# 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**

- Pb-Free Packages are Available\*
- 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

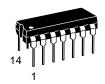


# ON Semiconductor®

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SOIC-14 D SUFFIX CASE 751A

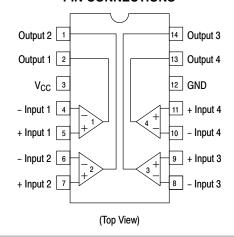


PDIP-14 N, P SUFFIX CASE 646



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.

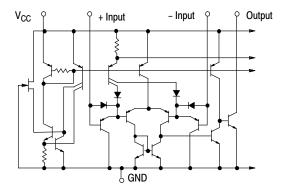
<sup>\*</sup>For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### **MAXIMUM RATINGS**

Ra	iting	Symbol	Value	Unit
Power Supply Voltage	LM239/LM339/LM2901, V MC3302	V <sub>CC</sub>	+36 or ±18 +30 or ±15	Vdc
Input Differential Voltage Range	LM239/LM339/LM2901, V MC3302	V <sub>IDR</sub>	36 30	Vdc
Input Common Mode Voltage Range		V <sub>ICMR</sub>	–0.3 to V <sub>CC</sub>	Vdc
Output Short Circuit to Ground (Note 1)		I <sub>sc</sub>	Continuous	
Power Dissipation @ T <sub>A</sub> = 25°C Plastic Package Derate above 25°C		P <sub>D</sub> 1/R <sub>θJA</sub>	1.0 8.0	W mW/°C
Junction Temperature		T <sub>J</sub>	150	°C
Operating Ambient Temperature Range	LM239 MC3302 LM2901 LM2901V, NCV2901 LM339	TA	-25 to +85 -40 to +85 -40 to +105 -40 to +125 0 to +70	°C
Storage Temperature Range		T <sub>stg</sub>	-65 to +150	°C
ESD Protection at any Pin Human Body Model Machine Model		V <sub>esd</sub>	2000 200	V

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, 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<sub>CC</sub>. Output short circuits to V<sub>CC</sub> can cause excessive heating and eventual destruction.



NOTE: Diagram shown is for 1 comparator.

Figure 1. Circuit Schematic

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

	(466 = 13.		M239/33		LM	2901/290 NCV290	)1V/		MC3302		
Characteristic	Symbol	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit
Input Offset Voltage (Note 3)	V <sub>IO</sub>	-	±2.0	±5.0	-	±2.0	±7.0	-	±3.0	±20	mVdc
Input Bias Current (Notes 3, 4)	I <sub>IB</sub>	-	25	250	-	25	250	_	25	500	nA
(Output in Analog Range)											
Input Offset Current (Note 3)	I <sub>IO</sub>	-	±5.0	±50	-	±5.0	±50	_	±3.0	±100	nA
Input Common Mode Voltage Range	V <sub>ICMR</sub>	0	_	V <sub>CC</sub> -1.5	0	-	V <sub>CC</sub> –1.5	0	-	V <sub>CC</sub> -1.5	V
Supply Current	Icc										mA
$R_L = \infty$ (For All Comparators)		_	0.8	2.0	_	0.8	2.0	_	0.8	2.0	
$R_L = \infty$ , $V_{CC} = 30 \text{ Vdc}$		_	1.0	2.5	_	1.0	2.5	_	1.0	2.5	
Voltage Gain	A <sub>VOL</sub>	50	200	-	25	100	_	25	100	-	V/mV
$R_L \ge 15 \text{ k}\Omega, V_{CC} = 15 \text{ Vdc}$											
Large Signal Response Time	-	-	300	-	-	300	_	_	300	-	ns
$V_I = TTL Logic Swing,$											
$V_{ref} = 1.4 \text{ Vdc}, V_{RL} = 5.0 \text{ Vdc},$											
$R_L = 5.1 \text{ k}\Omega$											
Response Time (Note 5)	-	-	1.3	-	-	1.3	_	_	1.3	-	μS
$V_{RL}$ = 5.0 Vdc, $R_L$ = 5.1 k $\Omega$											
Output Sink Current	I <sub>Sink</sub>	6.0	16	-	6.0	16	_	6.0	16	-	mA
$V_{I}(-) \ge +1.0 \text{ Vdc}, V_{I}(+) = 0,$ $V_{O} \le 1.5 \text{ Vdc}$											
Saturation Voltage	V <sub>sat</sub>	-	130	400	-	130	400	_	130	500	mV
$V_I(-) \ge +1.0 \text{ Vdc}, V_I(+) = 0,$ $I_{sink} \le 4.0 \text{ mA}$											
Output Leakage Current	I <sub>OL</sub>	-	0.1	-	-	0.1	_	_	0.1	-	nA
$V_I(+) \ge +1.0 \text{ Vdc}, V_I(-) = 0,$ $V_O = +5.0 \text{ Vdc}$											

