR2G | SOIC-14 (Pb-Free) | |
| MC3302DTBR2 | TSSOP-14* | |
| MC3302DTBR2G | TSSOP-14* | |
| MC3302P | PDIP-14 | |
| MC3302PG | PDIP-14 (Pb-Free) | 25 Units/Rail |

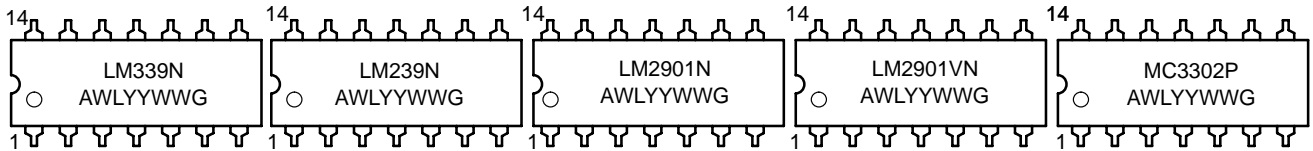
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*This package is inherently Pb-Free.

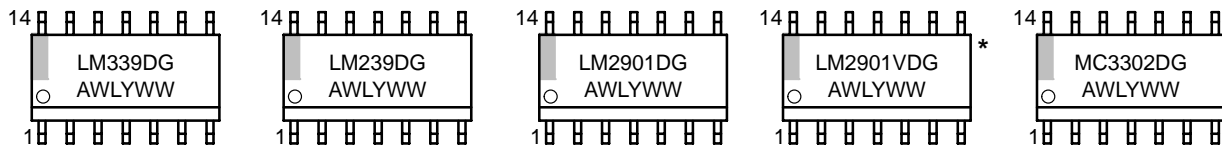
LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

MARKING DIAGRAMS

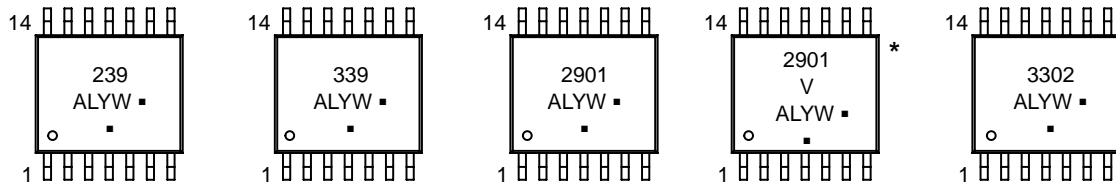
PDIP-14 N, P SUFFIX CASE 646



SOIC-14 D SUFFIX CASE 751A



TSSOP-14 DTB SUFFIX CASE 948G



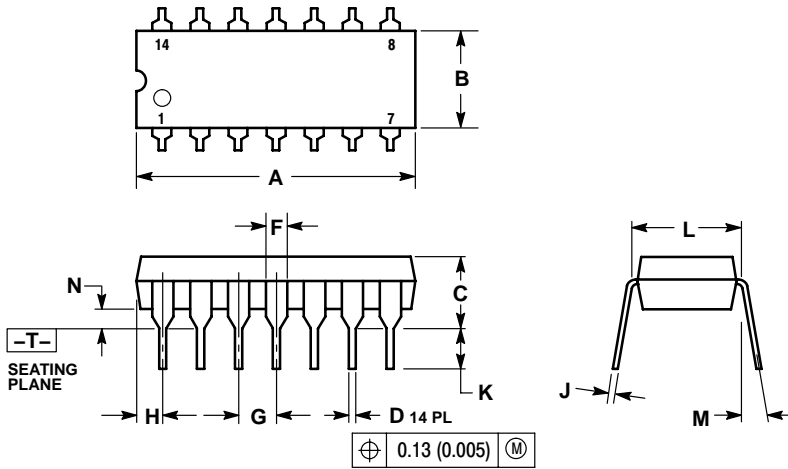
A = Assembly Location
 WL, L = Wafer Lot
 YY, Y = Year
 WW, W = Work Week
 G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

*This marking diagram also applies to NCV2901.

PACKAGE DIMENSIONS

PDIP-14
CASE 646-06
ISSUE P



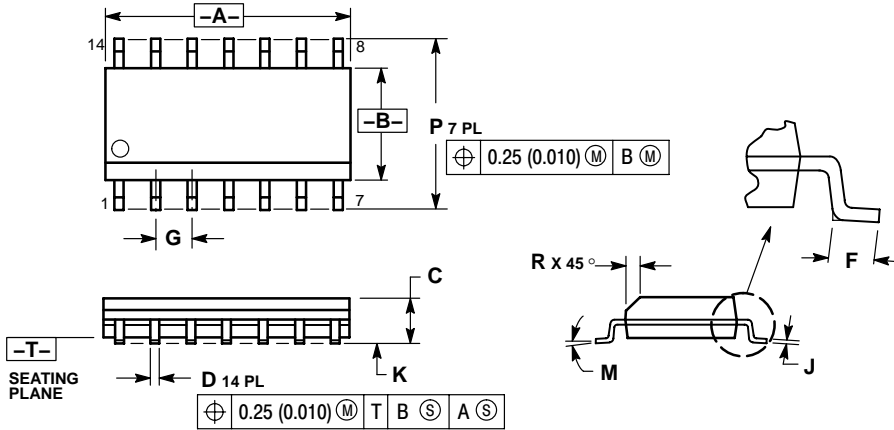
NOTES:

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 | 19.56 |
| 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 |

PACKAGE DIMENSIONS

SOIC-14
CASE 751A-03
ISSUE H

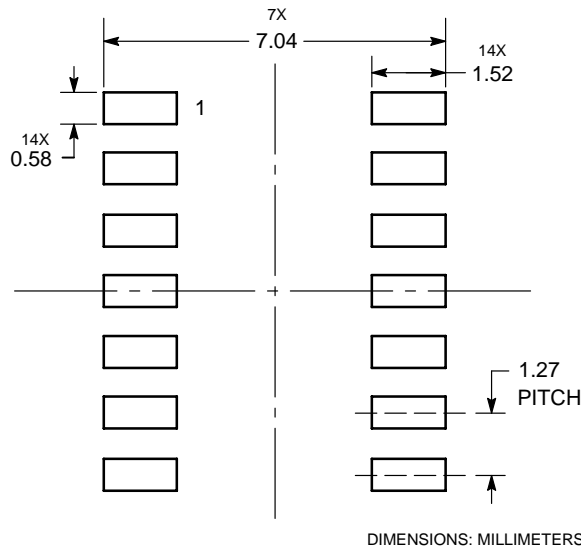


NOTES:

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 |

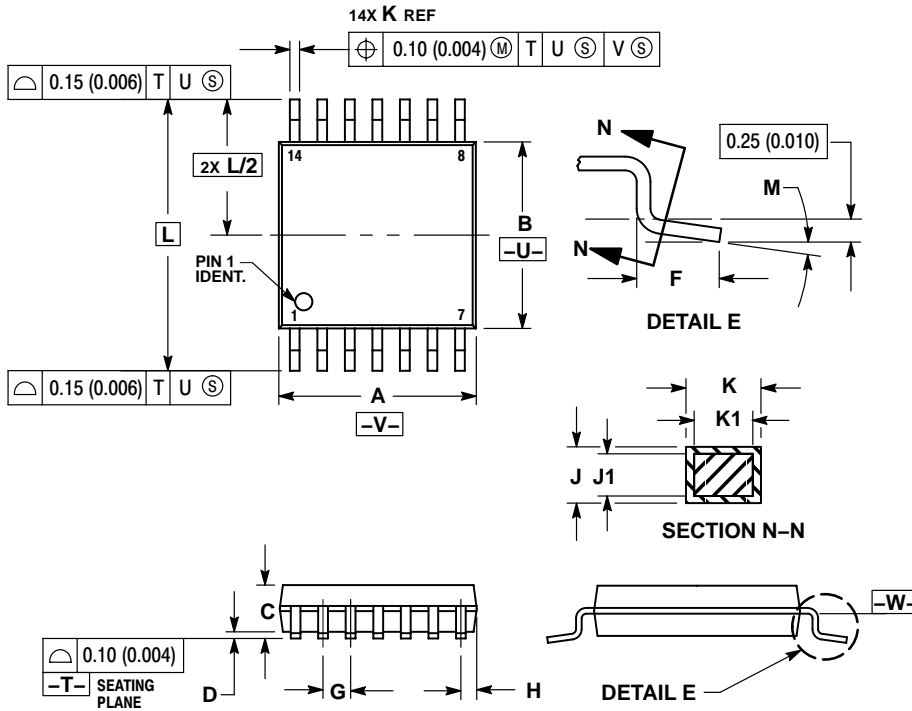
SOLDERING FOOTPRINT*



*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

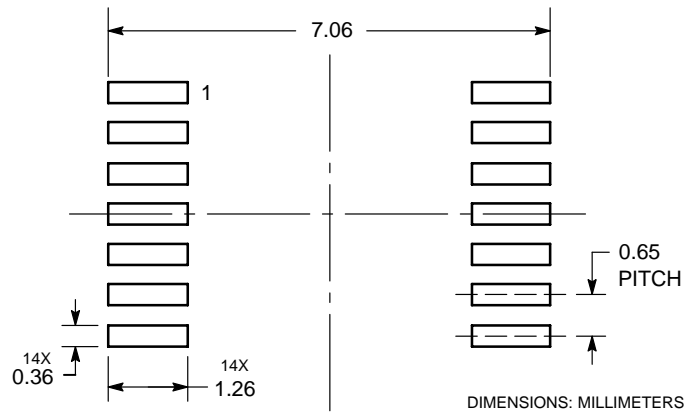
TSSOP-14
CASE 948G-01
ISSUE B



- 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 -V-.


| 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° | |

SOLDERING FOOTPRINT*



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

LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

ON Semiconductor and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5773-3850

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>
For additional information, please contact your local
Sales Representative