<sup>2. (</sup>LM239)  $T_{low} = -25^{\circ}C$ ,  $T_{high} = +85^{\circ}$  (LM339)  $T_{low} = 0^{\circ}C$ ,  $T_{high} = +70^{\circ}C$  (MC3302)  $T_{low} = -40^{\circ}C$ ,  $T_{high} = +85^{\circ}C$  (LM2901)  $T_{low} = -40^{\circ}C$ ,  $T_{high} = +105^{\circ}C$  (LM2901V & NCV2901)  $T_{low} = -40^{\circ}C$ ,  $T_{high} = +125^{\circ}C$  (LM2901V & valified for automotive use.

3. At the output switch point,  $V_{O} \approx 1.4$  Vdc,  $R_{S} \le 100 \Omega$  5.0 Vdc  $\le V_{CC} \le 30$  Vdc, with the inputs over the full common mode range (0 Vdc to  $V_{CC} = 1.5$  Vdc)

V<sub>CC</sub> -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.

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

		LI	M239/3:	39		901/290 ICV290	-	ı	MC3302	2	
Characteristic	Symbol	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit
Input Offset Voltage (Note 7)	V <sub>IO</sub>	_	_	±9.0	_	-	±15	_	-	±40	mVdc
Input Bias Current (Notes 7, 8)	I <sub>IB</sub>	-	-	400	-	-	500	_	-	1000	nA
(Output in Analog Range)											
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>sat</sub>	-	_	700	-	-	700	_	-	700	mV
$V_{I}(-) \ge +1.0 \text{ Vdc}, V_{I}(+) = 0,$ $I_{sink} \le 4.0 \text{ mA}$											
Output Leakage Current	I <sub>OL</sub>	_	_	1.0	_	_	1.0	_	_	1.0	μΑ
$V_I(+) \ge +1.0 \text{ Vdc}, V_I(-) = 0,$ $V_O = 30 \text{ Vdc}$											
Differential Input Voltage	$V_{ID}$	-	_	V <sub>CC</sub>	-	-	V <sub>CC</sub>	_	-	V <sub>CC</sub>	Vdc
All V <sub>I</sub> ≥ 0 Vdc											

- 6. (LM239) T<sub>low</sub> = -25°C, T<sub>high</sub> = +85° (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° (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,  $V_O \approx 1.4$  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).
- 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.

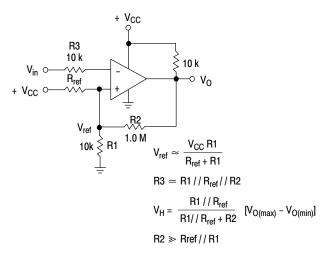


Figure 2. Inverting Comparator with Hysteresis

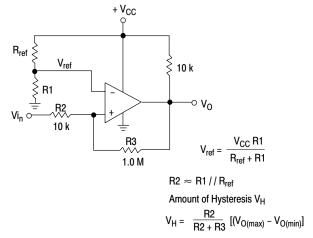
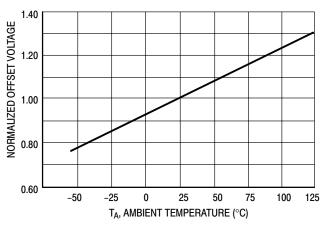


Figure 3. Noninverting Comparator with Hysteresis

# **Typical Characteristics**

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



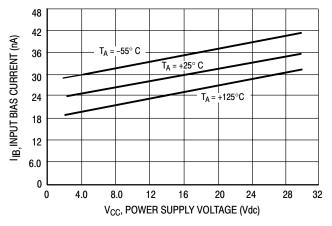


Figure 4. Normalized Input Offset Voltage

Figure 5. Input Bias Current

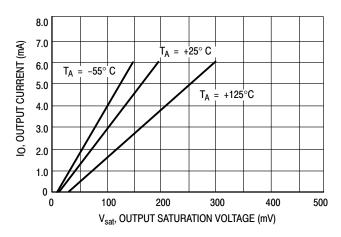
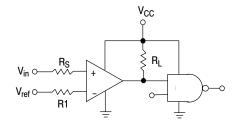


Figure 6. Output Sink Current versus
Output Saturation Voltage



 $R_S$  = Source Resistance  $R_1 \simeq R_S$ 

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

Figure 7. Driving Logic

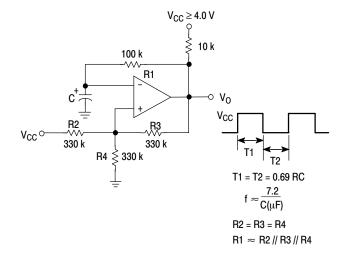


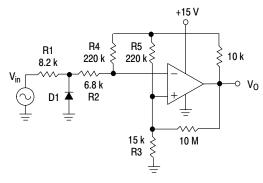
Figure 8. Squarewave Oscillator

# **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 k $\Omega$  should be used. The

addition of positive feedback (< 10 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)

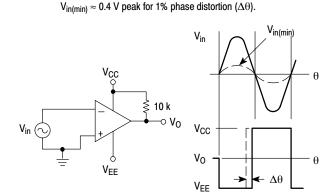


Figure 10. Zero Crossing Detector (Split Supplies)

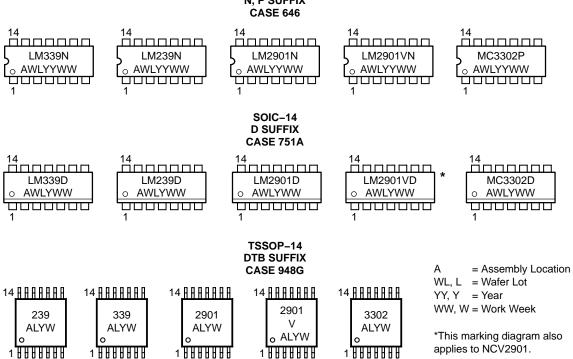
# **ORDERING INFORMATION**

Device	Package	Shipping <sup>†</sup>
LM239D	SOIC-14	55 Units/Rail
LM239DG	SOIC-14	55 Units/Rail
	(Pb-Free)	
LM239DR2	SOIC-14	2500 Units/Tape & Reel
LM239DR2G	SOIC-14 (Pb-Free)	2500 Units/Tape & Reel
LM239DTBR2	TSSOP-14	2500 Unito/Tong & Dool
LIVIZ39D1BRZ	(Pb-Free)	2500 Units/Tape & Reel
LM239N	PDIP-14	25 Units/Rail
LM239NG	PDIP-14	25 Units/Rail
	(Pb-Free)	
LM339D	SOIC-14	55 Units/Rail
LM339DG	SOIC-14	55 Units/Rail
	(Pb-Free)	
LM339DR2	SOIC-14	2500 Units/Tape & Reel
LM339DR2G	SOIC-14 (Pb-Free)	2500 Units/Tape & Reel
LM339DTBR2	TSSOP-14	2500 Units/Tape & Reel
LWOODFBRE	(Pb-Free)	2500 Office Tape & Neel
LM339N	PDIP-14	25 Units/Rail
LM339NG	PDIP-14	25 Units/Rail
	(Pb-Free)	
LM2901D	SOIC-14	55 Units/Rail
LM2901DR2	SOIC-14	2500 Units/Tape & Reel
LM2901DR2G	SOIC-14 (Pb-Free)	2500 Units/Tape & Reel
LM2901DTBR2	TSSOP-14	2500 Units/Tape & Reel
	(Pb-Free)	
LM2901N	PDIP-14	25 Units/Rail
LM2901NG	PDIP-14 (Pb-Free)	25 Units/Rail
LM2901VD	SOIC-14	55 Units/Rail
LM2901VDG	SOIC-14	55 Units/Rail
2.0.2001.000	(Pb-Free)	oo omorran
LM2901VDR2	SOIC-14	2500 Units/Tape & Reel
LM2901VDR2G	SOIC-14 (Pb-Free)	2500 Units/Tape & Reel
LM2901VDTBR2	TSSOP-14 (Pb-Free)	2500 Units/Tape & Reel
LM2901VN	PDIP-14	25 Units/Rail
NCV2901DR2	SOIC-14	2500 Units/Tape & Reel
NCV2901DR2G	SOIC-14	2500 Units/Tape & Reel
	(Pb-Free)	
MC3302D	SOIC-14	55 Units/Rail
MC3302DR2	SOIC-14	2500 Units/Tape & Reel
MC3302DTBR2	TSSOP-14 (Pb-Free)	2500 Units/Tape & Reel
MC3302P	PDIP-14	25 Units/Rail

<sup>†</sup>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.

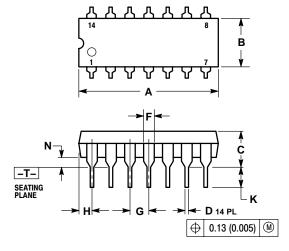
# **MARKING DIAGRAMS**

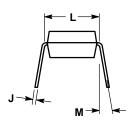
PDIP-14 N, P SUFFIX CASE 646



# **PACKAGE DIMENSIONS**

# PDIP-14 **P SUFFIX** CASE 646-06 ISSUE M





- 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- 114-3M, 1962.

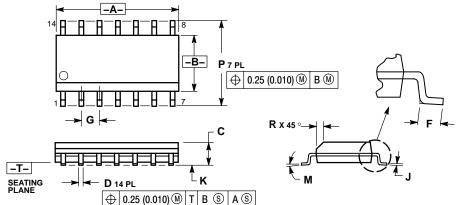
  CONTROLLING DIMENSION: INCH.

  DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL

  DIMENSION B DOES NOT INCLUDE MOLD FLASH.
- 5. ROUNDED CORNERS OPTIONAL.

	INC	HES	MILLIN	IETERS
DIM	MIN	MAX	MIN	MAX
Α	0.715	0.770	18.16	18.80
В	0.240	0.260	6.10	6.60
С	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
Н	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

# SOIC-14 **D SUFFIX** CASE 751A-03 ISSUE G

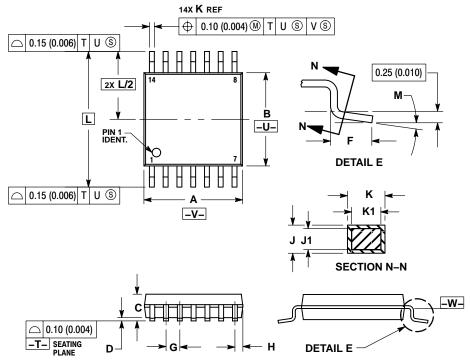


- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE
  DAMBAR PROTRUSION. ALLOWABLE
  DAMBAR PROTRUSION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

	MILLIN	IETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
Α	8.55	8.75	0.337	0.344
В	3.80	4.00	0.150	0.157
С	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
М	0 °	7°	0 °	7°
Р	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:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982. CONTROLLING DIMENSION: MILLIMETER.
- 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.
  DIMENSION B DOES NOT INCLUDE INTERLEAD
  FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
  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.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY
- DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-

	MILLIN	IETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
Α	4.90	5.10	0.193	0.200
В	4.30	4.50	0.169	0.177
С		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	0.65 BSC		BSC
Н	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
Ĺ	6.40		0.252 BSC	
M	0°	8°	0°	8°

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N. American Technical Support: 800-282-9855 Toll Free

Japan: ON Semiconductor, Japan Customer Focus Center 2-9-1 Kamimeguro, Meguro-ku, Tokyo, Japan 153-0051 Phone: 81-3-5773-3850

ON Semiconductor Website: http://onsemi.com

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